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OPTIMIZING PROPHYLACTIC STRATEGIES FOR POST-LASIK DRY EYE SYNDROME: A COMPREHENSIVE REVIEW

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Abstract. Laser-assisted in situ keratomileusis (LASIK) is a widely performed refractive surgery, but it can lead to postoperative Dry Eye Syndrome (DES), affecting patient satisfaction and visual outcomes. DES arises from factors such as corneal nerve disruption, tear film instability, and inflammation. This review explores the pathophysiology, risk factors, and advances in prophylactic strategies to mitigate post-LASIK DES. We examine preoperative assessments, intraoperative modifications, and postoperative management techniques that enhance patient comfort and reduce DES symptoms. Recent studies highlight the role of neurotrophic factors, anti-inflammatory agents, and novel surgical modifications in minimizing DES incidence. Additionally, advancements in tear film assessment and predictive biomarkers have improved the ability to identify high-risk patients and implement tailored interventions. This comprehensive review synthesizes the latest evidence to optimize prophylactic strategies for post-LASIK DES and offers practical recommendations for clinical application.

Key words: LASIK, DES, DED, tear film, corneal ablation, LLLT, IPL

Introduction

LASIK has revolutionized refractive surgery, offering millions of patients an effective alternative to corrective eyewear. Despite its high success rate, post-LASIK DES remains a significant complication that can impact visual recovery and patient satisfaction. This condition results from corneal nerve damage, tear film instability, and inflammatory responses triggered by the surgery¹.

Post-LASIK DES manifests as dryness, irritation, burning, and blurred vision, affecting overall patient experience and delaying visual recovery. Given its prevalence, optimizing prophylactic strategies is essential to improving post-surgical outcomes. This review explores interventions for preventing and managing DES after LASIK, emphasizing novel therapeutic approaches and evolving trends in preoperative and postoperative care².

Methods

In order to write this review article about the optimization of prophylactic methods for dry eye disease after LASIK operations on ametropic

patients, such as myopia, hypermetropia and astigmatism the data was taken from foreign internet databases such as PubMed, Scopus, Google Scholar and others.

Results

To begin with Pathophysiology of Post-LASIK Dry Eye Syndrome should be mentioned.

- Corneal Nerve Damage

LASIK involves creating a corneal flap, which disrupts the corneal nerve plexus responsible for tear regulation. This disruption leads to decreased tear secretion and reduced corneal sensitivity, resulting in impaired tear production and increased ocular dryness. Nerve regeneration can take months, prolonging tear film instability and delaying recovery³.

- Tear Film Instability

Surgical alterations affect the balance of the tear film's three layers (lipid, aqueous, and mucin), leading to increased tear evaporation and reduced lubrication. This instability contributes to common DES symptoms, such as discomfort, burning, and blurred vision⁴.

- Inflammatory Responses

Mechanical trauma from LASIK surgery triggers an inflammatory cascade, releasing pro-inflammatory cytokines and matrix metalloproteinases (MMPs). This exacerbates corneal epithelial damage, interferes with nerve regeneration, and perpetuates DES symptoms⁵.

Secondly, risk factors should be discussed. For example,

- Pre-existing Dry Eye Conditions

Patients with pre-existing dry eye disease (DED) are at a higher risk of developing post-LASIK DES. Proper preoperative management, including artificial tears and anti-inflammatory medications, can reduce postoperative complications⁶.

- High Myopia and Corneal Ablation Depth

Higher degrees of myopia require deeper corneal ablations, which can exacerbate nerve disruption and increase DES risk. Alternative refractive procedures, such as phakic intraocular lenses, may be more suitable for high-risk patients⁷.

- Gender and Hormonal Influences

Women, particularly those undergoing hormonal changes (e.g., menopause, oral contraceptive use), have a higher incidence of post-LASIK DES. Estrogen-related reductions in tear production contribute to increased dry eye symptoms in female patients⁸.

