Hydrophilic Acrylic versus Polymethylmethacrylate Intraocular Lens Implantation for Pediatric Cataract Surgery: Iraqi Study

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Abstract

Purpose

To make a comparison between the primary implantation of the foldable hydrophilic acrylic and the polymethylmethacrylate intraocular lenses of pediatric cataract surgery that generally includes short term complications and visual results.

Methods

This clinical study includes 40 eyes of 31 consecutive patients who aged from 1 to 6 years complaining from unilateral or bilateral, congenital or developmental cataracts. Two kinds of IOLs, including foldable hydrophilic acrylic and PMMA were randomly implanted in the capsular bag during surgery. Primary posterior capsulotomy and anterior vitrectomy were performed in all eyes. Patients were followed up for at least 1 year. Perioperative complications, visual results and refractive errors were compared between the study categories.

Results

In the study, regarding age, it was 3.2±1.8 years of the hydrophilic acrylic group and 3.7±1.3 years of the PMMA group. Regarding follow up mean period was 19.6±5 (12–28) months. Intraoperative complications don't occurr in any group. Postoperative uveitis was observed in 2 (10%) eyes in the acrylic group patient versus 5 (25%) eyes in the PMMA group patient (P=0.40). Other postoperative complications include pigment deposition (30%), posterior synechiae formation (10%) and iridocorneal adhesions (10%), were observed only in the PMMA group. Visual outcomes in these groups study were good and comparable and the visual axis was completely clear

Conclusion

In pediatric eyes in whom lensectomy was doing with the primary posterior capsulotomy and anterior vitrectomy, the comparison between the hydrophilic acrylic IOLs and PMMA IOLs was made including biocompatibility and visual axis. The observation was that hydrophilic acrylic IOLs is less frequent postoperative complications.

Keywords : Acrylic, cataract, intraocular, lens, foldable

Introduction

Regarding aphakia surgery, the Modern surgical techniques and correction with intraocular lens (IOL) implantation have improved the standard care for the children with cataracts.[1] Using automated vitrectomy equipment which cause development of techniques for both primary anterior and posterior capsulotomy,[1] and effective anterior vitrectomy procedures have promoted maintenance of a clear visual axis.[2] Improved cameral agents had made implant surgery easier and also safer in younger eyes, however, IOL implantation during infancy period remains controversial.[3]

Hydrophilic foldable IOLs have excellent uveal biocompatibility, are resistant to surface alterations or damage during folding and insertion, and have low potential to damage corneal endothelial cells in case of contact.[4] However, according to the 2001 children cataract surgery and IOL survey regarding ASCRS and AAPOS members , this kind of IOL was preferred by only 2.4% and 1% of the responders, respectively.[5] Lack of enthusiasm for hydrophilic acrylic IOLs may be due to lower capsular biocompatibility in comparison to other biomaterials; this type of IOLs are associated with higher rates of the outgrow of epithelial cell of lens, anterior capsule contracture, posterior capsule opacification and the surface calcification as experienced in adult cataract surgery.[6–8] The latter complication can be severe enough to necessitate IOL explantation in some patients.[6,7,9] The Primary implantation of the posterior chamber intraocular lenses has become common and also become accepted procedure in the paediatric cataract surgery, but controversy the early implantation of IOL in children is associated with higher rates of perioperative complications and risk of subsequent posterior capsule opacification in comparing to adults. Primary posterior capsulotomy with limited anterior vitrectomy has been advocated to decrease PCO risk in younger eyes3 where surgical capsulotomy may be required to deal with exuberant lens fibre reproliferation. Foldable soft acrylic IOLs have lower PCO rates than PMMA lenses of adult eyes,4 5 but to our knowledge only a single previous study has reported on comparative PCO rates with these lens types in infants and children .

Primary posterior capsulotomy and anterior vitrectomy are components of standard pediatric cataract surgery; they eliminate the scaffold for LEC outgrowth and visual axis opacification which seems unrelated to the type of IOL in pediatric eyes.

