Comparative study between Goniotomy, Trabeculotomy and viscotrabeculotomy in primary congenital glaucoma

Hosny Hassan Mohammad, Hisham Fawzy Khalil, Mahmoud Abd Elhaleem Rabea and Ibrahim Hassan Mohamed.
Ophthalmology Department, Faculty of Medicine Al-Azhar University, Egypt
sal.totti@gmail.com

Abstract: Background: To assess safety and efficacy of goniotomy, trabeculotomy and viscotrabeculotomy in the surgical management of primary congenital glaucoma. **Patient and Methods:** In a prospective study patient with congenital glaucoma matching the inclusion criteria underwent goniotomy (A) group, 15 eyes, trabeculotomy (B) group, 15 eyes. And viscotrabeculotomy (C) group, 15 eyes. Patients were followed up for 12 months. A probability value (p value) less than 0.05 was considered significant. **Results:** The mean preoperative IOP in A, B and C groups were, 28.53, 27.47, and 26.20, Postoperatively, IOP dropped at12 months to 17.67, 15.87 and 15.93 mmHg in A, B and C groups respectively. That was significant in each group when compared to preoperative IOP but was not significant between the groups at the same point of comparison. At 12 months postoperatively, complete success was achieved in (80 %), in the C group (73.3%), in the B group and (66.7%), in A group. **Conclusions:** goniotomy, trabeculotomy and viscotrabeculotomy are equally effective in the management of primary congenital glaucoma with no preference of one technique over the other.
[Hosny Hassan Mohammad, Hisham Fawzy Khalil, Mahmoud Abd Elhaleem Rabea and Ibrahim Hassan Mohamed. **Comparative study between Goniotomy, Trabeculotomy and viscotrabeculotomy in primary congenital glaucoma.** *Nat Sci* 2017;15(2):25-30]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 5. doi:10.7537/marsnsj150217.05.

Key words: congenital glaucoma, goniotomy, trabeculotomy and viscotrabeculotomy.

1. Introduction

Congenital glaucoma is an inherited abnormality of the trabecular meshwork that manifests itself during the first years of life with intraocular pressure elevation, edema and enlargement of the cornea, and optic nerve damage **(Papadopoulos et al., 2007).**

Clear cornea and good visualization of angle structures were key ingredients for successful goniotomy; unfortunately, many cases of congenital glaucoma present with cloudy corneas because of markedly elevated intraocular pressure or breaks in Desçemet's membrane. In such cases, goniotomy becomes little more than a blind procedure **(Girkin et al, 2012).**

The principal advantage of trabeculotomy is that it can be performed in the presence of cloudy cornea**(Mullaneyet al, 1999)**.

Use of viscoelastics during trabeculotomy might increase the success rate by prevention of postoperative hemorrhage and adhesion of the incision and this modified technique named viscotrabeculotomy **(Tamcelik et al., 2010).**

2. Patients and methods

Patient selection

Subjects for the study were recruited randomly from the patients attending the Elhuseein and EL Sayed Galal ophthalmology clinic who met the inclusion criteria for the study. Informed consent was obtained from the parents and care givers of all children participating in the study after explanation of the risks and benefits of the procedure

Inclusion criteria were: unoperated patients presenting with primary congenital glaucoma in the first 3 years of life.

Patients who were **excluded** were those who had horizontal corneal diameters more than 15 mm or the ones who had underwent any other ocular surgery or who had any coexisting ocular or systemic disease.

Forty-five eyes meeting the inclusion criteria were divided into three groups:

Group A: 15 eyes underwent **Goniotomy,**
Group B: 15 eyes underwent conventional **trabeculotomy.**
Group C: 15 eyes underwent **viscotrabeculotomy.**

Surgical technique

Goniotomy

The patient is placed in the supine position on the operating table; his head is turned away from the surgeon approximately 45° from the vertical plane and secured firmly in place. The operating microscope is oriented temporally and tilted 45°, but with straight eye pieces.

A limbal incision through the cornea just anterior to the corneosclerallimbus is created. Intra cameral viscoelastic substance is used to deepens the AC and protects both the corneal endothelium and the lens. Introduce the goniotomy knife through the stab incision. Once the blade advanced to the opposite limbus **Hill Surgical Gonioprism** left handed, is placed on the cornea The blade tip is used to create a

full thickness incision in the middle third of the trabecular meshwork, resulting in a superficial incision in the nasal angle about 80-90°.

