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Early corneal pachymetry maps after cataract surgery and influence of 3 D digital visualization system in minimizing corneal edema.

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Abstract

Purpose: To describe the early topography of corneal swelling occurring after cataract surgery and to evaluate the impact of the three-Dimensional (3D) digital visualization system in minimizing corneal edema.

Methods: Prospective observational, single-center, consecutive case series of 134 patients undergoing cataract surgery performed by the same surgeon, with either 3D or conventional visualization systems. Eyes were assigned to two groups on the basis of their anterior chamber depth (group ACD ≤ 3 mm and group ACD > 3 mm). Optical coherence tomography was performed to evaluate postoperative corneal swelling.

Results: Three corneal swelling profiles were identified on the first postoperative day type 1, limited corneal edema near peripheral corneal incisions; type 2, dome-shaped corneal swelling spreading from the principal corneal incision and reaching the paracentral cornea; type 3, continuous edema spreading from the principal incision to central cornea, with a generalized edema predominating in the upper part of the cornea.

On the first day after surgery, in group ACD ≤ 3 mm, visual acuity was significantly better in patients undergoing surgery with 3D visualization (0.023 vs 0.072 logMar, $p = 0.014$) with reduced central corneal thickening 17.3 µm (±3.2) in comparison with conventional visualization 44.0 µm (±9.3) ($p = 0.0082$). In group ACD > 3 mm, no significant association was found between the use of the 3D system and pachymetry changes and early visual rehabilitation.

On day 21 after surgery, no significant differences in corneal pachymetry values were observed between the two surgical approaches in both groups.

Conclusions: We describe early postoperative corneal map profiles providing insight into the pathogenesis of postoperative corneal swelling and possible prevention strategies. By improving visualization of the narrow surgical space in patients with shallow anterior chambers, the 3D system could help to minimize postoperative corneal edema.

Keywords: heads-up three-dimensional (3D) digital visualization system; corneal edema; cataract surgery; anterior chamber depth; depth of field; optical coherence tomography.

INTRODUCTION

Cataract surgery is one of the most frequently performed surgical interventions worldwide (Foster et al. 2000). The development of phacoemulsification technology, instrumentation, and surgical techniques has improved both the efficacy and safety of procedures, reducing rates of serious postoperative adverse events (Stein et al. 2011).

Early postoperative corneal edema is a frequent complication of cataract surgery that may delay the vision recovery and lead to patient dissatisfaction on the first day after surgery (David et al. 2002). Postoperative corneal swelling has a multifactorial pathogenesis and has mostly been studied by evaluating central corneal thickness (David & Reza Dana 2002; Narayanan et al. 2006; Choi & Han et al. 2019; Perone et al. 2018; Doors et al. 2013; Lhuillier et al. 2017).

Anterior segment optical coherence tomography (OCT) is a safe, noncontact technique providing a rapid, and accurate analysis of the corneal pachymetry map (Sandali et al. 2013). OCT has been used to analyze corneal incision architecture and healing after cataract surgery (Fine et al. 2007; Li et al. 2011). However, to the best of our knowledge, the topography of early postoperative corneal edema has not been studied with quantification methods.

In most cases, corneal edema resolves spontaneously following endothelial pump recovery after surgical stress, but postoperative corneal edema has been shown to be predictive of long-term (≥10 years) endothelial cell loss following uncomplicated cataract surgery (Choi & Han et al. 2019; Perone et al. 2018).

New probe and phacoemulsification technologies, such as femtosecond laser-assisted refractive cataract surgery, have been reported to reduce the amount of energy delivered during surgery, thereby preventing corneal edema and endothelial cell loss (Doors et al. 2013; Khokhar et al 2017; Krarup T et al 2019).

A heads-up three-dimensional (3D) digital visualization system was recently evaluated and shown to be safe for cataract surgery (Qian et al. 2019; Ohno 2019; Weinstock et al. 2019). The extended depth of field (DOF) of the 3D system provides good visualization in different planes without the need to refocus during procedures in the majority of cases. This new system also improves the quality of high-magnification visualization over that achieved with conventional microscopes (Ohno 2019; Freeman et al. 2019). Better visualization of the limited surgical space, particularly for eyes with shallow anterior chambers, should, theoretically, make intraocular maneuvers safer and improve the localization of ultrasound delivery from the endothelium.

