Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Three Case Series Report: The use of Axial Length in Myopia Management Clinical Decision Making

September 6, 2021

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Shalu Pal shares her personal experience on the application of axial length measures in the management of three of her young myopic patients, providing useful insight and real-world practical tips to help eye care practitioners make the best evidence-based decisions in their own practices.

Background

Our role as eye care providers is to provide the best possible treatment options for our patients. Over the last few years, the conversations around myopia – how we treat it and how we measure it – have been evolving. Where it was once so simple to just correct myopia, the treatment strategies and implementation to manage myopia have become more complex. We are ultimately responsible to stay up to date on the latest evidence-based research, gather the appropriate and sometimes extensive clinical data, and then make the best decisions for our myopic patients that will ensure the most optimal outcomes for their long-term eye health and vision. All while knowing as a profession, as we collectively continue to learn, our thoughts, treatment strategies and treatment philosophies will continue to change.

We have always looked to our refraction (both dry and cycloplegic) as our gold standard for assessing myopic progression and the need for intervention. In trying to control the progression of myopia we know that we cannot stop the progression, but we can reduce the rate of change. As a child continues to develop, the eye is likely to grow, to some extent, regardless of intervention. Minimising this continued elongation, not stopping it, is our goal in myopia management.

On average, we expect myopia to progress by 0.50 diopters (D) per year.[1,2] We also know that progression of myopia is correlated to the growth of the eye.[3] Although this is not truly a linear relationship with increasing magnitude of myopic refractive error, it is generally accepted that each -0.25D of increased myopic refractive error correlates to an eye length increase of approximately 0.1mm.[3] It has been reported that untreated myopic eyes grow on average by 0.2mm per year.[1,4] But we do have to remember that even a normal emmetropic eye grows on average at a rate of 0.1mm per year, which is considered “normative growth”.[3] We should take from this that myopia progression is an acceleration of this norm, reminding us again that interventions are unlikely to stop axial elongation entirely.

Looking at changes in axial length as an indicator of myopia progression and myopia control is very helpful. Measuring refractive error has its limitations in monitoring myopia due to its variable and subjective nature. A cycloplegic refraction can solve most of these issues but is not always practical or well tolerated. A further complication of refraction is that in some methods of myopia management, namely orthokeratology, refraction is intentionally altered and can be variable based on the time of day and length of treatment. In contrast, axial length is straightforward, reliable, and repeatable, and has been shown to be 5-10 times more accurate than refraction.[5,6]

Three cases histories from my practice are presented below, each use axial length measures to help inform the efficacy and ongoing use of the chosen myopia management intervention.

Case 1 KH

History

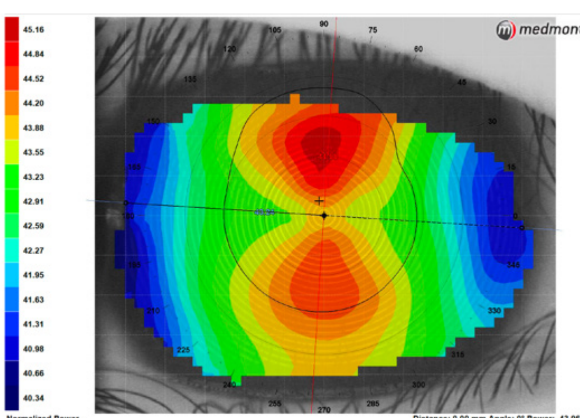
11 y/o Asian female referred to our clinic for a myopia management assessment from a binocular vision specialist. She presented habitually wearing progressive addition lenses for the past 3 years. KH was very active and played many sports. The goal of the family for the patient was to be fit with contact lenses that would also slow or halt the progression of myopia. Her reported computer time was 3+ hours a day; outdoor time playing sports was at least one hour daily, she ate well, and took vitamins daily. Both parents are highly myopic, and the patient's younger sister was not myopic at the time of her initial appointment for evaluation.