When the procedure is completed, withdrawal of the needle is done. The corneal stab incision should be closed using a single 10-0 nylon suture. Subconjunctival injections of a corticosteroid and antibiotic are usually given.

Trabeculotomy:

A fornix- based conjunctival flap was performed Excessive cautery is avoided. A partial thickness rectangular scleral flap was fashioned. The scleral flap should be deep to facilitate location of Schlemm'scanal which located by slowly deepening a 2mm radial incision placed at the corneoscleral junction.

Schlemm's canal is unroofed by a careful dissection layer by layer until the egress of a small amount of aqueous humor or blood is observed.

Trabeculotome is gently threaded into the canal and swept into anterior chamber; rupturing the internal wall of schelmm canal and trabecular meshwork (the upper probe is used as a guide to confirm the location of the lower one).

The procedure was repeated in the opposite direction using the right- handed trabeculotome. The scleral flap was closed with two 10/0 nylon sutures at its corners and the conjunctiva was closed by 10/0 nylon sutures. Subconjunctival 20 mg prednisolone acetonide, was then injected.

ViscoTrabeculotomy:

A fornix-based conjunctival flap was performed and a partial-thickness rectangular scleral flap was created. Schlemm's canal was identified and a radial incision was made in the bed of the scleral flap. Schlemm's canal was unroofed by a careful dissection layer by layer until the egress of a small amount of aqueous humor was observed.

High viscosity sodium hyaluronate (Healon GV) was then injected into the Schlemm's canal slowly and in the form of repeated boli using the 30 G Cannula. The procedure was repeated on the other side. The trabeculotome was then used to cannulate Schlemm's canal.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges when parametric distribution. The comparison between two groups with qualitative data were done by using **Chi-square test**.The comparison between more than two independent groups with quantitative data and parametric distribution was done by using **One Way ANOVA**.The comparison between two paired groups with quantitative data and parametric distribution was done by using **Paired t-test**.

3. Results

Table (1): Pre &post-operative IOP at different time interval in all groups.

IOP		Group A	Group B	Group C	One Way ANOVA test	
		No = 15	No = 15	No = 15	F	P-value
Pre	Mean ± SD Range	28.53 ± 4.67 23 – 37	27.47 ± 4.27 22 – 35	26.20 ± 5.24 20 – 37	0.909	0.411
1 week	Mean ± SD Range	13.20 ± 2.48 10 – 20	14.40 ± 3.89 10 – 24	11.80 ± 1.93 8 – 16	3.045	0.060
1 month	Mean ± SD Range	15.40 ± 4.64 10 – 26	15.73 ± 4.53 10 – 26	13.73 ± 3.75 8 – 22	0.921	0.406
3rd month	Mean ± SD Range	16.27 ± 5.50 10 – 32	16.87 ± 6.15 10 – 32	12.93 ± 3.56 8 – 22	2.504	0.094
6th month	Mean ± SD Range	15.87 ± 5.37 10 – 30	16.33 ± 6.00 10 – 30	14.00 ± 3.36 8 – 22	0.902	0.414
9th month	Mean ± SD Range	17.20 ± 5.03 12 – 30	16.20 ± 5.07 10 – 28	14.60 ± 3.96 10 – 24	1.160	0.323
1 year	Mean ± SD Range	17.67 ± 5.09 12 – 30	15.87 ± 5.25 10 – 30	15.93 ± 4.03 10 – 24	0.672	0.516

This study include Forty-five eyes of thirty patients who met the inclusion criteria. Patients were divided into 3 groups according to the type of surgery performed: goniotomy group (group A, 15 eyes), Trabeculotomy Group (Group B, 15 eyes) and Viscotrabeculotomy Group (Group C, 15 eyes).

The mean range of patients' age in A, B and C groups were, 10.00 ± 5.40 months (3 – 18 months), 14.13 ± 5.73 months (5 – 25 months) and 12.47 ± 5.62

months (5 – 20 months), respectively. Males represent (66.7%), (75%) and (80%) in A, B and C group respectively, that difference was not statistically significant.

