Torpedo Maculopathy: a Teaching Case Report

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Standardized Tests as Predictors of Success in Health Professions Education: a Scoping Review

Review of Standardized Testing in Doctoral Health Professions Admission Requirements

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CMV Retinitis: a Teaching Case Report  
Daniel Bastian, OD, FAAO, and Crystal Lewandowski, OD, FAAO | Optometric Education: Volume 47 Number 1 (Fall 2021)

**Background**

This case involves a 37-year-old Hispanic male who was diagnosed with cytomegalovirus (CMV) retinitis because of poorly controlled human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS). CMV retinitis is a full-thickness retinal necrosis resulting from reactivation of CMV, which is a common virus in humans and a member of the herpetic virus family. The virus manifests itself in the retina when a patient is immunocompromised from a disease such as HIV/AIDS. CMV retinitis is usually a unilateral disease but when left untreated can involve the fellow eye.

This teaching case report highlights the role of the primary care optometrist in the diagnosis and management of a patient with CMV retinitis while focusing on the importance of critical-thinking skills for accurate diagnosis and effective patient education. The current medical landscape for managing and treating HIV/AIDS is much different compared with 30 years ago because of the prevalence and use of antiretroviral medications. When antiretroviral medications are used in combination with one another, it is referred to as antiretroviral therapy (ART). ART has led to lower incidence rates of CMV, but timely diagnosis and management are still important for the primary care optometrist.

This case is appropriate for use with students who have a moderate level of patient care experience and knowledge in ocular disease. At most colleges, it would be appropriate for fourth-year optometry students and resident candidates.

**Case Description**

Patient HR, a 37-year-old Hispanic male, presented to a community health center eye clinic for a red-eye problem. He had been discharged recently after a 3-week hospital stay with instructions to establish eye care at the health center. HR reported redness and blurry vision in both eyes as his chief complaint. He stated that he drives a car for work and was having difficulty seeing while driving. HR stated that while in the hospital he was examined by an on-call eye doctor who told him that he had an infection inside his eye and needed to take medication for the infection. HR also said he had noticed floaters in both eyes but had not noticed flashes or a shadow over his side vision. HR was new to the eye clinic and denied any history of spectacle lens wear. He denied any previous ocular conditions and did not know when his eyes were last examined.

**Table 1.** Slit Lamp Findings at Initial Visit

<table>
<thead>
<tr>
<th>Lids/Lashes</th>
<th>Right Eye</th>
<th>Left Eye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conjunctiva</td>
<td>2 injection, diffuse, temporal and nasal</td>
<td>2 injection, diffuse, temporal and nasal</td>
</tr>
<tr>
<td>Cornea</td>
<td>1 keratic precipitates on endothelium and trace pigment cells on endothelium</td>
<td>2 keratic precipitates on endothelium</td>
</tr>
<tr>
<td>Anterior Chamber</td>
<td>3+ cells and flare</td>
<td>4+ cells and flare</td>
</tr>
<tr>
<td>Iris</td>
<td>flat</td>
<td>flat</td>
</tr>
<tr>
<td>Lens</td>
<td>clear</td>
<td>clear</td>
</tr>
<tr>
<td>Vitreous</td>
<td>1+ cells</td>
<td>2+ cells</td>
</tr>
</tbody>
</table>

Uncorrected distance visual acuity measured 20/40 in each eye, and uncorrected near visual acuity measured 20/25 in each eye. Pupils and extraocular muscles were normal. Finger-counting confrontation fields were full in the right eye but restricted in the nasal quadrant of the left eye. Intraocular pressure was 16 mmHg in each eye. See Table 1 for slit lamp findings and Figure 1 for fundus photographs.

HR was diagnosed with CMV retinitis in both eyes with active retinitis and retinal necrosis, left eye worse than right eye. He was shown his fundus photographs and educated about the seriousness of his conditions, which were life- and sight-threatening. HR was taken by ambulance to the ophthalmology department at a local eye hospital for immediate consultation.
Visit 2: same-day ophthalmology consult

At this visit, the diagnosis of CMV retinitis, left eye worse than right eye, was confirmed. HR received a 2-mg intravitreal injection of ganciclovir in the left eye based on the extent of the retinitis and proximity to the optic nerve. No injection was given in the right eye based on the extent and location of the retinitis. Topical prednisolone acetate was prescribed to be used four times per day in each eye. The patient was advised to accept admittance to the hospital for intravenous treatment and close monitoring, but he refused. Oral valganciclovir 900 mg twice a day was to be continued and he was to return in 3 days for further consultation.

Visit 3: 2-day follow-up

HR returned a day sooner than expected for follow-up because of concern with changes in his vision. At this time, he agreed to be admitted to the hospital and was started on 5 mg/kg of intravenous ganciclovir twice a day. He continued to receive prednisolone acetate eye drops twice a day in both eyes.

Visits 4-11

HR was examined eight more times over the course of 23 days. At visit five, the retinitis continued to regress in both eyes, and ART was initiated. Treatment for the opportunistic infection was continued. Following the initiation of ART, the level of ocular inflammation increased because of immune system recovery, a condition known as immune recovery uveitis (IRU). At subsequent visits the retinitis and opportunistic infection continued to regress (Figure 2).
Figure 2. Fundus photographs of the right eye and left eye following treatment, 9 months after the initial visit. Click to enlarge

Educator’s Guide

The Educator’s Guide includes the necessary information for teaching and discussing the case. The key concepts, learning objectives and discussion questions should guide the teaching of the information.

Key concepts

1. Managing patients diagnosed with HIV in the optometry office — lab markers, medications
2. Hallmark symptoms and signs of HIV retinopathy and CMV retinitis
3. Clinical course of HIV retinopathy and CMV retinitis
4. Critical thinking in diagnosis, using the optometry toolbox when extra testing is warranted
5. The role of communication from beginning to end of the exam; developing patient rapport and trust, thorough case history and patient education and reassurance
6. Understanding the HIV landscape, historical context and current public health status in the United States and globally

Learning objectives

At the conclusion of this case discussion, participants should be able to:

1. State how to elicit a comprehensive history for a patient with HIV in an optometry setting (i.e., lab values, current medications)
2. Describe the retinal findings seen in fundus photos
3. Describe the ocular signs and symptoms of CMV retinitis
4. Apply critical-thinking skills to correlate symptoms with clinical findings
5. Identify differential diagnoses that can present with similar findings to HIV retinopathy and CMV retinitis
6. Understand the critical role of communication, from being able to elicit patient’s concerns through a thorough case history to patient education
7. Describe additional testing that can be performed to confirm the diagnosis of CMV retinitis

Discussion questions

A. Knowledge, concepts, facts and information required for critical review of the case

1. Describe the classic signs and symptoms of CMV retinitis
2. Describe signs and symptoms of retinitis and how they differ from CMV retinitis
3. Determine the differential diagnosis in this case based on analysis of case history, risk factors and demographics
4. Describe the etiology and demographics of CMV retinitis
5. Discuss the general risk factors for CMV retinitis and compare them with the patient’s individual risk factors
6. Describe the testing performed to determine the diagnosis
7. Discuss the impact of CMV retinitis diagnosis on a patient’s life
8. Discuss management and expected prognosis
9. Discuss community health aspects as they impact care for patients with HIV
10. Discuss how barriers to care (patient education, access to care, cultural competencies) can impact progression or management of HIV and CMV retinitis

B. Differential diagnosis

1. What clinical findings were used in this case to diagnose CMV retinitis?
2. What were the differential diagnoses for the patient’s symptoms and how were the other hypotheses ruled out?
3. How were the clinical findings and information analyzed to rule out or support the potential differential diagnoses in this case?
4. What evidence or information is needed to diagnose CMV retinitis?
5. After analysis of the information, what is the best possible diagnosis at this time?
6. Is the diagnosis logical?
7. At this time, are there other diagnoses one should consider?
C. Patient management and the role of the primary care optometrist

1. What are appropriate management options?
2. What is an appropriate follow-up schedule?
3. What is the prognosis for a patient with CMV retinitis?
4. How does a patient’s mental or financial health influence the recommendations for follow-up?
5. What happens when symptoms worsen or do not improve?
6. What education should be given to patients diagnosed with CMV retinitis?
7. Discuss this patient’s reaction to diagnosis and how it affects the education provided and communication with the patient throughout the examination

D. Communication and doctor/patient relationship

1. Discuss the ethical and legal responsibilities of a provider in disclosing examination findings to a patient even if that information may increase patient stress
2. What are some strategies for reassuring patients at risk for irreversible vision loss as an outcome?
3. Use role-playing to simulate the delivery of the diagnosis and management
4. Identify the interactions where patient/doctor trust was established and lost
5. Discuss the interprofessional communication that facilitated or hindered care of this patient
6. Discuss the impact on family members or significant others given the diagnosis

E. Critical-thinking concepts

1. What inferences are made in the determination of the differential diagnoses?
2. What are the potential implications involving the management of this patient?
3. How might decision-making have changed if vision was not reduced?
4. How would management have been different if ophthalmology was not as easily accessible to the patient?
5. What is the role of empathy in this case?
6. What are some effective strategies when reassuring patients?
7. What impact do current breakthroughs in medical advances play for an optometrist?

Literature Review

HIV has extensive impact on the health and function of the eye. The impact of the virus on eye health is variable and gradient. The greater the immune system is compromised from increasing virus replication, the more significant the impact of the virus on the eye. Ocular involvement with HIV is most commonly due to opportunistic infection and neoplasms, but HIV microvasculopathy, which is called HIV retinopathy, also occurs. As the patient’s immune system tries to attack the virus, it causes damage to the vascular system in the body including the vascular system of the eye. The immune response causes immune complex deposition, increased plasma viscosity or invasion of vascular endothelium causing microvasculopathy and contributing to signs of retinopathy in the eye. Forty to sixty percent of HIV-positive patients demonstrate HIV retinopathy, which can include cotton-wool spots, intraretinal hemorrhages and microvascular changes such as microaneurysms and telangiectasia, during eye examinations.1

Virus replication contributes to further immune cell death, which shifts the balance between viral load and CD4 count in the body. Viral load, determined by a laboratory test, is the extent of virus present in the patient’s blood. The higher the viral load, the more the virus has replicated inside the patient. CD4 cells are part of the immune system and are targeted by HIV. As the viral load increases, the CD4 cell count decreases. If the CD4 count of a patient drops below 200 cells/µL, AIDS is diagnosed. As CD4 cells lower in a patient, other viruses that lie dormant and suppressed by the immune system can become active. A common opportunistic infection seen in HIV patients that has complications for the eye is CMV. CMV is a DNA herpes-class virus that is ubiquitous in humans.2 Within the United States, seroprevalence is estimated to be approximately 60% overall, and it rises with age, ranging from 36.3% in children ages 6-11 years to 90.8% in adults 80 years or older.2 Transmission requires contact with body fluids of individuals who are shedding the virus. Like other members of the herpesvirus family, CMV establishes latent infection after the resolution of acute (or primary) infection.3 Recurrence from latency occurs in patients who are immunocompromised. CMV infects the retina, central nervous system, reticuloendothelial system, kidneys, adrenal glands, lungs and gastrointestinal system.2

CMV retinitis occurs only in severely immunosuppressed patients, such as organ transplant recipients, patients who have malignancies or are receiving chemotherapy, and persons with HIV/AIDS.2-4 In patients with AIDS, CMV retinitis is the most common opportunistic ocular infection. CMV retinitis was first reported as a complication of AIDS in 1982. Prior to the availability of potent ART, CMV retinitis occurred in 21-44% percent of patients with AIDS, primarily in those with a CD4 T
lymphocyte count below 50 cells/µL. In early case series, patients who survived beyond 6 months without CMV-specific treatment became severely visually impaired or blind. The median time to progression of disease into previously uninvolved areas of the retina while on CMV-specific antiviral therapy was 47-104 days, mean survival after diagnosis was 6-10 months, and indefinite maintenance therapy was essential. Following the introduction of ART in 1996, the incidence of CMV retinitis declined sharply among patients with HIV/AIDS. Visual morbidity has also declined, with the rate of bilateral blindness (vision loss to 20/200 or worse) from CMV retinitis decreasing from 14.8/100 person-years in the pre-ART era to 0.4/100 person-years in the modern era.

ART is the use of at least three antiretroviral drugs to suppress HIV and stop progression of the disease. At least 25 antiretroviral medications in six different classes are available. The different classes are related to the life cycle of HIV. The HIV life cycle can be broken down into six steps: 1) entry (binding and fusion), 2) reverse transcription, 3) integration, 4) replication (transcription and translation), 5) assembly, and 6) budding and maturation. The identification and understanding of these processes have provided the basis for antiretroviral drug discovery. For most individuals, the ART regimen consists of a dual nucleoside combination plus a third agent from another class.

The exact pathogenesis of CMV retinitis is unknown, but many studies support the hypothesis that it results from the spread of CMV to the eye. Studies in transplant recipients and patients with AIDS indicate that CD4-dependent cytotoxic T lymphocyte activity of CMV antigen-specific CD8 T cells is critical for preventing CMV replication and end-organ disease. Impaired CD4 cell function or volume is the key immune deficit that allows uncontrolled CMV replication.

Clinical features

- Symptoms: Patients may complain of blurring or loss of central vision, scotoma, floaters or flashes of light. A complaint of floaters or photopsia is the single most powerful symptomatic predictor of CMV retinitis in an AIDS patient. Acute loss of vision can occur if retinitis leads to retinal detachment.
- Retinal lesions: CMV retinitis appears as areas of full-thickness retinal necrosis and edema. Yellow-white, fluffy or granular retinal lesions are often located close to retinal vessels and associated with retinal hemorrhages. There are several recognized patterns of CMV retinitis: wedge-shaped areas of whitening with associated hemorrhage (“brush fire”), variable small dot-like lesions (granular type), or, rarely, retinal vasculitis with perivascular sheathing. Lesions can be described as “fulminant and edematous” vs. “indolent and granular” based on several factors, including the degree of retinal whitening, retinal hemorrhage, and lesion shape and location.
- Other: CMV retinitis typically begins in the peripheral retina and progresses centrifugally toward the posterior pole.

Diagnosis and testing

CMV retinitis is generally diagnosed on the basis of characteristic retinal changes. These retinal changes include the degree of retinal opacification, degree of retinal hemorrhages and location. CMV viremia detected by polymerase chain reaction (PCR), antigen assays or blood culture are not used to make a diagnosis of CMV retinitis because these tests have poor sensitivity and specificity for end-organ disease. Careful case history, clinical appearance, appropriate lab testing and auxiliary testing will help differentiate among other forms of retinal disease.

- Smoldering retinitis and subtle reactivation may be difficult to recognize without examining serial fundus photographs. Several studies have shown that wide-angle fundus photographs are a more sensitive indicator of retinitis progression than clinical examination.
- Humphrey visual field testing may reveal scotomas in the areas of retinal necrosis. Scotomas are potentially noticeable on confrontation fields, as in this case.
- Optical coherence tomography does not provide any additional information in patients with HIV/AIDS and CMV retinitis. It can be helpful in patients with IRU to detect macular edema and epiretinal membranes.
- Fluorescein angiography is not useful in diagnosing patients with HIV/AIDS and CMV retinitis. For patients who develop IRU, it can be helpful for detecting macular edema and neovascularization.

Differential diagnosis

- HIV retinopathy: In certain cases, CMV retinitis may be subtle or less developed at the time of eye examination and could render a diagnosis of HIV retinopathy and not CMV retinitis. In rare cases of HIV retinopathy, retinal involvement could be extensive, demonstrating retinal hemorrhages and cotton-wool spots, and appear severe enough to mimic CMV retinitis. In cases of HIV retinopathy, the patient is not immunocompromised; therefore, careful history and laboratory testing can help with correct diagnosis.
- Toxoplasmosis: Ocular findings related to toxoplasmosis most often have a typical appearance of chorioretinal scar. During active toxoplasmosis, a vitritis might be present and an active infiltrative lesion in the retina can be present near the border
Management and treatment

For patients who develop HIV/AIDS-related CMV retinitis, treatment consists of CMV antiviral therapy and ART for the HIV. In clinical settings where follow-up care and patient reliability is trusted, it is best to initiate CMV treatment without ART for 2 weeks to help prevent any complications from an immune response. However, if compliance is in question, both treatment options can be started at the same time. Antiviral treatment options for CMV retinitis include systemic and/or intravitreal therapy. For patients with newly diagnosed infection, assessing the location of the lesions is the first step in determining treatment options. If the location of the lesions is central and immediately sight-threatening (lesions <1,500 microns from the fovea or adjacent to the optic nerve head), intravitreal injections in conjunction with systemic therapy should be started. For patients without sight-threatening disease, systemic therapy alone can be initiated. An initial induction therapy is typically administered until retinitis has become inactive. This can be in the time frame of 2-3 weeks. After initial induction therapy, a lower-dose maintenance therapy is put into place.

Teaching methodology, critical-thinking concepts and assessment

Often in health care, difficult conversations surrounding sensitive topics have to occur because of the impact on systemic or ocular health. These conversations can be about topics such as substance abuse, partner or child violence, or sexually transmitted disease. HIV/AIDS can be a difficult topic for interns and providers to talk about with patients in the eyecare examination setting because of complexity and social stigmas. Studies have demonstrated that communication techniques can increase reliability and validity of patient self-reporting in the context of sensitive topics. One study identified three factors that affect reliability and validity of patient self-reporting for sensitive topics: 1) the intern or provider’s own anxiety to talk about certain topics, 2) the patient’s anxiety to talk about certain topics, and 3) the “how” of asking questions.

Five communication techniques can help doctors to discuss sensitive topics with patients and improve patient self-reporting:

1. Normalizing - Use universality statements to normalize the problem (if appropriate) and/or the anxiety. For example, “Many people find it difficult to talk about their sexual concerns, activities, practices, etc.” Or, “Many people with chronic illness notice they have problems with sexual function. Have you?”
2. Using transparency – Explain why you are asking; be open about your reasons. For example, “I need to ask you some very specific questions about your sexual history in order to better understand your current problem.”
3. Asking permission – For example, “Would it be alright with you if I asked you some questions about your sexual history?”
4. Giving the option of not answering a question – Patients can be informed that they do have the option of not answering a question if it makes them feel uncomfortable.
5. Addressing confidentiality concerns – Patients have a right to be informed that a healthcare provider cannot promise them 100% confidentiality regarding their condition. Healthcare providers in many jurisdictions are required by law to report cases of sexually transmitted diseases to a public health agency.

An example of normalizing, transparency and permission all together: “I ask all my patients about their sexual activity as part of gaining their medical history (normalizing) because it can have an important impact on their overall health (transparency). Would it be OK if I asked you some questions about your sexual activities (permission)?

Doctor/patient communication has been evaluated and written about in many different ways. It is important that providers and...
A clinician should be aware that HIV/AIDS can have a serious impact on ocular function and lead to irreversible vision loss if left untreated. The patient in this teaching case report was negligent to his diagnosis of HIV/AIDS, which is currently uncommon. Prior to the initiation of ART, the rate of CMV retinitis in HIV/AIDS patients was 30%. Since 1996 and the introduction of ART, the rate has dropped 80-90%. The current incidence of CMV retinitis for individuals living with HIV/AIDS for 4 years is 1.2%, and the rate for 10 years is 4.9%. Though the rates of associated vision loss have decreased approximately eight-fold in the ART era, CMV retinitis remains an important predictor of incident vision loss. With ART in present time, HIV is typically well-controlled, resulting in high CD4 counts and undetectable viral loads. This type of control for the virus typically reduces any ocular involvement. However, certain barriers can be present for patients who may not understand the condition or have access to medication and care. Despite incredible advances in medication, primary eyecare providers have to be aware of the impact HIV/AIDS can have on the eye, especially when the patient is immunosuppressed and at risk for opportunistic infections such as CMV leading to CMV retinitis.

A clinical pearl for students to remember is how to correlate laboratory findings for a systemic condition and the risk for ocular findings. In this particular case, the patient had a CD4 count of 1 cell/µL. This CD4 count indicates a severely immunocompromised patient at high risk for opportunistic infections and ocular complications who should be evaluated urgently and carefully. The patient also had an anterior chamber reaction in both eyes. A key clinical pearl is to always dilate patients who demonstrate an anterior chamber reaction because the cells and flare in the anterior chamber can be a sign of further inflammation in the posterior segment. The cells and flare in the anterior chamber of this patient signified “smoke” to the “fire” that was occurring in the posterior segment.

**Conclusion**

This case serves as a reminder that HIV retinopathy and CMV retinitis are not extinct conditions. Despite incredible control of CD4 counts and viral loads in the ART era, immunocompromised patients with sight-threatening ocular manifestations can still present and require immediate attention and competent management. In a community health center optometric practice, barriers to care can exist. Patient education, access to medication, cultural barriers and barriers to compliance can exist. Primary eyecare providers need to be aware of the important history and laboratory findings (and what those values represent) to discuss with patients who have HIV. Providers should always remember the importance of dilated fundus examination and to be aware of the signs and symptoms of CMV retinitis, as it is still the leading cause of irreversible vision loss in the HIV
population in the ART era.

References

Review of Standardized Testing in Doctoral Health Professions Admission Requirements
Caroline Ooley, OD, FAAO, Naida Jakirlic, OD, FAAO, and Elizabeth Hoppe, OD, MPH, DrPH, FAAO | Optometric Education: Volume 47 Number 1 (Fall 2021)

PDF of Article

Background

The purpose of this study is to assess the current status of the role of standardized testing in the admissions process for graduate health professions in the United States by quantifying the number and percentage of health professions programs that require standardized testing for admissions, and to determine which standardized tests are required by each program. The driving force behind the research question is the growing skepticism in the academic arena regarding the value of standardized exams in predicting success and their potential bias against students of lower socioeconomic status, under-represented minorities and women.1-3

In recent years, a significant performance gap on standardized examinations has become obvious between students of different racial and socioeconomic backgrounds. In light of this evidence, standardized examinations are increasingly becoming regarded as barriers to higher education access for students of color and lower socioeconomic status. This observation has caused some undergraduate institutions to either eliminate college entrance examinations or make them optional in order to increase the diversity of their student body.1

Additionally, there is evidence of gender bias on the Scholastic Aptitude Test (SAT) as men tend to perform better on the math portion than women, which leads to an underprediction of women’s performance in college.2 Due to these concerns, since 1998 more than 275 undergraduate institutions no longer use the SAT or American College Test (ACT) in their admissions decisions.3 Many schools that still maintain an SAT score requirement admit to doing so to preserve a reputation of selectivity while the scores contribute minimally to admissions decisions.2 Most recently, the University of California system decided to suspend its SAT/ACT requirement for admissions until 2024, after which it will either eliminate or introduce a new entrance examination for in-state applicants.4

Reputable graduate institutions have started taking a similar approach to standardized exams. In 2018, Harvard University dropped its Graduate Record Examination (GRE) requirement for its English PhD program, and University of Pennsylvania (UPenn) dropped its GRE requirement for its philosophy department.5,6 The reasoning behind UPenn’s decision was multifactorial. The primary reason was that the financial burden of the exam gives an unfair advantage to wealthy applicants, thus limiting the diversity of matriculated students.5 UPenn also argued that GRE scores do not accurately predict academic performance in graduate school and result in bias against women and under-represented minorities.6

In 2019, Cornell University’s English doctoral program followed suit. Cornell’s decision to eliminate the GRE requirement for admission was based on the observation that the predictive value of the GRE to determine student success was outweighed by the expense of reducing the diversity of their applicant pool due to the exam posing a significant financial burden on historically under-represented student groups.7 Several months later, Cornell’s biomedical engineering department also eliminated its GRE requirement, citing that the GRE is “a poor predictor of success at graduate school.”8

The move by two Ivy League institutions to remove the GRE requirement for some of their graduate programs behooves those in higher education to take a closer look at their own institutional policies. It is undeniably true that the expense of standardized testing for graduate programs can be a significant financial burden for students from lower socioeconomic backgrounds, thus narrowing the applicant pool and potentially discriminating against minority students. It is particularly paramount for doctoral health professions programs to revisit their admissions criteria as these programs have arguably the greatest need to expand the diversity of their student body in order to effectively serve an increasingly diverse society.

This paper aims to evaluate which doctoral health professions currently require a standardized entrance exam for admissions. Though this information is publicly available through individual schools and centralized application systems, there is no central source where this information can be compared across health professions. This study collects and presents valuable data in one centralized location for individual admissions committees to review when discussing the role of standardized exams in admissions decisions. The study also discusses potential barriers to higher education that may be applicable to health
professions education. In the current climate of movement away from requiring standardized testing for admissions decisions, it is helpful to gain an appreciation of how this trend may also be impacting doctoral-level health professions.

Methods

A cross-sectional study design was used to capture data to evaluate and enumerate the proportion of doctoral health professions programs that require standardized testing for admissions. A list of doctoral-level health professions was reviewed to determine which professions to include in this study.1 Inclusion criteria for the professions reviewed included the following: health professional doctoral degree, defined as a degree that prepares someone to work in a particular profession, often, but not always, meeting the academic requirements for licensure or accreditation, recognized in the United States or Canada, and emphasizing clinical practice. Exclusion criteria were the following: an emphasis on biomedical or research careers, PhD or Master’s level, no longer recognized, or relatively few practitioners in the profession. The following doctoral degrees were excluded from the review: Doctor of Athletic Training, Doctor of Behavioral Health, Doctor of Professional Counseling, Doctor of Health Science, Doctor of Naturopathy, and Doctor of Social Work.

Twelve health professions meeting the inclusion criteria were identified. The corresponding central application service was used to identify which schools within the doctoral program required a standardized entrance exam. Several of the programs did not have a central application system, or the central application system did not have the information desired. In these cases, each individual school website was accessed to identify standardized testing requirements. Dental, audiology, occupational therapy, chiropractic and acupuncture programs required accessing each individual program’s website.

The following list of professions included in the study describes the methods by which the data were collected.

Optometry - A list of optometry schools accredited by the Accreditation Council on Optometric Education (ACOE) was accessed via the Optometry Centralized Application System, OptomCAS. OptomCAS provides a table of accredited programs and the required standardized exam for each program. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Dentistry - A list of dental schools was accessed through the American Dental Association (ADA). Only schools accredited by the Commission on Dental Accreditation were included in the study. The websites for each of the programs listed were searched for details regarding the admissions requirements. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Medicine (MD) - A list of allopathic medical schools accredited by the Liaison Committee on Medical Education (LCME) was accessed through the American Medical College Application Service, AMCAS. All schools listed required the Medical College Admission Test (MCAT) for admissions at the time of this review. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Medicine (DO) - A list of osteopathic medical schools accredited by the American Osteopathic Association Commission on Osteopathic College Accreditation (COCA) was accessed through the centralized application system, AACOMAS. All schools listed required the MCAT for admissions at the time of this review. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Podiatry - A list of podiatry schools was accessed through the American Association of Colleges of Podiatric Medicine. Only schools accredited by the Council on Podiatric Medical Education were included in the study. All schools listed required the MCAT for admissions at the time of this review. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Audiology - A list of schools awarding a Doctorate in Audiology (AuD) and accredited by the Council on Academic Accreditation (CAA) were included in the study. The CAA also provided a list of audiology degree programs. The websites for each of the AuD programs listed were searched for details regarding the admissions requirements. Master’s-level degrees in audiology were not included. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Table 1. Click to enlarge
Physical therapy – A complete list of physical therapy schools accredited by the Commission on Accreditation in Physical Therapy (CAPTE) was accessed via the Physical Therapist Centralized Application System, PTCAS. PTCAS provided a complete table of programs that required a standardized exam. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Veterinary medicine – A list of veterinary schools accredited by the American Veterinary Medical Association Council on Education (AVMA COE) was accessed through the Association of American Veterinary Medical Colleges. A complete list of U.S. schools with standardized testing requirements was used in this study. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Occupational therapy – A list of occupational therapy doctoral programs accredited by the Accreditation Council for Occupational Therapy Education (ACOTE) was obtained from the American Occupational Therapy Association website. The websites for each of the programs listed were searched for details regarding the admissions requirements. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions, in this case the GRE.

Pharmacy – A list of pharmacy schools accredited by Accreditation Council for Pharmacy Education (ACPE) was accessed using the American Association of Colleges of Pharmacy. A PDF listing of required entrance exams for each program was utilized in this study. The centralized Pharmacy College Application Service, PharmCAS, was not used for reference as several PharmD programs did not participate in this service at the time of data collection. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Chiropractic – A list of chiropractic doctoral programs accredited by the Council on Chiropractic Education (CCE) Directory of Doctor of Chiropractic (DC) Degree Programs was obtained from the CCE. The websites for each of the programs listed were searched for details regarding the admissions requirements. Additional information was accessed from the Chiropractic College Application Service, ChiroCAS. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Acupuncture – A list of doctoral-level acupuncture programs accredited by the Accreditation Commission for Acupuncture and Oriental Medicine (ACAOM) was obtained from the Acupuncture Today website. The websites for each of the programs listed were searched for details regarding the admissions requirements. Results were summarized in Table 1 and categorized as to the number and percentage of programs that required a standardized test for admissions.

Table 1 summarizes the data collected. Limitations to the data collection include changes in standardized exam requirements over the span of the search as well as possible accreditation status changes since the time of the search. The data collection was done prior to the COVID-19 pandemic, which began in the United States in March 2020. Since then, some schools have made exceptions or changes to their standardized testing requirements, which is another limitation to the methods and results of this study.

Results

A total of 12 health professions doctoral degree programs and 890 schools were identified and evaluated. Of the 12 professions, 10 (83%) had at least one school that required a standardized exam. Acupuncture and chiropractic programs did not require any standardized examinations. In optometry, dental, medicine (MD and DO) and podiatry programs, all schools required a standardized entrance exam. Several other programs varied on the number of schools requiring a standardized exam (audiology [95.9%], physical therapy [88.4%], veterinary [73.3%], occupational therapy [52.8%], and pharmacy [47.4%]).

Of the 890 professional schools included in this study, 679 (76.3%) required a standardized exam. Of the professions where at least one program required a standardized exam (10 of the 12 professions), 83.2% of individual schools (679 of 816) required an entrance exam.

The results for each profession are summarized below and presented in Table 1.

Optometry – There were 23 optometry (OD) programs accredited by the ACOE. At the time of this study, all 23 programs (100%) required a standardized exam for admissions. All programs required the Optometry Admission Test (OAT) and 19 programs (82.6%) varied on other standardized exams, including the GRE, Pharmacy College Admission Test (PCAT), MCAT or Dental Admission Test (DAT), that could be submitted in lieu of the OAT.

Dentistry – There were 66 dental (DMD, DDS) programs accredited by the ADA. At the time of this study, all 66 programs (100%) required the DAT as the standardized exam for admissions.
Medicine (MD) - There were 147 Doctor of Medicine programs accredited by the LCME at the time of this study. All 147 programs (100%) required the MCAT for admissions.

Medicine (DO) - There were 35 Doctor of Osteopathic Medicine programs accredited by COCA. At the time of this study, all 35 programs (100%) required the MCAT for admissions.

Podiatry - There were nine podiatry (DPM) programs identified. At the time of this study, all nine schools (100%) required the MCAT as the standardized exam for admissions.

Audiology - There were 74 audiology (AuD) programs accredited by the CAA. Of these, 71 (95.9%) required a standardized exam. All programs that required an exam accepted the GRE. Several programs accepted various other standardized exams in lieu of the GRE.

Physical therapy - There were 242 physical therapy programs (DPT) accredited by CAPTE. Of these, 214 (88.4%) required a standardized exam. The GRE was the required exam for these schools.

Veterinary medicine - There were 30 veterinary (DVM) programs accredited by the AVMA COE. Of these, 22 (73.3%) required a standardized exam. The GRE was the most common exam required in those programs, though some accepted the MCAT instead of the GRE.

