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An Investigation of Keratoplasty Procedures and Their Outcomes in Iraq

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A B S T R A C T

Introduction: The treatment of corneal disorders involves the use of various forms of keratoplasty. The objective of this study was to provide a detailed description of the various types of keratoplasty procedures performed in Iraq, as well as their corresponding outcomes. **Methods:** An observational study was conducted at Al-Zahraa Teaching Hospital to document cases of keratoplasty. The collected data included age, gender, types of keratoplasty, indications, previous surgical or medical history, and postoperative outcomes. The types of keratoplasty included penetrating keratoplasty (PKP), deep anterior lamellar keratoplasty (DALK), and Descemet's stripping endothelial keratoplasty (DSEK). Additionally, we performed cataract surgery and intraocular lens (IOL) insertion for those with cataracts, using either IOLs with scleral fixation or IOLs with iris fixation. We complete the task on the first day following the purchase order, then the first week, the first month, and every six months thereafter. Prior to surgery, patients with corneal vascularization had laser photocoagulation of the blood vessels in the cornea. **Results:** Ages range from 4 to 90. People over 40 (60.8%) were the most common age group. The female prevalence was 52.9%. Right-eye illness was diagnosed 51.6% of the time. 60% of patients underwent PKP. 26.8% had DALK, 12.4% had DSEK. Post keratoplasty, the statistically-significant improvement-ratio was 68.5% as eyes best corrected visual acuity (BCVA) improvement, while 12.2% of eyes showed a decline in BCVA and 19.3% discharged with no changes in BCVA. Postoperatively, BCVA was significantly lower in cases with a duration below 1 year (1.5), and better among the duration > 3 years (0.5). The greatest improvements were seen in cases with infective keratitis (-0.7), corneal dystrophies (-0.6), and advanced keratoconus (-0.7) whereas the lowest rates were documented in cases with a graft rejection (-0.3), and bullous keratopathy (-0.3) **Conclusion:** Keratoplasty is associated with a substantial enhancement of visual acuity in the younger population. Infective keratitis, keratoconus, and corneal dystrophy produce the most optimal and superior results. The PKP method is the most frequently performed.

1. Introduction

Corneal disorders are the fourth most common cause of blindness worldwide, with a 5.1% prevalence rate.[1] In Iraq, the prevalence of blindness was 2.7% in 2007, with 1.6% of cases attributed to corneal illness.[2] Corneal transplantation, also known as keratoplasty, involves replacing damaged corneal tissues with healthy corneas from donors.[3,4] The transplantation of the cornea can be classified into two categories; full-thickness graft and partial-thickness graft. The anterior lamellar keratoplasty procedures include superficial-anterior-lamellar-keratoplasty (SALK), automated-lamellar-therapeutic-keratoplasty (ALTK), and deep-anterior-lamellar-keratoplasty (DALK). The techniques of posterior lamellar keratoplasty include descemet-stripping-automated-endothelial-keratoplasty (DSAEK) and descemet-membrane-endothelial-keratoplasty (DMEK).[5,6]

The indications for keratoplasty are categorized as follows: optical (aimed at improving vision), tectonic (focused on preserving corneal integrity and repairing it), therapeutic (involving the removal of infectious

corneal tissues), and cosmetic (intended to enhance the appearance of the eye).[5] In general, the success rates of keratoplasty are higher compared to other organ transplantations.[6] Over time, ophthalmologists' enhanced skills, technique advancements, the availability of post-operative anti-inflammatory targets, and immune-suppressive agents have all contributed to the improvement in outcomes.[6] The outcomes of keratoplasty differ according to geographic areas, ethnicity, and socioeconomic background.[7] The objective of this study was to ascertain the demographics, indications, and outcomes of keratoplasty procedures.

2. Methods

A retrospective, observational study of keratoplasty cases records in Al-Zahraa Teaching Hospital. Data collected included age, sex, keratoplasty types, indications, past surgical or medical history, and postoperative outcomes. The timeframe for data collection was extended for 8 years from 2014 to 2022. The inclusion criteria were patients diagnosed with a traumatic eye injury, keratoconus and ectasias, corneal degenerations and dystrophies, noninfectious ulcerative keratitis, infective keratitis (fungal, bacterial, and viral), scarring post-infectious keratitis, congenital opacities, and bullous keratopathy. This study has received ethical approval from the hospital system authority.

