

Lenticule implantation and intrastromal lenticule rotation for treatment of hyperopia and high mixed astigmatism

On September 6, 2019, Iben Bach Damgaard defended her thesis “Femtosecond laser surgery and tissue implantation for treatment of corneal refractive errors” for the degree of PhD at the Department of Clinical Medicine, Faculty of Health, Aarhus University, Denmark. The PhD project was carried out at the department of Ophthalmology, Aarhus University Hospital, with Professor Jesper Hjortdal as main supervisor and Anders Ivarsen as co-supervisor.

Small incision lenticule extraction (SMILE) has become a well-established laser refractive procedure for correction of myopia and myopic astigmatism. In SMILE, an intrastromal lenticule is cut using a femtosecond laser and subsequently extracted through a minor corneal incision. Currently, only limited laser refractive procedures are available for management of hyperopia and high mixed astigmatism.

Femtosecond laser technology offers new interesting possibilities for creating customized lenticules for tissue additive surgery and for stromal remodeling. This PhD project aimed to evaluate the feasibility of two new surgical laser refractive procedures; SMILE-derived lenticule implantation for correction of hyperopia and intrastromal lenticule rotation (ISLR) for correction of high mixed astigmatism. The surgical procedures were evaluated in a laboratory setting using human donor corneas deemed unsuitable for patient treatment.

Our studies provided a deeper insight into corneal curvature alterations following implantation of SMILE-derived lenticules. Lenticule implantation induced hyperopic

corrections were generally less powerful than the SMILE-derived lenticule, especially in higher hyperopic corrections. A large proportion of the curvature change occurred in the posterior corneal surface, while the intended effect was lost due to the similar refractive indices of the cornea and aqueous humour.

Intrastromal lenticule rotation (90 degrees) of sphero-cylindrical lenticules showed promising results for correction of up to 10 dioptres of astigmatism, although a minor myopic shift was observed after the procedure. The

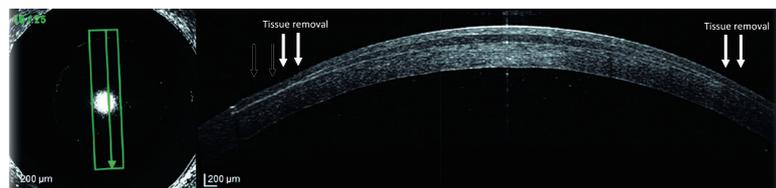
technique does not require removal of stromal tissue, which theoretically reduces the risk of postoperative keratectasia. ISLR may be a useful alternative to arcuate keratotomy or re-transplantation in patients with post-keratoplasty astigmatism and clear grafts. However, clinical trials are needed as the refractive outcome in post-keratoplasty eyes may differ from that of healthy eyes due to the wound healing response in the graft-host interface. Also, epithelial remodelling and time until refractive stabilization should be evaluated in future studies.

- Intrastromal lenticule implantation for hyperopia is feasible, but with limited effect in high hyperopic corrections.
- Intrastromal lenticule rotation (ISLR) showed promising results with correction of up to 10 D of astigmatism.
- A minor myopic shift was observed following ISLR.
- Future clinical studies are needed to evaluate the stromal and epithelial remodeling after ISLR. ■

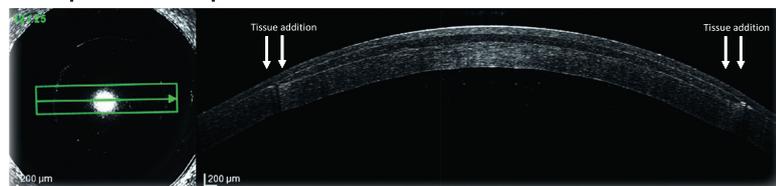


Iben Bach Damgaard

Preoperative flat meridian



Preoperative steep meridian



OCT images following Intrastromal Lenticule Rotation (ISLR) for high mixed astigmatism