

Excimer Laser Photorefractive Keratectomy

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It is thought that one-fourth of the world's population is myopic. Therefore, refractive surgery has been a big market in the past ten years and today. The most common two techniques in this area are radial keratotomy and excimer laser photorefractive keratectomy (PRK). Excimer PRK has been accepted as an effective and safe surgery for correction of low to moderate myopia and astigmatism. In this technique, corneal tissue is removed with a high degree of predictability with virtually no damage to adjacent areas. [Journal of Turgut Özal Medical Center 1996;3(4):382-385]

Key Words: Excimer laser, myopia, refractive surgery

“Excimer” lazer fotorefraktif keratektomi

Dünya nüfusunun 1/4'nün miyop olduğu düşünülmektedir. Bundan dolayı refraktif cerrahi geçen 10 sene içerisinde ve günümüzde büyük bir market halini aldı. Bu alandaki en yaygın iki teknik radial keratotomi ve excimer lazer fotorefraktif keratektomidir (PRK). Excimer PRK düşük ve orta dereceli miyopi ve astigmatizm tedavisinde güvenli ve etkili olarak kabul edilmektedir. Bu teknikte bitişik dokulara zarar vermeksizin oldukça yüksek tahmin edilebilirlik içerisinde korneal doku çıkarılmaktadır. [Turgut Özal Tıp Merkezi Dergisi 1996;3(4):382-385]

Anahtar Kelimeler: Excimer lazer, miyopi, refraktif cerrahi

Excimer laser photorefractive keratectomy (PRK) is a new refractive technique for the treatment of low to moderate myopia, low hyperopia, and astigmatism. Excimer is a contraction of the words; **excited** and **dimers** (1). The purpose of this procedure is to flatten or steepen central corneal curvature to correct myopia or hyperopia and corneal astigmatism by direct photoablation with 193 nm argon fluoride excimer laser. Especially myopic PRK has a widespread usage in this area.

First studies concerning the laser system were made by Trokel et al.(2) in 1983 who succeed central ablation in bovine eyes using the argon fluoride excimer laser. In 1984, Serdarevic et al.

were used this laser system in rabbit corneas (3). After that L'Esperance (4) (1987) and Taylor (5) (1988) were performed separately the first PRK studies on humans eyes with the Taunton technology. First results of blind and sighted human eyes were then reported by Seiler in 1988 and in 1990 (6). In PRK, attempted tissue from Bowman's membrane and the stroma on the visual axis was removed by producing local heating to alter the corneal curvature. In this procedure, no or minimal damage occurs to adjacent or underlying tissue. To date many papers regarding the excimer laser procedure have been published with long term follow up with high accuracy and low side effects in low to moderate myopia (7,8).

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DEVICE

The most common two machines used in excimer laser PRK are Summit (Waltham, Mass), and VisX Twenty/Twenty (Sunnyvale, Calif). Other machines than Summit and VisX are Aesculap-Meditech GmbH (Heroldsberg, Germany), Technolas Keracor 116 (Chiron Vision, Irvine, Calif), and Nidek EC-5000 (Gamagori, Alchie, Japan). Recently, third-generation mini-excimer laser was developed by LaserSight, Inc., which is about one-tenth size of the Summit and VisX machines. LaserSight has got allow for Phase 2a trial by FDA (9). On the other hand, it is being used in many country including Turkey. Mini-excimer's use a 1-mm-scanning beam. Summit's first laser was the ExciMed UV200. The company then developed OmniMed and finally the second generation OmniMed II. The Summit technology received FDA approval for phototherapeutic (PTK) in March 1995, for PRK on 20 October 1995. The cover of approvement is -1.5 D to -7.0 D of myopia using a 6-mm ablation zone (10). VisX technology also received approval for PTK in October 1995 and for PRK in early 1996. The approval of VisX in PRK is valid -1.0 D to -6.0 D of myopia using a 6-mm ablation zone, less than 1.0 D of astigmatism, and in patients 18 years or older (11). VisX 20/20 was replaced by a new Star model that is more sophisticated and preferred by users. Other two machines Nidek and Technolas have joystick system that is very useful for phototherapeutic keratectomy (PTK). The machine prices are changing between 400.000 and 600.000 dollars. The cost of excimer laser PRK to patient is 2000 dollars in USA and about 400 to 500 dollars in our country.

