

PENETRATING KERATOPLASTY FOR KERATOCONUS
A LONG-TERM REVIEW OF RESULTS AND COMPLICATIONS

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ABSTRACT

Purpose: To study the long-term complications of penetrating keratoplasty for evaluation of current recommendations to patients with keratoconus.

Setting: John Moran Eye Center at the University of Utah, as well as an affiliated outpatient clinic (Rocky Mountain Eye Center).

Methods: Retrospective study taking all penetrating keratoplasties performed for keratoconus during a 3-1/2 year period performed by four surgeons. Follow-up postop dates of 1 day, 1 month, 3 months, 6 months, 12 months and 24 months were recorded. Data from 93 eyes were reviewed for rejection, astigmatism, visual acuity, reasons for decreased visual acuity, and all other complications during the follow-up period.

Results: Allograft reaction was seen in 31% of total cases, but no graft failure due to rejection. Mean astigmatism was 2.76D (+/- 1.99) at 24-month follow-up with only 15% > 5 D. Last best-corrected visual acuity was 20/25 or better in 77% of cases (87% had 20/25 or better at some time during follow-up). Various other complications of the procedure were noted that did not cause decreased visual acuity. Punctate keratitis was noted in 20% of the patients 180 days or more after the surgery.

Conclusion: Penetrating keratoplasty is a very good treatment option for patients with keratoconus, but should be held in reserve for those who do not tolerate contact lenses or do not get needed visual acuity with contact lenses because of the

complications noted. This procedure has become a second-line treatment for keratoconus patients with generally very good results.

SYNOPSIS: This long-term follow-up of keratoconus patients receiving PKP proves its effectiveness as a good treatment option for patients, but does not come without risks.

INTRODUCTION

Are we ready for a paradigm shift in the treatment of keratoconus? For many decades, consideration of penetrating keratoplasty (PK)¹ has been controlled by two almost ironclad rules:

1. Unsuccessful contact lens use with poor visual acuity using spectacles, or
2. Poor visual acuity even with otherwise successful contact lens use.

With contact lenses as the mainstay of therapy for visual disability in association with keratoconus, the art or facility of contact lens fitting became extremely important. Many centers reported unsuccessful contact lens usage being turned into a success by further refinement of contact lens fitting. Penetrating keratoplasty was always seen as an excellent option held in reserve.²

A recent provocative paper by Buzard, et al,³ suggested that PK has evolved into such a successful procedure that it should be a routine first-line treatment for keratoconus in those who are having spectacle difficulty. It should be a viable option in place of contact lenses due to the excellent results and low complication rates.^{4,5} This would be a major paradigm shift if this new standard is uniformly accepted.⁶ We have reviewed our recent cases of penetrating keratoplasty for keratoconus done at the John Moran Eye Center to see if they support this paradigm shift as suggested by Buzard, et al.

MATERIAL AND METHODS

All penetrating keratoplasties for keratoconus from 3/25/92 to 10/13/95 performed at the outpatient center of the John Moran Eye Center were reviewed for this study. This retrospective review included an evaluation of all surgical reports and all postoperative visits to list all complications, visual acuity best corrected (when available) and astigmatism by Tomey topography (when available).

Penetrating keratoplasty technique during this period was a double running suture using single continuous 10-0 and 11-0 running in the same direction or interrupted 10-0 nylon sutures twelve byte with a running 10-0 or 11-0 nylon.

RESULTS:

Ninety-three cases were found in our database from the time period, representing 78 patients operated by 4 surgeons. Of these, 23 (25%) were operated by the double-running suture technique⁷ and 70 (75%) by a combination of continuous (12 bytes) with a second running suture. Postoperative follow-up was available on all but one case that was followed after referral by the local ophthalmologist and, therefore, additional postoperative results were not available.

ALLOGRAFT REACTION:

Table 1 shows a 31% incidence of allograft reaction in all cases with 36 total episodes (7 had similar recurrent reaction).⁸ Twelve were epithelial reaction alone with 15 endothelial reaction⁹ alone and nine combined. As can be seen by the table, the majority occurred between one to two years postoperatively. Epithelial reaction alone was defined by subepithelial infiltrates in a graft that previously had been clear.