Occupational therapy - There were 36 occupational therapy (DOT) programs identified as accredited by ACOTE. Of these, 19 (52.8%) required the GRE. One of these 19 programs did not require the GRE but noted that if scores were submitted they would be considered as part of the admissions process; 13 (36.1%) did not require the GRE. For one program it could not be determined whether the GRE was required based on information provided on the website. If a school offered programs at multiple campus locations, each campus was counted as an individual program.

Pharmacy - There were 154 PharmD programs accredited by the ACPE. Of these, 73 (47.40%) of the programs required the PCAT. Aside from the doctoral professions in this study that do not require any standardized exam, pharmacy had the lowest percentage of programs requiring a standardized exam for admissions.

Chiropractic - There were 18 chiropractic (DC) programs identified as accredited by the CCE. None of the programs was found to require standardized testing as part of the admissions process, but one program noted that GRE scores could be submitted if they were available.

Acupuncture - There were 56 acupuncture (DACM) programs identified as accredited by ACAOM. One of the programs listed had subsequently closed. There were five programs for which it could not be clearly determined whether any standardized test was required for admission based on information provided on the website. The remaining 50 programs did not require any standardized testing for admission.

Discussion

Required standardized entrance exams have been a topic of discussion among undergraduate and graduate programs in the past several years. Many schools have been moving away from this requirement as it may pose a barrier for many potential applicants. The goal of this study was to determine which U.S. doctoral health professions programs currently require a standardized exam. The results of this study showed that the use of standardized testing in admissions varied among the doctoral health professions, though most (83%) had at least one school that required a standardized exam. As seen in Table 1, 41.7% of professions required standardized testing of all schools, and 41.7% of professions required standardized testing of some schools. Furthermore, 58.4% (seven of 12 professions) either did not require any standardized testing or required testing of some schools. This study indicated that if optometry programs were to move away from required standardized testing, the programs would not be outliers when considered in the broader context of doctoral-level health professions education institutions that were included in this assessment.

It is noteworthy that within most of these professions, the use of standardized testing was variable from program to program. The professions that were most uniform in their use of standardized testing were chiropractic and acupuncture, in which no programs were found to use standardized testing, and medicine (MD and DO), podiatry, dentistry and optometry, in which all programs were found to use standardized testing at the time of this study. The professions that demonstrated the most variability in the use of standardized testing for admissions were audiology, physical therapy, veterinary medicine, occupational therapy and pharmacy.

Our study adds to the current knowledge base for admissions committees and provides summarized information in a central
location. The relevant information about more than 200 of the schools included in this study had to be individually accessed through school websites. One program required emailing the admissions liaison because the information was not easily found on its public web page. To the knowledge of the authors, no other cross-sectional study that presents the status of standardized testing in admissions for all doctoral health professional programs in the United States has been published.

The literature suggests that graduate programs outside of the health professions have identified standardized testing as a potential barrier due to its bias against under-represented minorities, female students and students of lower socioeconomic status. While there is a plethora of published literature on the ability of standardized exams to predict student success in undergraduate education, research in this area for doctoral health professions education is limited. Of the studies that do exist, some cite standardized testing as a good predictor of success in doctoral health professions education, while others conclude that standardized exams are not reliable predictors of success.

As for optometry-specific literature on predictors of success, there are a few studies though most are dated. An article by Bailey in 2000 looked at undergraduate grade point average (GPA), OAT scores and optometry school GPA in correlation to performance on National Board of Examiners in Optometry (NBEO) Part I at Southern California College of Optometry. The study found that optometry school GPA after 2 years was most predictive of NBEO performance. However, the OAT academic average along with optometry school GPA after 2 years showed slightly better predictions of success while undergraduate GPA was not a good predictor. An article by Buckingham and Bush in 2013 looked at the OAT and undergraduate courses taken by 322 students at Michigan College of Optometry. They concluded that OAT reading comprehension and OAT academic average scores as well as undergraduate GPA predicted success in their optometry program. Several other optometry-specific studies agreed that undergraduate GPA and certain OAT scores are predictive of success. Wingert, Goodwin and Kramer showed that undergraduate GPA and certain OAT scores are predictive of first- and second-year optometry GPA. These studies varied on which OAT subject tests were most predictive of success, and several also varied on the predictability of the personal interview for admissions.

Because optometry is a relatively small health profession and there is limited literature on this topic, it can benefit from looking at what other health professions are doing at this time. As our profession becomes more medically focused, and we work more interprofessionally within the healthcare system, it is important to look at the admissions processes of other professions.

One concern optometry programs may have when deciding to keep or eliminate admissions requirements is the potential threat to professional scope of practice because removing standardized entrance exams may seem like a watering down of the admissions process. However, this study shows that less than 50% of pharmacy programs require the PCAT, yet their professional scope of practice has been growing to include the continued expansion of prescribing ability (including hormonal contraception in most states) and the ability to administer vaccines. Similarly, physical therapy has also expanded its scope to include the ordering of imaging and lab work despite only 88.4% of its programs requiring a standardized exam. These two professions are sound examples of successful expansion of scope of practice regardless of standardized examination requirements for admission.

When balancing considerations between scope of practice and decision-making authority, some potential differences may emerge among the health professions, perhaps causing the profession of optometry to pursue greater alignment with trends in some health professions as compared with others. The professions of human medicine (MD and DO), podiatric medicine and dental medicine are currently aligned with 100% of programs utilizing standardized testing as part of the admissions process. It is uncertain whether this status is likely to persist, particularly as society emerges from the recent experiences of the global pandemic. Alternatively, two professions with advanced levels of scope of practice and decision-making authority, veterinary medicine and pharmacy, show greater variation in their use of standardized testing across professional programs.

As health professions programs continue to need qualified applicants of various backgrounds to fuel the growing healthcare system, it is important for schools to look at ways to reduce admissions barriers. Options may be to eliminate standardized testing altogether, or to evaluate ways to reduce the cost of the exam and increase accessibility. Currently, many of the standardized tests are taken in-person at testing centers, with exams only offered during certain times of the year and in certain locations (some offered only in the United States). If standardized tests continue to be required in the admissions process, moving to an online platform, as the GRE has done in the past year, may increase accessibility for applicants. Due to the COVID-19 pandemic, the GRE now provides the option for test-takers to take the exam online in their own home. It is proctored by a human through ProctorU, and applicants are able to take the exam 24 hours a day, 7 days a week. Though moving to an online platform may increase accessibility, an underlying bias against under-represented minorities and genders remains. Although this study concluded that the majority (83%) of health professions doctoral programs had at least one school that required a standardized exam and that overall 76.3% of the individual programs required a standardized exam,
this may change in the near future. With the need for a more robust and diverse applicant pool and the questionable utility and predictability of standardized exams, the hope is that doctoral health professions programs will look into evaluating applicants using different means. Many studies have looked into a more holistic approach to admissions decisions, including various undergraduate GPA calculations, essays, behavioral interviews and multiple mini interviews.34,35

One limitation to this study is the possible change in admissions requirements for each program listed. For example, after collecting the data and analyzing the results, the authors became aware that in July 2020, Indiana University School of Optometry made the GRE and OAT exams optional for admissions.33 This test-optional model is becoming a trend among many undergraduate and graduate institutions including the University of California system, Harvard University, Cornell University and the University of Pennsylvania. In our study, one occupational therapy and one chiropractic program allowed for optional submission of exams scores. The authors believe this will likely be the trend among optometry programs in the near future. Some undergraduate institutions have also begun to implement test-flexible or test-optional models. The test-optional model removes standardized test requirements for all applicants, while the test-flexible model allows students who meet certain criteria to apply without submitting a standardized exam score. Examples of qualifying criteria include achieving a certain GPA and/or involvement in extracurricular activities. Though the test-flexible model may sound appealing, it likely does not actually increase applicant diversity due to the difficulty accessing extracurricular activities and academic support by under-represented minorities.34 The test-optional model also has its limitations. A study by Cahn in 2015 looked at 30 graduate health professions schools and concluded that the test-optional model did not increase program diversity unless other recruitment strategies were implemented as well. These strategies included diversifying the faculty, giving extra weight to under-represented applicants, increasing high school and undergraduate presentations, and increasing outreach to minority populations in the community.35

With the knowledge gained from this study, further research needs to be conducted looking at trends of institutions changing standardized testing requirements for admissions, especially as new studies evaluating the validity and predictability of standardized exams are published. Though the decision to make any changes to standardized testing in admissions is up to individual optometry programs, this study may help admissions committees in their discussions on this topic.

Conclusion

This study provides a centralized location for optometry admissions committees to access valuable information on the current use of standardized testing in doctoral health professions in order to make informed admissions decisions and to track changes over time. Though the majority of individual health professions programs still require standardized exams, there is variation among several professions. If optometry programs were to eliminate standardized testing requirements, they would not be outliers and, in fact, would still be aligned with some of the other doctoral-level health professions. As more research is published regarding potential barriers to higher education and the predictive value of standardized exams, optometry programs may decide to make changes to their admissions requirements.

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Student Perceptions of Attaining the Association of Schools and Colleges of Optometry Graduate Attributes
Raymond H. Chu, OD, MS, and Stanley Woo, OD, MS, MBA | Optometric Education: Volume 47 Number 1 (Fall 2021)

Background
Assessment of learning is a necessary step in providing feedback to students on their learning and providing the institution valuable information for making programmatic changes. Assessment is defined as the process of gathering data to understand changes in students’ knowledge, ability or attitude. Assessment can take many forms. In the classroom, formative assessment is used to provide ongoing feedback to the instructor on how to improve teaching and to the student on how to improve learning. Likewise, summative assessments are employed in the classroom to assess student learning outcomes, and on a program level to assess program learning outcomes. For example, Standard 1.3 of the Professional Optometric Degree Standards adopted by the Accreditation Council on Optometric Education (ACOE) states: “The program must identify and use outcome measures to evaluate its effectiveness by documenting the extent to which its goals and objectives have been met and must use such assessment to improve its performance.” As part of the ACOE standards 1.3 and 1.4, programs are obligated to assess:

- passage rates on the National Board of Examiners in Optometry licensure exams
- graduation rates
- attrition rates

Although these are important metrics for gauging the education effectiveness of an institution, they provide little perspective about the students’ experiences. To address this gap, professions such as allopathic medicine have annually administered the Medical School Graduation Questionnaire (GQ), which serves as a tool for program evaluation and feedback on how to improve the medical student experience. Rickards et al. noted the limitation with most graduate medical education surveys is the lack of reliability and validity evidence on the survey tool; however, the GQ has been assumed to be valid because of its employment since 1978 and its many uses within education research.

In 2000, Heath et al. published an initial report outlining attributes of a U.S.-trained optometric graduate. Rather than documenting education effectiveness through the number of clock hours spent or resources dedicated to learning, the report took a more contemporary view by focusing on outcomes that graduates are expected to demonstrate. In 2011, the Association of Schools and Colleges of Optometry (ASCO) revised the competencies to reflect current practices. Similar to learning objectives, graduate attributes are orienting statements used to describe the profession’s expectations of graduates. Institutions of higher learning have adopted the use of graduate attributes as a means of articulating to faculty, accrediting agencies and the workforce community alignment with expected knowledge and skills. Hughes and Barrie advocated for the use of student perceptions and longitudinal studies as part of the assessment of graduate attributes. The purpose of this paper is to report on how students perceived their attainment of the ASCO graduate attributes and how the data has been used in curriculum review.

Methods

ASCO graduate attributes survey development

“Attributes of Students Graduating from Schools and Colleges of Optometry” contains a series of attribute statements that broadly define entry-level competencies expected of students graduating from a U.S.-based optometry program. The document defines competency within three attribute areas: 1) professional values and ethics, 2) knowledge, and 3) skill. To assess students’ self-perceptions of attainment of the ASCO graduate attributes, the skills domain was used because it encompasses both the cognitive and motor skills of a new Doctor of Optometry.

- all the skills required for the diagnosis, triage, management and/or treatment of common visual conditions, including or resulting from:
  - refractive anomalies
  - abnormalities of accommodation, monocular or binocular vision skills, oculomotor and sensory/perceptual dysfunctions
- ocular disease and trauma
- prior ocular surgery and/or laser intervention
- systemic disease
- environmental or occupational conditions
- the ability to order and interpret frequently needed laboratory and diagnostic procedures
- the critical-thinking skills needed to assess the patient’s visual and physical status and to interpret and process the data to formulate and execute effective management plans
- the ability to prescribe or use ophthalmic materials, contact lenses, vision therapy, low vision devices, pharmaceuticals and certain surgical procedures to treat and manage vision disorders and disease
- an understanding of nutritional influences on ocular physiology and systemic health and disease
- the ability to understand, evaluate and apply the use of contemporary imaging technologies in the provision of eye and vision care
- the ability to prescribe or use ophthalmic materials, contact lenses, vision therapy, low vision devices, pharmaceuticals and certain surgical procedures to treat and manage vision disorders and disease
- the ability to order and interpret frequently needed laboratory and diagnostic procedures
- the ability to recognize and initiate the coordination of patient care requiring advanced medical, systemic, interprofessional or specialty care
- the ability to recognize life-threatening conditions and to initiate immediate intervention
- effective communication skills, both oral and written, as appropriate for maximizing successful patient care outcomes
- the ability to appropriately use all resources, including the use of ancillary personnel, intra- and interprofessional collaboration, co-management and referral, in ensuring the best quality patient care
- the ability to access evidence-based knowledge (including through the use of information technology) and manage information, and to apply that information in making decisions about patient care and healthcare delivery
- the ability to embrace the cultural diversity and individual differences that characterize patients, populations and the healthcare team
- the ability to work in cooperation with those who receive care, those who provide care, and others who contribute to or support the delivery of prevention and health services

Ten survey items (Table 1) were created from the skills domain list and were embedded within the Southern California College of Optometry at Marshall B. Ketchum University (SCCO) Graduating Class Exit Survey where students responded based on a four-point Likert scale ranging from Strongly Disagree, Disagree, Agree and Strongly Agree.

**Survey development and deployment**

The SCCO Graduating Class Exit Survey was designed to learn from the graduating students’ opinions about their didactic and clinical education, career aspirations, satisfaction with student affairs services, and treatment during optometry school. The questionnaire was based on the types of questions asked in the GQ, which include:

- pre-clinical, clinical and elective experiences
- general medical education and readiness for residency
- student services
- experiences of negative behaviors
- financial aid and indebtedness
- career intentions
- strengths of the medical school and areas that need improvement

Beginning in the 2014-2015 academic year, students completed the SCCO Graduating Class Exit Survey (Appendix A). Students from the graduating classes of 2015, 2016 and 2017 were invited to respond to the exit survey. The class of 2015 had 96 members, the class of 2016 had 96 members, and the class of 2017 had 101 members. Students volunteered to respond to the exit survey during the week leading up to the commencement ceremony (May of each year) and were assured their responses would be anonymous. The survey was posted on the MyCoursEval (Invoke Solutions, Waltham, MA) portal for each class. The survey remained open until the day after the ceremony, with an initial invitation and two email reminders. The process was the same for all classes.
An application was submitted to the Institutional Review Board at Marshall B. Ketchum University, and the research was found to be exempt due to the anonymity of the survey.

**Statistical methods**

Descriptive statistics (mean, distribution and standard deviation) for each survey item were generated by the MyCoursEval software. Questions using a four-point Likert scale were designated with “Strongly Agree” equal to a numerical score of four and “Strongly Disagree” equal to a numerical score of one. A one-way analysis of variance (ANOVA) was performed to assess statistical significance between the three graduating classes with statistical significance set at a p-value less than 0.05.

Survey responses from all three graduating classes were also aggregated to assess areas of strengths and weaknesses with the following definitions:

- 90% or above of responders agreeing or strongly agreeing with a survey statement = an area of strength
- 80-89% percent of responders agreeing or strongly agreeing with a survey statement = an area to monitor
- less than 80% of responders agreeing or strongly agreeing with a survey statement = an area to focus on change

**Results**

**Subjects**

Refer to Table 2 for the survey response rates from each class. From the class of 2015, 76 responses (79%) were recorded. From the class of 2016, 59 responses (61%) were recorded. From the class of 2017, 29 responses (29%) were recorded.

Based on ASCO Annual Student Data Reports, the demographics of the SCCO class of 2015 were 66.7% (n=64) female and 33.3% (n=32) male. The ethnic distribution of the class was 67.7% (n=65) Asian, 27% (n=26) White, and 5.2% (n=5) Black/Latino/other/unknown. The demographics of the class of 2016 were 77.1% (n=74) female and 22.9% (n=22) male. The ethnic distribution of the class was 46.9% (n=45) Asian, 34.4% (n=33) White, and 18.7% (n=18) Black/Latino/other/unknown.
The demographics of the class of 2017 were 68.4% (n=67) female and 31.6% (n=31) male. The ethnic distribution of the class was 51.0% (n=50) Asian, 35.7% (n=35) White, and 13.3% (n=13) Black/Latino/other/unknown.

**ASCO graduate attributes**

Mean responses on the attainment of the ASCO Attributes of Students Graduating from Schools and Colleges of Optometry were reported by class year in **Figure 1**. Each class reported the highest mean (3.4 to 3.6) with question 17 (practice in a professional and ethical manner) and the lowest mean (2.4 to 2.5) with question 12 (order and interpret laboratory and diagnostic procedures).

The distribution of student responses were reported in **Table 3** along with the results from the one-way ANOVA analysis. The responses for individual questions were not statistically different among the 2015, 2016 and 2017 graduating classes (p=0.44 to 0.69).

When all responses for each survey item were combined (**Figure 2**), students indicated the following as areas of strength (≥90% strongly agree or agree):

- question 10 (95%): prescribe or use ophthalmic materials, contact lenses, vision therapy, low vision devices, pharmaceuticals and surgical procedures to treat and manage vision disorders and disease
- question 14 (96%): use written and oral communication that is understandable to patients, families and other healthcare team members
- question 16 (90%): engage in continuous professional and interprofessional development
- question 17 (99%): practice in a professional and ethical manner
- question 18 (95%): promote wellness and disease prevention services

The highest response came from practice in a professional and ethical manner (99%).

Students indicated the following as areas to monitor (80-89% strongly agree or agree):

- question 13 (82%): understand, evaluate and apply the use of contemporary imaging technologies in the provision of eye and vision care
- question 15 (83%): access evidence-based knowledge, manage information, and to apply that information in making decisions about patient care and healthcare delivery

Students indicated the following as areas needing improvement (<80% strongly agree or agree):

- question 11 (79%): recognize and initiate the coordination of patient care requiring advanced medical, systemic, interprofessional or specialty care
- question 12 (46%): order and interpret laboratory and diagnostic procedures
- question 19 (74%): work within an interprofessional collaborative team to improve patient outcomes

The two lowest responses came from ordering and interpreting laboratory and diagnostic procedures (46%) and working within an interprofessional collaborative team (74%).
Discussion

The American Optometric Association defines an optometrist as an independent healthcare provider who examines, diagnoses, treats and manages diseases, injuries and disorders of the visual system, the eye and associated structures as well as identifies related systemic conditions affecting the eye. Based on the results from the SCCO Graduating Class Exit Survey, students graduating from SCCO felt competent in fulfilling the core responsibilities of a Doctor of Optometry. Most students, but not all, felt competent with imaging technologies and implementing evidenced-based practice.

Working within an interprofessional collaborative team and recognizing and initiating the coordination of patient care requiring advanced medical, systemic, interprofessional or specialty care were areas identified for curriculum improvement. The mission of SCCO is to “educate caring, inspired healthcare professionals who are prepared to deliver collaborative, patient-centric health care in an interprofessional environment.” In fulfilling the mission, students within the three programs at Marshall B. Ketchum University — SCCO, College of Pharmacy, and School of Physician Assistant Studies — began attending classes together in the 2015-2016 academic year in an effort to prepare future graduates for interprofessional collaborative practice. Students were enrolled in Medical Ethics (first year), Population and Public Health (first year), Evidence-Based Practice (second year), and Interprofessional Case Conferences (third year) so they could learn with, from and about each other. In addition to classroom learning, complementary clinical experiences that model interprofessional collaborative practice are being developed. Because the students from the graduating classes of 2015, 2016 and 2017 did not complete the interprofessional education curriculum, the results from questions 11 and 19, coordination of care and work within an interprofessional collaborative team, serve as a baseline for evaluating the effectiveness of the interprofessional education curriculum.

Similar to the ASCO graduate attributes, the Medical School Objectives Project was developed by the Association of American Medical Colleges to describe the skills, attitudes and knowledge a graduating medical student should possess. Promes et al. administered a survey to first-year medical residents and found that the variability in undergraduate medical school curricula resulted in varying levels of competence. Sanders et al. made a similar observation when surveying medical school associate deans for academic affairs where the teaching and assessment of technical procedures had differing levels of rigor. Question 12, order and interpret laboratory and diagnostic procedures, was identified as a skill needing additional instruction. Learning from the lessons from medicine, collaboration within the university’s other health professions, identifying and monitoring opportunities within clinical externship, and more rigorous forms of assessment are all being considered.

Limitations

Although the administration of the exit survey was exactly the same for each class year, the response rates varied. The especially low response rate for the class of 2017 may have been the result of this cohort being particularly non-responsive to survey inquiries. Despite the different response rates and diminished number of responses with each class year (2015: 79%, 2016: 61%, 2017: 29%), there was good agreement among the responders to the survey items.

The results of the survey have limited generalizability due to the response rate and the sampling from one program’s curriculum.

Conclusion

Chen et al. recommended that reform to medical education should be empirically based, and noted that little is known about how graduates feel regarding preparation for work and life as medical residents. For SCCO, assessing the ASCO graduate attributes with other assessment data has helped provide a more holistic view in triangulating program learning outcomes.

Gehlbach et al. recommended a seven-step process for education research survey development, which includes a final step of pilot testing. The information learned from the SCCO Graduating Class Exit Survey can serve as pilot testing for future study consideration expanding the assessment of graduate attributes across graduating students from all ASCO member institutions.

References


Appendix A
Southern California College of Optometry Graduating Class Exit Survey
The faculty and administration of Southern California College of Optometry value each and every one of you as our incoming patients. We all hope that you will enjoy your time with us and that we will provide you with the best education possible. Your feedback is crucial to our success and we are asking for your honest and constructive feedback. Thank you in advance for your time.

ACADEMIC PROGRAM

Rate the quality of your didactic education experiences:

1. The curriculum was coherent and relevant.
2. The sequence of courses was appropriate.
3. Basic science content was sufficient.
4. There was effective integration of basic sciences.

Please provide written comments on the following:

5. What do you perceive as the strengths of the didactic education program at SCCO?
6. What do you perceive as the weaknesses of the didactic education program at SCCO?

7. Rate the quality of your clinical education experiences in the following areas:
   - Primary Care
   - Ocular Disease
   - Contact Lens
   - Low Vision Rehabilitation
   - Ocular Therapy
   - Optometry

   How satisfied were you with the following aspects of your clinical education experience at SCCO?

   - Cost of clinical education
   - Faculty/staff availability
   - Faculty/staff teaching quality
   - Clinic environment
   - Clinic organization
   - Clinic schedules
   - Clinic resources

Please indicate the degree in which you agree or disagree with whether SCCO prepares you for the intern professional examination:

- Strongly Agree
- Agree
- Disagree
- Strongly Disagree

STUDENT AFFAIRS

Indicate your level of satisfaction with the Office of Student Affairs:

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

Indicate your level of satisfaction with the Financial Aid Office:

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

Indicate your level of satisfaction with the following organizations:

- Yes
- No

8. Would you recommend an intern program to your friends and family?
9. Would you recommend an intern program to other intern candidates?
10. Would you recommend an intern program to other intern candidates?

Indicate your level of satisfaction with the Student Achievement Center:

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

FACILITIES

Indicate your level of satisfaction with the following facilities:

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

CAREER PLANNING

Indicate your level of satisfaction with the Career Planning Services:

- Very Satisfied
- Satisfied
- Neutral
- Dissatisfied
- Very Dissatisfied

PERSONAL TREATMENT DURING OPTOMETRY SCHOOL

For each category, please rate how satisfied you were with the treatment you received during optometry school. This may include interactions that occurred with students, faculty, staff, and other students.

OPTOMETRY SCHOOL EXPERIENCES

62. Please provide any additional comments, positive or negative, regarding your experiences during optometry school that you would like to share.

Comments will not be linked to your identity in any way.
Standardized Tests as Predictors of Success in Health Professions Education: a Scoping Review

Naida Jakirlic, OD, FAAO, Caroline Ooley, OD, FAAO, and Elizabeth Hoppe, OD, MPH, DrPH, FAAO | Optometric Education: Volume 47 Number 1 (Fall 2021)

PDF of Article

Background

Standardized testing is used as a formal assessment of academic ability in order to predict student success in higher education at both the undergraduate and graduate levels. Standardized tests differ from in-class assessments of knowledge because they are administered in a controlled environment, thus allowing for comparison of student performance that is presumably independent of socioeconomic status (SES), gender and race. Two supporting arguments for standardized testing assume that the standardization process eliminates potential for bias and that standardized tests can accurately assess students’ intellectual ability.  

The first large-scale standardized tests were administered in 1901 by the College Entrance Examination Board, which is known today as the College Board. One reason for creating and administering the tests was to reduce the volume and variety of pre-matriculation exams required by each undergraduate institution. Due to a national push to mandate aptitude tests for college admission, the College Board administered the first Scholastic Aptitude Test (SAT) in 1926 to thousands of students. In 1959, the American College Testing Company administered the ACT for the first time. Shortly after the first administration of the SAT, American graduate institutions followed suit. The first Medical College Admissions Test (MCAT) was given in 1928, the first Graduate Record Examination (GRE) in 1949, and the first Law School Admissions Test (LSAT) was given in 1948. The first Optometry College Admission Test (OCAT) was developed in 1971 by the Psychological Corporation under the sponsorship of the Association of Schools and Colleges of Optometry and was administered for the first time in the fall of 1972.

Despite attempts to eliminate bias from standardized examinations, many in academia argue that requiring standardized exams for admission into undergraduate and graduate programs significantly disadvantages students of female gender and lower SES and those in under-represented minority (URM) groups. Miller and Stassun argue that requiring the GRE significantly decreases the opportunities for women, URM students and lower SES students to enter the science, technology, engineering and math (STEM) professions. They point out that the Educational Testing Service, which administers the GRE, publicizes that women score 80 points lower in the physical sciences than men, and African Americans score 200 points below white test-takers on the exam.

Moneta and Koehler report that students with low SES perform worse on standardized exams, possibly due to lack of access to academic preparation and lack of funds to pay for exam retakes if the first score is low. Nankervis argues that the SAT underestimates future success of female test-takers because males average 35 points higher than females in the mathematics section. In another publication, Wilson discusses a study demonstrating that metrics-based file reviews of applicants excluded twice the number of applicants who identified as historically URM, and moving away from metrics-based admissions processes resulted in a remarkable increase in admission of URM students to a doctoral biomedical science program. Wilson also reiterates that women and URM students score lower on the GRE than white and Asian-American men; therefore, using GRE scores to stratify doctoral applicants significantly reduces the diversity of the applicant pool.

In addition to the reported bias against women, URM students and students of lower SES, there are conflicting reports about the ability of standardized exams to predict academic success at both the undergraduate and graduate level. Kuncel argues that standardized exams are effective predictors of performance in graduate school but the combination of standardized exam scores and undergraduate grade point average (uGPA) gives the most accurate prediction of academic success. He also states that student motivation and interest are crucial for continued exertion throughout graduate school and cannot be measured with standardized exams.

In contrast, Miller and Stassun argue that there is a weak correlation between the GRE and success in STEM fields. They point out that research from the Educational Testing Service shows that the predictive validity of the GRE is limited to first-year graduate grade point average (gGPA) but academic success is much broader than first-year gGPA. Academic success encompasses first-year gGPA, gGPA, degree attainment, licensing examination performance, faculty evaluation of students, residency attainment and completion, and numerous other outcomes that cannot be predicted by GRE scores.
Similarly, Moneta-Koehler and colleagues found that GRE scores are moderate predictors of first-semester graduate grades and weak to moderate predictors of overall gGPA. They also found that the GRE does not predict other skills necessary to succeed in biomedical doctoral programs and concluded that the limited benefits of the GRE do not outweigh the expense of excluding URM students and students of lower SES from entering graduate biomedical doctoral programs.

Table 1: Click to enlarge

Table 1. List of Doctoral Degree Programs Requiring a Standardized Exam

<table>
<thead>
<tr>
<th>Doctoral Health Profession</th>
<th># of Schools</th>
<th>Total # of Schools</th>
<th>% of Schools Requiring a Standardized Exam</th>
<th>Exam Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optometry (OD)</td>
<td>23</td>
<td>23</td>
<td>100.0%</td>
<td>DAT (some accept others)</td>
</tr>
<tr>
<td>Dentistry (DMD, DDS)</td>
<td>69</td>
<td>69</td>
<td>100.0%</td>
<td>DAT</td>
</tr>
<tr>
<td>Medicine (MD)</td>
<td>147</td>
<td>147</td>
<td>100.0%</td>
<td>MCAT</td>
</tr>
<tr>
<td>Medicine (DO)</td>
<td>35</td>
<td>35</td>
<td>100.0%</td>
<td>MCAT</td>
</tr>
<tr>
<td>Pharmacy (PharmD)</td>
<td>3</td>
<td>3</td>
<td>75.0%</td>
<td>MCAT/PharmD</td>
</tr>
<tr>
<td>Podiatry (DPM)</td>
<td>6</td>
<td>6</td>
<td>100.0%</td>
<td>MCAT</td>
</tr>
<tr>
<td>Audiology (AuD)</td>
<td>7</td>
<td>7</td>
<td>71.4%</td>
<td>GRE (some accept others)</td>
</tr>
<tr>
<td>Physical Therapy (DPT)</td>
<td>20</td>
<td>214</td>
<td>95.0%</td>
<td>GRE</td>
</tr>
<tr>
<td>Veterinary (DVM)</td>
<td>35</td>
<td>35</td>
<td>100.0%</td>
<td>GRE (some accept MCAT)</td>
</tr>
<tr>
<td>Occupational Therapy (DOT)</td>
<td>16</td>
<td>19</td>
<td>52.6%</td>
<td>GRE</td>
</tr>
<tr>
<td>Pharmacy (PharmD)</td>
<td>151</td>
<td>73</td>
<td>47.1%</td>
<td>PGAT</td>
</tr>
<tr>
<td>Chiropractic (DC)</td>
<td>10</td>
<td>0</td>
<td>0.0%</td>
<td>None</td>
</tr>
<tr>
<td>Acupuncture (DACM)</td>
<td>56</td>
<td>0</td>
<td>0.0%</td>
<td>None</td>
</tr>
<tr>
<td>Total Schools</td>
<td>286</td>
<td>279</td>
<td>78.0%</td>
<td>None</td>
</tr>
<tr>
<td>Total Professions</td>
<td>32</td>
<td>10</td>
<td>83.3%</td>
<td>None</td>
</tr>
</tbody>
</table>

While a reasonable amount of literature about the ability of standardized exams to predict success in biomedical graduate programs exists, current studies exploring the validity of standardized exams in predicting academic success in doctoral health professions programs are relatively scant, particularly in the field of optometry. To gain insight into how many doctoral health professions programs require standardized exams as part of their admissions requirements, the authors first identified 12 health professions to explore, including optometry, dentistry, allopathic medicine, osteopathic medicine, podiatry, audiology, physical therapy, veterinary medicine, occupational therapy, pharmacy, acupuncture and chiropractic programs. Nursing was not included due to the wide range of doctoral-level nursing programs, the diverse pathways to attainment of doctoral degrees within the nursing profession, and the differing requirements for each program. Once the programs for inclusion were identified, their respective standardized test requirements were summarized (Table 1).

