

Is Trabeculotomy a Procedure of Choice in Primary Congenital Glaucoma? Assessment by Measuring the Change in Intraocular Pressure after the Procedure

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ABSTRACT

Objective: To study the success of Trabeculotomy procedure in Primary Pediatric glaucoma by measuring the change in intraocular pressure (IOP) after procedure.

Study Design: This was prospective, non-comparative, interventional study.

Study Period: 18 months from March, 2013 to September, 2014. **Material and Methods:** This was carried out in the department of Ophthalmology at Allied Hospital/Punjab Medical College, Faisalabad, Pakistan. 24 eyes of 13 patients, from birth to 42 months of age with Primary Congenital Glaucoma (PCG) were included in the study. The patients were selected after a suspicion of pediatric glaucoma from history and clinical examination. The patients were admitted from pediatric eye OPD of Allied Hospital Faisalabad. Examination under general anesthesia was performed and intraocular pressure (IOP) measurements were recorded. Those diagnosed as primary congenital glaucoma underwent trabeculotomy. Post-operative serial examinations within 1st, 3rd and 6th month were performed with recording of IOP measurements. **Results:** Twenty four eyes

of 13 patients of primary congenital glaucoma were included in this study. 7 patients (53.84%) were males and 6 patients (46.16%) were females. 2 (15.38%) patients had unilateral disease and 11 (84.62%) patients had bilateral disease. The age of patients ranged from 2 months to 42 months with a mean of 22 months. 18 eyes (75%) were involved in patients upto 12 months of age, 5 eyes (20.83%) were involved in patients of 13 to 36 months. 1 eye (4.16%) was involved in the patient of 37 months and above age. All patients had raised intraocular pressure than normal age matched children. All underwent trabeculotomy. There was a decrease in intraocular pressure in all eyes immediately after surgery. In 22 eyes IOP remained within normal limit after 6 months of trabeculotomy but in two eyes it started to rise so was declared failed. **Conclusion:** The success of trabeculotomy procedure can be assessed by Intraocular pressure measurements before and after the procedure. Trabeculotomy has proven to be a safe and effective procedure for control of primary congenital glaucoma **Key words:** Primary congenital glaucoma, Intraocular pressure, Trabeculotomy.

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INTRODUCTION

The pediatric glaucoma is rare heterogeneous and

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potentially blinding group of disorders with a raised intraocular pressure in common.¹ The clinical manifestations and sequelae are due to the raised intraocular pressure (IOP). These also are related to the age of onset, level of IOP and the speed of its rise. The control of IOP is the most important factor which is achieved surgically, with medical treatment playing a supportive role. After control of glaucoma, correction of refractive

error, treatment of amblyopia and restoration of useful vision throughout life is very important. All this is only possible by developing special relationships with parents of child. The pediatric glaucoma is further classified into two major groups, the Primary pediatric glaucoma (PPG) with no obvious ocular or systemic disease and secondary glaucoma caused by an ocular disease, injury, drugs or a systemic disease. The primary pediatric glaucoma is further sub classified into primary congenital glaucoma (PCG) that constitute congenital (presents at birth), infantile (presents before one year of age), delayed onset (presents before 3 years of age); and juvenile open angle glaucoma (JOAG) (presents after 3 years to early adulthood)^{2,3}. The Primary congenital glaucoma is the commonest among the pediatric glaucoma and its incidence varies in different communities. It ranges from 1:10,000-20,000 live births in western countries and increases in eastern countries because of higher consanguineous marriages⁴. PCG has been mostly sporadic but in 10% cases there is a definite family history demonstrating an autosomal recessive inheritance. Four gene loci have been detected as GLC3A, GLC3B, GLC3C and GLC3D. It is CYP1B1 gene on locus GLC3A that is responsible for normal synthesis of enzyme cytochrome P4501B1^{5,6,7}. The mutation of this gene leads to defective synthesis of that enzyme causing maldevelopment and malfunction of ocular tissues.

