

Deep Anterior Lamellar Keratoplasty With the Femto LDV Z8



Low energy and small spot size contribute to this laser's ability to support a DALK software module.

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There has been a plethora of advances in the field of keratoplasty over the past 15 years, taking us from an era dominated by full-thickness penetrating keratoplasty to the era of lamellar keratoplasty—a technique that minimizes replacement of the recipient cornea by selectively replacing only diseased corneal stroma. One such technique is warranted in eyes in which the corneal disease does not involve the endothelium, as it minimizes unnecessary replacement of the healthy endothelial layer: deep anterior lamellar keratoplasty (DALK).

The main advantage of the DALK technique is that the eye retains its own endothelium, so that the risk of endothelial rejection—a major cause of graft failure—is eliminated. Today, my lamellar keratoplasty technique of choice is DALK. Because DALK is an extraocular procedure, the eye is much stronger after the procedure than it would be after penetrating keratoplasty. It is also not associated with the sort of intraoperative and long-term complications that are seen with conventional penetrating keratoplasty.

THE PROBLEM AND THE SOLUTION

So why is DALK not enjoying more widespread use around the world? The problem is that DALK is a difficult and long procedure to perform. If it's not done well, the patient's visual acuity results are worse than they would have been with full-thickness penetrating keratoplasty.

One way for DALK to gain more traction as a surgical alternative to penetrating keratoplasty is to try to de-skill the surgical procedure, so that more surgeons can do this safely and effectively. A solution, which has been recently envisioned, is to use femtosecond laser technology during the DALK procedure to help creation of the big bubble. I have been using the Femto LDV Z8 (Ziemer) for DALK for the past 6 months in this manner.

With the DALK software module on the Ziemer femtosecond laser, I use the system's built-in, intraoperative OCT to guide the depth of the lamellar dissection. This module has a separate corneal patient interface to the one that is used during laser cataract surgery. The module also can be used

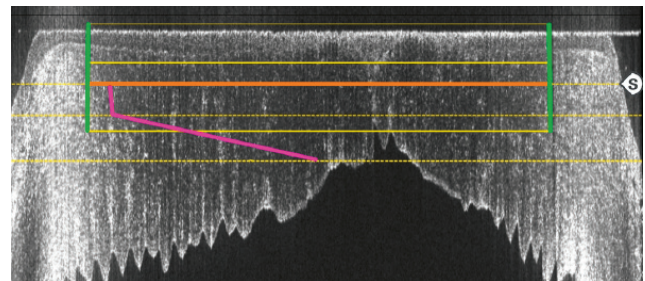


Figure 1. OCT-guided femtosecond DALK with guiding tunnel for the big-bubble technique.

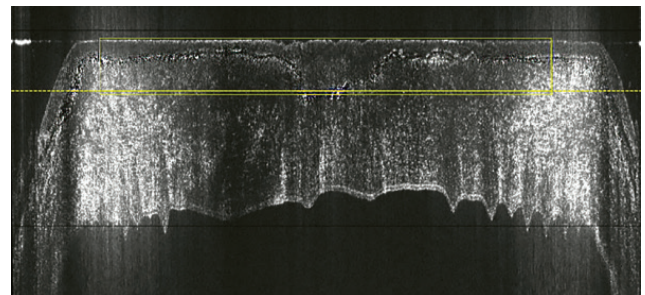


Figure 2. Intraoperative OCT helps the surgeon to visualize scars and other abnormalities.

to make a tunnel incision to easily facilitate creation of the big bubble, allowing me to place the DALK cannula easily through the tunnel (Figure 1). Because of the intraoperative OCT guidance (Figure 2), these maneuvers are very accurate and more consistent than if performed manually.

ADVANTAGES

Prior to the availability of the DALK software module on the Femto LDV Z8, OCT could only be performed preoperatively to help guide the femtosecond laser depth for the lamellar cut and the sidecut. This limited the usefulness of femtosecond laser technology in the procedure, as the surgeon did not have any real-time data to help guide him or her through the crucial steps in DALK. But by having the availability of intraoperative OCT, the accuracy of the tunnel incision and the depth of the lamellar dissection is performed in real-time. Following our wet lab studies, I have confidence that the laser will perform

these maneuvers with extreme accuracy, and therefore I know exactly what's happening to the patient at every point during the procedure. And of course, from one patient to the next, I do not have to worry about varying accuracies in the depth of the dissection and in the creation of the tunnel incision and the big bubble.

