PEER REVIEWED

Teaching Pupil Dilation: Faculty Perceptions Regarding Elevated Blood Pressure and Dilating Agents

Katie Foreman, OD, FAAO, and Anne Rozwat, OD, FAAO

Abstract

Background: *To assess whether a common blood pressure threshold exists, above which faculty members at an optometry school would instruct students to abstain from dilating a patient's pupils.* ***Methods:*** *Seventy-three faculty members completed a survey about their practice habits regarding dilating the pupils of individuals who have elevated blood pressure.* ***Results:*** *The majority of optometrists surveyed (94.5%) were not concerned about using 1% tropicamide, but more than half (64.4%) were concerned about using 2.5% phenylephrine. The highest percentage of survey respondents typically refrain from dilating a patient with systolic blood pressure higher than 200 (45.2%) and diastolic blood pressure higher than 105 (34.3%).* ***Conclusion:*** *The majority of optometrists in an academic setting have reservations about using 2.5% phenylephrine in patients with elevated blood pressure. A need for this apprehension about dilation is not proven in the literature but seems to be a medical-legal concern. This clinical decision-making rationale is imparted on students, potentially shaping their practice habits.*

Key Words: *blood pressure, dilation, tropicamide, phenylephrine*

Introduction

To be considered comprehensive, an eye examination should include visualization of the fundus through a dilated pupil. To achieve maximal mydriasis for optimal visibility, a combination of 1% tropicamide (a muscarinic receptor antagonist) and 2.5% phenylephrine (an alpha-receptor agonist) is typically used.[1] While adequate pupil dilation may be achieved with 1% tropicamide alone, some situations (e.g., dark irides, diabetes, aging) require a combination of the two drops to achieve greater dilation in a shorter time.[2-5]

Optometric educators guide optometry students as to when it is necessary to dilate a patient's pupils. Evidence-based clinical guidelines have been established to aid in this decision.[6-7] While the indications for dilating the pupils are clear, the contraindications and precautions are more difficult to navigate for clinicians and students.[8]

No consensus exists on a systolic or diastolic blood pressure threshold at or above which a practitioner should abstain from dilating due to the potential risks of the dilating drops. When given systemically, phenylephrine is known to cause cardiovascular adverse effects including increases in systolic blood pressure, diastolic blood pressure and heart rate.[9-11] A mounting body of evidence suggests that short- and long-term increases in blood pressure, as well as short- and long-term variability in blood pressure, are associated with the development, progression and severity of cardiovascular events.[12] Adverse

systemic side effects associated with topical phenylephrine have also been reported to the National Registry of Drug-Induced Ocular Side Effects.[13] These side effects include marked increase in blood pressure, syncope, ventricular arrhythmias, pulmonary edema, myocardial infarction and subarachnoid hemorrhage.[14] However, the majority of these side effects occurred with the use of 10% phenylephrine, a concentration that is not typically used in a clinical setting to dilate a patient's pupils.

Conversely, numerous studies have shown no statistically significant increase in blood pressure or other systemic side effects after the instillation of 2.5% or 10% phenylephrine and/or 1% tropicamide.[9, 14-20] The largest clinical trial, involving 150 subjects, compared 10% phenylephrine against 1% tropicamide and found no increase in blood pressure or heart rate up to 30 minutes after either drop was administered.[7] A meta-analysis of studies evaluating cardiovascular adverse effects of topical phenylephrine, which included eight randomized clinical trials and data on the 2.5% and 10% concentrations, found 2.5% phenylephrine did not cause an increase in blood pressure at either 20-30 minutes or 60 minutes or longer after application. Ultimately the investigators concluded that the sum of the data provided no evidence of an effect of 2.5% phenylephrine on blood pressure or heart rate and only a short-lived effect of 10% phenylephrine.[21]

The conflicting reports make it challenging for a practitioner to make an evidence-based medical decision about using 2.5% phenylephrine and/or 1% tropicamide to dilate pupils when blood pressure is elevated.[15] Students at the Illinois College of Optometry (ICO) are educated about the side effects of mydriatic pharmaceutical agents in their pharmacy courses; however, guidance on when to dilate is not taught in the classroom.