The primary aim of this study was to evaluate the influence of visualization with the 3D system on early corneal anatomic and visual outcomes in eyes with shallow and deep anterior chambers. The secondary aim was to describe early postoperative corneal pachymetry changes by the use of wide-field 9-mm zone OCT pachymetry.

MATERIALS AND METHODS

Patients

We prospectively studied patients scheduled to undergo phacoemulsification surgery at the Guillaume de Varye Hospital (Bourges, France) between June 2020 and November 2020. Approval for the study was obtained from the ethics committee of our institution, and informed consent was obtained from patients before inclusion. The study was performed in accordance with the Declaration of Helsinki.

The exclusion criteria were: patient with another ocular disease that might limit visual recovery after cataract surgery, diabetes, corneal disease, thin cornea (< 490 microns), cataract surgery combined with glaucoma or retinal surgery, need for a corneal suture or prolonged surgery (> 15 min), and postoperative complications, such as hypertonia or severe superficial punctate keratitis.

We included only patients with endothelial corneal cell densities between 2400 and 2700 cells/mm^2 in this study, to minimize the variables likely to influence postoperative corneal edema.

Consecutive cases were included in this study. The surgeon and patients were unaware of the visualization system used before surgery, and had no influence on the choice of system. Indeed, the surgeon routinely performs surgery in two different operating rooms equipped with an OPMI Lumera 700 surgical microscope: one using conventional visualization with microscope oculars and the other using a 3D digital visualization system (NGENUITY®, Alcon, Fort Worth, TX) in which a high-dynamic range video camera connected to the microscope replaces the oculars. The iris diaphragm of the digital video camera was set to approximately 30% open for 3D surgery.

Patients were randomly distributed between the two operating rooms according to the surgical timetable planned by the operating room manager on the day before surgery. The surgeon was not aware of the ACD values and had access only to the intraocular implant values during surgery, after lens removal.

The resulting series included 134 patients, assigned to two groups on the basis of anterior chamber depth (ACD): group ACD $\leq$ 3 mm and group ACD > 3 mm.

Surgical technique

All operations were performed under topical anesthesia, by the same experienced surgeon (O.S.). The Constellation® (Alcon Surgical, Ft. Worth, TX) microsurgical system was used for ultrasound phacoemulsification, with a 45-degree Kelman® 0.9 mm mini-flared TurboSonics® tip. A 2.2 mm clear superior corneal incision was made in the superotemporal quadrant for right eyes and the superonasal quadrant for left eyes (at 120°-140°). The same irrigating balanced salt solution and ophthalmic viscoelastic Combivisc® (Zeiss, Jena, Germany) were used for all patients.

A capsulorhexis of about 5.0 mm in diameter was created with forceps, and a cortical cleaving hydrodissection was then performed. The nucleus was emulsified by the stop-and-chop technique. After irrigation and aspiration of the cortex, a foldable hydrophobic acrylic intraocular lens (ARTIS ® Cristallens, Lannion, France) was implanted in the bag. At the end of surgery, the stroma was hydrated on either side of the incision.

Data collection

Endothelial corneal cell densities and ACD were assessed before surgery, with a Nidek CEM-530 (NIDEK Co., Ltd. Japan) specular microscope and an OA-2000 (Tomey, Nagoya, Japan) optical biometer, respectively. Mean cumulative dissipated energy (CDE) values and operating times were recorded for each patient at the end of surgery.

Ocular examination, including visual acuity and corneal OCT, was performed before surgery and programmed for the first and 21st days after surgery. Best corrected visual acuity (BCVA) was determined with a conventional Snellen chart.

Pre-and postoperative corneal thicknesses were analyzed with a Fourier-domain OCT system (RTVue; Optovue, Inc., Fremont, CA), which provided a wide 9-mm diameter pachymetry map. Two cornea specialists (O.S., V.B.) blind to the ACD data analyzed the corneal pachymetry maps.