The mean (SD) & range of patients' **preoperative IOP** in A, B and C groups were, 28.53 ± 4.67mmHg (23 – 37 mmHg), 27.47 ± 4.27mmHg (22 – 35 mmHg) and 26.20 ± 5.24 mmHg (20 – 37 mmHg), respectively. Differences in preoperative IOP between the three groups was statistically insignificant (P value =0.411).

When comparing the preoperative IOP to that achieved postoperatively at one week, first month, 3rd month, 6th month, 9th month and 1 year. All techniques achieved significant reduction of IOP at these time intervals. IOP differences between the three groups were statistically insignificant.

The mean(SD) & range of patients' **preoperative horizontal corneal diameter (HCD)** in A, B and C groups were, 13.53 ± 0.81mm (12.5 - 15 mm), 13.20 ± 0.94mm (12 to 15 mm) and13.67 ±± 0.90mm (12 to 15 mm), respectively.

Table (2): Pre &post-operative HCD at different time interval in all groups.

		Group A	Group B	Group C	One Way ANOVA	
		N = 15	N = 15	N = 15	F	P-value
Pre	Mean±SD Range	13.53 ± 0.81 12.5 – 15	13.20 ± 0.94 12 – 15	13.67 ± 0.90 12 – 15	1.104	0.341
1 week	Mean±SD Range	13.53 ± 0.81 12.5 – 15	13.20 ± 0.94 12 – 15	13.67 ± 0.90 12 – 15	1.104	0.341
1 month	Mean±SD Range	13.53 ± 0.81 12.5 – 15	13.20 ± 0.94 12 – 15	13.67 ± 0.90 12 – 15	1.104	0.341
3rd month	Mean±SD Range	13.53 ± 0.81 12.5 – 15	13.20 ± 0.94 12 – 15	13.67 ± 0.90 12 – 15	1.104	0.341
6th month	Mean±SD Range	13.53 ± 0.81 12.5 – 15	13.20 ± 0.94 12 – 15	13.65 ± 0.89 12 – 15	1.054	0.358
9th month	Mean±SD Range	13.50 ± 0.82 12.5 – 15	13.18 ± 0.94 12 – 15	13.63 ± 0.87 12 – 15	1.043	0.361
1 year	Mean±SD Range	13.49 ± 0.80 12.25 – 14.75	13.16 ± 0.89 12 – 14.75	13.62 ± 0.87 12 – 15	1.156	0.325

It was found that insignificant reduction in corneal diameter after surgery in all groups.

The mean(SD) & range of patients' **preoperative Cup to disc ratio(C/D ratio)** in A, B and C groups were, 0.51 ± 0.22 (0.2 – 0.9), 0.55±0.25(0.2-0.9)and 0.52 ± 0.24 (0.2 – 0.9), respectively.

Table (3): Pre &post-operative C/D ratio at different time interval in all groups.

C/D ratio		Group A	Group B	Group C	One Way ANOVA test	
		No = 15	No = 15	No = 15	F	P-value
Pre	Mean ± SD Range	0.51 ± 0.22 0.2 – 0.9	0.55 ± 0.25 0.2 – 0.9	0.52 ± 0.24 0.2 – 0.9	0.112	0.894
1 week	Mean ± SD Range	0.51 ± 0.22 0.2 – 0.9	0.55 ± 0.25 0.2 – 0.9	0.52 ± 0.24 0.2 – 0.9	0.112	0.894
1 month	Mean ± SD Range	0.51 ± 0.22 0.2 – 0.9	0.55 ± 0.25 0.2 – 0.9	0.52 ± 0.24 0.2 – 0.9	0.112	0.894
3rd month	Mean ± SD Range	0.51 ± 0.22 0.2 – 0.9	0.54 ± 0.25 0.2 – 0.9	0.51 ± 0.23 0.2 – 0.8	0.087	0.917
6th month	Mean ± SD Range	0.47 ± 0.23 0.2 – 0.8	0.52 ± 0.24 0.2 – 0.9	0.50 ± 0.23 0.2 – 0.8	0.155	0.857
9th month	Mean ± SD Range	0.47 ± 0.23 0.2 – 0.8	0.52 ± 0.24 0.2 – 0.9	0.49 ± 0.23 0.2 – 0.8	0.199	0.820
1 year	Mean ± SD Range	0.47 ± 0.23 0.2 – 0.8	0.52 ± 0.24 0.2 – 0.9	0.48 ± 0.24 0.2 – 0.8	0.207	0.814

When comparing the preoperative C/D ratio to that achieved postoperatively at six month, 9th month, 12 month, all techniques achieved significant reduction of C/D ratio at these time intervals. C/D ratio reversal usually takes place around third to six month postoperatively.

