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Impact of Tea Tree Oil on Dry Eye Syndrome After Photorefractive Keratectomy Laser Surgery

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Abstract

Background: The present study was conducted to investigate the effect of tea tree oil on Dry Eye Syndrome (DES) after Photorefractive Keratectomy (PRK) laser surgery.

Methods: This retrospective historical cohort study was conducted on 64 patients with complaints of DES after PRK surgery. The patients were classified as and assessed in two groups: (1) tea tree oil group who used antibiotic, steroid drop and tea tree oil shampoo, and (2) artificial tear group with antibiotic, steroid and artificial tear drops usage. The data of the study was obtained by the Ocular Surface Disease Index (OSDI) and the Standard Patient Evaluation of Eye Dryness Questionnaire (SPEED) questionnaires' scores on two occasions, one and three months after surgery in follow-up visits. Additionally, refraction, corrected distance visual acuity, Schirmer's and tear break-up time tests were recorded.

Results: The patients' mean age was 35.12±13.97 (range: 18-70 years), of whom 38 (59.4%) were female and 26 (40.6%) were male. The average score of the dry eye calculated from OSDI and SPEED questionnaires in patients treated with tea tree oil shampoo was significantly reduced compared with patients treated with artificial tear drop in three months after surgery (AR=0.136 and $p<0.05$). Furthermore, tear break-up time significantly increased in patients, indicating the improvement of DES. Schirmer's test and corneal staining with fluorescein did not improve significantly ($p<0.05$).

Conclusion: The use of tea tree oil shampoo can improve dry eye syndrome after photorefractive keratectomy laser surgery.

Keywords: Dry eye syndrome, Photorefractive keratectomy, Tea tree oil

Introduction

Nowadays, dry eye is one of the common complaints of patients visiting eye clinics. Dry Eye Syndrome (DES) causes symptoms such as burning, itching, tearing, photophobia and blurred vision. Ophthalmic surgeries like cataract and refractive surgery are among the most important risk factors causing DES. The prevalence of dry eye disease in Asia is higher than that in Europe and North America, demonstrating the importance of climate, cultural and racial factors in the etiology of disease (1). The prevalence of dry eye is between 5 and 50%, which increases with age and chronic comorbidities (2), so that it can affect up to 75% of adults over 40 years of age (3). However, only 2.7% of young adults between 18 and 45 years' experience dry eye (4).

DES occurs due to decreased tear production or increased evaporation of tears on the surface of the eye. As cornea has the largest number of nerves, the smallest change in the eye surface can cause annoying symptoms for the patient like burning, itching, feeling of a foreign body, and tearing, affecting the person's quality of life. Risk factors for DES are aging, chronic and autoimmune diseases, use of drugs reducing tear production, eye injuries, and eye surgeries such as cataract surgery and refractive surgery (5-7).

Trauma and eye surgeries such as cataract surgery and refractive surgeries are also common causes of dry eyes (8). Cataract is the most common cause of blindness in the world (9,10). Dry eye is one of the most common complications occurring after cataract surgery (11). Care after cataract surgery, including topical steroids and anti-glaucoma drugs, may also play a role in causing or aggravating dry eye (12,13). Refractive surgery is one of the most common surgeries in ophthalmology, and millions of people undergo this surgery annually. Refractive surgery is a known risk factor for dry eye after Laser-Assisted in situ Keratomileusis (LASIK) and Photorefractive Keratectomy (PRK) surgery. Disturbance in the functional units of the lacrimal glands on the surface of the eye is associated with dry eyes in such patients. Furthermore, damage to the corneal afferent nerves during surgery causes the interruption of the nerve feedback secreting tears (14). Dry eye is one of the most common side effects after this procedure. Epidemiological information about dry eye after photorefractive surgery is limited. According to the data provided by DEWS (Dry Eye Workshop) in 2007, the prevalence of dry eye after LASIK surgery in patients without a previous history of dry eye is estimated from 0.25 to 48% (15).

