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Evaluation of Anterior Chamber Parameters in Keratoconus Patients with Post-Deep Anterior Lamellar Keratoplasty Glaucoma

Derin Ön Lameller Keratoplasti Sonrası Glokom Gelişen Keratokonus Hastalarında Ön Kamara Parametrelerinin İncelenmesi

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ABSTRACT

Objectives: The purpose of this study was to evaluate iridocorneal angle (ICA) and anterior chamber depth (ACD) that would be associated related to trabecular alteration as a cause of glaucoma following deep anterior lamellar keratoplasty (DALK).

Methods: Ninety-eight eyes of 98 keratoconus (KC) patients were included in this study. We compared pre-operative and post-operative 1st-year values of the ACD and ICA of patients with and without glaucoma following DALK.

Results: Four patients (4.1%) had glaucoma following DALK. Pre-operative ACD was 4.24±0.64 mm and it reduced to 3.41±0.44 mm post-operatively in glaucoma patients following DALK and; 4.12±0.56 mm and it reduced to 3.35±0.53 mm postoperatively in patients without glaucoma following DALK. Pre-operative ICA was 48.65±7.08 and it reduced to 48.05±13.14 post-operatively in glaucoma patients following DALK and; 49.48±7.62 and it reduced to 47.96±10.32 post-operatively in patients without glaucoma following DALK.

Conclusion: Our results demonstrate that ACD and ICA values are not significantly different between both groups with or without post-DALK glaucoma in KC patients.

Keywords: Anterior chamber depth; deep anterior lamellar keratoplasty; glaucoma; iridocorneal angle.

ÖZET

Amaç: Bu çalışmada, derin anterior lameller keratoplasti (DALK) sonrası glokom gelişen keratokonus hastalarında ön kamara derinliği ve iridokorneal açının değerlendirilmesi amaçlandı.

Yöntem: Çalışmaya 98 keratokonus hastasının 98 gözü dahil edildi. DALK sonrası glokom gelişen ve gelişmeyen olguların, ameliyat öncesi ve ameliyat sonrası birinci yıl ön kamara derinliği ve iridokorneal açı değerleri karşılaştırıldı.

Bulgular: Çalışmada, 4 (%4,1) hastada DALK sonrası glokom tespit edildi. DALK sonrası glokom gelişen hastalarda operasyon öncesi ve sonrası ön kamara derinliği sırasıyla 4,24±0,64 ve 3,41±0,44 mm idi. DALK sonrası glokom gelişmeyen hastalarda ise operasyon öncesi ve sonrası ön kamara derinliği sırasıyla 4,12±0,56 ve 3,35±0,53 mm idi. DALK sonrası glokom gelişen hastalarda operasyon öncesi ve sonrası iridokorneal açı sırasıyla 48,65±7,08 ve 48,05±13,14 idi. DALK sonrası glokom gelişmeyen hastalarda ise operasyon öncesi ve sonrası iridokorneal açı sırasıyla 49,48±7,62 ve 47,96±10,32 idi.

Sonuç: Çalışmamızda DALK sonrası glokom gelişen ve gelişmeyen keratokonus hastalarında operasyon öncesi ve sonrası ön kamara derinliği ve iridokorneal açı değerlerinde anlamlı bir fark tespit edilmedi.

Anahtar sözcükler: Derin anterior lameller keratoplasti; glokom; iridokorneal açı; ön kamara derinliği.