The males are affected more than females. The primary pediatric glaucoma is typically bilateral (70-80%) and usually manifests in the first year of life (25% at birth and 60% in first year). The Juvenile open angle glaucoma (JOAG) manifests after 3 years. These are caused by the developmental arrest of the anterior chamber angle structures (trabeculodysgenesis) resulting into the increased resistance to the aqueous outflow leading to rise of intraocular pressure with subsequent changes in the affected eye. The classic triad of epiphora, photophobia and blepharospasm / buphthalmos with corneal clouding is alarming symptom of primary pediatric glaucoma. The glaucoma is diagnosed on examination with detection of corneal signs like clouding, Haab's striae and/enlargement, deep Anterior chamber, gonioscopic findings of

trabecular maldevelopment, Lens may be subluxated or dislocated, myopic refractive error, optic disc cupping and⁸, raised IOP checked by tonometry⁹ longer axial Length, B-Scan showing flat retina and cupping of disc in hazy cornea. Ultrasound biomicroscopy (UBM) can be utilized to assess the anterior segment, angle and lens abnormalities. High resolution Optical Coherence Tomography (OCT) of anterior segment is also helpful¹⁰.

A-Scan can be performed for repeated measurements of axial length. Abnormally high readings are suggestive of enlargement of the eyeball.¹¹ Ultrasound/ optical pachymetry can be performed for central corneal thickness (CCT) to avoid under- or overestimation of IOP.¹² The assessment of IOP is the most important factor in diagnosis, and control of Pediatric glaucoma after successful treatment during the follow up period. The Tonometry¹³ is the measurement of IOP. The instrument used is called tonometer. There are two types of tonometer depending upon the principle involved. These are Indentation and appplanation tonometer. Schiottz Tonometer works by principle of indentation. The most commonly used are Appplanation tonometers such as Goldmann appplanation tonometer(GAT), Perkin's Hand held tonometer, Tonopen, Non- contact tonometer (NCT), and tonometers used in Dynamic Contour tonometry (DCT), Ocular response analyzer, Rebound tonometry. Implantable tonometer are under development. The factors affecting the measurement of IOP are, inappropriate Fluorescein pattern, pressure on the globe(by finger of the examiner, eyelid squeezing), crying of child, breath holding of child, Central corneal thickness(CCT)¹² (in thinner cornea underestimation and in thicker cornea overestimation is likely, in Corneal edema underestimation is likely), astigmatism, inappropriate calibration, repeated reading over a short period, General Anaesthesia, some drugs reduce the IOP, others increase it. It has been studied that the IOP is least changed when measured just after induction and before intubation.¹⁴ The IOP in children rapidly increases since birth to the age of 5 years after which it slows down. It ranges between 8 to

14mm since birth to the age of 5 years. The IOP in children has been lower than that of adults¹⁵.

The treatment of pediatric glaucoma is essentially surgical. Medical therapy is only instituted when surgery carries a risk to the vision; eye or life because of general anesthesia. It is only prescribed for short term to lower the IOP, raised IOP after surgery, or to clear the cornea before surgery for internal drainage because these have serious adverse effects and cannot be used on long term.¹⁶ The drugs used in pediatric glaucoma are, Timolol 0.25% eye gel or 0.1% eye drops¹⁷ in newborn or Betaxolol eye drops in asthmatic children and Pilocarpine 1% eye drops or gel. Carbonic anhydrase inhibitors (CIAs) can be used as topical eye drops like Dorzolamide and Brinzolamide, and or oral as Acetazolamide.¹⁸ One of these is selected as first line drug.

Prostaglandins analogues as Latanoprost, Travoprost, Bimatoprost, Unoprostone, and Tafluprost may be used in JOAG but they are less effective and may cause lengthening and thickening of lashes and permanent color change in iris.¹⁹ Sympathomimetic such as topical alpha-2 agonists Brimonidine and apraclonidine has not been used in infants because it crosses the blood-brain barrier and leads to severe bradycardia, hypotension, somnolence and apnea.²⁰

Surgery on pediatric eye is difficult and sometimes complex because of different and changed anatomy in glaucomatous eyes²¹. So it should be performed at a referral center to ensure both skillful surgery and safe anaesthesia¹⁴. The surgical procedures in primary pediatric glaucoma are goniotomy²², trabeculotomy,^{23,24,25} trabeculotomy combined with trabeculectomy,²⁶ trabeculectomy or augmentation with use of antifibrotic agents like mitomycin-C (MMC)²⁷ or 5-fluorouracil (5FU), Tube drainage surgery^{28,29} and cyclodestruction with trans-scleral semiconductor diode laser,³⁰ Nd:YAG laser, endocyclophotocoagulation³¹ and cyclocryotherapy³². Prognosis regarding visual outcome is not favorable in PCG³³.

MATERIALS & METHODS

This prospective, non-comparative, interventional study was carried out in the department of Pediatric Ophthalmology at Allied Hospital,

Faisalabad, Pakistan. After permission from institutional ethical committee, the patients were admitted from Pediatric Eye OPD Allied Hospital, Faisalabad. The duration of the study was for 18 months from March, 2013 to September, 2014.