Dry eye following photorefractive surgery is usually temporary; however, in some patients, it can become chronic dry eye. In a 2015 study in the United States, after 12 months of surgery, 5% of the patients who underwent PRK and 0.8% of the patients who underwent LASIK developed chronic dry eye. According to the studies conducted, the surgical method, the individual characteristics of the patient, the amount of correction of refractive errors, and the history of dry eye in the patient can be effective in causing chronic dry eye after surgery (16). Dry eye is classified as three categories based on symptoms and clinical examination: mild, moderate and severe, and the treatment of patients should be performed according to the severity of the disease and individual characteristics. According to the Tear Film Ocular Society, step therapy approach modification is used in the treatment of dry eye. The first step in the treatment of dry eye emphasizes patient education, including improvement of the environmental condition, optimization of the nutritional status, removal of aggravating drugs, and health education. If these strategies do not respond, preservative free artificial tears and specific glasses can be used. In cases of treatment-resistant dry eye, amniotic membrane transplantation, long-term local corticosteroid, and surgical punctal closure are used (17).

Tea Tree Oil (TTO), which is steam extracted from tea tree leaves, has been utilized for hundreds of years in Australia and now is available worldwide. TTO is a common compound used in numerous cosmetic and beauty products such as shampoos, massage oils, creams and detergent solutions (18). This oil has antimicrobial, anti-inflammatory and antifungal properties. Several studies have investigated the effect of this oil on treating dry eyes and improving the symptoms of meibomian gland disorders, particularly disorders caused by Demodex mites. It is reminded that it can be associated with greater satisfaction of patients after the operation (16). The main aim of this study was to investigate the effect of tea tree oil on dry eye after laser photorefractive keratectomy

(PRK) objectively and subjectively in patients.

Materials and Methods

This was a retrospective cohort study conducted on 64 patients with complaints of dry eye symptoms, including burning, tearing and photophobia one month after PRK surgery. This research was approved by the Ethics Committee of Alborz University of Medical Sciences, Karaj, Iran, and then conducted according to the Declaration of Helsinki. Thirty-four patients were treated with tea tree oil 2% (Argusol shampoo, Kimia Kala Razi Pharmaceutical Co., Tehran, Iran) twice daily, in the morning and at night, antibiotic drop (Chloramphenicol 0.5%, Sinadarou Co., Tehran, Iran) every 6 hours, steroid drop (Betamethasone 0.1%, Sinadarou Co., Tehran, Iran) every 6 hours, whilst the other thirty patients received artificial tear drop (Artipic Advanced, 0.15%, Iran Injection and Pharmaceutical Products Company, Tehran, Iran) every 6 hours, antibiotic and steroid drop every 6 hours without tea tree oil shampoo after epithelial defect healing till three months after surgery except chloramphenicol eye drop which discontinued one week post-op in both groups. The patients' information was completed by the patients using a questionnaire on two occasions, one and three months after surgery. The demographic information questionnaire consisted of the patients' age, sex, and medical records such as history of dry eye before surgery, history of systemic diseases, history of taking drugs effective on dry eye syndrome, history of eye surgery, and eye trauma. In addition, two questionnaires were filled out for the patients to evaluate the symptoms and severity of dry eye using Ocular Surface Disease Index (OSDI) and Standard Patient Evaluation of Eye Dryness Questionnaire (SPEED) questionnaires.

The Ocular Surface Disease Index (OSDI; Allergan Inc., Irvine, CA) (19) is one of the most frequently used instruments to assess dry eye disease's symptoms severity. This questionnaire is comprised of 12 questions and evaluates the frequency of symptoms over the preceding week. The questionnaire requires approximately 5 minutes for the patient to complete, and the scores range from 0 to 100. Based on the score, the patients' symptoms can be categorized as normal (0–12), mild dry eye (13–22), moderate dry eye (23–32), or severe dry eye (33–100) (20).

SPEED is a 20-item questionnaire developed in 2005 to assess the severity and changes in the subjective symptoms experienced over time by patients with dry eye disease (21).

The results of the examinations performed by slit lamp, Tear film Breakup Time (TBUT), corneal staining areas and Schirmer's test were recorded for all the patients separately.

Inclusion criteria

Patients complaining of dry eye symptoms like burning, tearing and photophobia after epithelial healing time on the 3rd to 5th day after PRK surgery, who were between 18 and 70 years old, OSDI score more than 13, TBUT less than ten seconds, Schirmer's test without anesthesia less than ten millimeters, and moderate to severe corneal staining were included.