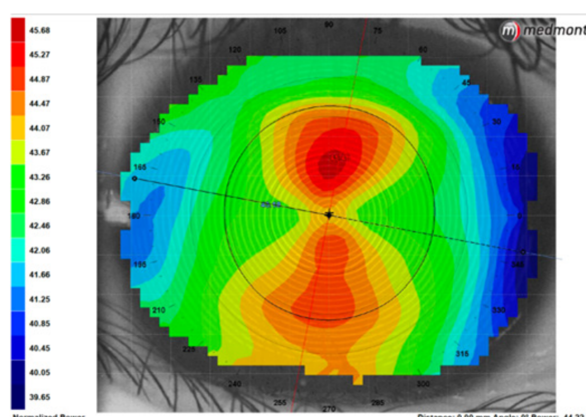
Baseline Clinical Findings

Refraction
-5.25 – 1.50 x 5
-2.25 – 1.00 x 5

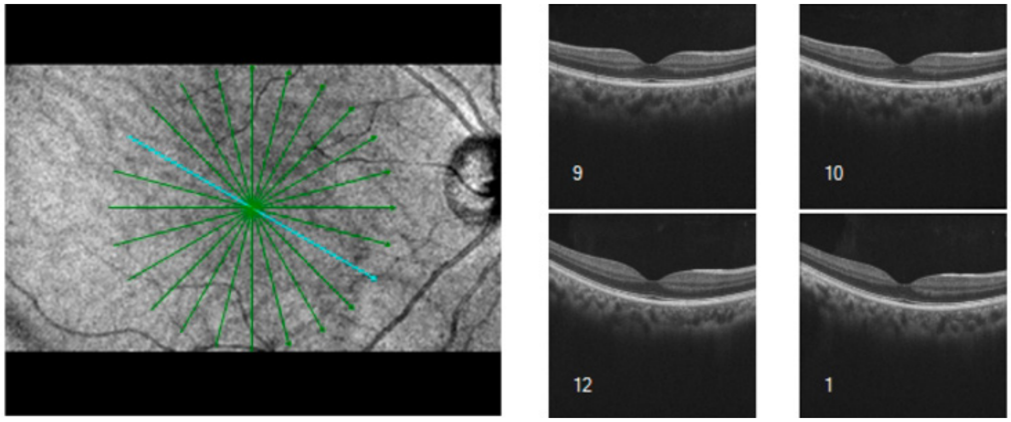
K Readings
43.00/44.50 x 3
43.25/45.25 x 12

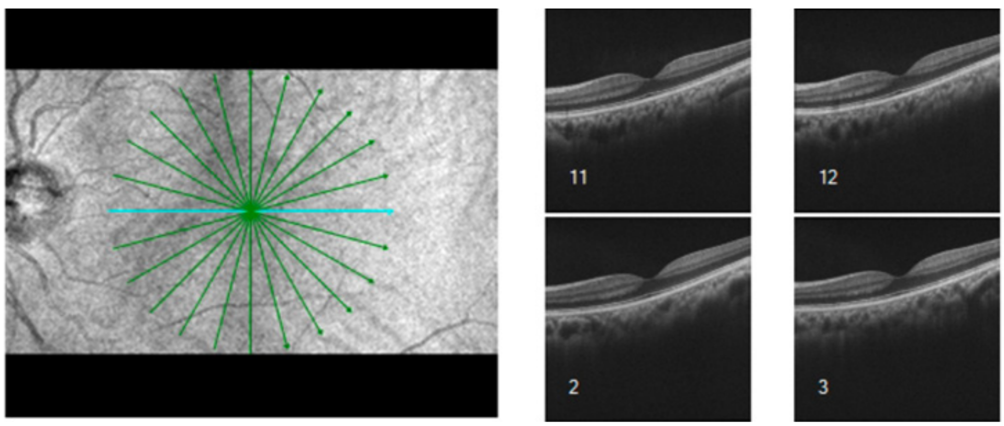
Topographies



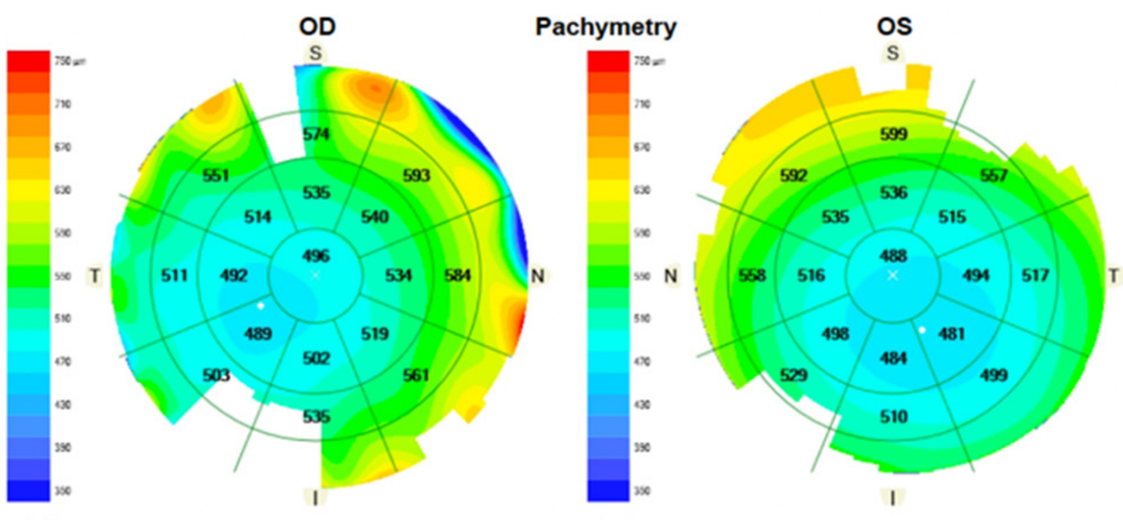


Retinal OCT Images





Pachymetry



Assessment

After discussing the contact lens options between soft multifocal monthly lenses or orthokeratology, the family decided on orthokeratology. The family also decided not to initiate any treatment at this time for KH's sister, preference being to monitor her with routine care.

