Comparison of Manual Capsulorhexis and 25-Gauge Vitrectorhexis in Pediatric Cataract Surgery: A Pilot Study

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ABSTRACT

Purpose: To compare short-term visual outcomes (best corrected visual acuity [BCVA]), visual axis opacification, anterior (ACCC) and posterior (PCCC) continuous curvilinear capsulorhexis size, shape, and extension, and their decentration between manual capsulorhexis and 25-gauge vitrectorhexis in pediatric cataract surgery with intraocular lens (IOL) implantation.

Methods: Thirty eyes of children aged 3 to 8 years with developmental cataract were randomly selected for ACCC and PCCC by manual capsulorhexis forceps and 25-gauge vitrectomy cutter followed by IOL implantation and limited anterior vitrectomy. The size of the ACCC and PCCC was measured intraoperatively with calibrated capsulorhexis forceps. Patients were followed up for 3 months postoperatively and were evaluated for BCVA and visual axis opacification. Slit-lamp photographs of operated eyes were taken in retroillumination. The size in millimeters and decentration of the ACCC and PCCC from the center of the IOL were measured with the help of the Python imaging library.

Results: There was no statistically significant difference between BCVA ($P > .05$), visual axis opacification ($P > .05$), size of the ACCC ($P > .05$) and its decentration ($P > .05$), extension of the rhexis ($P > .05$), and size of the PCCC ($P > .05$) and its decentration ($P > .05$) between the two methods.

Conclusions: In both groups, BCVA, visual axis opacification, and ACCC and PCCC size, shape, and decentration from the center of the IOL were comparable, making 25-gauge vitrectorhexis a good alternative to manual capsulorhexis.

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INTRODUCTION

Pediatric cataract surgery consists of anterior continuous curvilinear capsulorhexis (ACCC), lens matter aspiration, posterior continuous curvilinear capsulorhexis (PCCC), limited anterior vitrectomy, and intraocular lens (IOL) implantation. Primary PCCC and anterior vitrectomy are preferred in younger children to avoid posterior capsule opacification and vitreous in the anterior chamber.

ACCC and PCCC are the most critical steps during pediatric cataract surgery. Various methods exist for performing these steps, depending on the surgical situation and the surgeon's preference and expertise. These include manual capsulorhexis using the manual forceps, vitrectorhexis using the vitrectomy cutter, Nischal's two-incision pull–push technique, capsulotomy diameter mark, calipers, femtosecond laser, Fugo plasma blade (MediSURG Research & Management Corporation, Norristown, PA), and pulsed electron avalanche knife**AQ1**. Two

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Figure 1. The calibrated MST CRF capsulorhexis forceps (MST, Redmond, WA).

of the most commonly used methods are rhexis by manual forceps and vitrectomy cutter (vitrectorhexis). After nearly three decades of dominance of 20-gauge vitrectomy systems for vitrectorhexis, the 25-gauge vitrectomy systems have recently been introduced. The potential advantages of 25-gauge instruments are a smaller, sutureless entry wound, easier manipulation in the narrow palpebral fissures and small eyes of children, less postoperative inflammation, and shorter learning curve for anterior segment surgeons.[1] There is limited literature on pediatric cataract surgery with IOL implantation using the 25-gauge vitrectomy system. Our aim was to compare the visual and surgical outcomes and complications of manual capsulorhexis versus 25-gauge vitrectorhexis in pediatric cataract surgery with IOL implantation.