Methods

As suggested by Arksey and O’Malley, a scoping review methodology is well-suited for four primary contexts. The review question undertaken in this research addresses three of the four circumstances identified: 1) to examine the extent, range and nature of research activity; 2) to summarize and disseminate research findings; and 3) to identify research gaps in the existing literature. This project utilized a scoping review methodology to gain a deeper understanding of the current status of standardized testing in health professions admissions processes, along with any research evaluating the predictive power of pre-admissions standardized test results for ultimate academic and/or professional success. Furthermore, this research seeks to summarize what is currently known by gathering and assessing published works relevant to this inquiry, and upon review of the summary, to identify needs for further research on this topic.

The investigators determined the inclusion and exclusion criteria prior to searching the literature. The inclusion criteria focused specifically on scholarly, peer-reviewed indexed literature describing information related to health professions education, admissions to health professions education programs, and standardized testing. The time period for inclusion was limited to the past 10 years, and language was limited to English. Only articles published about health professions education in the United States and Canada were included due to potential differences in health professions education relative to governmental, regulatory, economic and cultural factors in countries outside North America.

Articles with a focus on non-health professions programs, such as biomedical sciences, and articles from gray literature sources were excluded. Gray literature was defined as a thesis, dissertation, non-peer reviewed study, conference proceeding or editorial. It was noted that one article could have multiple reasons for rejection. To establish clearly defined guidelines for rejection, each reason was enumerated. In each case where a paper was excluded, the primary reason for rejection was noted.

Literature search

A combination of methods was used to locate articles for this scoping review. Keywords were used to retrieve the broadest possible number of articles related to the research question, and controlled language was used to construct a narrow, defined search strategy. A discussion among the investigators, serving as content experts, and two vision science librarians, serving as technical experts, reviewed the research question in depth and resulted in a listing of the following keywords for a broad search: educational measurement, school admissions criteria, academic success, GRE admissions health professions, standardized testing graduate education. A review of the controlled language (Table 2) available in electronic databases was
conducted using the keywords to locate appropriate terms to create focused search strategies. All keywords, controlled language terms and subsequent search strategies were vetted by both vision science librarians.

The databases included in the study were selected based on library subscription, availability of controlled language search option, and comprehensive coverage of the topic. The investigators and the consulting librarians determined which search filters (Table 3) would yield the best, most relevant results. The searches of the following databases were conducted in August 2019: PubMed/Medline, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Cochrane Library.

All searches for all databases were filtered for English-only articles published in the past 10 years. Embase had the following additional filters added: Embase-only articles, articles in press, and review-only articles. After a review of the keywords, the controlled language terms were chosen to best retrieve search results that were focused more on the topic being searched.

Inter-rater reliability calibration

After mechanical and manual de-duplication of all articles resulting from the full electronic search, all investigators participated in a calibration session to determine inter-rater reliability. In this session, 14 abstracts were reviewed to gauge inter-rater reliability regarding the application of the inclusion and exclusion criteria. This session took place prior to the title, abstract and full-text review. The decision-making process for each of the articles reviewed was documented on a case-by-case basis then summarized to identify major categories for the reasons to include or exclude an article. Through discussion, the investigators’ inter-rater reliability for title/abstract review was able to reach 100% agreement.

After calibration, each investigator reviewed two-thirds of the titles and abstracts, with two investigators randomly assigned to each article. If consensus was reached by two of the investigators to either include or exclude an article, that action was immediately taken. If there was no consensus, the third investigator was used as a tiebreaker to determine final inclusion or exclusion of the article. Once a full consensus was achieved regarding every article, each investigator was randomly assigned 11 full-text articles for a thorough review.

As suggested by Arksey and O’Malley, data extracted from each source were charted and entered into a data-charting form using the database program Excel. Data were charted independently by each investigator with confirmations by co-investigators when questions arose. Data charting focused on summarizing each publication’s process and methodology, predictors and outcomes. For each source included in the scoping review, the following variables were included: authors, year of publication, study location (to ensure United States or Canada), health professions studied, study design utilized, standardized admissions test evaluated, outcome measures or indicators of success and means of measuring outcomes, statistical test, results and significance level, and the publication’s main conclusions.

Results

A total of 323 articles underwent title and abstract review by two authors to determine inclusion for full article review. Of the 323 articles reviewed, the two authors agreed on 305 (94.4%) of the articles, with 18 (5.6%) articles requiring a title and abstract review by the third author. Of the 18 titles and abstracts that underwent a review by the third author, five were accepted for the full article review, resulting in a total of 33 articles accepted for full article review and 290 rejected articles. The primary reasons for rejection were summarized in Table 4. After the full article review, 18 additional articles were excluded for the reasons summarized in Table 5. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart20 for this review can be found in Figure 1.
The final scoping review was completed for a total of 15 papers (Table 6). The six different health professions represented in the 15 papers included in the scoping review were pharmacy (5 papers), dental medicine (3 papers), veterinary medicine (2 papers), physical therapy (1 paper), allopathic medicine (3 papers), and allopathic medicine combined with PhD (1 paper).

Four different standardized tests were represented in the papers included in the scoping review: GRE (four articles), Pharmacy College Admission Test (PCAT – five articles), Dental Admission Test (DAT – two articles), and MCAT (four articles).

The majority of papers included in the scoping review assessed more than one primary outcome variable. Eleven of the papers included some assessment of the association between standardized tests and gGPA, including the ability to predict the gGPA at different points in the program, such as at the time of graduation, in the first-year curriculum, multiple years in the program, or for specific courses such as basic science courses or clinical evaluations. Eleven of the papers evaluated the association between standardized tests and performance on board examinations. Three papers evaluated the predictive value of standardized exams on residency success. One paper evaluated the predictive value of the MCAT on gGPA, time to defend PhD, board scores, publication number and career outcomes.

Ten of the papers reported positive findings. The DAT, GRE, MCAT and PCAT were all found to be predictive of board examination results.\(^{21-26}\) The GRE, DAT and PCAT were found to be positive predictors of gGPA.\(^{25,27-29}\) One paper found that the GRE indirectly predicted board scores via the gGPA.\(^{32}\) Thus, in essence, the gGPA was more predictive of board scores than the GRE.

Five of the papers reported somewhat mixed results. For example, it was found that the PCAT was predictive of gGPA; however, PCAT scores were inadequate when used alone.\(^{30}\) PCAT scores were also found to be less strongly predictive of pharmacy program GPA than the uGPA.\(^{31}\) One paper found that PCAT scores were predictive of pharmacy program GPA but not predictive of board examination results.\(^{28}\) Similarly, another paper found that the DAT was less predictive than the uGPA for the gGPA.\(^{27}\) One paper found that the GRE indirectly predicted board scores via the gGPA.\(^{32}\) Thus, in essence, the gGPA was more predictive of board scores than the GRE.

Three papers did not find an association between a standardized test and the outcome of interest. In two studies, the MCAT did not predict board examination results or gGPA.\(^{33,34}\) In one study, the GRE did not predict specialty board results.\(^{35}\)
Several limitations are noted for this scoping review. The review did not yield any optometry-specific literature using the databases that the investigators chose; thus, optometry-specific literature was not included in the scoping review. Additionally, the review focused only on graduate, doctoral-level health professions in the United States and Canada. Other research for non-doctoral-level professions as well as research in other countries may have provided additional insight into this research question. The authors decided not to include literature about nursing programs due to the wide range of programs and varying pathways to degree attainment within the profession as it differs greatly from the traditional academic trajectory of an optometry student. Including studies from doctoral nursing programs may add additional insight about the question at hand. The time frame for inclusion in the scoping review was limited, and publications before and after the period of the review may provide additional information. The scoping review used qualitative techniques for interpreting the data and did not employ quantitative methods. Additional research on this topic might have been found by including published abstracts, conference proceedings or other sources of gray literature. Despite these limitations, this scoping review seeks to shed light on a topic of great interest for the profession of optometry, particularly due to the paucity of current research on this topic as it relates directly to optometric education.

**Discussion**

Standardized tests have been used to assess academic aptitude in order to determine student preparedness for higher education. Initially designed to minimize potential for bias and increase accuracy in assessing students’ intellectual ability, standardized tests have come under increasing scrutiny due to possible bias against low-income, minority and female students. In addition to this drawback, many have questioned the true ability of standardized exams to predict student success, particularly in under-represented populations. The purpose of this study was to conduct a scoping review of the ability of standardized tests to predict success in doctoral health professions programs in order to shed light on the role of these exams for admission into optometry school.

The results of the scoping review suggest that health professions programs are invested in evaluating the predictive value of standardized testing as a tool to be utilized in the admissions process. Most of the publications included in this scoping review assessed the relationship between standardized testing and academic achievement within a specific health professions program. Few publications carried the assessments further into correlations with ultimate success in clinical practice. The publications included in this scoping review demonstrate disagreement about the value of standardized exams in predicting success in doctoral-level health professions education.

The limited number of articles included in this scoping review suggests that there is not an abundance of solid evidence to support the value of standardized testing for admissions decision-making in the health professions. There certainly appears to be some evidence of the value of standardized exams to predict academic success, but the magnitude of the potential benefits of testing has not been compared to the potential costs of limiting access to, and perpetuating bias against, under-represented student groups. Because the predictive value of standardized exams cannot be compared for applicants who did not matriculate into a health professions program, there is no means of knowing how many of those candidates would have been successful in the programs they were denied entrance into based on their exam scores. There is also no way to measure the ultimate impact on the pipeline of healthcare providers and the public who would have been served by the individuals who were denied entrance into the various programs.

Since the first administration of the OCAT in 1972 (which was renamed Optometry Admission Test in 1987), few studies have explored the ability of the exam to predict success in optometry school. Out of eight studies that looked at the predictive value of the OAT, four studies used the first- and second-year optometry GPA as the main outcome measures. Another four studies looked at additional outcome measures, including class rank at graduation, clinic performance, cumulative 4-year GPA, and National Board of Examiners in Optometry (NBEO) Part 1 performance. Three of these studies were published in the year 2000 or earlier, which makes extrapolating the results to today’s optometry students extremely problematic as substantial changes have been made to both the OAT and individual program curricula since the studies were conducted. These circumstances highlight the necessity for updated research on this topic so that optometry admissions committees do not continue to rely on outdated information to guide their admissions policies. Until such studies come to fruition, it behooves optometric institutions to look at what is currently known in other doctoral health professions about the role of standardized exams in predicting academic success that is not limited to first- and second-year gGPA. This scoping...
review aims to achieve exactly that, and its findings can be utilized by optometric institutions until new optometry-specific research comes to light.

Of particular interest to the authors of this study is the value of standardized examinations in admissions decisions for schools and colleges of optometry. While optometry programs continue to review the potential benefits and limitations of the OAT, until very recently all 23 schools of optometry in the United States required a graduate entrance exam as part of their admissions criteria. Historically, all 23 programs required the OAT, but in recent years many optometry schools have started to accept other graduate entrance exams in lieu of the OAT, including the GRE, DAT, PCAT and MCAT. While several studies suggest a positive predictive value of the OAT for academic success in optometry school, the shift away from the OAT by many optometry schools leads one to ask what predictive power the exam truly has for ultimate student success, and whether requiring an entrance exam negatively affects the diversity of the student body across all 23 programs. Furthermore, given the fact that many optometry schools are now accepting the GRE, DAT, PCAT and MCAT in lieu of the OAT, the results of this scoping review provide timely and valuable information for optometric institutions by looking at their predictive value for success in other doctoral health professions where the exams have been utilized for far longer.

There is certainly an increasing move away from requiring standardized examinations across many disciplines, including the health professions, due to several reasons. If the recent decision by Indiana University School of Optometry (IUSO) to move toward test-optional admissions requirements is any indication, the profession of optometry may start to follow suit. One of IUSO’s motives for the pivotal change is its finding that “test scores are becoming a weaker predictor of future academic success,” which is at least partially consistent with the results of this scoping review. In light of this, the glaring lack of optometry representation in the literature search on this topic is greatly concerning. It needs to be ameliorated with future research so that optometry admissions committees have sound and current data on which to base their admissions decisions so they may ensure student success in their programs without affecting the diversity of their graduates.

Conclusion

This scoping review demonstrates the limited body of research on a critical topic and highlights the need for further exploration to fully understand the complexities of the value of standardized testing as part of the admissions process for doctoral health professions programs, particularly for the profession of optometry. The paucity of studies on this topic, particularly in regard to optometry, is troubling due to the ever-increasing demand for qualified and diverse healthcare providers. Understanding the framework of doctoral health professions education and the lessons that have been learned by other doctoral health professions will help guide decision-making by optometry admissions committees until new and relevant optometry-specific research is published. The current studies that exist on this topic suggest conflicting data about the ability of standardized exams to predict student success in doctoral health professions education. This finding makes it even more critical to invest in research on this topic as standardized exams can heavily disadvantage certain student populations, thus negatively impacting the profession of optometry by decreasing the diversity of the healthcare provider force.

Of particular interest to the authors is the ability of standardized exams to predict student success in optometry school and future clinical practice. There exists a dire need for longitudinal research comparing students admitted with and without the OAT and their success in school and in future optometric careers. Retrospective analyses of longer-term outcomes, such as on-time licensure, NBEO success on first attempt, residency placement or measures of “practice success” linked back to pre-matriculation variables, including standardized test scores, will shed more light on the value of standardized exams in the optometry admissions process. Furthermore, due to the growing utilization of the GRE, DAT, MCAT and PCAT in lieu of the OAT for optometry school admissions across many institutions, it is imperative for similar research to be conducted about the validity of those exams in predicting short- and long-term success outcomes for optometry students. Until such research comes to realization, the current scoping review provides vital information about the utility of these exams in predicting success in other doctoral health professions. Prospective comparison within and between programs for policies of test-optional or test-agnostic admissions vs. traditional requirements for OAT would yield tremendous information that admissions committees could utilize when selecting students into their programs. Additionally, case studies to further elaborate on perceived barriers and biases associated with the OAT are necessary to complete the picture of why this research needs to be conducted in the first place.

Acknowledgments

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2. Angela Lee, Associate Professor, Health Science Librarian, Pacific University

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Introduction

Torpedo maculopathy (TM) is a rare, congenital, predominantly unilateral macular lesion. TM lesions can be classified as type I or type II with the assistance of optical coherence tomography (OCT). Both classifications of the condition are typically non-progressive, but a few reports of accompanying progressive pathology exist in the literature.\(^1\)\(^2\) TM often presents with a classic fundoscopic appearance and a frank lack of symptomatology. Optometrists play a key role in properly diagnosing and managing this condition as it is most often first seen incidentally during a routine comprehensive eye exam. It is important to differentiate TM, a typically benign and non-progressive condition, from other progressive pathologies that may require treatment. Patient education is particularly important for rare conditions such as this because it allows patients to better communicate their diagnosis with future eyecare providers. This case report outlines the presentation, diagnosis and management of TM type II in a 68-year-old White man and is directed toward third- and fourth-year optometry students, optometry residents and practicing doctors.

Student Discussion Guide

Case presentation

A 68-year-old White male presented to the eye clinic for a comprehensive eye exam. His chief concern was bilateral near blur with his +2.75D over-the-counter reading glasses. He had no other associated symptoms such as eye strain or headaches at presentation. He was happy with his distance vision correction. According to previous records, the patient’s ocular history was significant for mild non-proliferative diabetic retinopathy without macular edema in both eyes, dry eye syndrome from which he experienced relief with over-the-counter artificial tears, a bilateral blepharoplasty in 2015, hyperopia, presbyopia and a scar of unknown etiology adjacent to the macula in the left eye.

The patient’s medical history was significant for abdominal pain, alcoholism, anxiety, cardiomyopathy, dermatitis, diabetes mellitus type II, diverticulitis, gastroesophageal reflux disease, hyperlipidemia, hypertension, ischemic heart disease, obstructive sleep apnea, surgery of back, knee and neck, and umbilical hernia. The patient’s diabetes was managed with insulin, metformin and saxagliptin. His last blood sugar reading that morning was 118 mg/dL, and his most recent A1c was 8.0% one month prior. His other medications included aspirin, atorvastatin, baclofen, clopidogrel bisulfate, hydrochlorothiazide, lisinopril, metoprolol succinate, omeprazole, sertraline and spironolactone. The patient had no significant family ocular or medical history.

At presentation the patient’s visual acuities with his distance correction were 20/25 OD and 20/20 OS. Lensometry readings of his distance correction were +1.75sph OD and +1.50sph OS. His entering near acuities with his over-the-counter reading glasses were 20/25 OD and OS. Pupils, extraocular muscle movements and confrontation fields were all unremarkable in both eyes. His vision was correctable to 20/20 OD and OS at distance and near with small changes in refraction, OD: +2.00sph, OS: +1.50sph, add: +1.50. The patient preferred a lower add for his age due to his tall stature and longer reading distance.

Anterior segment evaluation was unremarkable in both eyes. Intraocular pressures by Goldmann applanation tonometry were 16 mmHg in each eye. The dilated ocular health exam revealed a few scattered hemorrhages and microaneurysms in the posterior pole of both eyes consistent with mild non-proliferative diabetic retinopathy. The macula was flat in both eyes without any apparent edema. The left eye had a lesion superior-temporal to the macula, beginning just adjacent to the fovea. The lesion appeared as a flat oval area of hypopigmentation with sharp borders and retinal pigment epithelium (RPE) hyperplasia at the temporal edge (Figure 1). The lesion was ellipsoid, longer horizontally at 1.5 disc diameters (DD) and 1 DD vertically. There was no evidence of edema, hemorrhaging or abnormal vasculature associated with the lesion. The optic nerve head...
appeared healthy and well-perfused and had a cup to disc ratio of 0.30/0.30 H/V in both eyes. There were no significant peripheral retinal findings in either eye.

The same day, fundus photography (Topcon TRC-NW200 Fundus Camera, Topcon Healthcare), OCT (Spectralis OCT, Heidelberg Engineering) and Humphrey visual field testing (Humphrey Visual Field Analyzer II-i, Carl Zeiss AG) were performed. The fundus photographs revealed mild non-proliferative diabetic retinopathy without macular edema in both eyes, and a unilateral macular lesion with a characteristic shape, appearance and location in the left eye (Figure 1). The OCT line scan through the lesion showed outer retinal attenuation and choroidal excavation consistent with type II TM (Figure 2). A 24-2 SITA-Fast test was performed in each eye. The visual field assessments were reliable in each eye. The field for the right eye was essentially clear, while the left eye had a dense central defect corresponding to the torpedo lesion location (Figure 3).

![Figure 2. Optical coherence tomography single-line scan through the center of the macular lesion showed outer retinal attenuation and choroidal excavation consistent with torpedo maculopathy type II.](Click to enlarge)

![Figure 3. Humphrey visual field test results of the right and left eye showing an essentially normal field in the right eye and a dense to absolute defect in the left eye corresponding with the retinal lesion location. This pattern is consistent with torpedo maculopathy type II.](Click to enlarge)

The patient was diagnosed with TM type II in the left eye, and the examination findings were explained to him. Because this condition is typically non-progressive, and the patient had good visual acuity, he was instructed to return in 1 year for his comprehensive eye examination. This recommended follow-up interval was also appropriate for his other examination finding of mild non-proliferative diabetic retinopathy without macular edema. At the next comprehensive eye exam 1 year later, the torpedo lesion and OCT findings were stable.

**Educator’s Guide**

**Key concepts**

1. Recognize the signs and pattern of presentation of TM
2. Discuss differential diagnosis for TM and other similar retinal lesions
3. Review appropriate auxiliary testing to be performed as part of workup and management

**Learning objectives**

1. Describe the classic funduscopic presentation of TM and lack of symptoms
2. Describe other similar retinal lesions and how they differ from TM
3. Understand current theories of lesion epidemiology
4. Identify additional testing that should be performed to confirm diagnosis and further classify the lesion
5. Outline a management plan for a patient with TM

**Discussion questions**

1. Knowledge, understanding and facts about the clinical case and condition presentation
   a. What is the pathophysiology of TM and how is it suspected that the lesion forms?
   b. Describe the classic appearance and presentation of TM
c. Does a patient with TM typically present with related symptoms?
d. What are the differentiating features of TM type I and TM type II?

2. Differential diagnosis

a. What other conditions are on the list of differential diagnoses?
b. How can TM be differentiated from other similar retinal lesions?
c. What testing should be done at initial presentation before TM is diagnosed?

3. Patient management and role of the optometrist

a. What is the typical prognosis of TM?
b. How would you manage TM following the initial diagnosis?
c. How might your management differ with an atypical presentation?

Assessment of learning objectives

This case may be used in either the classroom or clinical setting. For classroom learning and assessment:

- The case and images can be used to enhance an advanced ocular disease course lecture.
- Live quiz features (TurningPoint, Turning Technologies LLC) or Zoom Polling (Zoom Polling, Zoom Video Communications, Inc.) during presentation may assess understanding of key concepts in real time.
- Knowledge can also be assessed through traditional examination techniques such as multiple-choice or fill-in-the-blank questions based on case presentation or pathology imaging.

For learning and assessment in the clinical setting:

- The case can be presented and discussed in small groups.
- Discussion about the use of OCT can increase the knowledge base of retinal imaging and diagnosis.
- The extensive medical history and medication list involved in this case can be used to review systemic disease and general pharmacology. One activity could include developing a table or list of this patient’s systemic conditions and the corresponding medication used to treat that condition.

The recommended approach for this case would be to first review the learning objectives and read the discussion questions. Then, read the case presentation. Finally, use the Educator’s Guide to answer the discussion questions and fulfill the learning objectives. This case information could also be used to generate a slide show about this condition and/or case.

Discussion

Epidemiology and pathophysiology

Torpedo maculopathy is a rare, congenital condition that predominantly presents unilaterally. It has a characteristic funduscopic appearance. The lesion was first alluded to in 1989 by Gass and further described in 1992 by Roseman and Gass as a hypopigmented nevus of the RPE. Shortly thereafter, it was renamed torpedo maculopathy. The lesion is occasionally referred to as paramacular coloboma, solitary hypopigmented nevus and amelanotic nevus. In 2018, Shirley et al. studied TM in the pediatric population and reported a prevalence of 2 per 100,000 in patients younger than 16. It is thought that this may be an underestimation of the true prevalence due to the asymptomatic nature of the condition. In 2021, a large systematic review found 110 case reports of TM in the literature.

While TM is congenital, the etiology of the lesion is somewhat debated. One theory suggests that the lesion is formed due to a disruption in choroidal vasculature development. In 2010, Shields et al. outlined the most widely accepted explanation of the etiology, suggesting that the lesion is derived from the “site of the fetal bulge.” This theory postulates that a bulge forms in the temporal-macular retina during 4-6 months gestation, and while this bulge retracts during later months of gestation, it is thought that a mild residual depression remains. It is believed that a disruption in the RPE cells occurs at this time within the residual depression, resulting in the torpedo-shaped lesion. This RPE disruption can also lead to significant attenuation of RPE cells and outer retinal layers, or a complete loss of the RPE cells altogether. Occasionally, the torpedo lesion may have an associated satellite lesion presumed to arise from the same process. Once the TM lesion is formed, it tends to be a stable, non-progressive finding. However, a few isolated case reports have outlined atypical comorbidities or progression of the lesion.
The TM lesion is flat, oval shaped, and has well-defined borders. The vast majority of cases have presented unilaterally. When the fetal bulge retracts during gestation and leaves RPE disruption in its wake, the classic torpedo shape remains along with hypopigmented tissue nasally and hyperpigmented RPE hyperplasia temporally. The lesion is always temporal to the fovea due to the corresponding site of the fetal bulge. It is ellipsoid and longer horizontally than vertically, with a point facing toward the fovea matching the shape of the bulge. This classic appearance and location is pathognomonic for TM.

Fortunately, individuals with TM are typically asymptomatic. Therefore, the condition is most often diagnosed incidentally during a comprehensive eye exam. For this reason, optometrists play a key role in the initial diagnosis and management of patients with TM. Patients typically obtain 20/20 visual acuity in the involved eye because the lesion rarely involves the fovea. There have been a few case reports in which vision is slightly reduced, but this seems to be more common with other associated pathology. Scotomas of varying depth may be present but are often not bothersome and unknown to the patient due to the congenital nature of the lesion.

It is well-documented that the majority of TM lesions are benign and remain stable. Few case reports have noted progression or associated complications. To the author’s knowledge at this time, there has been one case report of a neurosensory retinal detachment, and three case reports of choroidal neovascular membrane (CNVM) associated with TM. As additional case reports emerge, there is more to be learned about potential comorbidities of this condition. For most cases, the prognosis for TM is good, and risk of vision loss or visual complication is low.

**Auxiliary testing and differential diagnosis**

In addition to the funduscopic evaluation, auxiliary testing can be used to help differentiate and confirm the TM diagnosis and further classify the lesion. In particular, OCT can significantly assist in this endeavor and is key to torpedo lesion classification. TM can be classified as type I or type II based on the presence or absence of retinal and choroidal excavation on OCT; both types have outer retinal layer attenuation. Type I TM is characterized by outer retinal attenuation without retinal and/or choroidal excavation, and type II TM is characterized by outer retinal attenuation with retinal and/or choroidal excavation. In addition to TM classification, OCT can also help differentiate the lesion from other retinal pathology. For example, in retinal scars from toxoplasmosis, the inner and outer retina is attenuated, but in TM the inner retina will remain unchanged; this can be readily observed on OCT cross-sectional scans (Table 1). OCT angiography has shown hypopigmentation at the temporal edge of the lesion, typically in the corresponding location of the choroidal excavation and RPE hypertrophy, while hyperpigmentation is observed closer to the fovea. Fundus fluorescein angiography has been performed on patients with TM and has shown no leakage in areas of retinal and choroidal excavation unless an associated CNVM is present.

Fundus photography is a helpful tool for baseline documentation of TM and can be used to show the lesion to the patient as part of patient education. Due to the varying degree of RPE loss and retinal attenuation, visual field defects are variable in type I TM. Visual field defects are always present in type II TM due to the loss of RPE cells accompanying the choroidal excavation. Baseline visual field testing is useful as it can be used to distinguish long-standing scotomas from new pathology. This is arguably more important in type I TM where the visual field defect is variable and thus may be due to a different etiology. Both 10-2 and 24-2 visual field tests have been used to map TM lesions and there does not yet appear to be a clear recommendation for one test vs. the other.

Other lesions that may appear similar to TM include toxoplasmosis scars, congenital hypertrophy of the retinal pigment epithelium (CHRPE), histoplasmosis scars, traumatic scars and amelanotic nevi. These lesions can be differentiated based upon their appearance, location, laterality, associated visual field defects and OCT features (Table 1). A thorough case history is another important tool for differentiation. It may be helpful to ask the patient if they have had a history of toxoplasmosis infection, blunt ocular trauma, or a history of living in the Ohio-Mississippi River Valley region due to the higher risk of histoplasmosis exposure in that geographic area.

### Table 1. Click to enlarge
Differentiation of similar retinal lesions:

- **Toxoplasmosis** scars present in the retina after a toxoplasmosis infection has subsided. These scars are full-thickness chorioretinal scars that typically present within the posterior pole and may involve the macula. Toxoplasmosis scars can be differentiated from TM due to their full-thickness chorioretinal atrophy and their non-uniform location, shape and size. A known history of toxoplasmosis infection can be helpful in determining the cause of retinal findings.

- **CHRPE** are pigmented lesions with well-defined borders. They may have a pattern of hyperpigmentation and hypopigmentation depending on the presence and location of lacunae. CHRPE lesions are most often found in the periphery of the retina and rarely present near the macula, which is a key differentiating factor from TM.

- **Histoplasmosis** is a fungal infection endemic to the Ohio-Mississippi River Valley. Patients with this condition would most likely have lived in or visited that region. Histoplasmosis scars are found in the retina after a histoplasmosis infection has resolved. These scars are often numerous and occur along with peripapillary atrophy and CNVM. The numerous lesions along with the two other classic findings of histoplasmosis can be used to differentiate this condition from TM.

- **Chorioretinal scars** may present following blunt ocular trauma. These scars have varying degrees of hyperpigmentation and hypopigmentation. They most often occur concentric to the optic nerve head and are typically vertically elongated in the pattern of a choroidal rupture. Patients with chorioretinal scars would have a history of blunt ocular trauma to the involved eye.

- **Amelanotic nevi** are round non-pigmented or hypopigmented retinal lesions most often found in the retinal mid-periphery or periphery. These lesions are rarely found near the macula, thus a key differentiator from TM. Although amelanotic nevi have a variable OCT presentation, they typically lack the outer retinal attenuation and excavation seen in TM.

**Treatment and management**

Management of TM is typically observational and includes an annual dilated fundus exam. Baseline testing should be performed at initial presentation and should include fundus photography, visual field testing and OCT. OCT is particularly useful not only to determine the type of TM but also to differentiate the lesion from other similar retinal pathology and confirm the diagnosis (Table 1). Many case study authors have described TM as non-progressive, but Wong et al. postulated that the lesions may progress very slowly over many years. However, no treatment or intervention has been deemed necessary for retinal and/or choroidal excavation as seen in type II lesions without other associated pathology. OCT can be used to confirm stability by measuring the area of outer retinal atrophy or choroidal excavation. Isolated case reports of accompanying CNVM have shown good outcomes with anti-VEGF therapy. Atypical presentations of the condition may require more frequent follow-up or at-home monitoring with an Amsler grid. The presence or suspected presence of CNVM or retinal detachment necessitates referral to a retina specialist for further evaluation and management.

Patients with TM should be educated on the congenital, typically non-progressive nature of the lesion. Thorough patient education is important for rare conditions such as this to improve individuals’ awareness of their diagnosis and enable better communication and continuity of care at future eye health visits. Patients should be advised of the potential rare accompanying pathology and advised to return if symptoms arise. Because pediatric patients are less likely to report symptoms, the importance of maintaining their routine eye exams should be emphasized. Proper identification and diagnosis of TM can be challenging due to the rarity of the condition. An increasing number of case reports, systematic reviews, and optometric education may assist with awareness and thus proper diagnosis and management of this condition.

**Conclusions**

Torpedo maculopathy is a rare, congenital retinal lesion with a unique funduscopic appearance. Patients with TM are typically asymptomatic and have 20/20 visual acuity. TM can be diagnosed upon funduscopic examination and can be further classified into type I or type II TM based on OCT appearance. TM is classically non-progressive and can be managed with annual observation. Few case reports have documented TM with accompanying pathology, but patients should be educated about the potential for these rare associations. It is important to differentiate TM from other progressive retinal pathology in order to determine appropriate management plans. Additionally, thorough patient education is imperative for rare conditions such as this so the patients can better communicate their diagnosis in subsequent encounters. This case outlined a typical presentation and appearance of TM type II that was managed with annual observation.

**References**

Transient Vision Loss: a Teaching Case Report
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Dipl. | Optometric Education: Volume 47 Number 1 (Fall 2021)

**Background**
Transient vision loss is the acute loss of vision, either monocular or binocular, lasting less than 24 hours.\(^1\) The potential etiologies are wide-ranging, and many are ocular or systemic emergencies. A thorough case history and attention to patient demographics is key. Clarifying the laterality, duration, pattern of loss and recovery, associated visual and systemic symptoms, provoking factors, patient age and personal and family health history can guide the physician to an accurate diagnosis. The ocular examination can reveal the direct cause (as in retinal embolus), but in some cases the exam may be normal. Determining the most likely cause of vision loss directs further evaluation and treatment to preserve vision and overall health.\(^1\,^2\)

Transient vision loss is a common symptom presenting to eyecare providers. Its evaluation, treatment and management are learned skills. The target audience for this teaching case report is optometric educators with the targeted learner being third- or fourth-year optometry students and optometric residents.