Axial Length

EXAM	*OD, mm*	*OS, mm*
1st Exam – Baseline	25.62 (A-Scan*)	25.62 (A-Scan*)
2nd Exam – 6 months	25.70 (A-Scan*)	24.60 (A-Scan*)
3rd Exam – 1 year	25.90 (Myah^)	24.95 (Myah^)
4th Exam – 18 months	25.83 (Myah^)	24.92 (Myah^)

* Ultrasound
^ Optical biometer (Optical low-coherence interferometry)

Follow Ups & Plan

6 months post completion of the orthokeratology fit, we found no change to KH's prescription but did find some discrepancies in the A-Scan axial length readings in the left eye (from baseline to 2nd reading the measurement was significantly shorter, which likely indicates poor data of one of the scans; further data points are usually recommended to ensure reliable data is considered when making or changing a treatment plan). No changes were made at this time. After an additional 6 months of orthokeratology lens wear, her vision and prescription did change. We saw a 1D increase in myopia in the right eye and 0.5D of myopia increase in the left eye. We also saw an increase in the axial length in both eyes between the 6 and 12 month visits. We made a change to the target base curve in her orthokeratology lenses to accommodate this change in prescription.

It is known there is a significant increase in ocular complications once the eye surpasses the axial length of 26mm and this number is used as a benchmark in myopia management. [14,15] Based on the axial length change in the right eye, and how close it was to the benchmark, a recommendation to add 0.02% atropine was discussed. The use of 0.02% atropine has been shown to slow down elongation in axial length.[24] Both mom and KH decided against the use of atropine drops at this point. We collectively decided to wait for another 6 months to re-evaluate. At the next 6 month follow up, all was stable and we will re-evaluate in another 6 months.

Due to some fluctuation in axial length data measurements, and with the relatively low number of data points, it is difficult to accurately assess an absolute number for change in refractive error; however, from the data we know the refractive error has progressed.

Summary to date

Based on the axial length formulas from the Comparison of Ocular Component Growth Curves Among Refractive Error Groups in Children paper,[19] the expected axial length for this now 12 y/o female is 24.34mm. She is above the current expected axial length. However, the amount of change in axial length from age 11 to age 13 with her myopia management interventions is less than what we would have otherwise predicted based on the predicted charts from the Orinda Longitudinal study of Myopia (OLSM) and Singapore Cohort Study of the Risk Factors for Myopia (SCORM) studies.

Case 2 BT

History

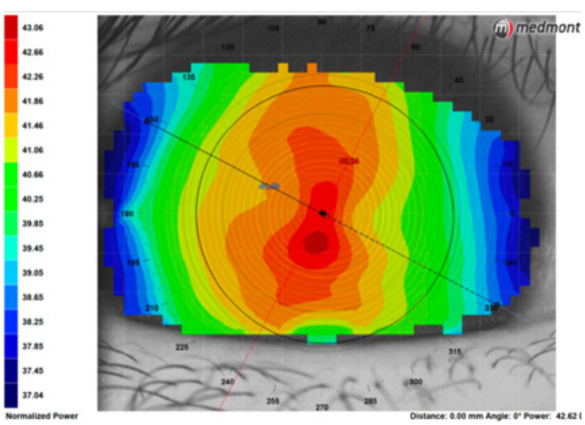
12 y/o Asian male was referred to our clinic from a classmate who was also our patient undergoing myopia management with the use of orthokeratology lenses. His mom was very concerned about his myopia progressing and prescription increasing. The whole family was prepped and ready to move forward with orthokeratology. He reported spending over 5 hours a day on computers and very little time outdoors. His eating habits were reported to be good and he did not take any medications or vitamins. BT’s mom was a high myope with a history of retinal complications, and dad was a low myope; the patient had no siblings.