Data were collected for the central 2-mm zone (Z1) and the two paracentral 2-5 mm zones (Z2 and Z3) towards the principal corneal incision, for statistical analysis (supplemental Fig. 1). The centering of the corneal maps was systematically checked, and decentered acquisitions were excluded from the study.

Statistical analysis

Results are presented as the mean ± standard deviation for continuous variables and as proportions (%) for categorical variables. The distribution pattern of the variables included was compared with a theoretic normal distribution using a Komolgorov-Smirnov test. Student's *t*-test and non-parametric Mann-Whitney *U* tests were used to compare continuous data, as appropriate. Paired Student's *t* tests were used for the statistical evaluation of comparisons between preoperative and postoperative corneal thicknesses on anterior segment OCT. For binary outcomes, the stratified Cochran chi-square test and the Fisher exact test were used for intergroup comparisons of proportions when appropriate. Linear regression analyses, with evaluation of Pearson's correlation coefficient, were performed to evaluate associations between two continuous variables. Multivariate linear regression was used to identify associations between mean corneal thickness and the other variables studied. Values of $p<0.05$ were considered statistically significant. Statistical analysis was performed with SPSS for Windows version 27.0 (SPSS, Inc., Chicago, IL).

RESULTS

In total, 134 eyes from 134 patients were enrolled in the study. Group ACD ≤ 3 mm included 61 patients and group ACD >3 mm included 73 patients. In group ACD ≤ 3 mm, 29 patients underwent surgery with the 3D approach and 32 patients underwent surgery with conventional visualization. In group ACD >3 mm, 30 patients underwent surgery with the 3D approach and 43 patients underwent surgery with conventional visualization.

Preoperative data, including mean age, refractive error, axial length, anterior chamber depth, eye laterality, and pachymetry thicknesses, and intraoperative CDE did not differ between the patients undergoing surgery with conventional or 3D visualization, in either group (tables 1 and 2).

On the first day after surgery, multivariate regression analysis (including laterality, mean CDE, AC depth, and type of visualization) for group ACD ≤ 3 mm showed that CDE was associated with the presence of central (Z1) and paracentral (Z2 and 3) edema, whereas the use of the 3D system was associated with lower levels of corneal swelling than in patients undergoing surgery with conventional visualization (table 3). Mean (standard deviation) corneal thickening at the central Z1, Z2, and Z3 zones was 44.0 µm (±9.3 µm), 72.8 µm (±11.7 µm), and 68.6 µm (±11.8 µm), respectively, for patients undergoing surgery with the conventional visualization system, and 17.3 µm (±3.2 µm), 39.6 µm (±6.3 µm), and 31.9 µm (±4.8 µm), respectively, for patients undergoing surgery with 3D visualization ($p = 0.0082$, $p = 0.0175$, and $p = 0.0084$, respectively, Mann-Whitney test). BSCVA on the day after surgery was significantly better in patients undergoing surgery with 3D visualization (0.023 vs. 0.072 logMar) than in those undergoing surgery with conventional visualization ($p = 0.014$, Mann-Whitney U test). In group ACD > 3 mm, no significant association was found between mean CDE or the use of the 3D system and the presence of central and paracentral corneal edema and BCVA on the day after surgery.

A linear regression analysis performed on the whole population showed no significant association between ACD and the presence of central and paracentral corneal edema and BCVA on the day after surgery

On day 21 after surgery, paracentral and central pachymetry values did not differ significantly from preoperative values, and BCVA did not differ significantly between patients undergoing surgery with conventional visualization and those undergoing surgery with 3D visualization, for both ACD ≤ 3 mm and ACD >3 mm groups.

For corneal swelling topography on the first day after surgery, the corneal pachymetry maps were classified into different profiles according to the topography of the corneal edema (supplemental Fig. 2). Corneal swelling was considered to be significant if corneal thickening exceeded 50 microns. Type 1, limited corneal edema close to peripheral corneal incisions, in the 5-9 mm area (Fig. 3). Type 2, dome-shaped configuration of corneal swelling spreading from the principal corneal incision and reaching the 2-5 mm paracentral area of the cornea. Corneal edema was observed principally in the upper part of the cornea (Fig. 4). Type 3, appearance of continuous edema spreading from the principal corneal incision and reaching the central cornea. Generalized corneal edema is present, but with a predominance in the upper part of the cornea (Fig 5).

