GMR
The Original

COMPARING CYCLODIODE LASER THERAPY TO AHMED GLAUCOMA VALVE IMPLANTATION IN PEDIATRIC REFRACTORY GLAUCOMA

Mohammad Daniyal Monis[1], Israr Ahmed Bhutto[2], Sadia Bukhari[1], PS Mahar[1], Munawar Hussain[1], Nasir Ahmed Memon[1], Sanan Akbar[1]

[1] Isra Postgraduate Institute of Ophthalmology, Karachi, Pakistan
[2] Jinnah Postgraduate Medical Center, Karachi, Pakistan
Corresponding Author: Mohammad Daniyal Monis: drdaniyal@hotmail.com

Abstract

Purpose: Glaucoma is a leading cause of irreversible blindness worldwide. Although less common in children, pediatric glaucoma is a serious condition that can impair visual development and cause permanent vision loss. Management is particularly challenging in refractory cases where intraocular pressure (IOP) remains uncontrolled despite medications and previous surgeries. Ahmed Glaucoma Valve (AGV) implantation has shown favorable outcomes, while cyclodiode laser therapy has produced variable results. However, direct comparisons between these treatments remain limited, especially in resource-limited settings. This study aimed to compare the safety and efficacy of AGV implantation and cyclodiode laser therapy after six months in refractory pediatric glaucoma patients.
Materials and Methods: This quasi-experimental study was conducted at the pediatric ophthalmology department of Al Ibrahim Eye Hospital, Karachi, with a six-month follow-up from November 2024 to April 2026. Eligible patients underwent either Ahmed Glaucoma Valve (AGV) implantation (Group A) or cyclodiode laser therapy (Group B). Patients with prior AGV or cyclodiode treatment and those lost to follow-up were excluded. Data were analyzed using SPSS.
Results: Among 76 pediatric patients, the AGV group achieved lower mean IOP at 6 months (16.0 vs. 20.2 mmHg, p=0.001), greater IOP reduction (52.9% vs. 40.2%, p=0.002), higher success rates (79.0% vs. 60.5%, p=0.031), and required fewer postoperative medications (p=0.012) than cyclodiode group, with similar complication rates.
Conclusion: Ahmed Glaucoma Valve implantation demonstrated statistically significant better results as compared to Cyclodiode Laser Therapy at 6 months in pediatric refractory glaucoma.

Keywords: Ahmed Glaucoma Valve, Cyclodiode Laser Therapy, Pediatric Refractory Glaucoma.

INTRODUCTION

Glaucoma, a progressive optic neuropathy, characterized by optic disc changes and corresponding visual field defects usually in the setting of raised intraocular pressure (IOP) [1]. Although less common in children, pediatric glaucoma is a serious eye condition that can lead to permanent vision loss. It includes both primary (congenital) and secondary types and is recognized worldwide as an important cause of blindness in children [2].
Early onset of glaucoma and inadequate management can cause a life-long disability of poor vision. Pediatric glaucoma therefore causes significant psychological impact and much greater socio-economic impact in comparison to glaucoma in adults [3]. One such type of pediatric glaucoma known as pediatric refractory glaucoma is termed as glaucoma with uncontrolled intraocular pressure (IOP > 21 mmHg on Goldmann applanation tonometry) with documented glaucomatous damage despite being on triple therapy (i.e. 3 different groups) of topical antiglaucoma medications, and previously failed non-seton surgical intervention, or high clinical risk of trabeculectomy failure. [4]. Due to physiological and anatomical variations among children, management of pediatric refractory glaucoma remains a challenging task. In such cases, conventional trabeculectomy surgery shows high rates of failure [5,6]. Moreover in pediatric refractory cases, multiple issues are observed such as surgical side effects, poor compliance issues and lack of data on long-term efficacy of treatments [7].
Surgical interventions include trabeculectomy, glaucoma drainage devices and cyclodestructive procedures. The choice of surgical technique depends upon various aspects including but not limited to severity of disease and any previous interventions. AGV aids in providing a controlled outflow pathway and effectively lowers IOP being widely utilized especially in cases of pediatric refractory glaucoma. However there are some limitations of AGV