**Student Discussion Guide**

**Case description**
A 70-year-old Black male presented for an emergency eye examination with the complaint of acute, recurrent, transient vision loss of the right eye (OD) presenting as gradual dimming and inferior altitudinal visual field loss with associated angina pectoris. The first episode occurred 6 months prior to the visit and recurred monthly with a duration of 5 minutes. The vision loss was not gaze-evoked or associated with photostress, Valsalva maneuver or postural change. The patient denied confusion, fever, focal weakness, dysarthria, emesis, headache, intracranial noises, malaise, nausea, neck pain, phonophobia, photophobia, photopsia, presyncope, Raynaud phenomenon, scalp tenderness, tinnitus or visual aura.

Ocular history was remarkable for dry eye syndrome and pseudophakia in both eyes (OU). Medical history was significant for aortic regurgitation, constipation, depression, eczema, erectile dysfunction, hyperlipidemia, hypertension, low testosterone, malignant prostate neoplasm (in remission), osteoarthritis, polysubstance abuse (in remission), thyroid nodule and vitamin D deficiency. Medications included bupropion (Wellbutrin XL, Teva Pharmaceuticals), vitamin D3 (cholecalciferol, Polymed Therapeutics), hydrochlorothiazide (Microzide, Allergan), loratadine (Claritin, Schering-Plough), polyethylene glycol 3350 oral powder (Miralax, Bayer Healthcare), sildenafil citrate (Viagra, Pfizer), simvastatin (Zocor, Merck) and testosterone intramuscular injections (Delatestryl, Endo Pharmaceuticals). The patient reported no known drug allergies. Family history was positive for coronary artery disease in the mother. He described a history of tobacco use, occasional alcohol intake and daily marijuana use. He was oriented to person, place and time; his mood was appropriate.

Best-corrected distance visual acuities were 20/20- OD and 20/20 left eye (OS). Pupils were equally round and reactive to light without an afferent pupillary defect. Extraocular muscles were smooth and full OU. Confrontation visual fields were full to finger counting OD, OS. Near cover test was orthophoric. Slit lamp examination revealed normal adnexa, lids, lashes, sclera, conjunctiva, cornea, anterior chamber and iris OD, OS. The posterior chamber intraocular lenses were well-centered and clear OD, OS. Goldmann applanation tonometry measured intraocular pressures of 17 mmHg OD and 18 mmHg OS at 9:37 a.m. Dilated funduscopic examination revealed normal optic nerve (cup-to-disc ratio 0.30/0.30), macula, vitreous, choroid and retinal periphery OD, OS. Vessels were mildly tortuous and attenuated with no evidence of retinal emboli OD, OS.

The patient was diagnosed with recurrent transient vision loss OD with associated angina of unknown etiology and advised to report to the emergency department for STAT physical evaluation and initiation of a stroke protocol. A phone call was made to the emergency department, and eye exam results were forwarded for review.
In the emergency department, presenting vital signs included temperature 97.4° F, pulse 65 bpm, respiratory rate 16, blood pressure 120/73, pulse oximetry 98% and chest pain scale 5/10. Echocardiogram revealed sinus bradycardia of 54 bpm. Complete blood cell count was consistent with anemia. Comprehensive metabolic panel, hemoglobin A1c, prothrombin time, partial prothrombin time, international normalized ratio, Westergren erythrocyte sedimentation rate, C-reactive protein, troponin I and urinalysis were normal. Computed tomography (CT) of the head with contrast revealed microvascular ischemic disease of the brain. Computed tomography angiography (CTA) of the head and neck showed atherosclerotic plaque at the right carotid bifurcation extending to the right carotid bulb and proximal internal carotid artery contributing to approximately 60% narrowing of the vessel as seen in Figure 1. The left side showed similar findings with approximately 50% stenosis. Chest CT with contrast revealed moderate to severe coronary atherosclerosis. Magnetic resonance imaging (MRI) of the brain with and without contrast using diffusion weighted imaging was negative for stroke. Neurology evaluation confirmed a transient ischemic attack (TIA) causing amaurosis fugax of the right eye. The patient was discharged on aspirin 81 mg daily and advised to continue all current medications. After communication of exam findings, outpatient bilateral carotid artery duplex (a.k.a. Doppler ultrasound) was coordinated with primary care within 2 weeks. Eye clinic follow-up was scheduled for 1 month. Neurology instructed that a vascular surgery consultation should be considered pending carotid duplex results.

**Educator’s Guide**

The educator’s guide includes the necessary information for teaching and discussing the case.

**Key concepts**

1. Recognizing clinical symptoms and the importance of a detailed history
2. Specifying the differential diagnoses of TVL
3. Developing management strategies to work through differential diagnoses
4. Understanding timely referral to the emergency department and other specialists

**Learning objectives**

Upon conclusion of this case, participants should be able to:

1. Describe the diagnostic criteria of TVL
2. Differentiate TVL from other vision disturbances
3. Review visual pathway and its relationship to the nature and features of TVL
4. Recommend and understand the appropriate additional diagnostic tests
5. Develop an interprofessional collaborative treatment plan for emergent evaluation

**Discussion questions**

1. Knowledge, concepts, facts and information required for critical review of the case
   a. How does the patient’s systemic health play a role in the ocular diagnosis?
   b. Does the patient fit the typical demographics of TVL?
   c. What are the history of present illness (HPI) elements that help differentiate TVL from other forms of temporary vision loss (e.g., transient vision obscurations, uncontrolled dry eye syndrome?)
   d. What other providers need to be included as part of an interprofessional care team?

2. Differential diagnosis
   a. What is the differential diagnosis of TVL after case history and after the ocular exam?
   b. What tests should be performed to narrow the differential diagnosis?
   c. What further testing may be needed pending the results of the initial studies?

3. Patient management and the role of the optometrist
a. What treatment/management would be most appropriate for the patient medically and regarding lifestyle changes?
b. How quickly should the patient undergo laboratory and imaging studies?
c. How should the patient be managed after test results are obtained?
d. How soon should a patient be seen for an eye examination with TVL symptoms?
e. Should TVL always be managed in an emergent manner?
f. How might the provider manage this case differently?

4. Critical-thinking concepts

a. In the case described, what aspects of the patient’s health history were important in determining the underlying etiology?
b. What were some of the distinguishing features of the patient’s TVL that helped guide the workup?

Learning assessment

Teaching instructions and assessment methodology can include:

The purpose of this case report is to help clinical novices critically review the case history and clinical findings consistent with TVL and to develop management strategies. A faculty member or teaching assistant could lead a discussion of the case presentation in either a large classroom setting or small group. In a larger setting, real-time audience polling can monitor student comprehension. During the discussion, students should be given the initial case presentation in a stepwise fashion (i.e., history, clinical findings, serology results, vascular imaging reports, neuroimaging studies). This enables the learner to critically think through the presentation and differential diagnosis. Following the discussion, management strategies including collaboration with other medical professionals can be reviewed. It is important for the discussion to review the various differential diagnoses and how the management strategy and referrals change depending on the case history and examination findings.

<table>
<thead>
<tr>
<th>Table 1: History Questions</th>
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<tr>
<td><strong>Monocular or binocular</strong></td>
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<tr>
<td>Age</td>
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<tr>
<td>Onset</td>
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<tr>
<td>Duration</td>
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<tr>
<td>Pattern of loss</td>
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<td>Pattern of recovery</td>
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<tr>
<td>Gaze-evoked</td>
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<tr>
<td>Preceded by light exposure / photostress</td>
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<tr>
<td>Associated symptoms</td>
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*Table 1. Click to enlarge*
Knowledge base of the pertinent case history questions can be tested through verbal discussion or listing.  
Knowledge base of the differential diagnosis can be tested through table development comparing and contrasting characteristics of varying etiologies.  
Critical-thinking skills can be expanded via review of other published TVL-specific case reports.  
Management skills can be assessed by creating various case scenarios with differing serology and imaging results.

**Discussion**

**Etiology**

Disease at any level in the visual pathway can result in temporary vision loss. However, disease to structures that refract light such as the cornea and ocular media typically do not result in complete loss of vision as light can still stimulate the retina. Disease to the retina, optic nerves, optic radiations or visual cortex can cause more explicit vision loss. This overt TVL most often stems from transient vascular compromise to the eye or afferent visual pathway in the brain. A disruption in blood flow to the retina or occipital lobe, from ischemia or vascular insufficiency whether hemodynamic or embolic, can result in a dark curtain of vision loss in one or both eyes lasting up to 30 minutes.\(^3\) Perfusion of the optic nerve and retina are also dependent on intracranial pressure. When intracranial pressure is increased, as in papilledema, simultaneous transient monocular or binocular vision obscurations that last less than 10 seconds can occur.\(^4\) To assist in finding the etiology of TVL, **Table 1** highlights important questions to ask when gathering the ocular history. Staff may find it helpful for phone triaging. **Table 2** focuses on the TVL-associated symptoms serving to further refine the differential diagnosis.

**Clinical features**

Patients presenting with TVL often have an unremarkable eye examination; however, ocular findings help point to an etiology and differentiate true TVL from other vision disturbances. The following paragraphs highlight the most common ocular

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**Table 2**

<table>
<thead>
<tr>
<th>Common Symptoms Occurring Before, During or After Transient Vision Loss</th>
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<tr>
<td>Arthralgia</td>
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<td>Decreased appetite</td>
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<td>Diplopia</td>
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<td>Dizziness</td>
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<td>Dysarthria</td>
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<td>Emesis</td>
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<td>Exacerbation with postural change</td>
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<td>Exacerbation with Valsalva maneuver</td>
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<td>Fever</td>
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<td>Focal weakness</td>
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<td>Headache</td>
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<td>Intracranial noises</td>
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<td>Jaw claudication</td>
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<td>Loss of consciousness</td>
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<td>Malaise</td>
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<td>Nausea</td>
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<td>Neck pain</td>
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<td>Phonophobia</td>
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<td>Photophobia</td>
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<td>Photopsia</td>
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<td>Presyncope</td>
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<td>Raynaud phenomenon</td>
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<td>Scalp tenderness</td>
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<tr>
<td>Skin or joint changes</td>
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<tr>
<td>Tinnitus</td>
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</table>
Dry eye syndrome, corneal erosion and corneal hydrops are known to cause vision fluctuations especially with blinking and eye-drop instillation.\textsuperscript{5}

Hyphema, including uveitis-glaucoma-hyphema syndrome, can present with gradual, diffuse "misting" of vision and slow recovery.

Subacute angle-closure attacks cause intermittent temporary vision loss from corneal edema.

Pupil abnormalities accompanying TVL increase suspicion for optic nerve or neurological disease. Ipsilateral Horner syndrome accompanied with facial or neck pain warrants emergent evaluation for carotid dissection.\textsuperscript{6}

Gaze-evoked TVL may be elicited by having the patient move the eyes and hold each position of gaze for 5 seconds with the examiner noting any change in vision function or pupil activity. Orbital disease can produce a gaze-evoked monocular TVL especially in downgaze with reading.

Dilated examination is essential to evaluate for optic nerve anomalies, retinal emboli or vascular occlusive disease. Patients with carotid and cardiovascular disease are at high risk for retinal emboli. Emboli are primarily composed of either cholesterol, which makes them refractile and gold in appearance, or a combination of platelets and fibrin, which form longer grey-white plugs that fill the vessel lumen.\textsuperscript{5} Calcium emboli, which are chalky white, globular and often near the optic disc, come from calcified heart valves.\textsuperscript{6}

Ocular ischemic syndrome (OIS) is characterized by mid-peripheral dot-and-blot hemorrhages and may cause monocular TVL, particularly with exposure to bright light known as photostress. Venous stasis retinopathy, as seen in OIS, is associated with a vascular occlusion anywhere from the heart to the eye. Sludging of conjunctival vessels is a subtle anterior segment finding in which small areas of blood pooling are evident with red-free light due to vascular impedance.\textsuperscript{7}

Optic nerve edema, optic neuritis, papilledema or other disorders disrupting the anatomy of the optic nerve can cause transient vision obscurations described as "gray-outs" or "black-outs" of vision for less than 10 seconds, often precipitated by postural change.

Delayed photostress recovery can manifest as binocular TVL in age-related macular degeneration and other bilateral maculopathies.\textsuperscript{5}

\textit{Differential diagnosis}

Tables \textbf{3} and \textbf{4} detail the differential diagnosis for monocular and binocular TVL, respectively. Careful history regarding the nature and features of TVL are an important guide to the differential diagnosis of each patient. Monocular vision loss localizes to a prechiasmal or anterior circulation problem; whereas, binocular vision loss implies a chiasmal, retrochiasmal or posterior circulation issue. Be aware that patients experiencing hemifield loss may interpret vision loss as monocular because the involvement of the ipsilateral temporal field is larger than the corresponding nasal field and non-redundant.\textsuperscript{6} Clarify whether each eye was covered to ascertain laterality. Rarely, bilateral ocular pathology presents as simultaneous TVL.
Seeing lights in the vision, known as positive symptoms, vs. darkening of vision, known as negative symptoms, is another helpful distinction. Purely negative symptoms of vision loss are more likely due to ischemia; whereas, positive symptoms commonly indicate migraine, retinal disease or occipital lobe seizure. Positive visual phenomena originate from the retina or the brain. Retinal photopsias are typically unilateral, white, lightening-like flashes that last for less than 1 second. They are often noted with retinal breaks or epiretinal membranes. Neurologic photopsias are generally bilateral, white or colored, positive vision disturbances lasting longer than a few seconds to several minutes.

Symptoms of intracranial noises, pulse-synchronous tinnitus, headache, diplopia, nausea and emesis can point to elevated intracranial pressure.

Giant cell arteritis (GCA) should be of concern in elderly patients with TVL, especially in combination with temporal headache, scalp tenderness or jaw claudication.

Transient binocular vision loss noted as a small scotoma in homonymous portions of the visual field surrounded by jagged, shimmering edges is called a scintillating scotoma. The scotoma enlarges over 20-30 minutes but no longer than 60 minutes and then gradually disappears. The vision loss may enlarge to a complete homonymous hemianopsia. A hemicranial, throbbing headache, known as a migraine with aura, follows. A migraine aura without headache, formerly known as acephalgic migraine, presents as binocular TVL as described above; no headache follows. Giant cell arteritis (GCA) should be of concern in elderly patients with TVL, especially in combination with temporal headache, scalp tenderness or jaw claudication.

Vertebrobasilar ischemia can cause complete binocular TVL with both eyes affected equally and at the same time. Patients with vertebrobasilar ischemia may also present with other neurologic symptoms such as speech or vestibular deficits. Table 4 details considerations for the underlying etiology.

Retinal or ocular migraine presents with at least two attacks of recurrent, monocular aura similar to classic migraine aura in appearance and progression. The aura is followed by a headache occurring within 60 minutes of the vision disturbance. This group of patients often has a personal or family history of migraine and they are predominantly females younger than 50. This
is a diagnosis of exclusion; therefore, workup is warranted.\textsuperscript{3}

Gaze-evoked TVL is indicative of an orbital space-occupying lesion such as cavernous hemangioma, optic nerve sheath meningioma, orbital inflammatory disease, thyroid orbitopathy or foreign body.\textsuperscript{10} Compression of the orbital vasculature and reduction of blood supply are often monocular in nature.

Carotid artery disease is a common cause of monocular TVL, whether from narrowing due to plaque formation, embolus, plaque ulceration and hemorrhage, carotid trauma or carotid dissection. Recurrent orbital or facial pain that improves when the patient lies down is highly suggestive of carotid occlusive disease. Ultrasound imaging, magnetic resonance angiography (MRA) and CTA can all be used to assess for carotid artery disease. Carotid dissection may be too distal to be visualized on carotid ultrasound; therefore, MRA or CTA of the head and neck is indicated to exclude this diagnosis.\textsuperscript{4} An ipsilateral Horner syndrome with headache or neck pain indicates a carotid dissection until proven otherwise.\textsuperscript{6}

Other less common causes of insufficient vascular supply to the eye may include stenosis or dissection of the ophthalmic artery, aortic arch atheroma, arteriovenous malformations, intravascular lymphoma, hypercoagulable states, systemic hypotension, vasospasm or vasculitis.\textsuperscript{5}

**Management**

TVL is a symptom of an underlying disease; therefore, there is no single protocol for treatment. As such, this case report highlights the relevance of collaboration with other members of the healthcare team to most effectively manage the health of the patient. Management is aimed at treating the underlying condition to reduce symptoms and prevent future complications. Depending on the suspected cause and onset of symptoms, this may require emergent referral for stroke protocol initiation, outpatient serology and/or imaging, referral to other specialists, or coordination with the patient’s primary care doctor and the patient to implement appropriate lifestyle changes. The following discussion offers guidance for common causes.

If the ocular examination reveals pathology consistent with an ocular or orbital etiology, the patient should be managed as appropriate. Gaze-evoked TVL warrants neuroimaging with an MRI study preferred.

Patients experiencing central retinal artery occlusion (CRAO) or branch retinal artery occlusion should be carefully followed for the ocular sequelae and undergo emergent stroke protocol at a stroke-certified hospital. Management should also include mitigating other risk factors for stroke such as hypertension, hyperlipidemia and diabetes and implementing lifestyle changes such as tobacco cessation, healthy diet/nutrition, exercise and stress reduction. A study of vascular risk factors and CRAO found that 64% of patients with CRAO had at least one new vascular risk factor that was not known prior to the occlusive event, with hyperlipidemia being the most common.\textsuperscript{11}

In patients presenting with complete monocular TVL (also known as amaurosis fugax), especially with a history of cerebrovascular risk factors, carotid disease should be highly suspected whether retinal emboli are present or not. Approximately 19% of patients with amaurosis fugax were found to have significant carotid stenosis.\textsuperscript{12} The absence of retinal emboli does not rule out carotid disease. Patients presenting with retinal emboli who are experiencing TVL have a much higher chance of having significant (>69%) carotid artery stenosis than asymptomatic patients with retinal emboli.\textsuperscript{13} Emergent referral for a stroke workup is warranted for those suspected of TIA or evolving stroke. Patients diagnosed with mild or moderate carotid stenosis are typically managed with anti-platelet medications and lifestyle changes with annual bilateral carotid artery duplex. Carotid artery disease >69% warrants vascular surgery consultation for possible carotid endarterectomy or angioplasty with stenting. When carotid evaluation is normal and a thromboembolic cause is suspected, an echocardiogram and electrocardiogram should be considered to evaluate for a cardioembolic source.\textsuperscript{1}

TVL presenting with head pain, scalp tenderness or jaw claudication is highly suspicious for GCA. Ninety percent of known GCA cases present with ocular signs or symptoms with amaurosis fugax reported in 20-30% of them.\textsuperscript{14,15} GCA should be a differential in any patient older than 50 with TVL. Important serology testing includes complete blood count with platelet differential, Westergren erythrocyte sedimentation rate, and C-reactive protein. GCA-associated vision loss is often severe, with 43% of cases presenting with transient vision loss resulting in significant permanent vision loss after treatment.\textsuperscript{16,15} Recognizing early signs and symptoms of GCA prior to sustained vision loss is important for early treatment with steroids and better visual prognosis. With overlap in health and lifestyle risk factors for TVL caused by GCA and carotid disease, all patients presenting with monocular transient vision loss in the setting of cerebrovascular risk factors should be evaluated for both.\textsuperscript{12}

For recurring TVL in which other cerebrovascular testing is normal, a hypercoagulable workup should be considered. Patients at risk for acquired hypercoagulable states include who are immobile, smoke, or have elevated estrogen due to pregnancy or pharmacologic treatments including birth control.\textsuperscript{1}
Retinal migraine or central retinal artery vasospasm should be considered in cases of unilateral TVL in younger patients especially those with history of migraine or Raynaud phenomenon. Retinal migraines respond to traditional migraine management such as NSAIDS, caffeine and triptans, as well as avoidance of lifestyle triggers, if known. Calcium channel blockers such as nifedipine or verapamil can be useful for retinal vasospasm management.

Binocular TVL has a similar differential diagnosis as monocular TVL including thromboembolic causes. Binocular TVL can also be caused by occipital lobe pathology such as ischemia or compressive lesion; therefore, neuroimaging must be considered. In cases where the TVL history and examination are suggestive of TIA or stroke, emergent referral must be made to the emergency department for stroke protocol initiation.

Critical-thinking concepts

How soon should a patient be seen for examination with TVL symptoms? Because the etiology of TVL can range from benign to potentially sight- or life-threatening, emergent ocular examination is warranted. For this reason, it is not only important for the doctor to recognize the significance of TVL symptoms, it is also important for office staff to be well-trained in triaging. In the presence of a normal ocular exam with a high suspicion for vascular cause, emergent referral to the emergency department for stroke protocol initiation is warranted. Effective interprofessional collaboration can be initiated by courtesy phone call to the charge nurse or admitting physician to coordinate timely care and clarify the need for emergency evaluation.

In the case described, what aspects of the patient’s health history were crucial in determining the etiology of TVL? The patient is a 70-year-old Black male with recurrent episodes of monocular, altitudinal TVL associated with angina. Health history was positive for aortic regurgitation, hyperlipidemia and hypertension; family history was positive for coronary artery disease. This history led the clinician to suspect a vascular etiology. Given the vast differential, careful attention to age, race, gender and cardiovascular status can significantly reduce the diagnosis possibilities. Altitudinal TVL is well-known to correlate with a vascular cause. The associated symptom of angina was also key.

What were some of the distinguishing features of the patient’s TVL that helped guide the workup? Alongside the health history, a detailed HPI can help steer the diagnostic process while minimizing unnecessary tests. One of the first and most distinguishing questions to ask in a case of TVL is whether the vision loss is monocular or binocular. Other questions to follow should include the pattern of vision loss and recovery, the duration of symptoms, any known triggers such as light exposure, and any other symptoms associated with onset or resolution. Monocular TVL localizes the pathology to pre-chiasmal structures or the anterior circulation. As in the case presented, the patient’s monocular TVL correlated with a right carotid artery bulb cholesterol plaque. Altitudinal episodes of monocular TVL often have carotid or retinal embolic causes.

Conclusion

Transient vision loss is a symptom that signals underlying ocular or systemic conditions, some of which are emergent. Because patients with transient vision loss commonly present to eyecare providers, understanding the potential etiologies of vision loss and initiating evaluation and treatment are essential. To preserve life and sight, providers should be able to identify emergent conditions and initiate evaluation protocols including emergency department referral and timely communication with other medical professionals.

References

Phlyctenular Keratoconjunctivitis: a Teaching Case Report
Lindsay A. Sicks, OD, FAAO, FIACLE, FSL, and Jennifer S. Harthan, OD, FAAO, FSL | Optometric Education: Volume 47 Number 1 (Fall 2021)

Background

Phlyctenular keratoconjunctivitis (PKC) is an acute localized nodular inflammation of the conjunctiva, limbus or peripheral cornea.\(^1\)\(^2\) It is a delayed-type (IV) hypersensitivity reaction to foreign microbial proteins.\(^3\)\(^4\) The traditional association in developing countries is with *Mycobacterium tuberculosis* (sensitivity to tuberculin protein). In developed countries, the most common cause is non-tuberculous hypersensitivity to *Staphylococcus aureus*.\(^5\)\(^6\)\(^7\) In North America, an association with tuberculosis has been reported among the Inuit and Native American populations of Alaska and Canada.\(^10\)\(^13\)\(^14\) PKC also has associations with chlamydia, gonorrhea, herpes simplex virus and parasitic intestinal infection.\(^11\)\(^15\)\(^16\)

A phlyctenule is a focal, subepithelial inflammatory nodule of the eye, commonly found at the limbus (in the interpalpebral region) or on the bulbar conjunctiva.\(^1\)\(^7\)\(^8\) Repeat episodes of inflammation at the limbus can cause the phlyctenule to progress across the corneal surface (a “wandering phlyctenule”) with an elevated leading edge trailed by neovascularization.\(^1\)\(^4\)\(^9\)\(^10\)

Inflammatory cells found within phlyctenules include macrophages, lymphocytes, plasma cells and polymorphonuclear leukocytes.\(^1\)

Conjunctival phlyctenules cause mild to moderate symptoms such as blurred vision, tearing, foreign body sensation and itching. Corneal phlyctenules can progress to ulceration and tend to present with more moderate to severe eye pain, photophobia or blepharospasm.\(^1\)\(^4\)\(^20\)\(^21\)

Complications of PKC can include corneal ulceration, neovascularization, fibrosis, scarring, reduced vision and amblyopia. Secondary infection is possible if an epithelial defect is present. Corneal melting and perforation are rare, but potential, complications of persistent inflammation.\(^7\)\(^9\)\(^22\)\(^23\)

Pediatric blepharokeratoconjunctivitis (BKC) is a spectrum of chronic anterior segment inflammatory disorders in children that can lead to loss of vision.\(^23\)\(^24\) Within the past decade, the term pediatric blepharokeratoconjunctivitis has been used to describe the wide range of clinical manifestations that present with varying degrees of lid margin inflammation, meibomian gland dysfunction, conjunctival hyperemia, recurrent chalazia, conjunctival or corneal phlyctenules and keratitis, which can lead to corneal neovascularization and scarring.\(^23\)\(^24\) Some of the clinical entities encompassed under the broad term BKC include phlyctenular keratoconjunctivitis, ocular (acne) rosacea keratoconjunctivitis, atopic keratoconjunctivitis and marginal keratitis, among others.\(^25\)

Still, some suggest that eyecare practitioners should label each clinical presentation individually and treat them separately, rather than combine all the inflammatory disorders into a single, perhaps poorly defined, category.\(^25\)

Management of BKC involves suppressing the inflammatory response and reducing the antigens involved in the inflammatory process. It often requires a two-pronged approach with both anti-inflammatory and antibiotic therapies.\(^26\) Additionally, warm compresses are recommended for all patients.\(^27\) A majority of patients (97%) are prescribed topical antibiotic ointment (bacitracin or erythromycin).\(^27\) Other common additional therapies for BKC include topical steroids such as dexamethasone, prednisolone, loteprednol or fluorometholone, and/or one of a variety of oral antibiotics such as macrolides (erythromycin or azithromycin), tetracyclines (doxycycline, tetracycline or minocycline) or penicillins (amoxicillin/clavulanate or dicloxacillin).\(^1\)\(^2\)\(^12\)\(^24\)\(^26\)\(^29\) Recalcitrant, recurrent or steroid-dependent cases may benefit from more aggressive topical therapy, such as topical cyclosoripine (standard or compounded preparations) or topical tacrolimus.\(^1\)\(^2\)\(^4\)\(^26\)\(^29\)\(^31\)

Long-term maintenance of lid hygiene therapy for any associated chronic blepharitis is another critical component to continued success.\(^24\)\(^26\) Visual sequelae, such as reduced visual acuity or a large degree of anisometropia, can be successfully managed in many cases with spectacle lenses and standard contact lens designs. In cases of corneal irregularity or residual scarring, the prescription of specialty contact lens designs may optimize visual outcomes.\(^32\)\(^37\) If the corneal scarring is severe, referral for penetrating keratoplasty may also be warranted; however, corneal transplantation in children is challenging.\(^26\)\(^38\)\(^39\) Additionally, any eye prone to inflammation may have an increased risk of transplant rejection.\(^26\)

This teaching case report addresses the management of a symptomatic presentation of PKC in the setting of pediatric BKC. The treatment of choice for any corneal or conjunctival phlyctenule is a topical corticosteroid to suppress ocular surface
inflammation and prevent corneal scarring. Topical and oral antibiotics are also often prescribed for pediatric patients with PKC in order to manage the bioburden and inflammation related to their co-existing BKC. It is crucial to examine the potential side effects of both of these treatment options and to determine the proper dosage for any oral medications. This case will also review the potential visual sequelae of PKC and considerations for successful management with contact lenses after resolution.

This teaching case report is appropriate for third-year optometry students who have completed didactic coursework in infectious and inflammatory cornea and anterior segment disease, dry eye disease and blepharitis. Students should be proficient at slit lamp evaluation and corneal assessment. Some knowledge of didactic coursework in contact lenses and pediatric prescribing may be useful but is not required. This teaching case report would also be appropriate for fourth-year optometry students as a journal club/reading assignment in primary care, anterior segment or contact lens rotations. Optometry residents in primary eye care, ocular disease, pediatric optometry or cornea and contact lenses may also find this material useful.

**Case Description**

*Initial visit*

A 12-year-old female presented as a referral from an outside provider for evaluation and treatment of “large pannus, scarring and corneal neovascularization OS.”

The patient’s chief complaint was irritation and associated foreign body sensation OS only. She had also noticed redness and watery discharge from that eye. She described episodes of minor pain and itching OS. All symptoms had been present intermittently for the past 6 months but had worsened in the past week. She denied any history of chalazia. She denied any breathing problems or recent illness. There was no systemic disease history, and the patient denied having known tuberculosis (noting a recent negative tuberculin sensitivity test). She had no known allergies to any drugs or medication. She denied any other medical or ocular history, and there was no family history of any ocular disease. She was not taking any medications.

Uncorrected distance visual acuities were OD 20/200 and OS 20/80. With her habitual spectacles, visual acuities were OD 20/30-1 and OS 20/40. Entrance tests (color vision, cover test, extraocular muscle balance, pupils and confrontation visual fields) were within normal limits OU.

Retinoscopy results were OD -2.75 -1.00 x 180, 20/25, and OS -1.00 -0.75 x 170, 20/30. Distance-balanced subjective refraction
Anterior segment evaluation was performed with slit lamp biomicroscopy. **Table 1** lists the findings. Meibography with the Oculus Keratograph 5M (Oculus, Wetzlar, Germany) showed Grade 1 meibomian gland dropout on the lower lids OD and OS, along with Grade 1 dropout on the upper lid OD and Grade 3 dropout on the upper lid OS, according to the JENVIS Meibo Grading Scale (JENVIS Vision Research, Jena, Germany). Baseline anterior segment photographs were taken to demonstrate elements of the anterior segment condition to the patient and parent (Figure 1). The patient’s intraocular pressure (IOP) readings by Goldmann applanation tonometry were OD 14 mmHg and OS 16 mmHg. After the instillation of one drop of 1.0% tropicamide and one drop of 2.5% phenylephrine in each eye, a dilated fundus examination revealed no abnormalities.

The patient was diagnosed with 1) phlyctenular keratoconjunctivitis OS, 2) pediatric blepharokeratoconjunctivitis OU, 3) chronic allergic conjunctivitis OU, and 4) paracentral corneal opacity OS. The initial treatment recommendations, including the purpose of each treatment, specific therapies prescribed and the management goals, are outlined in **Table 2**. The treatment of choice for PKC is a topical steroid, so the patient was prescribed prednisolone acetate 1.0% ophthalmic suspension 4 times a day OS only. Because the dose uniformity of an ophthalmic suspension depends on the homogeneity of the liquid at the time of administration, the patient was advised to shake the dropper bottle thoroughly before each use. To manage the BKC, the patient was advised to begin lid hygiene with warm compresses using the “bundle towel” method (heating several moistened, folded, washcloth-sized towels, wrapped together into a circular bundle) and lid scrubs OU with an individually wrapped, pre-moistened lid scrub pad. She was also prescribed bacitracin ophthalmic ointment each night at bedtime OU and oral azithromycin 250 mg/day. In addition, she was started on a short-term dose of ketotifen fumarate 0.025% ophthalmic solution twice a day OU to gauge any improvement in the signs or symptoms of ocular allergy. Preservative-free artificial tears (PFATs) were also recommended as needed up to 4 times a day OU. She was asked to return for a follow-up visit, with an IOP check, in 2 weeks. We reviewed the chronic nature of BKC with the patient and parent and reviewed the potential side effects of therapy. We advised that some of the treatments may continue for 3-6 months or more depending on the clinical course of the disease. The need for aggressive management due to the risk of sight-threatening sequelae was also discussed. A follow-up visit was set for 2 weeks later.

