Effects of posterior chamber lens implantation on the endothelium of transplanted corneas

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Abstract

***Aims*—The morphological changes of the corneal endothelium after posterior chamber lens implantation in the transplanted corneas were investigated.**

***Methods*—36 patients underwent extracapsular cataract extraction with posterior chamber lens implantation. Among these, penetrating keratoplasty had been performed in 18 patients before cataract surgery. The indications for penetrating keratoplasty in these cases included keratoconus, herpetic keratitis, and macula cornea. 18 cataract patients with normal corneas were also studied as controls. The central corneal endothelium in each subject was examined with a wide field specular microscope at a few days before and 3 months after cataract surgery.**

***Results*—Although the transplanted corneas showed lower endothelial cell densities, marked polymegethism, and pleomorphism in the baseline variables, the endothelial morphological changes in the transplanted corneas after posterior chamber lens implantation were comparable with those in the normal corneas. Also, there was no clinical evidence, especially, of corneal epithelial and/or endothelial rejections and corneal decompensation in all corneas.**

***Conclusion*—Even though the transplanted corneas have a lower endothelial cell density and marked polymegethism, it is believed that cataract surgery does not induce corneal decompensation in cases where the peripheral recipient endothelium can be considered to have normal morphology.**

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While there are many advocates of combined penetrating keratoplasty and cataract removal in the presence of corneal opacification associated with a cataract,[1–5] other surgeons continue to prefer to have the cataract removed after keratoplasty.[6–8] Corneal transplantation can also accelerate the progression of cataract.[9] Cataract extraction following successful penetrating keratoplasty, as well as other subsequent surgeries, has been reported to result in clouding of the graft in a significant number of cases.[6–8] This is primarily due to mechanical damage to the graft endothelium at the time of cataract removal.

Previous studies have demonstrated that the corneal endothelium with low cell density or morphological abnormalities (polymegethism and pleomorphism) is more susceptible to surgical trauma and to a variety of stresses such as contact lens wear.[10–14] Cataract surgery may induce corneal oedema at a high rate in the transplanted corneas because endothelial cell densities in these corneas are usually less than 1500 cells/mm^2 even with an uncomplicated postoperative course.[15–18]

In the past, the effect of cataract surgery on the transplanted corneas has been studied for incidence of graft decompensation alone and not for endothelial morphological changes. Here, we present the response of the endothelium in transplanted corneas after cataract surgery.

Methods

Eighteen patients (18 eyes) had a penetrating corneal transplant in the presence of a mild to moderate lenticular opacity that required posterior chamber lens implantation as early as 1 year later. The average time between keratoplasty and cataract surgery was 2.7 years (Table 1). This period was chosen because previous studies have shown that morphological changes of the graft endothelium stabilises within 2–3 years after penetrating keratoplasty.[12–14] The age of these patients ranged from 32 to 68 years (mean 52.1 years). Keratoplasty had been done for interstitial keratitis (one case), keratoconus (two cases), herpetic keratitis (four cases), and corneal opacity of unknown origin (11 eyes). The donor age ranged from 48 to 73 years (mean 64.9 years). The sizes of the donor button varied from 7.0 to 8.5 mm (mean 8.0 mm). The surgical procedures used for keratoplasty have been described previously. Eighteen eyes from 18 patients of similar age scheduled to undergo posterior chamber lens implantation were chosen to serve as a control group. In the control group, patients with neither surgical nor postoperative complications were included in the study.

All patients had undergone posterior chamber lens implantation performed by one of us (SK), with the same medications. The surgical procedures used have been extracapsular cataract extraction (ECCE) because our surgeon could control the degree of the damage to the endothelium during surgery more uniformly than with phacoemulsification aspiration (PEA). Balanced salt solution (BSS) was used to irrigate the eye during surgery. We made a limbal incision of a 11 mm arc length and filled the anterior chamber with 1% sodium hyaluronate. After anterior capsulotomy with