The aim of this study was to poll optometrists who are involved in patient care at Illinois Eye Institute and determine what they teach their students about elevated blood pressure and pupil dilation. In addition, their dilation routine was evaluated to see whether it correlated with their gender, years in practice or practice specialty.

Methods

Table 1. Click to enlarge

This study was approved by the ICO Institutional Review Board. A survey was distributed to all 79 optometric clinical faculty at ICO. All faculty members surveyed taught at Illinois Eye Institute, the on-site clinic for ICO. No faculty who taught at satellite clinics were included in the study. The faculty represented attending doctors in primary care, pediatrics, contact lens, low vision and advanced care clinics. The survey was anonymous and inquired about gender and years in practice. The seven questions for the survey were developed by the authors based on their clinical experiences and observations. A literature review did not reveal any similar survey or research on this subject. The participants were asked questions regarding their practice habits related to dilating asymptomatic adult patients with elevated blood pressure. They were also asked questions pertaining to their opinions about specific dilating eye drops and their effect on blood pressure and any medical-legal concerns they might have regarding dilating a patient with elevated blood pressure **(Table 1)**. All data were analyzed using Statistical Package for Social Sciences (IBM SPSS version 21.0, Chicago, IL). The chi-squared test of independence was used to interpret the survey results. A p value of <0.05 was considered statistically significant.

Results

Seventy-three of the 79 clinical faculty members (92.4%) participated in the study. The majority of optometrists (94.5%) were not concerned about 1% tropicamide increasing blood pressure in patients

who presented with elevated blood pressure. However, more than half of the optometrists (64.4%) were concerned that 2.5% phenylephrine may increase blood pressure in individuals with elevated blood pressure. The majority of optometrists (71.2%) were concerned for medical-legal reasons about dilating a patient with elevated blood pressure.

Figure 1. Survey respondents' cutoff for dilation based on systolic blood pressure. Click to enlarge

Figure 2. Survey respondents' cutoff for dilation based on diastolic blood pressure. Click to enlarge

When asked at what blood pressure level they would typically not dilate an asymptomatic adult patient with 2.5% phenylephrine and 1% tropicamide, the highest percentage of faculty reported they would not dilate individuals with systolic blood pressure higher than 200 mmHg (45.2%) **(Figure 1)** and diastolic blood pressure higher than 105 mmHg (34.3%) **(Figure 2)**. Neither gender nor years in practice had any significant association with dilation decision-making for tropicamide ($?^2_{1df}$ = 0.77, p=0.38) and ($?^2_{1df}$ = 0.60, p=0.44) respectively or phenylephrine ($?^2_{1df}$ = 0.75, p=0.39) and ($?^2_{1df}$ = 0.00, p=0.99) respectively. However, a significant difference was found between subspecialty optometrists and primary care optometrists with regard to practice habits and concern about the use of 1% tropicamide ($?^2_{1df}$ = 7.05, p=0.03). Conversely, no statistically significant difference was found between the various subspecialties regarding concern about 2.5% phenylephrine increasing blood pressure in hypertensive patients ($?^2_{1df}$ = 0.60, p=0.29).

Discussion

Optometrists in this teaching setting tend to act conservatively when considering whether to use 2.5% phenylephrine in patients with elevated blood pressure. This approach may be guided by the small number of studies that indicate an increase in blood pressure and heart rate following administration of 10% phenylephrine.[9-11] Overwhelmingly, the concern seems to be driven by the medical-legal implications of using these drops in these particular individuals.

This approach with hypertensive patients and discussions while managing the cases may make students much more aware of the status of each patient's systemic health beyond the diagnosis. Students are taught to take an accurate blood pressure reading and to ask about the specifics of the patient's hypertension, including current medications and compliance and recent visits to primary care physicians. It is also important to take any physical symptoms a patient is having into account when making the decision to dilate. The students are taught to ask how a patient is feeling when they measure elevated blood pressure. Specific symptoms that would impact the decision to not dilate include dizziness, headache, nausea and vomiting. In these instances, students are taught that they should contact the primary care physician, or, in extreme cases, call for an ambulance or send the patient directly to the emergency room.