**2-week follow-up visit**

At the 2-week follow-up visit, the patient’s symptoms had improved. She had been unable to obtain the prescribed ketotifen but noted compliance with all other medications, aside from minor lapses in lid scrub use. There were no remaining subjective symptoms of eye redness or irritation OS. Refraction and best-corrected vision were stable at this visit, although the patient noted improved subjective visual acuity OS.
On slit lamp evaluation, the lids still had mild scurf present with stable lid margin telangiectasia, moderately inspissated meibomian glands, and minimal turbid gland expression. There was still 1+ injection and 1+ papillary response on both palpebral conjunctiva. The corneal appearance had improved significantly, with regression of the corneal phlyctenule (Figure 2). Trace interpalpebral punctate staining OU, but no focal staining, was visible with sodium fluorescein. A dense scar in the inferior paracentral cornea and some inferior neovascularization with visible blood flow were present. IOP was stable at 14 mmHg OD and 14 mmHg OS.

The patient was tolerating the topical prednisolone acetate 1.0% OS and the oral azithromycin well with no side effects; therefore, they were continued at the same dosage for 2 more weeks to control the PKC. Due to the presence of persistent lid scurf and meibomian gland dysfunction OU and punctate staining OS, the warm compresses, lid scrubs, bacitracin ointment and PFATs were continued at the same dosing schedules to ensure continued management of the BKC. The patient was asked to try to obtain the ketotifen from her local pharmacy to manage the allergic response. She was also asked to look into the purchase of over-the-counter 0.02% hypochlorous acid solution spray, a topical preparation with broad-spectrum antimicrobial activity, to add to her lid hygiene regimen twice daily. This spray could be used after lid scrubs, which remove bulky debris, to further reduce the bacterial bioburden on the lids and lashes and reduce the antigens involved in the inflammatory process, thereby controlling the overall inflammatory response seen in BKC. We again reviewed the chronic nature of BKC with the patient and parent, noting the importance of long-term adherence to lid hygiene procedures. The next follow-up visit was set for 2 weeks later to allow for close observation.

1-month follow-up visit

At the 1-month follow-up appointment, the patient was symptom-free. She had been using the ketotifen twice a day OU for the past week but did not feel as though it made much of a difference. She was able to obtain the hypochlorous acid solution spray but had not started using it. She noted compliance with all other aspects of her regimen.

On slit lamp evaluation, the lids still had trace scurf present. There was still 1+ injection and 1+ papillary response on both palpebral conjunctiva. The corneal appearance was stable with persistent trace interpalpebral punctate staining OS. The patient was confirmed to have complete lid closure OU (i.e., no lagophthalmos was present). The inferior corneal neovascularization OS still showed visible blood flow but had improved slightly since the previous visit. The IOPs were stable at 12 mmHg OD and 13 mmHg OS.

We elected to continue the prednisolone acetate 1.0% at 4 times a day OS and oral azithromycin due to the persistent neovascularization and lid appearance. Warm compresses twice a day OU and bacitracin ointment each night at bedtime OU were continued, but the patient was advised she could reduce the lid scrubs to once a day in the morning OU and add in the hypochlorous acid solution spray twice a day OU. Because she had only been using ketotifen twice a day OU for 1 week, that was continued. Because punctate corneal staining that could be attributed to the use of preserved drops 6 times daily persisted, the dosing of PFATs was increased to 6 times daily OU with hopes of tapering some medications at the next follow-up in 1 month.

2-month follow-up visit

At the 2-month follow-up appointment, the patient remained symptom-free. She noted compliance with her medications and lid hygiene regimen but had only been using the PFATs 3 times a day OU and had yet to start the hypochlorous acid solution spray.

On slit lamp evaluation, the lids had minimal scurf. There was trace injection and a 1+ papillary response on both upper and
lower lids OU. The corneal appearance was improved with very trace punctate staining OS and almost complete resolution of the inferior neovascularization OS. Inactive (ghost) vessels remained in the inferior cornea, but no active blood flow was visible. The IOPs were unequal at 13 mmHg OD and 18 mmHg OS.

Due to the elevated IOP OS and resolution of the neovascularization, a topical steroid taper was initiated with dosing at 3 times a day OS for a week, then twice a day OS for a week, then once a day for a week, stopping the medication before the next follow-up in 1 month. The oral azithromycin was discontinued due to improvement in the lids, lashes and corneal appearance and the now quiescent corneal neovascularization. All lid hygiene measures were continued, including warm compresses twice a day OU, lid scrubs once a day in the morning OU and bacitracin ointment each night at bedtime OU. Because the patient had not yet started using the hypochlorous acid solution spray, it was again prescribed at twice a day OU. The ketotifen was discontinued with the intent to gauge any rebound in allergic symptoms at the follow-up visit. PFATs were still recommended at least 4 times a day OU. A follow-up was set for 1 month later.

3-month follow-up visit

At the 3-month follow-up appointment, the patient remained symptom-free. She had completed the prednisolone acetate 1.0% taper and experienced no issues after stopping the oral azithromycin. She denied any persistent itching after having stopped ketotifen. She noted continued compliance with the nightly application of bacitracin ointment, hypochlorous acid solution spray twice a day OU and PFATs 4 times a day OU. She confirmed minor lapses in the use of lid scrubs once a day in the morning OU.

On slit lamp examination, the lids were essentially clear OU, with a few areas of trace scurf. There was trace injection and a trace papillary response on both upper and lower lids OU. The corneal appearance was stable, with much of the residual scarring located below the visual axis. The neovascularization was quiescent with inactive (ghost) vessels inferiorly. The IOPs were 12 mmHg OD and 13 mmHg OS.

At this visit, the antibiotic ointment was discontinued in favor of bland artificial tear (AT) ointment for longer-term maintenance therapy due to the concern for antibiotic resistance and fungal overgrowth with long-term antibiotic use. She was allowed to discontinue the lid scrubs since she was no longer regularly using them and the lashes appeared mostly clear of bulky debris. Lid hygiene with warm compresses twice a day OU and hypochlorous acid solution spray twice a day OU was continued to maintain meibomian gland function and reduce lid bacterial bioburden. The PFATs were also continued 4 times a day OU with a plan to follow-up in 3 months unless symptoms of irritation, foreign body sensation, eye pain or light sensitivity occurred sooner.

6-month follow-up visit

At the 6-month follow-up appointment, the patient remained symptom-free and denied any flare-ups or recurrences. She noted compliance with nighttime AT ointment OU, hypochlorous acid solution spray twice a day OU and PFATs approximately twice a day OU. She had been using warm compresses at least once a day, but not always twice daily as directed. It was suggested she switch from the “bundle towel” warm compress to a microwaveable warm compress mask to improve adherence to therapy.

On slit lamp examination, the lid margins and lashes were essentially clear OU, with a few areas of trace scurf. There was trace injection and a trace papillary response on both upper and lower lids OU. The corneal appearance was stable with some reduction in density of the corneal opacity since the last visit (Figure 3). The neovascularization was still quiescent with inactive (ghost) vessels inferiorly. Some mild corneal thinning was noted in the area of scarring OS when visualizing with an optic section.

Distance-balanced subjective refraction at this visit showed results of OD -4.00 -0.75 x 160, 20/20, and OS -1.25 -2.75 x 160, 20/25. A topography image was obtained to examine the difference in astigmatism between the two eyes. The topography images can be seen in Figure 4 (OD) and Figure 5 (OS), with irregular corneal astigmatism evident OS. The IOPs were 14 mmHg OD and 13 mmHg OS.

The patient and parent were advised to continue regular lid hygiene with warm compresses twice a day OU, hypochlorous acid solution spray twice a day OU and PFATs OU as needed due to the chronic nature of the BKC. They were advised to call the office if the patient experienced any symptoms of recurrence such as irritation, foreign body sensation, eye pain or light sensitivity.

We discussed the option of contact lens fitting at this visit. The patient would be a candidate for a soft toric, gas permeable or specialty contact lens to achieve her best vision and reduce the anisometropia. She would require close monitoring due to the presence of the residual corneal neovascularization and scarring. She declined a contact lens fitting at this visit but would
consider it in the future.

Figure 3. Clinical appearance after 6 months of follow-up. Click to enlarge

Figure 4. Topography maps OD showing normal cornea with regular astigmatism. Click to enlarge

Figure 5. Topography maps OS showing corneal irregularity from residual scarring. Click to enlarge

Education Guidelines

Key concepts

1. Identification of hallmark signs and symptoms of PKC and pediatric BKC
2. Differentiating PKC from infectious or other etiologies
3. Proper prescription of oral antibiotics in pediatric patients including correct dosage calculation
4. Using patient education to assist in adherence to the prescribed treatment plan
5. Recognizing the potential for vision loss/amblyopia that exists with PKC and BKC
6. Proactively recommending contact lenses upon resolution and when indicated

Learning objectives

1. Identify and list the signs and symptoms of PKC
2. Describe the natural history/course of PKC
3. Describe populations at a higher risk for PKC, including those with co-existing pediatric BKC
4. Differentiate PKC from other conditions that may present similarly
5. Determine a management plan for a pediatric patient presenting with PKC and associated BKC

Discussion questions

1. Knowledge, concepts, facts and information required for critical review of the case
   a. Describe the signs and symptoms of PKC
   b. Describe the signs and symptoms of pediatric BKC
   c. Describe the etiology of PKC
   d. Describe several conditions that fall under the spectrum of disease that is pediatric BKC
   e. Discuss common ocular and systemic diseases to screen for in someone presenting with PKC
   f. Describe the potential side effects of treatment with topical steroids
   g. Describe the potential side effects of treatment with oral antibiotics
   h. Describe the potential side effects of treatment with topical antibiotics
   i. Describe common sequelae following the resolution of PKC
   j. Describe various options for vision correction following the resolution of PKC

2. Differential diagnosis
   a. What clinical observations and tests are used to diagnose PKC?
   b. Which clinical entities should be included in the differential diagnosis? How might they be ruled out?

3. Patient management
   a. What is the treatment of choice for PKC?
What are common management options for pediatric BKC?

Which antibiotics (oral or topical) are useful in these conditions?

What patient education should be given to the guardian(s) of a patient with this condition?

What are some concerns with the dosing of oral medications in pediatric patients?

What tests can help determine potential contact lens options for patients with corneal neovascularization?

4. Critical-thinking concepts

a. What if symptoms worsen or do not improve?

b. What if IOP starts to rise during treatment?

c. When fitting a patient with corneal neovascularization in contact lenses, what are the concerns and potential issues?

Teaching instructions and assessment methodology

This case could be incorporated into clinical or didactic discussions to achieve learning objectives. Students could also independently provide written answers to the learning objectives or discussion questions.

Clinical skills could be assessed through small group evaluation of anterior segment photography and corneal topography images, including a discussion of normal vs. abnormal findings and with a focus on describing the results as they are recorded in the electronic health record (e.g., in the written description of slit lamp findings or the interpretation/report for diagnostic testing). There could also be a discussion of the utility of photography to facilitate understanding of normal vs. abnormal findings and change over time, as well as their role in patient education. A series of presentation slides could show the case’s progression and resolution, with a discussion of which therapies to continue or discontinue based on findings.

The student knowledge base could be further assessed through student-directed presentations to compare/contrast and rule out potential differentials in the diagnosis. A role-play could occur with the preceptor playing the patient’s role and students performing a case history. The student(s) would need to ask appropriate history questions, request particular ocular examination results (provided by the preceptor) and discuss the differential diagnosis. The student(s) would then discuss the primary diagnosis, suggest an appropriate management plan, discuss the prognosis, provide patient education, and determine a follow-up schedule.

Discussion

BKC has an average age of onset of around 3 or 4, but patients may not present for treatment until they are school age or older. The condition is more common and severe among Asian and Middle Eastern children. These children are more likely to develop severe corneal complications, such as phlyctenular disease, scarring, visual loss and amblyopia. A particularly aggressive phenotype has also been identified in Caucasian children and adolescents that persists into early adult years and, in some cases, requires systemic immunosuppression. In a study of patients with chronic BKC, the majority (63%) of whom were Caucasian, corneal involvement was noted in 81% of subjects. In another study of BKC patients, the condition was most often bilateral (97% of cases) but potentially asymmetric (21% of cases) and commonly presented with eyelid inflammation (100% of cases).

Symptoms of BKC include redness, tearing, foreign body sensation, itching, photophobia and mild discharge. Signs of BKC include conjunctival hyperemia, recurrent chalazia, meibomian gland inflammation and inspissation, lid margin telangiectasia and thickening, eyelash crusting, scales or collarettes, corneal punctate epithelial keratitis and marginal corneal infiltrates. By definition, those with BKC will have lid disease, so a thorough evaluation of the eyelashes, lid margin, conjunctiva and cornea are required for diagnosis. Reports indicate between 14% and 50% of pediatric patients with BKC present with classic phlyctenules while up to 62% have inferior corneal vascularization and infiltrates. Punctate keratitis is common, occurring in a reported 55-87% of patients with active disease.

In PKC, pediatric populations are more affected than adults, and females tend to be more affected than males. Sex predilection has been linked to the expression of various steroid hormone receptors on the ocular surface. PKC is unilateral in 59% of patients and bilateral in 41% of patients. There is also a risk of recurrence. In one study of recurrent cases, the mean duration from the last episode of PKC to recurrence was 7.2 ± 3.6 months, and the mean duration from steroid withdrawal to recurrence was 2.4 ± 1.3 months. Recurrence rates may be higher in patients with systemic disease-associated PKC (such as those with tuberculosis or intestinal parasite). Meibomitis was present 100% of the time in a study of recurrent, steroid-dependent PKC patients, which highlights BKC as a spectrum of disorders that includes PKC.

There are also potential geographic implications to PKC. The disease shows a warm-weather predilection and is more of a risk to those in crowded living conditions or at high endemic risk for tuberculosis. In North America, populations in Canada
and Alaska have been followed for the tuberculosis-associated form of phlyctenular disease. 13-14,38

Symptoms of PKC include varying degrees of blurry vision, tearing, irritation, foreign body sensation and itching. If a corneal phlyctenule is present, the symptoms may progress to pain, photophobia and blepharospasm. 1,4,20 A secondary bacterial infection could also occur, causing mucopurulent discharge. 1 Symptomatic morbidity in PKC can cause frequent absences from school, inability to keep the eyes open, and psychological disturbances. 7

Signs of PKC can include single or multiple nodular lesions located near the limbus or on the cornea, with associated conjunctival hyperemia, corneal neovascularization or corneal scarring. In later stages, PKC may trigger or morph into Salzmann’s nodular degeneration. 52 Vision change or loss is possible due to refractive shift, induced astigmatism, corneal scarring, corneal neovascularization or the development of amblyopia. 24,53

The etiology of BKC (the entity which encompasses PKC) is multifactorial but includes chronic inflammation. 24,54 The inflammatory response is exacerbated by increased bacterial bioburden on the eyelids and lashes. The predominant pathogens in pediatric BKC are Staphylococcus aureus, Staphylococcus epidermidis and Propionibacterium acnes. 54 The goals of treatment for this spectrum of conditions include reducing bacterial bioburden on the eyelids, suppressing bacterial lipase activity on the eyelids, reducing antigens involved in the inflammatory process, and reducing the overall inflammatory response. 24,56

**Differential diagnosis**

PKC is typically diagnosed based on history, symptoms and slit lamp examination. A baseline IOP assessment at the time of diagnosis is critical, as measurement should occur before starting any corticosteroid therapy. Many studies report that IOP rises 3-6 weeks after starting topical corticosteroids, though some elevation of pressure can be found in most patients as early as the first or second week. To identify any steroid response (using the same IOP measurement method as baseline), the IOP should be measured again 2 weeks later and then monthly for 2-3 months and again at 6 months. 57 Clinicians should monitor refractory cases or patients who require even more prolonged therapy at least every 6 months. An IOP increase of >6 mmHg is generally considered clinically significant, though each case can vary. 58 Because PKC more often affects a pediatric population, it should also be noted that the possibility of a steroid response is greater in children younger than 6. 58-66 In refractory cases where complete withdrawal of the steroid is not possible, yet a steroid response occurs, clinicians may consider other strategies such as altering the dosing, concentration or formulation of steroid, adding a topical beta-blocker, or switching to a steroid-sparing agent. 57

Several differential diagnoses are considered if a vascularized corneal lesion is noted. The appearance, onset, staining pattern and any associated findings will help clinicians arrive at the correct diagnosis. The differential diagnosis for phlyctenular eye disease includes: corneal infiltrate, ocular (acne) rosacea keratoconjunctivitis, nodular episcleritis, Salzmann’s nodular degeneration, trachoma pannus, luetic or viral interstitial keratitis, chlamydial conjunctivitis, inflamed pingeuleula (pingueculitis), inflamed pterygium, conjunctival intraepithelial neoplasia, limbal vernal keratoconjunctivitis, allergic conjunctivitis, Demodex blepharitis, microbial keratitis, marginal ulcer, peripheral ulcerative keratitis, herpes simplex keratitis and ocular cicatricial pemphigoid. 4,7,18,24,46,61-63 It should be noted that a clinical entity termed “meibomitis-related keratoconjunctivitis (MRKC)” has been suggested to present identically to the corneal presentation of phlyctenular keratitis and with treatment focusing on eradicating ocular surface inflammation. 5,64 For the purposes of this case report, we will consider MRKC part of the varied spectrum of pediatric BKC as others have suggested. 64

**Management**

The treatment of choice for any corneal or conjunctival phlyctenule is a topical corticosteroid. One older case series detailed topical steroid treatment ranging from 1-4 times daily for 1-4 years in a series of six patients with PKC. 5 A more recent review of BKC noted that lower potency steroids, such as loteprednol and fluorometholone, are often sufficient and that dosing is quickly tapered from more frequent to less frequent, and then a slow taper occurs thereafter, to as little as once or twice a week to control the inflammation. 24

Steroid treatment not only suppresses the ocular surface inflammation but also prevents corneal scarring, which could lead to visual compromise. It does carry a significant side effect profile, including the risk of elevated IOP, cataract formation, corneal melt and secondary bacterial or fungal infection. 26,29,66-68 Some patients may also become “steroid-dependent,” meaning that when the anti-inflammatory therapy is withdrawn, the condition recurs, usually within a few months. 20,31 Children are more vulnerable to an increase in IOP with topical steroid use than adults, so special attention to IOP is warranted in this population to prevent ocular hypertension. 59 A secondary goal is to avoid corticosteroid-induced glaucoma, which can occur if the ocular hypertensive response is of sufficient magnitude for a prolonged duration and results in damage to the optic nerve. 57 Because of the risks associated with topical steroids, practitioners tend to try to dose sparingly and at the lowest concentration.
possible. Some prefer “soft” steroids, such as loteprednol etabonate or fluorometholone, especially in cases of potential long-term therapy. A lack of insurance formulary coverage and resulting high out-of-pocket cost left this patient seeking an alternative to our initial consideration of a branded, ester-based “soft” topical loteprednol 0.5% suspension. Instead, generic prednisolone acetate 1.0% ophthalmic suspension was prescribed.

A multifaceted approach to treatment is recommended in pediatric BKC, with warm compresses seen as a mainstay of therapy (both for a flare-up and for long-term management) and recommended in 100% of cases. Additional considerations are removing any bulky debris (eyelid scurf) from anterior blepharitis with a specialized eyelid wipe or wash once or twice daily. This cleaning makes the lid more receptive to the addition of hypochlorous acid solution spray, a topical preparation with broad-spectrum antimicrobial activity, including to both Staphylococcus aureus and Staphylococcus epidermidis.

Both topical and oral antibiotic therapies have been used to treat patients with significant levels of bacterial bioburden and inflammation related to BKC. Several oral antibiotics have been suggested for the treatment of BKC in children. Oral tetracyclines, such as doxycycline, are often avoided in pediatric patients under 8-9 years old due to the risk of tooth discoloration. The drugs should also be avoided in pregnant women or anyone allergic to tetracyclines. Some practitioners do still consider the use of tetracyclines for patients older than 10-12 years old, as the medication has been shown to be effective in the management of PKC and BKC in children in some studies. In an older case series of six children age 8-14 years with PKC who did not respond to topical corticosteroid and topical antibiotic therapy, Zaidman and Brown prescribed oral tetracycline 250 mg 2-3 times a day until 3 weeks after the patient was completely asymptomatic. They then decreased the dose by 250 mg per day, at 3-4-week intervals, until the patient was using just 250 mg once a day. Overall, the approach of prescribing oral antibiotics, including tetracyclines, for BKC was not supported by a 2016 Cochrane Review.

For younger children in whom tetracyclines are contraindicated, oral macrolide antibiotics may be used as an alternative and have been shown to have anti-inflammatory activity. It is unclear if the macrolide mechanism of action in BKC is a direct effect on lipid synthesis or an influence on the microflora. Both erythromycin and azithromycin concentrate readily within polymorphonuclear leukocytes and macrophages, inflammatory cells found in phlyctenules. Erythromycin is the most commonly prescribed macrolide antibiotic for pediatric BKC as it is generally well-tolerated and safe, with little incidence of allergic reaction. One potential side effect to monitor is dose-dependent gastrointestinal upset (e.g., diarrhea, abdominal pain, nausea or vomiting). Erythromycin in oral suspension or chewable tablet form can be prescribed for pediatric patients. Recommendations in the literature range from full strength (250 mg/kg/day) to one-quarter of full strength (50 mg/kg/day) dosing for BKC. The literature also shows total daily doses ranging from 60 to 500 mg/day, at once or divided over the day depending on patient weight and severity of disease. Most children are tapered off oral antibiotic therapy within 6 months of treatment, though treatment can last up to 12 months, depending on the disease and other ocular comorbidities.

In cases where oral erythromycin cannot be used (such as allergy), case reports show the efficacy of oral azithromycin, a second-generation macrolide that is available in oral suspension form. Azithromycin has also been shown to achieve high tissue concentrations and is a more stable, more potent, better absorbed and more well-tolerated macrolide than erythromycin with fewer side effects such as gastrointestinal upset. A recent study also suggests that oral azithromycin may have enhanced efficacy in meibomian gland dysfunction due to the addition of lipid-promoting activity, which stimulates meibomian gland epithelial cell function. This is occurring in addition to the antibacterial and anti-inflammatory actions of azithromycin, functions that are shared by oral doxycycline as well as other oral tetracyclines prescribed for meibomian gland dysfunction.

Clinicians should be aware that prescription of azithromycin may have long-term effects on the ocular microbiome and more research is needed to fully understand the implications for pediatric patients.

The dosage of oral azithromycin for pediatric BKC, as described in the literature, is either 15 mg/kg/day or 5 mg/kg/day. Zaidman advocates once-daily dosing at 15 mg/kg/daily, stating it is better tolerated, more available and more convenient than erythromycin. Choi and Djaliani also published a small case series using oral azithromycin at a lesser dosage of 5 mg/kg/day, in conjunction with topical anti-inflammatory agents, with promising results. When using oral agents to treat BKC, it is generally recommended to treat for 3-6 months and then taper according to the clinical course. In this case, the patient’s weight was initially estimated (and later confirmed) by the parent as 100-115 lb (45-52 kg), so the prescribed dosage of azithromycin at a concentration of 250 mg/5 mL, based on an estimated 50 kg weight, was 250 mg/day (or 5 mL of suspension) by mouth. Several apps, such as Epocrates or Pedi QuikCalc, are available for helping to calculate the dosage for oral medication given a patient’s weight. Practitioners can also consult with the pediatrician or local pharmacist.

Considerations in the topical management of BKC include management of the inflammatory response and increased bacterial bioburden on the eyelids and lashes. The predominant pathogens in pediatric BKC are Staphylococcus aureus, Staphylococcus epidermidis and Propionibacterium acnes; therefore, a combination of lid scrubs, hypochlorous acid solution and topical antibiotic therapy can be employed to reduce the bacterial bioburden, and therefore lipase activity, near the lids and lashes. When choosing a topical antibiotic, one could start with broad gram-positive coverage with a particular aim at Staphylococcus
and Streptococcus organisms, using bacitracin or erythromycin ointment at night to the lids and lashes for BKC. Another approach in anterior blepharitis suggests that first-line therapy is broad-spectrum coverage with polymyxin-B/trimethoprim ointment (or similar) and then topical azithromycin 1.0% if first-line treatment fails. Topical azithromycin has been shown to be effective in the adult population as an off-label medication to manage blepharitis, meibomian gland dysfunction and rosacea, and also in the pediatric population for blepharitis. In one study, topical azithromycin was used to treat steroid-dependent PKC in pediatric patients. The drug has been cleared for the treatment of bacterial conjunctivitis in pediatric patients age 1 and older; thus, use in pediatric BKC would be considered off-label. Fixed-combination products containing topical steroids and antibiotics may be an additional convenient and effective option for addressing lid margin disease.

Prolonged use of antibiotic-containing topical preparations may result in antibiotic resistance and potential for overgrowth of non-susceptible organisms, particularly fungi. Methods of preventing resistance in chronic cases include adhering to appropriate dosing schedules, cycling or rotating the antibiotic being used, employing oral therapy, and discontinuing topical therapy when the clinical picture improves. Additionally, some ophthalmic antibiotic ointment package inserts recommend the removal of “scales and crusts” before the application of ointment; thus, the use of a lid scrub as a preliminary step in the eyelid cleaning regimen is advisable.

Recalcitrant, recurrent or steroid-dependent cases of PKC and BKC may benefit from more aggressive topical therapy, such as topical cyclosporine (standard or compounded preparations) or topical tacrolimus. There are also reports in the literature of extreme, recurrent cases requiring oral steroids or systemic immunosuppression therapy for resolution. One case used azathioprine and methotrexate to manage BKC, and another used infliximab and methotrexate to manage PKC. In recalcitrant cases, it is also prudent to ensure no systemic tuberculosis is present. In children, confirmation with blood testing (via Quantiferon Gold) is recommended over tuberculin skin testing. One should also thoroughly examine the ocular surface to rule out other etiologies or comorbidities with similar presentation to BKC/PKC and treat any underlying disease such as dry eye, allergic conjunctivitis and Demodex blepharitis.

Compliance can be a challenge with pediatric patients. Anecdotal success with warm compress therapy has been noted when the activity is coupled with bathing, listening to music or watching television. Lid scrubs could be modified to be performed in conjunction with showering to improve ease of use and compliance.

For the patient in this teaching case report, several signs of BKC were present, any one of which could confirm the diagnosis: lid scurf, meibomian gland inspissation, turbid meibomian gland expression, lid wiper epitheliopathy and line of Marx staining. The patient was instructed on the performance of warm compresses twice daily for at least 10 minutes using the “bundle towel” method to improve meibomian gland secretion. The “bundle towel” method involves heating several moistened, folded, washcloth-sized towels wrapped together into a circular bundle. The bundle’s concentric geometry helps the towels maintain heat inside while the outer towels are used consecutively. Warm compresses using the “bundle towel” method have been shown to increase inner eyelid surface temperatures above the required therapeutic level (>104 degrees Fahrenheit) if performed correctly. The patient was advised not to rub the eyes or massage the lids after performing warm compresses to prevent corneal warpage from occurring.

The patient was instructed to begin eyelid hygiene twice daily using an individually wrapped, pre-moistened lid scrub pad to provide mechanical removal of scurf. To further manage the patient’s lid margin inflammation and anterior blepharitis, as well as to reduce the bacterial bioburden on the lid, bacitracin ophthalmic ointment was prescribed for use at night on the eyelids and eyelashes OU. Additionally, oral antibiotic azithromycin was prescribed at 250 mg/day by mouth, as her case was considered severe with concomitant lid disease and untreated symptoms for the past 6 months. She was also advised to begin over-the-counter hypochlorous acid 0.02% solution spray twice daily on the eyelids OU to reduce the bacterial bioburden, as we suspected compliance with the spray might be easier for a pediatric patient. The spray could be easily integrated into the consistent long-term eyelid hygiene regimen that is often necessary to manage BKC and prevent visual sequelae.

In cases where the patient cannot tolerate medical therapy, a sub-tenon steroid injection may be possible. In a case series of three pediatric patients with BKC treated with oral azithromycin (dosed 5 mg/kg, once daily) and topical anti-inflammatory agents, Choi and Djalilian note two patients had associated phlyctenules that resolved during treatment. In the case series, oral azithromycin was continued for approximately 2 months for each patient, but the authors discuss continuing various oral antibiotics for anywhere from 1-8 months for BKC. In an adult population, dosing is more commonly done as pulsed therapy (e.g., 500 mg per day over 3 consecutive days each week for 1 month; or 1 g per week for 3 consecutive weeks) or as a 5-day course with 500 mg on the first day and 250 mg each day for 4 consecutive days.

In this case, an oral antibiotic was also prescribed at the initial visit due to the presence of the sight-threatening phlyctenule and concomitant anterior and posterior meibomian gland dysfunction. The efficacy of oral azithromycin for meibomian gland dysfunction and blepharitis in adults has been established. In a case series of three pediatric patients with BKC treated with oral azithromycin (dosed 5 mg/kg, once daily) and topical anti-inflammatory agents, Choi and Djalilian note two patients had associated phlyctenules that resolved during treatment.
In this case, the patient’s self-estimated weight was 100-115 lb. If we assume the lower weight of the given range, it converts to 45 kg. At 5 mg/kg, that is a total daily dose of 225 mg. Assuming the higher weight of 115 lb, which converts to 52 kg, the total daily dose would be 260 mg. Given this range, we prescribed 250 mg/day based on the prescribing recommendations of Choi and Djalilian (5 mg/kg/day). The patient’s exact weight of 110 lb was provided at a follow-up appointment, and the dosage was confirmed as correct. Consultation with a pharmacist can also ensure that any dosage calculations are appropriate.

In cases where patients are using other medications, have comorbidities, have a history of sensitivity to the drug class in question, or are unsure of their weight or unable to obtain it, consultation with the primary care physician or pediatrician is highly recommended. Parents should inform their child’s physician of any oral antibiotic therapy prescribed by the optometrist for the management of ocular conditions. Optometrists can also consult with the physician and co-manage any changes in ocular therapy should the patient need concurrent oral antibiotic treatment for any other indication.

Topical cyclosporine of varying concentrations has also been suggested as a steroid-sparing alternative, adjunctive or sole treatment for phlyctenular disease. The safety and efficacy of commercially available topical cyclosporine products to increase tear production in patients with keratoconjunctivitis sicca have not been established in patients younger than 16 for the 0.05% ophthalmic emulsion and younger than 18 for the 0.09% ophthalmic nanomicellar suspension; thus, use in pediatric patients would be considered off-label.

For the patient described in this teaching case report, treatment for bilateral allergic conjunctivitis was also recommended due to the papillary reaction noted on each eye’s palpebral conjunctiva. Initially, it was difficult to determine the exact cause of the papillary response noted. Because inflammation and allergy symptoms often co-exist, it is no surprise that pediatric BKC is sometimes misdiagnosed as allergic conjunctivitis if it presents with chronic conjunctivitis, though a typical allergic response would not also have the concomitant lid disease. In some chronic cases of staphylococcal blepharitis, the presenting conjunctivitis has been attributed to a toxin reaction.

Patient education for these conditions includes informing the parent or guardian that long-term maintenance of lid hygiene procedures and topical anti-inflammatory therapy (such as cyclosporine) may be required. The oral antibiotic therapy may continue for up to 12 months or more, depending on the patient’s comorbidities and clinical response. While PKC is not infectious, it may recur. It may also have visual sequelae that require correction or cannot be fully corrected.