ASTIGMATISM:

Table 2 shows a gradual, progressive improvement with a mean of 2.75 diopters at 48 months (the maximum was 8.4 diopters).¹⁰ There were 5 astigmatism surgeries performed for this group of patients.^{11,12} Our best-corrected visual acuity results were 72 of 93 (77%) 20/25 or better on their last reported examination. Looking at all postoperative visits, 81 of 93 (87%) were 20/25 or better at some point during the postoperative follow-up.

CAUSES OF DECREASED POSTOPERATIVE VISION ON THE LAST VISIT:

Table 3 relates all causes of decreased visual acuity on the last examination with some patients having more than one cause. The three most common reasons for decreased vision were cataract, punctate keratopathy and rejection. It should be noted there were two graft failures not due to rejection. The first case required immediate regraft because of poor tissue, and the second failed because of infectious corneal scarring. It is otherwise expected, even though others

had decreased vision due to rejection on the last visit, that the majority will resolve in the patient's favor. Interestingly, only three had recorded visual acuity of 20/25 or less due to irregular astigmatism. Our database is incomplete as to the use of contact lenses or glasses for routine correction. Although other causes of decreased vision were relatively infrequent, there were a total of seven other individual diagnoses that had caused decreased vision on the last visit.

OTHER COMPLICATIONS NOT RESULTING IN DECREASED VISION:

We did have 16 patients with elevated IOP after surgery with no elevated pressures pre-operatively. The highest IOP was 42 mmHg immediately after surgery which spontaneously resolved and was felt to be a viscoelastic effect. Of the additional 15 patients, the highest IOP was 33 mmHg and all were felt to be steroid responders. All patients responded to decreasing, stopping, or switching steroids.

Patients had other reasons why they had to come in that did not result in decreased vision (Table 4). Obviously, the primary graft failure resulted in early loss of vision, but with replacement the patient achieved the best-corrected visual acuity that was achieved.

PUNCTATE KERATITIS:

Table 5 presents the incidence of punctate keratitis with seven patients reporting this as a cause of their decreased vision below 20/25 on their last visit. Furthermore, 20% who were beyond 180 days had punctate keratitis noted in the chart.

DISCUSSION:

There is no question that penetrating keratoplasty for keratoconus has come a long way in the last several decades. In agreement with Buzzard, et al.,³ clear grafts are an expected outcome with good spectacle-corrected visual acuity and minimal astigmatism. The latest in keratoplasty techniques result in moderate regular and irregular astigmatism over time and what astigmatism does exist is increasingly easily handled through different surgical maneuvers.^{13,14} This certainly supports the argument that we should loosen our indications for penetrating keratoplasty and consider PK as a viable alternative for contact lens fitting. While 87% were 20/25 or better at some time postoperatively, 23% had decreased visual acuity on the last visit with a specific cause due to irregular astigmatism in only three of these. The complication results clearly suggest that undertaking PK for keratoconus is not without significant risks!

Digging into the complications, which was the main purpose of this study, shows that a careful evaluation of both epithelial and endothelial allograft reactions gives a 31% first episode incidence at two years after surgery.¹⁵ While this result may be higher than some studies, this is not inconsistent with the literature.¹⁶ Our usual regimen for treatment of graft reaction is frequent topical steroids (starting at every 15-60 minutes) and tapering over time combined with intravenous Solumedrol, 500 mg. Interestingly, two grafts (2%) failed out of 93. This was a surprising result for us and, we must let patients know about this risk.

On the other hand, steroid complications resulted in glaucoma and postoperative cataract affecting visual acuity in two patients.¹⁷ Steroid cataracts are easily fixed in this day and age;

however, in a young patient the loss of accommodation is not an insignificant by-product of such surgery. Furthermore, although taken individually problems such as corneal ulcer with scar or stromal outgrowth would seem very uncommon; taken in aggregate there were a fair number of such individual causes resulting in decreased vision at the last examination seen.