Methods

This study includes 40 eyes of 31 consecutive patients aged from 1 to 6 years complaining from unilateral or bilateral , congenital or developmental cataracts. Because it was difficult and not very possible to ensure the age of onset of cataracts certaintly, we did not try to distinguish developmental from congenital cataracts. The eyes were randomly categorized into two groups (20 eyes each) , to undergo implantation of foldable hydrophilic acrylic IOL (Corneal) with 6 millimeter optic and overall diameter of 12 mm, or a single piece PMMA IOL (Corneal) with 6.5 millimeter optic and overall diameter of 13 millimeter. Exclusion criteria consisted of monocular patients and cataracts associated with ocular abnormalities (microcornea, microphthalmos , glaucoma, uveitis and posterior lenticonus) or systemic disease, and cataracts. Patients were followed up and evaluated for a minimum period of one year.

All patients should undergo a detailed preoperative information and evaluation. Regarding visual acuity, it was determined using standard E-chart when feasible; fixation patterns were observed in preverbal/uncooperative children. There is special attention paid to the existence of following nystagmus, amblyopia or strabismus. If necessary, an examination under general anesthesia was carried out.

Intraocular pressure was measured nearly in all patients by either the Perkins applanation tonometer or the Schiotz hand-held tonometer. To increase accuracy, biometric measurements were performed twice in all eyes; first with the IOL master (Carl Zeiss), followed by conventional keratometry. Axial length of the orbit was measured via a special contact technique using Compuscan LT A-scan ultrasonography under general anesthesia, preoperatively. IOL power calculations were performed using the SRKII formula[10] in all cases. The IOL power was adjusted according to patient age (Table 1) to achieve postoperative hypermetropia in order to counterbalance the myopic shift in pseudophakic pediatric eyes.[11] Other routine ocular examinations included assessment of pupil dilatation, funduscopy and B-scan ultrasonography if necessary.

Table 1
Age-adjusted target hypermetropia

Age (yr)	Target hypermetropia
1–3	5 Diopter
3–5	3.5 Diopter
> 5	2 Diopter

Regarding the surgical technique, the operations were done under general anesthesia using a standard technique by one of two experienced anterior segment surgeons. A wire lid speculum was used in operation. For the PMMA group, a 6/0 silk superior rectus suture was sutured using a tapered needle. The conjunctiva was incised at the limbus in 3 clock hour superiorly. A partial thickness of the scleral groove 6.5 mm in length was done 2 mm posteriorly to the limbus. Also blade was used to make a scleral tunnel anteriorly until reach the clear cornea. A microvitreoretinal blade was needed to enter the anterior chamber to the center of the tunnel. A paracentesis site was fashioned in the tunnel 3 clock hour apart to allow the insertion of a 23gauge butterfly needle for infusion of salt solution. For the acrylic IOL group, a temporal corneal tunnel incision was created with a 3.2 millimeter keratome and a paracentesis site was made 3 clock hour apart.

In patients with young age (1–4 years, 24 eyes), the anterior capsulotomy was done using an automated vitrector in a circular motion to make a 4–5 mm opening, in older children (16 eyes), a bent tip G27 needle and forceps were used under viscoelastic support to make a 4–5 mm anterior curvilinear capsulorrhexis. After doing anterior capsulotomy, an automated aspiration hand piece was used to remove cortical and nuclear materials. Other material is Viscel 2% (Corneal) was used to cause inflation of the capsular bag to fill the anterior chamber. Also posterior capsulotomy in which at least 4 mm in diameter and an adequate anterior vitrectomy were about performed in all subjects.

The acrylic hydrophilic IOL (foldable) was folded generally with forceps and was implanted into the capsular bag and after IOL implantation, the viscoelastic material was clearly removed from the capsular bag and anterior chamber. Regarding corneal incision closed using 2 separate sutures 10/0 nylon sutures. This was done in the PMMA group, the limbal groove was incised with corneal scissors and in the capsular bag the IOL was inserted ,and after the complete removal of viscoelastic material, the incision was closed by using 4 to 5 separate sutures 10/0 nylon sutures.

Results

In this study, forty (40) eyes of 31 patients including 18 (58%) male and 13 (42%) female with their mean age group of 40.8±19.2 (range 12–72) months were operated. Twenty-two (70.9%) patients had unilateral cataracts. The two groups were comparable regarding the age at the time of surgery and follow up period. Table 2 shows preoperative characteristics of the patients.