Anterior segment photographs can be useful for educating caretakers on the course of their child’s disease, especially if communication between the optometrist and the caretaker (for example, if there is a language barrier) is limited. Images can demonstrate the severity of initial presentation, record progression and improvement over time, and document clinical resolution.

Contact lenses

The scarring and neovascularization often associated with conjunctival and corneal phlyctenules carry a risk for visual compromise and amblyopia in the pediatric population. The corneal appearance may cause a practitioner to shy away from fitting contact lenses, citing hypoxia concerns and worsening neovascularization. However, the etiology of neovascularization in phlyctenular disease is not hypoxic but rather inflammatory. Patients with a history of PKC may have medically necessary reasons to wear lenses, such as reduced vision with glasses, high ametropia (sphere or cylinder) or anisometropia. In addition to clear vision, contact lenses confer self-esteem benefits for children.

New refraction and topography performed after PKC resolution will help determine whether amblyopia or irregular astigmatism limits a patient’s best-corrected vision. This patient’s anisometropia may have been present before the corneal condition or exacerbated by it. In either case, with reduced best-corrected acuity OS, a contact lens may assist with achieving an improved visual result after the resolution of the phlyctenule. The application of a diagnostic gas permeable contact lens will help determine the eye’s best-corrected vision if any corneal irregularity exists. Contact lens management should include close monitoring and use of materials highly permeable to oxygen to ensure corneal neovascularization does not progress, despite its known inflammatory etiology, and that new neovascularization does not develop. If the benefits are deemed to outweigh the risks, patients with a history of PKC and associated neovascularization can successfully wear soft, gas permeable or specialty lenses, each with appropriate monitoring.

Conclusion

Optometrists can effectively manage the signs and symptoms of PKC and pediatric BKC. This teaching case report is intended to educate eyecare providers and optometry students on the clinical course and management of phlyctenular eye disease, highlighting the importance of thorough clinical examination, immediate identification, appropriate treatment and follow-up care. Prompt recognition of the acute nature of phlyctenular disease can stem symptoms and progression, while recognizing
the chronic nature of pediatric BKC can prevent recurrence. Appropriate management of these two associated conditions can help minimize debilitating symptoms and prevent profound vision loss in children. Because tetracyclines are contraindicated in pediatric patients, oral macrolides such as erythromycin and azithromycin are often used. However, a recent comprehensive Cochrane Review found insufficient evidence for the prescription of any oral antibiotics in pediatric BKC. Thus, management with aggressive lid hygiene efforts, topical steroids and topical antibiotics should be a priority. Practitioners should also consider the advantages of contact lens wear despite the presence of residual corneal neovascularization. When appropriately prescribed and managed after the resolution of phlyctenular disease, contact lenses can provide optimal visual function and overcome limitations posed by corneal scarring, irregularity, anisometropia or astigmatism.

References


Murakami DK, Blackie CA, Korb DR. All warm compresses are not equally efficacious. Optom Vis Sci. 2015;92:e327-e333.


In an upcoming issue of *Optometric Education*, the Educator’s Toolkit feature will focus on Universal Design for Learning (UDL) and UDL concepts that optometric faculty can incorporate into our instructional repertoire.

Based on scientific insights into how people learn, UDL is a framework designed to provide a flexible learning environment in which the instructional needs of all students can be met. Such a framework can decrease barriers to learning, which is an important goal as the demographics and backgrounds of students entering post-secondary education programs continue to change.
A Clinical Approach to Pupil Testing: a Teaching Case Report
Shelby Kruse, OD, FAAO, DiplABO, and Alanna Khattar, OD, FAAO, DiplABO | Optometric Education: Volume 47 Number 1 (Fall 2021)

PDF of Article

Background

The following case report discusses the appropriate testing and diagnosis of a patient with ipsilateral ptosis and miosis. It demonstrates the importance of investigating all differential diagnoses, and it provides a guide for teaching third- and fourth-year optometry students and residents to manage cases of ptosis and abnormal pupillary findings. Also provided are an overview of differential diagnoses and additional testing or imaging that may be appropriate in cases of ptosis and abnormal pupils. Anisocoria and ptosis are two findings with varying etiologies that all optometrists encounter. Depending on the etiology, a prompt diagnosis and appropriate treatment may significantly benefit the patient and could be life-saving.

Case Description

A 60-year-old Black male was referred to the neuro-ophthalmology clinic for further evaluation of right eyelid ptosis and ipsilateral pupil miosis. He reported that these signs had been stable for more than a year. He reported a history of multiple mildly traumatic ocular events that included being poked in the right eye 2 years prior. He did not seek any care at that time and did not notice any changes in vision, eyelid appearance or pupil size following that injury. He also stated that a few months following that injury the eyelid droop may have started after bird waste got into his eye.

In addition, the patient had undergone laser retinopexy to repair a retinal tear in the right eye, and glaucoma was suspected in both eyes. He was not using any ocular medications and reported no drug allergies.

The patient’s medical history was positive for hypertension and high cholesterol. His medications included aspirin, atorvastatin and hydrochlorothiazide. He had no significant family medical or ocular history. The patient smoked 10 cigarettes a day and had been doing so for at least 20 years. He was also a social drinker and denied any illicit drug usage. He had an appropriate mood and was oriented to time, space, person and place.

The referring provider had seen him 5 months prior to the neuro-ophthalmology consult. Right eyelid ptosis and ipsilateral pupil miosis were documented at this visit. The referring provider noted that the patient complained of pain in his right shoulder and adjacent to the right side of his neck. The patient had also reported previous right arm weakness and a history of trauma to the right shoulder for which he had undergone rotator cuff surgery. Due to the patient’s ipsilateral eyelid ptosis and pupil miosis in the setting of a complicated history and potentially associated ipsilateral systemic symptoms, the referring provider admitted the patient for emergent neuroimaging to rule out Horner’s syndrome secondary to a life-threatening etiology. A neurology consult was recommended as well. Pupil testing (using apraclonidine 0.5% ophthalmic solution) for Horner’s syndrome was performed with a negative result. Magnetic resonance imaging (MRI) of the brain with and without contrast, magnetic resonance angiography (MRA) of the head and neck, and a chest X-ray were performed. All of the neuroimaging obtained showed no evidence of an acute life-threatening etiology, and the patient was given a follow-up appointment in the neuro-ophthalmology clinic and discharged. Following the in-patient workup, the patient was lost to follow-up for 5 months before presenting to the neuro-ophthalmology clinic.

At the neuro-ophthalmology clinic, the patient’s uncorrected distance visual acuity was 20/25-2 in the right and left eye. His confrontation visual fields were full to finger count, and his extraocular motilities were full-range in both eyes with no pain or diplopia in either eye. His intraocular pressure as measured with Goldmann applanation tonometry was 14 mmHg in both eyes.
At this visit, the right pupil was measured to be 5 mm in the dark and 3 mm in light. The left pupil was measured to be 6 mm in the dark and 4 mm in light. The palpebral fissure was measured to be 8 mm in the right eye and 11 mm in the left eye. Margin to reflex distance (MRD) 1 was measured to be 1 mm in the right eye and 4 mm in the left eye. MRD2 was measured to be 7 mm in the right eye and 7 mm in the left eye (Table 1). Color vision testing with Ishihara color plates was performed with a score of 11/11 in both the right and left eyes. To further assess the ptosis, cranial nerve VII motor testing was performed, and the patient had a normal blink, nasolabial folds and mouth function. The orbicularis oculi strength was normal in both the right and left eyes.

Slit lamp examination showed the patient had nasal and temporal pingueculae in both eyes. He also had multiple subepithelial corneal scars outside of the visual axis in both eyes with no corneal staining or endothelial pigment. No iris transillumination defects were noted. He had grade 1+ nuclear sclerotic cataracts in both eyes.

On dilated fundus exam, a small retinal tear in the inferior periphery of the right eye that had previously been treated with laser retinopexy was observed. The optic nerves were asymmetric with a cup-to-disc ratio in the right eye of 0.7 round and 0.5 round in the left eye. Diagnostic test results ordered upon initial presentation to the referring provider were reviewed and can be seen in Table 2. Due to the incidental finding of hepatic lesions of the liver on the chest X-ray, the patient was directed to follow-up with his primary care physician for additional care.

At this point, differential diagnoses of the ptosis and miosis included idiopathic Horner’s syndrome, damage to the sympathetic nerve pathway following rotator cuff surgery, and ptosis secondary to trauma resulting in damage to the levator palpebrae superioris muscle or possible aponeurosis. Physiological anisocoria also remained a consideration but could not be confirmed until further testing was complete.

A computed tomography (CT) scan of the chest with contrast was ordered to further evaluate a differential diagnosis of Horner’s syndrome. Blood urea nitrogen and creatinine tests were ordered prior to the CT chest scans to evaluate kidney function. The patient was to return in 1 month after the CT for review of test results and further evaluation.

Follow-up #1

At this visit, clinical findings were stable to previous exams. The chest CT results showed no evidence of a chest mass. Apraclonidine 0.5% pupil testing was repeated to ensure that the first negative result was not a false negative. No dilation was observed in either eye, indicating a repeatable negative test. A CT of the neck was ordered to rule out any possible pathology in this region.

Brief encounter for review of test results

The patient presented for a scheduled follow-up appointment, but he was intoxicated; therefore, an examination was not performed. The neck CT results were reviewed and showed no evidence of a cervical mass or significant cervical lymphadenopathy. The patient was made aware of the findings and rescheduled for a 2-week follow-up.

Follow-up #2

The patient was again lost to follow-up but returned to the neuro-ophthalmology clinic 11 months later.
At this visit, ptosis and pupil measurements remained stable to previous visits (Table 3). Although it was believed that the right eye was miotic, to rule out any mydriasis of the left eye, pupil testing was performed with pilocarpine 0.125% ophthalmic solution. No constriction was observed, demonstrating no abnormal innervation of the pupil of the left eye.

Upon comprehensive review of all clinical findings, pharmacological testing and neuroimaging, it was determined the patient’s ptosis and miosis were not related to a neurological etiology. It was determined the ptosis was likely secondary to trauma. Given that multiple pupil measurements demonstrated equal asymmetry in light and dark conditions, a diagnosis of concurrent physiological anisocoria was made.

At this time, the patient was advised to return immediately to the emergency room for evaluation if an intense headache or sudden vision change occurred.

**Education Guidelines**

**Learning objectives**

At the conclusion of this case report, readers should be able to:

1. Understand how to accurately assess pupils
2. Understand the pathophysiology of the pupillary response and eyelid innervation
3. Identify pupil and eyelid abnormalities and their differential diagnoses
4. Understand diagnostic pupil testing of anisocoria
5. Determine which ancillary testing may be warranted in cases of pupil miosis

**Key concepts**

1. Pupil testing should be performed on all patients at every exam
2. Suspected acute onset of Horner’s syndrome should receive emergent evaluation
3. All differential diagnoses for ptosis and miosis should be considered in every patient presenting with these signs
4. Physiological anisocoria is present in up to 20% of the healthy population
5. Trauma can affect all ocular structures including the eyelid and pupil

**Discussion questions**

1. Measurements
   - a. What should be assessed when measuring pupils?
   - b. What is classified as average pupil size?
   - c. What is the difference between MRD1 and MRD2?
   - d. What are average MRD1, MRD2 and palpebral fissure measurements?

2. Pathophysiology
   - a. What controls pupil constriction and dilation?
   - b. What provides innervation to the eyelid?
   - c. What causes levator aponeurosis dehiscence?

3. Differential diagnoses
   - a. What differential diagnoses exist for anisocoria greater in bright light?
   - b. What differential diagnoses exist for anisocoria greater in the dark?
   - c. What differential diagnoses exist for eyelid ptosis?
   - d. What is classified as physiological anisocoria?
   - e. What is the pathophysiology of the classic triad of Horner’s syndrome signs/symptoms?
4. Pharmacological agents utilized for diagnosis

a. What two agents can be utilized to confirm a diagnosis of Horner’s syndrome?

b. What result is expected with the use of diagnostic pharmacological agents in a diagnosis of Horner’s syndrome?

c. When Horner’s syndrome has been diagnosed, what two agents may be used to localize the neuronal order of the lesion?

d. When are 1% pilocarpine and 0.125% pilocarpine utilized in pharmacological pupil testing?

5. Primary care optometrist’s role

a. How urgently should a patient be evaluated when new-onset Horner’s syndrome is suspected?

Discussion

Teaching instructions

For students: small group discussion. After being taught the pertinent information, the class is divided into small groups. Each small group is given a case chosen by the professor and given time to discuss what testing they would utilize. Case by case, each small group will discuss what methods they have chosen to confirm a diagnosis. Appropriate feedback is given by the professor, and other small groups are given time to ask questions. Following discussion, a quiz may be given to assess the students’ understanding of the learning objectives.

For residents: grand rounds. Residents should present cases involving pupil abnormalities. They would outline the case presentation, present the pathophysiology and discuss how they utilized ancillary testing and/or pharmacological agents to confirm a diagnosis. Another option to consider when educating residents is to have the supervisor present an initial case such as the case presented here. The residents would then discuss differential diagnosis, diagnostic testing and pharmacological testing. To assess the residents’ knowledge of the learning objectives, the supervisor could ask questions during the discussion. The residents may also be presented with exam findings from a new case involving pupil abnormalities and asked how they would manage the case, applying their new knowledge.

Pupil exam

Pupil testing is an important part of the eye exam and should be performed on all patients at every visit. Components of a thorough pupil exam include measuring pupil size in dark and light, evaluating direct and consensual pupil response, and checking for an afferent pupillary defect (APD). Anisocoria has a wide variety of potential etiologies ranging from physiological anisocoria to life-threatening conditions.

The afferent pupillary light reflex begins in the retina and travels through the optic nerve with nasal fibers decussating at the optic chiasm traveling to the opposite optic tract and the temporal fibers continuing to run temporally along the ipsilateral optic tract. Pupillary fibers then pass through the superior colliculus to the pretectal nuclei. At this point, fibers pass ipsilaterally and contralaterally to the Edinger-Westphal nucleus. The decussation of the pupillary fibers at the optic chiasm and then again after the pretectal nuclei ensure that each Edinger-Westphal nucleus receives information about incoming light from both eyes. This is why the pupils should be equal in size.

When performing a pupil exam, it is important to use a bright light and a pupil gauge. Throughout all pupil testing, it is important that the patient focus on a distance target to prevent any accommodative miosis. Pupil size should be measured in both bright light and in the dark. If it is difficult to measure in the dark, a light source may be held below eye level to provide slight illumination. Normal pupil size is 2-4 mm in bright light and 4-8 mm in dark light. Pupil size is controlled by the activity of the iris sphincter muscle and the iris dilator muscle. The iris sphincter muscle is located in a circumferential fashion at the iris margin and is innervated by the parasympathetic nervous system. The iris dilator muscle runs radially from the iris root to the peripheral border of the iris sphincter and contains alpha-adrenergic receptors that respond to the sympathetic nervous system.

In addition to measuring pupil size, the provider should evaluate the direct and consensual pupillary responses. In a normal pupil, a light shone in one eye causes pupil constriction in both eyes. The response in the eye in which the light is shone is called the direct response. Constriction in the eye in which the light is not shone is called the consensual response.

It is also important to assess for AFD, sometimes referred to as Marcus Gunn pupil, using the swinging flashlight test. In assessing for APD, the provider is essentially measuring the difference in signal strength between the two eyes. A light should be shone in one eye for 3-4 seconds and then immediately shone in the fellow eye for 3-4 seconds. This sequence should be repeated several times. A normal finding would be consistent constriction of both pupils due to the consensual response. In
a patient with a relative APD, both pupils will dilate when the light is shone in the affected eye and then constrict when the light is shone in the unaffected eye.2-4

In patients with only one functioning pupil, the provider can test for a reverse APD. The swinging flashlight test is performed as usual, but only the functioning pupil is observed. If constriction is observed at all times, no APD is present. If the functioning pupil constricts more when the light is shone directly in that eye, an APD is present in the fellow eye with the unreactive pupil. If the functioning pupil constricts more when the light is shone directly in the non-functioning pupil, there is an APD in the eye with the functioning pupil.7

Additional findings about pupil abnormalities may be revealed upon slit lamp exam.1-2 It is important to evaluate for any signs of inflammation, injury or infection as they may contribute to pupil changes. Iris transillumination and gonioscopy may also prove beneficial to rule out any abnormalities secondary to other causes such as trauma.2

In cases of anisocoria, it is important to obtain a thorough case history to assess if the patient has started any new medications or used any illicit substances and to assess for any other neurologic symptoms including ptosis, diplopia, changes in vision and ipsilateral head or neck pain.1

**Eyelid anatomy**

The facial nerve, cranial nerve VII, innervates the orbicularis oculi, which is used to close the upper and lower eyelids. The patient in this case had normal and equal cranial nerve VII function on both sides of his face. The oculomotor nerve, cranial nerve III, innervates the levator palpebrae superioris, which is used to elevate the upper eyelid. The levator palpebrae superioris becomes a tendinous aponeurosis, which fuses with the superior tarsal plate.5-6 The muscle of Müller elevates the eyelid 1-2 mm and is innervated by the sympathetic nervous system.7

Multiple measurements — of MRD1, MRD2 and palpebral fissure size — are essential to thoroughly evaluate for the presence and extent of ptosis. These measurements are typically recorded in millimeters.

To measure MRD1, the patient and examiner should be at the same level. The examiner should hold the light source so the patient is looking directly at it in primary gaze. The patient should keep both eyes open naturally, and the examiner should measure the distance between the light reflex on the cornea and the central portion of the upper eyelid margin. This measurement is MRD1. An average MRD1 is 4-5 mm. 5-8

To measure MRD2, the examiner should measure the distance between the light reflex on the cornea and the central portion of the inferior eyelid margin. This measurement may indicate reverse ptosis if asymmetric between eyes.8 An average MRD2 is 5-6 mm.5

The palpebral fissure measurement is the distance between the central portions of the upper and lower eyelid margins when the patient is looking in primary gaze. The average palpebral fissure is 9-12 mm.5 The palpebral fissure measurement may also be obtained by the summation of MRD1 and MRD2.

In general, a difference of approximately 2 mm between eyes is classified as mild ptosis. Anything greater than a difference of 4 mm between eyes is considered severe ptosis.5

**Inter-observer measurement differences**

One factor to consider when making a diagnosis based on such small measurements is the presence of inter-observer differences in assessing the same patient. One study utilizing a pupilometer showed that less inter-examiner variability was seen in scotopic conditions than in photopic conditions.10 The same study also found greater variability in measurements repeated 24 hours apart. This variability seen between examiners utilizing the same piece of equipment indicates that multiple measurements in-office may be necessary. Another study evaluated both intra- and inter-observer measurements of MRD and detected no difference in either factor. These results led to the conclusion that any variability noted was mild and clinically acceptable.11 The patient in this teaching case report was examined by multiple doctors at a number of visits. It is important to take this potential variability into consideration when evaluating for stability of exam findings.

**Anisocoria greater in the dark**

With this patient, ipsilateral ptosis and miosis were noted upon clinical exam. When performing the pupil exam, several differentials should be considered in patients with anisocoria greater in the dark, including:
Horner’s syndrome

Pharmacological miosis

Argyll Robertson pupil

As this patient had ipsilateral ptosis and miosis, Horner’s syndrome had to be considered. In addition, it is important to consider pharmacological miosis and an Argyll Robertson pupil.

The classic presentation of Horner’s syndrome is ipsilateral ptosis, miosis and anhidrosis. Ptosis occurs due to denervation of the muscle of Müller, which normally provides 1-2 mm of elevation of the upper eyelid. In some cases, the ptosis may be so mild that it goes unnoticed. One study found that in 12% of those with Horner’s syndrome, no ptosis was present. A “reverse ptosis” might also be noted, where the lower eyelid appears more elevated than normal. This occurs due to a lack of sympathetic innervation of the muscles of the lower eyelid retractors. Miosis occurs due to a lack of sympathetic innervation to the iris dilator and the resultant uninhibited parasympathetic system acting on the iris sphincter muscle. Anhidrosis occurs when a lesion of the sympathetic pathway is proximal to the external carotid artery. This proximity causes denervation of the facial sweat glands leading to a dry, warm face.

Another finding that may present in Horner’s syndrome is dilation lag of the affected pupil. This is best observed in the first moments after the lights are dimmed. Rather than quickly dilating, the affected eye will take 10-15 seconds to fully dilate. This lag can cause anisocoria to be overlooked.

Horner’s syndrome may also be congenital, resulting from birth trauma. Iris heterochromia is common in congenital Horner’s syndrome. This heterochromia occurs because sympathetic innervation is believed to be responsible for the production of iris melanin by melanocytes.

A lesion identified as the cause of new-onset Horner’s syndrome may be classified as a first-order, second-order or third-order neuron lesion of the sympathetic pathway. First-order (central) neurons originate in the hypothalamus and descend to synapse in the spinal cord. A lesion of the hypothalamus, brainstem or spinal cord resulting from a stroke, neoplasms or demyelination may be classified as a first-order neuron lesion. Central Horner’s syndrome is uncommon and typically presents with other neurological signs indicative of where the lesion is located. In these patients, neuroimaging is guided by these neurological signs and symptoms.

The second-order (preganglionic) neuron exits the spinal cord and travels through the cervical sympathetic chain, through the brachial plexus and over the lung apex to synapse in the superior cervical ganglion. A lesion of the mediastinum, thoracic region or neck is classified as a second-order lesion. The most common second-order neuron lesion resulting in a preganglionic Horner’s syndrome is a Pancoast tumor, a tumor at the apex of the lung. In patients with suspected first- or second-order lesions, multiple types of neuroimaging may be ordered including a CT or MRI of the chest, an MRI of the head and neck with contrast, and potentially an MRA or computed tomography angiography (CTA) of the head, neck and chest.

Third-order (postganglionic) neurons exit the superior cervical ganglion and travel along the internal carotid artery into the cavernous sinus where they eventually join the ophthalmic division of the trigeminal nerve and enter the orbit to innervate the iris dilator muscle. A lesion or aneurysm of the internal carotid artery along with tumors, arterial dissection and trauma may be classified as third-order neuron lesions. If a third-order lesion is suspected, an MRI of the head with contrast and an MRA or CTA of the head and neck may be utilized to visualize the lesion.

An acute presentation of Horner’s syndrome should be worked up emergently because of the risk of underlying neurological pathology. Imaging both with and without contrast of the spine and chest should be performed to rule out any lesions. It is important to note that after a thorough workup, 35-40% of Horner’s syndrome cases are determined to be idiopathic.

Pharmacological miosis is uncommon but may occur after contact with pilocarpine ophthalmic solution. In our patient, the pupillary findings were consistent over an extended period of time, and no contact with pilocarpine ophthalmic solution outside of the clinical setting occurred.

Argyll Robertson pupils typically present as bilateral, miotic pupils and are commonly associated with syphilis. These pupils dilate poorly in darkness and with mydriatic agents. “Light-near dissociated” is often used to describe this pupillary response. The pupils will not constrict in response to light but will become more miotic in response to a near target. Our patient had only unilateral miosis, no history of syphilis, and his pupils dilated in darkness and with the use of mydriatic agents, thereby ruling out this condition.

Anisocoria greater in light
In all settings of anisocoria, it is important to evaluate which pupil is the abnormal pupil. It was believed this patient had miosis of the right eye, but he was also evaluated for possible mydriasis of the left eye. In cases of anisocoria that is greatest in bright light, consider the following differentials:

- Adie’s tonic pupil
- Oculomotor nerve (CN III) palsy
- Pharmacological dilation

Adie’s tonic pupil is a result of postganglionic denervation of the internal ocular muscles including the ciliary body and iris sphincter. Patients are typically asymptomatic and present with one dilated pupil. They may report some mild blur of vision or photophobia due to persistent unilateral dilation. Loss of deep tendon reflexes of the lower extremities is a documented systemic association. With time, the ciliary body and sphincter muscles are reinnervated almost exclusively by the accommodative system, which results in slow constriction in response to a near object or target.³

An oculomotor nerve (CN III) palsy can present with complete ptosis, a “down and out” eye and a dilated pupil. The palsy can be either complete or partial. There are many causes of these palsies including vascular pathologies, trauma, aneurysms or other forms of compressive lesions. These patients are typically neuroimaged to identify the underlying etiology.²³

In addition to the commonly used diagnostic mydriatic agents tropicamide and cyclopentolate, agents that cause pharmacological dilation include scopolamine, marijuana, lysergic acid diethylamide (LSD) and other illicit drugs.³

Physiological anisocoria

It was important to consider physiological anisocoria in the differential diagnosis of this patient. Physiological anisocoria is found in approximately 20% of the normal population. In patients with physiological anisocoria, the difference in pupil size is equal in dark and light conditions. Any difference larger than 2 mm is considered abnormal and should warrant a thorough workup. It may be beneficial to examine old photographs to assess for any long-standing presentation of the anomaly.³ Physiological anisocoria was not diagnosed on initial presentation as other conditions should always be ruled out first. In this case, after no other underlying etiologies were identified, the patient was ultimately diagnosed with physiological anisocoria.

Ptosis differentials

Important conditions to consider in the setting of ptosis include:

- Trauma
- Levator aponeurosis dehiscence
- Myasthenia gravis
- Horner’s syndrome
- Congenital ptosis
- Oculomotor nerve (CN III) palsy

In cases of trauma, damage to the levator palpebrae superioris may occur as a result of cranial nerve damage, muscle damage, neurotoxins or scarring of the skin.²² Although the patient in this case could not provide significant details regarding his previous episodes of trauma, he did note being poked in the eye, which could have caused subsequent levator palpebrae superioris damage.

Levator aponeurosis dehiscence is the most common cause of acquired ptosis and occurs in the elderly population due to natural changes in the levator muscle. This causes a slowly progressive ptosis that may not be noticed initially. With age, multiple changes, including fatty infiltration of the muscle, levator stretching or dehiscence of the levator from the tarsus, may cause ptosis.⁶²²

Often in cases of myasthenia gravis, patients report varying degrees of ptosis throughout the day as well as difficulties breathing, walking or speaking. To evaluate for myasthenia gravis, a serum assay for acetylcholine receptor antibodies should be ordered. An edrophonium chloride (Tensilon) test may be used to make a definitive diagnosis.²³ The patient in this case report denied any associated symptoms, and he denied any changes in appearance of ptosis throughout the day. Additionally, all measurements were consistent across multiple visits. Given the patient’s history, normal orbicularis oculi strength, lack of change in eyelid position throughout the day and the absence of diplopia, a diagnosis of myasthenia gravis was ruled out.

Congenital ptosis is present from the time of birth and may result in varying degrees of ptosis. During development, the levator palpebrae superioris muscle does not form properly, resulting in minimal levator function. Some of these patients find that a
A chin-up position provides better vision. An additional sign of congenital ptosis is the lack of an upper eyelid crease. In all cases of ptosis, evaluating the patient’s driver’s license or old photographs may be useful in identifying ptosis onset. A driver’s license or photo ID may also serve as a useful tool as most patients present to exams with this on hand. The patient in the case described here reported his ptosis began just a few years prior.

**Pharmacological pupil testing**

When evaluating for the presence of Horner’s syndrome, several diagnostic agents may be used. It is important to always measure pupil size in both eyes prior to instillation of any medication.

To diagnose Horner’s syndrome, a cocaine solution or apraclonidine 0.5% or 1% ophthalmic solution may be utilized. In Horner’s syndrome, an interruption to the sympathetic system stops the release of norepinephrine from the presynaptic nerve endings. Cocaine ophthalmic solution blocks the re-uptake of norepinephrine at the synaptic cleft, which causes dilation of the normal pupil. A Horner’s syndrome pupil will not dilate when cocaine is instilled. As cocaine is a controlled substance and not readily available, apraclonidine ophthalmic solution is typically used in a clinical setting. Apraclonidine is an alpha-2 adrenergic agonist with a weak alpha-1 adrenergic agonist effect. In a Horner’s syndrome pupil, apraclonidine causes dilation due to the heightened sensitivity of the receptors on the iris dilator muscle. A negative apraclonidine result occurs when dilation is not observed. Pupil size should be measured carefully in both eyes both prior to, and after, drop instillation. After instillation it is necessary to wait at least 30-45 minutes before evaluating pupillary response.

To localize the lesion, hydroxyamphetamine bromide 1% ophthalmic solution or phenylephrine 1% can be utilized. Hydroxyamphetamine bromide causes the release of norepinephrine from the intact adrenergic nerve endings causing dilation in a normal pupil. One-hour after hydroxyamphetamine instillation, the affected eye will dilate if the lesion is a first- or second-order neuron lesion. This is because the postganglionic nerve endings are intact. If the lesion is a third-order neuron, the eye will not dilate as there has been a loss of the stores of norepinephrine. Phenylephrine 1% will cause only a pupil with a postganglionic lesion to dilate due to the heightened adrenergic sensitivity of the iris dilator. After phenylephrine instillation the clinician should wait at least 45 minutes before evaluating the pupillary response.

To confirm an Adie’s pupil, 0.125% pilocarpine is instilled. As a result of denervation, the pupil in question is hypersensitive to cholinergic agonists and miosis will be observed in the Adie’s pupil. No change is expected in the eye not suspected of Adie’s pupil. To create the desired concentration of 0.125% pilocarpine, both 1% pilocarpine ophthalmic solution and saline solution are needed. Using a syringe, seven parts saline solution should be combined with one part pilocarpine 1% in a new vial. The new mixture should be thoroughly mixed before instillation. The new solution should be instilled in both eyes and pupillary response should be observed after 30-60 minutes.

It is important to keep in mind that testing may need to be repeated because false positive or false negative results can occur. In the case of this patient, testing was performed both with apraclonidine to assess for any excess miosis and with pilocarpine to assess for any excess dilation.

**Follow-up care**

Typically, physiological anisocoria does not need to be treated nor does it require follow-up care. In cases of pharmacological dilation or miosis, Adie’s tonic pupil or physiological anisocoria, the patient does not need further intervention. If patients have Argyll Robertson pupils and are found to have syphilis, they would need further care coordinated through their primary care physician or an infectious disease doctor. Horner’s syndrome typically resolves on its own after the underlying systemic condition has been treated. Both pupil and eyelid abnormalities resulting from cranial nerve III palsies also often resolve with systemic management. In cases of ptosis due to myasthenia gravis, it is necessary to treat the underlying condition and subsequent improvement in ptosis is expected. In cases of trauma, levator dehiscence or congenital ptosis, surgical intervention may be warranted as these are not self-limiting conditions.

**Conclusion**

In patients with ipsilateral ptosis and miosis, pupil testing and neuroimaging play an important role in evaluation. Any patient
suspected of having new-onset Horner’s syndrome should be thoroughly worked up in an emergent fashion with the appropriate diagnostic imaging to rule out any life-threatening etiology. In the case of this patient, a detailed case history along with the results of pupil testing and neuroimaging ultimately led to a diagnosis of physiological anisocoria and concurrent ptosis due to trauma.

Acknowledgements

The authors would like to acknowledge Nancy Blace, MD, PHD, for her contributions to this manuscript.

References

Third-year optometric interns generally enter their clinical rotations at a point in their education where they are making the transition from thinking as students to thinking as clinicians. This transition is reflected in how they present their cases to their preceptors, as well as in the quality of their assessments and plans. Historically, healthcare disciplines have used case studies to enhance knowledge base and clinical proficiency. Optometry is no exception, and students have been shown to learn well from hands-on opportunities to report to their preceptors and receive feedback from them.

As preceptors in a community health center setting, we decided to develop nine case vignettes to test whether leading our students through practice scenarios would equip them to make the transition more quickly. The healthcare landscape is focused more than ever on productivity, and preceptors must constantly balance this with teaching their interns. While the Teaching Case Reports currently published in the journal *Optometric Education* are effective tools for teaching when adequate time is available, preceptors often have only 5-10 minutes at a time to have teaching moments during the daily course of patient care. The vignettes we developed enable us to present extra material to the students for testing themselves (with no grading) on their entering status in presenting cases or writing management plans.

