Surgeon proposes keratoconus is caused by eye rubbing

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Damien Gatinel

Clinician and researcher **Damien Gatinel, PhD, MD,** strongly believes that keratoconus is caused by patients rubbing their eyes and sleeping with their faces against the pillow.

Since 2007, he has headed the service for anterior segment and refractive surgeries at the Rothschild Foundation in Paris. He manages patients with refractive surgery, cataract surgery and keratoconus and also regularly performs research on the optical design of IOLs, mathematical modeling of the optical and topographic properties of the cornea, detection of keratoconus, and the effect of laser corrections in refractive surgery.

He discussed his cutting-edge theory on the main cause of keratoconus with *Primary Care Optometry News.*

PCON: It has long been suspected that corneas with keratoconus (KCN) are biomechanically more fragile. Given that KCN is often associated with floppy eyelid and sleep apnea – other forms of soft tissue abnormality – do you believe KCN is strictly ocular or is it part of a system-wide disease?

Gatinel: KCN corneas are indeed more biomechanically fragile, but the one important question is how and why this biomechanical weakening occurs. Does the biochemical weakening pre-exist or does it accompany a process causing the cornea to weaken and deform? I propose that most keratoconus cases are actually not part of a systemic disease.

In my opinion, from assessing the logical evidence and clinical investigation, the root cause of KCN is undeniably eye rubbing. Without exertion of local and repeated corneal trauma leading to focal weakening of the corneal stroma, I do not believe that the classic picture of KCN can occur spontaneously. It is important to understand that eye rubbing may not be the sole ingredient in the KCN recipe, but I consider it as indispensable. I have coined this hypothesis as the “no rub, no cone” conjecture.

The perfect systemic disease model contradicting the assumption that corneal weakness alone can spontaneously cause KCN is Marfan syndrome. We know that Marfan syndrome is a connective disease affecting the fibrillin protein causing disproportionate height, arachnodactyly, ectopia lentis and cardiac complications such as mitral valve prolapse and aortic enlargement. In these eyes, the cornea is

also abnormally weak and gets thinner, but not steeper and irregular. The corneas (which are homogeneously weaker) actually tend to become flatter. This is, of course, not surprising, because the eye wall, including the cornea and sclera, tends to stretch over time. This occurs due to the relative excess of intraocular to atmospheric pressure stressing the weaker tissue, which, just like in the Marfan aortic vessel's inner wall, incurs a larger radius of curvature over time. In other words, the uniform thinning seen in Marfan corneas is contradictory to the focal pathology demonstrated in KCN, as it simply would not make sense that despite all collagen fibrils being affected, the disease would only present itself focally.

The uneven distribution of thinning in KCN corneas can also be directly attributable to eye rubbing. Recent studies using Brillouin scanning microscopy have confirmed that the biomechanical impairment of KCN corneas is focal and affects central or paracentral areas without much peripheral involvement. To me, it is clear that this focal biomechanical impairment is caused primarily by eye rubbing. The repeated mechanical stress exerted against the corneal dome weakens the corneal tissue through pathways both mechanical and biological.

Repeated mechanical trauma inflicted on the cornea results in permanent thinning and deformation and also explains very well the frequent inter-eye asymmetry, as a large proportion of patients tend to rub one eye more than the other. In some patients who rub only one eye, a strictly unilateral keratoconus can be observed, as no topographic or biomechanical clinically detectable alteration can be found in the other eye that is not rubbed. Interestingly, the more affected eye is not correlated with the dominant hand, but rather the preferential side on which the patient sleeps. KCN appears to be more frequent in patients who sleep on their stomach or on one side, which causes the globe to be compressed and subjected to increased heat during sleep.

These factors combined cause local irritation and trigger the subsequent need to rub. Over time, repeated rubbing leads to a permanent corneal warpage via the combination of mechanical and biological factors.