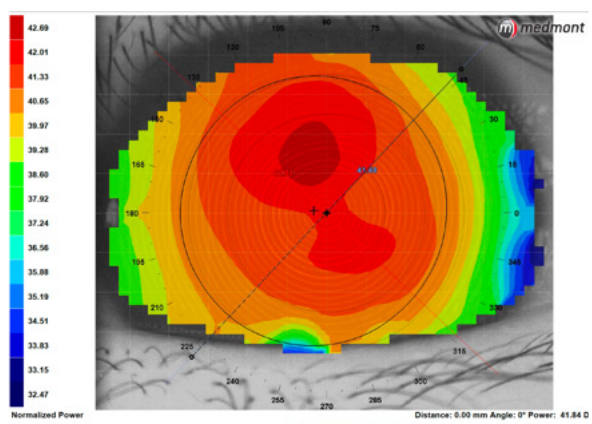
Clinical Findings

Initial Refraction
-3.25 – 0.25 x 180
-3.75 – 0.25 x 47

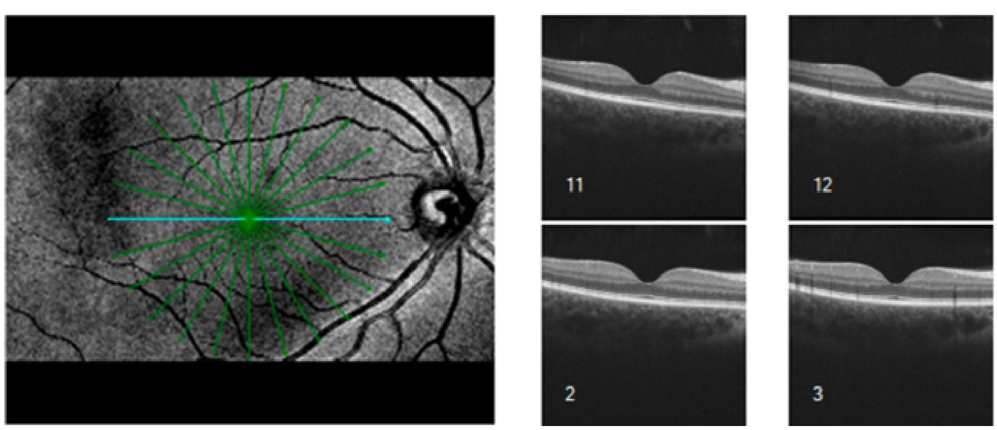
Initial K Readings
41.20/42.20 x 172
41.20/42.05 x 19