such as risk of tube displacement, implant exposure, fibrosis and hypotony. Under complicated conditions this is a high risk surgery, requiring surgical expertise [8-11].
Another commonly used treatment for refractory pediatric glaucoma is Cyclodiode Laser Therapy a cyclodestrcutive procedure that uses a diode laser for reducing production of aqueous humor through ablation of ciliary body. Though a minimally invasive procedure it is useful for patients having a poor surgical prognosis. However, as the procedure cannot produce predictable outcomes and is irreversible, it carries high risk of hypotony, inflammation and phthisis bulbi, thereby having variable success rates [12-14].
With regards to comparison of AGV and cyclodiode laser therapy, limited comparative data exists between AGV implantation and laser therapy especially among the pediatric populations. For refractory glaucoma, both techniques are seldom used. But their comparison is fairly limited [15,16]. This research was therefore carried out to compare the safety and efficacy of AGV implantation and cyclodiode laser therapy after six months among pediatric patients having refractive glaucoma.

METHODS

This quasi experimental research was carried out at the pediatric ophthalmology department of Al Ibrahim Eye Hospital, Karachi for a follow up period of six months starting from November 2024 to April 2026. Using non-probability consecutive sampling, pediatric patients of either gender ranging in ages from newborn to 16 years diagnosed with refractory pediatric glaucoma were included in the study. Patients presenting to the hospital during the study time period were scheduled for either Ahmed Glaucoma Valve implantation (group A) or Cyclodiode laser therapy (group B) were included. Pediatric patients with a history of cyclodiode laser therapy or AGV implantation were excluded. Patients lost to follow up were also excluded from final analysis.
Sample size was calculated on OpenEpi software taking efficacy of AGV as 70%(5) and efficacy of cyclodiode laser therapy as 89%(24) taking 80% power of test and 95% confidence interval. The calculated sample size is 140 (70 in each), but the achievable sample size was expected to be 70 (35 each group) to rarity of the disease. During the study period a total of 76 patients completed follow up with 38 patients in each group.
Ethical approval was taken from IRB and CPSP. Pediatric patients that presented to pediatric eye OPD of the hospital and diagnosed with pediatric glaucoma were assessed according to inclusion and exclusion criteria and included or excluded from the study. After selection of patients, informed consent was taken from the parents or their guardian. After informed consent, demographical and clinical data was recorded using a pre-designed questionnaire. Patients will either receive Ahmed Glaucoma Valve (AGV) as in group A or cyclodiode treatment as in group B. AGV was defined as implantation of a glaucoma drainage device for diverting aqueous humor from anterior chamber to sub-conjunctival bleb while cyclodiode laser therapy was defined as trans-scleral diode laser ablation of ciliary processes aiming to reduce production of aqueous humor for decreasing IOP. Patients were scheduled for regular follow ups in the OPD till six months after treatment. Thorough clinical examination was performed at each follow up and recorded.
For data analysis SPSS v26.0 was used. For data collection, age, pre-operative, post-operative intra ocular pressure were collected and reported as mean and standard deviation after testing of the quantitative variables for normality using Shapiro Wilk test. For qualitative variables such as gender, site, progression of glaucoma and post-operative complications were reported as frequency and percentages. For comparison of outcomes on day 1, week 1, month 1, month 2^{nd} and month 6^{th} (follow up) between group A and group B, Fisher exact or chi-square test were applied where applicable and $p < 0.05$ was considered as statistically significant. Controlling of effect modifiers like age, gender and locality were done by both stratification and post-stratification.

RESULTS

The baseline demographic and clinical features of included patients are presented in Table I according to the type of treatment done. Group A underwent Ahmed Glaucoma valve surgery while group B underwent Cyclodiode Laser Therapy. The variables include age, gender, type of glaucoma (primary congenital, secondary (uveitic) or aphakic (post-surgical), baseline IOP (mmHg) and any history of prior glaucoma surgeries. Both groups were similar at baseline and there was no statistically significant difference noted between them [Table I].