Corneal transplant surgery has evolved in the past decades from a process of replacement of the whole cornea as in penetrating keratoplasty (PK) to replacement of partial cornea as in deep lamellar keratoplasty (DALK), Descemet's striping-automated endothelial keratoplasty, and Descemet membrane endothelial keratoplasty. DALK currently is accepted as the first-line surgical treatment option in patients with corneal disease that is not involving the endothelium, such as corneal ectasies, stromal scars, and stromal dystrophies.[1] It requires the removal of only the stromal part of the cornea and replaces it with a full-thickness stromal bed, spares endothelium, and Descemet membrane. PK carries a higher risk of rejection and longer post-operative rehabilitation time than lamellar keratoplasty.[2,3] Since the DALK technique leaves the host endothelium intact, DALK reduces the risk of immune rejection and endothelial cell loss, and therefore, it can provide graft longevity potentially for the life of the patient.[2,3]

Glaucoma is a well-known complication following various corneal transplantation surgeries leading to loss of the visual potential of the eye due to irreversible damage to the optic nerve. The incidence of glaucoma following DALK was reported to range from 0 to 9.[4-8]

The pathophysiology of post-PK glaucoma is multifactorial and may be related to distortion of the angle with the collapse of the trabecular meshwork, suturing technique, post-operative inflammation, use of corticosteroids, peripheral anterior synechiae formation, and pre-existing glaucoma.[9,10]

Edema and inflammation after surgery lead to further compromise in the trabecular meshwork function, and the situation is further aggravated by angle distortion. Factors that contribute to angle distortion include tight suturing, long bites, larger trephine sizes, smaller recipient corneal diameter, and increased peripheral corneal thickness.[9]

We evaluate iridocorneal angle (ICA) and anterior chamber depth (ACD) that would be associated with some of these hypotheses related to trabecular alteration as a cause of glaucoma following DALK using corneal topography that can visualize the trabecular outflow pathways.

Methods

In this retrospective study, we reviewed the medical records of 98 patients diagnosed with keratoconus (KC) who underwent DALK between 2014 and 2017 at Kartal Lütfi Kırdar Training and Research Hospital, Eye Clinic. The study was conducted according to the criteria set by the Declaration of Helsinki.

All patients underwent the same surgical procedure with the same surgeon. Air bubble technique is used to separate the corneal stromal bed from the Descemetic membrane. Following injection of air through a trephine, a flap usually with a 7–7.5 mm diameter carefully removed. Injected air accesses the plane between the pre-Descemetic membrane and the Descemetic membrane by passing through tiny fenestrations along the corneal periphery, central to the attachment of the Descemetic membrane is exposed. The donor cornea was cut from the underlying endothelium with a 0.25 or 0.50 mm larger Barron Donor Cornea Punch (Katena Products, Inc., Denville, NJ, USA), and the endothelium was scraped completely from the button. The donor cornea was placed on the recipient bed and sutured using eight separate and 16-bite single-running sutures with 10–0 monofilament nylon sutures. Patients who underwent DALK with manual lamellar dissection technique due to the unsuccessful big bubble technique were excluded. Patients who had perioperative and post-operative complications (like micro- or macroDescement perforation and double anterior chamber formation) were also excluded.

Changes in corneal thickness, postoperative astigmatism, and refractive changes often preclude reliable post-operative assessment of IOP.[11] If the corneal graft surface is regular with an intact epithelium, Goldmann's applanation tonometer can be used to measure the IOP.[12]

Post-operative IOP was recorded using Goldman applanation tonometer once the corneal epithelial defect has healed. Patients having IOP >21 mmHg on two different visits after surgery, with or without associated disc and/or visual field changes, were diagnosed to have post-DALK glaucoma in the study. Patients with pre-existing glaucoma were excluded.

All patients were evaluated with Sirius topography device (Sirius; Costruzione Strumenti Oftalmici, Scandicci, Florence, Italy) which enable to combine Placido disk topography with Scheimpflug tomography. In topographic records, we compared pre-operative and post-operative 1st-year values of the ACD and ICA of patients with and without post-DALK glaucoma.

Statistical Analysis

All statistical analyses were performed using SPSS (IBM SPSS Statistics for Windows, Version 23.0. Released 2014.