- Environmental and Lifestyle Factors

Extended screen exposure, dry climates, air conditioning, and smoking can worsen dry eye symptoms. Preoperative counseling on mitigating environmental and lifestyle risk factors can enhance post-LASIK recovery⁹.

Thirdly, it would be better to discuss points like

Preoperative Assessment and Preventive Measures

- Tear Film Assessment

Diagnostic tools such as the Schirmer test and Tear Breakup Time (TBUT) help assess tear production and stability. Ocular surface staining with fluorescein dye can identify pre-existing corneal damage¹⁰.

- Inflammatory Marker Detection

Testing for inflammatory markers like MMP-9 can identify patients at risk for severe post-LASIK DES. Preoperative anti-inflammatory treatments, including cyclosporine A, can help manage ocular inflammation¹¹.

- Optimizing Ocular Surface Health

Artificial tears, lipid-based formulations, and punctal occlusion can improve tear film stability. Preoperative interventions ensure optimal ocular surface conditions before LASIK¹².

- Nutritional Supplements

Omega-3 fatty acids have been shown to improve tear production and reduce inflammation. Preoperative supplementation may enhance postoperative tear film stability¹³.

Intraoperative Techniques to Minimize Dry Eye

- Femtosecond LASIK

Femtosecond laser technology creates precise corneal flaps with minimal nerve disruption, resulting in faster corneal nerve recovery and reduced DES symptoms¹⁴.

- Smaller Flaps and Customized Ablation Profiles

Smaller corneal flaps preserve more nerve fibers, maintaining tear production and reducing postoperative dry eye risk. Customized ablation profiles ensure corneal integrity and tear film stability¹⁵.

- Anti-inflammatory Strategies

Intraoperative use of mitomycin-C, corticosteroids, or NSAIDs can mitigate inflammation, promoting faster ocular surface healing and minimizing DES incidence¹⁶⁻¹⁸.

Postoperative Management Strategies

- Artificial Tears and Lubricants

Preservative-free artificial tears reduce irritation and enhance tear film stability. Hyaluronic acid and lipid-based formulations provide additional relief¹⁹.

- Anti-inflammatory Agents

Cyclosporine A and corticosteroids reduce inflammatory responses and improve tear production, offering significant benefits in post-LASIK DES management²⁰.

- Neurotrophic Factors and Serum Eye Drops

Nerve growth factors (NGFs) and autologous serum eye drops promote corneal nerve regeneration and support tear film stability²¹.

- Punctal Occlusion

Temporary or permanent punctal plugs help retain tears on the ocular surface, improving moisture retention and reducing dry eye symptoms²².

- Low-Level Light Therapy (LLLT) and Intense Pulsed Light (IPL)

Emerging therapies like LLLT and IPL enhance meibomian gland function, stabilize the tear film, and alleviate persistent DES symptoms²³.

Future Directions.

Advancements in regenerative medicine, neurostimulation, and gene therapy hold immense potential for the long-term prevention and treatment of post-LASIK dry eye syndrome (DES). Regenerative approaches, including stem cell therapy and biologically inspired tear substitutes, aim to restore damaged corneal nerves and improve tear film stability. Emerging neurostimulation techniques, such as transcutaneous electrical stimulation of the lacrimal gland, may offer non-invasive methods to enhance tear production and alleviate persistent dry eye symptoms.

Gene therapy represents another promising frontier, with ongoing research exploring genetic modifications to enhance ocular surface resilience and modulate inflammatory pathways associated with chronic DES. Additionally, novel biomaterials and drug delivery systems are being developed to provide sustained and targeted treatment, reducing the dependency on frequent artificial tear application.

Conclusion. Post-LASIK DES is a significant concern that requires proactive management. A combination of preoperative screening, surgical modifications, and targeted postoperative interventions can minimize DES incidence and improve visual outcomes and patient satisfaction.

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