CLINICAL OUTCOME OF PENETRATING KERATOPLASTY IN CORNEAL OPACITIES OF DIFFERENT AETIOLOGY- A CLINICAL STUDY

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ABSTRACT

BACKGROUND

Corneal transplantation or grafting is an operation in which abnormal corneal host tissue is replaced by healthy donor cornea. According to the World Health Organization (WHO), corneal diseases are among the major causes of vision loss and blindness in the world today after cataract and glaucoma.

The aim of the study is to-

1. Evaluate the different aetiology of corneal opacity including active infective aetiology as indicated for penetrating keratoplasty.
2. Determine the clinical outcome of penetrating keratoplasty in relation to graft survival, graft rejection and peri-operative complications in different aetiology groups.
3. Determine the final visual outcome.

MATERIALS AND METHODS

Candidates for keratoplasty were selected from-

1. Eye Bank of Regional Institute of Ophthalmology (R.I.O).
2. R.I.O OPD. The study period was from September 2014 to August 2015. 30 cases were taken in the study.

Descriptive statistics were applied to analyse the data wherever necessary.

RESULTS

34.6±19.73 yrs. (mean±SD) was the mean age at which transplants were done in the study. Out of total 30 cases, 13 (43.33%) and 17 (56.66%) were male and female, respectively. The different indications for penetrating keratoplasty are- Post ulcer corneal opacity in 14 cases (46.66%), posttraumatic corneal opacity 9 cases (30%), pseudophakic bullous keratopathy 4 cases (13.33%), corneal dystrophy in 2 cases (6.66%) and non-healing corneal ulcer in 1 case (3.33%). 16 cases (53.33%) showed clear graft till the last follow up while 11 (33.33%) cases showed partially clear graft resulting in improved visual outcome while 3 cases (10.00%) of the grafts were opaque due to graft failure.

CONCLUSION

The major indications for penetrating keratoplasty in this part of the world are post ulcer and posttraumatic corneal opacity and majority of them are illiterate agricultural workers who failed to get adequate treatment on time. Graft survival rate is high, which can be attributed to the gradual improvement in all the aspects of penetrating keratoplasty, be it the improved viewing system, effective medications to counter complications and better understanding of corneal physiology.

KEYWORDS

Post Ulcer Corneal Opacity, Penetrating Keratoplasty, Graft Survival and Graft Failure.

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BACKGROUND

Corneal transplantation or grafting is an operation in which abnormal corneal host tissue is replaced by healthy donor cornea. Cataract and corneal diseases are major causes of blindness in countries with less-developed economies.[1] According to the World Health Organization (WHO), corneal diseases are among the major causes of vision loss and blindness in the world today after cataract and glaucoma.[2] In India, it is estimated that there are approximately 6.8

million people who have vision less than 6/60 in at least one eye due to corneal diseases; of these, about a million have bilateral involvement.[3]

According to the National Programme for Control of Blindness (NPCB) estimates, there are currently 1,20,000 corneal blind persons in the country. According to this estimate, there is addition of 25,000-30,000 corneal blindness cases every year in the country.[3] The burden of corneal disease in our country is reflected by the fact that 90% of the global cases of ocular trauma and corneal ulceration leading to corneal blindness occur in developing countries.

Franz Reisinger initiated experimental animal corneal transplantation in 1818, coining the term "keratoplasty." Subsequently, Wilhelmus Thorne created the term corneal transplant and 3 years later Samuel Bigger, 1837 reported successful corneal transplantation in a gazelle.[4] The first recorded therapeutic corneal xenograft on a human was reported shortly thereafter in 1838- unsurprisingly this was unsuccessful. Further progress in corneal transplantation was significantly hindered by limited understanding of antiseptic principles, anaesthesiology, surgical technique and immunology. There ensued an extremely prolonged period of debate and experimentation upon the utility of animal compared to human tissue and lamellar versus penetrating keratoplasty. Indeed, the first successful human corneal transplant was performed by Eduard Zirm in 1905.[5] Since, that first successful corneal transplant, innumerable ophthalmologists have contributed to the development and refinement of corneal transplantation aided by the development of surgical microscopes, refined suture materials, the development of eye banks and the introduction of corticosteroid.