The presence of corneal edema in the central and paracentral zones (Z1, Z2, Z3) was associated with lower visual acuity on the first day after surgery ($p<0.05$). Type 2 and 3 increased corneal swelling profiles were significantly more frequent for the conventional approach than for the 3D approach in group ACD ≤ 3 mm (Chi-squared test, $p = 0.013$) (table 4).

On day 21 after surgery, corneal pachymetry maps showed a mild residual edema close to the corneal incision in all patients.

DISCUSSION

Postoperative corneal swelling is a frequent event on the first day after cataract surgery. Corneal edema, although frequently transient, is associated with delayed vision recovery and higher levels of endothelial cell loss (David & Reza Dana 2002; Narayanan et al. 2006; Choi & Han 2019; Perone et al. 2018). With the use of wide-field anterior segment OCT pachymetry, we described three topographic aspects of corneal pachymetry on the first day after cataract surgery in a series of 134 patients. In eyes with shallow anterior chambers, the use of the 3D visualization system was associated with a lower level of corneal edema on postoperative day 1, and a faster recovery of vision.

The pathogenesis of postoperative corneal edema is multifactorial, and depends on preoperative factors, such as age, cataract density, endothelial cell density, and anterior chamber depth, and surgery-related factors, such incision size, duration of the operation, cumulative dissipated energy, surgical technique, and instrument-related trauma (Li et al. 2011; Hwang et al. 2015; Khalid et al. 2019; Walkow et al.2000; O'Brien et al.2004; Storr-Paulsen et al. 2008).

The three early postoperative topographic appearances defined here highlight particular aspects of cataract surgery and pathways involved in postoperative corneal swelling (David & Reza Dana 2002; Narayanan et al. 2006;. Schultz et al. 1986).

Type 1 topography was associated with the BCVA on the first day after surgery, with localized edema at the corneal incision. Corneal tissue injury due to incision and friction with surgical instruments during surgery is probably responsible for the occurrence of peripheral edema close to the incision. Moreover, the effects of stromal hydration close to the corneal incision may last from one day to one week, depending on endothelial pumping (Matossian et al. 2015).

In type 2 topography, the corneal edema spread from the principal corneal incision to reach the paracentral zone. A mild corneal edema was observed principally in the upper part of the cornea. This appearance of prolonged peripheral corneal thickening was reported by Bolz et al. 2006, and probably results from movements of the handpiece delivering ultrasound during surgery, causing both physical and thermal injury (Sippel & Pineda 2002). The handpiece is closer to the corneal endothelium peripherally near to the incision than centrally, due to the decrease in anterior chamber depth from the center to the iridocorneal angle, resulting in a dome-shaped swelling of the cornea, spreading out from the principal corneal incision.

The predominance of edema in the superior cornea is probably due to the location of the incisions in the upper part of the cornea and the surgical technique used. Indeed, intraoperatively, lens fragments are moved centrally by the surgeon towards the phaco tip that principally delivers energy centrally and at the upper part of the cornea.

The type 3 profile was similar in appearance to type 2, with a spreading of swelling from the corneal incision, but the edema is more pronounced and reaches the central zone, thereby having a significantly greater effect on visual acuity. The profiles described here correspond to uncomplicated surgery and will differ in cases when the corneal endothelium is inadvertently touched by the instruments.

The energy delivered during cataract surgery is known to be predictive of postoperative corneal edema and endothelial cell loss (O'Brien et al. 2004). However, the distance of the site of energy delivery from the endothelium is also important, and eyes with shallow anterior chambers have been reported to be at high risk of postoperative endothelial loss (Hwang et al. 2015; Khalid et al. 2019). Indeed, in our study, CDE was associated with postoperative corneal edema in ACD ≤ 3 mm group (shallow anterior corneal chambers) but not in ACD >3 mm group (deep anterior corneal chambers).

