# Advances in endothelial keratoplasty

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**Advances in Endothelial Keratoplasty**
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| Cover: | The cover image displays a watercolor drawing of the Sakura flower. The Sakura flower is a symbol of spiritual beauty and hope. When it blooms, it is a stunningly, transformative depiction of spring's promise of renewal after a dark winter. Its fleeting presence reminds us to live life with gratitude and to savour small joys in every moment. |
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*For my Family*

# CONTENTS

# PREFACE

Corneal diseases are among the leading causes of reversible blindness worldwide. When conservative measures fail, many eyes can be managed with corneal transplantation, also known as corneal grafting or keratoplasty.

The first successful corneal allograft transplantation in a human was performed by Dr. Eduard Zirm in 1905. Since then, innumerable ophthalmologists and scientists have contributed to the development of operating microscopes, the refinement of surgical instruments and new methodologies for corneal transplantation and the establishment of eye banks. Additionally, an increased understanding of corneal biology and an improved management of allograft rejection with anti-inflammatory agents, such as corticosteroids, have dramatically improved clinical outcomes.

Currently, corneal transplantation is one of the most often performed and most successful types of tissue transplantation. Historically, *full* thickness corneal transplantation, also known as penetrating keratoplasty (PK), has been the mainstay of care in the treatment of corneal disorders. In the past two decades, however, there has been a trend towards the selective, minimally-invasive replacement of the diseased corneal layers, rather than replacement of all layers. These *partial* thickness corneal transplantations are known as *lamellar keratoplasties.* Lamellar keratoplasty has revolutionized the management of corneal disorders and has significantly improved the utilization of cadaveric corneal grafts and clinical outcomes after keratoplasty.

In 2006, *Descemet membrane endothelial keratoplasty* (DMEK), the latest refinement of lamellar keratoplasty*,* was introduced, enabling selective replacement of Descemet membrane (DM) with its endothelial layer. DMEK provides a near-perfect corneal restoration yielding drastically improved clinical outcomes for patients with endothelial disorders.

Shortly after its introduction, corneal clearance was described in eyes with a (partial) graft detachment after DMEK or an almost 'free-floating' DMEK graft in the recipient anterior chamber. The latter procedure, which at some point was performed intentionally, was tentatively referred to as *Descemet membrane endothelial transfer* (DMET). DMET entailed descemetorhexis followed by insertion of a free-floating DMEK graft that contacted the posterior cornea only at the corneal incision. While some eyes showed corneal clearance after

the procedure, a major drawback of DMET is that, if corneal clearance occurs at all, it may take up to several months.

While DMEK was clinically very successful, it had yet failed to adequately address the significant shortage of corneal donor tissue in many parts of the world. Therefore, attempts were made to obtain more than one endothelial graft out of one donor cornea and a further refinement of DMEK included Hemi-DMEK, that is, transplantation of a full diameter, semi-circular graft. A preliminary study on the clinical outcomes of Hemi-DMEK showed that Hemi-DMEK may result in visual outcomes similar to those after conventional DMEK.

Aiming to use donor tissue even more efficiently and to surpass the drawbacks of DMET, Quarter-DMEK was developed as a hybrid technique that aimed to combine the advantages of both DMEK (fast corneal clearance) with DMET and 'descemetorhexis only' (host peripheral endothelial cell migration). Quarter-DMEK has shown promising 6-month results for an initial cohort of Fuchs endothelial corneal dystrophy eyes and bears the advantage of potentially quadrupling the availability of endothelial donor grafts if outcomes would remain stable on the longer term.

This thesis will focus on donor tissue preparation for DMEK and the feasibility and clinical outcomes of DMEK, DMET, Hemi-DMEK and Quarter-DMEK.