HHS Public Access

Author manuscript

Curr Opin Ophthalmol. Author manuscript; available in PMC 2018 March 01.

Published in final edited form as:

Curr Opin Ophthalmol. 2017 March ; 28(2): 199–203. doi:10.1097/ICU.0000000000000349.

Pediatric Glaucoma: Review of recent literature

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Abstract

Purpose of review—The purpose of this review is to update the clinician on the recent work in the field of pediatric glaucoma.

- Using the iCare tonometer to measure intraocular pressure in children is highly successful.
- New data from the Infant Aphakia Treatment Study shows that after 5 years of follow-up the risk of developing glaucoma is similar between patients that receive initial intraocular lens implantation and those who are left aphakic.
- New data shows effective lowering of intraocular pressure using either approach to trabeculotomy: treating the angle partially with trabeculotomes or circumferentially with a suture or iTrack microcatheter.
- Recent data on an updated approach to trabeculectomy in children shows success in lowering intraocular pressure with few complications, however visual outcomes continue to be suboptimal. A separate study shows that the addition of tenonectomy may not increase surgical success, but may increase survival time and reduce bleb encapsulation.
- Glaucoma drainage devices in general, and the Ahmed implant in particular, continue to be found to be moderately successful to control intraocular pressure, and are therefore employed, especially after initial angle surgery has failed.

Summary—Continued work to evaluate the techniques used in the clinical and surgical management of pediatric glaucoma patients support that both newer and older approaches remain standard of care.

Keywords

Pediatric glaucoma; iCare; trabeculotomy; trabeculectomy; Ahmed implant

Introduction

The goal of treating pediatric glaucoma is to minimize vision loss that can otherwise be expected from corneal edema, Haab striae, amblyopia, and optic nerve damage. This goal is

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Conflicts of interest

Dr. Beck receives grant support from Allergan. The remaining authors have no conflicts of interest.

achieved best by controlling intraocular pressure (IOP) and the traditional approach to diagnosis and long-term follow up of glaucoma in children is largely unchanged. Serial exams under anesthesia to evaluate ocular dimensions, corneal clarity, and optic nerve status are a mainstay during infancy and early childhood, and the use of timely angle surgery for primary congenital glaucoma continues. Technological advancements including the advent of the iCare tonometer have improved clinical success at obtaining intraocular pressure and reduced the burden of exams under anesthesia.[1] The objective of this article is to review some of the recent important studies on the assessment and management of pediatric glaucoma.

Intraocular Pressure Measurement

Measuring IOP in clinic remains central to following glaucoma stability in children, despite the associated challenges with cooperation. The 'gold standard' for measuring IOP remains undefined, but with the advent of iCare and its greater tolerability in children, much work has ensued to evaluate its accuracy.[2] A retrospective analysis of IOP as measured by noncontact tonometry, rebound tonometry(iCare PRO) and Goldmann applanation tonometry(GAT) on 419 children with a mean age of 8.89 (range 3–15 years) showed that for children less than 10 years old, there was greatest success in obtaining an IOP measurement with noncontact tonometry, followed by rebound and GAT(89%, 75%, 64%, respectively). [3] Not surprisingly there was greater success with all types of tonometry when measuring children greater than 10 years of age, with success at obtaining and IOP measurement at 100%, 98% and 94%, respectively. In addition, consistent with prior literature, for all methods of tonometry, there was a positive correlation between IOP and central corneal thickness: greater central corneal thickness was associated with greater IOP. Finally, this study showed that the when comparing IOP by the three types of tonometers, it measured greatest with the noncontact, followed by the rebound then the GAT(mean IOP 17.69 vs. 16.87 vs. 15.21 mm Hg, respectively). The greater feasibility of using the iCare in clinic with children will keep it a mainstay in the clinical assessment of stability, but it must be kept in mind that IOP is greater with central cornea thickness and that IOP as measured by the iCare may trend higher than other techniques.

Glaucoma Following Cataract Surgery

The Infant Aphakia Treatment Study (IATS) recently released their findings of glaucoma-related adverse events of 113 patients at 5 years of age after cataract surgery.[4] IATS is a multi-center, randomized, controlled study of infants between 1 and 6 months of age that received surgery for unilateral cataract and compared 2 groups: those receiving primary intraocular lens implantation (IOL) versus surgery without IOL (patients were left aphakic and received contact lens correction). A strength of this study was its well-defined endpoints and prospective, randomized design, and it is considered to be the most robust available in the literature on this topic. The IATS investigators identified that the risk of developing glaucoma at 4.8 years was 17%, and that for developing glaucoma or glaucoma suspect was 31%, however there was not a statistically significant difference between those that received an IOL at the time of surgery and those that were left aphakic.