In group ACD ≤ 3 mm, the use of 3D visualization was found to be an independent factor associated with lower levels of postoperative corneal swelling and better first day visual acuity. Better visualization of the shallow surgical space in group ACD ≤ 3 mm may account for our findings.

In some of the patients in ACD ≤ 3 mm group , we compared anterior chamber depth perception between 3D and conventional visualization by removing the Ngenuity ® system from the microscope before the start of surgery. We found that the anterior chamber appeared to be deeper with the 3D viewing system. It was not possible to quantify this impression of deepening with the 3D system, but this effect was observed in all patients for whom the comparison was performed.

At high magnification, the 3D system seems to provide a better depth of field (DOF) than can be achieved with conventional microscopy (Freeman et al. 2019). Indeed, DOF, which decreases significantly with magnification, is more affected on conventional microscopy, decreasing the impression of depth at high magnification (Chena et al.

2011; Du et al. 2001). The extended DOF of the 3D system provides a high magnification of the surgical space, with a good residual DOF, providing an impression of deepening. The narrow surgical space in eyes with a low ACD remains narrow in reality, but appears deeper, thereby increasing the surgical safety of intraocular maneuvers and, probably, rendering the site of ultrasound delivery for phacoemulsification more precise and safer for the endothelium during surgery.

It would be interesting to evaluate the utility of 3D visualization for reducing postoperative corneal edema among fellows or surgeons performing phacoemulsification mainly within the anterior chamber and close to the cornea.

No significant differences with respect to preoperative values were found in the central and paracentral areas 21 days after surgery, following resorption of the corneal edema. Calabuig-Goena et al. 2016 reported similar results one month after surgery.

One possible limitation of our study is that we did not monitor endothelial cell loss. However, this study was designed to evaluate mainly the early postoperative anatomic and visual outcomes. Early postoperative corneal edema, which has already been shown to be predictive of long-term endothelial cell loss, is an adequate and sufficient indicator of surgical trauma during cataract surgery. Indeed, Choi & Han 2019 reported, in a series of 81 eyes from 48 patients, that the degree of corneal swelling on the first postoperative day was significantly predictive of endothelial cell loss 10 years after cataract surgery. Furthermore, a more detailed, longer period of follow-up would be required for the monitoring of endothelial cell loss, which was not possible in the particular context in which this study was performed, due to lockdown and the susceptibility of elderly patients to COVID-19 (Nanda et al. 2020).

Another limitation of the study is the lack of a preoperative nuclear grading system. However, mean CDE, which was collected for all patients, is strongly correlated with nuclear density (Mandelblum et al. 2020) and reflects the direct impact of cataract hardness in cataract surgery.

In conclusion, we describe here different aspects of early postoperative pachymetry corneal maps based on anterior segment OCT. The profiles obtained provide insight into the pathogenesis of postoperative corneal swelling and possible strategies for reducing the frequency and severity of this relatively frequent event. By improving visualization of the limited, narrow surgical space in patients with shallow anterior chambers, the 3D system could help to decrease corneal edema, improving the satisfaction of both patients and surgeons on the first day after surgery.

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Figure legends:

Supplemental Fig. 1:

Wide 9-mm corneal pachymetry OCT map. Zone (Z) 1 represents the central 2 mm corneal zone. Z2 and Z3 correspond to the paracentral 2-5 mm corneal zones towards the principal corneal incision.

Supplemental Fig. 2:

Preoperative corneal map pachymetry (left) and corresponding pachymetry change analysis on the first postoperative day (right). A-C maps (right) correspond to type 1-3 postoperative corneal swelling profiles, respectively.