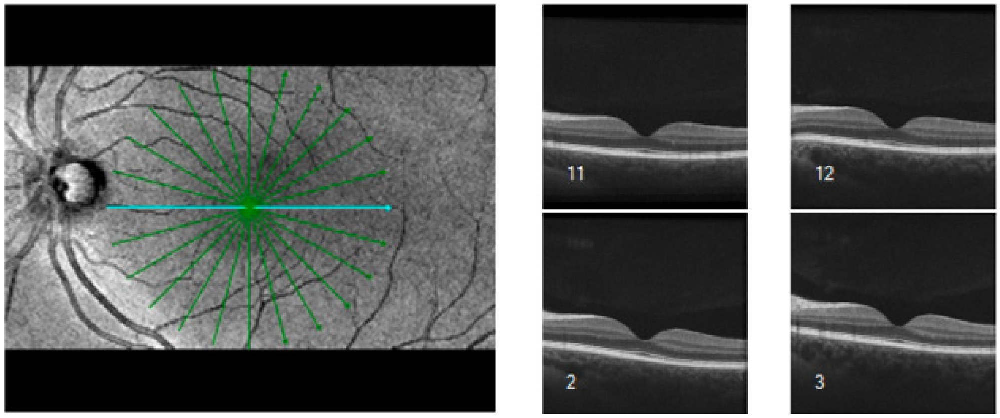
Baseline Topographies



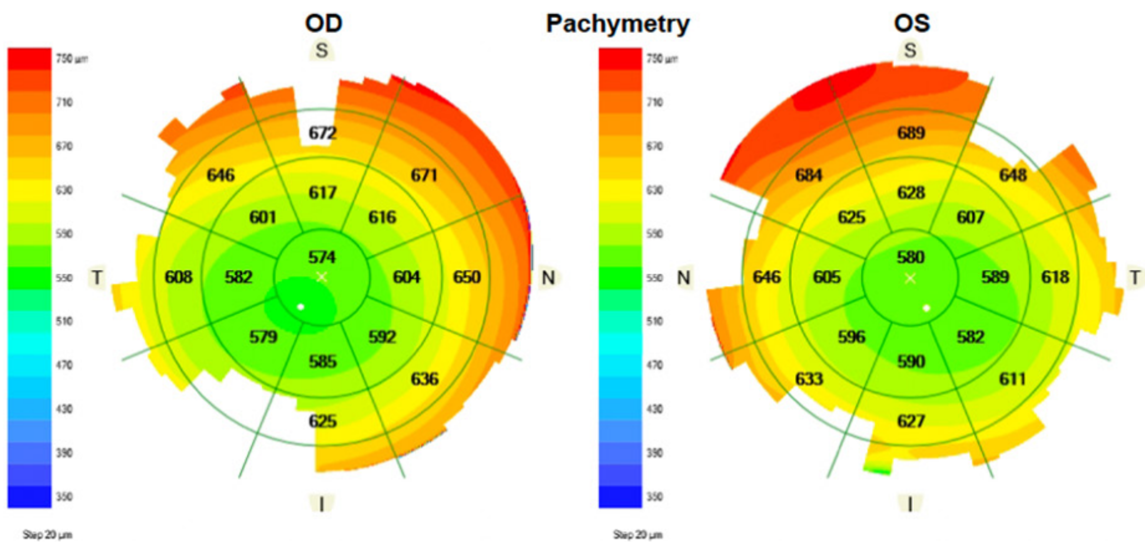


Baseline Retinal OCT Images





Baseline Pachymetry

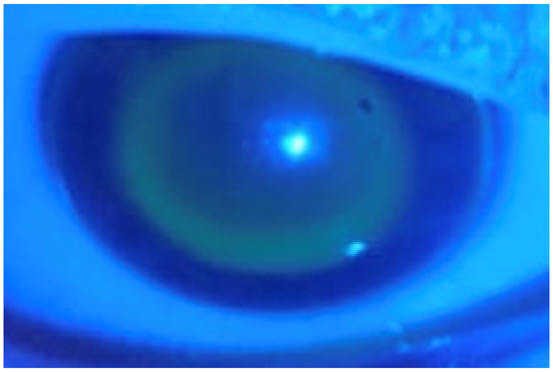


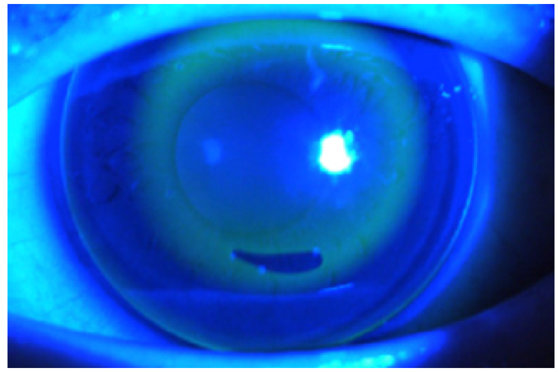
Axial Length

EXAM	***OD, mm***	***OS, mm***
1st Exam – Baseline	25.73 (Myah^)	25.93 (Myah^)
2nd Exam – 6 months	25.67 (Myah^)	25.78 (Myah^)

Assessment, Follow Up & Plan

Considering BT was 12-years old, had a refractive error of -3.50D, and axial length close to 26mm, the patient was considered high risk for progression and immediate treatment was indicated. Treatment was initiated with an orthokeratology fit as requested. Vision was 20/20 in both eyes post treatment with no increase in prescription or axial length after 6 months.





Summary to date

Both axial length and refractive error were found to be stable at 6 months post initiating use of orthokeratology lenses. No change to the lenses or treatment plan were recommended. With only two axial length data points, further follow up and data collection is required for best evidence-based decisions moving forward. We will continue to monitor BT, bringing him back in 6 months for a full evaluation of his prescription and repeat axial length. Because the axial length was very close to 26mm with an increased risk of future ocular complications,[14,15] we will watch him closely and if changes in prescription or axial length occur, we will consider adding atropine to his treatment plan.

Based on the axial length formulas from the Comparison of Ocular Component Growth Curves Among Refractive Error Groups in Children paper, the expected axial length for this now 13 y/o male is 24.37mm. He is above the current expected axial length. Based on the OLSM and SCORM studies we would expect to see 0.2mm of change at age 12. At this time it is difficult to draw conclusions given the limited data we have, but he will be monitored carefully.

Case 3 TT

History

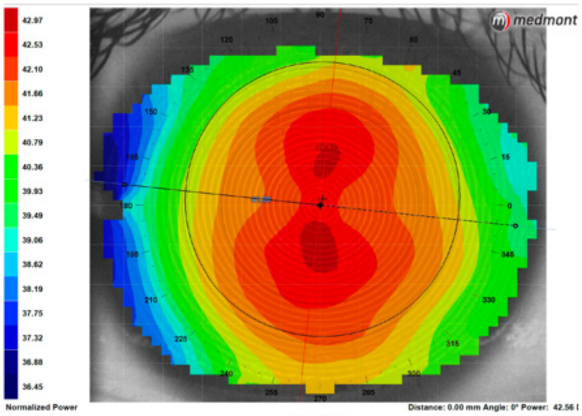
13 y/o Asian female was self-referred to our clinic from our website. Mom was looking for myopia management options for both daughters. TT was very active and played many sports. Their family was looking for a contact lens option that also promotes slowing down the progression of myopia. She reported spending 6+ hours a day on computers, was highly academic, and reported spending no regular time outdoors or participating in sports. Diet was reported to be regular, and she did not take any medications or vitamins. Her mom was highly myopic and post-LASIK, and TT's dad was emmetropic. Her younger sister was a mild myope starting myopia management concurrently with Hoya MiyoSmart lenses due to her fear of contact lenses.

