

APERTURE

MAGAZINE



MARCH 2018
ISSUE 2



CANADIAN ASSOCIATION OF OPTOMETRY STUDENTS
ASSOCIATION CANADIENNE DES ÉTUDIANTS EN OPTOMÉTRIE

TABLE OF CONTENTS

- 5. CAOS EXEC TEAM
- 6. PRESIDENT'S MESSAGE
- 8. A MESSAGE FROM CAO
- 10. THE CENTRE FOR OCULAR RESEARCH & EDUCATION
- 12. PROGRESSIVE ADDITION LENSES
- 14. MAGAZINE CONTEST ARTICLES
- 22. CLINICAL CASE REPORTS

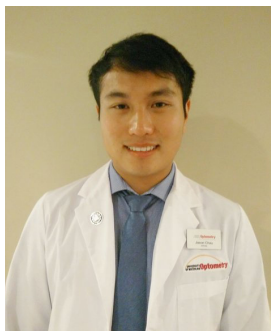
EDITOR'S NOTE

Thank you for your interest in our second issue of Aperture! With the continued support of our CAOS members, executive team, sponsors, and readers like you, we are honored to bring you another Aperture magazine for 2018. Because of you, we have grown CAOS by expanding our mediums to reach out to students, optometrists, and optometry leaders across the country. We would like to give special thanks to Naomi Kong for leading the way by creating our first inaugural issue of Aperture, and her great contributions and mentorship to CAOS.

This issue of Aperture features a special message from the CAO president, as well as articles written by students and faculty from the University of Waterloo School of Optometry and Vision Science. We hope you enjoy the tips, opinions, perspectives, and humour from these talented writers! We also want to share two Grand Rounds Clinical Case Reports written by 4th year optometry students, selected by our Clinical Professor: Dr. Sarah MacIver.

As your editors, our goal is to curate content that is enlightening, thought-provoking, yet still enjoyable. We want you to have as much fun reading Aperture as we did creating it. Please feel free to share your thoughts with us at vpcomm@caostudents.ca. Happy reading and cheers to another great year!

Sincerely,



Jason Chau
*Communications Technical
Director*



Jennifer Tran
*Communications Director
Elect*



Jonathan Niavis
Communications Director

**KEEP AN EYE
OUT FOR OUR**



YOUTUBE CHANNEL

“CAOS STUDENTS”
**WHICH WILL BE
LAUNCHED SOON**



UW CHAPTER

CAOS EXEC TEAM

2017-2018



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EXEC-ELECTS

PRESIDENT'S MESSAGE

Dear CAOS Members,

On behalf of the Canadian Association of Optometry Students (CAOS), I would like to welcome you to the second edition of our annual magazine, Aperture. This magazine is a work of our students, for our students. Aperture was inspired to bring together Canadian optometry students studying at institutions across North America, to showcase their ideas and to recognize them as future leaders of our profession.

As a national optometric student association, our goal has always been to facilitate our optometric education by promoting clinical and professional development, raising awareness of current challenges facing the industry, and promoting leadership and advocacy. CAOS has also been actively involved in advocating the profession of optometry to the public, clearly emphasizing the importance of our role as primary eye care providers. We strongly believe that as future leaders of our profession, it is critical to get involved early during our education so that we can all work together in moving our profession forward and providing the best eye care possible to our patients

The 2017-2018 school year has been a fantastic time of growth for our organization! In April 2017, we hosted our annual Interview Day, in which graduating students had access to over 50 employers, representing 70 jobs. We also had the honour to represent the student voice at CAO Congress by presenting at the Annual General Meeting. We were able to demonstrate the passion and drive that our members share for the profession, and help promote the programs and services that we offer. Our professional development team hosted 15 different clinical and professional lectures from acclaimed speakers on a plethora of topics, including vision therapy, dry eye, nutrition for eye care and specialty contact lenses. In addition, through our Mentorship Program, our CAOS members visited the successful private practices of 21 doctors across the country to network, ask questions, and see optometry practices first-hand.

Our Summer Internship Program has continued to grow over the years to enable our optometry students to secure summer job placements across Canada. We continue to work towards actively establishing our fellow chapters in Montreal and in the United States, so that our colleagues studying at these institutions can also benefit from our programs. With the continued support of Eye Recommend, we recently celebrated our third consecutive year of providing members of the incoming class complimentary CAOS backpacks. We even expanded this opportunity to our colleagues studying at Illinois College of

Optometry (ICO). Finally our Education Committee has extensively grown our iCare Eyecare program, to continue to educate the public and raise awareness for optometry within our community.

We also recently conducted a survey of our members to investigate topics such as student financial debt, practice goals and residency interests. Our findings were presented to Canadian professional optometric associations and the FORAC committee, as well as summarized into a report which can be found under the Resources tab on our website: www.caostudents.ca. We hope that the findings of the CAOS 2018 Annual Survey will help practicing doctors and industry leaders to better connect and appreciate the perspective of recent graduates.

Our executive committee is always working eagerly to improve our existing programs as well as to create additional opportunities for our members. We are thrilled to be launching our CAOS YouTube channel very soon, which we aspire will help promote our profession and illustrate the significance of eye care to the public. This is all in addition to our Facebook page, Twitter and Instagram page - all under the handle of @caostudents. Currently, we are working on additional partnerships with industry leaders to help further expand our programs and services.

I would like to thank each and every one of our executive members for all of their tremendous efforts that they have put into CAOS 2017-2018. I would like to acknowledge Jason Chau, Jennifer Tran and Jonathan Niavis who have invested an extensive amount of time and energy into this magazine. Furthermore, I would like to thank all of our sponsors, doctors, industry leaders and student members who have supported us in achieving our goals.

I deeply encourage each and every one of you to get involved and support your associations so that we can continue to grow together, and create the best Doctors of Optometry. If you have any questions, feedback or concerns, please feel free to contact me at president@caostudents.ca.

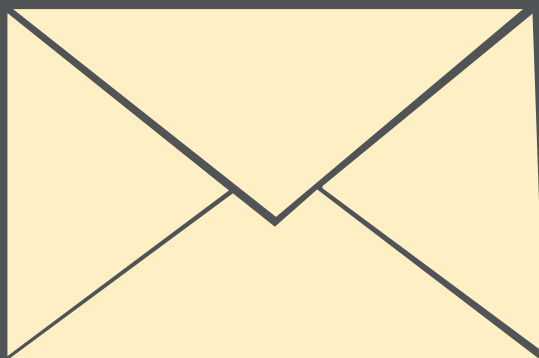
Sincerely,



Rahul Joshi

CAOS President

University of Waterloo Chapter



A MESSAGE FROM CAO

DR. MICHAEL DENNIS
PRESIDENT OF CAO



I would like to begin with a couple of “thank yous” – first, to Brij Patel, who serves as the student representative on the Canadian Association of Optometrists (CAO) Council (and has represented the student voice admirably), and who, with encouragement from CAOS President Rahul Joshi (my second thanks!) offered me the opportunity to share some news from CAO through Aperture.

I truly hope that those reading this know that CAO offers students complimentary membership. What does this mean for you? Well, it means that you have all the benefits of a full member – access to our resource library, the jobs board, the digital version of the Canadian Journal of Optometry, a special registration rate for the CAO Congress, regular communications regarding CAO activity as well as access to financial and other discount programs. It also means complimentary business cards and the white coats you receive in the White Coat

ceremony! CAO encourages student membership, because we know that an engaged membership not only advances the highest standard of primary eye care, but the profession itself.

We know that increasingly, students of optometry are enrolling in schools in the United States. Consequently, CAO began reaching out to Canadian graduates in the 22 American schools of optometry last Fall, extending the offer of membership to them as well as to the students at the Universities of Montreal and Waterloo. We want to make sure that when these Canadian students come home to practice, they not only have a sense of what the issues are at the national level, but that they feel some accountability for, and interest in, resolving them.

CAO sees membership as providing a venue for professional development and networking with colleagues from across the country. But CAO also sees membership as providing an opportunity to nurture and develop leaders at both the provincial and national levels, to help ensure that optometrists are acknowledged as “the” authority on primary eye care in Canada.

CAO’s role in facilitating that leadership includes tapping the membership to support the development of compelling CE and clinical practice guidelines supporting best practices; to advance research through the contribution of articles to the Canadian Journal of Optometry; to serve on Committees to pursue public policy issues; to sign petitions or send letters to Members of Parliament on issues of relevance to the profession, and to take part in meetings with government and other stakeholders to encourage education and awareness, as well as advance advocacy initiatives.

In our experience, students are keen ambassadors for their profession. School provides you with all the clinical training you need to become leaders. CAO is interested in supporting your enthusiasm by providing an opportunity to learn how to harness it for advocacy purposes.

It is why CAO is coming to the University of Waterloo School of Optometry and Vision Science on Saturday, March 24 for a “Leadership and Advocacy Training Session”, led by Laurel Craib-Laurin, CAO’s Senior Manager for Government Relations. Committed to advocacy as a means to advance public policy in favour of optimal eye health and vision care, this inaugural session is designed to provide some pointers on how to promote the profession to all levels of government, and forge closer ties with policy makers at the grassroots. Stay tuned for more information about the session.

CAO is interested in hearing the student voice. It is why we added a student representative to our Council. We will shortly be recruiting for a new representative, as Brij’s term comes to an end. Stay tuned for more information about that process, too. We believe that students bring a unique perspective to the work we do and that it can positively influence the Association’s strategic goals and objectives. While a role on Council is one way to connect with the Association, I would encourage each and every one of you to feel free to contact either the members of the Council itself, or the staff at CAO, if you have any questions about the work we are engaged in on behalf of the profession.

I began this column by thanking Brij and Rahul for the opportunity to speak to you directly. I will close by thanking each of you for your future commitment to the optimal eye health and vision care your will provide your patients, and to your role as ambassadors for our profession.



CANADIAN ASSOCIATION OF OPTOMETRISTS
ASSOCIATION CANADIENNE DES OPTOMÉTRISTES

THE CENTRE FOR OCULAR RESEARCH & EDUCATION (FORMERLY THE CENTRE FOR CONTACT LENS RESEARCH): *AN EVOLUTION THREE DECADES IN THE MAKING*

BY ALISA SIVAK

HEAD OF KNOWLEDGE TRANSLATION, CORE

WHAT YOU NEED TO KNOW

As of January 2018, the Centre for Contact Lens Research at the University of Waterloo's School of Optometry & Vision Science will be known as the Centre for Ocular Research & Education. This name change reflects expanded interests and capacity to explore a wider range of ocular research.

A TRADITION OF FORWARD MOMENTUM; AN EVOLUTION OF SCOPE

The Centre – the largest of its kind in the world – has been advancing ocular research for 30 years. In the early days, its researchers were involved in several key developments in the history of contact lenses, including the evolution of silicone hydrogel lenses and extended wear and the development of the disposable lens modality. Its interests and capabilities expanded over time to include a much wider reach, including:

- tear film and meibomian gland analysis,
- microbiology,
- toxicology
- myopia control
- the development of novel contact lens materials and technology designed to deliver drugs to the ocular surface, and
- the capacity to collect input from patients and practitioners

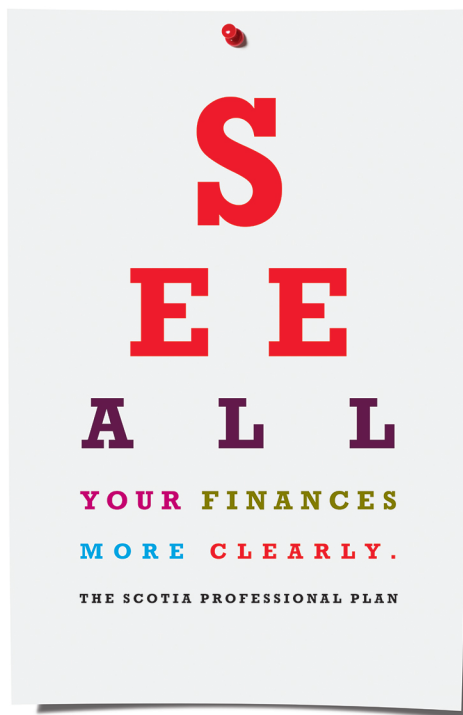


Los Angeles-based artist John Park was commissioned to create a massive 12-foot x 8-foot acrylic mural at the American Academy of Optometry's 2017 meeting in Chicago, to celebrate CORE's launch. Attendees were invited to make their mark on this collaborate painting, which is now housed at the University of Waterloo's School of Optometry and Vision Science.

