# Traumatic Wound Dehiscence After Deep Anterior Lamellar Keratoplasty

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**• PURPOSE: To analyze the outcomes of traumatic wound dehiscence after deep anterior lamellar keratoplasty (DALK).**

**• DESIGN: Retrospective and interventional case series.**

**• METHODS: SETTING: Single hospital. PATIENTS: A total of 338 consecutive cases were reviewed. Eleven eyes that had wound dehiscence related to ocular trauma were included. MAIN OUTCOME MEASURES: Incidence and causes, best-corrected visual acuity (BCVA), and endothelial cell density were evaluated. Complications and secondary surgeries were recorded.**

**• RESULTS: Seven patients were male (63.6%) and 4 patients were female (36.4%), with a mean age of 30.6 years (range, 24-40 years). The incidence of wound dehiscence was 3.2% (11/338). The mean interval between the initial DALK procedure and wound dehiscence was 9.45 months (range, 2-16 months). The mean follow-up time was 6 years. The most common trauma was a fist blow injury (36.3%). Descemet membrane perforation was observed in 8 eyes (72.7%); lens damage and vitreous prolapse occurred in 2 eyes (18.1%). The final BCVA was 0.51 and was maintained in 4 eyes (36.3%). At the final visit, 10 grafts (90.9%) were clear. The mean endothelial cell loss was 55.8% between before DALK and last visit.**

**• CONCLUSION: Although the intact Descemet membrane protects against dehiscing traumas after DALK, a relative weakness at the graft-host junction tends to persist and a severe deforming force may result in graft dehiscence. This case series indicates that despite the fact that the visual results following the repair are acceptable, corneal endothelium seems to be subjected to severe damage, which puts graft survival chances at risk in the long term. (Am J Ophthalmol 2013;156:767–772. © 2013 by Elsevier Inc. All rights reserved.)**

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TRAUMATIC WOUND DEHISCENCE AFTER PENETRATING keratoplasty (PK) is not a rare occurrence, suggesting that the graft-host interface does not achieve the tensile strength of a primary corneal tissue.[1,2] Even years after PK, wound dehiscence may happen with a relatively minor trauma.[3] Deep anterior lamellar keratoplasty (DALK) has been recommended as a viable surgical option to PK for the management of corneal disease with a healthy endothelium.[4] As the Descemet membrane is kept intact in DALK surgery, it is arguable that the healing is faster and the wound more durable compared to PK. Additional support provided by an uninterrupted endothelium, a healthier restoration process, and reduced need for topical steroids may contribute to the formation of a stronger graft-host interface.

To date, there are only a few case reports about traumatic graft dehiscence following lamellar keratoplasty.[5–7] Also, long-term results of the wound repair are yet to be demonstrated. In this study, we investigated causes and characteristics of traumatic wound dehiscence in eyes with DALK. We also summarized data related to graft survival and visual prognosis, changes in endothelial cell density, and secondary complications. On the other hand, our PubMed research yielded no data related to the effect of traumatic wound dehiscence on endothelial cell density in eyes with DALK.

## SUBJECTS AND METHODS

THIS STUDY IS A RETROSPECTIVE, NONCOMPARATIVE, interventional case series. Medical records of all patients having undergone DALK surgery between January 1, 2003 and August 30, 2012 at Kartal Training and Research Hospital, Istanbul, Turkey for the treatment of different corneal pathologies were reviewed. Eyes that had a wound dehiscence related to ocular trauma were included in the study. Eyes with nontraumatic loosening or breakage of corneal sutures were not included. Patients who were lost to follow-up were also excluded. Informed consent was obtained from all patients in accordance with the Declaration of Helsinki and the study was approved by the Institutional Review Board of Kartal Training and Research Hospital.

