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Dr. Langis Michaud
OD, MS, FAAO (Dipl)
FSLS FEAOO FBCLA

FULL PROFESSOR
Université de Montréal

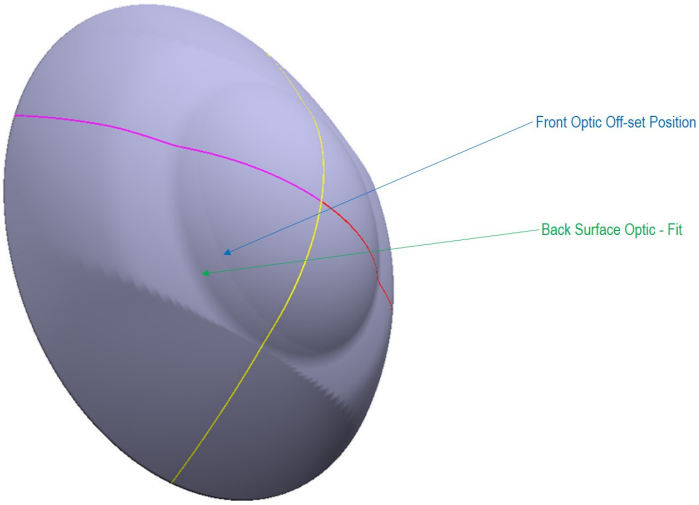
A Response to a Challenging Case of Keratoconus

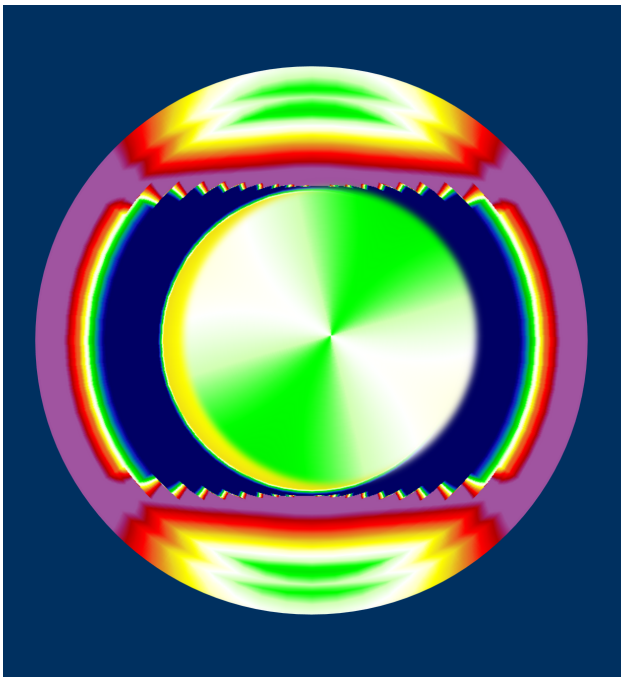
In recent years, the adequate correction of visual acuity in keratoconus patients adapted to scleral lenses has become a subject of interest and research. Indeed, some of these patients report a loss of contrast sensitivity, a shadowing of letters, or even diplopia when looking at light or precise targets at both distance and near.

Initially, the causes of this pollution of visual acuity were attributed to residual astigmatism secondary to lens flexure. It was then determined that an increase in lens thickness or to design a front toric lens, but none of these means managed to significantly improve the visual acuity of the patients. These steps are not recommended anymore.

It was later proven that the presence of optical aberrations, especially coma, was the main cause of optical impairment. These aberrations are generated by light at interfaces of material composed of various refractive indices (tears, lens, fluid reservoir, cornea) as well as the prismatic profile of the fluid reservoir, second to the decentering of the lens. Indeed, the vast majority of scleral lenses of larger diameter have a tendency to slide down and temporal, in response to gravity and uneven conjunctival profile. This decentering also leads, at the optical level, to a misalignment between the optical axis and the visual axis of the patient. This phenomenon generates aberrations and contributes to the patient's visual discomfort.

This case report illustrates such a situation where several options were explored before finally finding the one that allowed the patient to improve his vision while improving his comfort.
JF is 30 years Caucasian, working as a computer engineer, spending several hours a day in front of a computer screen. He also spends a certain number of hours on the road, his distance vision needs to be sharp, without compromise, according to what he reports. His first visit at my office dates back to 2019, when he was referred by an ophthalmologist for contact lens fitting following a diagnosis of keratoconus. The ophthalmologist had offered him a cross-linking treatment but the patient had declined this option, as long as his situation remained stable in visual terms. The case history reveals that he had consulted an OD colleague but the patient's anxiety about wearing lenses had led to repeated failures in trying rigid or scleral lenses. The family history is negative for ocular diseases. The general health of the patient is good, without the need for medication.
The clinical examination leads to the following results: Slight exo at distance and near, well-compensated, with unrestricted eye movements. We note the presence of the three degrees of fusion (glasses corrected).





Uncorrected visual acuity is 20/80 OD, 20/60 OS and 20/60 OR. The refraction gives OD +0.25 -5.50 x 80 (20/25) and +0.50 -2.00 x 90 (20/20) OS. The patient notes the difference between the two eyes and the presence of shadowing on the right side.
The corneal topography demonstrates a moderate nipple cone OD (Sim K 43.3 x 48.7mm) and low nipple cone OS (Sim K 42.7 x 44.5 mm). The examination with the slit lamp is normal, no visible signs of Keratoconus being identified. Examination of the posterior pole is normal as his intraocular pressure (OD 14 mm HG; OS 15 mm HG @ 14h00).
The diagnosis of the condition is simple: nipple keratoconus, moderate cone on the right eye and low one on the left.
The treatment plan, in order to satisfy the visual needs of the patient, requires the adaptation of a rigid contact lens in order to compensate for the irregular surface and improve visual perception, both qualitatively, for both eyes, and quantatively (aim 20/20 without shadowing) for the right eye.