General anesthesia was used during surgery. The forms of keratoplasty included penetrating keratoplasty (PKP), deep anterior lamellar keratoplasty (DALK), and Descemet's stripping endothelial keratoplasty (DSEK). Additionally, cataract surgery and intraocular lens (IOL) insertion were performed for individuals with cataracts. For patients without capsular support, IOLs were either fixated to the sclera or to the iris. Pupilloplasty and synechiolysis were performed when needed.

Penetrating keratoplasty

In order to prepare and punch the donated tissues, a paracentesis blade was used to cut into the host eye, and viscoelastic was used to fill the chamber. Then, a marker was used to mark the host eye, and it was trephined. After that, the donor tissues were put in the eye of the receiver. Then repaired the eye. The viscoelastic was then taken off, and a balanced salt solution was introduced into one of the holes in the graft host junction. Every stitch is turned. The eyes receive the administration of steroids and antibiotics. A cover is put over the eye, and a patch is put over it.[8]

Deep-anterior-lamellar-keratoplasty (DALK)

There are several approaches to performing DALK: first, by removing the host's anterior corneal tissue layer-by-layer until it reaches the deep stroma or bare Descemet's membrane. The surgery technique consists of steps, which are: (1) In the recipient's eye, the anterior corneal surface is cut by a suction trephine set. Then the layers are dissected by a rounded blade, angled parallel to the membrane. Then fluid (or air) is injected into the deep stroma and membrane to separate layers. Others can use intra-stromal air injection, hydro-delamination, viscoelastic dissection, big bubbles, or anterior chamber air. (2) In the donor eye, the fresh corneas are prepared by the surgeon. Descemet's membrane and endothelium are removed by dry cellulose sponges or forceps. Then a corneal button is punched out of the tissues. After suturing, a bandage soft contact lens is placed on the cornea.[9]

Descemet-stripping-automated-endothelial-keratoplasty (DSEK)

Both the endothelium and Descemet's membrane are stripped away by incision. Then a circular disc is removed from the inner lining of a donor, transplanted into the recipient's eye, and attached to the posterior portion of the recipient. Organ culture excises corneoscleral buttons from donors' globes and stores them. Dissection spatulas are used to manually make a stromal dissection and then extend it up to the limbus. About 16.0 mm of the corneo-scleral rim is excised. To score and strip a circular section of membrane from the posterior stroma, use a reverse

Sinskey hook. A crescent knife creates a temporal self-sealing 5.0 mm sclera-corneal incision. After trephinating, DSEK was grafted from the predissected corneoscleral rim. The graft is inserted with irrigating inserters or push-through techniques using specialized forceps or sutures on the opposite side of the main wound to draw the donor disc into the anterior chamber, with or without a glide. Manually, use the folding forceps insertion technique and insert and rotate the graft. The graft is positioned centrally by brushing, tapping, sweeping, and dragging techniques, then filling the anterior chamber with air. Once the donor disc is in tight apposition with no or minimal interface fluid between the donor and the recipient stroma, partially remove the air in the chamber and replace it with BSS.[10]

Follow-up

It is done on the 1st PO day, then at the 1st week then at the 1st month, then every 6 months. Case with a history of HVS keratitis received systemic acyclovir (400 mg twice daily). Cases with corneal vascularization underwent laser photocoagulation of vessels in the cornea prior to surgery (Nd-Yag frequency double 1064 nm laser photocoagulation or intrastromal bevacizumab).

Statistical analysis

Data was analyzed by SPSS version 24 (IBM, US). Frequency and percent described nominal variables while mean and SD described ordinal variables. The comparison was done by using the Wilcoxon Signed Rank chi-square test. P <0.05 was considered statistically significant.