PATIENTS AND METHODS

A prospective interventional pilot study was conducted in the Department of Ophthalmology at Guru Nanak Eye Centre, New Delhi, India, after receiving approval from the institute's ethical committee. An informed written consent was obtained from the parents of all patients. The study included 30 eyes of children between 3 and 8 years old with unilateral or bilateral developmental cataract randomly separated into two groups. In the case of bilateral cataract, only one eye was used in the study. Patients were randomized using computer-generated random numbers. In the vitrectorhexis group, ACCC and PCCC were done with the 25-gauge vitrectomy cutter using the Alcon Accurus vitrectomy machine (Alcon Laboratories, Inc., Fort Worth, TX) (1,000 cuts/min and 300 mm Hg suction). In the capsulorhexis group, the microsurgical technique with MST forceps (MST, Redmond, WA) was used. Limited anterior vitrectomy was done by the 25-gauge vitrectomy cutter in both groups after IOL implantation. All surgeries were performed by the same surgeon.**AQ2**

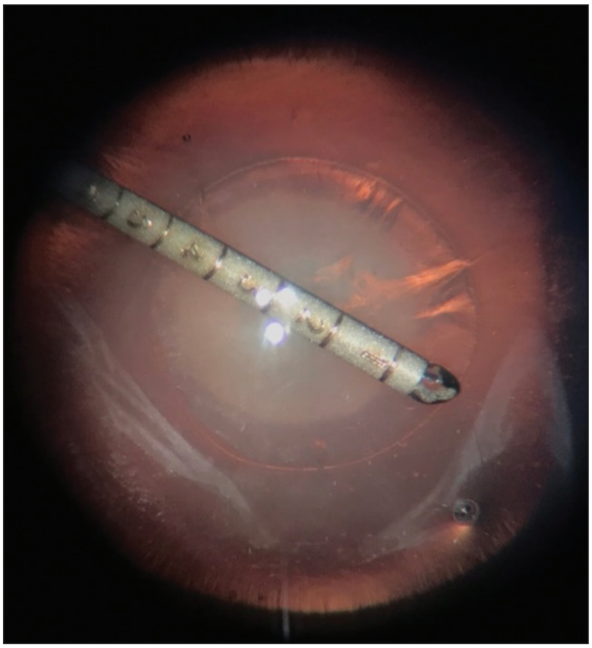

Figure 2. Intraoperative measurement of rhexis diameter using the calibrated MST CRF capsulorhexis forceps (MST, Redmond, WA).

The exclusion criteria included presence of corneal opacity, active or chronic inflammation, uveitis, any lens subluxation, secondary glaucoma, any gross ocular pathology (eg, microphthalmos, aniridia, and coloboma), presence of persistent fetal vasculature, retinal detachment, and presence of any significant systemic diseases that made the child unfit for surgery.

Preoperatively, a complete ophthalmic examination was done, which included a detailed history regarding previous ocular and systemic complaints, uncorrected distance visual acuity, best corrected visual acuity (BCVA), refraction under cycloplegia if cataract permitted, intraocular pressure, slit-lamp examination, keratometry, axial length, biometry, and posterior segment examination.

In the vitrectorhexis group, the 25-gauge vitrectomy system was used transcorneally to perform ACCC and PCCC, lens matter aspiration, and limited anterior vitrectomy. In the capsulorhexis group, MST CRF forceps were used to perform ACCC and PCCC, lens aspiration was done using bimanual cannulas, and limited anterior vitrectomy was done using the 25-gauge cutter. After completing the ACCC and PCCC, the horizontal and vertical diameters of the ACCC and PCCC were measured with the calibrated MST CRF forceps (**Figures 1-2**). The MST CRF forceps has calibrations of 1-mm interval at its tip, so it was easily used before