The modern era of keratoplasty began in 1952, when Stocker first reported successful penetrating keratoplasty for the treatment of corneal oedema.[6]

Indications for keratoplasty have changed drastically for the last 25 years or so. In the mid-twentieth century in developed countries, the most common indications for corneal grafting were scars following herpes simplex keratitis, regrafts and keratoconus. About ten to fifteen years ago, the main indications for transplants were regrafts, keratoconus and pseudophakic or aphakic bullous keratopathy.

AIMS AND OBJECTIVES

1. To evaluate the different aetiology of corneal opacity including active infective aetiology as indicated for penetrating keratoplasty.
2. To determine the clinical outcome of penetrating keratoplasty in relation to graft survival, graft rejection and peri-operative complications in different aetiology groups.
3. To determine the final visual outcome.

MATERIALS AND METHODS

Candidates for keratoplasty were selected from two sources- 1.) Registered patients in Eye Bank of Regional Institute of Ophthalmology (R.I.O); 2.) Patients attending R.I.O OPD. The study period was from September 2014 to August 2015. A total of 30 cases were taken in the study.

All patients selected for operation were subjected to detailed preoperative examinations and findings noted in the proforma.

Investigation

a. A Blood Examination- Routine examination was performed consisting mainly of TLC, DLC, Hb and ESR estimation. Random blood sugar was done in all cases. Serological test was done for HIV and hepatitis infection in donor blood.
b. A scan USG of the recipient eye of every case was done to rule out any posterior segment anomaly, condition of vitreous, lenticular thickness and axial length of the eyeball. In majority of the cases, keratometric and biometry was done on the same sitting.

Inclusion Criteria

1. Corneal opacity of different aetiology.
2. Corneal ulcer refractory to maximal medical therapy.
3. Impending perforation or impending limbal involvement.

Exclusion Criteria

1. Patient in which limbus or sclera is involved.
2. Patient with absence of light perception.
3. Patient with low intraocular pressure.
4. Patient with diabetes mellitus.
5. Patient with chronic dacryocystitis.
6. Patient with high intraocular pressure.

Donor Corneal Tissue

Donor corneal tissue were arranged from the following sources; 1.) Registered eye banks; 2.) Hospital collection from voluntary donors. The media used for preservation and storage was McCarey Kaufman media.

The donor corneal tissue was examined and evaluated under slit lamp.

Specular microscopy could not be done.

Follow up

The cases were examined thoroughly during their postoperative stay in the ward (average 5-6 days). Following discharge, they were followed up on 2nd week, 4th week and 24 weeks.

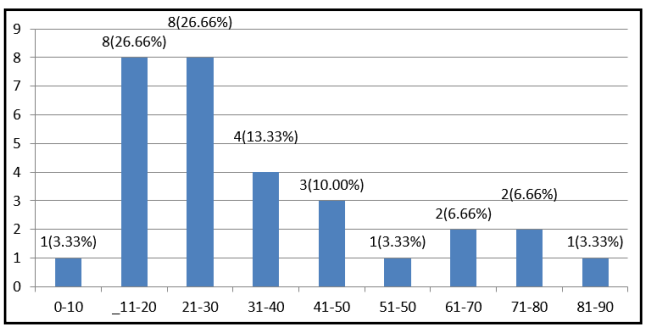
It is to be noted that descriptive statistics were applied to analyse the data wherever necessary.

RESULTS AND OBSERVATIONS

This prospective study has been carried out in 30 cases of corneal opacities of different aetiology who underwent penetrating keratoplasty in Regional Institute of Ophthalmology, Guwahati.

Age Distribution

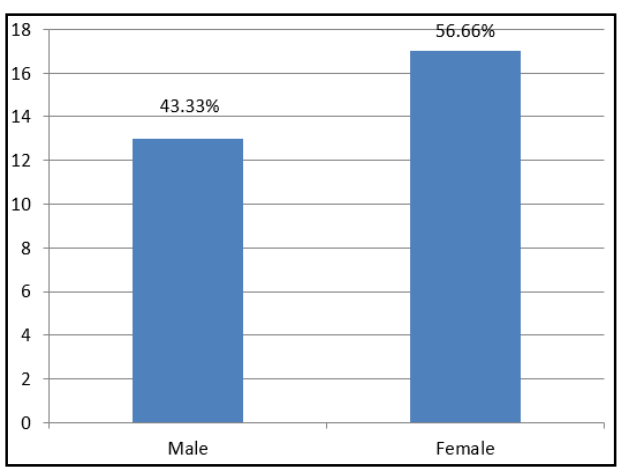
In this present study, the youngest patient was 9 years and the oldest patient was 82 years old. 34.6±19.73 yrs. (mean±SD) was the mean age at which transplants were done in this study.