The study was conducted in an attempt to assess the control of primary pediatric glaucoma by IOP measurements before and after trabeculotomy procedure. 24 eyes were included in this study. Patients with Primary pediatric glaucoma (PCG) under the age of 42 months were included in study. Patients with secondary glaucoma were excluded from study. The diagnosis of primary congenital glaucoma was based on history and clinical examination initially in clinic, with or without sedation. In case of suspected glaucoma the patient was admitted to the ward for examination under general anesthesia (EUA) and to proceed for trabeculotomy after confirmation of diagnosis. In the ward the detailed preoperative assessment was carried out and recorded by a senior pediatric ophthalmic surgeon including the detailed ocular and systemic history of the patients and parents. The detailed systemic examination of all the patients was performed and all relevant investigations for general anesthesia were performed. A formal informed consent was duly signed by parents.

The detailed ocular examination in operating room under general anesthesia included Slit lamp examination of anterior segment, fundus examination for vitreo-Retinal lesions and Cup/Disc Ratio, retinoscopy, intraocular pressure (IOP) with Perkin's applanation tonometer, this was measured after induction before intubation, Corneal diameter vertical and horizontal with Vernier caliper, Axial Length (AL) with Quantel medical AXIS-II biometer, and B-Scan if corneal opacification precluded fundus examination. After the diagnosis of primary pediatric glaucoma was established, the patients with moderate to severely high IOP were advised on anti-glaucoma medical therapy for a few days before surgery. The trabeculotomy was performed by senior pediatric ophthalmologists by standard procedure. After all the aseptic measures the eye speculum was placed to open the lids. Bridal suture was passed to hold the superior rectus muscle. The operation was performed under the microscope. The eye was

irrigated with Ringer's solution. The trabeculotomy was performed in superotemporal quadrant. Fornix based conjunctival flap was raised, a partial thickness scleral flap was fashioned as in trabeculectomy, a radial incision was made near the temporal incision of scleral flap. The incision was gradually deepened until the outer wall of Schlemm's canal was opened. The seepage of aqueous was used to identify the Schlemm's canal. The right sided Harm's trabeculotome was threaded into the Schlemm's canal and was swept into the anterior chamber and same was repeated on the other side. This ruptured the medial wall of the Schlemm's canal and trabecular meshwork to establish direct communication between the anterior chamber and Schlemm's canal for internal drainage of aqueous humor. The deep scleral incision was closed with 10/0 nylon to make it water tight. The scleral flap was closed again with 10/0 nylon sutures. The conjunctival flap was sutured with 10/0 nylon in the purse string manner. Subconjunctival injection of 5-10mg of gentamycin and 1-2mg of dexamethasone was given. A sterile pad was applied with sticking plaster. The detailed operation notes were recorded containing name of the surgeon, type of Anesthesia, date of operation, name of anesthetist, per-operative complication if any and postoperative drugs were prescribe including syrup Ibuprofen 3 times a day for 3 days and then as required. Syrup Augmentin 2 times a day for 5 days. A combination of Tobramycin and Dexamethasone eye drops 2 hourly and Moxifloxacin 0.5% eye drops 2 hourly were given after removal of dressing on first postoperative day. The patient was examined on the 1st post-operative day for any complication and discharged from ward on 2nd post-operative day.

All data including preoperative, operative and post-operative recordings was collected in the proforma designed. Follow up period was extended to six months with visits within 1st month, 3rd month and at 6th month. On every visit, a detailed ocular examination was conducted as

preoperatively. When second eye affected, the patient was advised on antiglaucoma drugs and surgery was planned after 2 weeks when EUA of both eyes was again performed. Also the amblyopia therapy was initiated.

RESULTS

In this study the success of trabeculotomy in primary congenital glaucoma (PCG) was assessed by the change in IOP after the procedure. Total 24 eyes of 13 patients were selected for the study, 11 patients (84.62%) had bilateral disease and 2 (15.38%) patients had unilateral disease this has been shown in graph1.

Out of 13 patients, 7 (53.8%) were males (6 bilateral, 1 unilateral) and 6 (46.2%) females (5 bilateral, 1 unilateral) shown in graph 2.

Two patients/4 eyes (16.66%) gave a family history of glaucoma. In 11 patient/20 eyes (83.33%) there was no family history. As shown in graph 3.

