

A novel method of tunnel creation using intraoperative optical coherence tomography-guided deep anterior lamellar keratoplasty

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The big bubble technique has become the technique of choice for performing deep anterior lamellar keratoplasty (DALK) since its inception in 2002. The main challenge with this technique is in achieving a big bubble while preventing inadvertent perforation of the Descemet's membrane. Although femtosecond lasers have increased the safety, accuracy, and predictability of corneal dissection in DALK, the challenge of achieving a big bubble still exists. To overcome this challenge, Zeimer Z8 Femto LDV has launched a new software module for DALK, which has an added advantage of real-time optical coherence tomography-assisted femtosecond tunnel creation for achieving a big bubble.

Key words: Big bubble DALK, corneal ectasia, femtosecond DALK, intraoperative OCT, keratoplasty

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We have seen significant technical advancement in keratoplasty after the introduction of deep anterior lamellar keratoplasty (DALK), particularly in corneal stromal diseases such as stromal dystrophies and corneal ectasias.^[1,2] The surgical technique is challenging but has a lesser risk of graft rejection as the patient retains their own corneal endothelium. One of the main complications of DALK is the perforation of Descemet's membrane during the preparation of the recipient bed, due to which the surgeon needs to convert the surgery to penetrating keratoplasty. The described technique uses real-time optical coherence tomography (OCT)-assisted femtosecond tunnel creation for achieving a big bubble, thereby minimizing the chances of Descemet's membrane perforation.

Femto laser has revolutionized the keratoplasty techniques, especially anterior lamellar keratoplasty.^[3] In femto-assisted DALK, the laser platforms perform lamellar and side cuts of a fixed depth leaving behind a thin portion of the posterior corneal stroma of around 70 to 100 microns. The big bubble step is then attempted in this remaining corneal stroma. Integrated OCT in femtosecond laser machines increases the predictability of laser cuts by providing better visualization throughout the procedure.^[4] Despite these technical advances, conversion rates from DALK to penetrating keratoplasty is as high as 25% due to Descemet's membrane perforation while doing pneumatic dissection for achieving a big bubble.^[5] The most important step of DALK is creating a posterior stromal tunnel in the

correct plane to achieve a big bubble, which was not possible in any of the femtosecond laser platforms so far. Thus, this step had to be done manually. Femtosecond laser LDV Z8 (Ziemer Ophthalmic Systems AG, Port, Switzerland) has launched a new DALK module in which the inbuilt software enables the surgeon to make stromal tunnel incisions with a femtosecond laser to facilitate the creation of a big bubble.

Surgical Technique

Preoperative detailed ophthalmic evaluation and Pentacam® (OCULUS, Wetzlar, Germany) was performed. The procedure was performed under local anesthesia (proparacaine hydrochloride 0.5%) by a trained corneal surgeon (BS). The 10-MHz laser device (Ziemer LDV Z8, Ziemer Ophthalmic Systems AG, Port, Switzerland) was used for trephination of the donor and recipient corneas. The donor graft was prepared by mounting the corneoscleral donor tissue on an artificial anterior chamber. Preoperative planning on femto platform for a ring size, outer and inner cut diameter, side cut, resection depth, tunnel width, and tunnel length was done. After achieving suction on the patient's eye, real-time OCT mode was switched on to see the cut pattern, resection depth, and depth, length, and angulation of tunnel entry. There is an option of changing

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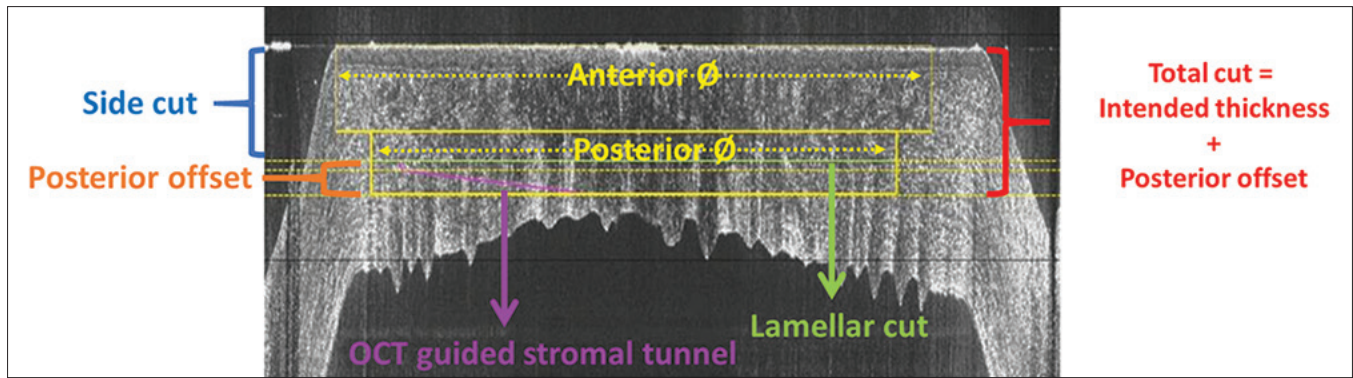