Graph 1. Showing Age Distribution of the Cases of Penetrating Keratoplasty

Sex Distribution

In the present study, out of total 30 cases, 13 (43.33%) and 17 (56.66%) were male and female, respectively.



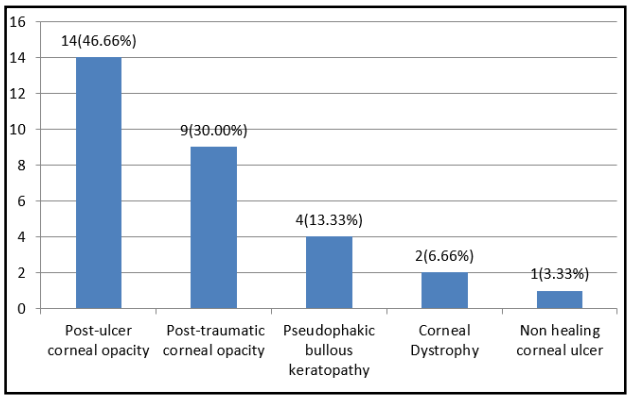
Graph 2. Showing the Sex Distribution of the Cases of Penetrating Keratoplasty

Females contributed to the majority of the recipients as most of them were illiterate agricultural workers.

Preoperative Examination

Indications	Number of Cases	Percentage (%)
Post ulcer corneal opacity	14	46.66
Posttraumatic corneal opacity	9	30.00
Pseudophakic bullous keratopathy	4	13.33
Corneal dystrophy	2	6.66
Non healing corneal ulcer	1	3.33
	Total=30	

Table 1. Indications for Penetrating Keratoplasty



Graph 3. Showing Indications for Penetrating Keratoplasty

Associated Findings with Corneal Opacity

In 14 (46.66%) cases, the iris was found to be adherent to the corneal scar.

Intraocular pressure was measured with non-contact tonometer and was found to be 17.89±2.48 mmHg.

Lenticular opacity was found to be in 12 cases- a) 7 cases preoperatively; b) 5 cases intraoperatively.

Preoperative Findings	N=30 N (%)	Subdivisions	N=12 N (%)
Corneal vascularisation	12 (40.00%)	Superficial	6 (50.00%)
		Deep	4 (33.33%)
		Superficial±Deep	2 (16.66%)
Cataract	7 (23.33%)		
Adherent leucoma	14 (46.66%)		

Table 2. Preoperative Findings In Relation to Graft Survival

Operative procedure and associated intraoperative procedure-

Associated Intraoperative Procedure in PK	Number of Cases (Total Number of Cases, n=30)	Percentage (%)
Synechiolysis	14	46.66
ECCE	3	10.00
ECCE with PC-IOL	2	6.66
Anterior vitrectomy	2	6.66
Floppy iris resection	2	6.66
Retrocorneal membrane removal	1	3.33
SICS with PCIOL (Secondary)	2	6.66

Table 3. Showing Different Associated Intervention Performed

Suturing- 10-0 nylon suture was used in all the 30 cases. Interrupted technique of suturing was used.

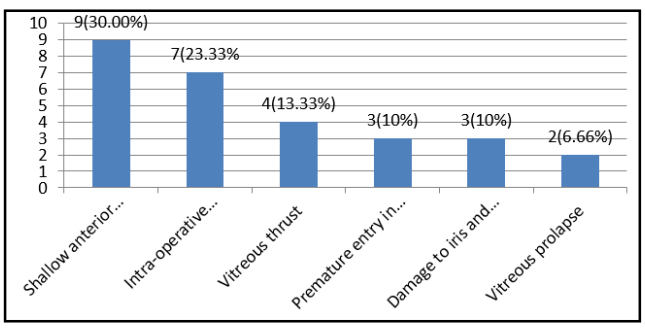
Number of Sutures Used	Number of Cases (N=30)	Percentage
16	28	93.33
12	2	*6.66*

Table 3. Showing Difference in Number of Sutures Used in the Study

Intraoperative Complications

Intraoperative Complications	Number of Cases (N=30)	Percentage (%)
Shallow anterior chamber	9	30.00
Intraoperative hyphaema	7	23.33
Vitreous thrust	4	13.33
Premature entry into the anterior chamber	3	10.00
Damage to iris and crystalline lens	3	10.00
Vitreous proplase	2	6.66