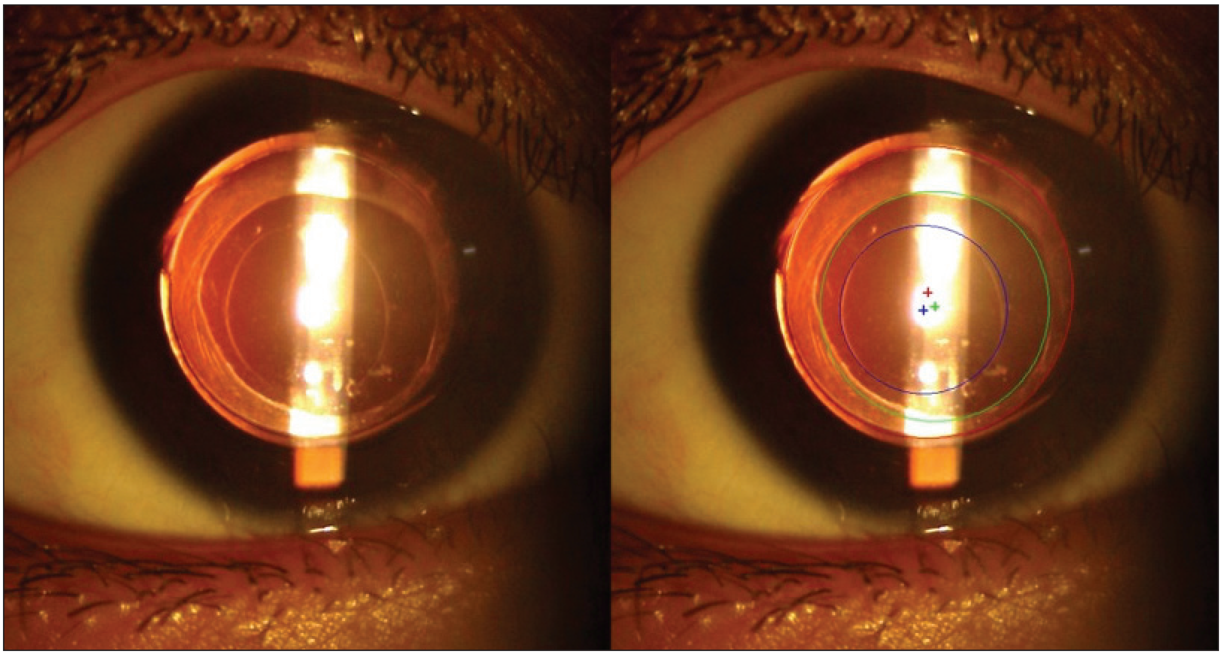

Figure 3. Postoperative measurement anterior (ACCC) and posterior (PCCC) continuous curvilinear capsulorhexis (decentration shown by their respective centers). Red = intraocular lens; green = ACCC; blue = PCCC

and after rhexis for measurements. A single-piece acrylic hydrophobic IOL (Acrysof SN60AT; Alcon Laboratories, Inc.) was implanted in the bag in all cases. The entry wound at the superior cornea was sutured with 10-0 polyglactin sutures.

Postoperative follow-up was conducted at 1 day, 1 week, 1 month, and 3 months postoperatively to record BCVA, any postoperative complications, and visual axis opacification.

At 3 months postoperatively, the implanted IOL was imaged on the slit lamp in retroillumination such that the margins of the ACCC and PCCC were also visible against the fundus glow. These images were then analyzed to measure the diameters of the ACCC, PCCC, and IOL with the help of the Python imaging library, which is a free library for the Python programming language that aids opening, analyzing, and saving many different image file formats. With the help of the Python imaging library, the most approximate circles were drawn manually over the contours of the ACCC, PCCC, and IOL on the slit-lamp image, and the diameters of these three circles were measured (**Figure 3**). These diameter values measured by the Python imaging library were in pixels. Knowing that the diameter of the IOL was 6 mm (diameter of the Acrysof SN60AT), the pixel values were calculated in millimeters, thus giving the measurement of the ACCC and PCCC diameters in millimeters. Similarly, with the help of the Python imaging library, the centers of the IOL, ACCC, and PCCC were located and their corresponding distances from the IOL center were measured, thus giving the amount of decentration of the ACCC and PCCC from the center of the IOL. Categorical variables were presented as number and percentage and continuous variables were presented as mean ± standard deviation and median.