IBM Corp., Armonk, NY, USA). p<0.05 was considered statistically significant. Kolmogorov–Smirnov test was used to assess the normal distribution of continuous variables. ICA and ACD values following DALK were compared to the baseline using paired t-tests in both groups; after seen, all of the continuous variables were normally distributed. Pre-operative and post-operative ICA and ACD values were also compared between groups with and without post-DALK glaucoma, using independent t-test.

Results

Ninety-eight eyes of 98 KC patients were included in this study. There were 59 (60.2%) male and 39 (39.8%) female patients. The mean age was 26.8±8.28 years (range: 16–40 years). According to the Amsler-Krumeich classification[13] of KC disease, 8 eyes (8.2%) were in stage I, 11 eyes (11.2%) were in stage II, 26 eyes (26.5%) were in stage III, and 53 eyes (54.1%) were in stage IV KC.

Four patients (4.1%) were diagnosed with post-DALK glaucoma. The mean diagnosis time for post-DALK glaucoma was 5.32±2.01 months. The mean İOP was 26,64±4.89 mmHg.

Pre-operative ACD was 4.24±0.64 mm and it reduced to 3.41±0.44 mm post-operatively in post-DALK glaucoma patients. This reduction was found statistically significant (p<0.001). The ICA values showed no significant difference (p=0.672) between pre-operative and post-operative values in post-DALK glaucoma patients (48.65±7.08 and 48.05±13.14, respectively).

Pre-operative ACD was 4.12±0.56 mm and it reduced to 3.35±0.53 post-operatively in post-DALK patients without glaucoma. This reduction was also found statistically significant (p=0.001). The ICA values showed no significant difference (p=0.286) between pre-operative and post-operative values in post-DALK patients without glaucoma (49.48±7.62 and 47.96±10.32, respectively). Pre-operative and post-operative ACD and ICA values are shown for both groups in Table 1.

Pre-operative and post-operative ACD and ICA values were also compared between two groups with and without post-DALK glaucoma. Pre-operative and post-operative ACD values were not significantly different between the two groups. Pre-operative and post-operative ICA values also were not significantly different between the two groups all values shown in Table 2.

Table 1. Pre-operative and post-operative ACD and ICA values shown for both groups

	Pre-operative	Post-operative	p*
With post-DALK glaucoma (n=4)			
Anterior chamber depth	4.24±0.64	3.41±0.44	<0.001
Iridocorneal angel	48.65±7.08	48.05±13.14	0.672
Without post-DALK glaucoma (n=94)			
Anterior chamber depth	4.12±0.56	3.35±0.53	<0.001
Iridocorneal angel	49.48±7.62	47.96±10.32	0.286

*Paired t-test. ACD: Anterior chamber depth; DALK: Deep anterior lamellar keratoplasty; ICA: Iridocorneal angle.

Table 2. Comparison of pre-operative and post-operative ACD and ICA values between groups

	With post-DALK glaucoma (n=4)	Without post-DALK glaucoma (n=94)	p*
Pre-operative			
ACD	4.24±0.64	4.12±0.56	0.364
ICA	48.65±7.08	49.48±7.62	0.446
Post-operative			
ACD	3.41±0.44	3.35±0.53	0.512
ICA	48.05±13.14	47.96±10.32	0.678

*Independent t-test. ACD: Anterior chamber depth; DALK: Deep anterior lamellar keratoplasty; ICA: Iridocorneal angle.

Discussion

The primary goal after corneal transplantation is the re-establishment of visual acuity for the patient. Achieving good visual acuity requires a clear graft and low and regular corneal astigmatism but could be limited by glaucoma due to irreversible damage to the optic nerve.[14]

The pathophysiology of post-PK glaucoma is multifactorial, including among the causes the compression of the angle's anatomical elements with the trabecular meshwork's collapse, incorrect suture of the graft, post-operative inflammation, and prolonged use of corticosteroids in the post-operative treatment.[9,10]