Table I: Baseline Demographics and Clinical Features of Included Pediatric Patients (n=76)

Variable	Group A Ahmed Glaucoma Valve (n=38)	Group B Cyclodiode Laser Therapy (n=38)	p-value
Age (years), mean ± SD	5.9 ± 4.1	6.3 ± 5.2	0.691
Gender, n (%)			

Male	21 (55.3%)	20 (52.6%)	0.641
Female	17 (44.7%)	18 (47.4%)	—
Glaucoma Type, n (%)			
Primary Congenital	18 (47.4%)	17 (44.7%)	0.814
Secondary (Uveitic)	11 (28.9%)	12 (31.6%)	0.801
Aphakic / Post-surgical	9 (23.7%)	9 (23.7%)	1.000
Baseline IOP (mmHg), mean ± SD	34.2 ± 6.4	33.8 ± 6.1	0.776
Cup-to-Disc Ratio, mean ± SD	0.74 ± 0.12	0.72 ± 0.13	0.483
Prior Glaucoma Surgeries, n (%)			
None	14 (36.8%)	16 (42.1%)	0.634
1 Previous Surgery	16 (42.1%)	14 (36.8%)	0.634
2 or More Surgeries	8 (21.1%)	8 (21.1%)	1.000
Pre-op IOP-lowering Medications (mean)	2.6 ± 0.8	2.5 ± 0.9	0.572

Regarding surgical outcome and complications at 6th month follow up, a significant difference was observed between the IOP at baseline and at six month follow up for both groups A and B was highly statistically significant. Overall higher surgical success was reported in group A (AGV) but it was not significantly different from group B. In terms of complications, 14 (36.8 %) incidence of frequency of complications were observed in group A while 10 (26.3 %) were reported in group B. However, the difference was not found to be statistically significant [Table II].

Table II: Surgical Outcomes and Complications at 6th-Month Follow-up (n=76)

Outcome Variable		**Group A Ahmed Glaucoma Valve (n=38)**	**Group B Cyclodiode Laser Therapy (n=38)**	**p-value**
IOP Outcomes	IOP at 6 Months (mmHg), mean ± SD	16.0 ± 3.8	20.2 ± 4.3	0.001*
	IOP Reduction from Baseline (%)	52.9%	40.2%	0.002*
	Post-op IOP-lowering Medications, mean ± SD	0.8 ± 0.9	1.4 ± 1.0	0.012*
Surgical Success	Complete Success, n (%) (IOP 6-21 mmHg, no medications)	22 (57.9%)	14 (36.8%)	0.066
	Qualified Success, n (%) (IOP 6-21 mmHg, with medications)	8 (21.1%)	9 (23.7%)	0.790
Overall Success (Complete + Qualified)		79.0%	60.5%	0.031*

Failure (Requiring further intervention), n (%)	8 (21.1%)	15 (39.5%)	0.083
Complications			
Total Complications, n (%)	14 (36.8%)	10 (26.3%)	0.317
Hypotony (IOP < 6 mmHg)	3 (7.9%)	4 (10.5%)	0.690
Tube / Device Exposure	4 (10.5%)	0 (0.0%)	0.040*
Hyphema	2 (5.3%)	3 (7.9%)	0.643
Corneal Edema (transient)	2 (5.3%)	2 (5.3%)	1.000
Posterior uveitis	0 (0.0%)	1 (2.6%)	0.313
Repetition or Revision of Procedure	3 (7.9%)	5 (13.2%)	0.456