Another advantage of the DALK module on the Femto LDV Z8 is that it produces a guided tunnel. What that means is that the tunnel is made with extreme precision, from the lamellar cut to the area in which the tip of the cannula will be. (This is the space in which the surgeon starts injecting air inside the eye to formulate the big bubble—or the separation of the stroma from the Descemet membrane/Dua layer).

The guided tunnel allows me to program the depth of the tunnel, including the starting and the ending depth; the angulation of the tunnel; and the length of the tunnel. Due to the fragility of endothelial cells, one of the issues with performing femtosecond DALK is to ensure that the laser pulses are not too close to the endothelium. During tunnel creation, the ending depth of the tunnel is about 80 to 100 μm away from the corneal endothelium. The Femto LDV Z8 is the only femtosecond laser available today that can be used to produce a guided DALK tunnel. This is because the laser uses a very low energy laser pulse, making it safe to use so close to the corneal endothelium. With other laser platforms, the energy needed to produce the tunnel at this depth can potentially damage the endothelium.

Another reason that the Ziemer femtosecond laser system can support a DALK software module is because the shots of the laser are fired very closely together, thus producing a smooth tunnel. This enables easy entry of the cannula into and out of the tunnel in order to achieve air separation.

START SLOWLY

The learning curve with the DALK module on the Femto LDV Z8 is relatively straightforward. With that said, it is important for surgeons to keep in mind that they must understand the entire DALK procedure prior to initiating treatment with this software. Once the procedure is understood and the surgeon is confident enough to begin, the Femto LDV Z8 laser platform is a huge asset to the surgeon in terms of achieving a big bubble—a crucial step in the DALK procedure.

But there is still the remaining part of the surgery to complete, which involves removing the stroma once the bubble is created and then suturing the graft, which also has to be performed carefully since there is still a risk of perforation during this part of the procedure. So the Femto LDV Z8 makes a difficult part of the procedure much easier, but the rest of the procedure still must be performed with extreme care.

I think that having access to the Femto LDV Z8 DALK software module will significantly cut down on the learning curve of DALK, and it can help most surgeons to achieve a

big bubble more frequently than they're currently achieving. At Singapore National Eye Centre, which is where I work, our conversion rate to full-thickness penetrating keratoplasty from DALK is approximately 0.37%. For comparison, conversion rates in the literature vary from 5% to 30%. Hence, there is a huge variation in the number of cases in which surgeons are able to achieve a successful DALK procedure. I am confident that having the availability of the DALK module on the Femto LDV Z8 would benefit any surgeon and increase his or her success rate with the procedure.

A VERSATILE PLATFORM

I perform a significant number of anterior lamellar keratoplasties at Singapore National Eye Centre, and anterior lamellar keratoplasty accounts for more than 30% of all the corneal transplants that I do every year. That is, however, very high compared to the percentage of anterior lamellar keratoplasties performed in other centers across the world. In the United States, for example, anterior lamellar keratoplasty accounts for about 2% to 3% of the annual volume of corneal transplant procedures.¹

With this in mind, another nice thing about the Femto LDV Z8 platform is its versatility. The same laser system can be used for cataract surgery as well as corneal surgery—all that is required is switching from one module and patient interface to another. This takes between 5 and 8 minutes to achieve, and it can be done by anyone on the surgical team, not just the surgeon.

CONCLUSION

Applying the functionality of a femtosecond laser to corneal surgery is a big advantage to the field of corneal transplantation, and speaking as a corneal surgeon, I think this has become a reality thanks to all of the many advances being made in laser cataract surgery. Having the availability of one machine that can do multiple procedures, from laser cataract surgery to refractive surgery to corneal surgery, is advantageous to us as surgeons as well as to our patients. Now adding the adjunctive DALK module software onto the Femto LDV Z8 is another step in the evolution of enhanced patient care and de-skilling this procedure. ■

1. Eye Bank Association of America. Statistical report. <https://restoresight.org/what-we-do/publications/statistical-report/>. Accessed August 20, 2018.

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