Ninety-five percent of cases of glaucoma were determined to be open angle, and 40% of these individuals required surgery. There was an increased risk of developing glaucoma with younger age at surgery (28–48 days old versus the remainder to 210 days old), with a hazard ratio of 3.2. They also identified an increased risk of being diagnosed with glaucoma or glaucoma suspect with smaller corneal diameter at the time of cataract surgery (<10 mm). Interestingly, the presence of persistent fetal vasculature did not influence the risk of developing glaucoma or glaucoma suspect. Notably visual acuity was not statistically different between eyes that developed glaucoma or glaucoma suspect compared to those without either diagnosis (20/283 vs. 20/141 vs. 20/100, respectively). Whereas analysis of this data at earlier time points suggested a trend toward less glaucoma in the aphakic group, the 5-year data showed no statistically significant difference.

360-degree versus traditional trabeculotomy

One approach to traditional trabeculotomy utilizes Harms or similar metal trabeculotomes to open the trabecular meshwork after accessing Schlemms canal under a partial thickness scleral flap. This approach tends to treat less than half of the angle, approximately 120 degrees. With 360-degree trabeculotomy, the entire angle is able to be opened via 1 entry point under the scleral flap by passing a suture, or iTrack (illuminated microcatheter) 360 degrees around Schlemms canal. In a retrospective review of trabeculotomy performed in the traditional manner versus 360 degree circumferential, Lim et al showed that both procedures significantly lowered IOP.[5] However, 360-degree trabeculotomy resulted in significantly lower IOP and better surgical success rate compared with the traditional approach.

The individuals included in this study carried multiple different diagnoses such as glaucoma following cataract surgery (formerly known as aphakic or pseudophakic glaucoma) and glaucoma associated with aniridia, but the predominant diagnosis was primary congenital glaucoma. There were 70 eyes in the traditional group and 14 in the 360-degree treatment group. The average age at the time of surgery was slightly older in the traditional group (1.52 years) versus the 360-degree group (0.61 years) but baseline IOP, number of eye surgeries, and number of glaucoma medications were similar between groups. At 1 year, mean IOP was 17 mm Hg for the traditional group and 11 mm Hg for the 360-degree group, a statistically significant difference. The number of glaucoma medications was similar at 1 year between the groups. The 360-degree group required fewer sequential glaucoma surgeries within the first year compared to the traditional group (14% versus 42%). The success rate was higher in the 360-degree group compared to the traditional group (85.7% versus 58.4%). If only eyes with the diagnosis of primary congenital glaucoma were compared, the success rate with the traditional approach was similar, but that of the 360-degree group (11 eyes of 6 patients) was 100%. While this study shows the efficacy of trabeculotomy by either approach, the main limitation of it is the small number of patients in the 360-degree treated group. It should also be remembered that there are many accepted approaches to initial treatment of pediatric glaucoma besides trabeculotomy, including goniotomy, combined trabeculotomy-trabeculectomy and others.

Trabeculectomy with Mitomycin-C in Children

The ideal timing along the treatment paradigm of the use of trabeculectomy in children is controversial. Many surgical options are available for the surgical treatment of pediatric glaucoma, and multiple factors regarding risk and efficacy need to be considered when selecting an approach.[6] A more robust healing response influencing failure and greater difficulty detecting early signs of blebitis have made some cautious in using this surgical approach. However, the surgical approach to performing trabeculectomy has been modified over recent years, therefore it is important to consider recent work in this area.

The Moorfields Safer Surgery System is a contemporary approach to trabeculectomy involving a fornix-based conjunctival incision, use of releasable sutures, and application of mitomycin-C over a broad area.[7] The proposed benefit of this approach is improved posterior aqueous flow and more diffuse bleb formation. A retrospective review of all cases of trabeculectomy with MMC done in this manner on children less than 2 years of age over a10 year period at Moorfields was completed.[7] Forty eyes of 26 patients were identified and 80% of these individuals had primary congenital glaucoma. Ten percent had Axenfeld-Rieger anomaly, and the remainder had mixed diagnoses. The mean age was 9 months, and most had primary congenital glaucoma and had undergone prior angle surgery. Mean preoperative IOP was 24.2 mm Hg and mean duration of follow up was 72.9 months for successful cases and 29 months for failures. Those that failed underwent further surgical management. The cumulative probability for success was 78% at 1 year, 67% at 5 years and 60% at 7 years. Mean final IOP was 11.9 mm Hg for the successes, and 14.5 mmHg for the failures (after subsequent surgical intervention). 44% of successful eyes achieved vision of 20/40 or better, whereas in the failures 15.4% achieved this level. Vision was 20/200 or better in 92% of the successes and 69.2% of the failures. There was a low complication rate with no occurrences of hyphema, flat anterior chamber, bleb leak, chronic hypotony, endophalmitis or retinal detachment, however 10% (4 eyes) experienced choroidal effusions. Two of these cases resolved with intracameral viscoelastic injection and 1 with conservative management. Therefore, the authors show that modern trabeculectomy can be an effective and safe approach to managing the surgical pediatric glaucoma patient. As the risks and complications to these surgical procedures are weighed, consideration must also be made of the risk and cost of managing them with serial exams under anesthesia.