3. Results

The age range is between 4 and 90 years old. The most frequent age group was above 40 years (60.8%). Females were frequent (52.9%). The right eye was frequent (51.6%). About 60 percent of cases underwent PKP. In contrast, 26.8% of cases underwent DALK, and 12.4% underwent DSEK (Table 1). Post-keratoplasty, the statistically significant improvement ratio was 68.5% as eyes showed BCVA improvement, while 12.2% of eyes showed a decline in BCVA and 19.3% discharged with no changes in BCVA (Figure 1).

Table 1. Baseline characteristics.

Variables		n	%
Age groups (years)	<40	60	39.2
	≥40	93	60.8
Gender	Male	72	47.1
	Female	81	52.9
Side	Right	79	51.6
	Left	74	48.4
Keratoplasty types	PKP	92	60.1
	DSEK	19	12.4
	DALK	41	26.8
	SALK	1	0.7

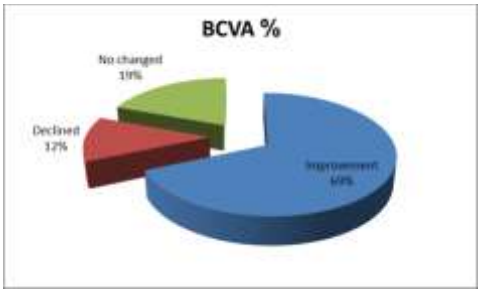

Figure 1. The overall outcomes of keratoplasty.

Postoperatively, the best-corrected visual acuity (BCVA) was significantly lower in cases with a duration below 1 year (1.5) and better among those > 3 years (0.5). The difference in BCVA between duration groups was statistically significant (p = 0.02); however, LogMAR improvement was greater among those with a duration of >3 years. Furthermore, DALK had significantly better BCVA than PKP and DSAEK; however, the improvement showed a statistically significant difference between the three arms, although DALK had the greatest improvement (-0.70 LogMAR) (Table 2). The greatest improvements were seen in cases with infective keratitis (-0.7), corneal dystrophies (-0.6), and advanced keratoconus (-0.7) whereas the lowest rates were documented in cases with graft rejection (-0.3), and bullous keratopathy (-0.3) (Figure 2).

Table 2. Distribution BCVA changes post keratoplasty according to the duration of follow-up and the types.

Duration (years)	**Pre**	**Post**	**Improvement rate**
	Median		-Median
< 1 year	2.8	1.5	-0.5
1-3 year	1.8	1	-0.5
> 3 years	1.8	0.5	-0.8
P=0.02			
Keratoplasty types	**Pre**	**Post**	**Improvement rate**
	Median		-Median
PKP	2	1.5	-0.6
DSAEK	2	1.5	-0.5
DALK	1.8	0.8	-0.7
P=0.01			

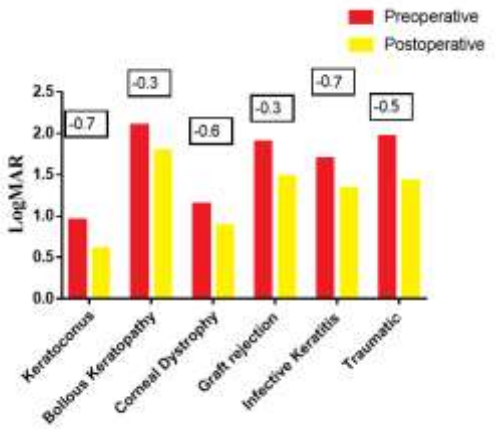

Figure 2. Relation between BCVA and keratoplasty indications.

