

## Unilateral Keratectasia Treated with Femtosecond Fashioned Intrastromal Corneal Inlay

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### Abstract

**Purpose:** In this case report, we describe the surgical procedure of corneal inlay preparation and corneal pocket creation using a femtosecond laser system.

**Case Report:** A 7-year-old girl who presented with unilateral paracentral corneal thinning underwent the surgical procedure of corneal inlay. Preoperatively, the refraction was +10.00-6.00 × 170. One month after the procedure, astigmatism and hyperopia were decreased and the refraction was +5.00-1.25 × 110.

**Conclusion:** Femtosecond laser-assisted pocket creation for the implantation of corneal inlays offers accuracy of pocket parameters, enhancing predictability, resulting in better final outcomes, and improving the safety of the procedure.

**Keywords:** Femtosecond Laser; Keratectasia; Intrastromalcornea Graft

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### INTRODUCTION

Corneal ectasia represents a group of disorders characterized by an inherent corneal weakness, leading to protrusion and irregular astigmatism resulting in loss of visual acuity, and rarely, perforation. These disorders comprise both primary conditions and secondary or iatrogenic corneal ectasia, which may occur after refractive procedures such as laser in-situ keratomileusis (LASIK) and affect a significant number of people.<sup>[1]</sup>

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Two approaches for corneal ectasia management include restoration of vision by optical means to obviate irregular astigmatism, and correction or restoration of tectonic corneal integrity by interventional means. Various treatments have recently emerged, which include methods to increase corneal rigidity, such as collagen cross-linking and the use of intrastromal implants to augment weakened areas of the cornea and reduce astigmatism.

Several human and animal studies have reported the safety and efficacy of inlay procedures to strengthen the cornea. McCarey et al<sup>[2]</sup> implanted hydrogel intracorneal lenses (lidofilcon A and lidofilcon B; Allergan Medical Optics, Irvine, CA, USA) into the eyes of rhesus monkeys and reported successful results up to 2 years after implantation.

Ismail,<sup>[3]</sup> Sweeney et al,<sup>[4]</sup> and Xie et al<sup>[5]</sup> studied the safety and efficacy of intracorneal lenses in rabbit

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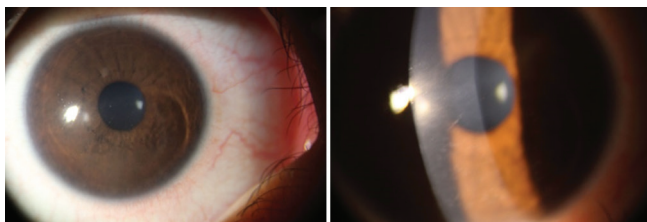
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eyes and reported excellent biocompatibility. Sweeney et al<sup>[4]</sup> extended this finding to human eyes. Other human studies evaluated visual outcomes of corneal inlay implantation for correction of hyperopia.<sup>[6,7]</sup> Conversely, other human studies reported the limitations of this procedure, including significant visual loss and scarring,<sup>[8]</sup> complications such as intrastromal epithelial opacification,<sup>[9]</sup> and poor visual and refractive outcomes.<sup>[10]</sup>

The implantation of corneal inlays for presbyopia or hyperopia has been described using pockets created by mechanical microkeratomes<sup>[11,12]</sup> or femtosecond lasers.<sup>[13,14]</sup> We describe corneal inlay implantation in a femtosecond laser-assisted intrastromal pocket for treatment of high astigmatism and hyperopia in a 7-year-old girl who presented with unilateral paracentral corneal thinning.