CORE: A RESOURCE FOR CLINICIANS AND STUDENTS AS WELL AS INDUSTRY

CORE's mission is to improve global eye health and vision through advanced bioscience, clinical research and education. Here is how you can get involved:

- CORE research is at the forefront of innovation in ocular health and contact lens technology; keep an eye out for CORE publications in leading journals, and watch for CORE speakers at international conferences, meetings and CE events.
- CORE offers multiple educational tools for students and practicing clinicians, including:
 - ContactLensUpdate.com -- an online publication that provides clinical insights grounded in the latest research
 - ContactLensCompendium (access via ContactLensUpdate.com) is an online database of contact lenses and solutions available in Canada
 - The Guide to Clinical Contact Lens Management provides online clinical guidance with respect to ocular signs, symptoms, diagnosis and management
- CORE offers training for graduate students and post-doctoral fellows for those interested in going beyond clinical management.



The Scotia Professional Plan for Optometrists.

You've worked hard to get where you are today and we can help ensure your ongoing success. The *Scotia Professional*® Plan lets you manage your professional and personal banking with a customized suite of products and services, preferred rates, and the support of a dedicated Scotiabank advisor. It's the best way to bring all your finances into focus.

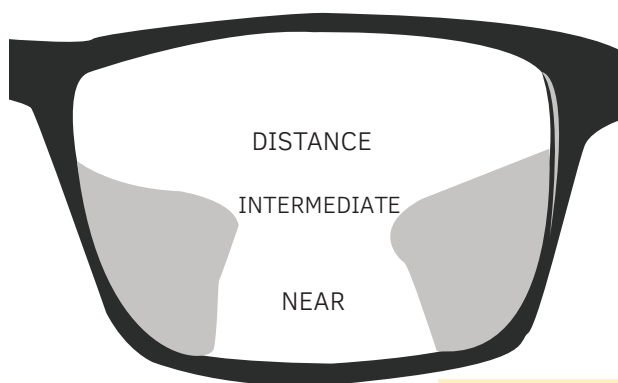
To learn more, visit your nearest branch or www.scotiabank.com/professional

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PROGRESSIVE ADDITION LENSES

HOW DO WE CHOOSE?

BY YVAN BERTRAND, RO
LAB INSTRUCTOR - LECTURER



Different Progressive Addition Lenses (PALs) have many similarities and differences. What is of fundamental importance in PALs is balance. Regardless of the direction of gaze, the wearer's perception must be stable with equal or similar amounts of distortion, direction and amount. Differences should be within tolerance threshold levels. How can balance be managed or maintained in cases of vertical imbalance? Some designs achieve near zone balance by adding prism and balancing fusion in the near zone. Rodenstock and Zeiss offer this feature in MyView and Individual 2 designs respectively among others.

So how do the best designs from Hoya, Nikon and Essilor, for example, compare with their better and good designs? Will every patient actually see the difference between the good, better and best designs of each company? The answer is no. A number of factors come into play. Does the Rx warrant a best design? What is the patient currently wearing? How satisfied is patient in current pair? If cost is not a concern, does everyone want the best design? Most likely. Does everyone need the ultimate design? No. If ten patients have an identical vision correction, will they all respond equally to a state of the art design? No. Practically speaking, Picky Paul, Average Andy and Happy Harry will all see and perceive lenses differently in some capacity.

So what are the most common errors in PAL dispensing?

1. *Centration - Fitting - Measurements*
2. *Deviation from original PAL fit*
3. *Refraction and consideration of patient's specific vision needs*
4. *Lack of patient education by OD, Optician or OA.*

Can one PAL design serve every patient successfully? No. I've yet to meet an OD or Optician who has experienced complete success with a single PAL design.

So why wouldn't a single state of the art design please everyone? The reason for this is the broad range of Rx types. As we have different Rx types, we also have diverse patient types as referenced earlier. Throw in a high or oblique cyl, and everything changes again. Every PAL design is optimized for a certain type or range of wearers by its lens designers. How is the 'average' patient defined by the designers in terms of PD, convergence, vertex, wrap, tilt, head position, etc?

So what's the solution to choosing the right progressive? In addition to the four points mentioned previously, consider these suggestions.

1. Determine what PAL design your patient is currently wearing. Observe how PALs are being worn in regards to fit and frame adjustment.

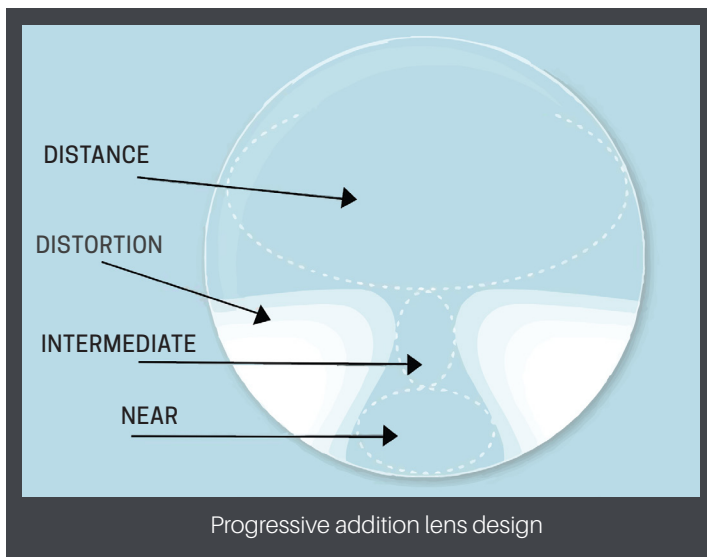
2. Verify how the PAL is fitted horizontally and vertically (PD and fitting height) by re-marking factory fitting reference points. Address accordingly in new pair.

3. Ask the patient what they like or dislike about their current PALs. Listen carefully.

4. Consider staying in the same family of lenses worn by the patient. If you don't know what they're wearing, go to your preferred designs.

Consider creating a "Good, Better, Best" PAL list specifically for your office. Determine who is best suited for each design. Know which design you prefer for 'bread & butter' Rx's, high plus or high minus, low, moderate, high or oblique cyls, etc.

When discussing a presbyopic patient's vision needs and expectations, dialogue inevitably leads to enhanced readers. Oftentimes, patients do not know about 'computer lenses' or other options. With significant performance and ergonomic advantages, educate your patient about their near and intermediate vision options. PALs are great however they are not designed for 20 plus hours per week staring at a monitor through an intermediate corridor. This applies most with advanced and mature presbyopes. PALs are critical to any successful Optometric practice. Developing professional fitting and dispensing habits combined with a strong patient education program will yield high patient satisfaction and adaptation results.





THE MAKINGS OF A GOOD DOCTOR

THE MUSINGS OF A PASSIONATE STUDENT IN THE JOURNEY TO BECOMING AN EXEMPLARY OPTOMETRIST

BY SHERENE VAZHAPPILLY

“ONE OF THE ESSENTIAL QUALITIES OF THE CLINICIAN IS INTEREST IN HUMANITY, FOR THE SECRET OF THE CARE OF THE PATIENT IS IN CARING FOR THE PATIENT.” - FRANCES W PEABODY IN THE CARE OF THE PATIENT

Perhaps it the benison of human kindness, the moments of compassion we have experienced in our lives or the insatiable medical curiosity which make us eager to repay the world in the white coat of an exemplary doctor. Through gifts of touch, tongue and healing we make an incredibly profound difference in the lives of our patients, may it be through management of vision or good counsel. Often, we in our rigorous educational training question whether we hold all of the virtues necessary to be deemed an incredible doctor. We pose the question to ourselves in moments of moral dilemma or patient mistrust, in the depths of uncertainty or the emotional highs of meaningful patient interactions. What makes a good doctor? And how can I, as a student, begin the moral, emotional and mental journey into becoming one?

We must be relieved in the understanding that a good doctor has all the merits of an excellent student. A good doctor is one who is passionate, diligent, optimistic, curious, honest, kind, moral, reflective and knowledgeable – all at the same time. How is it possible for so many virtues to exist within a single human being? Difficult as it may be to find, fortunately, in the optometry profession, such combinations are in abundance. Ardent students roam the halls here, following their hearts to various forms of art, literature, politics, and philosophy – growing their gifts of tongue, touch, and clarity of mind. A good doctor is a life-long learner, remarkable in his or her traits of curiosity and vigor for intellectual debate. In many ways, a good doctor is created exclusively on the foundation of a brilliant learner.

However, where a good doctor transcends the boundaries of an exemplary student is in his or her incredible capacity for benevolence, compassion and love of humanity. A caring optometrist in particular, is poignantly touched by the patient’s life, as well as his or her illness. The optometrist need not be an anthropologist to be sensitive to different cultures nor a psychiatrist to recognize the emotional status of the patient. They need not be a social worker to spot child abuse nor a marriage counsellor to understand a failing relationship. For this, a good doctor needs only to be observant and sensitive to the patient, gathering the full array of emotional, medical, social and spiritual tools to aid in the patient’s healing, as illness always tends to be a multifaceted entity. A compassionate optometrist then, must be someone who inspires in his or her patients a total confidence and optimism which is the best beginning for the holistic treatment of any illness or distress.

As exemplary students, we must strive to also progress in our journey to become exemplary optometrists. We may do ordinary things, but we can do them with an extraordinary love, attention and compassion for our patients, who become vulnerable the moment they entrust their vision into our hands. It is with this love of humanity that we develop within us the bubbling desire to go above and beyond in providing care to our patients, in counselling them, in supporting them, and most importantly, in instilling in them the hope and confidence that only a good doctor can provide.

DO YOU SEE WHAT I SEE?

BY SOPHIA CAPO



As a first year optometry student
I am happy to reply
Why are optometrists so important?
For this I'll tell you why!

Imagine Canada with a blindfold
What a difficult life that would be!
Now look at the role of an optometrist
And how much better you will see

Frankly, optometry is not just eye exams
That's what many people think
It is front line healthy eye care
With every passing blink

Perception, focus and coordination
Is the goal of a vision test
It's analysis and diagnosis
It is to make you see your best

You see without any optometrists
Our world would be a different place, I'm sure
Many problems with our vision
So many people would have to endure

Our quality of life would be affected
And so too our vision care
Days would be blurry, nights so dark
Venturing out we would not dare

Optometry is a regulated profession
Practicing exams and licensing fees
Only integrity and good ethics
Is exactly what you'll see

Optometrists find glaucoma, cataracts, strabismus
And other diseases of the eye
They recommend treatment, prescribe meds
They fix the problem, I do not lie

Blepharitis, pink eye, dry eyes
All conditions optometrists cure
There will be a treatment plan available
Of this I am very sure

Need new glasses? No problem!
Prescribe, supply, adjust and fit
Your optometrist takes care of you
And gives a cleansing and total care kit!