Normality of data was tested by the Kolmogorov–Smirnov test. If the normality was rejected, then the nonparametric test was used. Quantitative variables were compared using the paired Wilcoxon test (when the data sets were not normally distributed). A P value of less than .05 was considered statistically significant. The outcome parameters were visual BCVA, size of the ACCC and PCCC, extension of the rhexis, decentration of the rhexis from the center of the IOL, change in the size of the ACCC and PCCC, and visual axis opacification.

RESULTS

The pilot study included 30 eyes of pediatric patients (15 in each group) between 3 and 8 years of age selected randomly in each group. The median age was 6 years in both groups, 5.77 years in the vitrectorhexis group, and 5.83 years in the capsulorhexis group (P = .898).**AQ3** There was no sta-

TABLE 1

Mean Values[a] and Comparison Between the Two Groups

Parameter	Vitrectorhexis Group	Capsulorhexis Group	*P*
Intraoperative			
ACCC diameter, mm (mean of horizontal and vertical)	4.98 ± 0.41	4.94 ± 0.49	.811
PCCC diameter, mm (mean of horizontal and vertical)	3.17 ± 0.47	3.09 ± 0.60	.696
3 months postoperative			
ACCC diameter, mm (mean of horizontal and vertical)	4.89 ± 0.41	4.81 ± 0.49	.619
PCCC diameter, mm (mean of horizontal and vertical)	3.28 ± 0.45	3.14 ± 0.59	.491
Rhexis extension (no. of cases)	Nil	2	.483
Decentration ACCC, mm	0.24 ± 0.1	0.21 ± 0.07	.398
Decentration PCCC, mm	0.28 ± 0.08	0.3 ± 0.14	.763
Visual axis opacification (no. of cases)	Nil	1	.309

ACCC = anterior continuous curvilinear capsulorhexis; PCCC = posterior continuous curvilinear capsulorhexis
[a]Values are presented as mean ± standard deviation.

tistically significant gender distribution between the two groups (*P* > .05).

The mean average (average of horizontal and vertical diameters) intraoperative ACCC diameters in the vitrectorhexis and capsulorhexis groups were 4.98 ± 0.41 and 4.94 ± 0.49 mm, respectively (**Table 1**). The mean average intraoperative PCCC diameters in the vitrectorhexis and capsulorhexis group were 3.17 ± 0.47 and 3.09 ± 0.60 mm, respectively. There was no statistically significant difference between the above comparisons (*P* > .05). There was extension of the rhexis in 2 of 15 cases in the capsulorhexis group. No extension was noted in the vitrectorhexis group, but the difference was not statistically significant (*P* = .483). The power used to detect any statistically significant difference was 80%.

There were no cases of corneal edema, unstable anterior chamber, wound leakage, irregular pupil, or postoperative endophthalmitis. The 25-gauge vitrectomy ports were not sutured and there was no wound leakage. Only the main keratome entry wound was sutured with 10-0 polyglactin.

At 3 months postoperatively, BCVA improved to 6/12 (0.5 decimal) or better in all patients. The mean average diameters of the ACCC in the vitrectorhexis and capsulorhexis groups were 4.89 ± 0.41 and 4.81 ± 0.49 mm, respectively, with no statistically significant difference between the two groups (*P* = .619). The decentration of the ACCC and PCCC from the center of the IOL was also calculated at the end of 3 months. The mean decentration of the ACCC from the center of the IOL in the vitrectorhexis and capsulorhexis groups was 0.24 ± 0.1 and 0.21 ± 0.07 mm, respectively, with no statistically significant difference between the two groups (*P* = .398). A similar result was found for the PCCC (*P* = .763).

Visual axis opacification was noted in 1 of 15 patients (6.67%) in the capsulorhexis group and none in the vitrectorhexis group (*P* = .309), which was again not statistically significant. The power used to detect any statistically significant difference was 80%.