## CASE REPORT

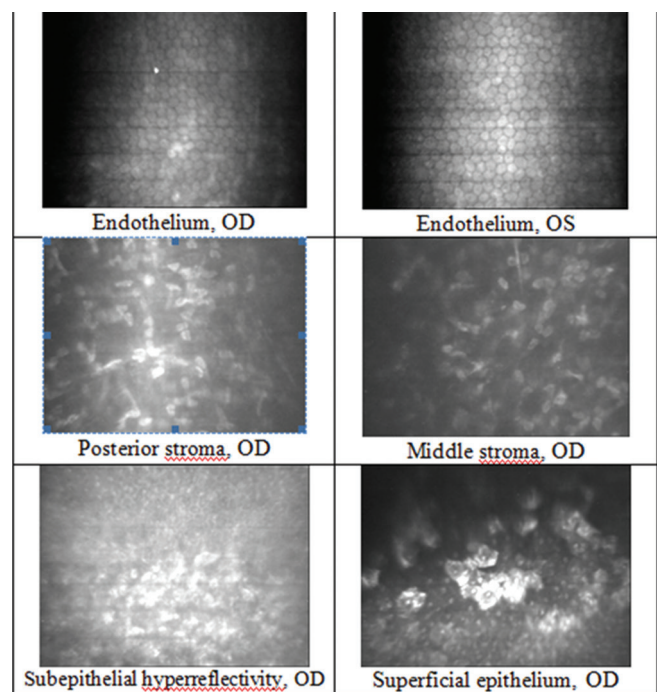
A 7-year-old girl presented with low vision in both eyes; best corrected visual acuity was 1/10 and 2/10 in the right and left eyes, respectively. Refraction was +10.00-6.00 × 170 and +8.00-2.75 × 180 in the right and left eyes, respectively. Slit lamp examination revealed unilateral paracentral corneal thinning and mild subepithelial haze [Figure 1]. A confocal scan revealed the epithelium and endothelium to be unremarkable; mid-stromal nerves were visible, but the subepithelial nerve plexus was not. In the confocal scan, corneal thickness at the involved area of the right eye was 461 μm, and 522 μm at the center of the left cornea. Endothelial cell density was 3,765 cell/mm<sup>2</sup> with a mean cell area of 265 μm<sup>2</sup> in the right eye and 3,393 cell/mm<sup>2</sup> with a mean cell area of 294 μm<sup>2</sup> in the left cornea. Non-inflammatory stromal thinning with increased anterior stromal involvement was observed [Figure 2]. A Pentacam (WaveLight Allegro Oculyzer™, WaveLight AG, Erlangen, Germany) showed an asymmetric bowtie pattern with superior steepening and with-the-rule astigmatism. Steepening of the anterior cornea curvature in favor of keratectasia was observed [Figure 3]. The anterior segment was normal, as confirmed by Visante™ OCT (Optical coherence tomography, Carl Zeiss Meditec, Germany) [Figure 4]. Ocular response



**Figure 1.** Slit lamp photograph of the right eye, diffuse illumination (right) and slit illumination (left) showing a disc of cornea thinning located in the paracentral and inferior cornea.

analysis (ORA) was performed repeatedly, with no remarkable result.

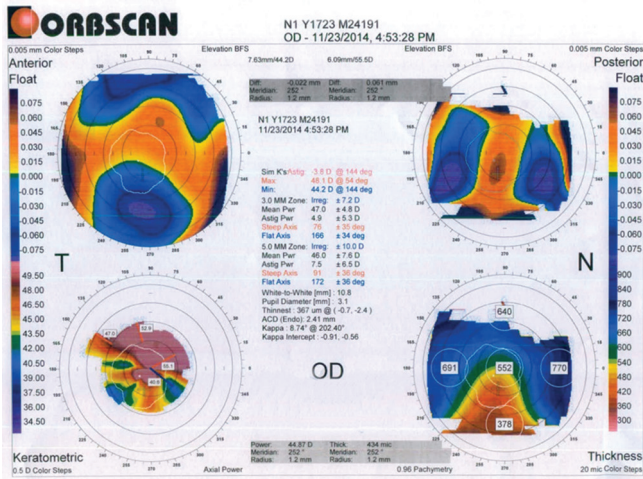
The surgical procedure was performed under general anesthesia. Donor cornea preparation was performed using a femtosecond laser system (FEMTO LDV Da Vinci™, Ziemer Ophthalmic Systems AG, Port, Switzerland). First, a whole globe was fixed in an artificial chamber, and pressure was increased to approximately 60 mmHg, as measured using a sterile Tonopen (Applanation Tonometer, Reichert, Inc. USA). The epithelium was removed and an 8.00-mm suction ring was inserted. The laser wavelength, pulse width, and spot size were 1,045 ± 10 nm, 250 fs ± 10%, and <2 μm with overlapping, respectively. Maximum pulse energy and pulse rate were 45 ± 5 nJ and 20.9 MHz, respectively. Donor thickness and diameter were 200 μm and 8.00 mm, respectively [Figure 5]. A normal cornea has a thickness of 540 μm and a thinnest point of 340 μm; the difference between these values was used for donor preparation. The inlay was removed from the remaining stroma using a special separator. A pocket was created in the recipient's cornea at a 150-μm depth with a diameter of 9.50 mm in the same way, with no manipulation of the epithelium. The diameter of the suction ring was 9.50 mm. The pocket was opened in the direction of the 2.00-mm incision using a special separator [Figure 6]. The anterior side-cut segment was placed on the steep meridian (80°). The inlay was inserted manually into the pocket and unfolded. A soft bandage contact lens was inserted, and was removed the next day. Laser parameters are shown in Table 1.