Sometimes heads get banged in accidents
Or eyes that are lazy are often seen
Vision therapy is recommended
To make your eye sight much more keen.

Optometrists have many contacts
Ophthalmologists are their best friend
Both will guide you through eye surgery
And see you through till the very end

Canadian Optometrists are committed
To helping small kids in our school
You see sometimes 4 year olds can't see well
And other kids can be so cruel

Children begin grade 1 with vision problems
About 20% of the time
So optometrists have come to help
And said "You don't have to pay a dime!"

With the "Eye See, Eye Learn" program
Canadian JK's get glasses free
They restore vision and also confidence
So kids can be the best that they can be

But optometrists don't help just young
They are committed to the old
Macular degeneration, diabetic retinopathy
These are issues that are so bold

The Canadian Association of Optometrists
Said in May to "Get Eye Wise"
Optometrists detect thyroid, vascular and brain disease
This skill should be of no surprise

Early detection and prevention
Are definitely the key
So get checked out by an optometrist
So much healthier you will be

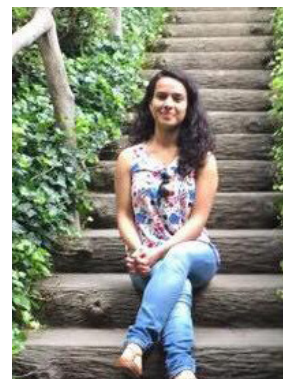
A Canada without optometrists
I don't even care to dream
Our vision care would be compromised
We wouldn't live fully, so it seems

So hats off to optometrists
And all the work they do
For their commitment and their passion
For their caring and patience too

So I will pursue my four years in optometry
And be the best that I can be
I hope you now look at optometry differently
And can see all that I can see!

OPTOMETRISTS: MORE THAN WHAT MEETS THE EYE

BY ANAMIKA OHRI



Before I learned more about what optometrists did, I viewed optometrists as someone you went to if you needed glasses. However, after learning more about the profession, it was obvious that it's more than just that. It is unfortunate that not everyone has the same opportunity to understand that optometrists are their primary eye care providers – rather than glasses dispensers. I don't blame them either, I also lived under the rock for the longest time. It is easy for the public to have this misconception since some patients only see optometrists solely for an updated prescription. As a result, they believe that getting an online eye exam for glasses prescription is a very convenient and a reasonable option, especially if they live in a fast-paced lifestyle.

This past summer, while working at both an optometrist office and an associated optical store, I interacted with many customers who held this misconception about optometrists. Customers would want the latest style of glasses but would hand me an expired prescription. When I would inform them that they needed a new prescription as well as an ocular health assessment, they did not understand the significance of a full eye exam. These types of patients only thought we worked with the phoropter and nothing more. However, on the other hand, I would also see patients who had the utmost respect for the profession and would comply to all the tests we offered because they wanted to make sure their eye health was top notch. This made me wonder as to what made the difference between these two points of views. After talking to patients, I realized that the patients who had a positive outlook on our profession were educated on the many things that optometrist performed, such as treating eye infections,

allergies and even detecting eye diseases. These patients also had a long-standing history with the optometrist. On the contrary, those who had a negative outlook said that their optometrist barely spent time with them during their exams, and just gave them a prescription for their glasses.

So where do we stand in breaking the misconceptions that our patients have? How do we ensure that we are educating our patients, especially when we work in settings that limit our patient chair time? The answer to these questions might be different for every individual. There are optometrists and optometry students who create websites, and online education campaigns, while others prefer to talk to their patients in person. Regardless of the strategy, I think every interaction of the patient's visit is an important opportunity to educate. This must be instilled from their encounter with the receptionist, to the person pre-testing, to the person dispensing their glasses. We work in a team of eye care professionals, and we play an important role in breaking these misconceptions, because "the less they know, the more they think they know", and will have wrong conceptions about the profession. It is our role to ensure that people know that optometry is a profession which is more than what meets the eye.



WHY THE MOST IMPORTANT THING I LEARNED FROM MY VOLUNTEER TRIP TO INDIA WAS **COMPASSION**

BY KEREN PRINCE

If you know me at all, then you know that I have a special place in my heart for people, and especially families. So, after a long five years, I finally decided it was time to pack up and take a trip to visit mine in India the summer after my first year in optometry school. This also seemed like the perfect chance to do some volunteering. Sure enough as the opportunity knocked, I found myself wearing my white coat and volunteering at Dr. Agarwals Eye Hospital in Chennai, India in July and August of 2017.

It's hard to know where to begin with so many experiences in those two months alone. There are many branches of Dr. Agarwals Eye Hospital. The main branch is located within one of the busiest areas of South India encompassed by many other concrete high-rise buildings, where the noise of crowded streets never dies down. The entire hospital was dedicated specifically to eye care and structured so that each floor served to assess and treat different segments of the eye; initial and final assessments, the cornea and laser



eye surgeries, the retina, pediatric eye care, and ophthalmic surgeries each were designated to their own floor. Every day the waiting areas were filled to maximum capacity with some patients waiting over six hours just to be seen by the doctor. As I spoke to patients, I learned that many of them travelled days, taking trains and buses from across the country to Dr. Agarwal's hospital due to limited access to eye care in their regions. We hear terms such as "access to care" and "limited resources" so often that we have become numb to their meaning; it is just another issue

that the world has to deal with. But hearing first-hand how people are struggling to reach this basic necessity showed me that this is a very real problem for millions of people. Even in Canada, there are many towns where families don't have the luxury of driving down the road to get their eyes checked. This really compelled me to think about how, and especially where, I practice as an OD in the future. I may not be able to go to developing countries and open up a practice in a remote area, but I could leave the city where I might potentially be busy with patients, and open a practice in a rural area, or do a mission's trip to underserved communities within Canada. As little an impact that may be, it is huge to those families who aren't getting the care they need.

To say that I learned a lot from my time at the hospital would be an understatement. I was thrown out of my comfort zone more times than I can count, but it was well worth it. Being fresh out of first year, not quite comfortable with my techniques yet, I was assigned patients to do retinoscopy, trial frame refractions, and check visual acuity. With lots of help, I tackled each task and made some mistakes, learned so much more, and made it through to the other side with some invaluable skills and experiences. Another type of challenge I dealt with was the language barrier, which would have been much worse had I not originally been from that region. Since the major language spoken is Tamil, my native tongue, I was able to understand most of the dialogue, but responding in Tamil was another playing field entirely. I had to learn how to say simple statements like "do you like 1 or 2?" and "place your chin here" to be able to communicate with patients which was much more difficult than I had anticipated. I enjoyed being able to expand my language skills however,

even though I served as a source of entertainment to some of my friends and fellow interns. India alone has hundreds of official languages and having patients from all over the country presented a challenge for many staff members as well. Many rooms were staffed with bilingual optometrists and equipped with acuity charts in different languages. In addition, there were quite a number of patients who were unable to read letters either in their own language or English, in which case numbers, symbols or tumbling E's were used. This is something that I would not commonly encounter in North America and was an interesting new experience, and perhaps something I should be prepared for in the future.

Over those weeks at the hospital, the interns and I carried out many of the initial diagnostic tests including checking visual acuities, doing trial frame refractions, conducting orbiscans / aberrometry, autorefracting, measuring IOPs with an NCT, and just making patients feel comfortable overall. I was also fortunate enough to transition between departments to learn from child specialists who educated parents on amblyopia treatments for their children, as well as observe others who conducted Fluorescein Fundus Angiographs in the retina department. One of the highlights of my visit was being able to watch a few QLASIK and SMILE (Small Incision Lenticular Extraction) refractive surgeries live. It was an amazing experience. Also due to the limited availability of care, the rate of ocular diseases encountered on a daily basis was quite significant. Patients came into primary care with uveal tumours, amblyopia, and painful red eyes and many other ocular diseases that are often easily treatable but have progressed far due to the lack of care. The most common condition being advanced and even morgagnian cataracts. Fortunately, there is an entire department designated to cataract extraction and patients were taken care of in a reasonable amount of time. However, witnessing the direct effect of these diseases on patients' lives was hard to say the least. I watched as their mobility was affected, needing guides to do simple tasks like walking, sitting and getting up. Others were in so much pain, not being able to talk and had family members speak for them. I carefully watched how empathetic the ophthalmologists were, treating patients as if they were family, all while providing excellent and very knowledgeable care; these doctors were experts at what they did. They inspired me to have the kind of compassion they have; to not only be compassionate, but also show it by actively serving people to the best of my ability. If this means taking those extra steps to learn about a disease at a conference, or putting in those extra hours perfecting my skills, that is what I will do – anything to make me a well-informed and proficient optometrist to serve the community in the best possible way.



Overall, it was a very eye opening and satisfying experience. There were mornings where waking up early and leaving for work was a struggle, but each day brought an exciting opportunity, whether it was a new test to perform, or a new patient to assist and maybe befriend, it did not disappoint. I loved getting to know each individual I was able to serve. Even with that communication barrier, I found that there was always a way to make someone's day a bit brighter even if it was just giving them a chair to sit on while they waited, or cleaning their glasses, or just a smile to show that I cared. Even more than the skills I developed and the ocular diseases I was exposed to, what I value most from my trip are the individual encounters with real people and learning first-hand the struggles they go through. It changed my focus from becoming an optometrist to benefit myself, to one who will serve other people with a heart of compassion. An optometrist who values each patient as an individual person and leaves an impact as someone who really cares about their wellbeing as a whole. I highly recommend reaching out and volunteering your time to provide eye care to people in need whether it is overseas or within Canada, it is 100% worth it. You will find yourself being stretched out of your comfort zone and reaching new limits. It may give you that shift in perspective to motivate you and even frame your future practice just as it has impacted me to show compassion.



5 THINGS YOU DID AS A FIRST-YEAR OPTOMETRY STUDENT

BY CARMEN OU

As you skim through this article, you'll realize to your horror that you've done some - if not all of the following! If you're reading this as a first year student, do not fret because these are classic first year things that you'll learn to move on and grow from. If you're reading this as an upper year student, this may be a trip down memory lane and you'll be delighted to see how much you've changed since year one optometry. Whoever you are and whatever the case may be, I hope you take away something valuable from this article or at the very least chuckle half-heartedly.

1. You proclaimed you'd open a practice cold-turkey immediately after graduating because you simply can't imagine working for anybody but yourself.

E.g. At a CAOS talk, the guest lecturer asks to "raise your hand if you would like to open your own practice." You realize over half your classmates stole your unique idea.

The key is not to discourage those who want to open their own practice but to embrace the fact that working for somebody else can be a wonderful thing. This is particularly true as a new graduate or even temporarily while you draft up your master business plan. The reality is that we still have so much more to learn even after graduating and passing boards!

2. You aimed for the 4.0s and 90s that you achieved in undergrad and often allowed your grades to dictate your self-worth.

E.g. Your friends are in a heated debate on whether the correct answer was -0.25D or -0.50D, meanwhile you silently reflect about how you wrote +10.25D.

Often when we don't perform as well as we used to, we are filled with immense doubt and even begin to question our own intelligence. "Am I getting dumber?" "When did my hippocampus start malfunctioning?" "I swear I was a physics superstar in high school!" We let the grades tell us how worthy we are and completely forget that in the grand scheme of things, we should be learning for ourselves, our career and future patients. In the end, the better practitioner will not boil down to who got the better histology grade.

3. You promised your mom, your mom's friend, your mom's friend's daughter and your old high school volleyball team all free eye exams.

E.g. After posting a fabulous white coat ceremony photo on Facebook, you're now somehow the go-to optometrist for your entire town, even though you're still a student.