Table 4. Intraoperative Complications During PK

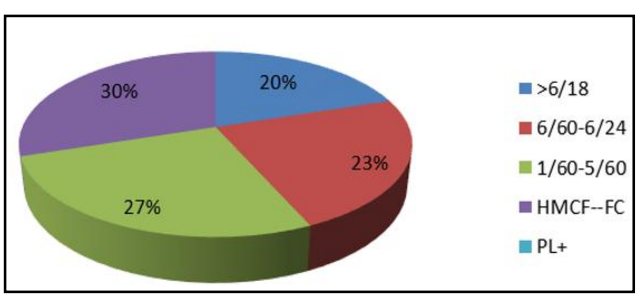


Graph 4. Showing Different Intraoperative Complications

Postoperative findings and follow up-
Visual outcome-

Visual Acuity	Preoperative	Postoperative (6 Months)
	No. (%)	No. (%)
>6/18	Nil	6 (20.00%)
6/60-6/24	Nil	7 (23.33%)
1/60-5/60	4 (13.33%)	8 (26.66%)
HMCF---FC	23 (76.66%)	9 (30.00%)
PL±	3 (10%)	0
	Total=30	

Table 5. Distribution of Visual Acuity in Preoperative and Postoperative Period



Graph 4. Showing Postoperative Visual Outcome

Postop Vd ⇨ / Indications (Number of cases)	>6/18	6/24-6/60	5/60-1/60	FC-HM	PL±
Post ulcer corneal opacity (14)	2	3	5	4	---
Trauma (9)	2	2	2	3	---
PBK (4)	---	2	1	1	---
Dystrophy (2)	2	---	---	---	---
Non-healing corneal ulcer (1)	---	---	---	1	---
Total (N)=30					

Table 6. Postoperative Visual Outcome of PK for Different Indications

Refraction of the cases in the postoperative period showed myopic astigmatism in the range of -1.5 D to -5.50 D.

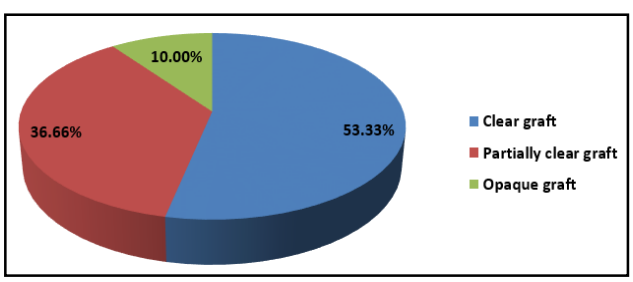
Graft Clarity

In the present study, 16 cases (53.33%) showed clear graft till the last follow up while 11 (33.33%) cases showed partially clear graft resulting in improved visual outcome while 3 cases (10.00%) of the grafts were opaque.

Graft Outcome	Number of Cases (Total=30)	Percentage (%)
Clear graft	16	53.33
Partially clear graft	11	36.66
Opaque graft	3	10

Table 7. Graft Outcome in PK

Thus, the graft survival rate is approximately 90.00% in the present study.



Graph 5. Pie Diagram Showing Graft Outcome in the Present Study

Graft Outcome ⇨ / Indications ⇩	Clear	Partially Clear	Opaque
Post ulcer corneal opacity (14)	7	6	1
Trauma (9)	5	3	1
PBK (4)	2	1	1
Corneal dystrophy (2)	2	------	------
Non-healing ulcer (1)	-----	1	-------
Total (N)=30			

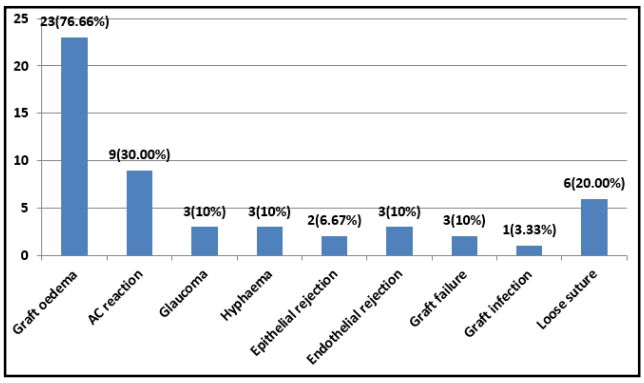
Table 8. Graft Outcome in Different Indications of PK