**Figure 2.** Confocal scan image of the right eye (left) and left eye (right) reveals normal endothelium (shape, size).







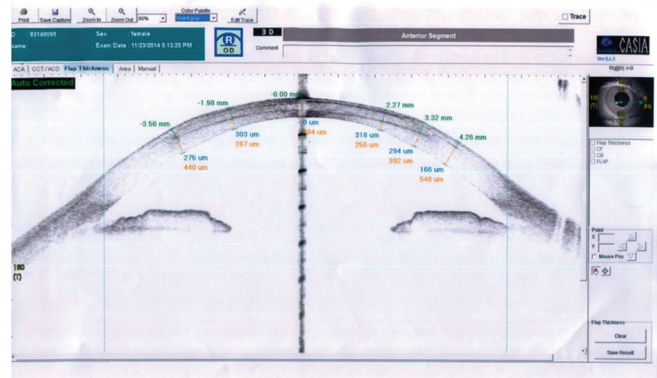
**Figure 7.** Postoperative Orbscan imaging reveals improvement of keratometric and thickness numeric data. Maximum central keratometric power is 48.1@54°. Corneal thickness was 552  $\mu$ m centrally and 378  $\mu$ m inferiorly as measured by Orbscan.

However, no studies have reported femtosecond-assisted intrastromal cornea inlays in humans. This approach entails advantages including augmentation of cornea hysteresis and resistance, performance under local anesthesia, and no manipulation of the epithelium or endothelium, leading to a decreased rate of rejection.

Similarly, the procedure of intracorneal pocket formation is less invasive compared to lamellar or penetrating keratoplasty. Larrea et al<sup>[15]</sup> reported the ideal position of three-fourths of the corneal thickness for the inlay to be implanted within the cornea to provide an optimal nutrient supply to the corneal cells. As a corneal inlay has sufficient oxygen and nutrient diffusion, it has no impact on these parameters.

Michieletto et al<sup>[6]</sup> and Guell et al<sup>[7]</sup> reported acceptable visual results by achieving target refraction within  $\pm 0.50$  diopters of emmetropia at 6 months and up to 12 months postoperatively, respectively. In contrast, Verity et al<sup>[10]</sup> reported less than satisfactory visual and refractive outcomes in more than half of the enrolled subjects. The Perma-Vision intracorneal lenses were used in these studies to correct hyperopia. With the development of haze around the implant and slight thinning of the epithelial layer, it was concluded that insufficient nutrient transfer through the cornea might still be a problem with this procedure. Therefore, haze formation may occur in our patient in further follow-up.

Femtosecond laser-assisted pocket creation for the implantation of corneal inlays offers accuracy of pocket parameters, enhancing predictability, resulting in better final outcomes, and improving the safety of the procedure. It also provides new treatment options. Prospective, comparative studies are needed to evaluate the long-term results of the technique and optimize the procedure.



**Figure 8.** Postoperative Visante OCT. The corneal inlay was inserted in the stroma. Corneal thickness measurement is visible.

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## Conflicts of Interest

There are no conflicts of interest.

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