Table 2
Demographic and clinical characteristics of the study groups

		Acrylic group (N=20 eyes)	PMMA group (N= 20 eyes)	P value**
Male/Female		13/7	10/10	0.337
Age (yr):	1–2	8	4	4
	2–5	8	12	4
	>5	4	4	
Age at surgery (yrs)*		3.2±1.8	3.7±1.3	0.20
Right/Left eye		14/6	12/8	0.507
Amblyopia/No amblyopia		6/14	8/12	0.507
Positive/Negative family history		6/14	7/13	0.736
Cataract type:	Mature	4	5	
	Lamellar	6	8	
	Nuclear	4	3	0.50
	Posterior subcapsular	3	3	
	Anterior polar	3	1	

*Mean ± standard deviation
**t-test for mean values and Chi-square (or Fisher exact) test for frequency values

All the patients were not excluded because the intraoperative complications were practically nil. Preoperatively, best-corrected visual acuity (BCVA) ranged from fixing, but not following light, and fixing and following light to 20/200 in both groups (Fig. 1,Table 3). Postoperatively, 18 (90%) eyes in the acrylic group had BCVA better than 20/200, of which 16 (80%) had BCVA better than 20/60. Corresponding values in the PMMA group were 17 (85%) and 16 (80%), respectively (P=0.83), (Fig.2 and Table3)

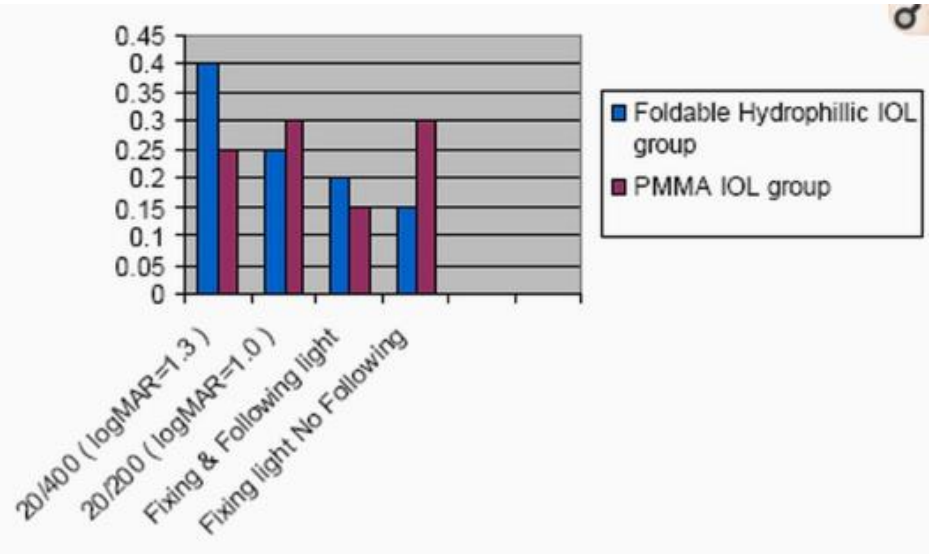

Figure 1
Preoperative visual acuity in the study groups

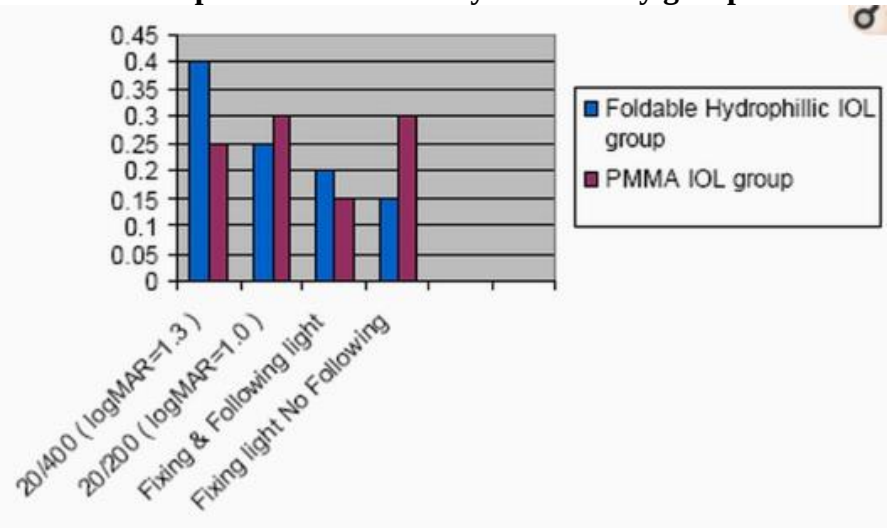

Figure 2
Postoperative visual acuity regarding the study groups.