4. Discussion

In this study, we observed a significant improvement in visual outcomes in 68.5% of the eyes. Keratoplasty is a highly successful form of solid-organ transplantation. A 2011 study at Ibn Al-Haitham Hospital revealed that younger individuals in Iraq underwent a higher percentage of keratoplasty procedures.[2] Keratoplasty outcomes vary between developing and industrialized countries due to differences in case profiles, indications, cornea storage, and socioeconomic position.[11] Individuals over 40 are the predominant age group in this study. Zare et al.[11] conducted a study in Iran from 2004 to 2009, which aligns with this conclusion. This study's

age distribution matches that of previous Turkish research, which reported a median age of 53.8 years for keratoplasty.[1] A study in Spain also reported a median age of 53.2 years.[12]

In Iraq, the primary reasons for doing keratoplasty are keratoconus, bullous keratopathy following phacoemulsification, stromal dystrophy, graft rejection, and infective keratitis. Before and after keratoplasty, the visual acuity in the younger age group is superior to that in the older age group. However, this difference is not statistically significant. Vail et al.'s study, which showed no discernible disparity in visual outcomes between individuals of different age groups,[13] aligns with this finding. A separate Swedish study revealed a correlation between visual deterioration before and after keratoplasty in older individuals.[14] Ocular diseases such as cataract, diabetic ophthalmopathy, glaucoma, and previous graft history cause this phenomenon.[14]

Our facility performed three primary forms of keratoplasty, with around 60% of cases undergoing PKP. Although our facility performed DALK on 26.8% of patients and DSEK on 12.4%, the percentages reported in an Iranian study varied. The frequency of PKP was 70.9%, DALK was 20.1%, and DSEK was 2.3%.[15] Similarly, a South Korean study reported a 77.81% incidence of PKP and a 22.19% incidence of DALK.[16] Lamellar procedures are superior to PKP because they reduce the risk of rejection and astigmatism while strengthening the globe structures. Additionally, there is a wider supply of graft materials and faster rehabilitation of vision.[4] PKP comes with a number of problems, such as wounds that take longer to heal, an increased risk of damage, the possibility of immune system rejection, unpredictable refractive outcomes, longer visual rehabilitation periods, and the possibility of high or irregular astigmatism.[13]

PKP is more advantageous than DALK and DSEK for several reasons, primarily because of the scarcity of corneal tissues available for keratoplasty procedures in Iraq. In this study, the average waiting period from the registration date to the operation date was one and a half years, an unusually long duration compared to a study by Shin et al.[16] in South Korea, where the average waiting time for keratoplasty was half a year. The waiting duration at Ibn Al-Haitham Teaching Eye Hospital is shorter than the average waiting time reported in research conducted in Turkey, which was 21 months.[1]

The study found that 68.5% of participants experienced an improvement in BCVA, whereas 12.2% experienced a decline, and 19.3% showed no change in BCVA. Previous study found that the improvement in BCVA occurred in 70% of the eyes.[17] Another study observed a notable enhancement in best corrected visual acuity (BCVA) in 75% of the eyes, a decrease in BCVA in 2% of the eyes, and no change in BCVA in 23% of the eyes.[1]

After surgery, if the condition lasts less than a year, the best-corrected visual acuity (BCVA) noticeably decreases but improves after three years. Vail et al. conducted a study in the UK in 2002, which found that 58% of eyes achieved a visual acuity of 6/24 at three months, and 70% achieved this level at one year of follow-up. This can be attributed to the elevated likelihood of graft rejection and failure during the initial three months, which subsequently decreases towards the end of the first year of follow-up.[14] According to some authors, a reduction in astigmatism leads to improved visual acuity for a lengthy period of time. This is because 51% of patients who underwent keratoplasty had less than 4 diopters of astigmatism after three months, while 57% had less than 4 diopters of astigmatism after the first year.[13] Best-corrected visual acuity (BCVA) goes down within 12 months of follow-up because of higher intraocular pressure (IOP), inflammation, and failed grafts following keratoplasty.[14]

The results of Han et al.,[18] which said that there was no statistically significant difference in how well the three surgeries improved vision, are different from those of DALK, which showed better best corrected visual acuity (BCVA) before and after surgery compared to PKP and DSEK. In Japan, Shimazaki et al.[19] conducted a comparison of visual outcomes between deep anterior lamellar keratoplasty (DALK)

and penetrating keratoplasty (PKP). The researchers reached the conclusion that there was no notable disparity in the results. Similarly, in Singapore, Fuest et al.[20] demonstrated that there was no statistical distinction in the outcome between DSAEK and PKP.