Patients who rub with their knuckles are at increased risk of KCN due to the higher inflicted pressures from knuckle exertion compared to finger pulp exertion. As for the association between sleep apnea and floppy eyelids, this can be explained by poor sleep quality. Poor quality sleep can result in ocular pruritis and, as can be often observed in children, a tendency to rub the eyes to relieve ocular fatigue. It is well documented that laxity of eyelid tissue and canthal tendons can be caused by excessive rubbing. The nocturnal exposure of the ocular surface due to incomplete palpebral closure can exacerbate local irritation and accentuate the need to rub. Hence a vicious circle can occur, where eye rubbing plays the central role.

In addition to these considerations, patients with repeated episodes of allergic or dry eye disease may be at higher risk of KCN, again, due to excessive eye rubbing. Patients with diseases reducing corneal resistance may also be more prone to corneal progressive and permanent deformation for the same amount of dispensed rubbing trauma. For example, a Marfan syndrome patient with abnormal fibrillin who rubs their eyes vigorously could expect to develop KCN faster than a patient with no biomechanically compromised tissue.

PCON: One of the differentiating features of KCN is central corneal thinning and ectasia (posterior float). Do you believe individuals with KCN have innately thinner corneas, or is this a result of apoptosis and progression?

Gatinel: I believe that both of these statements may hold true. For the same rubbing intensity, patients with thinner and/or weaker corneas (such as the Marfan patient) could expect to develop KCN faster than patients with thicker and stronger corneas. The thinning mechanism at play with rubbing associates with the centripetal redistribution of collagen fibers and extracellular matrix. In addition, it has been shown in normal patients that eye rubbing exerted for a duration such as 30 seconds increases the concentration of tear film collagenases. This may result in a synergistic corneal thinning process of enzymatic and mechanical nature.

We have shown using numerical simulations that for scaling reasons, parallel shape changes at the posterior and anterior corneal surfaces (similar levels of increased prolateness and steepening) induces a higher increase in the posterior float against its best fit sphere (BFS) than the anterior float against its own BFS. In addition to this scaling artifact, specific epithelial remodeling of the anterior distorted surface may also account for the false impression that KCN starts posteriorly. Again, I believe that the corneal deformation in early and mild cases of KCN is global and isometric (as there is no increase in surface area).

PCON: Obviously, trauma, including rubbing, fuels the progression of KCN. Do you believe it's the physical aspects of rubbing that induce change or is it that rubbing results in increased inflammatory mediators, which then ultimately lead to KCN progression?

Gatinel: Eye rubbing does not only fuel KCN progression, but it may be the prime hit in the pathway toward KCN. I believe that the physical aspects of rubbing and the trauma it inflicts on the cornea are the root mechanisms of KCN and, by the same token, I consider the alternative explanation, that KCN would trigger rubbing, invalid.

To support this statement, let us consider the natural clinical history of KCN and the sequence of events that patients report when properly questioned about their eye rubbing history. Eye rubbing always precedes the diagnosis of KCN, whether it is

caused by allergy or other factors, such as time spent on the computer, lack of good quality sleep, etc. In our experience at the Rothschild Foundation, the time that separates the onset of abnormal rubbing and the first visual manifestation of keratoconus (leading to its diagnosis using topography) takes about 2 to 3 years on average.

Dry eye results in increased local pruritic sensations leading to abnormal rubbing. In a significant number of cases, post-LASIK ectasia occurs not solely because of excessive thinning, but from the exertion of excessive rubbing on a thinned cornea.

Fortunately, not all eye rubbers will develop keratoconus. In my experience, it takes sustained and forceful rubbing episodes over an extended period of time to reach the threshold where the cornea buckles permanently and induces irregular astigmatism and increased myopia via central or paracentral steepening.

A simple analogy is this: After spending some time at the beach, not all sun bathers will get sunburn. Those who will often have intrinsic risk factors, such as light skin, or extrinsic risk factors, such as longer exposure time. However, getting sunburned absolutely requires some UV light exposure. Without this UV exposure, the risks of getting a sunburn is nil. Eye rubbing is to keratoconus what UV light is to sunburn.