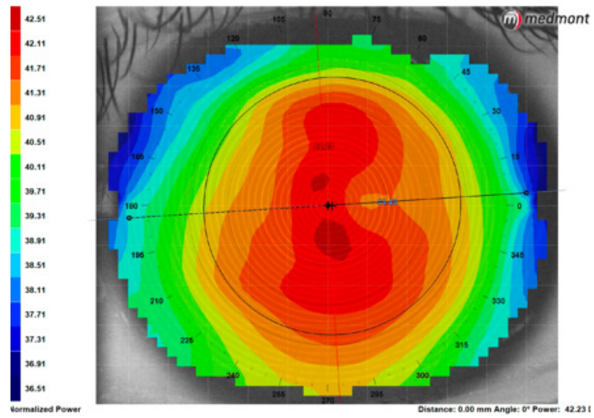
Clinical Findings

Initial Refraction
-7.25 – 0.25 x 165
-7.25 SPH

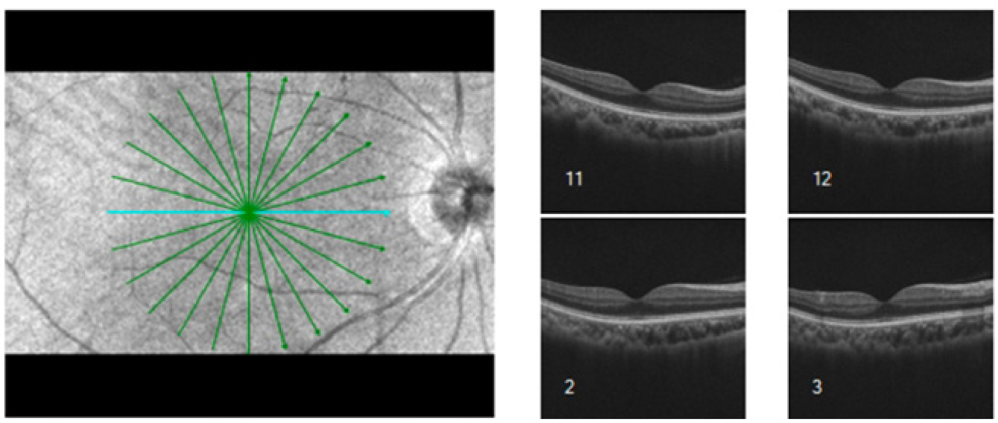
Initial K Readings
41.75/42.75 x 174
41.25/42.50 x 004

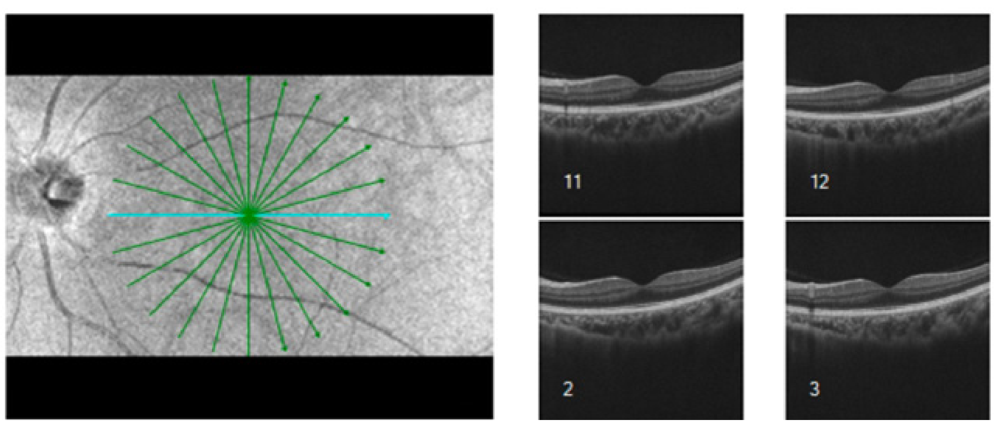
Baseline Topgraphies



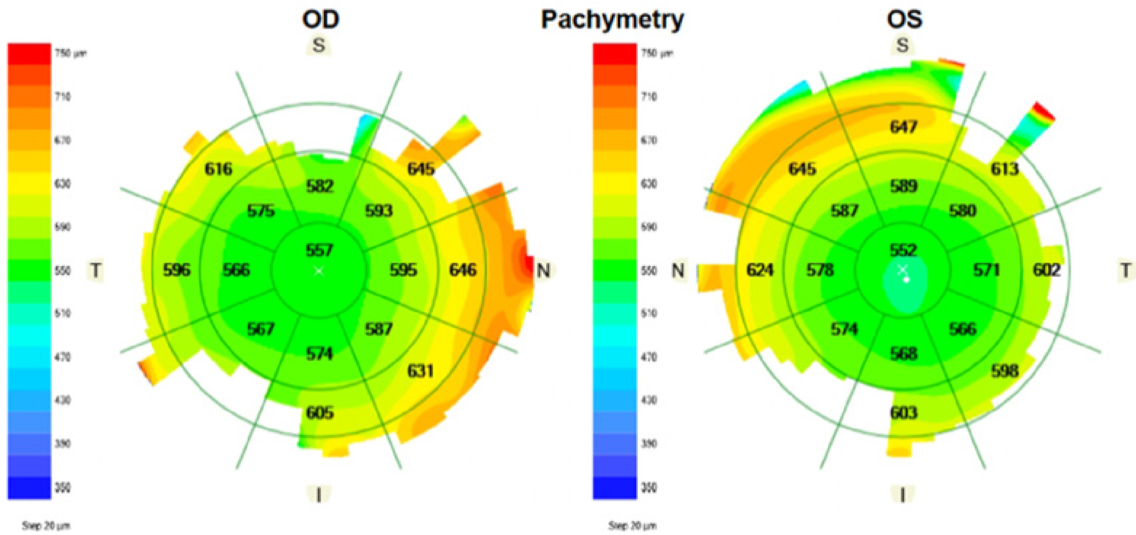


Baseline Retinal OCT images





Baseline Pachymetry



Axial Length

EXAM	*OD, mm*	*OS, mm*
1st Exam – Baseline	26.50 (A-Scan*)	26.39 (A-Scan*)
2nd Exam – 6 months	26.51 (A-Scan*)	26.37 (A-Scan*)
3rd Exam – 1 year	26.54 (A-Scan*)	26.41 (A-Scan*)
4th Exam – 18 months	26.80 (Myah^)	26.66 (Myah^)
5th Exam – 2 Years	26.78 (Myah^)	26.68 (Myah^)

* Ultrasound
^ Optical biometer (Optical low-coherence interferometry)

Assessment, Follw Up & Plan

I have been following TT for almost 3 years. She came to us with high myopia and a very strong parental concern of progression. After discussing the available options, her parents were initially interested in all three management options. We clarified that the use of orthokeratology at night and soft multifocals during the day would be redundant and not provide her any added benefit in using both. As for adding atropine to a peripheral plus strategy like orthokeratology or multifocals, I also advised that a stepwise approach – where we watch and monitor her to determine if we needed to add a second therapeutic strategy – would be warranted. TT initially choose orthokeratology but after wearing the lenses in office asked to switch to soft multifocal.