The mean(SD) & range of patients' **preoperative axial length (AL)** in A, B and C groups were, 23.13 ± 1.61 mm (20 – 26 mm), 22.93 ± 2.46 mm (18 to 26. mm) and 23.27 ± 2.02mm (19-26 mm), respectively.

When comparing the preoperative (AL) to that achieved postoperatively at six month, 9th month, 12 month, all techniques achieved significant reduction of (AL) at these time intervals.

Table (4): Pre &post-operative AL at different time interval in all groups.

AL		Group A	Group B	Group C	One Way ANOVA test	
		No = 15	No = 15	No = 15	F	P-value
Pre	Mean ± SD Range	23.13 ± 1.61 20 – 26	22.93 ± 2.46 18 – 26	23.27 ± 2.02 19 – 26	0.100	0.905
1 week	Mean ± SD Range	23.20 ± 1.67 20 – 26	22.93 ± 2.46 18 – 26	23.27 ± 2.02 19 – 26	0.108	0.897
1 month	Mean ± SD Range	23.07 ± 1.59 20 – 26	22.93 ± 2.46 18 – 26	23.27 ± 2.02 19 – 26	0.100	0.905
3rd month	Mean ± SD Range	22.90 ± 1.63 20 – 26	22.93 ± 2.46 18 – 26	23.00 ± 2.03 19 – 26	0.009	0.991
6th month	Mean ± SD Range	22.50 ± 1.90 20 – 26	22.67 ± 2.37 18 – 26	22.87 ± 1.85 19 – 25.5	0.120	0.887
9th month	Mean ± SD Range	22.47 ± 1.90 20 – 26	22.67 ± 2.40 18 – 26	22.87 ± 1.85 19 – 25.5	0.141	0.869
1 year	Mean ± SD Range	22.40 ± 1.97 20 – 26	22.56 ± 2.43 18 – 26	22.77 ± 1.81 19 – 25.5	0.116	0.891

At 12 months postoperatively, total success (Total=complete + qualified success) was achieved in 66.7% (10 eyes) of group A 73.3% (11 eyes) of group B and 80 % (12eyes) in group C.

Failure was encountered in 5 eyes (33.3 %) of group A, 4 eyes (26.7 %) of the group B and 3 eyes (20%) of the group C. Failure was due to persistently increased IOP above 18 mmHg in spite of addition of IOP lowering medications.

Table (5): Total success and failure between the three groups.

	Group A		Group B		Group C		Chi-square test	
	No.	%	No.	%	No.	%	X^2	P-value
Success	10	66.7%	11	73.3%	12	80%	0.682	0.711
Failed	5	33.3%	4	26.7%	3	20%		

4. Discussion

The management of congenital glaucoma is surgical, and traditional surgery has centered on incising or cleaving the abnormal trabecular meshwork to restore outflow facility. This can be achieved by incising the meshwork ab-interno or ab-externo, with goniotomy or trabeculotomy, respectively **(Ozkiris & Tamcelik, 2008).**

Goniotomy

The success rate of goniotomy is related with the age of the patient at the onset of glaucoma and types of abnormalities **(Elder, 1993)**. When the signs and symptoms of glaucoma were present at birth or over 24 months, the success rate was close to 30% **(Shaffer, 1980)** It has been reported that the surgical results are more favorable if the operation is performed within the first 2 to 12 months of life **(Alsheikheh et al., 2007)**. However, up to 50% of the population are reported to have varying degrees of corneal edema, rendering goniotomy technically impossible **(Luntz, 1984)**.