Punctate keratitis after PK for keratoconus has not been addressed in any detail in the literature as per our review. It is our feeling this is a form of neurotrophic keratitis and we had seven patients at the last visit who it was felt had decreased spectacle-corrected vision due to this problem. Obviously, we understand it is hard to differentiate decreased vision due to irregular astigmatism, possibly due to the graft-host interface from punctate keratitis. However, it was the clinician's best guess that the punctate keratitis was impacting vision. When contact lenses needed to be routinely used after penetrating keratoplasty, the punctate keratitis issue was basically hidden by the contact lens; however, increasingly, we have patients who are anxious to use spectacles or have excellent uncorrected vision and are not willing to jump into contact lenses as the means of getting full visual correction. This means punctate keratitis needs to be addressed and fully 20% of our patients after 180 days had punctate keratitis noted (our database is incomplete on contact lens use).

In regard to the "hassle factor" associated with penetrating keratoplasty, there were multiple visits for loose sutures or filaments causing irritation which, although not visually significant, certainly would have impact on the patient's overall lifestyle. Repeating a penetrating keratoplasty for a primary donor failure is another example of the not insignificant "hassle factor" in our review of our patients.

At this time in reviewing our recent patients we feel that the classical recommendation of PK for contact lens failure or poor visual acuity even with contact lenses is still the best approach. What we can tell the patient is that they should be very optimistic when they are ready for a PK of excellent spectacle-corrected visual acuity with minimal contact lens concern. We feel, however, it is mandatory to explain the real risks such as graft rejection or other problems that can upset the weekly routine and that all of these issues taken as an aggregate are not insubstantial. An accurate sense of what to expect when the decision is made by a patient for PK is important for all of our patients!

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Table 1: Allograft reactions

No. Days Post-op	Epithelial	% of Total	Endothelia	% of Total	Combined Epithelial & Endothelial	% of Total
0-90	0	0%	1	1%	0	0%
91-180	2	2%	4	4%	3	3%
181-360	2	2%	2	2%	2	2%
361-720	8	9%	8	9%	4	4%
Total Numbers	12		15		9	
Total No. of allograft reactions was 36						
29 rejections were 1 st episode						
(31% of total cases as incidence)						
7 cases of 2 nd episode						
(no graft failure due to rejection)						

Table 2. Astigmatism

	Preop	1 Month	3 Months	6 Months	12 Months	24 Months
	(n=76)	(n=63)	(n=68)	(n=53)	(n=56)	(n=48)
Mean (+/- SD)	6.14 (+/- 4.12)	4.04 (+/-2.45)	3.43 (+/-4.96)	3.00 (+/-2.31)	2.86 (+/-2.14)	2.76 (+/-1.99)
Range	(0.5, 17.9)	(0.1, 12.5)	(0.1, 40.3)	(0.1, 9.4)	(0.4, 9.9)	(0.2, 8.4)
% $\geq 5D$	55	40	21	17	20	15
Relaxing Incision/AK				1	3	1

Table 3. Reasons for Decreased Visual Acuity in 21 Patients with Best-Corrected Visual Acuity of Less than 20/25 on Their Last Visit

1. Pre Op Cataract - 3
2. Post Op Cataract -2
3. SPK - 7
4. Severe/Increasing Astigmatism - 3
5. Corneal Vascularization -1
6. Corneal ulceration and scar centrally - 1
7. Significant stromal outgrowth - 1
8. Late epithelial defect - 1
9. Allograft reaction - 7 (4 endothelial, 2 epithelial, 1 combined)
10. Graft Failure - 1 (Secondary to infectious corneal scarring)
- 11. Donor failure - 1 (Replaced)**

Table 4. Complications Not Causing Decreased Visual Acuity

1. Filaments - 5
2. Suture infiltrate - 2
3. Wound leak - 3 (Two spontaneously resolved found at the 1-month follow-up. One at 35 weeks secondary to relaxing incision procedure).
4. Anisometropia/Esotropia - 2
5. Mechanical (K abrasion, loose suture) - 3

Table 5. Incidence of Punctate Keratitis

Postop Day	n = # of Follow-ups	N (% total)
0-30	n = 82	12 (15%)
31-90	n = 85	10 (12%)
91-180	n = 67	6 (9%)
>180	n = 85	17 (20%)
Total SPK		45

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