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Factors influencing visual outcome after penetrating keratoplasty combined with intraocular lens implantation

J.B. JONAS[1,2], R.M. RANK[2], W.M. BUDDE[1,2], G. SAUDER[1]

[1] Department of Ophthalmology and Eye Hospital, Faculty of Clinical Medicine Mannheim, Ruprecht-Karls-University Heidelberg

[2] Department of Ophthalmology and Eye Hospital, Friedrich-Alexander-University Erlangen-Nürnberg - Germany

PURPOSE. *To establish which factors influence visual outcome after penetrating keratoplasty combined with intraocular lens implantation.*

METHODS. *This retrospective noncomparative clinical interventional case series study included 135 consecutive patients (mean age 70.2 ± 13.6 years) who underwent central penetrating allogenic keratoplasty combined with intraocular lens (IOL) implantation, all operated by the same surgeon. There were 79 triple procedures, 33 keratoplasties combined with an exchange of IOL, and 23 penetrating keratoplasties combined with a secondary implantation of a posterior chamber lens. Mean follow-up was 28.3 ± 18.7 months (range 3.3-112 months). Reasons for keratoplasty were herpetic or traumatic corneal scars or defects (46), Fuchs corneal endothelial dystrophy (22), pseudophakic or aphakic bullous keratopathy (49), corneal endothelial decompensation due to other reasons (15), and keratoconus (3). Main outcome measures were postoperative visual acuity and gain in visual acuity.*

RESULTS. *Mean postoperative visual acuity and mean gain in visual acuity were 0.33 ± 0.21 (median 0.30) and 0.25 ± 0.20 (median 0.20), respectively. Compared with the preoperative measurements, mean visual acuity increased in 129 patients (129 /135, 95.6%). Factors influencing postoperative visual outcome and gain in visual acuity were preoperative visual acuity ($p < 0.005$), reason for keratoplasty ($p < 0.005$), and diameter of the graft ($p = 0.046$). Postoperative visual outcome was independent of age, sex, right or left eye, presence of diabetes mellitus, preoperative refractive error, length of follow-up, duration of surgery, and preoperative intraocular pressure.*

CONCLUSIONS. *The most important factors influencing visual outcome after central penetrating allogenic keratoplasty combined with IOL surgery are preoperative visual acuity, graft size, and reason for keratoplasty. Other factors such as age, sex, diabetes mellitus, and preoperative refractive error do not substantially influence postoperative visual outcome. (Eur J Ophthalmol 2003; 13: 134-8)*

KEY WORDS. *Corneal graft, Intraocular lens, Penetrating keratoplasty, Triple procedure, Visual acuity*

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INTRODUCTION

Since Edward Zirm reported the first successful allogenic central penetrating keratoplasty in 1906, this procedure has become part of the standard repertoire of ophthalmic surgery in the treatment of corneal diseases (1). Corneal transplantation is thus the oldest, most common, and arguably the most successful form of tissue transplantation. In the United States alone, over 40,000 corneal transplantations are performed each year. Because corneal opacifications can occur in combination with disorders of the lens, or because corneal endothelial damage with resulting bullous keratopathy can be caused by cataract surgery, combined surgical approaches addressing corneal problems and lens-related problems and including implantation of artificial intraocular lenses (IOL) have been practiced for a long time (2). The purpose of the present study was to evaluate which factors influence the clinical outcome after combined procedures of penetrating keratoplasty with IOL implantation. The findings will enable the ophthalmologist to better predict postoperative visual outcome, to better judge the usefulness of surgery, and to better prevent complications after surgery.

PATIENTS AND METHODS

This retrospective noncomparative clinical interventional case series study included 135 patients (85 women, 50 men; 61 right eyes, 74 left eyes) who consecutively underwent central penetrating allogenic keratoplasty combined with IOL implantation between September 1989 and April 1997, all operated by the same surgeon (JBJ). Mean age was 70.2 ± 13.6 years (median 73 years; range 15-95 years). Mean preoperative refractive error was -0.31 ± 5.81 diopters (median -0.56 diopters; range -14 diopters to +16.50 diopters). Mean follow-up was 28.3 ± 18.7 months (median 22.4 months), range 3.3- 112 months. All patients were white.