The technique ofgoniotomymainly depend on corneal clarity it involve creation of a superficial incision into uveal TM allowing the iris root to move posteriorly and relieving the mechanical obstruction to aqueous outflow. The advantage of goniotomy is not to disturb the conjunctiva if filtering surgery is subsequently needed. Goniotomy, however, is a

technically challenging procedure **(Weinreb et al., 2013).**

The results of goniotomy procedures have been reported by several authors. The success rate in the western society is quite high, between 75 and 90%. In comparison, in South East Asian and the Middle East where the age of presentation is much earlier, the quoted success rate of goniotomy drops to approximately 50**% (Yu Chan et al., 2015).**

Russell et al. (1992)have used this procedure for infantile glaucoma with success rate of 70%. **Mendicino et al. (2000**) reported the success rate 60% of goniotomy after 4 years of follow-up.

In Saudi Arabia, however, a study including 254 goniotomies had a success rate of only 52% **(Al-Hazmi et al., 2005).**

In this study, the success rate of goniotomy was achieved in 66.7% which is comparable with many previous authors.

Trabeculotomy

Trabeculotomyabexterno is an alternative surgical technique that is possible even in the presence of severe corneal edema. The only disadvantage of trabeculotomy is that Schlemm's canal may not be found in 11–15% of procedures. This may be caused by surgical inexperience, abnormal anatomy, or hypoplasia of the canal. The idea of trabeculotomy is to open up the trabecular meshwork from the Schlemm canal to the anterior chamber to ease the penetration of the aqueous humor**(Weinreb et al., 2013).**

Success rates of trabeculotomy following multiple surgery reported in large pediatric series (47–116 eyes) are similar to those of goniotomy, varying between 84–93%**(Anderson 1983; Hoskins & Shaffer 1984; Meyer et al. 2000)**.

Autrata and Lokaj in 2003 did a retrospective study on 38 eyes of 21 patients underwent trabecuotomy and 45 eyes of 26 patients underwent trabeculectomy as a primary procedure. Follow up was done for 3 – 10 years. Success was 89% in trabeculotomy group and 54% in trabeculectomy group.

Yalvac et al 2007 did a retrospective study on 36 eyes of 24 patients underwent trabecuotomy. This study showed success rate of 97 % at 6 months and 92% at 1year.

In this study, the success rate of trabeculotomy was achieved in 73.3%which is comparable with many previous authors.

Viscotrabeculotomy

Viscoelastic materials remain in the canal for 4 to 6 days, prevent collapse of the Schlemm's canal, and create a barrier to the migration of fibrinogen released by the ciliary body during surgery **(Johnson & Johnson, 2001)**. In our study, a little amount of high viscosity sodium hyaluronate(Healon GV) was injected into the Schlemm's canal on either side to prevent late bleeding and adhesion of the incision lips.

In the study carried out by **Tamcelik and Ozkiris (2008),** the authors performed viscotrabeculotomy for the management of congenital glaucoma and compared the outcomes with classical trabeculotomy. They reported a success rate of classical trabeculotomy of 68.6% and 91.3% of viscotrabeculotomy.

In another study by **ElSheikha et al. (2015),** they assessed the efficacy of viscotrabeculotomy in the management of congenital glaucoma as compared to conventional trabeculotomy, in Egyptian infants. The mean preoperative IOP was 24.3 and 23.5 mm Hg in the trabeculotomy (T) and viscotrabeculotomy (VT) groups respectively. These dropped postoperatively to 17and 14.7 mmHg in the VT and T groups, respectively.With success rate 60.0% in the T group compared to 61.9% in the VT group that was significant in either.

In this study, the success rate of viscotrabeculotomy was achieved in 80 % which is comparable with previous authors.

In conclusion, comparing the results of the three groups revealed that goniotomy, trabeculotomy and viscotrabeculotmy appear to be equally effective for the reduction of IOP in the management of congenital glaucoma with no preference of one technique over the other.

Also we found that with intraocular pressure control in congenital glaucoma, C/D ratio and axial length may decrease. In contrast to corneal diameter in which changes was insignificant.