Studies that have investigated a relationship between phenylephrine and blood pressure and heart rate are limited in number, have small sample sizes or heterogeneous samples, and often include the application of tropicamide concurrently.[9,12] There is also a lack of data available on cardiovascular adverse effects of topical phenylephrine specifically in persons with cardiovascular risk factors or a

history of cardiovascular events. These unknowns may lead faculty to act more conservatively when deciding whether to use 2.5% phenylephrine in patients with elevated blood pressure.

While no blood pressure cutoff for pupil dilation is formally taught at ICO, like many aspects of clinical care, students may mirror their teachers and develop their practice habits based on those of their clinical faculty. As this study demonstrates, approaches to this particular issue vary as the long-term practice habits of students likely will.

A limitation of this study includes its small sample size, specifically of optometrists practicing in subspecialties. The small sample size prevents the data from accurately being extrapolated. Going forward, the authors would be interested in surveying other optometric educators. Assessing student perceptions about what they are learning in clinic about dilation would also inform understanding of this topic.

Medical decision-making is a complex process that is shaped by patient expectations and by doctors' efforts to maximize benefits while reducing risks. Typically, the aim is to make decisions based primarily on the highest levels of clinical evidence.[22-23] However, the reality is that management decisions are often shaped by a range of other influences, including individual intuition, professional experience and concern about malpractice litigation.[24-26] This is especially true in scenarios where strong evidence or clinical trial results are lacking, which ultimately leads to disparity in practices among clinicians. Clinical decision-making processes are imparted to students, potentially shaping their own practice habits and perpetuating such disparities. Optometry students should be taught about the decision-making process surrounding pupil dilation in patients with elevated blood pressure and be well aware of the positive and negative clinical and nonclinical influences on the decision. When they are aware of these aspects of the issue, they will be better equipped to make their own patient care decisions.

Conclusion

This study demonstrates that optometrists in an academic setting have reservations about using certain dilating eye drops in patients with elevated blood pressure, specifically 2.5% phenylephrine. The highest percentage of faculty typically instruct students to refrain from dilating a patient with systolic blood pressure higher than 200 and diastolic blood pressure higher than 105. A reason for concern about dilation in this scenario has not been proven in the literature but seems to be more of a medical-legal consideration.

A challenge in educating optometry students is teaching evidence-based medicine while also stressing the importance of nonclinical influences on patient management and treatment decisions. If educators understand the trends and driving forces behind specific clinical decisions, such as dilating patients with elevated blood pressure, they can create a more consistent approach to teaching and also to overall patient care.

References

1. Phillips C. Dilate the pupil and see the fundus. BMJ. 1984;288:1779-1780.
2. Anderson H, Bertrand K, Manny R, et al. A comparison of two drug combinations for dilating dark irides. Optom Vis Sci. 2010;87:120-4.
3. Jung BH, Kim SY. Pupillary dilation with mydriatics in diabetic retinopathy. J Korean Opthalmol Soc. 1992;33:495-500.
4. Cooper J, Feldman JM, Jaanus SD, et al. Pupillary dilation and funduscopy with 1.0% hydroxyamphetamine plus 0.25% tropicamide (Paramyd) versus tropicamide (0.5 or 1.0%) as a function of iris and skin pigmentation, and age. J Am Optom Assoc. 1996;67:669-75.
5. Lei HL, Yang KJ, Sun CC, et al. Obtained mydriasis in long-term type 2 diabetic patients. J Ocul