Tenonectomy in Trabeculectomy

Among the many challenges regarding the use of trabeculectomy in children, one is reduced efficacy compared to adults, which may be caused by a more robust healing response.[8] Besides the use of mitomycin-C as an adjuvant to improve efficacy, the effect of removing tenons layer (and the fibroblasts it contains) is often discussed. A pilot study was recently performed to compare standard trabeculectomy with mitomycin-C to standard surgery with tenonectomy in pediatric patients.[9] Eyes were randomized to receive standard surgery or standard plus tenonectomy and all surgery was performed with a fornix-based flap of conjunctiva with application of mitomycin-C for 3 minutes at a concentration of 0.4mg/mL. The tenonectomy was done just prior to conjunctival closure and about 8 mm diameter area was removed from over the scleral flap and area expected to be occupied by the bleb. The

patients had an average age of 11.1 months and included 64 eyes of 46 patients. Each surgical group included 32 eyes and there was no significant difference between groups in regards to age, sex, lens status, diagnosis, or prior glaucoma surgeries. Surgery reduced IOP significantly in both groups but it was significantly lower in those that received tenonectomy from the 1 month postoperative visit through 2 years of follow up. Both groups had significantly reduced glaucoma medication use with surgery, but those receiving tenonectomy had significantly less medication use from 3 months postoperative through the second year. Regarding the success of surgery with or without additional glaucoma medication use, there was not a statistical difference between the surgical groups, however, the mean survival time was significantly longer in the tenonectomy group (16.6 versus 11.6 months). At 2 years, there were statistically more failures in the group that did not receive tenonectomy, (55% failures versus 30% in patients receiving tenonectomy). After multivariate analysis, only the number of prior glaucoma surgeries was a risk factor for failure. There was more bleb encapsulation reported in the group that did not receive tenonectomy (25% vs. 3%), however there were no reports of bleb leak, and only 1 report of endophalmitis (which occurred in a patient that did not receive tenonectomy). This study supports that there may be a benefit to tenonectomy at the time of trabeculectomy in children, and their failure rate is similar to that of the work described above.

Glaucoma drainage devices

Implantation of a glaucoma drainage device (GDD) continues to be central to the surgical management of the pediatric glaucoma patient, especially after initial angle surgery has failed. Recent work reports on the efficacy and outcomes of Ahmed implantation in the pediatric population. A retrospective review of 119 eyes of 89 pediatric patients that had average follow up of 6.1 years was performed.[10] The mean age at implantation was 6.8 years and patients received either the S-2 or FP-7 models of the Ahmed valve (made of polypropylene versus silicone, respectively). Patients had varied diagnoses which were categorized into one of 3 groups: primary glaucoma, uveitic glaucoma and other secondary glaucomas. IOP was reduced by 13 mm Hg at 5 years postoperatively and the preoperative medication usage was similar to usage at 5 years postoperatively. IOP reduction and postoperative medication use were similar for the S-2 and FP-7 Ahmed models. For all eyes, the success rate at 1 year was 85.7% whereas at 5 years it was 55%. Eyes with uveitic glaucoma had a more favorable 5-year success rate of 75%. In addition, the S-2 implant carried a success rate of 66.9% whereas that of the FP-7 was 41.2%. No eyes failed due to hyoptony, rather most eyes failed due IOP>21, IOP reduction <20% or requirement of implantation of a second GDD. Multivariate analysis evaluating age at surgery, diagnosis, ethnicity and GDD model showed that only the implant model remained a risk factor for failure, with S-2 model having a risk ratio of .45. Thirty-six of the 119 eyes required a second GDD and the mean time between implantations was 2.2 years. The 5-year success rate of this second GDD was 52.8%. The possible influence of selection bias should be considered when interpreting the results of this study, however, overall, this study was consistent with other work showing moderate success of Ahmed implantation in pediatric glaucoma. Further work to improve the technology of the device or surgical and postoperative management recommendations to improve outcomes would be ideal.

Conclusion

In conclusion, the use of iCare to measure IOP will likely continue to be important in the management of pediatric patients since it is associated with increased success of obtaining a measurement in this population. In addition, new data from IATS shows the risk of developing glaucoma at 5 years after unilateral pediatric cataract surgery is similar whether refractive error is managed with intraocular lens placement at the time of surgery or with leaving the patient aphakic and using a postoperative contact lens. Further, trabeculotomy, trabeculectomy and Ahmed implantation continue to hold central roles in managing surgical glaucoma as their efficacy continues to be supported.

Acknowledgments

Financial support and sponsorship

Supported in part by NIH grant P30EY006360 and an unrestricted departmental grant from Research to Prevent Blindness.

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Key points

- Using iCare to measure IOP is important in the management of pediatric patients since it is associated with increased success of obtaining a measurement in this population.
- IATS shows the risk of developing glaucoma at 5 years after unilateral pediatric cataract surgery is similar whether refractive error is managed with intraocular lens placement at the time of surgery or with leaving the patient aphakic.
- Trabeculotomy, trabeculectomy and Ahmed implantation continue to hold central roles in managing surgical glaucoma as their efficacy continues to be supported.