DISCUSSION

Surgical management of pediatric cataracts is a challenging task because of the elastic lens capsule, higher positive vitreous pressure, greater postoperative inflammatory reaction, and higher rate of complications requiring reoperation.[2-4] In children, there is also a higher rate of posterior capsular opacification as compared to adults. This visual axis opacification is even more relevant in younger children because it may lead to amblyopia. Management of the posterior capsule has been a challenging aspect of pediatric cataract surgery, especially when IOL implantation is involved.[5] The techniques introduced to prevent postoperative reopacification of the visual axis include primary posterior capsulorhexis with or without anterior vitrectomy, optic capture through PCCC, and pars plana posterior capsulotomy combined with anterior vitrectomy.[6] ACCC and PCCC are critical steps during pediatric cataract surgery. Two of the most common methods for ACCC and PCCC include using manual forceps and a vitrectomy cutter. Manual capsulorhexis has been the gold standard in pediatric cataract surgery. It allows surgeons to perform capsulorhexis of a desirable size and integrity with greater ease and control.[6] It creates a smooth regular edge with greater resistance to tearing and unwanted extension to the periphery. But manual capsulorhexis in pediatric patients has the disadvantages of a longer surgery time and difficulty in achieving the appropriate size and shape of the rhexis with proper centration.[6] The pediatric capsule is highly elastic, making it difficult to perform capsulorhexis with a bent needle or forceps, especially in younger children.[7] Many surgeons have been using the vitrectomy cutter for performing PCCC using either the transcorneal or pars plana route. Even the ACCC is being done using the vitrectomy cutter.

The 20-gauge vitrectomy instruments have been used most commonly with the pars plana route, but this requires scleral incision suturing.**AQ4** Larger instruments also carry a higher risk for ciliochoroidal detachment, vitreous incarceration, and postoperative inflammatory response in children.[6] With the use of 25-gauge vitrectomy, the smaller wound size, rapid wound healing, preservation of conjunctiva, no need for sutures, ease of manipulation, intraoperative anterior chamber stability, no intraoperative corneal decompensation, and minimal postoperative inflammation have made these systems a better alternative.[6] The 25-gauge vitrectomy system is being used for the management of pediatric cataract by both the pars plana and transcorneal routes.[6,8]

Anterior capsular fibrosis, posterior capsular fibrosis, visual axis opacification, and capsule contraction are common capsular complications that result from the high proliferative capacity of the lens epithelium and severe postoperative inflammation in pediatric cataract surgery. The efficacy of the CCC depends on its centration, location, and size. The size of the rhexis is important to prevent posterior capsular opacification, as proposed in a study by Lin et al.[7] It has been reported that the optimum ACCC should be small enough to overlap 360 degrees of the IOL optic periphery to reduce posterior capsular opacification.[9] An accurate CCC helps accomplish this 360 degree overlap[10] and this overlap may be more important than IOL design.[11] A CCC that is larger than the IOL optic has been associated with greater posterior capsular opacification and poor visual acuity than a smaller capsulorhexis.[12] In contrast, when the CCC is too small, anterior capsule phimosis,[13] decreased vision, decreased visualization of the retina, and decreased effectiveness in the properties of aspheric IOLs can occur. A study by Neuhann[14] on adult cataract surgery proposed that a properly shaped and sized capsulorhexis enhances hydrodissection, cortical clean up, and IOL fixation and centration while decreasing the risk for posterior capsular opacification. An ACCC diameter of 4 to 5 mm yielded optimal capsular outcomes based on its relatively moderate contraction of the anterior capsular opening, moderate enlargement of the posterior capsular opening, and lower percentage of opacification of the posterior capsular opening and visual axis.[7] For age-related cataracts, many studies have clarified that the optimal anterior capsulorhexis diameter is slightly smaller than the diameter of the simultaneously implanted IOL optic surface, with 0.50 to 1.00 mm capsulorhexis edges covering the IOL optic surface.[12] As opposed to the anterior capsular opening, for the initial posterior capsular opening, a 3-mm diameter capsulorhexis is well accepted and has a tendency to widen. In our study, we measured the size of the ACCC and PCCC intraoperatively and 3 months postoperatively, and we also measured the decentration of the ACCC and PCCC from the center of the IOL. In our study, we were able to achieve an adequately sized ACCC and PCCC in both groups.