The vignettes are based on actual patients seen in the clinic, and we adjusted them to be theoretical case scenarios that test student readiness to handle complex situations involving analytical thinking and pattern recognition. Examples include knowing what to do with a patient taking hydroxychloroquine, recognizing increased intraocular pressure and understanding what needs to be done for follow-up, and awareness of the philosophy of refraction. The nine case vignettes form our “case bank,” and we also developed an answer key with discussion questions and references to serve as a Preceptor Guide.

Multiple preceptors in two different clinical settings tested the case vignettes, with the same results. Students reported the cases to be helpful exercises in the real-time clinical setting.

**Evaluation of the Usefulness of the Case Vignettes**

To test the case vignettes, preceptors presented nine of them (with intentionally varied topics and level of complexity) to third-year optometry students at two different clinical sites. The initial presentation of the exercise included this summary of basic principles for writing assessments and plans:

1. Every diagnosis should have a matching plan, even if it is to just monitor yearly.
2. Chief complaint should be listed as first assessment.
3. Think of an assessment as the problem and the plan as the action we are taking. For example, “dry eye” is the assessment and “Rx Refresh Optive ophthalmic solution 1 drop TID OU” would be the plan, because it’s the action we are taking to address the problem.
4. Your assessment should reflect the diagnosis for which you are coding on a billing sheet/screen. The primary diagnosis would be the first assessment listed.
5. Sometimes you don’t know the diagnosis, but can write “diagnosis A vs. diagnosis B” and create a plan to do further testing.
6. Do not list a test as the first work in your diagnosis. “HVF normal” is not appropriate as an assessment. “Hx of long-term therapy with Plaquenil x 6 years; HVF 10-2 today within normal limits” is appropriate.
7. Even if a test is normal, sometimes you need to list it in your assessment and plan. “History of retinal detachment s/p laser repair 2011 OD” is very appropriate to list as an assessment further down your list. This way you are aware of it the following year. Another example is “History of narrow angles, open to gonioscopy in 2017 OU” or “History of uncontrolled Type II diabetes mellitus with no retinopathy or CSME.” All of these have an impact on subsequent exams.

The students were split evenly into an experimental group and a control group with a mix at both sites. Before and after the exercise, both groups completed a survey about their comfort level developing an assessment and plan using a 5-point Likert-style scale. They also rated the nine cases on level of difficulty using a 5-point scale as part of the conclusion survey following the study. The study group received three cases from the bank per week, developed an assessment and plan based on the cases provided, then participated in small group discussions about the cases. The small group discussions were outlined to address the knowledge base of the topic, analytical thinking skills, development of differential diagnosis, and final development of an assessment and plan. This pattern continued over 3 weeks until all nine cases were reviewed. The control group then received...
the same cases after the “study period” so that no students were deprived of a potential learning activity.

Our initial hypothesis was that third-year optometry interns who were given formal guidelines on writing assessments and plans at the beginning of the semester rather than 1 month into their rotation would show a faster learning curve for developing their management plans. As the exercise went through 2 full years of interns, we found no significant difference between the control group (receiving the exercise 1 month into the rotation) vs. the experimental group (receiving 3 cases each week for the first 3 weeks). Our team believes that one factor that negated the difference in timing could be the need for adjustment and acclimation to a new clinical environment and electronic health record system. Therefore, it appears appropriate to allow time for adjustment to the new clinical setting before issuing these case vignettes.

Both groups reported improved comfort in writing an assessment and plan over the 3-week study period. Students consistently said that they found the exercise helpful during any semester. They saw value in hearing what their peers added to each other’s management plans, working toward a collective goal of a comprehensive plan. During the first few cases, some students were timid, but it was evident that the small group setting was less threatening and more comfortable for them to make mistakes or forget to include a certain element. Students started volunteering to read their plans more readily toward the end of the nine cases.

We received other useful feedback about the exercises as well, such as the students’ appreciation of being able to review concepts they had learned in the classroom.

**How to Apply These Exercises**

Preceptors can release three cases at a time, asking students to use each case as a worksheet. Our students have either written on the side of the case, used a separate notebook or paper, or typed their management plans. This exercise can also be used as a way to improve case presentation skills. In that situation, the case findings would be handed to the students, and they would be given a set amount of time to read the exam details before role-playing in presenting the case to the preceptor.

For management writing, here are some options for proceeding:

1. With 10-15 minutes available in the clinic, gather the students to discuss their assessment and plan, asking for one volunteer per case. (We did not read the case out loud again, in the interest of time, but quickly summarized before discussing the plan.) Each case discussion can take anywhere from 5-25 minutes, depending on case complexity and tangential discussions.
2. Read out loud or present on the screen partial exam findings up to a certain point to quiz students on what further testing may be necessary.
3. The exercise can be used as a worksheet that is turned into the preceptor who reviews it and hands back written comments. However, discussion is highly encouraged when handing comments to the student.

The Preceptor Guide is used for leading discussions and creating new side discussions based on points raised by the students. We have developed common ‘side trip’ discussions to facilitate deeper analysis. A survey can be done pre- and post-exercise to measure learning outcomes for the students’ comfort level in writing management plans or presenting case findings.

To request copies of all the cases currently in our case bank, email Dr. Amy Moy or Dr. Jennifer Reilly.

**Case 1 and Sample Preceptor Feedback for Student**

Figure 1 shows Case 1 as presented to the students. Figure 2 shows one student’s response. The following preceptor comments were conveyed verbally to the student in a mini-discussion setting.
From Dr. Moy: This looks very comprehensive. I would use caution to order the assessment items in order of how we would code for this exam. Since this exam is a routine eye exam and the patient’s chief complaint is blurry vision with glasses, then the refractive error item goes first. I would include dry eye in tandem with the meibomian gland dysfunction (MGD) diagnosis, and rate the severity of this condition as moderate severe, due to the low TBUT and 1+ MGD. I like that the student included the brand of artificial tear recommended to the patient. This is really key when we follow up on her dry eye symptoms later on and potentially adjust the kind of drops used. The presence or lack of macular edema should also be noted in the assessment and plan for any diabetic patient. I like how the cataract findings were written such that it’s clear that there is visual impact and there is a plan to follow up due to the progression of the cataract density.

From Dr. Reilly: This is very thorough, but I would aim to make some of the plan components more concise. For example, the blood sugar education under the refractive error can likely be excluded in that line item since it is already discussed under diabetes in assessment #2. The diabetic line item should also specify presence or absence of macular edema. I often do not comment on mild piaugeculea in an assessment unless there is an abnormality present to be addressed. I would reorder the assessment items to reflect the refractive error first, and then work my way anterior to posterior segment addressing any medical diagnoses.

From Dr. Pham: The cataract grade is appropriate for the patient’s age; therefore, it is not “likely related to uncontrolled
diabetes,” and there is no evidence for that. Cortical cataracts are more likely related to diabetes than nuclear sclerotic cataracts. I would comment on whether or not the cataracts are visually significant, which would determine whether or not a referral is warranted. I would recommend UV eye protection to reduce cataract progression. For diabetes without retinopathy, it is missing right, left, or both eyes. It is also important to note whether or not there is CSME and include last A1c and last glucose reading. It is important to include how many years the patient has had diabetes, as this determines their level of risk. Additionally, it is good to mention whether or not it is controlled or uncontrolled. Meibomian gland dysfunction is missing the right, left, or both eyes. There is a dry eye component, since there is reduced TBUT, so it should include type, severity, and diagnosis of dry eye.

Case 2 and Sample Preceptor Feedback for Student

**Figure 3** shows Case 2 as presented to the students. **Figure 4** shows one student’s response. The following are sample preceptor comments.

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**From Dr. Moy:** This student made a great start. She has hit the right elements of the assessment and plan. I would ask her what testing needs to be done to confirm a separate Rx for computer glasses. I would also ask her about what it means when a patient has lupus and dry eye, in terms of next steps for long-term treatment (testing for a secondary Sjogren’s syndrome and considering Restasis or Xiidra). I would also discuss considering inclusion of the cumulative dose in her assessment for the history of hydroxychloroquine treatment. She should be complimented for recognizing that it is an Asian patient and that an HVF 24-2 may at first be more appropriate than an HVF 10-2 for extramacular defects.

**From Dr. Reilly:** Wonderful attempt at the assessment and plan. I like the specification of latent hyperopia due to uncorrected 20/20 vision in each eye. I might have cut the script slightly at distance and wrote the Rx in bifocal/progressive form to allow for other glasses purchase options. I do agree with the student on performing a 24-2 instead of a 10-2 for a patient taking hydroxychloroquine of Asian descent, but I would have them back in 2-4 weeks for a baseline rather than 1 year. I would also
list the cumulative dose of the medication and daily dose by weight if that information is available. Finally, I would have recommended a specific artificial tear and visual hygiene on the computer as the student did, but I would not have recommended warm compresses due to no evidence of meibomian gland dysfunction.

From Dr. Pham: This is a very detailed and thought-out assessment and plan. I would disagree that the severity of dry eye is “severe.” While this patient has a reduced TBUT of 2 seconds, the grading of SPK is “mild diffuse SPK,” which should fall into the category of mild dry eye, especially if we are only treating with artificial tears. I would recommend being more specific with medication instructions, such as “Refresh ATs 1 gtt TID-QID OU.” In addition to HVF 24-2, I would also perform a HVF 10-2, as it is more visually threatening than parafoveal defects.

A Flexible and Expandable Tool

We see our original case bank as a springboard for other case banks that can be used as shorter time-sensitive exercises for clinical preceptors. In the future, it would be valuable to compile case banks of pediatric vignettes, contact lens vignettes, interdisciplinary vignettes, and more. Other variations could include exam documentation for different types of exams, such as optical coherence tomography findings, visual field visits, and dry eye follow-ups for second-year level. Residents or new preceptors could also use the case banks as practice for leading small group discussions to boost their precepting skills.

The overarching goal for the case vignettes is that they provide optometric preceptors with a time-sensitive method for testing students’ case presentation and management skills early in each semester, especially for third-year interns.
Positive Changes in Applicant Pool Follow ASCO’s Optometry Gives Me Life Campaign
Aurora Denial, OD, FAAO, DipOE | Optometric Education: Volume 47 Number 1 (Fall 2021)

In the spring of 2019, the Association of Schools and Colleges of Optometry (ASCO) launched the Optometry Gives Me Life campaign. The objective of this public awareness campaign is to develop a robust, diverse and highly qualified pool of applicants to ASCO member schools and colleges of optometry. Early results were promising, and the most recent data indicate the campaign’s success is continuing.

As ASCO previously reported, in the first 4 months of the campaign, its online ads were viewed more than 19 million times, 76% of its video views were to the end (a completion rate much higher than the 30% benchmark), and there were 50,000 visits to the campaign’s landing page FutureEyeDoc.org.¹ According to the latest data, after 2 years, more than 100 million ads have been viewed, the video completion rate is 79.19%, and there have been 331,576 visits to FutureEyeDoc.org.² In addition, 604,040 social engagements, such as likes, reactions, shares, comments or follows, have been made with ads.²

As of September 2021, the campaign has garnered 3,123 applicant leads and 172 verified applicants, the latter representing an 11% increase.² Other changes in the applicant pool since the launch of Optometry Gives Me Life are as follows.²

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<tr>
<th>2019-2020 OptomCAS application cycle</th>
<th>2020-2021 OptomCAS application cycle</th>
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<tbody>
<tr>
<td>Change in size of applicant pool</td>
<td>+3.7%</td>
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<tr>
<td>Change in number of Black and Latino/Hispanic applicants</td>
<td>+10% (from 384 to 424 applicants)</td>
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<tr>
<td>Percentage of applicants with GPA ≥3.0</td>
<td>83%</td>
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To achieve its goals, Optometry Gives Me Life raises awareness of optometry as a career option among the key target audience of college juniors and seniors enrolled in a science, technology, engineering and mathematics (STEM) curriculum. The campaign presents online to individuals fitting this profile in response to their search history and age. It utilizes specialized and targeted social media outreach, publications, ancillary promotional materials, emails, direct mail and the landing page at FutureEyeDoc.org. It keeps prospective students engaged while supporting them in taking the first step in the application process. Videos highlight, through the experiences of three practicing Doctors of Optometry, what an optometric careers offers, including work-life balance, personal fulfillment and job security. The videos provide insight into the personal, social and professional lives of the doctors.

Expect Additional Strategies and Initiatives in the Coming Months

The Optometry Gives Me Life Campaign is ongoing, and ASCO says new strategies and initiatives are on the way. Connecting with and supporting future optometry students and graduates will always be important as they are essential to the viability of the profession.

References
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Myasthenia Gravis, the Great Masquerader: a Teaching Case Report
Ashley Rone, OD, FAAO, and Tara Foltz, OD | Optometric Education: Volume 47 Number 1 (Fall 2021)

Background

A 76-year-old patient presented with a complaint of binocular diplopia that began months prior. A complete history, eye examination and review of systems were performed, after which he was diagnosed with a presumed, isolated left fourth nerve palsy. Given the patient’s systemic history of hypertension and hyperlipidemia, along with lack of other neurological signs or symptoms, the palsy was thought to be likely vasculopathic in nature. His condition was monitored for 5 months and eventually he was prescribed glasses with ground-in prism to neutralize the small, residual deviation. One month later, the patient presented with nearly complete ophthalmoplegia of his right eye and concurrent severe, bilateral ptosis of the upper eyelids. He was referred to neurology for same-day neuroimaging and evaluation as myasthenia gravis was suspected.

This case provides an example of why myasthenia gravis (MG) is often called “the great masquerader.” The initial presentation of the disease is highly variable and can mimic other conditions, such as cranial nerve palsies. Moreover, other conditions that can cause diplopia and eyelid ptosis, such as intracranial mass and aneurysm, can be life-threatening. Because of this, it is imperative for optometrists to have a sound understanding of myasthenia gravis and the many ways it can present so that timely referral and treatment can be achieved for optimal patient care. In addition, myasthenia gravis is a condition that provides a great opportunity for optometrists to collaborate with neurology and possibly other specialties in order to provide the best outcome for the patient. Lastly, this case details the possibility and presentation of cholinergic toxicity from pyridostigmine, a condition that can mimic myasthenic crisis. All optometrists should be familiar with this life-threatening complication so that it can be quickly identified and treated. This case report is intended for third- and fourth-year optometry students, optometry residents and practicing eyecare providers in a primary-care or tertiary-care setting.

Case Description

A 76-year-old White male presented to the optometry clinic on Jan. 31, 2019, with a complaint of constant, binocular diplopia for months. He also reported painless, progressive vision loss in both eyes. Both complaints were present for an unknown specific duration as the patient was a poor historian. His known ocular history included bilateral senile cataracts and dry eye syndrome. His systemic history included hypertension and hyperlipidemia. When asked, he stated that his diplopia was less bothersome in left gaze or with right head tilt. It resolved with closing either eye. In primary gaze, it seemed to be mainly vertical but had a small horizontal component. The patient denied any difficulty breathing or swallowing. He was oriented to time, person and place.

Upon examination, his visual acuities were 20/40 in each eye, with no improvement with pinhole or refraction. Pupils were normal in reaction OU without an afferent defect. Confrontation fields were full OU. Extraocular motility testing showed restriction of the left eye in right and down gazes. He had a left hypertropia (8 prism diopters) measured by cover test. Parks three-step test showed the left hypertropia worsened in right gaze and in left head tilt suggesting a left fourth nerve palsy. The patient denied recent trauma as well as any other neurological symptoms. He did not present with a noticeable head tilt, and one was not noted in his driver’s license photograph that was examined that day for historical purposes. Given his age and known vascular risk factors of hypertension and hyperlipidemia, the condition was thought to be isolated and likely of a vasculopathic etiology. Neuroimaging was considered but not pursued at the initial visit given the patient’s vascular risk factors, lack of other neurological symptoms, and report of the condition being relatively new (within the past 6 months). He did not complain of ptosis, and it was not noted in the clinical findings from that exam. Dilated exam showed nuclear sclerosis OU that was consistent with his vision. Optic nerves revealed healthy rims and distinct margins OU. Fundus exam was unremarkable in both eyes. The exam summary findings were senile nuclear cataracts OU and a new, presumed left fourth cranial nerve palsy. On trial frame, the patient was able to achieve fusion with 8 diopters of base-down prism in front of the left eye. An 8-diopter Fresnel prism was applied base-down over his left eyeglass lens and he was scheduled to be seen again in 1 month. He was educated that if he experienced any worsening of diplopia or new neurological symptoms, he should seek emergent care.

Follow-up examinations in March and April 2019 showed partial resolution of the presumed left fourth nerve palsy, with all
other ocular findings stable. His left hypertropia was consistently neutralized with 6 diopters of prism. A 6-diopter Fresnel prism was applied base-down over his left eyeglass lens. No additional neurological signs or symptoms were noted at those exams. The patient was followed monthly until June 2019, at which time he was prescribed new glasses with 6 diopters of ground-in prism, base-down over the left eye, to correct the residual deviation. Given the stability of the condition and no new symptoms being reported, he was scheduled for a follow-up visit in 6 months.

The patient presented to the optometry clinic on Aug. 15, 2019, for an acute visit with complaints of severe bilateral upper eyelid drooping and worsening vertical and horizontal diplopia in all gazes over the previous month. Upon exam, the ptosis was complete in the right eye, with the palpebral aperture measuring zero. The patient was unable to open the right eye without manually lifting his upper eyelid. His left eye also had severe ptosis, with a palpebral aperture of 3 mm measured in primary gaze. In primary head position, extraocular motility testing showed near complete ophthalmoplegia of his right eye, with very limited movement in all directions of gaze. His left eye showed limited movement in down and right gazes, findings consistent to his previous exams. Pupils were normal in reaction OU without an afferent defect. Confrontation fields were grossly full OU. With his eyelids being held during testing, visual acuity was stable at 20/30 in each eye. Upon questioning, the patient stated that his ptosis was less severe in the morning but worsened throughout the day. He denied difficulty breathing but did state that swallowing and speech were sometimes labored, which he had also noticed over the previous month. The patient was diagnosed with severe bilateral upper eyelid ptosis and pupil-sparing ophthalmoplegia of both eyes, worse in the right than the left. Myasthenia gravis was the suspected etiology due to his ocular and systemic symptoms. Given the severity and acute worsening of his condition, it was deemed appropriate to forgo further clinical testing, such as the ice pack or rest test, and instead refer emergently for a neurologic workup. A routine consultation in the outpatient neurology clinic would likely not be available for several weeks to months; therefore, neurology advised the patient to be seen in the emergency department that day.

Examination in the emergency department included neuroimaging and chest X-ray, which were both unremarkable. Diagnostic blood work was ordered. The only additional clinical finding from this exam was fatigable weakness of the shoulders and neck. Neurology diagnosed the patient with presumed generalized myasthenia gravis and prescribed pyridostigmine bromide 60 mg three times a day by mouth. It was noted that the patient was currently taking atorvastatin 40 mg daily, but no change or discontinuation of this medication was recommended.

Blood test results received a week later confirmed the condition. The patient’s acetylcholine receptor (AChR) binding antibody serum level was highly elevated at 3.89 nmol/L (reference range 0.00-0.24). The patient was monitored by phone call 1 week later by his optometrist, at which time the patient reported noticeable improvement in symptoms. However, in the second week of using pyridostigmine, the patient called to complain of severe side effects after taking medication, including dysphagia, dysarthria and diarrhea. Neurology was consulted, and the patient was instructed to discontinue the medication and seek emergent care. When he presented to the emergency room several days later, he was noted to have lost 25 pounds in the previous month. Neurology diagnosed cholinergic toxicity from pyridostigmine as the cause of his severe reaction and side effects. The patient was taken off pyridostigmine and hospitalized so that he could be given a short course of intravenous immune globulin. He was also started on mycophenolate mofetil (MMF) 500 mg twice per day by mouth for myasthenia gravis. His condition improved dramatically during his 5-day hospitalization.

At a follow-up optometry appointment 1 month later, he showed improved ocular motility of his right eye and only mild ptosis of both eyelids. He again was measured to have a 6-diopter left hypertropia in primary gaze, stable to previous examinations since diagnosed with a left fourth nerve palsy nearly a year prior. The patient noted that his habitual glasses with ground-in prism worked well at times, but that he continued to experience diplopia in secondary gazes and when fatigued. At that visit, his optometrist frosted the right eyeglass lens of an older pair of his glasses. By phone call the next week, the patient reported great success with these glasses. At his next monthly follow-up visit in November, the patient stated that he no longer wore the frosted lens spectacles and had returned to using his habitual glasses with prismatic correction of 6 prism diopters base-down over the left lens.

The patient continues to experience improvement in symptoms as he is followed closely by neurology and optometry. Dysarthria resolved after nearly 3 months of treatment with MMF. The patient continues to take 500 mg of MMF twice per day by mouth to manage his symptoms. At the time of publication, the patient has no ptosis and no diplopia with his habitual prismatic correction.

**Education Guidelines**

**Learning objectives**

1. Understand the subtypes of myasthenia gravis and their typical presentations
2. Understand the clinical and diagnostic tests available
3. Understand available treatments and their possible side effects

Key concepts

1. Providers should be aware of the many variable, initial presentations of myasthenia gravis, as well as common ocular and systemic signs and symptoms
2. Appropriate diagnostic tests should be ordered, and neurology referral made in a timely fashion to initiate therapy and rule out other concerning etiologies
3. The treatments available for myasthenia gravis are evolving, and these should be well-known to optometrists so they can effectively educate patients and be a meaningful part of their multidisciplinary care

Discussion questions

1. What are possible first symptoms and signs of myasthenia gravis?
2. What questions should we ask patients with suspected myasthenia gravis?
3. What clinical and diagnostic tests can be performed?
4. What medical treatment options for MG are available and how successful are they?
5. What side effects can patients experience from treatment?
6. What ophthalmic treatment options are available to manage ocular manifestations?

Literature review

Myasthenia gravis is an autoimmune condition affecting the neuromuscular junctions and is characterized by fatigable muscle weakness. The neurotransmitter acetylcholine (ACh) acts at neuromuscular junctions, which causes muscle contraction. In MG, ACh antibodies cause damage to acetylcholine receptors in striated muscle. This condition causes weakness and fatigability of certain skeletal musculature and most often affects the limbs, facial expression, ocular movements, chewing and speech. The eyelids and extraocular muscles (EOMs) are involved in more than 90% of cases. Possible explanations for why the EOMs are so often affected in MG include that only slight weakness of extraocular muscles can result in diplopia, the high firing frequency of these muscles make them more susceptible to fatigue, and/or these muscles may be more vulnerable to neuromuscular blockade. The prevalence of MG is approximately 20/100,000 per year in the United States. MG has a bimodal distribution, most commonly affecting women in their 20s and 30s and men in their 60s and 70s. MG shows no racial or geographic predilection.

The condition can be subtyped by clinical features and serum antibodies. Most classify MG as either ocular myasthenia gravis (OMG) or generalized myasthenia gravis (GMG), with the former describing disease that affects only the orbicularis oculi, levator palpebrae superiors, and extraocular muscles causing ptosis and/or diplopia. Generalized disease involves the facial, bulbar, lumbar and/or respiratory muscles. It is estimated that 50-80% of patients with OMG will develop generalized symptoms, usually within 2 years. The subtypes by antibodies include MG with AChR antibodies, MG with anti-muscle-specific kinase (MuSK) antibodies, MG with anti-lipoprotein receptor-related protein-4 (LRP4) antibodies, and seronegative MG. More than 80% of cases are MG with AChR antibodies, 4% are with MuSK antibodies, and 2% are with LRP4 and seronegative disease. Research in MG continues to examine whether these classifications affect prognosis and/or should guide treatment recommendations.

The condition can also result from thymus hyperplasia and thymoma. With up to 15% of adult cases of MG having an associated thymoma, thoracic imaging is part of the recommended workup when MG is suspected. Other autoimmune conditions such as hyperthyroidism and lupus erythematosus can occur in association with MG. Lastly, the condition can be drug-induced or exacerbated by medications such as D-penicillamine, aminoglycosides, beta-blockers, statins and quinidine.

As discussed above, OMG often converts to GMG as more muscles become involved. The most serious complication of MG is referred to as myasthenic crisis, which involves extreme muscle weakness of the diaphragm and chest muscles that support breathing. Patients should be educated about the symptoms of myasthenic crisis, which include difficulty breathing and swallowing, and told to seek emergent care if they occur. While many patients with MG eventually improve and may be able to cease treatment, this may take several years, and the disease may have a relapsing and remitting course. Treatment aims to minimize patient symptoms and discomfort and to keep the patient safe until the disease improves.

Discussion

Teaching instructions: Participants in this teaching case report should answer each discussion question and then read the discussion section below to enhance their knowledge of the topic. Completion of the discussion questions will allow the
What are possible first symptoms and signs of myasthenia gravis?

An estimated 67-85% of patients initially present with ocular symptoms, the most common being ptosis and/or diplopia. These symptoms are often asymmetric and variable throughout the day and dramatically worsen with use and fatigue. Also experienced in the first few years of diagnosis is generalized weakness, specifically in the bulbar, neck and proximal limb muscles. This can inhibit chewing, swallowing, speech, facial expression, raising arms or climbing stairs. Additionally, approximately 40% of patients with MG can develop respiratory muscle weakness that results in shortness of breath with exertion. The patient discussed in this case report presented initially with ocular symptoms and later noticed labored swallowing and speech. His ptosis and ophthalmoplegia were asymmetric and worsened as the day progressed.

What questions should we ask patients with suspected myasthenia gravis?

When patients present with any of the ocular symptoms discussed, it is important to ask if they vary with time of day and continued effort. Other pertinent questions include whether there is difficulty with swallowing, coughing after attempting to swallow, or shortness of breath with exertion. Various clinical signs such as fatigability of speech and facial weakness can be observed by asking the patient to count out loud to 50 or perform facial expressions such as smiling or closing their eyelids. If the patient is unable to reach 50 or speech becomes less intelligible during the test, it is a sign of enhanced dysarthria and MG should be suspected. Similarly, if a patient is unable to sustain facial expression or eyelid closure for 60 seconds, it is considered consistent with the typical nature of MG.

What clinical and diagnostic tests can be performed?

If a patient presents with any of the previously mentioned symptoms, several clinical tests can be conducted in-office to see whether a diagnosis of MG is supported. A hallmark sign known as Cogan’s lid twitch was first described in MG patients in 1965. When the patient is asked to gaze downward for 15 seconds, then return to primary gaze, the affected superior lid briefly twitches upward as a result of the rapid recovery of the levator muscle. This is not specific for MG but is often noted as a characteristic sign. Ptosis is the most frequently reported initial symptom with both forms of MG. A “fatigue” test involves having the patient sustain an upward gaze for 30 seconds. If the levator becomes fatigued, a positive test results in increased ptosis after the prolonged upward gaze. The subsequent lid lag or increase in ptosis is referred to as pseudo Von Graefe’s sign. Another non-pharmacologic simple but effective test is the “ice” test. An ice pack is placed on the patient’s eyes for 2-5 minutes. A positive result is an improvement of the ptosis greater than 2 millimeters. The decrease in temperature slows the breakdown of ACh, allowing an increase of its availability in the neuromuscular junction. The specificity of this test is reported as high as 98%. An additional screening of the orbicularis oculi involves asking the patient to tightly squeeze their eyelids shut. Normally, the examiner should not be able to pry open a tight lid closure by finger pressure alone. A positive test for weakening of these muscles is a successful attempt at manually overcoming the blepharospasm. A longer duration test is the “sleep” test, which requires the patient to lie in a quiet room for 30 minutes while closing the eyes. The period of rest reduces the demand for and allows replenishing of ACh. A positive test result is improvement of ptosis and/or eye movements after the rest period.

Diplopia is caused by a paresis or fatigability of one of the extraocular muscles and is the second most frequent symptom of both OMG and GMG. Cover test and Parks three-step test can be used to assess the alignment and comitancy of deviations. One of the challenging aspects of diagnosing MG is the disease’s ability to mimic nerve palsies or other causes of pupil-sparing ophthalmoplegias. A variable and fatigable nature of symptoms are indications for an MG diagnosis. Other historical information such as history of trauma, presence of other neurologic symptoms, systemic history and pupil involvement can help rule out differential causes of diplopia and direct appropriate referral to other services.

Diagnostic methods can be utilized to help confirm the diagnosis of MG. The edrophonium (Tensilon or Enlon) method is still recognized as a gold standard diagnostic test. Edrophonium is a short-acting, reversible acetylcholinesterase inhibitor that is administered intravenously. The onset of action is 30-60 seconds, with effects resolving within 5-10 minutes. A positive test result is an improvement in muscle function observed in the eyelids or extraocular muscles as edrophonium increases the availability of ACh at the receptor site. The edrophonium test is highly sensitive for diagnosis when measuring ptosis, as high as 86-97% in OMG and 82-100% in GMG. Caution is advised during testing due to the rare risk of serious side effects such as bradycardia, hypotension and cardiac arrest. It is recommended to monitor blood pressure and have atropine and resuscitation equipment available during testing. Less invasive tests are now preferred due to these risks and the cholinergic side effects that can be experienced.
Laboratory testing for several antibodies can help support or confirm a diagnosis when MG is suspected. An elevated AChR antibody titer confirms the diagnosis, although a negative titer does not exclude the disease. This titer is most helpful in GMG, as 85-90% of GMG patients are “seropositive” and possess these antibodies, compared to only 50-70% of patients with OMG.\textsuperscript{10,11} Of the AChR seronegative cases, 40-70% have antibodies to MuSK. The MuSK titers are generally used when a patient tests negative for AChR antibodies. These patients are predominantly female and less likely to have ocular features or a thymoma.\textsuperscript{1,10,12} Another antibody test now available is LRP4. Anti-LRP4 antibodies have been found in approximately 9% of patients who are negative for anti-AChR and anti-MuSK antibodies.\textsuperscript{12}

With seronegative patients, electrophysiologic testing such as repetitive nerve stimulation (RNS) and single-fiber electromyography (SFEMG) can be performed. With the former, patients with MG show a decrease in the action potential of the repetitively stimulated nerves. An abnormal result is found in 75% of patients with GMG and 20-50% of patients with OMG.\textsuperscript{12} SFEMG is the most sensitive test for MG in adults, and up to 80% of OMG patients and 94-99% of GMG patients show an abnormal result. It is not readily available for most communities and is a specialized skill.\textsuperscript{5,6} Like the edrophonium test, electrophysiologic testing is typically administered if other testing such as antibody titers are negative.

Lastly, thoracic imaging such as radiography, computed tomography (CT) or magnetic resonance imaging (MRI) can be used to detect a thymoma, which can be associated with MG. Laboratory tests for thyroid function and antibodies are also routinely obtained during initial workup as thyroid disease often coexists with MG.\textsuperscript{1,12} Table 1 summarizes the tests discussed in this section. Our patient’s diagnosis of MG was confirmed with an elevated level of circulating AChR antibodies, along with unremarkable chest and neuroimaging.

What medical treatment options for MG are available and how successful are they?