This is an excellent scenario. You've now established a remarkable network of patients pledged to be under your care and you couldn't have done it without the help of your mom gushing about how smart you are for getting into optometry school. The only thing left to do is to inform all these people that the exams will NOT BE FREE. Repeat after me: "There will be a fee for your eye exam unless you are 19 or younger, 65 or older or you have a cool eye disease that I would love to be exposed to!"

4. You did a bit of soul searching and questioned whether optometry was actually the perfect career for you.

E.g. It's 4 A.M. and you're up studying, averaging 5 hours of sleep, overdosed on instant coffee, wondering if this is worth it all.

Well of course it is! That's why you're browsing the CAOS website and reading my article right now because you did end up stickin' around, didn't you? In all seriousness, if you are still here, chances are you've come to love optometry along with all the perks and flaws she comes with. Know that the ever-increasing love will become more deep-seeded throughout your four years and that for some people, the love and passion for optometry is only blatantly evident once they step foot in clinic.

5. You realized what an amazing support system you have around you and how these people you've met through optometry will become lifelong friends.

E.g. Your classmate says she is A-OK even after your 6 gonio lens re-insertions and acquiring exposure keratopathy in the other eye.

How could we have done it on our own? At optometry school we lifted each other up, leaned on one another and met people whose values resonated with our own. We unified in clubs, associations, intramural sports teams and most of all, as a class. Together, we overcame the hardships of schooling and occasional feelings of inadequacy and embraced with open arms that this will be the best 4 years of our lives.

DOUBLE TAKE: SIXTH CRANIAL NERVE PALSY AND AN UNFORESEEN COMORBIDITY

BY DANA SMART

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KEYWORDS

Sixth nerve palsy;
Lateral rectus palsy;
Abducens nerve palsy;
Hypertension;
Diabetes;
Cranial nerve testing;
Ocular coherence tomography

ABSTRACT

Damage to the sixth cranial nerve (CN VI, abducens nerve), causes dysfunction of the lateral rectus muscle. While lesions are often idiopathic or microvascular in nature, causes vary by age and may include more sinister pathology such as neoplasm, demyelinating disease or aneurysm.¹ This report describes a case of unilateral CN VI palsy in which there was also an ipsilateral reduction in visual acuity. It discusses the differential diagnoses and potential management strategies for CN VI palsy, highlighting the clinical challenges faced by optometrists and potential for future research

INTRODUCTION

A lesion at any location along the course of the sixth cranial nerve can cause a paresis or palsy of the lateral rectus muscle.¹ Affected patients present with esotropia and double vision that is worse at distance than near. Prompt and accurate diagnosis by the optometrist is essential to begin identifying an underlying cause. However, a large proportion of cases remain seemingly idiopathic.^{2,3,4} The following report recounts a case of isolated CN VI palsy for which no underlying etiology was identified upon presentation or with subsequent systemic testing. It is unique in that the ipsilateral visual acuity was also reduced due to a posterior segment comorbidity. The case demonstrates optometrists' role in the diagnosis and management of cranial nerve palsies affecting the extraocular muscles. Diagnostic challenges and opportunities for future research are also reviewed.

CASE REPORT

A 46 year-old Caucasian male presented with a chief complaint of binocular double vision. Symptoms began suddenly one week prior to presentation and had not worsened or improved since that time. The diplopia was constant, more

noticeable at distance, and was not exacerbated by fatigue. The patient denied any neurological signs or symptoms such as numbness, tingling or ataxia. Systemic health was remarkable for significant headaches and the patient occasionally took Advil® (ibuprofen) and Topamax® (topiramate) for relief. Medication had not been used recently, as the headaches subsided several weeks prior to presentation. There was no history of diabetes, hypertension, neoplastic disease, viral illness or trauma. The patient's last eye examination was three years prior to presentation, at which time he was provided an updated prescription for low myopia and early presbyopia. Family history was positive for glaucoma, type II diabetes and systemic hypertension.

Distance visual acuities through the patient's habitual spectacles were 6/6 in the right eye and 6/15 in the left eye. There was no improvement in left eye acuity with subjective refraction. Cover test at six metres through the habitual prescription revealed a 30 prism diopter (Δ) constant left esotropia in primary gaze. The deviation decreased to 14 Δ in right gaze and increased to 45 Δ in left gaze. Cover test at near revealed a smaller constant left esotropia, with similar incomitancy: 20 Δ in primary gaze, 11 Δ in right gaze and 30 Δ in left gaze. Extraocular muscle motility was unrestricted in the right eye, but the left eye was

unable to abduct beyond the horizontal midline. Pupils were equal, round and reactive to light, with no relative afferent pupillary defect. Confrontation visual fields were full to finger count in both eyes. Intraocular pressures were 12 mmHg in the right and left eye at 10:00am via Goldmann applanation tonometry. Anterior segment health was unremarkable in both eyes. A dilated fundus examination revealed pink, distinct optic nerves and normal retinal vasculature. The right macula was flat and evenly pigmented, while the left showed a central yellow spot and subtle wrinkling appearance. Vitreous syneresis was noted in both eyes and there were no peripheral retinal abnormalities in either eye. Nidek Spectral-Domain OCT of the left macula showed cystic separation of the inner retinal layers from the underlying photoreceptors at the fovea and a small underlying pigment epithelial detachment (Fig.2). There was also notable retinal elevation, loss of foveal contour and localized ellipsoid layer disruption. Brachial blood pressure with the patient seated was 120/91mmHg via digital sphygmomanometry at 9:48am.

Left lateral rectus palsy was diagnosed and basic evaluation of cranial nerves I-XII performed in-office. As no other neurological deficits were noted, the CN VI palsy was deemed isolated and the decreased vision in the left eye attributed to vitreomacular traction (VMT).

The patient was educated on the potential causes of CN VI palsy and referred to his primary care physician for bloodwork and magnetic resonance imaging (MRI). Options for symptomatic relief were discussed, and the patient opted to wear a Bangerter foil over his left spectacle lens. He was also informed that visual acuity in the left eye was reduced due to a seemingly unrelated condition. Although spontaneous resolution of VMT was likely due to the small area of the tractional interface, the patient was offered referral to a retinal specialist. He opted to return to our clinic for monitoring and repeat OCT in one month.

At a two-week follow-up, the patient reported that all systemic testing was negative and his double vision remained relatively stable. Visual acuities were 6/6 in the right eye and 6/9 in the left eye. The deviation's magnitude, direction and comitancy remained unchanged upon cover testing, although the left eye showed some lateral movement beyond the midline. A four-week follow-up was scheduled

for continued monitoring and repeat OCT. The patient called to cancel this appointment and did not return for further testing. Despite multiple attempts at further communication, the outcome of this case remains unknown.

Differential Diagnosis

Numerous diagnoses should be considered when patients present with a unilateral abduction deficit and diplopia, including sixth nerve palsy, thyroid eye disease (TED), myasthenia gravis (MG), congenital defects, idiopathic orbital inflammation (IOI) and accommodative spasm.¹

Thyroid-related restrictive myopathy is characterized by enlargement of the extraocular muscles secondary to inflammation or fibrosis. As such, patients typically present with other ocular signs and symptoms such as dry eye, proptosis, lid edema and lid retraction, none of which our patient demonstrated.⁵ Furthermore, the patient's age and sudden symptomatic onset deemed TED unlikely in the case presented here. Similar to TED, idiopathic orbital inflammation usually involves chemosis, erythema and proptosis (typically painful).⁶ These diagnoses may be confirmed by performing a forced duction test on the affected eye. If the eye can not be passively abducted using forceps, the test is positive. Observed in patients with TED or IOI, a positive forced duction test indicates restriction of the medial rectus muscle, rather than true weakness of lateral rectus.⁶ Such testing may be warranted in some cases of diplopia to rule-out these restrictive myopathies. In the case presented here, lack of anterior segment findings deemed TED and IOI unlikely and forced duction was not performed. One must also consider the invasive nature of the test and optometrists' jurisdiction within their province or state.

Myasthenia Gravis can mimic virtually any pattern of ophthalmoplegia.⁷ Caused by neuromuscular blockade at acetylcholine receptors, the classic symptoms of MG are skeletal muscle weakness and fatigability. While recent-onset difficulty with swallowing or walking may suggest the disease, ocular myasthenia can be the presenting feature in as many as 60% of cases.⁸ Further testing such as intravenous edrophonium and acetylcholine receptor antibodies may be indicated when the ocular deviation is highly variable and/or there is concomitant

fatigable ptosis⁸ As the case presented here did not include either of these features, MG was not highly considered and such testing not performed.

Duane's retraction syndrome is a congenital lateral rectus palsy characterized by aberrant generation of the sixth nerve.⁹ The most common form involves limited abduction with narrowing of the palpebral aperture and globe retraction in the adducting eye.¹⁰ Duane's syndrome is present from birth and patients are generally asymptomatic.

Accommodative spasm was also deemed unlikely in this case, as several key features (i.e. pupillary miosis and full abduction) were absent. Moreover, the average age of onset is younger (15-20 years) and patients typically notice significant binocular blur.¹¹

Demographics & Etiology

Abducens nerve palsy is the most common cause of ophthalmoplegia in adults.^{3,12} Peak incidence is in the seventh decade and patients over age 50 often have diabetes and/or hypertension.⁴ Among younger adults, vascular etiology is uncommon and CN VI palsy is typically associated with serious pathology such as multiple sclerosis or intracranial neoplasm.¹³ In a retrospective case review involving patients aged 20 to 50 years, the most common cause of CN VI palsy was central nervous system mass lesion (33%), while multiple sclerosis (23%) and idiopathic (13%) were also common causes.¹³ Other nerves are more likely to be affected in such cases and patients may present with other focal neurological signs such as ataxia, numbness and tingling.⁴ Regardless of patient age, optometrists should obtain a thorough history of systemic health and symptoms when patients present with acute sixth nerve palsy; such information is crucial in dictating the appropriate management strategy.

Neurologically-Isolated & Non Neurologically-Isolated CN VI Palsy

Lesions of the abducens nerve and/or nucleus lead to different neurological symptoms based on the structures affected. As a result, six distinct syndromes of the abducens nerve have been

described: brainstem, elevated intracranial pressure, petrous apex, cavernous sinus, orbital and isolated sixth nerve palsy syndromes.^{26,27} Despite variable involvement of cranial nerves III-VIII, sympathetic and/or voluntary motor function, diplopia and esotropia may be the only findings during routine optometric examination. As such, a more comprehensive neurological assessment is warranted in cases of acute-onset strabismus. Gutierrez provides a neuro-optometric screening primer that is easily incorporated into clinical practice (See Table 1 for an adapted guide)²⁸ In combining this simple clinical tool with basic knowledge of sixth nerve syndromes, optometrists may help to identify the underlying cause in a timely and cost-effective manner. When CN VI palsy presents bilaterally, one must consider elevated intracranial pressure and carefully examine the optic nerves for concomitant papilledema.²⁷

In the case presented here, the patient demonstrated unilateral lateral rectus weakness only. Although optic nerve involvement was questionable prior to performing OCT and dilated fundoscopy, the sixth nerve palsy was ultimately deemed isolated in the absence of other neurological signs or symptoms.