With her high Rx, we chose a Biofinity centre distance -7.00 multifocal with a +2.50 add. She experienced non-satisfactory distance vision with the initial multifocal lenses and so her distance prescription was over-corrected by -0.50D in each eye which has been found clinically to alleviate some of the distance blur that patients may experience with new use of multifocal optics. She has remained happy with these lenses for almost 2 years, with no prescription changes or vision complaints. We did find, during this 2-year period, that her axial length presented higher with the Myah compared to the A-Scan readings, and we are aware that different methods of measuring axial length are not interchangeable in their results and may well measure slightly differently.

We discussed adding 0.02% atropine to her routine to assist controlling the elongation in axial length. Her mom wanted to incorporate this into the treatment plan but TT refused, as cleaning and caring for her lenses was already enough for her. We switched her to the NaturalVue 1 day multifocal lens to minimize her care routine. Distance power, as calculated by the manufacturer's fitting guide was -7.75 in both eyes. With the convenience of the new one-day disposable lenses, she was willing to try using atropine. She will be returning for her next 6 month follow up after being on the NaturalVue lens design and 0.02% atropine combination therapy.

Summary to date:

Based on the formulas from the Comparison of Ocular Component Growth Curves Among Refractive Error Groups in Children paper, the expected axial length for TT at age 15 y/o male is 24.87mm. Her eyes are longer than expected at her age and at greater risk. Based on the OLSM and SCORM studies, the expected increase in length is 0.37mm from age 13 to 15. Based on the data collected with our two instruments, TT only grew by 0.28mm in the right and 0.29mm in the left during these two years, which is less than expected indicating that our treatments are reducing the progression rate.

Discussion

The biggest challenge we face as practitioners with respect to treating and preventing myopia is the decision-making process to determine the best course of action. The challenging part is keeping up with the research and products that are very quickly emerging in this area of optometry. While changing technology and standards of care are exciting for health providers, they may also cause confusion in how to implement new products and procedures into clinical practice and current prescribing strategies.

For example, when working with children, we often don't think about corneal and retinal edema as common conditions we need to look out for. The one thing I have learned is that the more information you can gather at your baseline assessment, the easier your diagnostic evaluation can be if a challenge or complication does arise. I routinely perform pachymetry on my contact lens patients at their initial fitting visit. Monitoring their central corneal thickness throughout the fitting and monitoring process allows me to ensure no corneal swelling is taking place with the interventions I am providing. The device that I am using is the Zeiss Cirrus 5000 with the Corneal and Anterior Segment Lenses. This OCT is based on Spectral domain technology and provides highly repeatable and reproducible measurements.[7] Regardless of age, I also obtain a baseline OCT image of the child's retina to ensure we do not have any retinal complications which could impact vision. If a visual concern does arise, ruling out any retinal complications becomes very easy with having a baseline in place. Lastly and most importantly, I will obtain a corneal topography on all my contact lens patients. In order to fit orthokeratology lenses properly, this is the standard of care,[8,9] but it is also helpful to monitor corneal changes and molding that can occur from all modes of contact lens use. All of these data points assist in providing clinical measures to track, monitor and troubleshoot your management of myopia.

As I was growing my myopia management practice within our clinic, I initially did not have a measurement tool for axial length. As the practice grew and new research started to surface on the benefits of measuring axial length, I invested in an A-Scan. The low-cost investment allowed for our clinic to determine our flow, use and need for an axial length device. The use of an anesthetic, however, was a hinderance for both young patients and staff, and the need for corneal applanation impacted reliability and repeatability due to the inconsistent level of pressure applied by various operators.

Studies have shown that ultrasonography is limited in resolution in comparison to optical biometer interferometry measurement devices.[10] As the practice continued to grow alongside the collection of evidence supporting measuring eye growth, I invested in a more accurate, reliable, and repeatable, non-contact device to measure axial length, the Topcon Myah. There are many stand-alone and combination optical biometers available which can measure axial length. I was practicing for many years without the collection of axial length, and it is not required to manage myopia, but it does provide one additional tool to assist in your decision-making process. As our patients and parents become more knowledgeable about myopia management you will find that they come in seeking this diagnostic measurement.

The methods used to monitor progression of myopia fall into two categories: change in refractive error and growth of the eye. Both data points are needed and if available should be taken to assist in the monitoring of your treatment plan. Axial length is recommended to be measured every 6 months.[11] We know that changes in axial length are influenced by seasons; a child's eyes tend to grow faster in the winter months compared to the summer.[12,13] As a result, when looking at axial length data, I look at the measurements taken over a 1-year minimum period before deciding to continue or modify the current treatment plan.