Fig. 3:

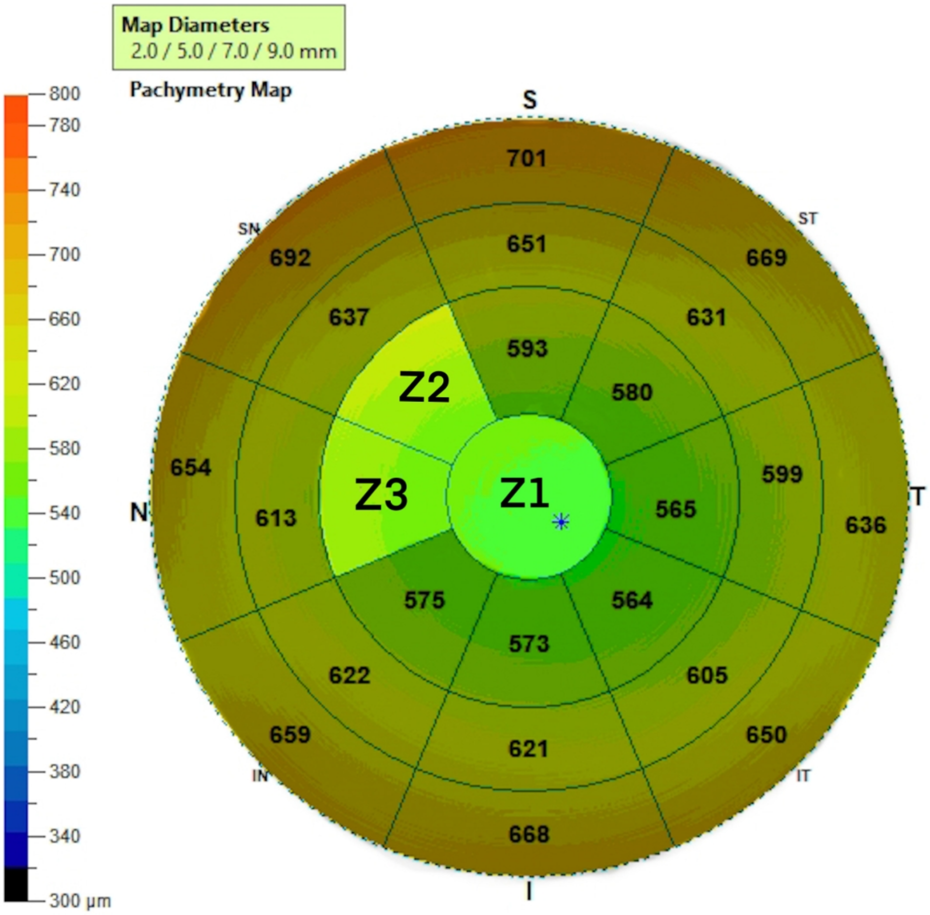
Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 1 corneal swelling profile: a limited corneal edema near peripheral corneal incisions is present in the 5-9 mm area.

Fig. 4:

Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 2 corneal swelling profile: dome-shaped corneal swelling spreading from the principal corneal incision and reaching the 2-5 mm paracentral cornea. Corneal edema is observed principally in the upper part of the cornea.

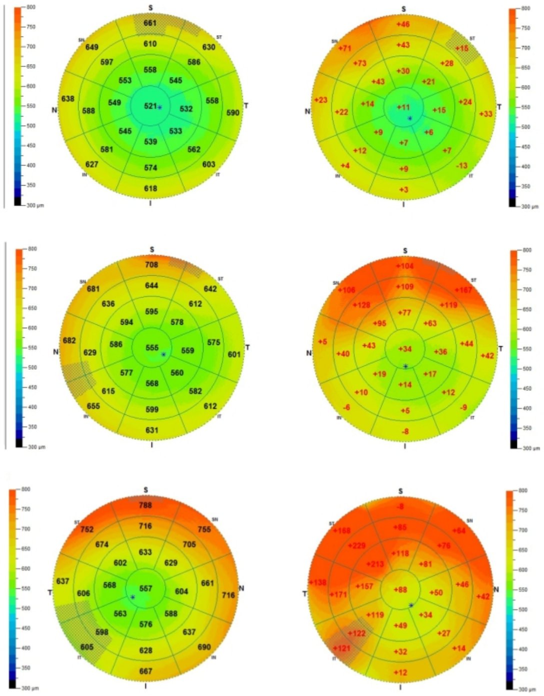
Fig. 5:

Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 3 corneal swelling profile: appearance of a continuous edema spreading from the principal corneal incision and reaching the central cornea. Generalized corneal edema is present and predominates in the upper part of the cornea.