Management

Conservative management is typically reserved for cases in which there are known ischemic risk factors or when the patient is over age 50.⁹ This includes blood pressure, serum glucose, inflammatory marker and syphilis testing.⁹ Continued observation by the optometrist is advised, and one should request MRI with contrast if the ophthalmoplegia does not improve within 3 to 4 months or becomes non-neurologically isolated.^{4,9} For cases involving younger patients and those without known vasculopathy, recommendations are more variable.¹⁴ Several protocols suggest that such cases should undergo the same initial serological testing, but that imaging is also warranted.^{4,15,16} Others conclude that all patients with CN VI palsy should undergo MRI.¹⁷ This recommendation follows a single retrospective study in which 63% of patients (27/43) were found to have a CNS lesion responsible for CN VI palsy and 15% with abnormal MRI also presented with vasculopathic risk factors.¹⁷ This is a costly management strategy considering the

lack of large-scale prospective studies to support the diagnostic yield of immediate neuroimaging.¹⁸ Ultimately, clinical judgement and a case-by-case approach should be exercised when determining if neuroimaging is indicated in the initial workup. For the case presented here, MRI was requested immediately. This decision was based on the patient's age and lack of known vasculopathic risk factors, even though testing suggested an isolated CN VI palsy.

While systemic management is priority, optometrists must not neglect the chief complaint: double vision. Diplopia associated with CN VI palsy is typically addressed using monocular occlusion with a patch or Bangerter foil. Base-out Fresnel prism may allow for binocular single vision in the primary position, but is typically unsuccessful due to incomitance.¹⁹ Surgical intervention and botulinum toxin are generally reserved for cases in which the deviation is stable for at least three to six months.⁹

"Idiopathic" CN VI Palsy

Despite using diagnostic tools such as hematology and MRI, 6-26% of CN VI palsies remain undetermined in cause.^{2,3,4,20,21,22,23} Interestingly, the natural history and recovery rates of such patients are similar to those with a vascular etiology.^{1,24,25} In a large retrospective case review by Clayton et.al., at least partial recovery was reported among 84% of cases labeled as vasculopathic and 85% deemed idiopathic.²⁴ Furthermore, the median time to recovery in both groups was 3 months.²⁴ This suggests that the underlying physiological mechanism for a large proportion of patients in the undetermined group may involve a microvasculopathy that is undetectable to standard laboratory tests and imaging. This potential "contamination" of the so-called idiopathic group makes the distinction between microvascular and idiopathic cases arbitrary, as the underlying mechanism may be similar.²⁴ In the case presented here, the patient reported no diabetes or hypertension upon presentation and with subsequent testing. However, other clinical observations suggest that he may be at risk for systemic vasculopathy: moderately overweight, high in-office blood pressure and a family history of type II diabetes. Provided the opportunity,

it will be interesting to observe whether the patient is diagnosed with diabetes or hypertension as he enters middle age. Further evidence is required before altering clinic decision-making based on this potential association.

Unrelated Comorbidities?

Visual acuity is often slightly reduced when patients present with sixth nerve palsy.⁶ This occurs when the affected eye is unable to fixate in the presence of the deviation. Our patient was previously correctable to 6/6 in both eyes but when he first presented with paralytic left esotropia, best corrected visual acuity was 6/15 in the left eye. At the time, inaccurate fixation was not considered a potential cause and the reduced visual acuity was presumed to be related to optic nerve or macular pathology. As such, a thorough investigation of other cranial nerve function and ocular health was performed. Spectral Domain OCT ultimately identified cystic maculopathy and vitreomacular traction was attributed as the cause for the reduced visual acuity in the left eye. Upon retrospective analysis of the OCT scans, there is sufficient parafoveal vitreous detachment to support this diagnosis. However, the reduced visual acuity was likely due to a combination of the maculopathy and abducens palsy. Consistent with the improvement in extraocular muscle motility, visual acuity in the left eye improved from 6/15 to 6/9 during the following two weeks. Were VMT the only contributing factor, such rapid resolution would not have been observed.

As discussed above, several clinical observations suggest that the patient may be at risk for systemic vasculopathy, including diabetes. Moreover, macular edema is the most common cause of visual reduction among patients with diabetes and can occur in the absence of other fundus signs.²⁹ Thus, one must consider whether the intraretinal separation observed with OCT actually represented diabetic macular edema. Were serial OCT follow-up and fluorescein angiography readily available, the cause of intraretinal separation could have been more definitively ascertained. That being said, OCT of the left macula is more consistent with VMT than diabetic macular edema (DME). The cystic spaces in DME are typically numerous and more diffuse throughout the outer foveal layers.²⁹ Additionally,

hyper-reflectivities consistent with exudative material are observed adjacent to DME.²⁹

This case demonstrates that while ocular coherence tomography has revolutionized the diagnosis and management of posterior segment pathology,³⁰ the technology's value is limited by optometrists' ability to thoroughly and effectively analyze the information it allows them to obtain.

Ophthalmoplegic Headaches

Migraine and cluster headaches are associated with a spectrum of ocular involvement. While pupillary miosis, lacrimation, photophobia and visual aura are common, oculomotor dysfunction is rare.³¹ There are three prior case reports in which cluster headaches are associated with ocular nerve palsies.^{31,32,33} Similar to the patient presented here, pain from the headaches in all three cases resolved hours to days before the onset of oculomotor involvement.^{31,32,33}

While the pathophysiological mechanism of cluster headaches is not completely understood, symptoms are often attributed to autonomic dysregulation, including dilation of the internal carotid artery.³⁴ When occurring within the cavernous sinus, this damages the surrounding sympathetic plexus, resulting in pain.³⁴ CN VI may also be affected, as it traverses the cavernous sinus in close proximity to the internal carotid artery. Grosberg suggests that although patients with concomitant cluster headaches and CN VI palsy should be evaluated for

other conditions, oculomotor palsy attributable to cluster headache should be considered following a negative systemic workup.³¹ For the patient presented here, the nature of his headaches could have been further questioned to clarify whether this association was present in this case.

CONCLUSION

A thorough case history and comprehensive assessment are essential in the management of CN VI palsy. Optometrists may be the first healthcare professionals to examine the patient, as sudden-onset diplopia is often the chief complaint. Cases are classified as neurologically non-isolated or isolated based on the presence of other neurological signs and symptoms.¹ Optometrists should have an understanding of cranial nerve testing and conduct a basic screening whenever patients present with an apparent CN VI palsy. While various guidelines exist, neuroimaging is typically recommended in the initial workup of non-isolated cases.²⁶ When best corrected visual acuity is significantly decreased in the absence of gross biomicroscopic findings, auxiliary testing is indicated. OCT is an invaluable diagnostic tool, but proper analysis and interpretation are necessary to avoid diagnostic error. Loss to follow-up presents a further challenge when monitoring for the resolution of CN VI palsy. Effective communication on behalf of the optometrist and patient is required to ensure that an appropriate follow-up schedule is obtained. There are opportunities for future research into the potential association between cluster headaches and oculomotor palsies.

APPENDIX

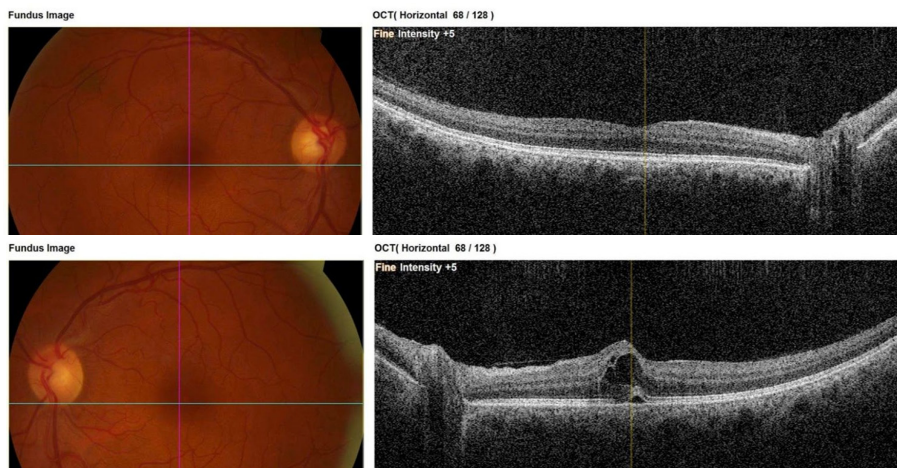


Figure 1: Nidek ocular coherence tomography (OCT) X-Y macula map of the right eye. This scan was taken at the initial visit. Best corrected visual acuity in the right eye was 6/6.

Figure 2: Nidek ocular coherence tomography (OCT) X-Y macula map of the left eye. This scan was taken at the initial visit. Best corrected visual acuity in the left eye was 6/15.

REFERENCES

- Goodwin D. Differential diagnosis and management of acquired sixth nerve palsy. *J Am Optom Assoc*. 2006;77(11):534-539.
- Shrader EC, Schlezinger NS. Neuro- ophthalmologic evaluation of abducens nerve paralysis. *Arch Ophthalmol*. 1960;63:84-91.
- Rush JA, Younge BR. Paralysis of cranial nerves III, IV, and VI: cause and prognosis in 1,000 cases. *Arch Ophthalmol*. 1981;99:76-79.
- Patel SV, Mutyala S, Leske DA, et al. incidence, associations, and evaluation of sixth nerve palsy using a population-based method. *Ophthalmology*. 2004;111(2):369-75.
- Bartley GB, Fatourechi V, Kadrmas EF. Clinical features of Graves' ophthalmopathy in an incidence cohort. *Am J Ophthalmol*. 1996; 121: 284-90.
- Dinkin M. Diagnostic approach to diplopia. *Continuum*. 2014;20(4):942-965.
- Gandhi RA, Nair AG, Patil-Chhablani P, Venkatramani DV. Ocular myasthenia gravis: A review. *Indian Journal of Ophthalmology*. 2014;62(10):985-991.
- Cardwell CR, Carr AS, McCarron PO. A systematic review of population based epidemiological studies in Myasthenia Gravis. *BMC Neurology*. 2010; 10(1): 46-55.
- Wong A. Abducens nerve palsy. In: *Eye Movement Disorders*. New York, NY: Oxford University Press, 2007:232-240.
- Bodack MI. Evaluation of abduction deficits in pediatric patients: a case report and review of differentials. *J Behav Optom*. 2002;13:143-148.
- Goldstein JH, Schneekloth BB. Spasm of the near reflex: a spectrum of anomalies. *Surv Ophthalmol*. 1996;40:269-78.
- Bagheri A, Khodabakhshi M, Anisian A, Mirdehghan A. Epidemiology and etiologic characteristics of patients with paralytic strabismus. *Bina J Ophthalmol*. 2004;9:323-332.
- Peters GB 3rd, Bakri SJ, Krohel GB. Cause and prognosis of nontraumatic sixth nerve palsies in young adults. *Ophthalmology*. 2002;109(10):1925-8.
- Ambika S, Gandhi RA, Nair AG, Noronha VO. The diagnostic yield of neuroimaging in sixth nerve palsy - Sankara Nethralaya Abducens Palsy Study (SNAPS): Report 1. *Indian Journal of Ophthalmology*. 2014;62(10):1008-1012.
- Kline LB, Bhatti MT, Chung SM, Eggenberger E, Foroozan R. Basic and clinical science course; Neuro-ophthalmology. San Francisco: American Academy of Ophthalmology. 2010.
- Moster ML, Savino PJ, Sergott RC, Bosley TM, Schatz NJ. Isolated sixth nerve palsies in younger adults. *Arch Ophthalmol*. 1984;102:1328-1330.
- Bendszus M, Beck A, Koltzenburg M, et al. MRI in isolated sixth nerve palsies. *Neuroradiology*. 2001; 43:742-745.
- Bhatti MT, Chi SL. The diagnostic dilemma of neuro-imaging in acute isolated sixth nerve palsy. *Curr Opin Ophthalmol*. 2009;20(6):423-9.
- Atik B, Keskin ES, Keskin E, Koçer A. A case of isolated abducens nerve paralysis in maxillofacial trauma. *Annals of Maxillofacial Surgery*. 2015;5(2):258-261.
- Rucker CW. The causes of paralysis of the third, fourth, and sixth cranial nerves. *Am J Ophthalmol*. 1966;61:1293-1298.
- Johnston AC. Etiology and treatment of abducens paralysis. *Trans Pac Coast Otoophthalmol Soc Annu Meet*. 1968;49:259-277.
- Robertson DM, Hines JD, Rucker CW. Acquired sixth-nerve paresis in children. *Arch Ophthalmol*. 1970;83:574-579.
- Bagheri A, Babsharif B, Abrishami M, Salour H, Aletaha M. Outcomes of surgical and non-surgical treatment for sixth nerve palsy. *J Ophthalmic Vis Res*. 2010;5:32-37.
- Clayton G, Craig EA, MacEwan CJ, Tiffin PAC. Acquired palsy of the oculomotor, trochlear and abducens nerves. *Royal College of Ophthalmologists*. 1996;10:377-384.
- Richards BW, Jones FR, Younge BR. Causes and prognosis in 4278 cases of paralysis of the oculomotor, trochlear, and abducens cranial nerves. *Am J Ophthalmol*. 1992; 113: 489-496.
- Azarmina H, Azarmina M. The six syndromes of the sixth cranial nerve. *J Ophthalmic Vis Res*. 2013;8(2):160-171.
- Bahreini M, Rasooli F, Safaei A, Sotoodehnia M. Unilateral sixth nerve palsy. *Am J Emerg Med*. 2017;35(6):934.
- Gutierrez M. *Neuro-Optometry Primer: The Brain*. Review of Optometry. 2009;146(8):1-12.
- Lesiewska-Junk H, Malukiewicz G, Raczyńska D, Sikorsk BL, Stafiej L. The Diagnostic Function of OCT in Diabetic Maculopathy. *Mediators of Inflammation*. 2013:1-12.
- American Academy of Ophthalmology Retina/Vitreous Panel. Preferred Practice Pattern® Guidelines. Diabetic Retinopathy. San Francisco, CA: American Academy of Ophthalmology; 2016.
- Grosberg BM, Lipton RB, Robbins MS, Vollbracht S. Cluster headache associated with a sixth nerve palsy: A case report. *Cephalgia*. 2011;31(1):122-125.
- Ahmed F, Cariga P, Nandakumar TP. Cluster headache associated with a third nerve palsy: a case report. *Cephalgia*. 2004;24:228-230.
- Peatfield RC. Recurrent VI nerve palsy in cluster headache. *Headache*. 1985;25:325-327.
- Moskowitz MA. Cluster headache: evidence for a pathophysiologic focus in the superior pericarotid cavernous sinus plexus. *Headache*. 1988;28:584-586.