Clinical decisions based on axial length should be made based on the current axial length and the rate of change. We know that an axial length of greater than 26mm has a greater risk of ocular complication and potential vision impairment is much higher.[14,15] The risk of vision impairment or blindness is 3.8% in eyes less than 26mm in size, 25% in eyes 26mm to 30mm and 90% in eyes longer than 30mm.[16]

The dichotomy between monitoring myopia with refraction vs axial length continues when looking at how to best predict future levels myopia. The Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) study would suggest refractive error is best to predict future amounts of myopia,[17] while other studies showed that axial length is the best predictor of future myopia in 50% of cases.[18] A third option is using growth patterns and formulas to determine the expected axial length for a child.[19] However, these formulas do not take ethnicity into account. This adds another layer of complexity, as data suggest that Asian eyes show 40% more eye elongation than Caucasian Eyes.[20] The comparison of Ocular Component Growth Curves Among Refractive Error Groups in Children paper shows the following formulas created for Myopes, Emmetropes and Hyperopes of various ages to predict the expected axial length at a given time in their life according to exam age. Table 1 below. The annual axial length growth for both myopes and hyperopes predicted by the OLSM[22] and SCORM[23] studies is below in Table 2.[25]

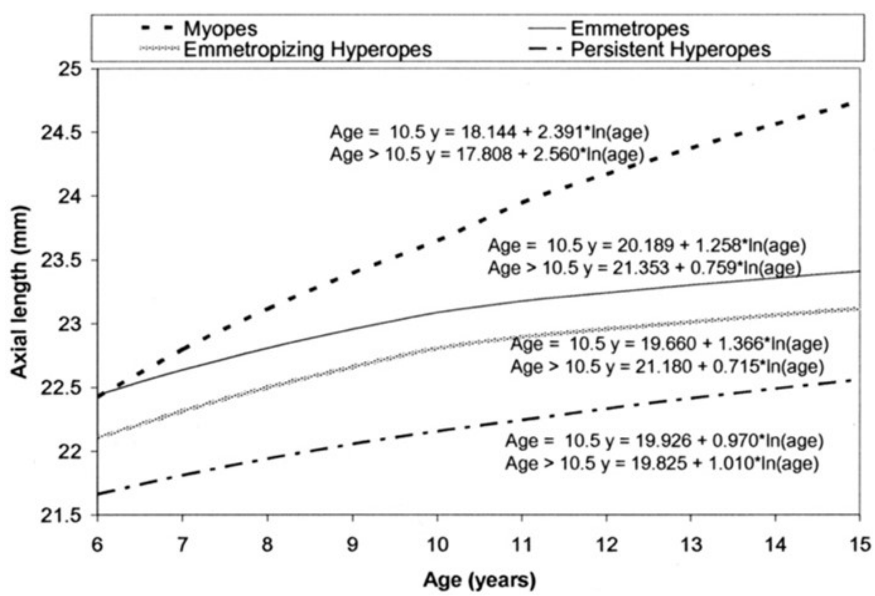


Table 1: Growth curve for axial length, using the best model derived from emmetropic data and applied to various refractive groups.

	Myopes		Emmetropes	
Age	OLSM	SCORM†	OLSM	SCORM
8	0.28	0.39	0.15	0.14
9	0.25	0.31	0.13	0.11
10	0.30	0.25	0.09	0.09
11	0.22	0.20	0.07	0.08
12	0.20	0.17	0.06	0.06
13	0.19	0.14	0.06	0.06
14	0.18	0.12	0.05	0.05

All values are in mm. OLSM, Orinda Longitudinal Study of Myopia; SCORM, Singapore Cohort Study of the Risk Factors for Myopia.
†For the SCORM cohorts, equations for vitreous chamber depth elongation were used

Table 2: Annual Axial elongation (mm/year) as a function of age modeled for myopes and emmetropes

Given the expected rate of growth of an emmetropic eye (0.1mm per year), and a myopic eye of 0.2mm per year, we can use this information to help guide us in predicting future expected axial length. Using the formulas provided, we can calculate age-expected axial length and compare them to our actual patient axial length to determine our relative risk levels. The OLSM and SCORM studies put together a predicted rate of change in axial length at each age based on these growth curves and formulas.

In each of our cases we can see that we are still seeing changes in axial length over a 2-year period. Indeed, we do not expect axial length to stop changing. We are changing at a rate less than the predicted or expected rates. Over the 2 years of monitoring these 3 patients, more data and research has come out and the initial decisions were not based on all the data we currently have. Looking back and analyzing the numbers gives us the confidence that we are making good clinical decisions and doing the best with the instruments and knowledge we currently have.

Final Tips

My general tips are to monitor axial length, keep in mind expected age lengths, look at an average rate of change to be 0.2mm per year, and act quickly the closer your patient is to 26mm. All while remembering that for every 1D less myopia (or 0.4mm less axial length) our patients are 40% less likely to experience myopic maculopathy.[21] Protecting our patient's future vision is our goal, and the more accurate data we have to do so, the easier and more successful our jobs become. While there is no right answer, infusing our clinical decisions with current and accurate data and well-researched guidelines can be invaluable in clinical decision-making.

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