Table 3
Perioperative visual acuity regarding the study groups

		Acrylic group	PMMA group	P value**
Preoperative				
	BCVA (logMAR)*	1.18±0.15 (13 eyes)	1.13±0.15 (11 eyes)	0.453
	Fixing and following light	4	3	0.677
	Fixing but not following light	3	6	0.256
Postoperative				
	BCVA (logMAR)	0.42±0.16 (18 eyes)	0.41±0.13 (17 eyes)	0.836
	Fixing and following light	2	2	1
	Fixing but not following light	0	1	0.311

BCVA, best-corrected visual acuity.
*mean ± standard deviation
**t-test for mean values and Chi-square (or Fisher exact) test for frequency values.

Mean postoperative spherical refractive error was +4.22±2.53 diopter in the hydrophilic acrylic group and +3.38±2.79 diopter in the PMMA group (P=0.2). The corresponding figures for cylindrical error were 1.03±0.84 and 1.58±1.10 D in the two groups respectively (P=0.2).

Table4 summarizes postoperative complications. The inflammation was observed in 5 (25%) eyes in the PMMA category and 2 (10%) eyes in the acrylic category (P=0.407). The inflammation subsided by increasing the frequency of steroid drops and use of mydriatic-cycloplegic eye drops in all 7 eyes.

Table 4
Postoperative complications in the study groups

	Acrylic group	PMMA group	P value*
Uveitis	2	5	0.40
Corneal edema	4	1	0.34
Iridocorneal adhesions	0	2	0.48
Distorted pupil	0	5	0.04
Posterior synechiae	0	2	0.48
Traumatic wound dehiscence	0	2	0.48
Iris capture	0	1	1
Pigment deposit	0	6	0.02

*Fisher exact test.

Discussion

In general, Hydrophilic acrylic intraocular lenses are composed of a hydroxyethlmethacrylate represents backbone and hydrophilic acrylic monomers. The lenses is regarded as a member of the family of acrylic-methacrylic polymers similar to PMMA which is acrylic material made from only one kind of monomer. Hydrophilic acrylic IOL characteristics are soft and have good biocompatibility due to their hydrophilic surface and its 18%–38% water content, and also these IOLs appear little or no surface alterations from the folding process due to their soft flexible surface.[4] The Low surface energy and the hydrophilic nature are major causes for excellent uveal biocompatibility. They also have low potential to cause damage when touching corneal endothelial cells. Hydrogel IOLs appear to have lower capsular biocompatibility if compared to other materials, thus resulting in more LEC outgrowth, and this following adult cataract surgery and also anterior capsule contracture and PCO formation.[12] Fortunately, if Nd:YAG laser capsulotomy necessitate , these lenses have high threshold for laser induced destruction.[13] Furthermore, hydrophilic traits of these lenses including lower surface energy, cause less adhesion to silicone oil in patient requiring the vitreoretinal surgery.[14]

Due to the greater inflammatory response, the risks of postoperative complications of pediatric cataract surgery is higher than adults. In very young children, VAO is virtually inevitable and rapidly develops following surgery this while the posterior capsule is remained intact.[15] VAO requiring secondary intervention is the most common complication of infant cataract surgery with intraocular lens implantation. Despite performing primary posterior capsulotomy and vitrectomy, an another procedure was required in as many as eighty percent of eyes operated in the first 6 months of life.[15,16] So we decide to include only the subjects in which patients age is older than one year in this study.