Supplemental Fig. 1: Wide 9-mm corneal pachymetry OCT map. Zone (Z) 1 represents the central 2 mm corneal zone. Z2 and Z3 correspond to the paracentral 2-5 mm corneal zones towards the principal corneal incision.

172x173mm (300 x 300 DPI)



Supplemental Fig 2: Preoperative corneal map pachymetry (left) and corresponding pachymetry change analysis on the first postoperative day (right). A-C maps (right) correspond to type 1-3 postoperative corneal swelling profiles, respectively.

459x320mm (132 x 132 DPI)

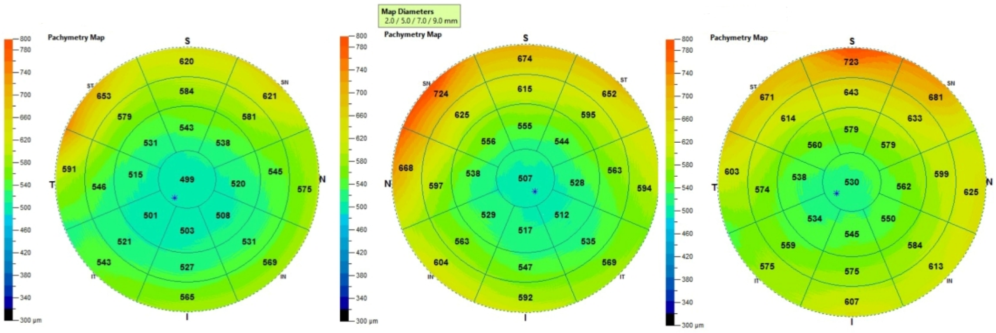


Fig. 3: Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 1 corneal swelling profile: a limited corneal edema near peripheral corneal incisions is present in the 5-9 mm area.

459x320mm (132 x 132 DPI)

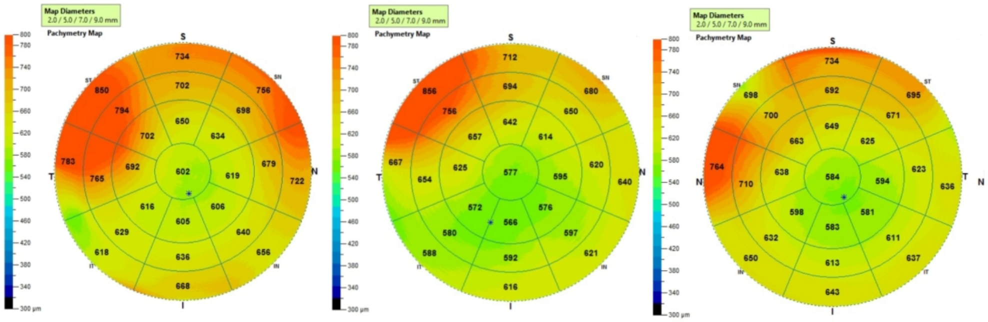


Fig. 4: Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 2 corneal swelling profile: dome-shaped corneal swelling spreading from the principal corneal incision and reaching the 2-5 mm paracentral cornea. Corneal edema is observed principally in the upper part of the cornea.

459x320mm (132 x 132 DPI)

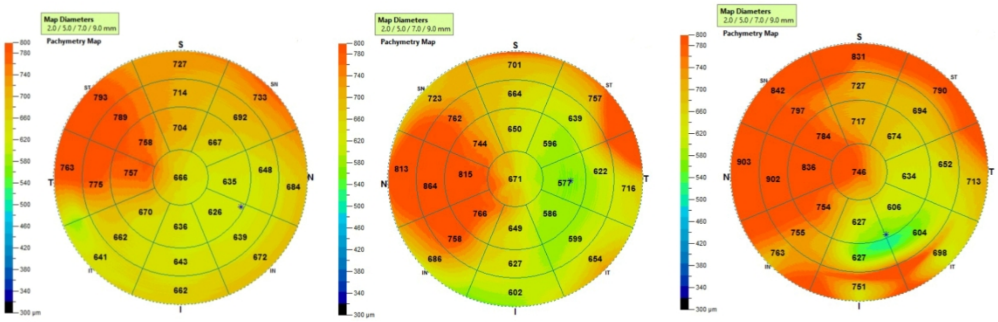


Fig. 5: Corneal pachymetry maps obtained on the first post-operative day after surgery and corresponding to the type 3 corneal swelling profile: appearance of a continuous edema spreading from the principal corneal incision and reaching the central cornea. Generalized corneal edema is present and predominates in the upper part of the cornea.