Table 1 Clinical data and preoperative analysis of specular microscopy

Patient	*Age (years)*	*Donor age (years)*	*Post PK period (years)*	*Corneal disease*	*Cell density*	*Coefficient of variation*	*% Of hexagonal cells*
1	51	70	1.2	Macula cornea	845	0.582	26.0
2	61	75	1.3	Macula cornea	1018	0.202	66.0
3	43	58	1.8	Macula cornea	2064	0.260	51.0
4	54	64	2.0	Macula cornea	977	0.579	41.0
5	61	57	2.5	Macula cornea	669	0.551	45.0
6	61	67	2.7	Macula cornea	498	0.224	68.0
7	68	71	2.8	Macula cornea	563	0.193	74.0
8	48	68	3.5	Macula cornea	1275	0.264	57.0
9	55	68	3.5	Macula cornea	2590	0.351	59.0
10	65	48	3.8	Macula cornea	618	0.222	53.0
11	46	67	4.4	Macula cornea	797	0.456	44.0
12	58	67	1.8	Herpes simplex	991	0.594	45.0
13	47	59	2.5	Herpes simplex	3051	0.284	54.0
14	44	60	2.8	Herpes simplex	857	0.442	54.0
15	38	71	3.0	Herpes simplex	662	0.451	47.0
16	32	61	3.1	Keratoconus	1852	0.308	49.0
17	38	65	3.1	Keratoconus	1357	0.426	41.0
18	68	73	2.8	Interstitial keratitis	957	0.255	57.0

a bent 27 gauge needle, the lens nucleus was expressed by a two point compression without collapse of the corneal dome. We then performed a cortical clean up with an aspiration-irrigation instrument, followed by expansion of the capsular bag with 1% sodium hyaluronate, insertion of posterior chamber lens in the capsular bag, and aspiration of the viscoelastic substance. The wound was closed with five to seven interrupted 10-0 nylon sutures. No adrenaline was added to the irrigating solutions or injected into the anterior chamber. At the end of surgery, 0.1–0.3 ml of acetylcholine chloride was injected into the anterior chamber. After surgery, all patients were managed with antibiotic and corticosteroid drops four times daily for 3 months.

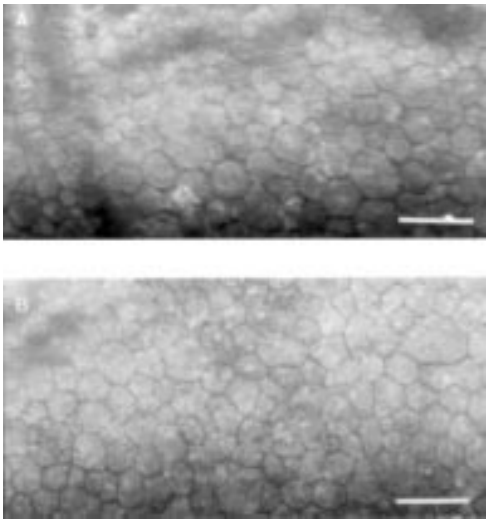

Figure 1 Typical specular microscopic appearance of transplanted corneal endothelium before and after operation. (A) Indicates the preoperative endothelial status of patient No 1 (Table 1) and (B) shows postoperative status. (Before; cell density 845 cells/mm^2, coefficient of variation 0.582, percentage of hexagonal cells 26.0, after; cell density 836 cells/mm^2, coefficient of variations 0.561, percentage of hexagonal cells 31.0. Bar=100 µm.)

The endothelium of the central cornea was examined and photographed with a wide field specular microscope a few days before and 3 months after cataract surgery. This period was chosen because the endothelial changes have been shown to stabilise within 3 months after cataract extraction.[19–21] Approximately five to 10 photographs were taken of each cornea. The photographs with good cell boundaries were used for analysis. An independent masked examiner performed all tracing and digitation. A total of 100 cells were traced and analysed with a computerised digitiser, as previously described.[22]

Endothelial structure was evaluated by measuring a variety of factors, including cell density (cells/mm^2), coefficient of variation in cell size (an objective measure of polymegethism), and percentage of hexagonal cells (an index of pleomorphism). Cell loss was expressed as a percentage of the preoperative cell density. Differences were considered statistically significant if parametric (two sided Student's *t* test) and non-parametric (two sided Wilcoxon two sample test) tests yielded a p value of less than 0.05.