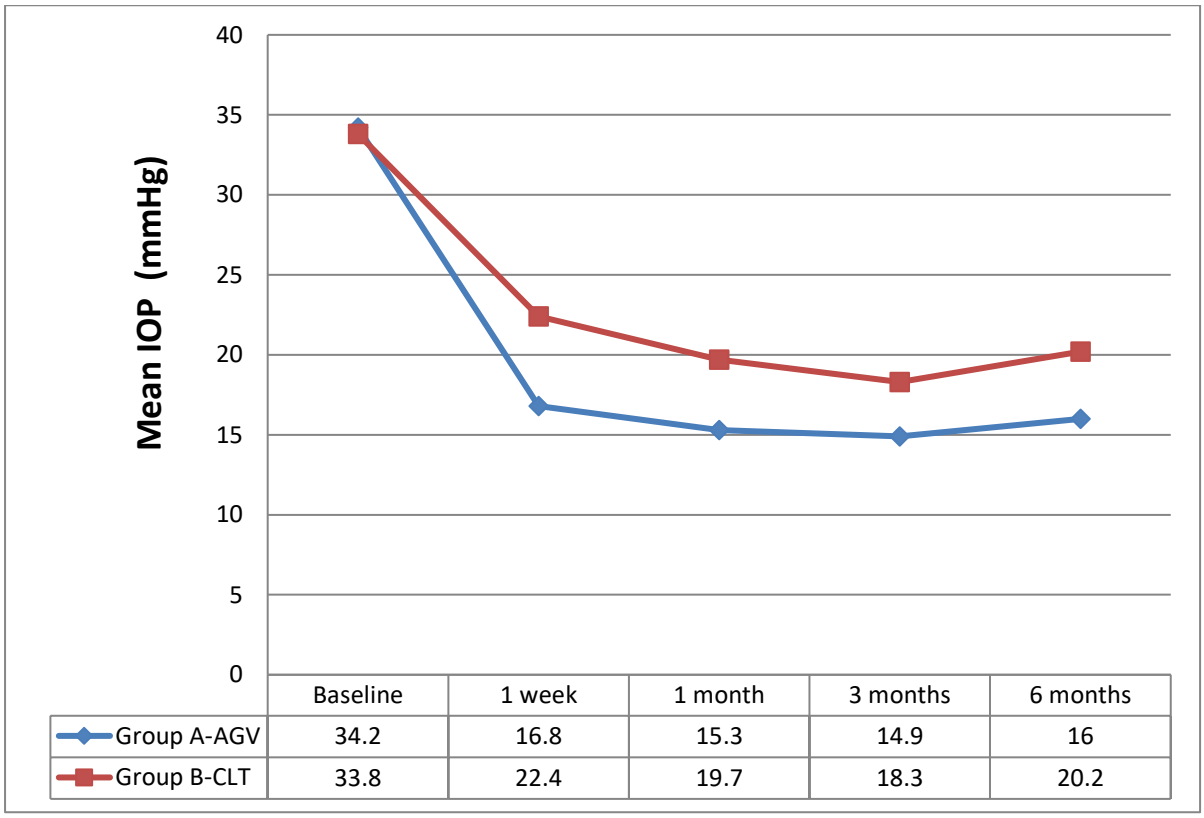

Figure I: Graphical representation of mean intraocular pressure at baseline till 6 months post-operative between group A (AGV) and group B (CLT) (n=76)

Figure I show the mean changes in intra ocular pressure over the period of six months from baseline. The intraocular pressures were measured in both groups at week 1, month 1, 3 and finally at 6th month post-operative. Group A (AGV) demonstrated a steeper and greater mean reduction in intraocular pressure (16.1 versus 20.2 mmHg) over six months postintervention than group B (CLT).

Kaplan Meier surgical success probability showed that, group A (AGV) demonstrated higher success rates at each follow up interval viz. week 1, month 1, 3rd and finally at 6th then group B (CLT) [Figure II].