KERATOCONUS: A CASE REPORT OF DISLODGED RIGID GAS PERMEABLE CONTACT LENSES AND DECREASED QUALITY OF LIFE

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KEYWORDS

Keratoconus
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Scleral contact lenses
Vision-related quality of life

ABSTRACT

To determine if increasing the total lens diameter of rigid gas permeable (RGP) contact lenses in a piggyback system can resolve a patient's concern of frequent RGP displacement. Methods: A case report of a 34-year old male with advanced keratoconus OU, who has been fitted with piggyback lenses (Boston XO2 and delefilcon A) with compromised fit and comfort. Results: Although, the increased diameter of the RGPs reduced lens dislodgement, it concomitantly exacerbated upper lid awareness which made the patient cease using the new piggyback system. A scleral contact lens fit (Boston XO) was attempted but was unsuccessful at initial attempt due to ocular discomfort. Conclusions: Piggyback contact lenses can cause RGP dislodgement due to steep cones in advanced keratoconus. Scleral contact lens fits require sufficient time to obtain an ideal fit and may not provide immediate ocular comfort for all patients.

INTRODUCTION

1.1: Epidemiology

Keratoconus is a progressive, bilateral, asymmetric, corneal ectasia [1]. Keratoconus onset begins in puberty and progresses until the third to fourth decade of life, after which it stabilizes [2]. Historically, the prevalence of keratoconus has been 1:2000 [3]. However, recent data from a large-scale population study revealed a much higher prevalence of 1:375 [4]. Although the increased prevalence is likely attributed to modern, sensitive corneal topography tools [4], this finding highlights that keratoconus may be more common than previously thought. This data is applicable to primary eyecare providers, such as optometrists, since they are on the frontlines to screen and diagnose eye conditions such as keratoconus.

1.2: Genetics and Pathogenesis

Keratoconus is inherited in an autosomal dominant pattern, with approximately 12-26 % of afflicted individuals reporting a family history of the disease [5]. Consanguinity increases the risk of keratoconus by four times, which could explain the higher prevalence of keratoconus in certain ethnic groups [6]. Although keratoconus is considered a

noninflammatory ectasia, keratoconus demonstrates high levels of inflammatory biomarkers, such as, interleukin 6 (IL-6), tumour necrosis factor alpha (TNF- α) and matrix metalloproteinase 9 (MMP-9), compared to controls [7]. Furthermore, keratoconic corneas have decreased levels of antioxidants such as superoxide dismutase and aldehyde dehydrogenase which can elicit corneal oxidative stress [8]. Oxidative damage in keratoconus is precipitated by atopic disease, ultra-violet light exposure and mechanical trauma secondary to illfitting contact lenses and or eye rubbing [1,9].

1.3: Treatment

Non-surgical treatment includes spectacles and contact lenses (CLs) such as corneal RGPs, scleral CLs and piggyback CLs [10]. Surgical treatment includes penetrating keratoplasty (PKP), deep anterior lamellar keratoplasty, intrasomal corneal ring segments, and corneal crosslinking [10]. Although corneal RGPs are the most common CL therapy for keratoconus, piggyback lenses are recommended when the individual becomes RGP intolerant due to ocular discomfort [11]. The piggyback system consists of a soft lens carrier with the RGP riding on top [11]. Two percent of patients with keratoconus

employ a piggyback system [12]. Advantages of piggyback CLs include comfort, cone protection and RGP stabilization over an irregular corneal surface [13, 14]. Disadvantages include inconvenience and expense of handling two different lenses, CL displacement and loss, and historically, hypoxia and neovascularization with hydrogel soft lens carriers (but not likely with current high Dk/t silicone hydrogel CLs) [14].

1.4: Quality of Life

People with keratoconus have reduced vision-related quality of life comparable to those with category 3 and category 4 age-related macular degeneration as assessed by the National Eye Institute Visual Function Questionnaire [15]. The lifetime cost of keratoconus was estimated to be \$25,168 with a standard deviation of \$16,247 [16]. Therefore, there is a dual burden of keratoconus; a reduction in vision-related quality of life coupled with a financial burden of paying for professional fees, specialty CLs and or surgery [16]. Unlike other chronic and vision-threatening eye diseases such as, glaucoma and age-related macular degeneration, keratoconus affects individuals in their youth [15]. About 94% of people with keratoconus are diagnosed between the ages of 12 and 39 years of age [3]. This is significant as one's youth is the prime time for education, career development, and family planning [15]. A survey for people with keratoconus showed that binocular visual acuity less than 20/40 and keratometry values above 52.0 D were linked with compromised mental health and independence [15, 17]. We present a

CASE REPORT

2.1: Chief Complaint

A 34-year old man living with asymmetric, bilateral keratoconus for the past eleven years, presented to the clinic on August 30, 2017 for the delivery of new RGP lenses (a component of his piggyback system). He had been fitted with piggyback CLs for the past eight years. His chief concern was that his RGPs frequently dislodge out of his eyes, two to six times per day, which has been ongoing for the past eleven years. Furthermore, the discomfort from the RGPs in the piggyback system made it difficult for him to maintain eye contact and consequently, he felt socially isolated. Multiple CL adjustments have been made over the past years which have not resolved the patient's chief concerns.

2.2: History

He was unemployed and has been supported by the Ontario Disability Support Program for the past four years. He had a positive history of cigarette smoking for at least the past two years. He was in good general health and was taking no medications. He developed sterile corneal bilateral ulcers in 2016, secondary to sleeping and swimming in his piggyback CLs, which resolved with residual scarring after a topical course of a fourth-generation fluoroquinolone and a soft steroid. His past ocular history was unremarkable for acute hydrops and ocular surgeries. In 2013, PKP was recommended in the right eye due to contact lens intolerance and decreased best-corrected visual acuity (BCVA). The patient deferred the surgery at the time due to family obligations.

2.3: CL Parameters

The patient's piggyback system was comprised of RGPs (Dyna Z Cone Plus, Lens Dynamics) of lens material Boston XO2, Dk/t @ -3.00 D of 141 and daily disposable silicone hydrogel lenses (Dailies Total 1, Alcon Canada Inc.) of lens material delefilcon A, Dk/t @ -3.00 D of 156. The base curve, total diameter and power of the RGPs and the silicone hydrogel lenses are listed in Table 1.0.

2.4: Progression

This patient demonstrated progression in his refraction, keratometry and pachymetry values. His myopia increased two-fold over the past decade. Subjective refraction in 2008 was OD: -7.75 / -2.50 x 042° and OS: -9.75 / -3.00 x 145°, and in 2016 it was OD: -18.00 / -5.00 x 070° and OS: -19.00 / -3.00 x 160°. His maximum keratometry value, Kmax, steepened by 28% OD and 15% OS from 2006 to 2017 (Figure 1.0A). During this time span, thinnest pachymetry values diminished by 35% OD and 22% OS (Figure 1.0B). Presenting visual acuities, Kmax and pachymetry values are available in Table 2.0.

2.5: Grading

Using the Amlser-Krumeich keratoconus grading scale, an outdated yet widely used classification scale [18, 19], the patient had Grade 4 keratoconus in both eyes. The ABCD grading scale, a contemporary grading scheme for keratoconus, offers advantages over the former scale by using posterior corneal radius of curvature and thinnest

pachymetry values which may be more reflective of keratoconic changes [19]. The ABCD scale individually grades four parameters, Anterior corneal radius of curvature, Back or posterior corneal radius of curvature, Corneal minimum thickness and Bestcorrected Distance visual acuity, from a grading scale from zero to four [19]. Additionally, a modifier indicated by a plus or minus sign highlights the presence or absence of corneal scarring [19]. For example, (-) no corneal scarring, (+) corneal scarring with iris details visible or (++) corneal scarring with no iris details visible [19]. Thus, the patient had A4/B4/C4/D2+ OD and A4/B4/C3/D1+ OS, with more advanced keratoconus in the right eye than the left eye. The patient's corneal topography with globus cones OU are depicted in Figure 2.0 (Oculus Pentacam, Wetzlar, Germany).

2.6: Examination Findings

At this appointment we delivered a new pair of RGPs with two modifications, 1) increased total diameter of 0.5 mm OU in order to improve stability of the RGPs on the eye and reduce lens dislodgement. 2) RGP OD had an increase of -0.50 D in power for improved acuity. The incoming piggyback demonstrated good centration, coverage, lag and movement in primary gaze and upgaze. The RGP and the soft lens moved independently of each other. Likewise, the new piggyback system demonstrated identical characteristics. The new set of RGPs to be delivered today showed a three point-touch and adequate edge clearance. However, with the new piggyback system, the patient felt greater discomfort and upper lid awareness compared to his previous set of piggyback lenses. We advised that the modification had been made to reduce the dislodgement of the lenses in order to target the patient's chief concern. We reassured the patient that adaptation to the new piggyback system may take a few days to a few weeks. We advised a one-month follow-up to monitor the new piggyback back system. Additionally, we suggested a scleral contact lens (ScCL) fit at the next appointment if the piggyback system did not work, given the comfort and simplicity of ScCLs.