Exclusion criteria

Patients with symptoms of dry eye before surgery, meibomian gland dysfunction with symptoms of blepharitis, epithelial defects, history of trauma, uveitis, Sjogren's syndrome, trachoma, history of previous eye surgery, contact lens use, collagen vascular disease and systemic disorders causing dryness, and history of drugs causing dry eye syndrome were excluded.

Sample size

Sampling was simple random and the sample size is based on similar studies (22) and the prevalence of dry eye after PRK (4.3%) and considering the confidence interval of 95% and the p- vale ≤ 0.05, using the formula to determine the sample size. It was estimated that 64 people were enrolled.

Data analysis

SPSS version 22 (IBM Corp., Armonk, New York, USA) software was used for the statistical analysis of the study data. Descriptive results presented as mean ± SD. Based on Kolmogorov–Smirnov test, the data had normal distribution, except for OSDI data. Thus, the quantitative variables were compared with each other using the independent samples t-test and the comparison between the qualitative variables was performed using the Chi-square test. For OSDI data comparing, Wilcoxon non parametric statistical test

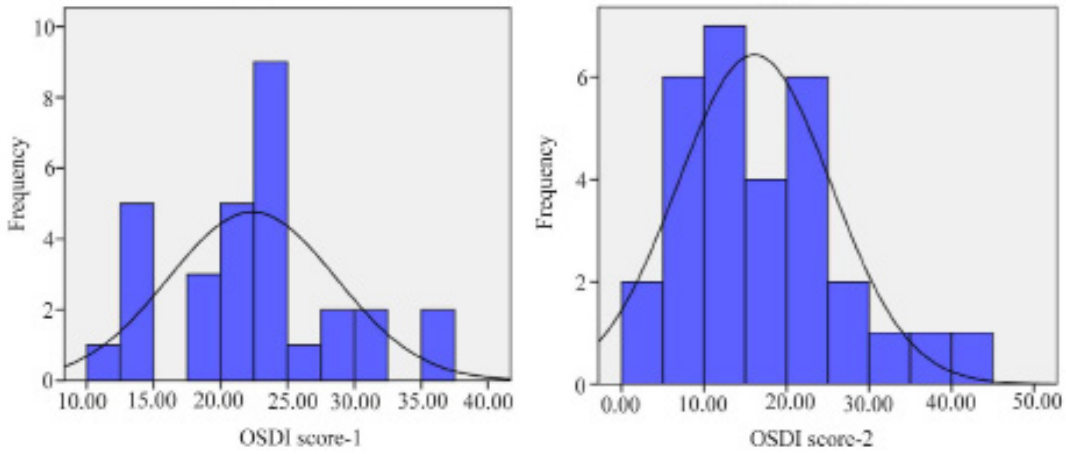

Figure 1. Diagram shows OSDI score distribution in the patients before and after tea tree oil.

was administered. Moreover, the two quantitative and qualitative variables were compared with each other using the t-test. Rank correlation was checked. The significance level of the data was considered to be 0.05.

Results

In this research, 128 eyes of 64 patients who complained of dry eye after PRK surgery were included in the study. The average age of the subjects was 35.12±13.97, and they were in the age range of 18-70 years. Of the people who entered the study, 26 (40.6%) were male, and 38 (59.4%) were female. A total of 34 patients (53.1%) were treated with tea tree oil shampoo, and 30 patients (46.9%) were treated with artificial tear drops.

The average age of patients treated with tea tree oil was 36.44±16.04, and the average age of patients treated with artificial tears was 33.63±11.27. The average Schirmer's test in tea tree oil users decreased, which means a decrease in tear production after three months; however, this finding was not significant (p=0.925). The average of this test also increased in artificial tear users, which means an increase in tear production; however, this finding was not significant (p=0.143). The average TBUT increased in tea oil users and was significant (p=0.001), which means an improvement in dry eye condition; however, this increase was not significant in the non-exposure group (p=0.212). The result of corneal staining with fluorescein was not significant in both groups.