Among the options that have not been tested so far, hybrid lenses can present interesting potential. I often improved the vision of patients suffering from a nipple cone with hybrid lenses, especially on cases where scleral lenses provided a visually disappointing result. I fitted a silicone hydrogel hybrid lens and it was well tolerated, positioned perfectly and the patient reported a good comfort. However, visual acuity was not optimal, compared to glasses, and over-refraction explained this result: OD plano -1.25 x 120 and OS plano -1.00 x 90. Residual astigmatism could not be corrected in hybrid lens, and the patient declined the option of wearing lenses and glasses on top of them, so the option of hybrids was abandoned.
The second option that was considered was the fitting of a GP lens, with a keratoconus design. This type of lens had been tested by my colleague, but had been a failure due to the patient's discomfort. In order to get around this obstacle, I tried to fit the lens with a piggy back system, using a disposable SiHy lens as a carrier. The optimal GP lens was determined to be a front-toric lens, Rose K BC 7.40 /-2.75 -.125 x 85/10.2 mm OD and 7.70/-2.00 -0.75 x 105/10.2 mm OS, to be worn with senofilcon A 8.4/14.2 +0.75D OU.
The patient was able to tolerate these lenses much better than the first time but after a few weeks he still complained of irritation on the right eye, excessive redness at the end of the day and fluctuating vision on occasion.
Symptoms increased in proportion to wear time, contrary to what might be expected.
A new visit was planned, post-pandemic, in order to explore the possibility of fitting scleral lenses, despite some negative factors: failure prior to such trial (made by a competent OD), apprehension of the patient to handling the lenses, due to very narrow palpebral apertures, and finally, the fact that scleral lenses are often leading to disappointing visual acuity in the presence of a niple cone, in cases where correctable acuity in glasses is better than 20/30 (my experience is that, in these circumstances, there is very often generation of coma that dramatically disturbs the visual acuity of the patient).

Previous failures are often a good indication of the final result. It is then necessary to aim to work with other products, whose characteristics are different, in order to hope to reverse the trend.

With regard to the patient's apprehension, the use of a small diameter lens (15.5) should allow relatively easy handling. If the patient was able to handle a soft lens, a slightly larger, rigid lens should not cause any problems. Second, using a small diameter lens significantly reduces the risk of decentering, causing the majority of the visual pollution observed in these cases. Nevertheless, a measurement of conjunctival toricity was performed with a profilometer (Eaglett Eye, The Netherlands) and a difference of 225 microns, at a 15 mm chord, was noted between the highest and lowest levels of the conjunctiva. Finally, the use of off-center optics could minimize visual discomfort.
Acculens' Easy Fit lens was chosen in order to allow the lens optics to be decentered, especially with On Point technology. The test lenses are marked and it is easy to estimate the value and orientation of the decentering. In this case, the lenses were decentered in the lower nasal OD and the lower temporal position. These results are forwarded to the laboratory so that they modify the optical alignment accordingly (posterior surface), in order to align it in the pupil area.
Acculens scleral lenses are also designed with an anterior asphericity that compensates for some of the optical aberrations. I have often measured a better outcome (aberrometry) with Acculens lenses vs those of other manufacturers as for aberrations compensations.

The final parameters of the lenses were
OD CB 7.85 Puiss -0.50 -1.25 x 137; Diam 15.5/9.0 OZ; Sag 4.59 – 'superior-temporal off-center optics; toric peripheries +175 um/-50 um
OS CN 7.85 Puiss -0.75; Diam 15.5/9.0; Sag 4.39- 'superior-nasal off-center optics. toric peripheries +150 um/-75 um
On delivery, the lens is positioned slightly differently than during the tests, due to a better conjunctival alignment (pc Torics). The central vault is also excessive on the right eye but optimal on the left eye (387 um/ 272 um after 30 minutes), requiring modification. An overrefraction demonstrates the presence of residual astigmatism, probably induced by the rotation of the lens. A new lens was then ordered, modified in power (+1.25 -1.50 x 163), taking into account a change in the base curvature to 8.04mm and the lens rotation.
This new lens is delivered a few days later and the monocular visual acuity is 20/15 for each eye. "I have never seen so well", confirms the patient, while noting the absence of discomfort and shadowing. He also had to handle the lenses after a training session for this purpose.

I saw the patient again after a few weeks of wearing and he is most satisfied with his vision. He can wear his lenses all day, without redness or fluctuations in vision. He notes the improvement in his acuity both at work and in driving, and mainly in the evening, where halos are less disturbing.

In conclusion, this case represented a major challenge, due to the visual requirements of the patient. The use of Easy Fit design with On Point technology (off-center optics) has made it possible to satisfy the patient, not only visually, but also in terms of comfort and eye health. This case illustrates here the positive results of these technologies, which I was able to verify in several other patients for whom the other lens options led to disappointing results in terms of visual acuity. The decentering of lens optics is becoming common in my practice and it will be used more frequently, so as to better serve our patients, as the manufacturing processes will be offered with many other designs in the future.

Dr Langis Michaud, OD MS FAAO (Dipl) FSLS FEAOO FBCLA.
Full professor.

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