Postoperative Complications

Postoperative Complications	Number of Cases (Total=30)	Percentage (%)
Graft oedema	23	76.66
AC Reaction	9	30.00
Glaucoma	3	10.00
Hyphaema	3	10.00
Rejection		

Epithelial	2	6.67
Endothelial	3	10.00
Graft failure	3	10.00
Graft infection	1	3.33
Loose suture	6	20.00

Table 9. Postoperative Complications Following PK



Graph 6. Showing Different Postoperative Complications

Vision	PL±	FC-HMCF	1/60-5/60	6/60-6/24	≥ 6/18
Preoperative Vd.	3	23	4	Nil	Nil
Postoperative Vd.	Nil	9	8	7	6

Table 10. Demonstration of Visual Improvement Following Surgery

In the present study, significant improvement of vision in the postoperative period was seen in 20.00% cases with vision of 6/18 or better 23.33% of cases had vision between 6/24-6/60 while 26.66% had an improvement of between 1/60 to 5/60. 30.00% of cases had postoperative vision of HM to FC, which includes 3 (10.00%) cases of graft failure.

DISCUSSION

Corneal transplantation or grafting is an operation in which abnormal corneal host tissue is replaced by healthy donor cornea. Corneal transplantation can visually rehabilitate patients of corneal blindness with reasonable improvement provided other structures are anatomically and functionally normal.

Age Distribution

In the present study, the youngest recipient was 9 years old while the oldest was 82 years old. The mean age was 34.6±19.73 (mean±SD) years at which transplants were done. 53% of total cases belonged to the age group 11-30 years in the present study.

Different Studies	Mean Age Group (Range in Years) of Recipient
I Rahman et al[7] (2008)	56.7 years (8-93 yrs.)
Moustafa K. Nassar et al[8] (2013)	36.5 years (9-78 yrs.)
Present study	34.6 years (9-82 yrs.)

Table 11. Mean Age Group with their Range in Different Studies

In the present study, the maximum recipient were between 11 and 30 years of age, which speaks for the reason as majority of them are illiterate agricultural workers and whose corneal opacity was either the result of post ulcer opacity or trauma.

Sex Distribution

In the present study, out of 30 cases, 13 (43.33%) cases were male, while 17 cases (56.66%) were female, respectively.

Different Studies	(Male %/Female %)
Moustafa K. Nassar et al (2013)[8]	66%/34%
Aruna K R Gupta et al (2014)[9]	62%/38%
Present study	43.33%/56.66%

Table 12. Sex Distribution in Different Studies

The sex distribution in the present study is characterised by female preponderance, which can be attributed to the fact that the majority of female recipient worked outdoors and most of them did not seek medical advice on time as per the history.

Indications for Penetrating Keratoplasty

The indications for PK in the present study are post ulcer corneal opacity in 14 (46.66%) cases, trauma in 9 (30.00%) cases, 4 (13.33%) cases of PBK, 2 (6.66%) cases of corneal dystrophy and 1 (3.33%) case of non-healing corneal ulcer. Similar results have been obtained by Lalit Dandona and co-workers (1997)[10] in their study carried out in India where the most common cause of PK was corneal scarring in 551 (28.1%) cases and the cause of scarring are post ulcer scar in 50.5% cases, trauma in 116 (21.0%), chemical injury in 9 (1.6%) cases, trachoma in 7 (1.3%) and unspecified in 141 (25.6%) cases. Adherent leucoma following ulceration and trauma accounted for 26.7% of cases.

G Singh and others (2015)[11] in their study in India reported the indications of penetrating keratoplasty carried out in 30 cases as traumatic corneal opacity 9 (30%) cases, healed infective keratitis 8 (26.67%) cases, PBK 1 (3.33%) case, graft failure 6 (20.00%) cases, keratoconus 2 (6.66%) cases and corneal dystrophies 3 (10.00%) cases.

I Rahman et al (2008)[7] in their retrospective study carried out in U.K. reported the indications of penetrating keratoplasty as regrafts 41 (20%) cases, ulcerative keratitis 11 (5%), infective keratitis 18 (9%) cases, previous ocular surgery 44 (22%) cases, dystrophies 28 (14%) cases, ectasia 48 (24%) cases and others 13 (6%).