Significant advancements were observed in instances of infective keratitis, corneal dystrophies, and progressive keratoconus, whereas the lowest rates were recorded in situations of graft rejection and bullous keratopathy. This phenomenon can be attributed to a reduced occurrence of corneal vascularization, inflammation, edema, and pathology in grafts, as well as a low correlation with other ocular disorders. Claesson et al. demonstrated that keratoconus patients have improved visual outcomes following keratoplasty due to reduced astigmatism and decreased rejection rates.[14] Balsak et al., demonstrated that keratoconus patients experienced improved visual outcomes, likely attributed to reduced endothelial cell loss at the outer edge of the cornea.[1] The bullous keratopathy resulted in reduced visual acuity due to ocular conditions such as age-related macular degeneration. In addition, keratopathy is characterized by corneal vascularization, edema, and inflammation, which are associated with poor visual outcomes.[22-24]

The study demonstrates a graft rejection rate of merely 12.2%. The bigger groups of patients who underwent corneal replacement surgery showed a post-transplant rate ranging from 18% to 21%.[25] The incidence of epithelial rejection is 2%, while subepithelial rejection occurs in 1% of cases. Endothelial rejection occurs in 50% of cases, making it the most frequent type of rejection. The occurrence of a mixture is 30%. The incidence of DELK ranges from 1% to 24%. The DSEK procedure has a 5% incidence rate, and the average rate of endothelium rejection is 10%.[26] The frequency of primary and secondary graft failure was 1.7–2.2% and 2.2%, respectively. In their investigation, Jonas et al. discovered that around 14% of patients experienced immunologic graft rejection due to loose sutures and vascularization before and after the operation.[27]

The recommended course of action is to promptly initiate treatment with a topical steroid, specifically prednisolone acetate 1%, administered at intervals of 1 to 2 hours. Next, administer a cycloplegic drug. In cases where topical steroids are ineffective and rejection episodes occur repeatedly, it is advisable to investigate the use of systemic steroids, such as prednisone, at a daily dosage of 40–80 mg. The management protocols include the use of topical corticosteroids (Cs), systemic Cs, intravenous Cs, cytotoxic agents (such as azathioprine and cyclosporin A), combined Cs with Tacrolimus (Tx), Rapamycin, Deoxyspergualin (DSG), mycophenolate mofetil, tissue-cultured C3H corneal epithelial and endothelial cells, anti-VEGF antibodies, and selective glucocorticoid receptor agonists (SEGRA).[8]

The complications of keratoplasty can be categorized as intraoperative, occurring during the surgery, and postoperative, occurring after the surgery. Intraoperative complications include poor graft centration, irregular trephination, damage to the lens and donor tissues, choroidal hemorrhage with effusion, incarceration of iris tissue in the wound, and the presence of vitreous in the chamber. Some problems that can happen after surgery are wound leak, glaucoma, endophthalmitis, primary endothelial failure, persistent epithelial defect, microbial keratitis, graft failure, and the primary disease coming back.[8] Our study found the lowest rate of problems and recommended doing a more comprehensive future study.

The limitations of this study include a small sample size, being a single-center study, potential biases in patient ascertainment and recall, variations in the level of experience among ophthalmologists, potential differences in keratoplasty procedures compared to global regions, and limited medical education and information on advances in corneal disease research in our center. Future research directions should focus on addressing the issue of overestimating rather than underestimating ophthalmology specialists' experience with keratoplasty in Iraq. We can achieve this by addressing the lack of keratoplasty experience,

increasing the educational levels of ophthalmologists, implementing comprehensive training programs for improvement, establishing standards and requirements for surgical training programs, upgrading the facilities for corneal sub-specialization certification, and conducting further investigation into the quality and quantity of residents and fellows training in this surgical specialty in developing countries.

5. Conclusion

Keratoplasty is associated with a significant improvement in visual acuity in younger patients. Cases involving infective keratitis, keratoconus, and corneal dystrophy yield the most optimal and superior results. Keratoplasty exhibits higher success rates.

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