The study population was divided into three groups depending on the surgical procedure employed. The triple procedure group comprised 79 (79/135, 58.5%) patients undergoing a conventional triple procedure (keratoplasty + cataract surgery + IOL implantation). The IOL exchange group consisted of 33 (33/135, 24.4%) patients in whom penetrating keratoplasty was combined with exchange of an anterior chamber IOL or an iris-fixated IOL for a posterior chamber IOL. The secondary IOL implantation group comprised 23 (23/135, 17.0%) patients in whom penetrating keratoplasty was combined with secondary implantation of a posterior chamber IOL. In the eyes undergoing secondary IOL implantation or IOL exchange, a transpupillary vitrectomy was routinely carried out. In the eyes with a secondary implantation, the lens was implanted into the scleral sulcus in front of the anterior lens capsule in 17 eyes (17/23, 73.9%). In 6 eyes (6/23, 26.1%), a transscleral suture fixation was used for the posterior chamber IOL . In all eyes with an IOL exchange, the posterior chamber lens was transsclerally fixated.

Reasons for keratoplasty were herpetic or traumatic corneal scars or defects (46), Fuchs corneal endothelial dystrophy (22), pseudophakic or aphakic bullous keratopathy (49), corneal endothelial decompensation due to other reasons (15), and keratoconus (3).

Mean preoperative visual acuity (VA) was 0.08 ± 0.10. Reasons for decreased vision were the corneal pathology and cataract in the group undergoing the conventional triple procedure. In the two other groups (IOL exchange and secondary IOL implantation), retinal pathology, mainly cystoid macular edema, could not be ruled out preoperatively as an additional cause of decreased vision. Consequently, preoperative VA was significantly ($p < 0.05$) lower in the group undergoing penetrating keratoplasty combined with a IOL exchange (0.04 ± 0.07; median 0.02) than in the standard triple procedure group (0.10 ± 0.10; median 0.05) and the group in which keratoplasty was combined with secondary implantation of a posterior chamber lens (0.10 ± 0.15; median 0.03). The two latter groups did not differ significantly in preoperative VA. The three groups did not differ significantly preoperatively in refractive astigmatism or keratometric astigmatism ($p > 0.50$) or in diameter of the graft ($p > 0.05$) (triple procedure: 7.50 ± 0.38 mm, median 7.5 mm; range 6.3 to 8.2 mm; secondary IOL implantation: 7.3 ± 0.50, median 7.5 mm; range 6.3 to 8.0 mm; IOL exchange: 7.5 ± 0.36 mm, median 7.5 mm; range 6.3 to 8.0 mm; mean oversize of the graft was 0.30 ± 0.05).

Mean preoperative intraocular pressure (IOP) was 14.57 ± 4.11 mmHg (median 14 mmHg). Postoperatively IOP increased slightly, though not significant-

ly, to mean values of 15.22 ± 5.09 mmHg (p = 0.07) and 15.58 ± 4.95 mmHg (p = 0.44).

Keratoplasty was done using a hand-held trephine for the first 20 patients operated in the study and a motor-driven one (Geuder, Heidelberg, Germany) for the last 115 patients . The donor material was excised from the endothelial side, using a hand-held trephine. An iridotomy was always performed in the 12 o'clock position unless an iridotomy or iridectomy had been carried out in previous surgery. In all eyes, a viscoelastic substance was used to form the anterior chamber. At the end of surgery, most of the viscoelastic substance was removed from the eye, the anterior chamber was completely reformed, and the wound was water-tight sutured.