Indications → / Different Studies ↓	Post Ulcer Corneal Opacity (%)	Posttraumatic Corneal Opacity (%)	PBK (%)	Corneal Dystrophy (%)
G Singh and others (2015)	26.67	30.00	3.33	10.00
I Rahman et al (2008)	9.00		18.00	28.00
Present study	46.66	30.00	13.33	6.66

Table 12. Indications for Penetrating Keratoplasty in Different Studies

From the above data, it is clear that the major indications for keratoplasty in this part of the world differs from that of the western countries. Various factors play part and one of them is that the recipient in this part of the world are illiterate agricultural workers where trauma to the eyes with vegetative material is common and also there is significant delay in receiving appropriate medical advices on time.

Graft Survival in Different Studies

Different Studies	Graft Survival Rate (%)
Kocak-Midillioglu and others (1999)	87.5
M A Tanure and others (2000)	86.7
RB Vajpayee and others (2001)	85.0
Tabuchi K and others (2002)	83.3
Mendes and others (2003)	79.9
Present study	90.00

Table 13. Graft Survival in Different Studies

In the present study, 30 cases of penetrating keratoplasty were performed and in which graft survived in 27 (90.00%) cases out of which 16 cases (53.33%) had clear grafts, while in 11 (36.66%) cases there were partially clear grafts. 3 (10.00%) cases had opaque grafts. The causes of graft failure in the present study are- 1.) Endothelial rejection, (2 out of total 3 cases, 66.66%); 2.) Primary graft failure, (1 out of total 3 cases, 33.33%).

Graft survival rate in the present study is comparable with the survival rate reported by R B Vajpayee and others (2001)[12] 85% Kochak-Midillioglu and others (1999)[13] 87.5%, Tabuchi K and others (2002)[14] -83.3% and M A Tanure and others (2000).[15]

The graft survival rate is variable and a few are enlisted below- Vanathi M and others (2005)[16] 66%, R Sinha and others (2005)[17] 50%, K.M. Aasuri and others (2000)[18] 70.6%, GC Tabin and others (2004)[19] 68% and Lalit Dandona and others (1997).[20]

Survival of the grafts post penetrating keratoplasty depends on various factors including the indications for the surgery. In developing countries like India, post-ulcer scarring is the most common indication, which has a fair prognosis for graft survival, whereas in the west, PBK and keratoconus are commoner indications with a very good prognosis.

Visual Outcome

Preoperatively, 76.66% (23 out of 30 cases) of cases had vision between finger counting to hand movement, 13.33% (4 out of 30 cases) had a preoperative vision of 1/60 to 5/60 and 10% (3 out of 30 cases) had a vision of perception of light only.

In the present study, significant improvement of vision in the postoperative period was seen in 20.00% cases with vision of 6/18 or better. 23.33% of cases had vision between 6/24-6/60, while 26.66% had an improvement of between 1/60-5/60. 30.00% of cases had postoperative vision of HM to FC.

Refraction of the cases in the postoperative period showed myopic astigmatism in the range of -1.5 D to -5.50 D.

On evaluating the causes of non-improvement of vision in the postoperative period despite having a clear graft was- Cataract (Mature) in the postoperative period in 4 cases (13.33%), amblyopia in 2 cases (6.66%) and high postoperative astigmatism in 2 cases (6.66%).

Comparable findings have been reported by Sinha R and others (2005)[17] with 16.4% patients with visual acuity of 6/18 or better. Singh and Monga and others (2015)[11] reported 16.66% cases with postoperative visual acuity better than 6/18, 33.33% cases between 6/24 and 6/60, 20% cases between 5/60 and 1/60.

RB Vajpayee and others (2001) in their study reported 70% cases with postoperative visual acuity of 6/12 or better at 1 yr. follow up. Sridhar MS and others (2000)[21] reported 40% of patients with visual acuity better than 20/40 at last check up.

Ruchita Lohiya and others (2015)[22] reported 5% cases with postoperative visual status of 6/18 or better, 20.00% cases had vision between 6/24 to 6/60, 57.5% between 5/60-1/60.

CONCLUSION

From the present study, the following conclusions can be drawn-

1. The major indications for penetrating keratoplasty in this part of the world are post ulcer and posttraumatic corneal opacity and majority of them are illiterate agricultural workers who failed to get adequate treatment on time.
2. Spectrum of recipient age for penetrating keratoplasty is wide, but majority of the cases were between 11-30 years of age.
3. Female patients predominated over male in the study.
4. Graft survival rate is high, which can be attributed to the gradual improvement in all the aspects of penetrating keratoplasty, be it the improved viewing system, effective medications to counter complications and better understanding of corneal physiology.