Zimmerman et al.[15] demonstrated how the trabecular meshwork's collapse is the main cause of glaucoma; they advocated that for easy access through the anterior chamber angle tothe trabeculum needs a posterior fixation, sustained by the ciliary body-lens complex and an anterior fixation at the level of Descemet membrane. In aphakic and pseudophakic eyes, the posterior support is relaxed due to lens removal. On the other side, the incision through the Descemet membrane in PK relaxes the anterior support, the Descemet membrane being capable of displacing toward the angle. Contribute to the distortion of the angle and so to the reduction of the outflow: Tight sutures (widen the gap between the margins of the incision in the Descemet membrane), lengthy sutures (compress even more the tissues), and large grafts and thick peripheral corneas.[11]

In summary of the literature, the incidence of secondary glaucoma after PK is highly variable, ranging from 10% to 42% that depended on the surgical indication of PK and the complexity of surgery.[4,16,17] The lowest incidence of IOP rise was reported in the patients with KC, ranging between 0% and 16.7%.[16,17] The incidence of glaucoma following DALK was lower to PK, reported to range from 0 to 9%.[4-8] Borderie et al.[4] studied the incidence of glaucoma in 284 KC patients who underwent DALK and PK. The incidence of glaucoma was 26% in 142 post-PK patients and 6% in post-DALK patients at 5 years after surgery. Han et al.[6] included 25 DALK and 100 PK patients diagnosed with KC in their study. The incidence of glaucoma was 14% after PK and 0% after DALK at 2 years after surgery. In another study by Huang et al.,[8] the incidence of glaucoma following DALK was reported %4.48 in 122 patients at 5 years after surgery. In our study, 4 of 98 (4.1%) KC patients developed post-DALK glaucoma as compatible with these studies.

Steroid-induced IOP elevation is one of the important causes of late-onset post-keratoplasty glaucoma.[14] Pramanik et al.[18] reported steroid-induced glaucoma in 4 (3.6%) of 112 eyes of patients with KC after PK with a mean follow-up of 13.8 years. We did not include patients with steroid-induced glaucoma in our study.

In the present study, we found that ACD values significantly decreased in both groups with and without post-DALK glaucoma as compatible with the literature.[19,20] Italon et al.[19] investigated axial length and ACD after PK in 30 eyes with KC. These researchers reported that the pre-operative ACD decreased from 3.72±0.43 mm to 3.47±0.33 mm at 2 years after PK. In another study, the mean pre-operative ACD decreased from 3.92±0.47 mm to 3.01±0.55 mm at 6 months after PK in 68 KC patients.[20]

We observed that there was no statistically significant change in the mean ICA value following DALK surgery in both groups with and without post-DALK glaucoma. Ort et al.[20] reported that there were so significant changes in IKA values following PK in 68 eyes of 68 KC patients.

Uncontrolled IOP is also an important risk factor for endothelial cell loss, and post-keratoplasty glaucoma represents the second leading cause of graft failure after rejection.[21] We evaluate ICA and ACD that would be associated with some of these hypotheses related to trabecular alteration as a cause of glaucoma following DALK using corneal topography that can visualize the trabecular outflow pathways. Our results demonstrate that ACD and ICA values are not different between both groups with or without post-DALK glaucoma in KC. In addition, in this study, the sample size was small, so studies with larger numbers of patients are needed to confirm our findings and to fully clarify the mechanism of post-DALK glaucoma in KC.

Disclosures

Ethics Committee Approval: FSMEAH-KAEK 2020/132, 24.10.2020 2020/23.

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Conflict of Interest: None declared.

Authorship Contributions: Concept – Ü.Ç, B.K.; Design – Ü.Ç.; Supervision – Ü.Ç., B.K.; Materials – Ü.Ç.,B.K.; Data collection &/or processing – Ü.Ç.; Analysis and/or interpretation – Ü.Ç.; Literature search – Ü.Ç.; Writing – Ü.Ç.; Critical review – Ü.Ç.,B.K.

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