Initial DALK procedures were performed using the big-bubble technique previously described by Anwar and Teichmann.[8] When a big bubble could not be generated

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after repeated attempts, a layer-by-layer manual dissection was performed. All patients received immediate surgical intervention within several hours after the admission. The wound was repaired under local anesthesia with interrupted or continuous 10/0 nylon sutures. Anterior vitrectomy, crystalline lens extraction, or iris repositioning was performed at the same session when necessary. Subsequent secondary surgeries, if any, were noted.

All patients underwent ophthalmic examination including decimal Snellen best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, and assessment of endothelial cell density (ECD) and graft clarity. The endothelium was evaluated with a Topcon SP 2000p noncontact specular microscope (Topcon Corp, Tokyo, Japan). Twenty endothelial cells were marked for each count and 3 measurements of ECD were averaged. Causes of the ocular trauma, demographic characteristics of patients, extents of the wound dehiscence, and surgical complications were also recorded. Quantitative data were described as mean ± standard deviation (range). The mean changes in endothelial cell density and BCVA were compared using SPSS statistics software package v. 15.0 (SPSS, Inc, Chicago, Illinois, USA). A *P* value less than .05 was considered statistically significant.

## RESULTS

IN OUR CLINIC, THE DALK PROCEDURE WAS PERFORMED IN 351 eyes during the years 2003-2012. Thirteen eyes were lost to follow-up and excluded from the data analyses. Among the remaining 338 eyes, 11 eyes (3.2%) presented with wound dehiscence attributable to ocular trauma. The Kaplan-Meier survival curve is demonstrated in the Figure. Demographic data of the patients are summarized in Table 1. Seven patients were male (63.6%) and 4 patients were female (36.4%). Their mean age was 30.6 ± 5.4 years (range, 24-40 years). The indication for DALK surgery was keratoconus in 6 eyes (54.5%), stromal dystrophies in 3 eyes (27.3%), and herpetic keratitis in 2 eyes (18.1%). DALK was performed with big-bubble technique in 7 eyes (63.7%) and with layer-by-layer stromal dissection in 4 eyes (36.4%). Following the trauma, the sutures had to be completely removed in 2 eyes (18.1%) and partially removed in 9 eyes (81.9%) by the treating ophthalmologist at the time of the injury. The mean interval between initial DALK procedure and traumatic wound dehiscence was 9.45 ± 5.0 months (range, 2-16 months). The mean follow-up time after the repair surgery was 6.09 ± 2.77 years (range, 1-9 years).

The most common type of trauma was a fist blow injury (4 cases; 36.4%). In all eyes, the wound dehiscence occurred at the graft-host interface. The dehiscence involved 3 quadrants in 2 eyes (18.1%), 2 quadrants in 6 eyes (54.5%), and 1 quadrant in 3 eyes (27.3%). Descemet membrane perforation attributable to the trauma was observed in 8 eyes (72.7%). During the repair surgery, microperforation occurred at the graft-host junction in 1 eye (9.1%). The repair surgery was continued with the help of air injection into the anterior chamber. All eyes were phakic before the trauma. Crystalline lens damage and vitreous prolapse occurred in 2 eyes (18.1%), which required lens extraction combined with anterior vitrectomy.