COMPARISON OF DEVICES

There are advantages and disadvantages of machines to each other. The Summit laser has a higher energy level. On the other hand VisX has a flatter profile (homogeneous beam) distributing energy more smoothly. Homogeneous beam might be the risk of cause central islands. The VisX laser is a huge machine and uses a lot of gas, while same risk of central islands for Summit laser is low. Likewise, nitrogen blow used in VisX is most likely to central island. Now, nitrogen blow is no longer used in any laser systems (12). Moreover, the rate of

central island formation is also high in Technolas Keracor and Nidek laser systems. Summit system has also easier data entry, takes less time because of repetition rate of 10 Hz, and a more controlled foot control. The VisX laser has more complete data entry, better microscope view, and the advantage of astigmatism correction. The most striking differences the Summit laser and VisX are high postoperative hyperopia and regression in Summit, and high irregular astigmatism in VisX.

DELIVERY SYSTEM

Entire functions of laser systems are controlled by equipped software program that can mounted coaxially the surgical microscope. The an other important controller is an internal microprocessor. Gases and cooling water were obtained from external sources, sensors monitor temperature (1). Gas pressure, coolant flow, gas replenish are all controlled by automatically. The beam system is not homogeneous that is brought to homogenize by delivery instrument. Homogeneous beam causes stable refraction but also increases the change of central islands. A beam delivery instrument has formed the ablation of intended amounts of tissue from Bowman's and stromal layer. The function of beam delivery system is send the laser beam on the cornea that is approximately 11x22 dimensions. The focus of the beam onto the cornea is obtained by a lens to get selective tissue ablation (13). The ablation effect begin after 12 mJ/cm² and stabilize at 120 mJ/cm². There are some terms in respect to laser system such as fluence and homogeneity. Fluence is energy distributed, homogeneity is pattern of energy.

TECHNIQUE

A lid speculum is inserted in the eye to obtain enough expose cornea. Topical anesthetic drop is instilled on the cornea. About 7-mm optical zone is marked to epithelial removal that can be made by mechanical using the blunt spatula or by transepithelial ablation using the laser. Then the patient is asked to look at the laser spot light (HeNe laser beam) to get foveal fixation. The ablation area is centered using this HeNe two beams on the cornea. Recently eye tracker device was developed

by Chiron Technolas that is mounted to the laser's optical delivery system. This tracker locks to the patients central axis during the procedure (14). Therefore, there is no problem patients involuntary or normal saccadic eye movement any longer. Then photoablation is performed at a wavelength of 193 nm argon-flouride excimer laser. After the procedure the central corneal epithelium regenerates over stroma. Following surgery, Voltaren or contact lenses are given to reduce pain, then steroid drop (preferentially fluoromethalon) is started for about 3 months. This is classical single zone technique. A single zone technique with a large ablation zone is one of the reasons of the central islands. New approach is a multizone technique to eliminate some complications such as central islands, glare, haze, and regression. In this technique, smoothing effect is obtained because of blend action in each ablation, while a single zone technique is occurred steeped cut.

Second eye treatment may be performed at the same time or whenever the first one is reached to enough vision (15).

RESULTS AND COMPLICATIONS

The results of excimer laser PRK is highly effective in low to moderate myopia (up to -6.0 diopters (D)). In high myopia (after -6.0 D) the risk of regression, haze, and unpredictability is increased (16). Retreatment rate is about %10-15. Retreatment is used in undercorrection, serious reticular haze and central islands (17). Excimer laser PRK has some complications such as central islands formation, glare, regression, haze, and irregular astigmatism. The reasons of central island formation are single zone technique, large optical zone, high myopia, flatter beams, and moisten cornea peroperatively. On the other hand moisten cornea is declined postoperative haze. Central island is taken place about %13 of patients at the first months postoperatively and then decreased to %1 at the end of 1 year. Laser pulses produce acoustic shock waves that cause stromal fluid accumulation. The stromal accumulation precludes to pulses centrally, so central cornea stays steep termed central islands that prevent visual acuity. Glare discomfort from light is arise from especially small optical zone. A regression effect is occurred particularly in correction of high myopia patients. Haze formation

is seen almost after all cases but this is not reached to serious levels (Grade 4 +) and resolve within 1 year mostly. If grade 4+ reticular haze comes accross, retreatment is required. Clinical haze is almost together with regression, but all regression is not always together with haze.

Finally, excimer laser photorefractive surgery is a very effective and safe method in the treatment of low to moderate myopia. After -6.0 D, the accuracy and predictability of this technique are declined and also carried the risk of some complications.

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