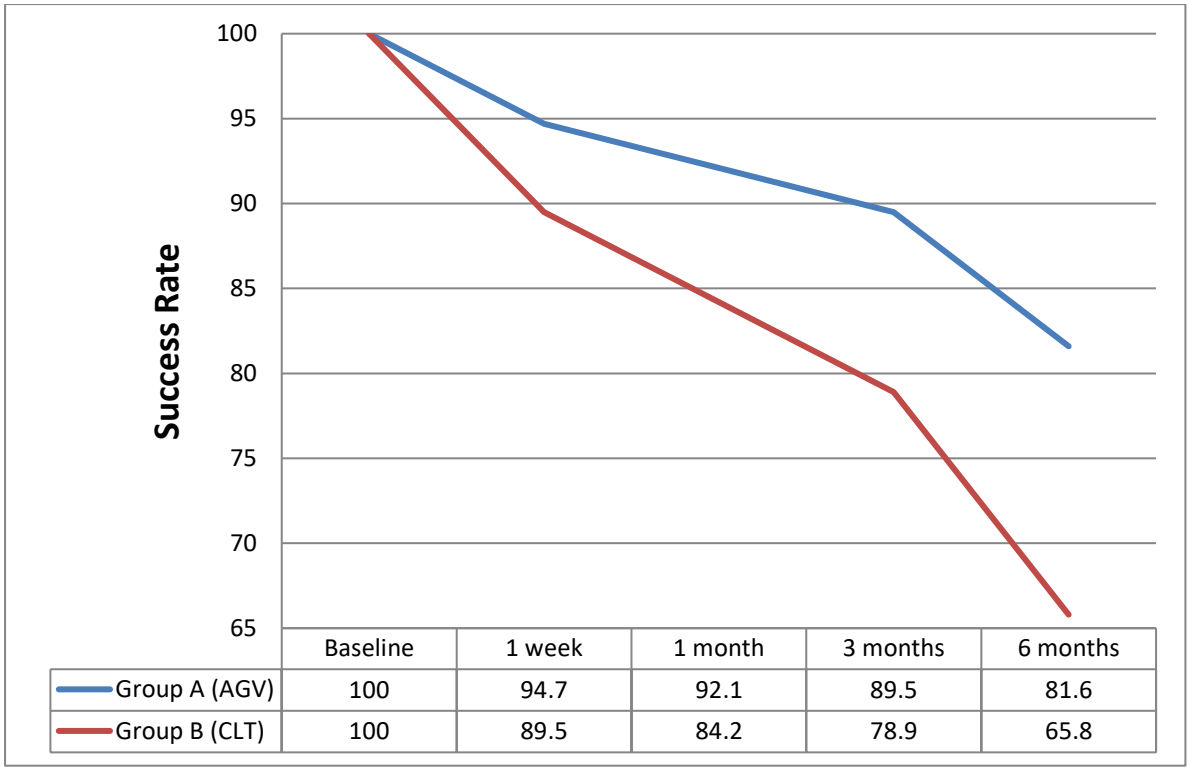

Figure II: Kaplan Meier Surgical Success Probability Graph between both groups (IOP ±21 mmHg without additional surgery) (n=76)

DISCUSSION

A total of 76 pediatric patients with refractory glaucoma were included in this study and equally divided into two groups undergoing Ahmed Glaucoma Valve (AGV) implantation or Cyclodiode Laser Therapy (CLT). Baseline demographic and clinical characteristics including age, gender, glaucoma subtype, baseline intraocular pressure (IOP), cup-to-disc ratio, prior glaucoma surgeries, and pre-operative medication burden were comparable between both groups, suggesting adequate matching between treatment arms.

At six months follow-up, AGV implantation demonstrated significantly better IOP control compared to CLT, with mean post-operative IOP of 16.0±3.8 mmHg versus 20.2±4.3 mmHg respectively (p=0.001). Similarly, percentage reduction in IOP from baseline was significantly greater in the AGV group (52.9% vs. 40.2%, p=0.002). Overall surgical success was also significantly higher among AGV-treated patients (79.0% vs. 60.5%, p=0.031). Although complete success rates were higher in the AGV group, the difference did not reach statistical significance, while qualified success rates remained comparable between groups. Furthermore, patients undergoing AGV required significantly fewer post-operative anti-glaucoma medications.

The overall complication rates between both groups were not significantly different. However, tube or device exposure was observed only in the AGV group, reflecting device-related complications associated with drainage implants. In contrast, one patient in the CLT group developed posterior uveitis. Despite these complications, both procedures were generally tolerated without major sight-threatening adverse events in most patients.

The findings of the present study are consistent with previously published literature regarding the efficacy of AGV implantation in pediatric refractory glaucoma. Fu et al. reported significant and sustained reduction in IOP following AGV implantation, with success rates exceeding 80% initially, although declining over time [18]. Similarly, the current study demonstrated a 79% overall success rate at six months. Balbaid et al. also observed significant reduction in IOP among pediatric refractory glaucoma patients treated with cyclophotocoagulation, although long-term success rates were comparatively lower [19].

Sakaorat et al. evaluated cyclodiode laser therapy as a primary surgical option in young children and reported meaningful reduction in IOP with acceptable safety outcomes, particularly in patients considered poor candidates for invasive surgery [20].

However, unlike the current study, their research did not include a direct comparison with AGV implantation. Vasconcelos et al., in their review on glaucoma drainage devices in children, concluded that AGV provides effective short-term IOP control, though long-term efficacy may gradually decline due to fibrosis and device-related complications [21]. The better short-term outcomes observed in the present study are therefore in agreement with existing evidence.

Local evidence regarding pediatric glaucoma surgery remains limited. Hussain and Mahmood reported favorable short-term outcomes of goniotomy in pediatric glaucoma, with success rates exceeding 80% [22]. However, goniotomy is generally more suitable for early-stage disease, whereas the current study specifically focused on refractory glaucoma cases where conventional angle surgeries are less effective. Khan et al. compared AGV implantation with trabeculectomy and found lower post-operative IOP and higher success rates with AGV at six months follow-up [23]. Their reported AGV success rate of approximately 74% closely corresponds with the 79% success observed in the present study.