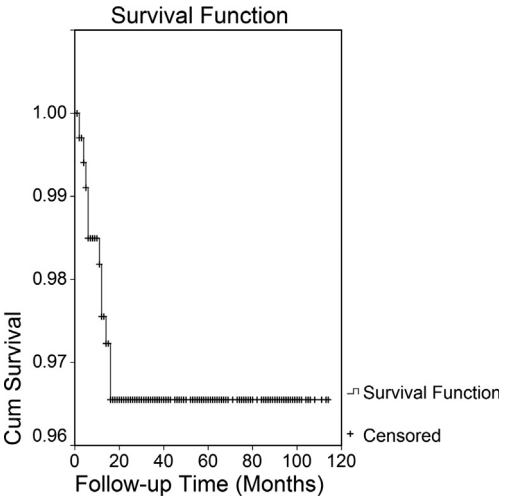


**FIGURE. Kaplan-Meier survival curve of traumatic wound dehiscence after deep anterior lamellar keratoplasty.**

The course of mean visual acuities is summarized in Table 2. The mean BCVA was 0.04 ± 0.03 (range, 0.01-0.1) before DALK and 0.60 ± 0.20 (range, 0.1-0.8) at the last visit before the trauma. BCVA on admission immediately after the traumatic wound dehiscence was light perception in 2 eyes (18.1%), hand movements in 3 eyes (27.3%), and counting fingers in 6 eyes (54.5%). At the final visit after the repair surgery the mean BCVA was 0.51 ± 0.19 (range, 0.05-0.8). The difference between the mean BCVA at the last visit before trauma and the mean BCVA at the final visit was not found to be statistically significant ($P > .05$). BCVA was maintained in 4 eyes (36.4%) and decreased in 7 eyes (63.6%) after the trauma.

At the final visit, 10 grafts (90.9%) were clear, while interface opacities were observed in 1 eye (9.1%). The course of endothelial cell density measurements throughout the follow-up period is documented in Table 2. Endothelial cell density measurements were unavailable in 5 eyes (45.4%) because of deep corneal scarring. The mean endothelial cell density was measured at 3120 ± 234 cells/mm$^2$, 2776 ± 313 cells/mm$^2$, and 1363 ± 445 cells/mm$^2$ before DALK, before the trauma, and at the final visit, respectively. The mean percentage of endothelial cell loss was found to be 55.8% ± 13.8% (n = 6, range 37.8%-69.5%) between the visit before DALK and the final visit ($P < .001$), and 53.5% ± 15.0% (n = 9, range 32.5%-67.5%) between the last visit before the trauma and the final visit ($P < .001$).

**TABLE 1.** Demographic Features and Clinical Findings in Patients With Traumatic Wound Dehiscence After Deep Anterior Lamellar Keratoplasty

| Patient | Age at Trauma (y) | Sex | Indication for DALK | Dissection Plane of the DALK Surgery | Interval DALK to Wound Dehiscence (mo) | Nature of Trauma | Number of Wound Dehiscence Quarants | Descemet Membrane Status Just After Trauma | Lens | Posterior Segment | Follow-up Time (y) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 25 | M | Stromal dystrophy | dDALK | 16 | Fist blow | 2 | Perforated | - | - | 9 |
| 2 | 26 | F | Keratoconus | dDALK | 12 | Fist blow | 1 | Intact | | - | 9 |
| 3 | 33 | F | Keratoconus | pdDALK | 6 | Fell during a fight | 3 | Perforated | Crystalline lens expulsion | Vitreous loss | 9 |
| 4 | 34 | M | Stromal dystrophy | dDALK | 6 | Fist blow | 1 | Intact | - | - | 8 |
| 5 | 38 | F | Keratoconus | dDALK | 14 | Struck by door | 2 | Perforated | - | - | 6 |
| 6 | 31 | M | Herpes keratitis | dDALK | 2 | Fist blow | 2 | Perforated | - | - | 6 |
| 7 | 28 | M | Keratoconus | pdDALK | 4 | Struck by metal object | 3 | Perforated | Crystalline lens expulsion | Vitreous loss | 4 |
| 8 | 24 | F | Keratoconus | pdDALK | 11 | Fell during a fight | 1 | Intact | - | - | 4 |
| 9 | 34 | M | Herpes keratitis | pdDALK | 12 | Struck by door | 2 | Peforated | - | - | 8 |
| 10 | 40 | M | Stromal dystrophy | dDALK | 16 | Fell on the face and struck eye | 2 | Perforated | - | - | 3 |
| 11 | 24 | M | Keratoconus | dDALK | 5 | Struck by door | 2 | Perforated | - | - | 1 |

DALK = deep anterior lamellar keratoplasty; dDALK = descemetic deep anterior lamellar keratoplasty; pdDALK = predescemetic deep anterior lamellar keratoplasty.