2.7: Follow-Up

The patient did not appear for his one-month follow-up, and instead visited the clinic one week later on September 20, 2017. Although he noted less RGP dislodgement with the new fit, he was unable to adapt to the new piggyback CLs due to increased

upper lid awareness OU (he was only able to wear them for three days) and elected to continue with his former piggyback system. We completed the patient's request to return the new set of RGPs and order a new pair of RGPs with the same parameters as his old RGPs. Furthermore, we trialled the patient with OneFit 2.0 ScCLs (Boston XO; Dk/t at -3.00 D of 100; Blanchard Laboratories) without success. The patient experienced a pressure feeling around his eyes which triggered severe migraines later that day. No limbal impingement or blanching was present OU. The patient did not return to complete the scleral fit. Ultimately, we were not able to resolve the patient's chief complaint of the dislodgement of the RGPs.

DISCUSSION

3.1: Scleral Contact Lenses: Advantages and Disadvantages

Although we did not see the ScCL fit to completion, one indication for ScCLs is intolerance to other CL modalities, such as, piggyback CLs, hybrid CLs or corneal RGPs [20]. ScCLs have superior visual satisfaction for people with keratoconus who were previously corrected with piggyback CL, hybrid CLs or corneal RGPs [21]. Likewise, in another study, ScCLs have shown improved comfort, visual acuity and overall satisfaction compared to patients' former CL correction (ie. piggyback CL, RGPs, semiscleral CL, soft CL and glasses) where 50.4% of the participants were those living with keratoconus [22]. Approximately 4.2% of people with keratoconus wear ScCLs [23]. There are three main advantages of ScCLs for our patient. First, ScCL can delay surgery [13, 24] which is advantageous because it implies the need for fewer, future corneal transplants. This is beneficial since graft survival decreases over time and with each new graft [25]. Second, ScCL offer improved stability and centration compared to corneal RGPs and are less likely to dislodge out of the eye [13]. This advantage is vital, given our patient's chief concern was the dislodgement of his current RGPs. Third, ScCL offer comfort because its edge is tucked under the upper lid, preventing edge lid interaction and therefore decreased lid awareness [26]. Indeed, our patient experienced lid awareness with his current piggyback system. Therefore, ScCL improve visual satisfaction, delay surgery, improve stability, decrease lid awareness.

However, ScCLs are not without their disadvantages. Drawbacks include handling

(insertion and removal) and midday fogging secondary to tear stagnation and tear debris build-up under the CL [13, 21, 27]. Furthermore, corneal hypoxia can occur but is less likely if the following parameters are satisfied; $Dk > 150$, maximum CL central thickness of 250 μm and maximum corneal clearance of 200 μm [28].

3.2: Managing Dry Eye and Pro-Inflammatory Mediators in Keratoconus

People with keratoconus have elevated levels of MMP-9 and decreased goblet cells and mucin production [7, 29]. Oral tetracyclines could be used to decrease MMP levels due to the anti-inflammatory properties of tetracyclines [30]. Mucin secretagogues, such as, Diquafosol tetrasodium, are being developed which could increase mucin production [30]. Furthermore, people with keratoconus have higher amounts of diadenosine tetraphosphate, a proposed biomarker for dry eye disease, compared to healthy controls [29]. ScCL wear for six to nine hours in people with keratoconus decreased diadenosine tetraphosphate levels and also improved Ocular Surface Disease Index scores and tear osmolarity [31]. However, it is important to note that ScCLs also increased MMP-9 levels which was attributed to tear stagnation and use of preserved saline [31]. Therefore, tetracyclines, mucin secretagogues and ScCLs could be used to manage dry eye symptoms and inflammation in keratoconus.

3.3: Scleral Contact Lenses: Fit Adjustments

Discomfort from scleral contact lenses can be caused by blood vessel impingement, air bubbles, excessive edge lift, a small landing zone diameter or a small total diameter [32]. Given that our patient demonstrated no vascular impingement or air bubbles we will focus on how to optimize edge lift, landing zone diameter and total diameter. Excessive edge lift can cause heightened lens awareness and discomfort [32]. Edge lift can be decreased by changing the landing zone angle or using a smaller landing zone radius [32]. The landing zone diameter should be at least 3 mm wide for optimal comfort [32]. Furthermore, given that our patient commented on a 'pressure feeling' with the ScCLs, we could increase the total diameter of the ScCLs because large-diameter ScCLs have shown to relieve local areas of pressure and provide more comfort than small diameter ScCLs [32]. A diameter of 14.9 mm OneFit 2.0 was tried in office which resulted in the 'pressure feeling'. The

largest diameter size available for OneFit 2.0 is 15.2 mm [33] which could be trialled at the next office visit. If this size does not resolve the discomfort, we could trial alternate ScCL brands, e.g., Mini-Scleral Design (Blanchard Laboratories) or DigiForm 18 (TruForm Optics Inc.) which are available in 18.00 mm total diameter sizes [33]. Therefore, edge lift, landing zone diameter and total diameter could be adjusted to provide improved comfort.

3.4: Counselling Services and Support Groups

Other ways to increase the quality of life for our patient include having a candid discussion on counselling services for depression and or smoking cessation, if the patient is inclined. Furthermore, connecting our patient to keratoconus support groups may be helpful in relieving him of his social isolation. A complete list of keratoconus support groups is in Table 3.0.

3.5: Assistive Devices Program

The patient is eligible for the Assistive Devices Program (ADP) through which he may qualify for CL funding. He meets the eligibility requirement of having a long-term visual disability which lasts more than six months which cannot be corrected 'medically, surgically or with ordinary glasses or contact lenses' [34]. Furthermore, without speciality contact lenses, his disability may prevent him from completing tasks for daily living. A referral is warranted given the patient's limited financial situation.

3.6: PKP and Vision-Related Quality of Life

A previous surgical consult indicated that this patient is a PKP candidate for his right eye due to contact lens intolerance and decreased BCVA. The research on whether a PKP improves vision-related quality of life is inconsistent. One study which surveyed people with keratoconus, found that despite satisfactory visual acuity post-PKP (80% had 20/40 or better in the better eye and 60% had 20/25 or better in the better eye), participants scored low on vision-related quality of life as measured by the National Eye Institute Visual Function Questionnaire [35]. On the other hand, a study which looked at visual satisfaction after PKP in a host of corneal conditions (including keratoconus, bullous keratopathy and corneal scars) found that 79% of patients were satisfied with their vision 1-year post-PKP, whereas 81% were dissatisfied with their vision before the surgery [36]. However, it is hard to compare these studies since

the latter included corneal conditions in addition to keratoconus. Nonetheless, it is interesting to note that both studies echoed that visual acuity and graft clarity were not correlated with vision-related quality of life [35, 36], rather pain relief, improved binocularity and decreased glare were better predictors of visual satisfaction [36]. Therefore, it is difficult to predict whether our patient would benefit from improved vision-related quality of life given current contentious data.

CONCLUSION

The key points of this case are:

- (1) Steep cones in advanced keratoconus can cause RGP displacement and loss.
- (2) Advantages of ScCL over piggyback CLs include decreased lens dislodgement and edge awareness.
- (3) Although, ScCLs are a viable alternative for steep cones, scleral fits require sufficient time to obtain an ideal fit and may not provide immediate ocular comfort for some patients.
- (4) Social services such as counselling, smoking cessation, support groups and disability funding should be considered for patients.
- (5) Having a PKP may not necessarily improve vision-related quality of life.

DECLARATION OF INTEREST

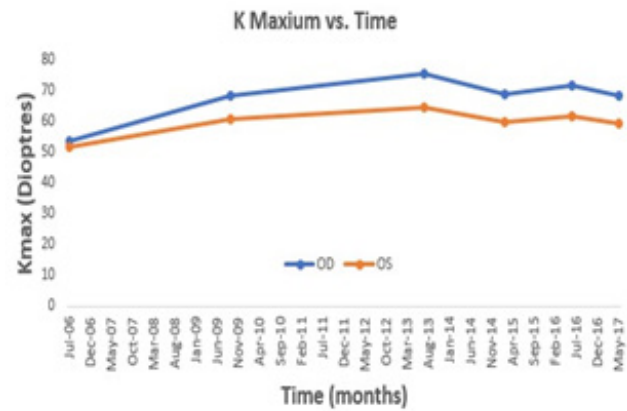
The author declares no conflict of interest and has no financial interest in any of the products mentioned in this manuscript. The patient provided written and verbal consent to use his data for teaching and research purposes.

APPENDIX

Table 1.0: Contact lens parameters of the piggyback system

	RGP OD	RGP OS	SoFT OD	SoFT OS
Base Curve (mm)	6.00	6.31	8.5	8.5
Total Diameter (mm)	10.1	10.1	14.1	14.1
Power (D)	-15.75	-12.75	-0.50	-0.50

A



B

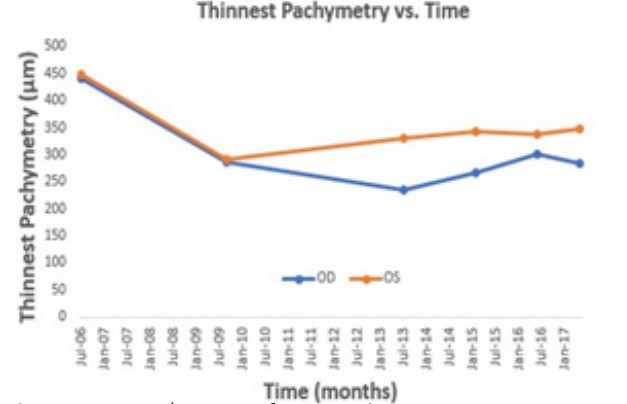


Figure 1.0 A) Kmax from July 2006 – May 2017 for the patient B) Thinnest pachymetry from July 2006 to May 2017 for the patient.

Table 1.0: Contact lens parameters of the piggyback system

	OD	OS
BCVA with piggyback CLs on August 30, 2017 (LogMAR and Snellen)	0.30 (6/12)	0.00 (6/6)
BCVA with spectacles on July 14, 2016 (LogMAR and Snellen)	0.60 (6/24)	0.48 (6/18)
Kmax on May 4, 2017 (Dioptres)	68.4	59.5
Thinnest pachymetry on May 4, 2017 (um)	285	348

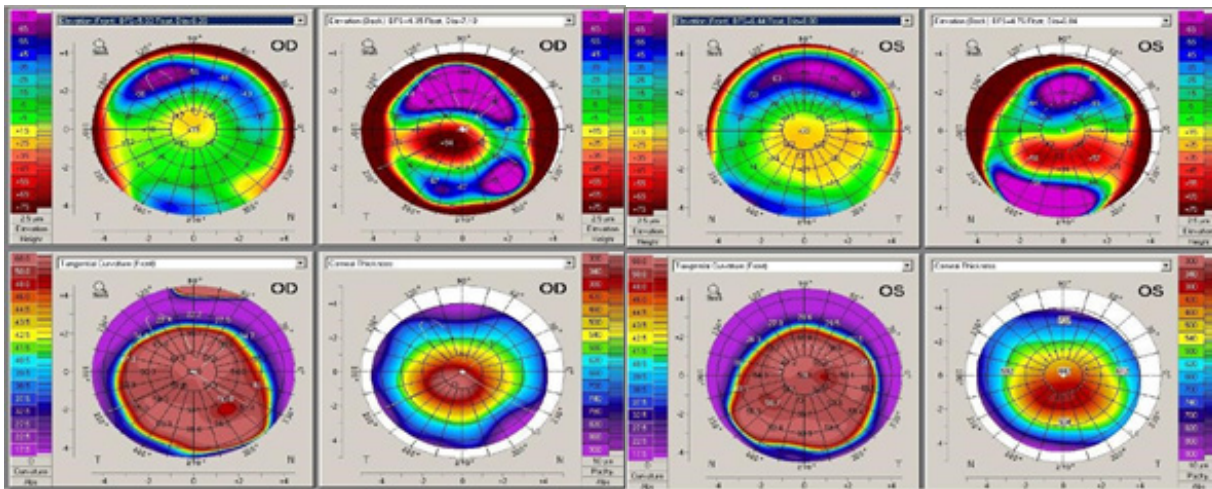


Figure 2.0: Oculus Pentacam maps of the right and left eyes of the patient on May 4, 2017.