Two histograms show the distribution of the OSDI score of patients treated with tea tree oil in the first and second visits. As the graph depicts, in the first visit, most of the patients were in the range of severe dry eyes (scores 33 and above) and in the second graph, the condition of dry eyes improved, and most of the patients were in the range of mild-to-moderate dry eyes (scores 13-32) (Figure 1).

Owing to the dispersion in the OSDI scores, a comparison of the median OSDI score was also performed; therefore, the median OSDI scores before and after consuming tea tree oil were 32.45 and 18.90, as well as 21.95 and 14.55 before and after consuming artificial tears, respectively, indicating the improvement of the condition of dry eyes in both categories.

Discussion

The results of this study represented that the patients had significant improvements in dry eye symptoms after three months of tea tree oil shampoo use; this improvement was determined as a decrease in the score calculated through two usual dry eye questionnaires: OSDI and SPEED. The average score of these two questionnaires showed a significant decrease ($p<0.05$) after three months of surgery in both patients treated with tea tree oil and in the use of artificial tears, but in patients treated with tea tree oil, the reduction was greater, AR=-0.136 and $p<0.05$). In the comparison of three variables of tear break up time, Schirmer's test and corneal staining with fluorescein in two groups, only the tear break-up time increased significantly ($p<0.05$), demonstrating the

improvement of dry eye conditions.

The current study showed that tea tree oil could effectively reduce the symptoms of dry eye syndrome supposedly by two possible mechanisms: (1) direct mechanism in which tea tree oil optimizes the ocular surface and reduction of tear film evaporation leads to controlling the dry eye symptoms and signs, and (2) indirect mechanism in which anti-inflammatory and anti-microbial effects of tea tree oil can improve blepharitis and eventually decrease dry eye syndrome. Nevertheless, more studies are needed to evaluate the effectiveness, potential toxicity, and the optimal dose of tea tree oil in the treatment of dry eye syndrome.

Woreta *et al* investigated the manifestations, prevalence and predictive factors of chronic dry eye after PRK surgery (23). This study was a prospective, non-randomized clinical trial conducted in the United States. In this study, 143 patients with myopia underwent LASIK or PRK surgery. The average age of the patients was 29.9±5.2, and out of 143 patients, 73 patients underwent PRK (34 men and 39 women), and 70 patients underwent LASIK (35 men and 35 women). The results of this study showed that the Schirmer's test with anesthesia changed considerably in PRK patients ($p<0.05$); however, there was no change in LASIK patients. This change was in the form of a decrease in the Schirmer's test score, which was observed only in the 1st and 3rd month. This change in the first month is similar to our study, since as it was stated, the Schirmer's test score decreased in our study; however, this decrease was not significant (16). Contrary to the Schirmer's test, TBUT did not change in patients undergoing PRK; however, in months 1, 3 and 12 after LASIK, it was much faster than before. This finding is similar to the TBUT test results in the non-exposed group in our study but contrary to those results. This test increased and was significant in the exposure group ($p<0.05$). Statistically, a significant change was observed in the Rose Bengal staining score after both surgeries. This variable was high only after 3 months of PRK; however, it was reported high in all cases after LASIK. In our study, rather than using Rose Bengal, Fluorescein was used in cornea staining; however, no significant changes were observed in the exposure group or in the control group after one month. Symptoms of dry eye after surgery occurred as a significant change in the McMonnies score, and this score after the surgery was clearly higher than before the surgery (p value<0.05). In our study, dry eye symptoms improved in both groups. After three months, it was observed based on the OSDI and SPEED questionnaire.

Mohammadpour *et al* investigated the effect of tea tree oil on eye dryness after cataract surgery (24). The study was a prospective triple-blinded randomized clinical trial conducted in the Cataract Clinic of the Farabi Hospital in Tehran, Iran. Sixty-two patients (49 women and 13 men) participated in this study, 33 patients were in treatment group, and 29 patients were in control group with an average age of 668±. In this study, the treatment group received eye shampoo containing tea tree oil, and the control group was treated with eye shampoo without tea tree oil. The results of this study indicated that the improvement of five variables, including CDVA, UDCVA, TBUT, OSDI and osmolarity were significant in both case and control groups ($p<0.05$). OSDI was similar to our study. But regarding TBUT in our study, it was significant only in the exposure group. Schirmer's test was non-significant in both control and treatment groups. These results are similar to the results of our study, being non-significant in both exposed and non-exposed groups. The improvement of the Demodex condition was significant only in the treatment group.