Keratoplasty was performed in 130 patients (130/135, 96.3%) under general anesthesia and in five (5/135, 3.7%) under retrobulbar anesthesia. For all patients, a 10-0 nylon thread was used for the suture. A running suture was used for the patients with keratoconus, Fuchs endothelial dystrophy, and pseudophakic/aphakic bullous keratopathy. In the first half of the study, a single running suture was used; in the second half a double running suture as described by Hoffmann was preferred (3). For patients with marked corneal cicatrization including fragmentation of the Bowman layer, single knots were used. Sutures were removed one or two years after keratoplasty. Before they were removed, topical steroid therapy was always stopped for about four weeks.

RESULTS

Mean postoperative VA was 0.33 ± 0.21 (median 0.30; range finger counting to 0.90). Compared with the preoperative measurements, it increased in 129 patients (129 /135, 95.6%). Factors influencing postoperative visual outcome were preoperative VA (correlation coefficient 0.32; p < 0.001), diameter of the graft (correlation coefficient 0.26; p = 0.005), and reason for surgery (p < 0.001), with the highest postoperative VA in patients undergoing the triple procedure (0.38 ± 0.22; median 0.40) followed by the group with IOL exchange (0.25 ± 0.17; median 0.25) and those with secondary IOL implantation (0.23 ± 0.17; median 0.20). Linear regression analysis indicated that all three factors were significantly associated with the postoperative outcome. The factor with the highest statistical significance was the reason for surgery (p = 0.001), followed by preoperative VA (p = 0.005) and diameter of the graft (p = 0.046).

Mean gain in VA after surgery was 0.25 ± 0.20 (median 0.20; range -0.10 to 0.90). One factor significantly influencing postoperative gain in VA was the reason for surgery (correlation coefficient 0.24; p = 0.007), with the largest gain in patients undergoing the triple procedure (0.30 ± 0.22; median 0.27) followed by IOL exchange (0.22 ± 0.17; median 0.18), then secondary IOL implantation (0.13 ± 0.14; median 0.09). Linear regression analysis showed that three factors were significantly associated with the gain in VA. The factor with the highest statistical significance was the reason for surgery (p = 0.001), followed by preoperative VA (p = 0.003) and diameter of the graft (p = 0.046). If the gain in VA was expressed in lines, the three study groups did not differ significantly (p > 0.10).

Diameter of the graft was one of the factors influencing postoperative outcome. The larger the graft, the lower were postoperative refractive and keratometric astigmatism and the higher was postoperative VA (correlation coefficient -0.29; p = 0.002). The three groups did not differ significantly in diameter of the graft and in fact linear regression analysis found that the graft diameter was one of the factors influencing the postoperative outcome.

Postoperative visual outcome was independent of age (p = 0.64), sex (p = 0.58), right or left eye (p = 0.10), presence of diabetes mellitus (p = 0.34), preoperative refractive error, length of follow-up (p = 0.25), duration of surgery (p = 0.28), year of surgery (p = 0.19), and postoperative IOP (p > 0.20). Thus , postoperative gain in visual outcome was independent of age (p = 0.81), sex (p = 0.20), right or left eye (p = 0.21), presence of diabetes mellitus (p = 0.65), preoperative refractive error (p = 0.47), length of follow-up (p = 0.11), duration of surgery (p = 0.92), year of surgery (p = 0.41), and IOP (p > 0.20).

An immune graft reaction occurred in 11 patients (11/135, 8.1%), independently of the graft diameter (correlation coefficient 0.03; p = 0.72) and the study group (p > 0.05). Suture removal was associated with a significant (p < 0.001) increase in the mean VA from 0.28 ± 0.18 (median 0.25) to 0.33 ± 0.21 (median 0.30). This increase did not differ significantly between the study groups (p > 0.20).