Table 3.0: Keratoconus support groups: National organizations and online communities

Group Name	Description
NATIONAL AND INTERNATIONAL ORGANIZATIONS	
Canadian Keratoconus Foundation [37] http://keratoconuscanada.org/	A non-profit group which raises awareness and funds for keratoconus research. It was formed in 2011 by ophthalmologists [37].
National Keratoconus Foundation [38] https://www.nkcf.org	An American keratoconus support group based out of Irvine, California [38].
Corneal Transplant Foundation [39] https://www.corneal-transplant-foundation.org/	A non-profit organization founded by Cornea Biosciences in 2011 whose aim is to support corneal transplant research and help people of a low socio-economic status access corneal transplants [39]. The group was supported by research from the University of Ottawa in Canada and Linköping University in Sweden [39].
Cornea Research Foundation of America [40] http://www.cornea.org/	A non-profit group founded in 1988 whose aim is to innovate corneal surgical techniques [40]. They also provide education to ophthalmologists, optometrists and patients [40].
ONLINE COMMUNITIES	
Keratoconus Group [41] https://www.keratoconusgroup.org/ https://www.facebook.com/KeratoconusGroup/	An online community of 18,000 members where patients and specialists share their stories via blog posts [41].
Keratoconus Group of Ontario [42] https://www.facebook.com/groups/369910393513/	An online group of 500 people with keratoconus in Ontario, Canada [42].
UK Keratoconus Self Help and Support Association [43] http://www.keratoconus-group.org.uk/	Features a discussion forum where members share their stories [43].
Keratomania [44] http://www.keratomania.com	An online support group with weblinks to individual blogs about personal stories about keratoconus journeys [44].
Keratoconus Support Group [45] https://www.dailystrength.org/group/keratoconus	An online community where members share their stories [45].

REFERENCES

- 1.Romero-Jiménez M1, Santodomingo-Rubido J, Wolffsohn JS. (2010). Keratoconus: a review. *Cont Lens Anterior Eye*, 33(4):15766.
- 2.Vazirani J, Basu S (2003). Keratoconus: current prospectives. *Clin Ophthalmol*, 7:2019-30.
- 3.Kennedy RH, Bourne WM, Dyer JA. A 48-year clinical and epidemiologic study of keratoconus. (1986). *Am J Ophthalmol*; 101(3):267-273.
- 4.Godefrooij, D. A., De Wit, G. A., Uiterwaal, C. S., Imhof, S. M., & Wisse, R. P. (2017). Age-specific incidence and prevalence of keratoconus: a nationwide registration study. *American journal of ophthalmology*, 175, 169-172.
- 5.Naderan, M., Rajabi, M. T., Zarrinbakhsh, P., Naderan, M., & Bakhshi, A. (2016). Association between family history and keratoconus severity. *Current eye research*, 41(11), 1414-1418.
- 6.Gordon-Shaag, A., Millodot, M., Essa, M., Garth, J., Ghara, M., & Shneor, E. (2013). Is consanguinity a risk factor for keratoconus?. *Optometry and Vision Science*, 90(5), 448-454.
- 7.Lema I & Duran JA. (2005). Inflammatory molecules in the tears of patients with keratoconus. *Ophthalmology*, 112, pp. 654-659.
- 8.Auffarth GU, Wang L, Volcker HE (2000) Keratoconus evaluation using the Orbscan topography system. *J Cataract Refract Surg* 26(2): 222-228.
- 9.Kenney MC, Brown DJ. (2003). The cascade hypothesis of keratoconus. *Contact Lens Anterior Eye*, 26:139-46.
- 10.Mohamed-Noriega, K., Butrón-Valdez, K., Vazquez-Galvan, J., Mohamed-Noriega, J., Cavazos-Adame, H., & Mohamed-Hamsho, J. (2016). Corneal melting after collagen cross-linking for keratoconus in a thin cornea of a diabetic patient treated with topical nepafenac: a case report with a literature review. *Case reports in ophthalmology*, 7(1), 119-124.
- 11.Romero-Jiménez, M., Santodomingo-Rubido, J., GonzálezMejío, J. M., Flores-Rodriguez, P., & Villa-Collar, C. (2015). Which soft lens power is better for piggyback in keratoconus? Part II. *Contact Lens and Anterior Eye*, 38(1), 48-53.
- 12.Zadnik K, Barr JT, Edrington TB, Everett DF, Jameson M, McMahon TT, et al. Baseline findings in the Collaborative Longitudinal Evaluation of Keratoconus (CLEK) Study. (1998) *Invest Ophthalmol Vis Sci* ;39:2537-46.
- 13.van der Worp, E., Bornman, D., Ferreira, D. L., Faria-Ribeiro, M., Garcia-Porta, N., & González-Mejome, J. M. (2014). Modern scleral contact lenses: a review. *Contact Lens and Anterior Eye*, 37(4), 240250.
- 14.Sengor, T., Kurna, S. A., Aki, S., & Özkurt, Y. (2011). High Dk piggyback contact lens system for contact lens-intolerant keratoconus patients. *Clinical ophthalmology*, 5, 331.
- 15.Kymes SM, Walline JJ, Zadnik K, Gordon MO. Quality of life in keratoconus. (2004). *Am J Ophthalmol*;138(4):527-535.
- 16.Rebinitsh RL, Kymes SM, Walline J, et al. (2011). The lifetime economic burden of keratoconus: a decision analysis using a Markov model. *Am J Ophthalmol*; 151:768-73.e2.
- 17.Kymes SM, Walline JJ, Zadnik K, Sterling J, Gordon MO. (2008). Changes in the quality-of-life of people with keratoconus. *Am J Ophthalmol*; 145(4):611- 617.
- 18.Krumeich, J. H., Daniel, J., & Knülle, A. (1998). Liveepikeratophakia for keratoconus. *Journal of Cataract & Refractive Surgery*, 24(4), 456-463.
- 19.Belin, M. W., & Duncan, J. K. (2016). Keratoconus: the ABCD grading system. *Klinische Monatsblätter für Augenheilkunde*, 233(06), 701-707.
- 20.Pecego M, Barnett M, Mannis MJ, Durbin-Johnson B (2012). Jupiter scleral lenses: the UC Davis Eye Center experience. *Eye Cont Lens*; 38:179-82.
- 21.Bergmanson, J. P., Walker, M. K., & Johnson, L. A. (2016). Assessing scleral contact lens satisfaction in a keratoconus population. *Optometry & Vision Science*, 93(8), 855-860.
- 22.Visser, E. S., Visser, R., Van Lier, H. J., & Otten, H. M. (2007). Modern scleral lenses part II: patient satisfaction. *Eye & contact lens*, 33(1), 21-25.
- 23.Shneor, E., Millodot, M., Blumberg, S., Ortenberg, I., Behrman, S., & Gordon Shaag, A. (2013). Characteristics of 244 patients with keratoconus seen in an optometric contact lens practice. *Clinical and Experimental Optometry*, 96(2), 219-224.
- 24.Smiddy WE, Hamburg TR, Kracher GP, Stark WJ. (1988). Keratoconus. Contact lens or keratoplasty? *Ophthalmology*; 95:487- 92.
- 25.Williams, K. A., Muehlberg, S. M., Lewis, R. F., & Coster, D. J. (1997). Long-term outcome in corneal allotransplantation. In *Transplantation proceedings* (Vol. 29, No. 1, p. 983). Elsevier.
- 26.Pullum, K. W., Whiting, M. A., & Buckley, R. J. (2005). Scleral contact lenses: the expanding role. *Cornea*, 24(3), 269-277.
- 27.AlRomeih, M. (2015). Piggyback Lens System in the Management of Keratoconus. *Adv Ophthalmol Vis Syst*, 2(6), 00067.
- 28.Michaud, L., Van Der Worp, E., Brazeau, D., Warde, R., & Giasson, C. J. (2012). Predicting estimates of oxygen transmissibility for scleral lenses. *Contact Lens and Anterior Eye*, 35(6), 266-271.
- 29.Carracedo G, Recchioni A, Alejandre-Alba N, et al. (2015). signs and symptoms of dry eye in keratoconus patients: A pilot study. *Current Eye Research*; 40(11): 1088-1094.
- 30.Dartt DA, Dana R, D'Amore P & Niederkorn J. (2011). Immunology, inflammation and diseases of the eye: 1st ed. (pp 7172). Academic Press.

- 31.Carracedo, G., Blanco, M. S., Martin-Gil, A., Zicheng, W., Alvarez, J. C., & Pintor, J. (2016). Short-term effect of scleral lens on the dry eye biomarkers in keratoconus. *Optometry & Vision Science*, 93(2), 150-157.
- 32.van der Worp E. (2010). A guide to scleral lens fitting [monograph online]. Forest Grove, OR: Pacific University, Available from: <http://commons.pacificu.edu/mono/4/>.
- 33.Contact lens compendium. (2017). Centre for Contact Lens Research. Retrieved from, <http://www.contactlensupdate.com>.
- 34.Visual aids policy and administration manual. (Feb 2016). Ministry of Health & Long-Term Care: Assistive Devices Program. Retrieved from, www.health.gov.on.ca.
- 35.Yildiz, E. H., Cohen, E. J., Viridi, A. S., Hammersmith, K. M., Laibson, P. R., & Rapuano, C. J. (2010). Quality of life in keratoconus patients after penetrating keratoplasty. *American journal of ophthalmology*, 149(3), 416-422.
- 36.Mendes, F., Schaumberg, D. A., Navon, S., Steinert, R., Sugar, J., Holland, E. J., & Dana, M. R. (2003). Assessment of visual function after corneal transplantation: the quality of life and psychometric assessment after corneal transplantation (Q-PACT) study. *American journal of ophthalmology*, 135(6), 785-793.
- 37.Canadian keratoconus foundation.(2015).Canadiankeratoconus foundation.Retrievedfrom,<http://keratoconuscanada.org/>.
- 38.NKCF. (2017). National keratoconus foundation. Retrieved from, <https://www.nkcf.org/contact/>.
- 39.Treating corneal blindness through tissue engineering. (2017). The cornea transplant foundation. Retrieved from, <https://www.corneal-transplant-foundation.org/>.
- 40.Cornea research foundation of America. (2017). Cornea research foundation of America. Retrieved from, <http://www.cornea.org/>.
- 41.Keratoconus group. (2017). Keratoconus group. Retrieved from, <https://www.keratoconusgroup.org/>.
- 42.Keratoconus group of Ontario. (2017). Facebook. Retrieved from, <https://www.facebook.com/groups/369910393513/>.
- 43.UK Keratoconus Self Help and Support Association. (2010). UK Keratoconus Self Help and Support Association. Retrieved from, <http://www.keratoconus-group.org.uk/>.
- 44.Keratomania. (2017). Keratomania. Retrieved from, <http://www.keratomania.com>.
- 45.Keratoconus support group. (2017). Daily Strength. Retrieved from, <https://www.dailystrength.org/group/keratoconus/>.

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