Zarei *et al* compared the effect of shampoo containing tea tree oil with normal shampoo on the treatment of meibomian gland disorders (25). Forty patients, 23 males and 17 females, with meibomian gland dysfunction participated in this study, and their average age ranged from 18 to 70 years. Each patient was given two solutions: eye shampoo containing TTO Eyesol® shampoo and Johnson's baby shampoo; both shampoos were without names just with the letters A or B, placed in a package, in which the patients randomly used each of the shampoos for each eye. Based on the random sampling method, the patients were visited and re-examined before the treatment and after 1 and 3 months. In this study, a total of 12 variables, including DEQ, plugging, capping, foamy tear, glandular secretion, meibum quality, Oxford staining, TBUT, and Schirmer's test, investigated in this study were significantly improved in both groups ($P<0.05$); however, trichiasis and distichiasis did not

improve in any group, and telangiectasia improved only in the treatment group. Unlike this study, TBUT was not significant, and other variables that were examined in this study were not examined in our study.

Shoja *et al* investigated the prevalence and risk factors of dry eye after myopic LASIK (22). A total of 190 patients with a mean average age of 31±8 years, who were subject to LASIK surgery with no symptoms of dry eye before the operation, participated in this retrospective study. The evaluations conducted on these patients included examination of dry eye complaints, TBUT, corneal staining, corneal sensitivity test, and Schirmer's test. They were examined after 1, 3, and 6 months later. The surgical method in this study was LASIK, while in our study, the surgery was PRK. Moreover, 20% of the patients (38 patients) suffered from dry eyes 6 months after the surgery compared to before the operation ($p<0.05$). The stability of the tear film decreased in all post-operative times compared to patients without dry eye, tear production in patients with dry eye decreased in 1, 3 and 6 months after LASIK, and Schirmer's test change was not significant ($p>0.05$) for tear production increased on the first day, but significantly decreased after 1 week and 3 months. But baseline secretion has decreased in months 1 and 3. Staining with fluorescein after the operation was more than before the operation, and the sensitivity of the cornea decreased sharply immediately after the operation; however, it returned to the pre-operation level within 6 months. Risk factors affecting dry eye after LASIK were female patients, older age, and greater depth of ablation. In our study, similar to this study, the Schirmer's test increased; however, this increase was observed after three months of surgery and was not significant. But in this study, dry eye increase was observed after one day of surgery and was not significant, but after 1 week and 3 months after surgery, it decreased. On the contrary, the staining of the cornea after the operation was not significant in our study.

In one systematic review and meta-analysis, Savla *et al* demonstrated the existence of uncertainty regarding the effectiveness of 5 to 50% tea tree oil for the short-term treatment of Demodex blepharitis. However, if used, lower concentrations may be preferred in the eye care to avoid induced eye irritation. It was suggested that future studies should be conducted to evaluate long-term outcomes and to study the effects of different concentrations of tea tree oil (26).

Koo *et al* in their study indicated that in people with Demodex mites, the most common accompanying symptom was dry eyes, which was found in 74.7% of the patients (27). Thus, a strong relationship is observed between the severity of symptoms and the level of Demodex contamination, and the reduction in the number of Demodex mites is associated with the improvement of eye problems.

Conclusion

The findings of this study demonstrated the greater improvement of dry eye syndrome after using tea tree oil shampoo. Our study revealed the improvement of dry eye based on the score calculated from two questionnaires of OSDI and SPEED, while the basic tear evaluation tests, including Schirmer's test, tear break-up time, and corneal staining improvement, were not significant in our study. Due to our study limitations, a more powerful study with randomized clinical trial design and larger sample size is suggested. The tea tree oil shampoo could be used after photorefractive keratectomy laser surgery to improve dry eye syndrome symptoms.

Conflict of Interest

The authors have no competing interests to report.

Ethical considerations

The present study was approved by the ethics committee of Alborz University of Medical Sciences (IR.ABZUMS.Rec.1400.014) and is in accordance with the Declaration Institutional of Helsinki.

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