**TABLE 2.** Visual Acuity and Endothelial Cell Density Outcomes as Well as Graft Clarity and Complications in Patients who Underwent Graft Repair Surgery Because of Traumatic Wound Dehiscence After Deep Anterior Lamellar Keratoplasty

| Patient | BCVA Before DALK | BCVA Before Trauma | BCVA Immediately After Trauma | Final BCVA | ECD Before DALK (Cells/mm$^2$) | ECD Before Trauma (Cells/mm$^2$) | Final ECD (Cells/mm$^2$) | Graft Clarity | Additional Complications and Surgeries |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1 | 0.8 | Hand movements | 0.7 | 3322 | 3053 | 1198 | Clear | Phacoemulsification and IOL implantation |
| 2 | 0.05 | 0.4 | Counting fingers | 0.4 | 3216 | 3018 | 1956 | Clear | - |
| 3 | 0.05 | 0.7 | Light perception | 0.5 | NDA | 2954 | 958 | Clear | Secondary IOL implantation with scleral fixation |
| 4 | 0.05 | 0.6 | Counting fingers | 0.6 | NDA | 2658 | 1745 | Clear | Phacoemulsification and IOL implantation |
| 5 | 0.05 | 0.8 | Hand movements | 0.6 | NDA | 2957 | 1013 | Clear | |
| 6 | 0.01 | 0.1 | Hand movements | 0.05 | NDA | 2156 | NDA | Hazy | Corneal melting, regrafting with penetrating keratoplasty |
| 7 | 0.1 | 0.5 | Light perception | 0.5 | 3162 | 2867 | 963 | Clear | Secondary IOL implantation with scleral fixation |
| 8 | 0.01 | 0.8 | Counting fingers | 0.8 | 2658 | 2448 | 1652 | Clear | |
| 9 | 0.05 | 0.6 | Counting fingers | 0.4 | NDA | 2348 | NDA | Clear | |
| 10 | 0.05 | 0.7 | Counting fingers | 0.6 | 3215 | 2956 | 1133 | Clear | |
| 11 | 0.01 | 0.6 | Counting fingers | 0.5 | 3148 | 3014 | 1249 | Clear | |

BCVA = best-corrected visual acuity; DALK = deep anterior lamellar keratoplasty; ECD = endothelial cell density; IOL = intraocular lens; NDA = no data available.

Secondary surgical interventions were needed in 5 eyes (45.4%, Table 2). In order to manage secondary cataracts, phacoemulsification and intraocular lens (IOL) implantation were performed in 2 eyes (18.1%) 22 and 24 months after the trauma. Scleral-fixated secondary IOL implantation was carried out in 2 eyes (18.1%) with crystalline lens damage 18 and 32 months after the graft dehiscence. Corneal graft melting secondary to herpetic keratitis reactivation occurred in 1 eye (9.1%) and regrafting with PK was required 56 months after traumatic graft dehiscence.

## DISCUSSION

DALK IS CURRENTLY RECOMMENDED AS THE PROCEDURE OF choice, particularly in young and active patients with keratoconus and corneal scars involving the stroma. Therefore, a sustained period of postoperative care and caution should be provided following the surgery. Traumatic wound dehiscence following keratoplasty has been considered a destructive complication associated with weak graft-host junction related to several factors such as inappropriate wound apposition, avascularity of the interface, prolonged treatment with topical steroids, and suture complications.[9] It is expected that lamellar keratoplasty techniques such as DALK maintain the integrity of the globe better and reduce the rate of traumatic graft dehiscence as well as the severity of its consequences. Several aspects of wound dehiscence after PK (ie, incidence, types of trauma, age and sex distribution, and visual prognosis) have been evaluated in many studies.[1–3] The incidence of traumatic wound dehiscence after DALK and its outcomes, however, have not been adequately studied yet.

In the current study, the incidence of traumatic wound dehiscence following DALK was found to be 3.2% (11/338). This finding is similar to that of other PK series in which the incidences have been reported between 0.6% and 5.8%.[10] In a previous report about DALK surgery, traumatic globe rupture was declared in 1 out of 186 cases and the incidence was calculated as 0.5%.[11] Although this rate is lower than the current study, Kawashima and associates' observation may be biased by a small population and a relatively short follow-up period.