5. Visual rehabilitation following the surgery in the present study has been hindered by quality of donor grafts and time gap between collection of donor tissue and surgery.
6. Epithelial rejection episodes can be controlled very well with topical and systemic steroids.
7. Endothelial rejection has got poor prognosis even with prompt and adequate treatment.
8. Long-term graft survival and visual outcome cannot be commented from this study because of the short follow-up of the present study.

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REFERENCES

[1] Garg P, Krishna PV, Straits AK, et al. The value of corneal transplantation in reducing blindness. Eye (Lord) 2005;19(10):1106-1114.
[2] Causes of blindness and visual impairment. [Last accessed on 2011 October 30]. from: http://www.who.int/blindness/causes/en.
[3] National Programme for Control of Blindness. Report of National Programme for Control of Blindness, India and World Health Organization 1986-89.
[4] Bigger SLL. An inquiry into the possibility of transplanting the cornea with a view of relieving blindness. Dublin J Med Sci 1837;11:408-417.
[5] Zirm E. Eine erfolgreiche totale keratoplastik. Arch Ophthalmol 1906;64:580-593.
[6] Stocker FW. Successful corneal graft in a case of endothelial and epithelial dystrophy. Am J Ophthalmol 1952;35(3):349-352.
[7] Rahman I, Carley F, Hillarby C, et al. Penetrating keratoplasty: indications, outcomes, and complications. Eye 2009;23(6):1288-1294. www.nature.com/eye.
[8] Nassar MK, Abd El-Rahman ES, El-Saweya MF, et al. Assessment and evaluation of visual acuity, indications, and complications after penetrating keratoplasty. Menoufia Medical Journal 2014;27(2)234-238.
[9] Kumari A, Gupta R. Indications for penetrating keratoplasty in western India. International Journal of Recent Trends in Science and Technology 2013;8(3):256-259.
[10] Dondona L, Ragu K, Janarthan M, et al. Indications for penetrating keratoplasty in India. Indian Journal Ophthalmol 1997;45(3):163-168.
[11] Singh G, Monga S, Bhandari H, et al. Visual outcome in patients undergoing penetrating keratoplasty. Int J Res Med Sci 2015;3(1):244-249.
[12] Vajpayee RB, Sharma N, Sinha R, et al. Laser in-situ keratomileusis after penetrating keratoplasty. Surv Ophthalmol 2003;48(5):503-514.
[13] Kocak-Midillioglu I, Akova YA, Koçak-Altintas AG, et al. Penetrating keratoplasty in patient with corneal scarring due to trachoma. Ophthalmic Surg Lasers 1999;30(9):734-741.
[14] Tabuchi K, Iwasaki Y, Shoji J, et al. Clinical study on surgical outcome of penetrating keratoplasty for herpetic leucoma. Nippon Ganka Gakkai Zasshi 2002;106(5):293-296.
[15] Tanure MA, Cohen EJ, Grewal S, et al. Penetrating keratoplasty for varicella-zoster virus keratopathy. Cornea 2000;19(2):135-139.
[16] Vanathi M, Sharma N, Sinha R, et al. Indication and outcome of repeat penetrating keratoplasty in India. BMC Ophthalmol 2005;5:26.
[17] Sinha R, Vanathi M, Vajpajee RB, et al. Outcome of penetrating keratoplasty in patients with bilateral corneal blindness. Eye 2005;19(4):451-454.
[18] Aasuri MK, Garg P, Gokhle N. Penetrating keratoplasty in children. Cornea 2000;19(2):140-144.
[19] Tabin GC, Gurung R, Paudyal G, et al. Penetrating keratoplasty in Nepal. Cornea 2004;23(6):589-596.
[20] Dandona L, Naduvilath TJ, Janarthanan M, et al. Causes of corneal graft failure in India. Indian J Ophthalmol 1998;46(3):149-152.
[21] Shridhar MS, Murthy S, Bansal AK, et al. Corneal triple procedure: indication, complications and outcomes: a developing country scenario. Cornea 2000;19(3):333-335.
[22] Lohiya S, Lohiya R. A study on post keratoplasty astigmatism and co-relation. Int J Cur Res Rev 2015;7(11):1-4.