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ORIGINAL ARTICLE

Intraocular pressure measurements and corneal biomechanical properties using a dynamic Scheimpflug analyzer, after several keratoplasty techniques, versus normal eyes

Évaluation de la pression intraoculaire et des propriétés biomécaniques de la cornée par un tonomètre non contact associé à une caméra dynamique Scheimpflug, après kératoplastie et chez le sujet sain

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KEYWORDS
Corneal biomechanics;
Keratoplasty;
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Summary
Purpose. — To evaluate the biomechanical properties of the cornea and their impact on intraocular pressure (IOP) measurement after lamellar keratoplasty, compared to healthy eyes, using a non-contact tonometer with a Scheimpflug camera.
Methods. — This study, from 2014 to 2015, included 22 primary DSAEK, 5 DALK, 6 DSAEK after PK, and 50 control eyes. Using a non-contact tonometer with a high-speed Scheimpflug camera (CORVIS ST, Oculus Optikgeräte GmbH, Wetzlar, Germany), several biomechanical parameters were recorded, including radius at highest concavity (R_{hc}) and defomation amplitude (DA). Central corneal thickness (CCT) and uncorrected IOP, were also recorded. For the control eyes only, a corrected IOP was calculated, based on age, central corneal thickness, and biomechanical parameters.

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Results. — R_{hc} was significantly lower after DALK ($R_{hc} = 5.54 \pm 0.71$, $P = 0.007$) and DSAEK ($R_{hc} = 6.26 \pm 0.77$, $P = 0.042$) compared to control eyes ($R_{hc} = 6.82 \pm 0.76$). DA was higher after DALK and DSAEK, but not significantly (respectively 1.24 ± 0.09 $P = 0.41$ and 1.22 ± 0.15, $P = 0.923$) compared to normal eyes (1.18 ± 0.15). Uncorrected IOP was not significantly different between post-keratoplasty and control eyes. In control eyes, the corrected IOP (15.23 ± 1.88) was lower than the uncorrected IOP (16.10 ± 2.34); a statistically significant positive correlation between R_{hc} and CCT ($R^2 = 0.6020$, $P < 0001$), and a significant negative correlation between DA and CCT ($R^2 = -0.641$, $P < 0.0001$) were found.
Conclusion. — Our study showed that, after lamellar keratoplasty, corneal biomechanics are altered. Corneas with higher ocular rigidity will show a lower DA and a higher R_{hc}.

MOTS CLÉS
Biomécanique cornéenne ;
Kératoplastie ;
Scheimpflug ;
Pression intraoculaire

Résumé
Objectif. — Évaluer les propriétés biomécaniques de la cornée et leur impact sur la mesure de la pression intraoculaire (PIO) après kératoplastie lamellaire, versus yeux sains, grâce à un tonomètre non contact associé à une caméra Scheimpflug.
Méthodes. — Cette étude a inclus de 2014 à 2015 22 DSAEK, 5 DALK, 6 DSAEK sur kératoplastie transfixiante, et 50 yeux sains. Grâce à un tonomètre non-contact associé à une caméra dynamique Scheimpflug (CORVIS ST, Oculus Optikgeräte GmbH, Wetzlar, Germany), plusieurs paramètres biomécaniques ont été évalués, en particulier le rayon de courbure à la plus haute concavité de la déformation (R_c), et l'amplitude de déformation (AD). Pour les yeux sains seulement, une PIO corrigée a été calculée, en fonction de l'âge, de la pachymétrie centrale, et des paramètres biomécaniques.
Résultats. — R_c était significativement plus faible après DALK ($R_c = 5{,}54 \pm 0{,}71$, $p = 0{,}007$) et DSAEK ($R_c = 6{,}26 \pm 0{,}77$, $p = 0{,}042$) que chez les sujets sains ($R_c = 6{,}82 \pm 0{,}76$). AD était plus élevée après DALK ($1{,}24 \pm 0{,}09$, $p = 0{,}41$) et DSAEK ($1{,}22 \pm 0{,}15$, $p = 0{,}923$) que chez les sujets sains ($1{,}18 \pm 0{,}15$). La PIO non corrigée n'était pas significativement différente après kératoplastie par rapport aux sujets sains. Chez les yeux sains, la PIO corrigée ($15{,}23 \pm 1{,}88$) était plus faible que la PIO non corrigée ($16{,}10 \pm 2{,}34$) ; une corrélation positive statistiquement significative était retrouvée entre R_c et pachymétrie ($R^2 = 0{,}6020$, $p < 0001$), et inversement, une corrélation négative statistiquement significative entre AD et pachymétrie fut notée ($R^2 = -0{,}641$, $p < 0{,}0001$).
Conclusion. — Notre étude montre qu'après kératoplastie lamellaire, la biomécanique cornéenne est altérée. Les cornées plus fragiles présentent une AD plus élevée et un R_c plus faible.

Introduction

For many years, penetrating keratoplasty (PK) has been the main technique used for corneal transplantation. However, the indications of penetrating keratoplasty have decreased since the development of selective lamellar keratoplasty, which are less invasive: deep anterior lamellar keratoplasty (DALK), descemet stripping automated endothelial keratoplasty (DSAEK), descemet membrane endothelial keratoplasty (DMEK).

Several studies have been published about the corneal biomechanical changes after keratoplasty. Till recently, the main device to study in vivo corneal biomechanics was the ocular response analyser (ORA, Reichert Ophtalmic Instruments, Buffalo, New York, USA). This device studies the corneal deformation after an air pulse, and measures corneal hysteresis and the corneal resistance factor. Many studies have used the ORA to evaluate corneal biomechanical properties in patients with keratoconus, glaucoma, after keratoplasty and after cross-linking.

However, the results of the studies comparing the corneal biomechanics after keratoplasty with control eyes were inconclusive [1—8].

The CORVIS ST (Oculus Optikgeräte GmbH, Wetzlar, Germany) is a non-contact tonometer with a ultra-high-speed Scheimpflug camera, that detects the dynamic corneal deformation after a constant air pulse.

Two studies [9,10] have used this technology after keratoplasty and have shown modified biomechanical properties after different keratoplasty techniques.

As ocular hypertension is an important etiology of graft failure by endothelial dysfunction, it is important to be able

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