Kochagaway et al.[15] reported extension of the PCCC in 9.09% cases in the vitrectorhexis group. In that study, the PCCC was done after IOL implantation, but in our study, we implanted the IOL after the PCCC to see the strength of the PCCC and found no extension of rhexis on IOL implantation.

In a retrospective study, Wilson et al.[16] reported anterior capsular extension in 5.3% of cases in the vitrectorhexis group. They reported that vitrectorhexis for ACCC can be safely used up to 6 years of age. In our study, we performed both ACCC and PCCC with the 25-gauge vitrectomy cutter. We found that 25-gauge vitrectorhexis can be used easily for both ACCC and PCCC in pediatric cataract surgery up to 8 years of age in children with no significant short-term complications. No extension of the rhexis was noted in the vitrectorhexis group. There was extension of the rhexis in 2 patients in the capsulorhexis group, but it was not statistically significant when both groups were compared.

Hazirolan et al.[17] compared manual capsulorhexis (ACCC and PCCC) with that of 23-gauge sutureless vitrectorhexis (ACCC, lens aspiration, and PCCC) in pediatric cataract surgery. There was extension of PCCC in 8.33% cases in the manual PCCC group and 10.4% in the vitrectorhexis PCCC group. They concluded that both manual capsulorhexis and vitrectorhexis are comparable in terms of safety and efficacy for the achievement of anterior and posterior capsulorhexis. Their study proved that in pediatric cataract surgery, sutureless 23-gauge ACCC, lens extraction, PCCC, and anterior vitrectomy by 23-gauge vitrectomy cutter is more reproducible, more predictable, faster, and has a shorter learning curve. In our study, we found that ACCC and PCCC were easier, less time-consuming, and safe with the 25-gauge vitrectomy cutter because there was no extension of the rhexis. The incidence of postoperative visual axis opacification was reported as 23.5% in the manual PCCC group.[17] In our study, no visual axis opacification was noted in any of the patients in the vitrectorhexis group, whereas 1 patient in the capsulorhexis group developed visual axis opacification ($P > .05$).

We found that the ACCC contracted and the PCCC increased in both groups over a period of 3 months postoperatively. No statistically significant result was noted between the two groups. Our study was a pilot study conducted on a relatively small sample size of 15 eyes, with a short follow-up of 3 months. We believe that a larger sample and a longer follow-up will be more representative of changes in ACCC and PCCC sizes over time.

Raina et al.[18] also conducted a study on cataract surgery with 25-gauge vitrectomy comparing the transcorneal and pars plana route in infants younger than 1 year without IOL implantation and 1 year of follow-up was evaluated. The authors concluded that the 25-gauge vitrectomy system allows sutureless surgery with excellent intraoperative control and minimal postoperative inflammation and astigmatism, with a clear visual axis by both the transcorneal and pars plana routes.

The 25-gauge vitrectomy system for the management of pediatric cataracts is a good alternative to manual ACCC and PCCC. The 25-gauge vitrectorhexis had no significant short-term complications and several advantages, including the ability to maintain a stable and deep anterior chamber intraoperatively despite the high intravitreal pressure in children and no intraoperative corneal decompensation or iris prolapse. It allows easier manipulations in pediatric eyes due to the smaller instrument size and higher instrument flexibility, causes minimal postoperative inflammatory response, and preserves the conjunctiva for future surgeries such as trabeculectomy, which may be required in patients with congenital cataracts who develop glaucoma. Achievement of adequately sized ACCC and PCCC with greater ease and no extension of rhexis are the other potential benefits of using the 25-gauge vitrectomy system.

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AUTHOR QUERIES

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