Posterior capsule and anterior vitreous management greatly influences visual axis clarity and final visual outcomes in children regardless of IOL material. Ram and coworkers[17] evaluated the effects and results of the primary posterior capsulotomy and the effect of anterior vitrectomy and various lenses materials in 64 eyes of 52 children age group from 3 month to 12 years in terms of development of PCO at least two years after performing cataract surgery. They used the Acrysof acrylic intraocular lenses in one group and a single-piece PMMA intraocular lenses in the other, each including thirty two eyes. Within each group, 16 eyes underwent posterior capsulotomy and vitrectomy however the posterior capsule was intact in the other 16 eyes. Postoperatively, 12 eyes with acrylic and 13 eyes with PMMA IOLs and an intact posterior capsule, versus only two eyes with acrylic and three eye with PMMA intraocular lenses in the posterior capsulotomy and anterior vitrectomy subgroup developed PCO ($P<0.05$).

Vasavada et al[18] evaluated VAO and require a second process after Acrysof intraocular lenses implantation in 103 eyes 72 consecutive children with congenital cataracts. The patients were classified into two classes based on age at the time of surgery: in which younger than 2 years (group 1) and 2 years or more (group 2). All eyes in group 1 (n=37) underwent primary posterior curvilinear capsulorrhexis and anterior vitrectomy. Regarding the management of the posterior capsule for the group 2 (n=66) was randomly assigned to no posterior curvilinear capsulorrhexis (group 2A, n= 37) or posterior curvilinear capsulorrhexis (group 2B, n=29). In the study, the latter group was generally categorized into 2 subgroups: no vitrectomy (group 2BN, n=14) or vitrectomy (group 2BV, n=15). After a mean follow up of 2.2±0.9 years, 3 (10.8%) eyes in group 1 and 31 (83.8%) eyes in group 2A developed PCO, of which 3 eyes in group 1 and 10 eye in group 2A required a second intervention. The rate of PCO formation was significantly higher in patients aged were less than 8 years at time of surgery as compared to older children ($P=0.01$). Five (37.5%) eyes in group 2BN had opacification of the anterior vitreous face, one of which required a second

procedure. The authors reached the results that Acrysof intraocular lenses implantation with appropriate treatment of the posterior capsule provided a visual axis in infant cataract surgery.

Ahmadieh et al,[2] in a prospective study on 38 eyes in two equal groups with bilateral developmental and unilateral traumatic cataract, compared two different techniques: limbal versus pars plana lensectomy, primary posterior capsulotomy and anterior vitrectomy. They implanted a single-piece PMMA IOL in the capsular bag in all cases. The visual axis remained clear in all eyes in both groups during the follow-up period. In one eye with inadequate capsulotomy (smaller than 3 mm), postoperative refraction was difficult, but this did not affect vision. In our study, primary posterior capsulotomy (at least 4 mm in diameter) and anterior vitrectomy was performed in all cases; mild peripheral PCO was seen in two eyes, but VAO did not occur with mean follow-up of 19.6±5 month in any case irrespective of IOL material. Visual axis clarity in our series is comparable to the study by Ram[17], group 1 in the study by Vasavada et al[18]

Fibrinous uveitis due to increased tissue reactivity is a common complication in the early postoperative period regarding the infant cataract surgery.[15] Kuchle et al[19] reported that fibrin formation postoperatively was less in frequency in eyes with Acrysof IOL as compared to PMMA IOL. In our study, although non-significant, the incidence of postoperative uveitis was higher with PMMA IOLs (25%) as compared to acrylic IOLs (10%). The lower incidence of anterior uveitis with hydrophilic IOLs may be attributed to higher biocompatibility, less iris manipulation and trauma during IOL implantation, and good positioning of the IOL within the capsular bag.

Kuchle et al[19] didn't report any posterior synechiae formation in the ten eyes with Acrysof acrylic IOLs versus six of twenty eyes with PMMA IOLs. Wilson et al[15] noted posterior synechiae in 4.5% of cases following Acrysof lens implantation versus 19.2% in the PMMA group. In our study, we encountered no case of iridocorneal adhesions or posterior synechiae in the acrylic group, but iridocorneal adhesions were seen in 2 cases with traumatic wound dehiscence, and posterior synechiae were detected in 2 other eyes in the PMMA group at the last visit (P=0.14).