DISCUSSION

In accordance with previous reports in the literature, the present study suggests that visual outcome after penetrating keratoplasty combined with IOL surgery and the increase in VA due to surgery depend on several variables (4-16). One of the most important is the reason for penetrating keratoplasty in combination with IOL surgery. Postoperative VA and the increase in VA were highest for patients undergoing conventional triple surgery, followed by those undergoing keratoplasty with IOL implantation, and finally patients in whom keratoplasty was combined with an IOL exchange. Cofactors may explain the relation between visual outcome and the reason for surgery. Besides the cornea, other intraocular structures may have been affected by the disease leading to the corneal pathology. All eyes in which keratoplasty was performed with an exchange of the IOL had pseudophakic bullous keratoplasty. This condition is usually associated with cystoid macular edema, often limiting the postoperative VA to values lower than 0.10 or 0.20. Correspondingly, postoperative VA was significantly lower in patients undergoing an IOL exchange than in those operated by the conventional triple procedure.

Postoperative VA was significantly associated with the diameter of the graft. The larger the graft, the lower the postoperative refractive astigmatism and keratometric astigmatism, and the higher the postoperative VA and the gain in VA. This relationship remained significant when linear regression analysis took account of how the variables depended on each other. This is in agreement with previous reports of a positive relationship between graft size, astigmatism of the graft, and VA (2).

The frequency of immune graft reactions (11 patients) was unrelated to the graft diameter. Because final visual outcome was positively correlated with the size of the graft, for penetrating keratoplasties in combination with IOL implantations, a graft diameter of 7.5-8.0 mm (the upper range of the grafts used in the present study) may be taken. This reflects an attempt to ensure relatively low postoperative corneal astigmatism and higher postoperative VA without raising the risk of an immune graft reaction.

The pre- and postoperative visual outcomes were significantly correlated. Patients with relatively high VA prior to surgery had significantly better visual outcome after surgery than patients with lower VA before surgery. The gain in VA, however, was independent of the preoperative VA. This suggests that patients with low preoperative VA should perhaps be advised that postoperative VA may not be extremely high, but the gain may nevertheless be sufficient to make surgery worthwhile.

Suture removal generally had a positive effect on VA (5, 14) although the gain was generally not very marked, did not differ significantly between the study groups and was independent ($p = 0.44$) of the type of suture. Patients might be told that a slight increase in VA can be expected after removal of sutures.

Other factors such as age, sex, diabetes mellitus, and preoperative refractive error were not correlated with postoperative VA or with the gain in VA due to surgery. This suggests that these factors do not play a major role in postoperative visual outcome, and do not need to be taken into account in the preoperative counseling of the patient.

There are factors limiting the present study. Only patients with a follow-up of more than three months were included. There were, however, only three patients who underwent penetrating keratoplasty combined with IOL surgery who did not turn up in the hospital more than three months after surgery. The reason may have been increasing morbidity and immobility in these three patients, who were older than the mean of the 135 patients included in the study. Difficulties in getting around may be important since many of the patients referred to this hospital come from more than 100 km away. In addition, it is unlikely that patients with postoperative complications were referred to another hospital because for many patients the nearest other major university-based corneal transplantation center was more than 200 km away. To reduce the influence of external factors, only patients operated by the same surgeon in the same operation theater for the whole study period were included. Postoperative VA was independent of the year of surgery, suggesting that the surgeon's experience gained during the study did not influence the results. In addition, during the study period there were no real changes in surgical technique.

In conclusion, major factors influencing the final visual outcome after penetrating keratoplasty combined with IOL surgery are the reason for surgery, the diameter of the graft, and preoperative VA. Because the

frequency of an immune graft reaction was statistically independent of the graft diameter in the present study, one may infer that for penetrating keratoplasties in combination with IOL implantations, a graft diameter of 7.5-8.0 mm is acceptable. Other factors such as age, sex, diabetes mellitus, and preoperative refractive error do not play a major role in postoperative visual outcome.

Reprint requests to
Jost Jonas, MD
Universitäts-Augenklinik
Theodor-Kutzer-Ufer 1-3
68167 Mannheim, Germany
Jost.Jonas@augen.ma.uni-heidelberg.de

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