The age of children ranged between 2 months to 42 months with the mean of 22 months. As the number of eyes was small, these were divided into 5 groups for convenience and data processing. The age was recorded in months. The number of eyes in each group was also recorded. Each of the first 4 groups had a range of 3 months because of maximum number of eyes in these groups and 5th group had a range of 13 months and above. 18 eyes (75%) presented in first year of life, 6 eyes (25%) in 13 months and above. This has been shown in table 1. The age distribution has been shown in graph 4.

The comparison of IOP in normal eyes with those having PCG before and within 1st month, 3rd month and 6th month after trabeculotomy in each age group has been shown in table 1 and graph 4, 5, 6. This shows much higher measurements in eyes with PCG than that of normal eyes. Table 1 also explains that IOP after surgery has been normalized in 6 months.

Table 1: The comparison of Mean IOP measurements of normal eyes with those having PCG before and 1st month, 3rd month and 6th month after trabeculotomy

Age Range (Months)	Age (Months)	Normal IOP	Pre-op IOP	Post-operative IOP		
				IOP1	IOP3	IOP6
< 3	3	8	21.50	11.33	12.67	13.00
4 - 6	6	10	25.50	15.83	13.83	11.00
7 - 9	9	12	20.00	17.50	15.50	13.50
10 - 12	12	13	21.75	13.50	18.75	15.25
13+	42	14	25.83	14.17	13.33	14.00

The table 2 shows the mean and standard error of values given in table 1.

Table 2: Comparison of Mean and Standard Error of change in IOP of normal eyes with those having PCG before and after trabeculotomy within 1st month, 3rd month and 6th month

Mean±SE values

Age range (months)	Age (months)	Normal IOP	Pre-op IOP	Post-operative IOP		
				IOP1	IOP3	IOP6
< 3	3	8	21.50±1.06	11.33±0.49	12.67±0.61	13.00±0.52
4 – 6	6	10	25.50±2.51	15.83±2.02	13.83±0.87	11.00±0.82
7 – 9	9	12	20.00±0.00	17.50±3.50	15.50±0.50	13.50±0.50
10 – 12	12	13	21.75±0.85	13.50±2.10	18.75±6.29	15.25±3.09
13+	42	14	25.83±0.95	14.17±2.60	13.33±1.45	14.00±1.59

SE = Standard Error

Bilateral and Unilateral Chart

■ Bilateral ■ Unilateral

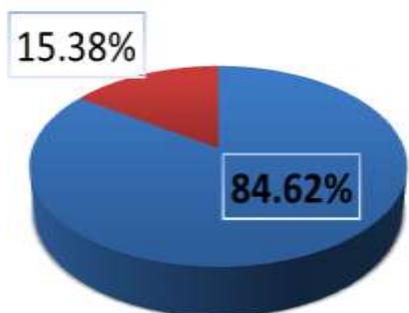


Figure 1: Bilateral versus Unilateral

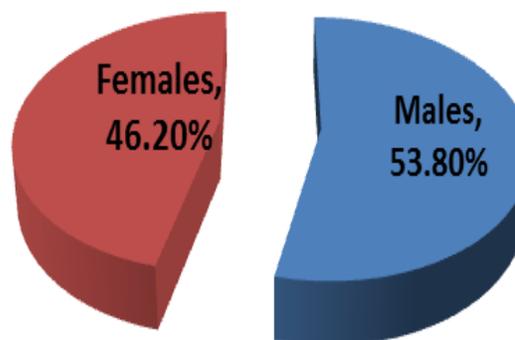


Figure 2: Gender distribution

This graph shows the gender distribution with male 53.8% & female 46.2%.

