In performing refractive surgery, we must always keep in mind that we are not only working on the cornea; we are also producing significant changes to the ocular surface.

The ocular surface is a complex system, consisting of eyelids, lacrimal and meibomian glands, tear film, and corneal and conjunctival epithelium, all of which operate in equilibrium to protect the eye and maintain visual acuity. The ocular surface has a limited capacity to respond to environmental factors that disrupt its function; if this capacity is exceeded due to the severity of an environmental challenge, a malfunction of any component of the ocular surface, or a combination of these factors, serious consequences can ensue.

**DRY EYE DISEASE**

Dry eye syndrome is an ocular surface disease that can affect virtually 100% of patients immediately following refractive surgery. In most patients, symptoms are short-lived; however, in some, dry eye symptoms persist and, in turn, can be associated with a worsened visual outcome and refractive regression. Dry eye symptoms of sufficient severity and persistence leading to patient dissatisfaction have been reported to occur in approximately 20% of patients after LASIK. As with cataract surgery, loss of corneal sensitivity appears to be involved. It is known that during LASIK the cornea is denervated, and a 50% decrease in the subbasal nerves may persist even 1 year postoperatively. Under such circumstances, reduced corneal sensation and reduced blink reflex can lead to a decrease in meibomian gland secretion and increased tear evaporation, which, in turn, will yield ocular surface damage and symptoms of dry eye disease.

**ANALYZING THE OCULAR SURFACE**

A number of studies have shown that the presence of dry eye before surgery is a predisposing factor for persistent dry eye problems after surgery and that effective treatment of dry eye pre- and postoperatively can reduce the severity and duration of symptoms. Therefore, the first and most important step before refractive surgery is to analyze the patient’s entire ocular surface for signs of dry eye. Schirmer testing should be performed to identify significant changes in tear secretion, particularly in patients who have worn contact lenses for prolonged periods of time and in those taking medications that reduce tear production, such as beta-blockers, antidepressants, and antihistamines. The lid margins should be observed at the slit lamp to exclude lid lag and to look for signs of inflammation (eg, telangiectasia), anterior blepharitis, or changes in the quantity and quality of the expressed meibum.

In some patients, meibomian gland dysfunction (MGD) is not obvious and is revealed only by digital or mechanical expression of the glands. The significance of lipid deficiency was illustrated in a study by Di Pascuale and colleagues.
who concluded that persistent dry eye after LASIK can be attributed not only to aqueous tear deficiency but also to previously unrecognized lipid tear deficiency. Fluorescein instillation is useful not only to measure tear break-up time and corneal staining but also to determine the rate of tear clearance, an important parameter of tear film functionality. Complete tear film turnover takes 16 to 20 minutes. Delayed tear clearance suggests depletion of ocular surface protective factors and accumulation of toxic and proinflammatory factors, which are certainly increased after refractive procedures and therefore responsible for chronic dry eye and corneal haze. The use of vital stains such as lissamine green is not common, but it is recommended to identify conjunctival epithelial damage that represents an early sign of dry eye (Figure 1).

It has been recently demonstrated that dry eye and MGD are characterized by inflammation and, in chronic cases, by an immunologic ocular surface response involving the conjunctiva and cornea (Figure 2). In vivo confocal microscopy of the cornea is recommended before refractive surgery in all eyes in which chronic ocular surface disease is suspected but without clinically evident signs, to determine the presence of antigen-presenting cells (Langerhans cells and macrophages) and changes in corneal nerves (Figure 3). Conjunctival inflammation can be evaluated by considering the degree of hyperemia; however, new techniques to quantify the expression of markers of inflammation on epithelial cells and the infiltration of immune cells into the tissue have been developed, and the hope is that their application in everyday practice will be possible in the near future.

**TREATMENT OPTIONS**

Treatments reported to be effective in improving the predictability of refractive surgery and reducing symptoms of dry eye include artificial tears, topical autologous serum, punctal occlusion, cyclosporine A 0.05% topical emulsion, and topical steroids. There are many artificial tears on the market, but only a few have been evaluated scientifically in clinical studies. These parameters should be considered when prescribing an artificial tear. Patients should also be advised to use artificial tears not only when they feel their eyes burning, but at specific times during the day in order to prevent the activation of the vicious cycle that determines dry eye.

**TAKE-HOME MESSAGE**

- Dry eye has been shown to be a common cause of dissatisfaction following LASIK.
- Effective pre- and postoperative treatment can reduce the severity and duration of symptoms and increase patient satisfaction.

Figure 1. Lissamine green stains damaged conjunctival epithelial cells, helping to diagnose dry eye. Staining should be performed before and after refractive surgery procedures.

Figure 2. Chronic meibomian gland disease alters the entire ocular surface system and can induce immunologic changes, with clinically evident signs on the lid margin and cornea.

Figure 3. In ocular surface diseases, activated keratocyte nuclei are characterized by increased hyperreflectivity and often demonstrate a dendritic shape.
Punctal plugs are important tools, but they should not be used if inflammation has not been controlled. Topical steroids are effective in reducing ocular surface inflammation. Cyclosporine is useful if T lymphocytes are involved in the inflammation, but it requires at least 3 months of treatment. A topical formulation of omega-3 fatty acid drops is promising to modulate inflammation by providing key factors for the tear film lipid layer.7

Blepharitis should be treated with lid hygiene and tetracycline antibiotics, following the guidelines provided by the International Workshop on Meibomian Gland Dysfunction.8

Several new antiinflammatory treatments developed specifically for ocular surface diseases, such as anti-interleukin-1, and new therapies for blepharitis are on the horizon.

CONCLUSION

Dry eye affects many patients undergoing refractive surgery and has been shown to be a common cause of dissatisfaction following LASIK. The presence of dry eye before surgery is a predisposing factor for persistent dry eye problems after surgery. Effective pre- and postoperative treatment can reduce the severity and duration of symptoms and increase patient satisfaction.

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