PCON: Do you advocate some form of topical anti-inflammatory eye drop for all patients with KCN as a means to quell inflammation and discourage rubbing? If so, what agents?

Gatinel: Anti-inflammatory eye drops do play a role in quelling the urge to rub, but the clinician needs to take a broader view of eye rubbing prevention first.

Every newly diagnosed KCN patient should be thoroughly interviewed to identify the moments of the day when vigorous eye rubbing occurs and the factors that cause the ocular itch and subsequent chronic and excessive eye rubbing. Patients must be encouraged to change their sleeping positions if they tend to exert nocturnal compression on their eyes (stomach sleepers). These patients tend to rub their eyes upon awakening because the direct contact of the peri-ocular region with the linen may cause local irritation, contamination, heating, etc. In some cases, eye shields can be prescribed for night-time wear, both to protect the eye from direct compression and to assist the patient in changing their sleeping position.

In many patients, ocular rubbing is caused by contact lens discomfort. Some newly diagnosed KCN patients have confided to me that they would often massage their affected eye while wearing conventional soft contact lenses to cause some tearing and improve local comfort. Additionally, in my experience, there appears to be more

men (70%) than women (30%) affected with KC. Some women are reluctant to rub their eyes during the day because of their eye makeup, and this may have a protective effect.

Depending on each case, specific eye drops may be prescribed, including anti-allergy formulations, topical lubricants, etc. Finally, there are probably ways to relieve ocular itch via non- or less dangerous rubbing methods applied specifically on the eyelid margins or internal canthi, in which the eyeball is not exposed to any heavy duty grinding or rotary movements.

In all cases, after the first visit, the patient should be monitored after a few weeks to evaluate the effectiveness of the prescribed therapy on the eye rubbing. To make it clear, every therapeutic means that helps prevent the patient from rubbing their eyes must be attempted.

PCON: Even the best fit contact lens inevitably results in rubbing. Do you believe the new standard of care should be early intervention with corneal collagen cross-linking?

Gatinel: In line with my no rub, no cone conjecture, I believe that the new standard of care of patients with KCN should be first to re-orient them toward the prevention and cessation of rubbing. That is, instead of prescribing CXL right away, adopting a more insightful attitude and trying to understand the global clinical picture and the causes of eye rubbing. When doing so, it is often possible to elucidate why one eye is more affected than the other and link this to particular rubbing habits and preferential sleeping positions.

If our assumption that eye rubbing is responsible for the onset and evolution of the disease is correct, then the cessation of eye rubbing must, at least in the early and moderate forms, stop the progression of KCN. We have studied a large number of KCN patients monitored at our institution to evaluate the impact of eye rubbing on not only the disease genesis but also on its progression. So far, adult patients who completely stop rubbing their eyes have stopped their KCN progression. With an average follow-up of 2 years, complete cessation of eye rubbing has resulted in stabilization of the corneal deformation. This is a very encouraging finding for patients with KCN.

Furthermore, in our studies, KCN progression has only been observed in patients who admit to being unable to abandon their eye rubbing habit. This is strong indirect evidence that eye rubbing is the root cause of the KCN. We have made the documentation of each of these cases accessible through the following website: https://defeatkeratoconus.com/.

Keratoconus is a condition whose origin has long been unknown and hotly debated. Through our clinical interactions with thousands of KCN patients over the years, I strongly believe that the origin of KCN may be elucidated and that eye rubbing is the all-important causative factor for this disease.

Interestingly, this proposed conjecture is compatible with all clinical and experimental findings to date, but challenging long-held assumptions about this disease is difficult. Although the absence of rejection of this conjecture should not strictly warrant its proof, it is nevertheless a very strong argument in favor of it. – *Interview by Abigail Sutton*

Disclosure: Gatinel reported no relevant financial disclosures.

Editor's note: To read more about Gatinel, visit his website at www.gatinel.com .

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