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Major review

Management of post-photorefractive keratectomy pain

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ABSTRACT

Photorefractive keratectomy (PRK) is a refractive procedure gaining popularity that eliminates the risk of ectasia and flap complications that can occur after laser in situ keratomileusis. Post-operative discomfort is a major drawback after PRK and thus the management of pain and discomfort following PRK is of great importance. We summarize corneal pain pathways and summarize current approaches to pain management after PRK.

1. Introduction

Photorefractive keratectomy (PRK) was the first type of refractive surgery approved by the U.S. Food and Drug Administration (FDA) in 1996. Although laser in situ keratomileusis (LASIK) has surpassed PRK as the most common refractive procedure performed worldwide,[16] PRK has begun to regain popularity as it is less destabilizing to the cornea than LASIK.[12] By reshaping the cornea without the creation of a stromal flap, PRK eliminates flap-related complications and avoids the risk of ectasia that may occur after LASIK.[43] PRK is the preferred technique in patients with epithelial basement membrane disease, thin, steep, or flat corneas, and those with a predisposition for contact injuries such as professional athletes.[1] In the United States Armed Forces, PRK is the most commonly performed refractive surgery procedure.[29,53,65]

One of the most important limitations of PRK is post-operative pain and discomfort, peaking about 24 hours after surgery.[42] The majority of patients experience significant discomfort after PRK, with most patients reporting a score of 8 or 9 on a 10-point pain scale.[A] Symptoms include foreign body sensation, light sensitivity, tearing, irritation, itching, and burning. This pain typically subsides within 72 hours after surgery, when repithelialization is complete.[11] Demographic factors such as age, sex, and race have not been found to be

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associated with the occurrence of pain after PRK.[A] We review pain management strategies after PRK.

2. Corneal pain pathways/mediators

The cornea is the most densely innervated tissue in the body. The majority (about 70%) of sensory afferent fibers are polymodal nociceptors activated by mechanical forces, exogenous chemical irritants, endogenously released chemical mediators, and extreme temperatures.[3] About 20% are pure mechano-receptors, responding only to noxious mechanical forces, and the remaining 10% are cold-sensitive receptors. Intense pain after PRK is attributable to enhanced spontaneous activity of injured nerve fibers.[22] PRK causes injury to the corneal sensory afferent nerves with release of pain-inducing inflammatory factors such as prostaglandins and neuropeptides.[20,56]

3. Techniques of epithelial removal

In PRK, the original technique of epithelial removal was mechanical, using a Paton spatula or blade. Other techniques of epithelial removal include an Amoils rotating plastic brush, dilute alcohol applied to the corneal epithelium, and laser transepithelial ablation.[27] Blake et al compared postoperative pain when the epithelium was removed with 18% ethanol versus a surgical blade and found those who underwent epithelial debridement with alcohol had more pain on postoperative day 1, but by postoperative day 3 these differences were not significant.[5]

Techniques to preserve the epithelium attempt to decrease postoperative pain. In 1998, Camellin described laser epithelial keratomileusis (LASEK), in which alcohol is used to loosen the epithelium, which is then retracted manually and replaced after excimer laser treatment.[9] Pallikaris described a modification of this procedure called epipolis-laser in situ keratomileusis (epi-LASIK) in which the corneal epithelium is separated using an instrument called an epikeratome and repositioned after stromal ablation.[52] If the epithelial flap is removed after stromal ablation, this is known as off-flap epi-LASIK.

The effect of epi-LASIK with removal of the epithelial flap versus preservation of the flap on postoperative pain and epithelial healing time is unclear. Kalyvianaki and et al compared epi-LASIK verus off-flap epi-LASIK and found subjective pain scores were lower at 2 hours following surgery in the off-flap epi-LASIK group, but not at 4, 6, 8, 10, or 24 hours, and epithelial healing times were similar between the two groups.[31] Wang found that postoperative pain was similar between epi-LASIK and off-flap epi-LASIK groups, but that off-flap LASIK led to more rapid reepithelialization.[72] In a recent double-masked, randomized study, Zhang et al found eyes treated with off-flap epi-LASIK had more discomfort at 2 hours postoperatively and on-flap eyes had more pain on postoperative day 5.[74] Those in the off-flap group also had a higher percentage of epithelial healing at day 5.

It is also unclear whether LASEK and epi-LASIK result in less postoperative pain than PRK, as results from studies conflict. In an early prospective study by Lee et al of 27 patients in which PRK was performed in one eye and LASEK in the other, LASEK-treated eyes had lower subjective pain scores.[36] In another prospective study by Litwak et al, however, patients who received PRK in one eye and LASEK in the other reported less discomfort in their PRK eye in the early postoperative period.[40] Saleh and 2 hours after laser surgery, but this difference was not statistically significant at 12, 24, and 48 hours.[59] Torres et al demonstrated patients who underwent epi-LASIK and PRK had similar pain on postoperative day 1, but those who underwent epi-LASIK had more on days 3 and 6.[67] In a recent paper, Magone et al demonstrated that patients who underwent off-flap epi-LASIK had decreased pain on days 1 to 4 following surgery compared with patients who underwent PRK with an automated brush. The difference in pain scores between the two groups was small, however (0.33 points on a scale of 0 to 6).[44]

Lee et al compared epithelial healing following epithelial removal with a blunt spatula, laser, and 20% dilute alcohol and found that the laser group had the fastest time to re-epithelialization and the dilute alcohol group had the fastest speed of epithelial healing. This did not, however, translate to less pain, as the pain scores on postoperative days 1 and 2 did not differ significantly for the three groups.[35]

4. Chilled balanced salt solution

Cold balanced salt solution (BSS) is thought to provide analgesia by blocking impulse conduction along the nerve fibers. Many surgeons apply chilled BSS after ablation and recommend the use of cool artificial tears. In one patient, Niizuma et al found that cooling the eye with cold BSS before and after PRK reduced pain and subepithelial haze.[50] At the American Society of Cataract and Refractive Surgery meeting, Larson reported patients pretreated with 40 to 50 drops of semifrozen BSS after epi-LASIK had significantly lower mean pain scores than those not treated.[B]

5. Bandage contact lens

After PRK, patients routinely wear a bandage contact lens (BCL) for 4–5 days to protect the deepithelialized stroma, allow faster re-epithelialization, and reduce pain. Although lenses with low oxygen permeability are most often utilized after refractive surgery, their use may lead to corneal edema and delay epithelialization.[30] The introduction of silicone hydrogel contact lenses, with oxygen transmissibility coefficients (Dk/t) five times higher than conventional hydrogel lenses, may offer advantages. Engle et al found that high-oxygen-permeable lenses led to faster corneal epithelialization (at 1–2 days) and reduced patient discomfort, although there was no statistically significant difference in epithelial defect size seen at 3 and 4 days.[19] Edwards et al found that patients wearing a low-oxygen-transmission lens (Proclear, Cooper Vision, New York), versus a high-oxygen-transmission bandage contact lens (Focus Night & Day, Ciba Vision, Georgia), had higher pain scores at day 1 and 4, but there was no statistically significant difference in reepithelialization.[17]