459x320mm (132 x 132 DPI)

Table 1: Comparison of baseline characteristics between conventional and 3D systems visualization in Group 1 (ACD < 3 mm)

	Conventional system (n=32)	3D viewing system (n=29)	P value
Age (years)	78.00 (7.63)	75.55 (8.20)	0.29*
Sex ratio	12/20	13/16	0.61†
Preop refractive error	0.18 (2.15)	0.86 (2.05)	0.32*
Axial length (mm)	23.04 (0.79)	22.89 (1.04)	0.80*
ACD (mm)	2.76 (0.17)	2.75 (0.22)	0.97*
Laterality (right/left)	18/14	14/15	0.61†
CDE	7.47 (2.58)	7.71 (2.86)	0.81*
Mean Z1 corneal thickness (µm)	530.5 (32.14)	526.1 (28.09)	0.75*
Mean Z2 corneal thickness (µm)	564.8 (34.99)	565.0 (30.88)	0.81*
Mean Z3 corneal thickness (µm)	548.8 (34.7)	548.2 (31.79)	0.82*

ACD = anterior chamber depth; CDE = cumulative dissipated energy; Z1 = central corneal 2-mm zone; Z2 and Z3 = paracentral 2-5 mm corneal zones towards the principal corneal incision.

*Mann-Whitney test

†Fisher's exact test

Table 2: Comparison of baseline characteristics between conventional and 3D systems visualization in Group 2 (ACD > 3 mm)

	Conventional system (n=43)	3D viewing system (n=30)	P value
Age (years)	72.74 (7.70)	72.23 (8.80)	0.82*
Sex ratio	18/25	13/17	1.0†
Preop refractive error	-1.41 (2.53)	-0.57 (3.11)	0.29*
Axial length (mm)	23.93 (1.14)	23.76 (1.09)	0.42*
AC depth (mm)	3.40 (0.34)	3.42 (0.33)	0.74*
Laterality (right/left)	25/18	14/16	0.35†
CDE	9.00 (4.33)	8.11 (3.22)	0.65*
Mean Z1 corneal thickness (µm)	531.1 (36.01)	528.7 (29.91)	0.80*
Mean Z2 corneal thickness (µm)	564.5 (37.76)	564.4 (33.55)	0.93*
Mean Z3 corneal thickness (µm)	551.8 (36.88)	552.2 (35.28)	0.94*

ACD = anterior chamber depth; CDE = cumulative dissipated energy; Z1 = central corneal 2-mm zone; Z2 and Z3 = paracentral 2-5 mm corneal zones towards the principal corneal incision.

*Mann-Whitney test

†Fisher's exact test

Table 3: Table showing P values for the association between dependent variables and the presence of central (Z1) and paracentral edema (Z 2 and 3) in group 1 (ACD ≤ 3 mm), using multivariate regression analysis.

	Change in Z1 corneal thickness	Change in Z2 corneal thickness	Change in Z3 corneal thickness
CDE	0.008	0.010	0.001
Type of visualization	0.006	0.009	0.004
Laterality of eye	0.345	0.164	0.306
ACD depth	0.199	0.180	0.393

CDE = cumulative dissipated energy; ACD = anterior chamber depth: Z1 = central corneal 2-mm zone; Z2 and Z3 = paracentral 2-5 mm corneal zones towards the principal corneal incision.

Table 4: Distribution and comparison of postoperative corneal edema type in group 1 (CA<3 mm).

	Conventional system	3D viewing system
Type 1	14 (44%)	22 (76%)
Type 2	9 (28%)	6 (21%)
Type 3	9 (28%)	1 (3%)
Total	32 (100%)	29 (100%)

Chi square test, p = 0,013