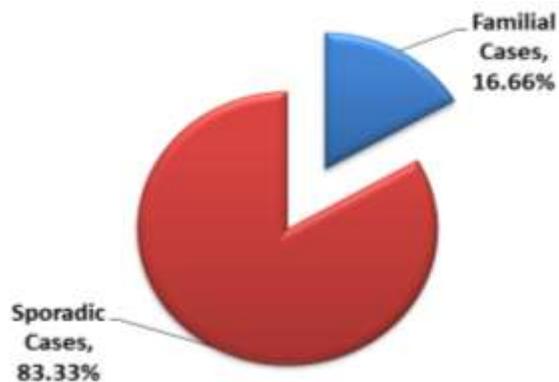


Figure 3: Familial Versus Sporadic Cases

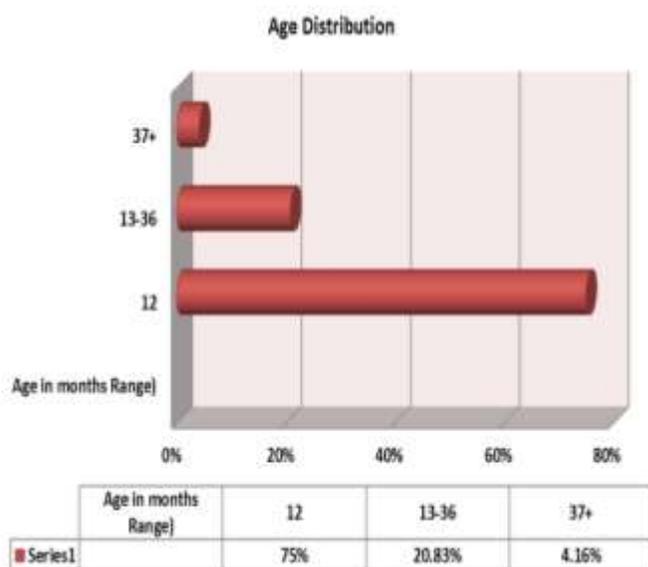


Figure 4: Age distribution

This graph shows the age distribution with 75% under 12 months, 20.83% between 12 to 36 months and 4.16% above 36 months of age.

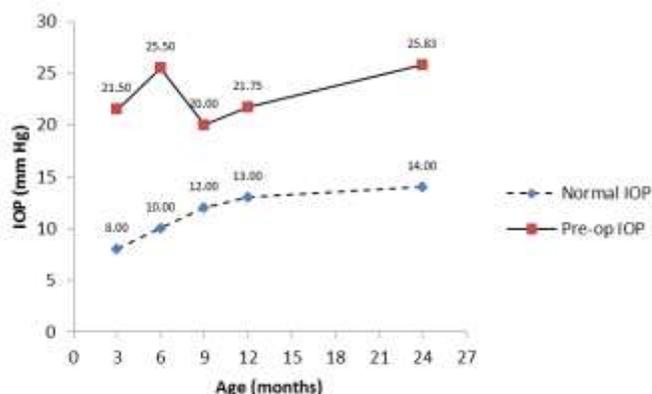


Figure 5: The comparison of preoperative IOP in eyes with PCG showing higher measurements to that in normal eyes of age matched children.

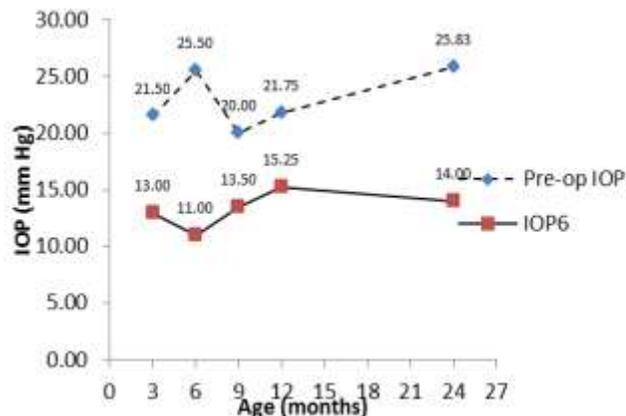


Figure 6: The comparison showing that pre-operative measurement of IOP in eyes with PCG is higher than that of six months after trabeculotomy.

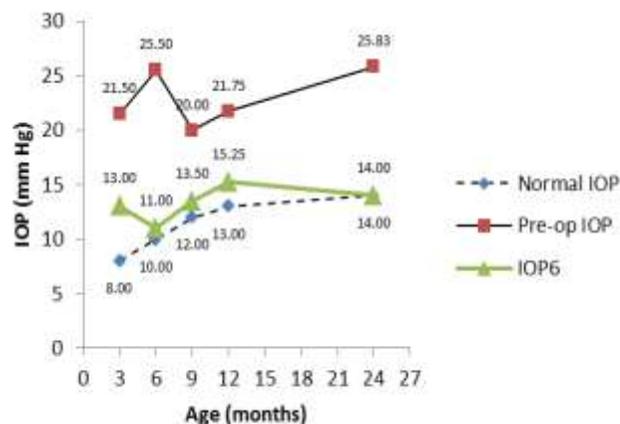


Figure 7: The comparison of measurement of IOP in normal eyes with those of PCG before and six months after trabeculotomy. This shows that IOP was much higher than normal before surgery but after Trabeculotomy has been normalized in age matched children.