Overall, the present findings suggest that AGV implantation provides superior short-term control of intraocular pressure with reduced dependence on medications when compared with Cyclodiode Laser Therapy in pediatric refractory glaucoma. However, longer follow-up studies are still required to determine long-term efficacy, complication profiles, and real-world functional benefits of both treatment modalities.

Strength of the Study

This study included equal distribution of patients between treatment groups, helping to minimize selection bias. Standardized definitions of complete and qualified success improved the reproducibility of outcome assessment. Objective intraocular pressure measurements reduced assessment bias, while inclusion of multiple glaucoma subtypes increased the generalizability of the findings.

Limitations of the Study

The study was carried out at a single center with limited sample size due to rarity of the condition, which tended to limit the generalizability of the study. Moreover, the follow up time period was kept at six months, meaning a more prolonged follow-up of patients and their evaluation could not be carried out. There was lack of randomization of patients into groups. Furthermore, patient or parent satisfaction and quality of life outcomes were not assessed in this research.

Future Recommendations

Multi-centered randomized controlled research with greater sample size and longer duration of follow up will help in further evaluating the superiority of either treatment method. Even analysis of cost-effectiveness should be carried out between both methods.

CONCLUSION

This quasi-experimental study showed that Ahmed Glaucoma Valve implantation was statistically more effective than Cyclodiode Laser Therapy in controlling intraocular pressure, achieving higher surgical success rates, and reducing the need for post-operative medications in pediatric patients with refractory glaucoma at six months. However, the extent to which these statistical differences result in meaningful practical benefits in real-life settings remains uncertain.

Conflict of Interest: None declared.
Source of Funding: None.

REFERENCES

1. Jayaram H, Kolko M, Friedman DS, Gazzard G. Glaucoma: now and beyond. The Lancet. 2023 Nov 11;402(10414):1788-801. https://doi.org/10.1016/S0140-6736(23)01289-8
2. Schuster AK, Erb C, Hoffmann EM, Dietlein T, Pfeiffer N. The diagnosis and treatment of glaucoma. Deutsches Ärzteblatt International. 2020 Mar 27;117(13):225. https://doi.org/10.3238/arztebl.2020.0225
3. Shen R, Li VS, Wong MO, Chan PP. Pediatric glaucoma—from screening, early detection to management. Children. 2023 Jan 18;10(2):181. https://doi.org/10.3390/children10020181
4. Heintz V, Bastelica P, Baudouin C, Lachkar Y, Labbé A. Management of refractory glaucoma, a new surgical paradigm: review of the literature. Current Eye Research. 2025 Aug 3;50(8):771-84. https://doi.org/10.1080/02713683.2025.2494799
5. Malik R, AlDarrab A, Edward DP. Contemporary management of refractory pediatric glaucoma. Current opinion in ophthalmology. 2020 Mar 1;31(2):123-31. DOI: 10.1097/ICU.0000000000000642
6. Aktas Z, Gulpinar Ikiz GD. Current surgical techniques for the management of pediatric glaucoma: a literature review. Frontiers in Ophthalmology. 2023 Mar 22;3:1101281. https://doi.org/10.3389/fopht.2023.1101281
7. Soomro FA, Soomro AQ, Sattar A, Shah SS, Shah AM, Laghari A, Tariq AB. Patterns of Self-Medication with Ophthalmic Drugs and Associated Determinants among Patients Visiting Ophthalmology Clinics. Higher Education.;47:24-10. https://doi.org/10.53350/pjmhs02024181824
8. Tóth G, Liu S, Li S, Váncsa S, Paczkó M, Kói T, et al. Outcomes of Trabeculectomy and Glaucoma Drainage Device Surgery in Congenital Aniridia-Associated Glaucoma: A Systematic Review and Meta-Analysis. Ophthalmology and Therapy. 2025 Oct;14(10):2323-43. https://doi.org/10.1007/s40123-025-01215-x