Precipitations on the IOL surface are com-posed of pigment, inflammatory cells, fibrin products, blood breakdown, and other elements; they are often seen during the immediate postoperative period. This complication is much more common in children with dark irides but is usually not visually significant. In a retrospective study, Wilson et al[15] reported IOL deposits in 6.4% of hydrophobic acrylic lenses as compared to 21.75% of PMMA IOLs. Deposits have been reported from 24.1% to 35.9% in other studies.[15,16,18,21] In the current study we found no instance of pigment deposition on hydrophilic acrylic IOLs, but 30% of eyes in the PMMA group had pigment deposition on the optic (P=0.008).

The incidence of iris capture following cataract surgery has been registered 8.5% by Basti et al[22] and 33% by Vasavada and Chouhan[23]; this condition occurs mostly in the children younger than 2 years, when the IOL optic is smaller than 6 mm and it is implanted in the ciliary sulcus. In our study, however, only one eye with a PMMA IOL developed pupil capture.

In our series, none of the eyes developed IOP rise, glaucomatous changes in the optic disc, clinical cystoid macular edema, also retinal detachm0ent or endophthalmitis. Considering the low rate of postoperative complications in eyes with foldable hydrophilic acrylic intraocular lenses in our study and despite the low acceptability of this type of IOL among ASCRS and AAPOS members;[5] it seems that these IOLs have good uveal biocompatibility and are suitable for implantation in pediatric cataract surgery. The major problem with hydrophilic IOLs is the low capsular biocompatibility, but with appropriate posterior capsule management (performing at least 4 mm posterior capsulotomy) and limited anterior vitrectomy, we encountered no case of VAO.

Although pediatric cataracts represent a treatable cause of lifelong visual impairment, good long-term visual outcomes depend on many factors such as age of onset, cataract density, surgical technique, control of postoperative inflammation, and finally a continuous refractive correction and visual rehabilitation. Our results showed that hydrophilic acrylic IOLs are as effective as PMMA intraocular lenses in terms of short- to intermediate-term outcomes after surgery regarding congenital and developmental cataracts.

CONFLICT OF INTERESTS.
There are non-conflicts of interest.

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الخلاصة

الغرض

لعمل دراسة و مقارنة بين الزرع الابتدائي للعدسة الأكريليك المطوية والعدسة الصلبة داخل العين لجراحة الماء الابيض للاطفال فيما يتعلق بالنتائج البصرية والمضاعفات .

طريقة العمل

دراسة سريرية شملت 40 عيناً لـ 31 مريضا تتراوح اعمارهم ما بين سنة الى ست سنوات كانو يعانون من الماء الابيض لعين واحدة او لكلتا العينين سواء كان ولاديا او مكتسبا .هناك نوعان من العدسات تم استخدامهما : المطوية والصلبة حيث ان عملية فتح محفظة العين الامامية وعملية قص السائل الزجاجي الامامي تم اجراؤها في جميع المرضى و بعد اجراء الجراحة تمت متابعة المرضى لمدة عام كامل .

النتائج

في هذه الدراسة كان متوسط عمر الاطفال لمجموعة العدسات المطوية 3.2 سنة ولمجموعة العدسات الصلبة 3.7 ومعدل متابعة المريض بعد العملية 19.6 شهرا (29–12) وفيما يخص المضاعفات فان المضاعفات اثناء اجراء العملية الجراحية لم تحدث اما ما يتعلق بالمضاعفات بعد العملية فان التهاب القزحية تم ملاحظته بنسبة 2% من اطفال مجموعة العدسات المطوية بينما 25% من اطفال مجموعة العدسات الصلبة. ومن المضاعفات الاخرى التي تم ملاحظتها من خلال المتابعة: تصبغ القرنية 30% والتصاقات القرنية الخلفية 10% والتصاقات القرنية بالقزحية 10% وهذه المضاعفات تم مشاهدتها بالعدسات الصلبة فقط اما بالنسبة للنتائج البصرية فقد كانت جيدة بشكل عام.

الاستنتاج

الاطفال الذين خضعوا لعملية رفع العدسة و عملية فتح محفظة العين الامامية وعملية قص السائل الزجاجي الخلفية تمت مقارنة النتائج البصرية والمضاعفات بين العدسات المستخدمة لهم (المطوية و الصلبة) وقد وجد خلال الدراسة ان العدسة المطوية افضل بالنتائج واقل مضاعفات.

الكلمات الدالة :الماء الابيض؛ عدسة داخل العين؛ مطوية؛ أكريليك.