There was no significant complication during surgical procedure except mild hyphaema in 17(70.83%) eyes that resolved later. One eye (4.16%) had hypotony without associated complications and recovered later. Two eyes (8.33%) who had failed trabeculotomy, responded well to Trabeculectomy with MMC. These eyes were excluded from our study because of urgency

of second surgery. In our study the success rate of trabeculotomy, assessed by change in IOP after 6 months of surgery, was 91.66%.

DISCUSSION

The primary pediatric glaucoma is a rare heterogenous group of potentially blinding ocular diseases with raised intraocular pressure in common.¹ It was recognized since long in the history with the names of hydrophthalmia, and buphthalmos⁸. The findings in my study are comparable with the different studies with the references quoted.

PCG presents since birth to 3-4 years of age but mostly before 7-8 years of age. It is bilateral in (70 to 80%). Up to 80% diagnosed in the 1st year of life⁴. These findings agree with that of my study.

Our finding of family history of 5 (20.83%) eyes (graph 3) agrees with that published in the literature of between 10% and 40%⁴. Most of the cases (79.17%) were sporadic without a family history which also is comparable with the other studies ranging from 40% to 100%. This high incidence may be due to parental consanguinity^{5,6}. There is no agreed normal range of IOP in children. Most studies show the IOP lower in children than in adults. Its measurement is also affected by the type of tonometer used such as Perkin's tonometer, Tonopen, Non-contact tonometer. Also it changes with the type of anaesthesia such as topical under sedation or general anaesthesia. The drugs used during General anaesthesia also affects IOP like halothane, ketamine and suxamethonium. Laryngoscopy and intubation also affects the IOP¹⁴. IOP changes rapidly from birth to 5 years (8 to 14 mm Hg)¹⁵, after which it is minimal. As the age was limited to 42 months and more number of cases of PCG were falling in the first year of age, so this was divided into four groups, each comprising of 3 months of age and remaining cases were classified into one group 13+ months. The maximum number of cases of primary congenital glaucoma (75%) was diagnosed in first year of life. This represents the primary congenital/infantile glaucoma group (PCG). 20.83% (5) cases of PPG were diagnosed between 2nd and 3rd year of age. This may

represent delayed onset or delayed diagnosed cases of PCG. Both of these groups comprise of 95.83% of cases of PPG. This is shown in graph 2. In other studies the incidence in 1st year was up to 80%^{4,8}. This matches with the incidence in my study.

Although there is a rapid increase in the IOP from birth (9.5 mm Hg) to 4 years (14mm Hg) but still it remains below 15 mm Hg. The preoperative mean IOP was measured and recorded in all 24 eyes of PCG and mean of each of 5 groups was recorded in the data. It was compared with the mean IOP of age matched normal eyes. It was found that measurement of IOP of all (100%) eyes with PCG was much higher than that of normal age matched children. This proves the importance of IOP measurement as a diagnostic tool for PCG (table 1,2, graph 5).

Trabeculotomy ab externo has been a popular surgical technique in primary congenital glaucoma especially when cornea is hazy and precludes visualization of angle. It has been safe in the hands of a pediatric ophthalmic surgeon who is aware of the limbal anatomy and can recognize the Schlemm's canal with the advent of microscope and a special probe called Harm's trabeculotome. It has given promising results in different studies.^{23, 24,25, 26}

After trabeculotomy the serial IOP measurements of all eyes with PCG were recorded after 1st, 3rd and 6th months as shown in table 1. It was found that the mean IOP has been decreased when compared with the preoperative IOP in the same age group (table 1,2, graph 6-7). This indicates that IOP measurement can be used postoperatively during follow up period to assess the effectiveness of treatment and control or progression of glaucoma.

The 6 months postoperative measurements of IOP in eyes with PCG was also compared with those of normal and it was found that mean IOP in eyes with PCG became closer to that of normal eyes and followed the same pattern with that of normal eyes of age matched children graph 7.

Serial IOP measurements have shown that these were initially higher than the normal age matched children but later after trabeculotomy these were stabilized and did not show any trend of increase in the children with controlled glaucoma.

The shortcomings of the study are smaller sample size and the shorter follow up period. The larger sample size and the longer follow up period are recommended to assess the control and progression of primary congenital glaucoma after trabeculotomy.

CONCLUSION

The success of trabeculotomy in treatment of primary congenital glaucoma can be assessed by using the IOP, in conjunction with other parameters like axial length, optic disc evaluation and corneal diameter.

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