In our study, the mean interval between keratoplasty and wound dehiscence was 9.45 months and the most common indication was keratoconus, with a mean age of 30.6 years. In the literature, the average time for traumatic wound dehiscence after PK has been reported between 15.6 months and 7.5 years.[1–3,12,13] The higher prevalence of wound dehiscence in the early postoperative period after DALK may be explained by the higher physical activity of a younger patient profile and by early mobilization attributable to rapid visual rehabilitation. Similarly, Rehany and Rumelt[14] reported traumatic wound dehiscence to be more common in younger patients and also in those who had undergone keratoplasty for keratoconus.

Previous studies concluded that concomitant posterior segment damage and lens injury were associated with poor visual prognosis.[13,15] Although in case of a trauma the recipient Descemet membrane may act as a physical barrier for intraocular tissues, in our study an intact Descemet membrane was observed in only 3 out of 11 eyes (27.2%) and lens damage with vitreous prolapse was observed in 2 eyes (18.2%). Final BCVA results have been reported from loss of light perception to 20/80 depending on the extent of posterior segment damage following PK.[1–3,10–16] However, posttraumatic visual outcomes seem to be better in DALK cases.[5,6,11] Accordingly, in the present study the mean BCVA was 0.51, and 4 out of 11 eyes (36.3%) maintained the visual acuity prior to the trauma. When compared to previous reports about traumatic wound dehiscence after DALK, relatively better visual outcomes observed in our study group may be related to the fact that posterior segment complications such as retinal detachment and vitreous hemorrhage did not occur in any of the cases and the damaged lens was successfully managed with secondary IOL implantation.

Corneal endothelial cell function is essential for long-term graft survival and functional success of any type of keratoplasty. It is reasonable to believe that a successful and uncomplicated DALK causes less damage to the endothelium and fewer immunologic reactions, resulting in a lower rate of postoperative endothelial cell loss. Although it is known that DALK complications such as Descemet membrane perforation, Descemet membrane detachment, double anterior chamber, and immunologic reactions cause accelerated loss of endothelial cell density, the effect of a traumatic graft dehiscence and its repair on endothelial cell density has not been evaluated yet.[17–21] In this study, we also aimed to assess corneal endothelial status throughout the follow-up period. In our previously published study, we have found that the mean endothelial cell loss was 22.5% at 8 years after DALK.[4] This rate was even more prominent in eyes with intraoperative Descemet membrane perforation, possibly related to intraoperative Descemet membrane trauma. In the current study, the mean endothelial cell loss was calculated as 55.8% between the visit before DALK and the final visit and endothelial cell density was found to be lower than 1500 cells/mm$^2$ in 54.5% of the eyes. This severe reduction in endothelial cell density seems to be caused by initial traumatic damage accompanied by iris and/or lens touch, as well as Descemet membrane perforation at the graft-host junction and additional trauma related to the repair and secondary surgeries. The small number of cases in our study and retrospective design, however, is a limitation that could cause bias and warrants further studies with larger numbers of cases for a more reliable judgment.

Although it is reasonable to suppose that the intact Descemet membrane provides a reinforcement against dehiscing traumas after DALK surgery, a relative weakness at the graft-host junction seems to persist and

a severe deforming force may result in graft dehiscence. Despite the fact that the visual results following the repair are acceptable, corneal endothelium seems to be subjected to a severe damage, which puts graft survival chances at risk in the long term. Therefore, warning patients against the risk of trauma and recommendation of the regular use of eye protection are crucial after DALK surgery.