Acetylcholinesterase inhibitors are typically the first class of medication initiated as treatment for MG symptoms. Pyridostigmine is the most used of this group and can provide relief of symptoms for up to 6 hours.\textsuperscript{8,13} Typically, the dosage is 30 mg taken two to four times daily, increased over time based on efficacy and duration of symptom relief. Approximately 50% of patients with OMG have successful reduction of symptoms with pyridostigmine. Its most beneficial action has been shown to be reduction of ptosis.\textsuperscript{8}

Immunosuppressive agents are the next course or additive treatment if acetylcholinesterase inhibitors fail to provide adequate therapeutic relief or cannot be tolerated due to unwanted side effects. Corticosteroids are widely used for their anti-inflammatory benefits, most frequently oral prednisone. Typically, oral prednisone is started at lower doses such as 15-20 mg daily and increased to 60 mg daily to achieve desired therapeutic effects. A reported 66-85% of MG patients benefit from this therapy though side effects must be taken into consideration when weighing treatment options.\textsuperscript{8} Non-steroidal immunosuppressive therapies for those who may be poor candidates for corticosteroids can include azathioprine, cyclosporine-A and MMF, all of which have their own set of costs, risks and side effects. MMF is generally used as a second-line therapy and acts by suppressing T-cell and B-cell proliferation. Although costly, it is well-tolerated and has a good safety profile. Typical daily starting dosage is 1000-2000 mg with maintenance dosage of 2000-3000 mg. In several published studies, a significant number of patients on combined MMF and prednisone treatment were able to either decrease dosage or discontinue prednisone entirely.\textsuperscript{14,15}
Intravenous immunoglobulin (IVIg) has a role for patients suffering from myasthenic crisis. Plasmapheresis has been used for GMG, but there are no current studies using it for OMG. Monoclonal antibody drugs such as eculizumab or rituximab have been used to treat both subtypes of MG. Although costly, these drugs require less frequent dosing. Most of the latter treatments mentioned are typically used when patients have failed the mainstay drugs.

Finally, thymectomy is performed for those patients with thymoma. It has also been shown to benefit non-thymomatous patients who are early in the course of their disease or younger than age 60. A benefit to thymectomy is the potential for remission of symptoms and discontinuation of medical therapy.

A controversial topic is whether immunosuppressive therapies, such as corticosteroids or azathioprine, may delay or prevent progression from OMG to GMG as has been suggested in several retrospective studies. Others point out the limitations of these studies, and instead suggest that the effects of chronic immunosuppression may mask the signs and symptoms of conversion to GMG. Further studies are needed for better understanding of the true effects of immunosuppressive treatment.

What side effects can patients experience from treatment?

As a mainstay drug for the symptomatic treatment of MG, pyridostigmine is generally considered to have a good safety profile. Its effects can be noticed within 30 minutes of the dose being taken and it has a short half-life. Common adverse events include gastrointestinal disorders such as stomach cramping, nausea, vomiting and diarrhea. Concurrent use of glycopyrrolate or atropine can help eliminate some of the unwanted side effects. Higher doses of acetylcholinesterase inhibitors can cause cholinergic crisis, which is rare but has a mortality rate of 3-25%, most often due to respiratory failure. Symptoms include increased muscle weakness and fasciculations and subsequent exacerbation of cholinergic symptoms such as excessive secretions, gastrointestinal distress and pupil miosis. In cholinergic crisis, acetylcholinesterase inhibitor treatment should be immediately ceased. Due to the many overlapping clinical symptoms, it is imperative this condition is quickly differentiated from myasthenic crisis with examination and edrophonium test, as the treatments are independent. Table 2 highlights the differences between these conditions.

Table 2. Click to enlarge

Among the non-steroidal immunosuppressive agents, azathioprine and MMF are widely used. Azathioprine generally has a delayed effect with improvement of symptoms in 6-15 months. Most of the literature indicates it has a safe profile, but patients should be monitored for hepatotoxicity and leukopenia. The therapeutic benefits of MMF are typically observed after 2 months of use. While serious side effects are rare, patients more commonly experience gastrointestinal intolerance such as nausea and diarrhea. The patient in our case was started on a conventional dose of pyridostigmine and initially showed improvement of symptoms. After only a short period, he unfortunately experienced the aforementioned condition of cholinergic crisis. This case demonstrates the significance of frequent monitoring with any MG medication, as well as the crucial liaison role of an optometrist to other specialties when new side effects are reported. Thus far, our patient has shown stable symptoms and has tolerated MMF.

What ophthalmic treatment options are available to manage ocular manifestations?

After diagnosis and appropriate neurology referral, our role as optometrists is focused on relief of persistent ocular symptoms.
Occlusion therapy is often an effective treatment for the variable diplopia synonymous with MG. Patching or the use of a frosted spectacle lens can be of great symptomatic relief when dealing with fluctuating diplopia throughout the day. In the rarer cases of stable diplopia, optometrists can utilize application of temporary Fresnel or ground-in prism glasses. In the setting of severe or longstanding ptosis, non-surgical treatments can include botulinum toxin injections or use of a ptosis crutch attached to a spectacle frame. Surgical treatment options include ptosis repair surgery, blepharoplasty, frontalis suspension, external levator advancement and tarsomyectomy.

Exposure keratopathy can result from orbicularis oculi weakness, incomplete or reduced blinking with ptosis crutch or botulinum toxin injections and can be managed with topical lubrication.

In addition to taking medication, the patient presented in this case report ultimately benefitted from the use of several optical therapies including Fresnel prism, frosted spectacle lenses and ground-in prism glasses. Optometrists can play a vital role in the management of MG patients to relieve ocular symptoms and provide appropriate surgical referral when indicated.

**Conclusion**

Myasthenia gravis is often called “the great masquerader” because the initial presentation of symptoms is widely variable and can mimic other conditions such as cranial nerve palsies. This case provides an example of how challenging diagnosis can be when only extraocular muscles are initially involved. Optometrists should be aware of the potential manifestations of this condition in order to facilitate appropriate and timely testing and diagnosis. Moreover, optometrists should be familiar with treatment options, as well as their potential side effects, so they can effectively co-manage these patients with their neurologists, primary care providers and other specialists. Myasthenia gravis can be a debilitating disease, but optometrists can play a crucial role in minimizing patients’ symptoms and suffering.

**References**

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"all he needed was a pair of glasses, followed with vision therapy. Now that he’s into sports, he will be fit in contact lenses, and he’s doing extremely well."

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Systemic and Ocular Associations of Angioid Streaks: a Teaching Case Report
Beata I. Lewandowska, OD, MS, and Marlon J Demeritt, OD, MBA, FAAO | Optometric Education: Volume 47 Number 1 (Fall 2021)

PDF of Article

Background

Angioid streaks (AS) are bilateral, linear, crack-like dehiscence of a mineralized, brittle Bruch’s membrane (BrM) that develop secondary to mechanical stress. The age of onset is variable. White people are most commonly affected, and there is no sexual predilection. While AS are associated with multiple systemic diseases, pseudoxanthoma elasticum (PXE) is the most frequently reported. Choroidal neovascular membrane (CNVM) is a common vision-threatening complication encountered in eyes with angioid streaks.

This case report focuses on the proper approach to diagnosing and managing patients with AS. A thorough review of the clinical aspects of AS is presented to facilitate the understanding of the course of action taken to manage this patient. In addition, concepts covering the retinal anatomy and physiology are integrated into the discussion to cultivate critical thinking and reinforce clinical competence in the optometric care of eyes with AS. This case can be discussed with optometry students who have not had any patient care experience. At most U.S. optometry programs, it would be appropriate for second-year students as well as third-year students.

Student Discussion Guide

Case description

A 55-year-old African American male presented to our clinic complaining of slowly worsening blurry vision without glasses at near in the left eye more so than the right eye. The patient stated the blurriness began approximately 2 month prior. His ocular history included mild myopia with regular astigmatism and presbyopia in both eyes, pinguecula in both eyes and angioid streaks in both eyes. The angioid streaks were noted during previous annual eye examinations at our clinic and documented with dilated fundus photography 4 years prior to the current visit (Figures 1A and 1B).

Figure 1A. Dilated retinal fundus photograph of right eye obtained 4 years prior to the current exam showing peripapillary pigment mottling, angioid streaks and crystalline bodies. Click to enlarge

Figure 1B. Dilated retinal fundus photograph of left eye obtained 4 years prior to the current exam showing peripapillary pigment mottling, angioid streaks and crystalline bodies. Click to enlarge
The patient’s medical history was unremarkable. He denied suffering from allergies to any medications and reported taking ibuprofen 200 mg as needed. Family history included a visually disabled brother with a history of angioid streaks and cerebral stroke. In addition, both parents suffered from hypertension. The patient also reported a maternal history of colon cancer and a history of breast cancer in his sister. The patient denied current or past tobacco use and alcohol consumption. He reported consuming approximately four cups of tea or coffee per day and exercising (i.e., running) three to four times per week. The patient’s mood and affect were normal. He was oriented to person, place and time. Blood pressure, measured manually at 2:16 p.m. on the right arm of the patient while he was sitting, was 145/85 mmHg.

Best-corrected visual acuities were 20/20 in each eye at both distance and near. The refraction was stable from the previous exam 1 year prior. Pupils were equal, round and reactive to light without a relative afferent pupillary defect in either eye. Confrontations visual fields were full to finger counting in four quadrants in both eyes. Ocular motility was full and smooth in both eyes. Slit lamp examination of the anterior segment revealed normal adnexa, a few capped meibomian glands with debris on eyelashes, and quiet lid margins in both eyes. Pinguecula were noted nasally and temporally in both eyes. The conjunctiva was quiet in both eyes. There was a small (<1 mm) dense white subepithelial opacity in the inferior nasal peripheral cornea without surrounding active infiltration in the right eye. Trace endothelial pigment was present in both eyes. Iris was flat, intact and brown in both eyes. The anterior chamber was deep and quiet, and the angles were open in both eyes. Trace nuclear sclerotic changes were noted in the lenses of both eyes. Intraocular pressure was measured by Goldmann applanation tonometry and found to be 11 mmHg OD and 10 mmHg OS at 2:43 p.m.

Dilated fundus examination revealed clear vitreous in both eyes. The optic disks were round and pink with distinct borders. The cup-to-disc ratio was observed to be 0.30/0.30 in both eyes. Peripapillary pigment mottling was noted to surround both optic nerves with progressively thinning, radially oriented AS in both eyes. Pigmentary changes were noted in both maculae. Approximately 1 disk diameter inferior to the fovea of the left eye, a semilunar elevation with internal hemorrhaging was noted. Crystalline bodies were present inferior to the optic nerves and along the inferior arcades in both eyes. The retinal periphery was intact 360 degrees OU with inferior-temporal spots of retinal pigment epithelium (RPE) hyperplasia in both eyes.

To document the retinal exam findings, dilated fundus photography (Figures 2A and 2B), optical coherence tomography (OCT) and OCT angiography (OCTA) were performed. The new crescent-shaped lesion, most likely a CNVM, a common complication in eyes with AS, was seen in the left eye (Figure 2B). The suspicion of CNVM was further confirmed by OCT (Figure 3) and OCTA (Figures 4A and 4B). While it was difficult to appreciate the changes associated with the AS, Figure 3 depicted a hyper-reflective lesion present in the subretinal space of the left eye with adjacent serous detachment and overlying retinal edema most consistent with neovascularization. An OCTA (Zeiss Cirrus) retina slab from the left eye showed neovascularization in the outer retina (Figure 4A), and a lacy vascular network in the avascular complex, most consistent with type 2 or classic CNVM, was seen on an OCTA outer retina slab from the left eye (Figure 4B).

![Figure 2A](image1.png) Dilated retinal fundus photograph of the right eye showing peripapillary pigment mottling and angioid streaks. Click to enlarge

![Figure 2B](image2.png) Dilated retinal fundus photograph of the left eye showing peripapillary pigment mottling, angioid streaks and subretinal hemorrhage. Click to enlarge
A report was sent to the patient’s primary care physician with a request to rule out the most common systemic associations of angioid streaks: PXE, sickle cell disease, Ehlers-Danlos syndromes (EDS) and Paget’s disease (PD). The patient was promptly referred for further evaluation and management to the retinal specialist who had treated his brother’s eyes in the past. Three months after the referral, the patient reported receiving injections in the left eye, most likely one of the available anti-vascular endothelial growth factor (VEGF) medications. He reported stable vision in both eyes. He also stated that no evidence of the systemic diseases commonly associated with AS was found.

Educator’s Guide

Key concepts

1. Understanding the epidemiology and etiology of AS
2. Understanding the pathogenesis of AS
3. Understanding clinical manifestations of AS
4. Understanding differential diagnoses for AS
5. Understanding systemic diseases associated with AS
6. Understanding the most common ocular complication associated with the presence of AS
7. Understanding treatment options for the most common ocular complication associated with the presence of AS
8. The importance of patient education about this condition
Learning objectives

At the conclusion of this case discussion, optometry students should be able to:

1. Recognize and describe the ocular signs associated with AS
2. Describe various common systemic conditions associated with AS
3. Have a basic understanding of the pathogenesis of CNVM formation in the presence of AS
4. Describe the available diagnostic tools and their application in the diagnosis of AS and CNVM
5. Possess general knowledge about patient education and the management options for the common ocular complications associated with the presence of AS

Discussion questions

1. Knowledge, concepts, facts, information required for critical review of the case
   a. Describe the etiology of AS
   b. Describe the epidemiology of AS
   c. Describe the pathogenesis of AS
   d. Describe the diagnostic tools available to clinicians that aid in the diagnosis, evaluation and monitoring of AS

2. Differential diagnosis
   a. What are the characteristics of the differential diagnoses of angioid streaks?
   b. Describe the common systemic conditions associated with AS
   c. Describe the pathophysiology of CNVM in the presence of AS
   d. Describe the diagnostic tools available to clinicians that can aid in the diagnosis, evaluation and monitoring of CNVM

3. Patient management and the role of the optometrist
   a. What treatment options are available to this patient?
   b. What is appropriate timing for specialist consultation?
   c. How would you counsel a patient with AS?
   d. How would you counsel a patient with AS and choroidal neovascularization?

4. Higher-order critical-thinking concepts
   a. Describe the peripapillary and macular findings observed on the retinal fundus photographs of this patient. What is different about the photographs taken at the current visit compared with previous photographs?
   b. Analyze and interpret the OCT and OCTA findings. How do these findings relate to the clinical findings and the final diagnosis?
   c. Identify and compare the risks and benefits of the different treatments available to patients with CNVM in the presence of angioid streaks. If you were the patient, which treatment would you choose and why?
   d. What is the prognosis for the left eye? Predict the consequences of delayed treatment of the CNVM. Describe how these consequences may affect the patient’s quality of life.

Teaching instructions and assessment methodology

The purpose of this teaching case report is to lead a discussion in a classroom or clinical setting on the topic of AS, including their systemic and ocular associations. Second- or third-year optometry students should be presented with the case in a stepwise fashion so they can analyze the clinical data, extract the critical aspects from the case history and exam findings, and arrive at differential diagnoses. They can then be presented with the results of OCT and OCTA to finalize their diagnosis and create and present a management plan for the patient. Formative assessment can take place during the activity.

Discussion

Angioid streaks are bilateral, linear, crack-like dehiscence of a calcified and brittle BrM. They typically emerge from the optic disk as dark reddish-brown bands of variable width. CNVM is a common vision-threatening complication encountered in patients with AS.

Epidemiology and etiology of angioid streaks
First reported by Doyne in 1889 in a patient with retinal hemorrhages secondary to trauma, AS were named by Knapp in 1892 and determined to be a dysfunction of BrM by Kopler in 1917. If the overlying retinal layers remain unaffected, AS have no adverse effects on visual function. However, in some cases AS may lead to impaired visual function through degeneration within the retinal pigment epithelium (RPE) and accompanying photoreceptor defects, which result in metamorphopsia and scotoma.

It is important to remember that complications associated with AS often occur in patients of working age and therefore can significantly impact quality of life. AS rarely occur in patients younger than 10 years. AS are usually found in patients age 20-50.

**Pathogenesis**

Angioid streaks are a result of cracks in an abnormally thickened and calcified BrM. They may result from a combination of diffuse elastic degeneration of BrM, iron deposition in elastic fibers from hemolysis with secondary mineralization, and impairment of nutrition supply secondary to sickling, stasis and small vessel occlusion. There is a loss of migration of the pigment granules in the RPE. When full-thickness breaks occur, there is disruption of the choriocapillaris, atrophy of the RPE and loss of the overlying photoreceptor cells.

AS predispose the tissue to localized rupture that may occur spontaneously or secondary to blunt trauma. AS can cause subretinal hemorrhages from choroidal fibrovascular ingrowth or CNVM. In the former case, the hemorrhage can resolve spontaneously. In the latter case, metamorphopsia and/or scotoma may be experienced secondary to the presence of hemorrhages and edema, leading to significant loss of vision from development of a fibrotic scar.

**Clinical manifestations**

On fundus biomicroscopy, AS appear as reddish-brownish, bilateral, jagged, progressively narrowing lines deep in the retinal layers. These lines appear to radiate from an annular area of peripapillary pigment mottling surrounding the optic nerve (Figures 1A, 1B, 2A, 2B). Visual acuity is not affected even when the AS cross into the foveal area unless there is degeneration within the RPE.

**Differential diagnosis**

**Choroidal rupture**

Choroidal rupture is a break in the choroid, the BrM and the RPE with an intact overlying neurosensory retina. It is often seen in eyes that suffered trauma. It often presents as a white crescent-shaped streak concentric to the optic disk (Figure 5).

During a closed globe injury, the eyeball first undergoes a mechanical compression followed by a rapid hyperextension of the tissues. The sclera possesses sufficient tensile strength to resist the compression, and the elastic retina stretches. However, the BrM does not have sufficient tensile strength or elasticity and it breaks. The injured choriocapillaris and choroidal vessels bleed into the sub-RPE and/or subretinal space. Initially, the deep hemorrhage may hide the choroidal rupture. As the blood clears over time, the subretinal streak appears.

CNVM that may cause delayed vision loss develops in 5% to 10% of eyes with a choroidal rupture. Over time, the CNVM involutes but tends to recur.

Fluorescein angiography (FA) typically shows hypofluorescence of the choroidal rupture in early frames and staining in late frames due to fluorescein leakage from adjacent choriocapillaris. Fundus autofluorescence (FAF) typically shows hypoautofluorescence of the rupture site where RPE is missing, with hyperautofluorescence at the edge of the choroidal rupture. OCT shows a loss of the continuity of RPE at the site of rupture with thinning of underlying inner choroid.

**Lacquer cracks**
The multiple yellowish-white irregular, horizontally oriented linear or stellate lesions known as lacquer cracks may be observed in eyes with high myopia (defined as a spherical equivalent exceeding -6 diopters and/or axial length longer than 26.5 mm) or pathological/degenerative myopia (defined as high axial myopia with characteristic pathological changes at the posterior pole). These eyes often have tilted disks with scleral crescents, posterior pole staphylomas, pigmentary changes and chorioretinal atrophy. Lacquer cracks are believed to be healed mechanical breaks of the RPE, BrM and choriocapillaris complex. The incidence of pathological myopia ranges from 5% to 11%, and CNV may develop in 57% of eyes with lacquer cracks.\(^7^8\)

FAs of lacquer cracks show linear hyperfluorescence without leakage. On FAF, they appear hypoautofluorescent. On OCT, lacquer cracks appear as interruptions of the RPE and increased hyper-transmission into the deeper tissue beyond the RPE.

**Diagnostic tools for AS**

FA, indocyanine green angiography (ICGA), FAF, OCT and infrared and red-free retinography are useful in diagnosing, evaluating and monitoring AS.

**Angiography**

In 1961, Novotny and Alvis described a method for the study of retinal blood flow dynamics, which used intravascular fluorescein and retinal fundus photography equipped with excitation and barrier filters that captured the luminescence of the fluorescein as it passed through the retinal vasculature.\(^9\) Hypofluorescence can occur secondary to a blockage or a vascular filling defect. Hyperfluorescence can occur secondary to leakage, fluorescein staining, pooling, autofluorescence or a transmission defect. Choroidal circulation can be better visualized using ICGA.

Historically, the diagnosis of AS was confirmed with FA, with the streaks appearing as hyperfluorescent.

**Fundus autofluorescence**

FAF can also aid in visualization of AS. This imaging modality relies on the light emitted from lipofuscin in the RPE cells. As such, it represents metabolic activity of the RPE. The typical pattern in the attenuated, atrophied or absent RPE in AS is that of a hypoautofluorescent fissure. Partial repopulation of the AS with RPE cells can be visualized as punctate areas of normal autofluorescence within the hypoautofluorescent streak.

**Optical coherence tomography**

OCT is a valuable tool for non-invasive imaging of the retinal layers at baseline as well as for comparison on subsequent visits. Calcium deposits can be observed as localized areas of hyper-reflectivity on OCT. Spectral-domain OCT can help in visualization of the defects of the BrM in eyes with AS.

**Infrared imaging**

AS may pass unnoticed on color fundus photographs. Infrared imaging enhances the visualization of AS. They appear as brick-red colored and well-demarcated dark fissures against a lighter background.

**Systemic associations**
AS can be idiopathic, but they can also be associated with several systemic conditions recalled through a popular mnemonic PEPSI: PXE, EDS, PD, sickle cell disease, with I standing for idiopathic. While there are reports of multiple other associations with systemic conditions (Table 1), those details are beyond the scope of this introductory article to AS.

**Pseudoxanthoma elasticum (P)**

PXE, also known as Grönblad-Strandberg syndrome, is an autosomal recessive mutation in the ABCC6 (ATP binding cassette subtype C number 6) gene on the short arm of chromosome 16 (16p13.1) resulting in fragmentation and calcification of elastic fibers found in the skin, retina and cardiovascular tissue. Approximately 80% of patients with PXE have AS. PXE is more common in females than in males. To confirm the diagnosis of PXE, a skin biopsy is necessary. If PXE is present, the skin biopsy will reveal mid-dermal clumps of calcified and fragmented elastic fibers. Systemic complications of PXE include yellowish skin papules (peau d’orange) commonly found on the neck, stomach, armpits and groin, calcification of the arteries, which leads to occlusive arterial disease that may lead to cerebrovascular disease, and mucosal bleeding in the stomach and the intestines. The disease can be life-threatening, causing sudden death due to a hemorrhage.

The reported incidence of AS in patients with PXE varies between 59% and 87%.

**Ehler-Danlos syndromes (E)**

EDS are a heterogenous group of 13 heritable connective tissue disorders characterized by genetic mutations that result in the abnormal synthesis of collagen. Common systemic manifestations include increased skin hyperextensibility, joint hypermobility and tissue fragility. The vascular subtype (vED), which is associated with an autosomal dominant mutation in COL3A1, responsible for the synthesis of type III collagen, can manifest with vascular aneurysms and vascular rupture leading to hemorrhages.

It is worth noting that according to the current literature, AS in EDS are extremely rare. In 1966, Green et al. reported a case of a mother and daughter with EDS who demonstrated AS in their retinas. This report has been referenced in the didactics of eye care as an association between EDS and AS.

**Paget’s disease (P)**

PD, also known as osteitis deformans, is a treatable skeletal disorder in which bones grow abnormally in size and shape secondary to focal areas of excessive osteoclastic bone resorption accompanied by a secondary increase in osteoblastic bone formation. It typically affects the femur, pelvis, lower lumbar area and cranium. While the cause is unknown, a strong genetic mutation (at the SQSTM1 loci of chromosomes 5 and 6) as well as viral (paramyxoviruses) influences have been shown. PD is more common in males and in patients older than 55 years. The diagnosis of PD involves radiographic imaging for bone deformities and laboratory testing. An elevated plasma total alkaline phosphatase (ALP) level is the most clinically useful marker of disease activity. ALP is an enzyme normally produced in several organs with the highest concentrations found in the bones and liver. It is not uncommon to find normal levels of ALP in patients with PD. Therefore, one should also measure γ-glutamyltranspeptidase levels to differentiate from liver disease that can also result in elevated ALP activity. The incidence of AS in patients with PD ranges from 8% to 15%.

**Sickle cell disease (S)**

Sickle cell disease is inherited from parents with an autosomal recessive pattern. It is more common in individuals with sub-Saharan ancestry. Human adults have red blood cells (RBC) with hemoglobin A, which is composed of two alpha-globin proteins with two beta-globin proteins. In sickle hemoglobin (HbS), a single point mutation substitutes valine for glutamic acid at the sixth position in the beta-globin chain. RBCs containing HbS have a lifespan of 10 to 20 days, unlike healthy RBCs that live between 90 and 120 days. The “sickling” or collapse of the red blood cells leads to vascular occlusions, which result in ischemia of surrounding tissue and finally necrosis of the blood vessel wall. Diagnosis of sickle cell disease is made by
obtaining a complete blood count, blood smears to identify sickling RBCs, and electrophoresis.

AS are most common in patients with HbS or sickle cell anemia (SCA). Pain and/or swelling of hands and feet are often an early manifestation of SCA. Organ damage from SCA can affect any organ system, including the bones, spleen, liver, brain, lungs, kidneys and joints.

The incidence of AS in patients with sickle cell hemoglobinopathies varies between 0.9% and 6.3.

**Idiopathic (I)**

AS are idiopathic in less than 50% of cases and associated with concurrent disease in more than half of patients presenting with AS.3

**Ocular complications: choroidal neovascularization**

CNVM is a growth of new blood vessels de novo (vasculogenesis) or from pre-existing blood vessels (angiogenesis). The new blood vessels often originate from the choroid and pass through a break in BrM into the sub-RPE or subretinal space. These vessels form networks or nets. CNVM appears to be a repair process initiated by tissue loss and/or damage that results in choroidal scar formation. Any pathologic process that involves damage to the RPE, the BrM and/or choriocapillaris can be complicated by CNVM. Upregulation of VEGF, which is a known factor in angiogenesis, is seen in CNVM. Its cause remains unclear. VEGF upregulation is known to occur secondary to hypoxia, high glucose and protein kinase C activation, advanced glycation end products, reactive oxygen species, activated oncogenes, and a variety of cytokines. Once secreted, VEGF binds to its tyrosine kinase receptors in endothelial cells activating several signal transduction pathways. This in turn induces vascular permeability, endothelial cell proliferation and cell migration, which results in the formation of new vessels.

CNVM is the major cause of vision loss and it affects 70-86% of patients with AS. CNVM also develops in the contralateral eye of 71% of these patients. Overall, the most common causes of CNVM are age-related macular degeneration, presumed ocular histoplasmosis syndrome, myopic macular degeneration, trauma and AS. CNVM can be asymptomatic when extrafoveal or it may present with symptoms of metamorphopsia or scotoma when present within the temporal arcades. OCT, FAF and angiography are used to confirm the diagnosis and evaluate treatment efficacy.

**Diagnostic tools for CNVM**

**Amsler grid**

In 1947, Marc Amsler developed a grid of horizontal and vertical lines to monitor the central visual field. Amsler grid is most commonly used to detect visual disturbances in the macular area of the eye.

**Angiography**

FA and ICGA were historically used to confirm the diagnosis of CNVM, determine the need for retreatment, and determine treatment efficacy. Classic or subretinal CNVM, which is classified as a type 2 lesion, is better visualized by FA than ICGA. Because of their irregular and ill-defined features, type 1 lesions, such as occult or sub-RPE CNVM, are difficult to detect on FA. Therefore, the fundamental advantage of ICGA is it allows for early detection and localization of type 1 CNVM.

**OCT and OCTA**

OCT has become an essential tool in diagnosis as well as determining the need for treatment, monitoring course, and determining the need for retreatment of eyes with CNVM. With advances in OCT technology, it is now possible not only to visualize subretinal fluid, pigment epithelial detachments and overlying retinal edema but also to identify CNVM. Recently, the introduction of OCTA has allowed physicians to visualize not only the retinal structures but also retinal vascular flow without the injection of dye.

**Treatment for angioid streaks**

Eyes with AS that are asymptomatic are observed. Systemic associations should be ruled out by properly obtaining a detailed history and with the assistance of a medical doctor when needed. Home Amsler grid testing should be recommended to monitor for potential ocular complications, and patients should be advised to report any changes immediately to their eye doctor.

**Treatment options for choroidal neovascularization**
The goal of CNVM treatment is to prevent choroidal scarring and accompanying scotoma. However, currently, there is no cure for this chronically active disease. Initially, laser photocoagulation and photodynamic therapy were used with relatively poor results and frequent recurrence. In 2015, Alagöz et al. showed that 65% of eyes with CNVM due to angioid streaks demonstrated an improvement or stabilization in visual acuity with a mean number of five intravitreal injections of bevacizumab over a mean period of 23 months. Over the past decade, intravitreal anti-VEGF medications, such as bevacizumab, ranibizumab and aflibercept, have shown promising results of reducing disease activity and stabilizing or improving visual acuity. Early diagnosis and intervention are crucial to improving outcomes; therefore, patients with AS who develop CNVM should be urgently referred to a retinal specialist for intravitreal injections of an anti-VEGF agent.

Patient education

Although 50% of AS are not associated with systemic conditions, systemic workup to rule out possible common associations should be considered in all patients with AS. It is important to inform patients about the presence of AS and to advise them to use protective eyewear to guard against accidental blunt trauma. Consideration should also be given to any activities that may put patients at risk for trauma to the eyes or head such as boxing, martial arts, basketball or soccer. It is also wise to advise patients with AS to seek care as soon as possible in the event of trauma or any vision change. An Amsler grid along with written instructions for use should be given to all patients diagnosed with AS so they may monitor their central vision. Current treatments for CNVM show more favorable results in patients with less advanced disease, suggesting the initiation of treatment should be as early as possible.

Optometrists play an important role in educating patients about the status of their vision and the health of their eyes. There are no standardized methods for patient education. Patients may require different strategies for counseling; therefore, a patient-centered approach is encouraged. Discussion about the findings and education about the condition as well as the possible ocular complications and systemic associations is warranted. For patients presenting with AS without evidence of retinal complications, periodic Amsler grid testing at home is recommended for both eyes. It is important to educate patients on the proper use of an Amsler grid as well as advise them what they should do if they notice vision changes in either eye. In addition, it is important to stress the need for regular re-evaluations of the ocular fundus.

Critical-thinking concepts

This case illustrates key concepts and goals in the care of a patient with AS. Visual acuity remains very good in eyes with AS; therefore, a change, no matter how small, can indicate the presence of CNVM, the most common ocular complication in eyes with AS. For this reason, Amsler grid testing should be performed early in the clinical examination to identify any macular abnormalities. In the case presented here, the CNVM observed with funduscopy and confirmed with OCT and OCTA was located a significant distance from the fovea and without subfoveal extension. Therefore, it was an unlikely cause for the patient’s complaint of blurry vision at near. Presbyopia or uncorrected refractive error are the most likely cause of monocular blurry vision at near in this patient’s age group in the absence of pathology affecting the central cornea (e.g., dry eye, edema or scarring) or the central lens (e.g., sclerosis or opacification).

Assessment of learning objectives

Instructors can evaluate students on the learning objectives of this case report in the following ways. The case can be shared with the students ahead of the learning session or presented on slides projected onto a large classroom screen at the beginning of the learning experience. Students can be asked to describe, compare and contrast the findings seen on the fundus photographs as well as the OCT and OCTA scans. Students should be able to accurately describe AS. Further discussion should focus on the differential diagnosis and common systemic associations of AS as well as the most common ocular complications. It is important to discuss the role of an optometrist in managing this condition and in patient education and counseling. Formative assessment can take place during group discussions of the case. Knowledge assessment can also be summative through oral or written quizzes.

Conclusion

Angioid streaks are cracks in Bruch’s membrane. In 50% of patients, they are associated with systemic diseases that require proper management. The most frequent systemic association is PXE. By themselves, AS do not cause decreased visual acuity even when crossing into the foveal area. CNVM is the most common retinal complication found in eyes with AS and should be suspected if symptoms of blurry or distorted vision occur. Patients need an urgent referral to a retinal specialist for treatment of CNVM in hopes of preserving vision. Finally, patients with a systemic association need a referral to the appropriate specialist for evaluation and treatment of the associated systemic pathology.

References
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