Results

Preoperatively, the mean (SEM) endothelial cell density of the transplanted corneas (1202 (726) cells/mm^2) was markedly lower than that (3093 (378) cells/mm^2) of the controls (Table 2). The coefficient of variation in cell size was significantly higher in the transplanted corneas (0.369 (0.142)) than that of the controls (0.285 (0.033)). A significant reduction in the percentage of hexagonal cells was also noted in the study corneas (51.7% (11.2%)) compared with the controls (63.2% (6.6%)).

After surgery, the endothelium of the transplanted corneas had a cell loss of 6.2%

Table 2 Comparison of the endothelial morphological changes, transplanted cornea versus normal cornea

	Cell density (cells/mm^2)			*Coefficient of variation*		*% Of hexagonal cells*	
	pre	*post*	*Cell loss (%)*	*pre*	*post*	*pre*	*post*
Transplanted cornea	1202 (726)	1119 (692)	−6.2 (18.5)	0.369 (0.142)	0.336 (0.098)	51.7 (11.3)	48.4 (9.0)
Normal cornea	3093 (378)	2943 (359)	−4.7 (6.3)	0.285 (0.033)	0.287 (0.024)	63.2 (6.6)	60.5 (5.8)
p Value	<0.0001	<0.0001	0.7564	0.0200	0.0481	0.0007	<0.0001

(18.5%), which was not significantly different from that of the controls (4.7% (6.3%)). In both groups, the coefficient of variation and percentage of hexagonal cells remained unchanged.

Figure 1 demonstrates the typical appearance of the endothelial cells in the transplanted corneas. During the observation period, no rejection or complications was observed.

Discussion

In this study, we found that despite a markedly reduced cell density (mean 1202 cells/mm^2) and significant morphological abnormalities (polymegethism and pleomorphism), the central endothelium of the transplanted corneas had a similar degree of morphological changes following posterior chamber lens implantation when compared to the normal endothelium. This observation was unexpected since the endothelium with low cell count or morphological abnormalities has been shown to be more susceptible to surgical trauma and stress.[15–18]

The endothelial cell loss noted in each of the transplanted corneas and controls compared favourably with recent reports and was much lower than earlier reports of cell loss after posterior chamber lens implantation.[19–21] This improvement is probably related to advances in surgical techniques and the use of viscoelastic solutions, which may partly explain a similar magnitude of endothelial changes after surgery in spite of significant differences in cell density and morphology between the two groups preoperatively.

Alternatively, our result can be explained by the difference in endothelial cell distribution between normal and transplanted corneas, which may result in different healing processes after cataract surgery. Normally, the entire endothelial cells are fairly uniform in cell size and shape. After cataract surgery, endothelial cells migrate from the central to the peripheral superior cornea where more endothelial damage occurs. By comparison, several histological studies on transplanted corneas have noted that recipient and donor endothelial cells may exist as two distinct cell populations, and that altered anatomy of Descemet's membrane at the keratoplasty scar may offer a poor scaffold for the spread of endothelial cells across the host-recipient junction.[23–28] It appeared, therefore, that in the transplanted corneas, the peripheral recipient endothelial cells may primarily contribute to resurfacing the defects caused by cataract surgery, which are mostly in the peripheral superior cornea, and the central donor endothelium may be involved the healing process to a lesser extent when compared with the normal corneas.

The majority of our patients had a corneal transplant for keratoconus, herpetic keratitis, and centrally localised leucoma. In the post-keratoplasty patients with similar preoperative diagnoses, Rao and Aquevella have observed that the peripheral recipient endothelium has a higher cell density and more normal morphology than the donor endothelium.[28] In this study, therefore, there appeared to be less need for cellular migration from the central to the peripheral superior cornea because of better peripheral healing by the more plentiful recipient endothelial cells. On the other hand, the same authors have also reported that in cases where penetrating keratoplasty were performed for Fuchs' dystrophy, the peripheral recipient endothelium demonstrated the changes consistent with the appearance of guttata.[28]

In these cases, the contribution of the peripheral recipient endothelium to healing process may be insufficient so that the central donor endothelium may be required to participate in the healing process to a greater extent. This could explain the higher incidence of graft failure after later lens removal in patients with Fuchs' dystrophy.[6–8]

In conclusion, we believe that cataract surgery on the transplanted corneas is safe in cases where the peripheral recipient endothelium can be considered to have enough cell density and normal morphology.

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