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## REFERENCES

1. Farley MK, Pettit TH. Traumatic wound dehiscence after penetrating keratoplasty. *Am J Ophthalmol* 1987;104(1):44–49.
2. Raber IM, Arentsen JJ, Laibson PR. Traumatic wound dehiscence after penetrating keratoplasty. *Arch Ophthalmol* 1980;98(8):1407–1409.
3. Tseng SH, Lin SC, Chen FK. Traumatic wound dehiscence after penetrating keratoplasty: clinical features and outcome in 21 cases. *Cornea* 1999;18(5):553–558.
4. Kubaloglu A, Sari ES, Unal M, Koytak A, Kurnaz E, Cinar Y, Ozertürk Y. Long-term results of deep anterior lamellar keratoplasty for the treatment of keratoconus. *Am J Ophthalmol* 2011;151(5):760–767.
5. Lee WB, Mathys KC. Traumatic wound dehiscence after deep anterior lamellar keratoplasty. *J Cataract Refract Surg* 2009;35(6):1129–1131.
6. Chaurasia S, Ramappa M. Traumatic wound dehiscence after deep anterior lamellar keratoplasty. *J AAPOS* 2011;15(5):484–495.
7. Prasher P, Muftuoglu O, Mootha VV. Traumatic graft dehiscence after anterior lamellar keratoplasty. *Cornea* 2009;28(2):240–242.
8. Anwar M, Teichmann KD. Deep lamellar keratoplasty: surgical techniques for anterior lamellar keratoplasty with and without baring of Descemet's membrane. *Cornea* 2002;21(4):374–383.
9. Lam FC, Rahman MQ, Ramaesh K. Traumatic wound dehiscence after penetrating keratoplasty-a cause for concern. *Eye (Lond)* 2007;21(9):1146–1150.
10. Williams MA, Gawley SD, Jackson AJ, Frazer DG. Traumatic graft dehiscence after penetrating keratoplasty. *Ophthalmology* 2008;115(2):276–278.
11. Kawashima M, Kawakita T, Shimmura S, Tsubota K, Shimazaki J. Characteristics of traumatic globe rupture after keratoplasty. *Ophthalmology* 2009;116(11):2072–2076.
12. Friedman AH. Late traumatic wound rupture following successful partial penetrating keratoplasty. *Am J Ophthalmol* 1973;75(1):117–120.
13. Agrawal V, Wagh M, Krishnamachary M, Rao GN, Gupta S. Traumatic wound dehiscence after penetrating keratoplasty. *Cornea* 1995;14(6):601–603.
14. Rehany U, Rumelt S. Ocular trauma following penetrating keratoplasty: incidence, outcome, and postoperative recommendations. *Arch Ophthalmol* 1998;116(10):1282–1286.
15. Elder MJ, Stack RR. Globe rupture following penetrating keratoplasty: how often, why, and what can we do to prevent it? *Cornea* 2004;23(8):776–780.
16. Das S, Whiting M, Taylor HR. Corneal wound dehiscence after penetrating keratoplasty. *Cornea* 2007;26(5):526–529.
17. Salouti R, Masoumpour M, Nowroozzadeh MH, Zamani M, Ghoreyshi M, Melles GR. Changes in corneal endothelial cell profile measurements after deep anterior lamellar keratoplasty for keratoconus. *Cornea* 2013;32(6):751–756.
18. Tan DT, Dart JK, Holland EJ, Kinoshita S. Corneal transplantation. *Lancet* 2012;379(9827):1749–1761.
19. Sarnicola V, Toro P, Sarnicola C, Sarnicola E, Ruggiero A. Long-term graft survival in deep anterior lamellar keratoplasty. *Cornea* 2012;31(6):621–626.
20. Borderie VM, Sandali O, Bullet J, Gaujoux T, Touzeau O, Laroche L. Long-term results of deep anterior lamellar versus penetrating keratoplasty. *Ophthalmology* 2012;119(2):249–255.
21. Cheng YY, Visser N, Schouten JS, et al. Endothelial cell loss and visual outcome of deep anterior lamellar keratoplasty versus penetrating keratoplasty: a randomized multicenter clinical trial. *Ophthalmology* 2011;118(2):302–309.

## Biosketch

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