Pharmacol Ther. 2011;27:599-602.
6. American Academy of Ophthalmology Preferred Practice Patterns Committee. Preferred Practice Pattern Guidelines. Posterior vitreous detachment, retinal breaks and lattice degeneration. San Francisco, CA; American Academy of Ophthalmology; 2014. Available at https://www.aao.org/preferred-practice-pattern/posterior-vitreous-detachment-retinal-breaks-latti-6.
7. American Optometric Association Evidence-based Optometry Guideline Development Group. Evidence-Based Clinical Practice Guideline. Comprehensive adult eye and vision examination. American Optometric Association. St. Louis, MO; 2015. Available at https://www.aoa.org/documents/EBO/Comprehensive_Adult_Eye_and_Vision%20QRG.pdf.
8. Fishbaugh J. Lessons on dilation. Insight: The Journal of the American Society of Ophthalmic Registered Nurses. April 1994;19(1):30-32.
9. Motta M, Coblenta J, Fernandes BF. Mydriatic and cardiovascular effects of phenylephrine 2.5% versus phenylephrine 10%, both associated with tropicamide 1%. Ophthalmic Res. 2009;42(2):87-89.
10. Chin KW, Law NM, Chin MK. Phenylephrine eye drops in ophthalmic surgery – a clinical study on cardiovascular effects. Med J Malaysia.1994 Jun; 49(2):158-163.
11. Kumar V, Schoenwald RD, Chien DS, Packer AJ, Choi WW. Systemic absorption and cardiovascular effects of phenylephrine eyedrops. Am J Ophthalmol. 1985 Feb;99(2):180-184.
12. Parati G, Ochoa JE, Lombardi C, Salvi P, Bilo G. Assessment and interpretation of blood pressure variability in a clinical setting. Blood Press. 2013;22:345-54.
13. Fraunfelder FT. Pupil dilation using phenylephrine alone or in combination with tropicamide. Ophthalmology. 1999 Jan;106(1):4.
14. Hakim O, Orton R, Cadera W. Topical 2.5% and 5% phenylephrine: comparison of effects on heart rate and blood pressure. Can J Ophthalmol. 1990;25:336-9.
15. Brown MM, Brown GC, Spaeth GL. Lack of side effects from topically administered 10% phenylephrine eyedrops. A controlled study. Arch Ophthalmol. 1980;98:487-89.
16. Jennings B, Sullivan D. The effect of topical 2.5% phenylephrine and 1% tropicamide on systemic blood pressure and pulse. J Am Optom Assoc. 1985;57:382-9.
17. Tsui E, Sehi M, Cheng R, Wan J, et al. The impact of topical mydriatic ophthalmic solutions on retinal vascular reactivity and blood flow. Experimental Eye Research. 2013;112:134-38.
18. Fraunfelder FT. Possible cardiovascular effects secondary to topical ophthalmic 2.5% phenylephrine. Amer J Ophthalmol. 1985;99:362.
19. Bhatia J, Varghese M, Bhatia A. Effect of 10% phenylephrine eye drops on systemic blood pressure in normotensive and hypertensive patient. Oman Med J. 2009;24:30-32.
20. Malhotra R, Banerjee G, Brampton W, Price NC. Comparison of the cardiovascular effects of 2.5% phenylephrine and 10% phenylephrine during ophthalmic surgery. Eye. 1998;12:973-975.
21. Stavert B, McGuinness M, Harper A, Guymer R, Finger R. Cardiovascular adverse effects of phenylephrine eyedrops; a systemic review and meta-analysis. JAMA Ophthalmology. 2015;133:647-49.
22. LeFevre M. From authority- to evidence-based medicine: are clinical practice guidelines moving us forward or backward? Ann Fam Med. 2017;5:410-412.
23. Guyatt G, Cairns J, Churchill D, et al. Evidence-based medicine: a new approach to teaching the practice of medicine. JAMA. 1992;268(17):2420-2425.
24. Classen D, Mermel L. Specialty society clinical practice guidelines: time for evolution or revolution? JAMA. 2015;314(9):871-872.
25. Carrier E, Reschovsky J, Mello M, Mayrell R, Katz D. Physicians' fears of malpractice lawsuits are not assuaged by tort reforms. Health Affairs. 2010;29(9): 1585-92.
26. 26. Garcia-Retamero R, Galesic M. On defensive decision making: how doctors make decisions for their patients. Health Expect. 201;17(5):664-669.

Dr. Foreman [kforeman@ico.edu] is an Assistant Professor of Optometry at Illinois College of Optometry.

Dr. Rozwat is an Associate Professor of Optometry at Illinois College of Optometry and Chief of the Primary Care Clinic.