Figure 1: Intraoperative optical coherence tomography image showing the stromal tunnel path along with the total cut, side cut, and posterior offset profile

any of these parameters intraoperatively if a need is felt on OCT visualization. There are default settings given by the company for tunnel creation based on the size of the cannula used for pneumatic dissection. The femtosecond laser setting parameters were as follows: donor lenticule diameter 8.4 mm, 360° circular vertical cut at 90° side cut angle; donor corneal lenticules were oversized by 0.1 mm in diameter compared with the recipient lamellar cut.

Parameters for recipient cornea were as follows: The diameter was 8.3 mm. The OCT-guided tunnel length was 2.5 mm and was made at 300 μ m depth with a tunnel width of 0.4 mm with 30° side cut. This guiding tunnel was 60 to 70 μ m above the thinnest level of endothelium [Fig. 1].

The resected stromal tissue was gently removed from the recipient's eye after the completion of the laser procedure. The femtosecond laser-created tunnel was then identified in the remaining stromal tissue. The DALK air injection cannula was inserted into this stromal tunnel more toward the center, ensuring no air leak. The big bubble was then created, and the stromal tissue was removed gently without damaging the Descemet's membrane. The donor corneal tissue was also cut with femtosecond laser. The anterior and posterior cut diameter size of the donor was kept at 0.1 mm more than the recipient cut diameter to ensure better apposition. The donor graft was placed on the recipient's bare Descemet's membrane after removing the endothelium. It was then sutured with 10-0 nylon sutures, and the knots were buried [Supplementary Video 1].

This DALK software technology uses a laser of low energy in the range of 120% and a high frequency of 10 MHz used for cutting the stromal bed, thereby providing a smooth stromal bed without tissue bridges. Moreover, the software module gives the facility of creating the stromal tunnel of the desired length, width, and depth for pneumatic dissection. Real-time OCT helps in the visualization of cut and uncut portions of the cornea, thereby allowing any intraoperative changes after achieving suction. Intraoperative OCT thus replaces subjective assessment with accurate intraoperative measurements,

simplifies and standardizes the procedure, and makes the big bubble step more reproducible.

The study conducted adhered to the tenets of the Declaration of Helsinki, and the Bharti Eye Foundation Ethics Board Committee reviewed and approved the study. We did this technique in 10 patients at the time of submission. We were able to achieve a big bubble in each case without any Descemet perforation and were able to complete the procedure safely.

Conclusion

This advanced software module of Zeimer Z8 works very well for performing successful DALK. The feature of tunnel creation in the stroma for air injection makes this software module superior to other laser platforms. Due to OCT-guided tunnel construction, the success rate of achieving a big bubble is increased. Comparative study with manual DALK is needed to establish its efficacy further.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Anwar M, Teichmann KD. Big-bubble technique to bare Descemet's membrane in anterior lamellar keratoplasty. *J Cataract Refract Surg* 2002;28:398-403.
2. Colin J, Velou S. Current surgical options for keratoconus. *J Cataract Refract Surg* 2003;29:379-86.
3. Chamberlain WD. Femtosecond laser-assisted deep anterior lamellar keratoplasty. *Curr Opin Ophthalmol* 2019;30:256-63.
4. Liu YC, Wittwer VV, Yusoff NZM, Lwin CN, Seah XY, Mehta JS, *et al.* Intraoperative optical coherence tomography-guided femtosecond laser-assisted deep anterior lamellar keratoplasty. *Cornea* 2019;38:648-53.
5. Gadhvi KA, Romano V, Fernández-Vega Cueto L, Aiello F, Day AC, Gore DM, *et al.* Femtosecond laser-assisted deep anterior lamellar keratoplasty for keratoconus: Multi-surgeon results. *Am J Ophthalmol* 2020;220:191-202.