9. Mofti A, Alharbi A, Alsuhaibani M, Aljaber A, Altamimi L, Ahmad S, et al. Long-term outcomes of the Ahmed glaucoma valve surgery in childhood glaucoma. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2020 Dec 1;24(6):346-e1. https://doi.org/10.1016/j.jaapos.2020.06.014
10. Spiess K, Peralta Calvo J. Outcomes of Ahmed glaucoma valve in paediatric glaucoma following congenital cataract surgery in persistent foetal vasculature. European Journal of Ophthalmology. 2021 May;31(3):1070-8. https://doi.org/10.1177/1120672120919066
11. Luzu J, Baudouin C, Hamard P. The role of Ahmed glaucoma valve in the management of refractory glaucoma: Long-term outcomes and complications. European Journal of Ophthalmology. 2021 Sep;31(5):2383-9. https://doi.org/10.1177/1120672120968733
12. Sakaorat P, Mohamed-Noriega J, Sharara A, Daniel MC, Brookes J. Cyclodiode laser as the first surgical approach in childhood glaucoma under the age of 8 years. Journal of Glaucoma. 2021 Apr 1;30(4):352-6. DOI: 10.1097/IJG.0000000000001754
13. Barış ME, Yılmaz SG. Treatment Results of Diode Laser Cyclodestruction Treatment in Refractory Glaucoma. Journal of Glaucoma-Cataract/Glokom-Katarakt. 2023 Jul 1;18(3)131-35. DOİ: 10.37844/glau.cat.2023.18.19
14. Salari Y, Venugopal D, Sohail T, Burton D, van der Hoek J, Alaghband P. Safety and Efficacy of Transscleral Cyclodiode Laser in Advanced Glaucoma: A Retrospective, Single-center Observational Cohort Study. Journal of Current Glaucoma Practice. 2025 Dec 15;19(4):175. https://doi.org/10.5005/jp-journals-10078-1495
15. Toptan M. Comparison of the Intraocular Pressure-lowering Effects of Three Primary Surgical Procedures in Pediatric Aphakic Glaucoma. Journal of Current Glaucoma Practice. 2025 Mar 24;19(1):50. https://doi.org/10.5005/jp-journals-10078-1456
16. Mandal AK, Chakrabarti D, Gothwal VK. Approach to primary congenital glaucoma: A perspective. Taiwan journal of ophthalmology. 2023 Oct 1;13(4):451-60. DOI: 10.4103/tjo.TJO-D-23-00104
17. Azhar F, Qayyum S, Mushtaq A, Raza A, Zaman A. Effectiveness of trans-scleral cyclophotocoagulation for refractory paediatric glaucoma. Journal of Fatima Jinnah Medical University. 2021;15(3):136-9. https://doi.org/10.37018/DOTE2300
18. Fu X, He J, Li G, et al. Ahmed glaucoma valve implant for refractory glaucoma in children: A systematic review and meta-analysis. Ther Adv Chronic Dis. 2025;16:20406223241301520. https://doi.org/10.1177/00368504241301520
19. Balbaid N, AlJodai M, Fairaq G, AlEnzi M, AlShahwan S. Micropulse transscleral cyclophotocoagulation (MP-CPC): efficacy endpoints for the treatment of refractory paediatric glaucoma-a retrospective case-series. BMC ophthalmology. 2024 Feb 28;24(1):91. https://doi.org/10.1186/s12886-024-03358-0
20. Sakaorat P, Mohamed-Noriega J, Sharara A, Daniel MC, Brookes J. Cyclodiode laser as the first surgical approach in childhood glaucoma under the age of 8 years. Journal of Glaucoma. 2021 Apr 1;30(4):352-6. DOI: 10.1097/IJG.0000000000001754
21. Vasconcelos AT, Massote JA, Senger C, Barbieri LP, Cronemberger S, Paula JS. Glaucoma drainage devices in children: an updated review. Arquivos Brasileiros de Oftalmologia. 2024 Apr 8;87(6):e2021-0338. https://doi.org/10.5935/0004-2749.2021-0338
22. Hussain MU, Mahmood MA. Success Rate of Goniotomy in Terms of Intraocular Pressure Control in Pediatric Glaucoma Patients. Pakistan Armed Forces Medical Journal. 2022 Apr 30;72(2)505-8.
23. Khan MA, Bukhari S, Khan ZA, Mengal M, Khan MA, Panezai AK. Efficacy of ahmed glaucoma valve and trabeculectomy with mitomycin-C in pediatric glaucoma. Journal of Bahria University Medical and Dental College. 2021 Mar 2;11(1):9-12. https://doi.org/10.51985/GYHZ2543
24. Murphy CC, Burnett CA, Spry PG, Broadway DC, Diamond JP. A two centre study of the dose-response relation for transscleral diode laser cyclophotocoagulation in refractory glaucoma. Br J Ophthalmol. 2003;87(10):1252-7.