References

1. Al-Hazmi A., Awad A., Zwaan J., Al-Mesfer S. A., Al-Jadaan I., and Al-Mohammed A. “Correlation between surgical success rate and severity of congenital glaucoma,” Br J Ophthalmol, 2005;89:(4):449–453.
2. Alsheikheh A, Klink J, Klink T, Steffen H, Grehn F. Long-term results of surgery in childhood glaucoma. Graefes Arch Clin Exp Ophthalmol 2007; 245: 195–203.
3. Anderson DR. Trabeculotomy compared to goniotomy for glaucoma in children. Ophthalmology, 1983; 90: 805–6.
4. Autrata R. and Lokaj M. Trabeculotomy versus Trabeculectomy for Primary Congenital Glaucoma. Scripta Medica (Brno); 2003; 76(2):79–86.
5. Elder MJ. Congenital glaucoma in the West Bank and Gaza Strip. Br J Ophthalmol1993;77:413–16.

6. ElSheikha OZ, Abdelhakim MA, Elhilali HM & Kassem RRIs viscotrabeculotomy superior to conventional trabeculotomy in the management of Egyptian infants with congenital glaucoma? Acta Ophthalmol, 2015;93: e366–e371.
7. G, Rhodes L, Mc Gwin G, Marchase N, Cogen MS.: Goniotomy versus circumferential trabeculotomy with an illuminated microcatheter in congenital glaucoma. J AAPOS 2012; 16: 424-427.
8. Hoskins HD., Shaffer RN., and Hetherington J., "Goniotomyvstrabeculotomy," J Pedi OphthalmolStrab, 1984;21:(4)153–158.
9. Johnson DH, Johnson M. How does nonpenetrating glaucoma surgery work? Aqueous outflow resistance and glaucoma surgery. J Glaucoma 2001; 10: 55–67.
10. Luntz MH. The advantages of trabeculotomy over goniotomy. J Pediatr Ophthalmol Strabismus1984;21: 150–153.
11. Meyer G, Schwenn O, Pfeiffer N, Grehn F. Trabeculotomy in congenital glaucoma. Graefes Arch Clin Exp Ophthalmol2000; 238: 207-213.
12. Mendicino ME, Lynch MG, Drack A, et al. Long-term surgical and visual outcomes in primary congenital glaucoma: 360° trabeculotomy versus goniotomy. J AAPOS 2000;4:205–10.
13. Mullaney P. B., Selleck C., Al-Awad A., Al-Mesfer S., and Zwaan J., "Combined trabeculotomy and trabeculectomy as an initial procedure in uncomplicated congenital glaucoma," Arch Ophthalmol;1999:(117), no. 4, 457–460.
14. Papadopoulos M, Cable N, Rahi J, Khaw PT: BIG Eye Investigators. The British Infantile and Childhood Glaucoma (BIG) Eye Study. Invest Ophthalmol Vis Sci2007; 48:4100-4106.
15. Russell-Eggitt IM, Rice NS, Jay B, et al. Relapse following goniotomy for congenital glaucoma due to trabecular dysgenesis. Eye 1992; 6:197–200.
16. Shaffer RN., Prognosis of goniotomy in primary infantile glaucoma (trabeculodysgenesis). Trans Am OphthalmolSoc1982; 80: 321–325.
17. Tamcelik N, Ozkiris A. Long-term results of viscotrabeculotomy in congenital glaucoma: comparison to classical trabeculotomy. Br J Ophthalmol.2008; 92:36-9.
18. Tamcelik N, Ozkiris A, Sarici AM. Long-term results of combined viscotrabeculotomy-trabeculectomy in refractory developmental glaucoma. Eye, 2010;24:613-8.
19. Weinreb RN, Grajewski A, Papadopoulos M, Grigg J, Freedman S,: Childhood Glaucoma. WGA Consensus Series-9. Amsterdam: Kugler Publications; 2013; 3 –120.
20. Yalvac IS, SatanaB, Suveren A, Eksioglu U and Duman S: Success of trabeculotomy in patients with congenital glaucoma operated on within 3 months of birth. Eye, 2007; 21,459-464.
21. Yu Chan JY, Choy BNK, Alex LK Ng, Shum JWH. Review on the Management of Primary Congenital Glaucoma. J Curr Glaucoma Pract 2015;9(3):92-99.

1/15/2017