

■ *Original article*

Surgical management challenges and clinical results of bimanual micro-incision phacoemulsification cataract surgery in children with congenital cataract

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Abstract

Introduction: Small incisions in cataract surgery have shown to reduce tissue damage, postoperative inflammation and pain.

Objective: To describe in detail the surgical management challenges and clinical results of bimanual micro-incision phacoemulsification cataract surgery in children with congenital cataract.

Materials and methods: In 22 eyes of 14 children aged from 11 months to 17 years with congenital cataract, micro-incision cataract surgery with lensectomy, bimanual aspiration or phacoemulsification and implantation of an intraocular lens (SN60WF, Alcon®) was performed under general anesthesia. The visual equivalent obtained with age-related methods, the slit-lamp examination, and refractive outcome were documented in the medical records and were analyzed retrospectively. The patients fulfilled at least 3 months of follow up.

Results: In all operated eyes, micro-incision cataract surgery could be performed without serious intra-operative complications. Lensectomy was safely combined with a primary posterior capsulorhexis and anterior vitrectomy in 17 of 22 eyes. Corneal incision length ranged between 2.2 mm and 2.6 mm (mean: 2.3 ± 0.2 mm). No cases of postoperative hypotony and increased inflammation were observed. One eye required surgical removal of the after-cataract 7 months after surgery. Laser capsulotomy for posterior capsular opacification had to be performed in 2 (9 %) eyes. In all other eyes (19/22), visual axis remained clear during follow-up.

Conclusion: Micro-incision cataract surgery is a promising alternative to conventional pediatric cataract surgery, since the technique showed to be comparably safe and effective. Longer follow-up examinations will now be performed.

Key words: congenital cataract, bimanual micro-incision phacoemulsification

Introduction

Many of the advantages of phacoemulsification cataract surgery are closely related to small incisions, since small incisions have shown to reduce tissue

damage, postoperative inflammation, and pain in adult patients (Linebarger et al 1999, Dick et al 2000).

To be astigmatically neutral and resistant to deformation, the incision width of a clear corneal incision must be significantly smaller than 3 mm. Moreover, smaller wounds may heal more rapidly, with possibly less risk for leakage and endophthalmitis (Lundström, 2006).

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Therefore, microincision cataract surgery (MICS) has been developed as a new surgical approach. Phacoemulsification and implantation of new foldable intraocular lenses (IOLs) may now be performed through incisions of 2 mm or smaller (Alio, 2004). For bimanual MICS, irrigation is separated from aspiration and 2 incisions ranging from 1.2 to 1.5 mm are made to receive the sleeveless phacoemulsification tip and the irrigating chopper (Alio, 2004; Paul & Braga-Mele, 2005; Agarwal et al 2001). For the next surgical step of implanting the foldable IOL into the capsular bag, the incision has to be enlarged to 1.8 – 2.2 mm.

These new developments may also offer new opportunities for pediatric cataract surgery, since new foldable IOLs with blue-light filters exist, e.g. the Alcon® Acrysof SN60WF. Now, the retinal photo-protection achieved by blue light blocking intraocular lenses may be combined in micro-incision cataract surgery with the reduction of tissue damage and postoperative inflammation. In addition, smaller incisions may provide benefits for wound construction and tightness. Therefore, a first series of pediatric MICS has been evaluated retrospectively with respect to intra-operative safety and postoperative outcome.

Materials and methods

This retrospective evaluation of the first series of pediatric micro-incision cataract surgeries comprised 22 eyes of 14 children aged from 11 months to 17 years with unilateral or bilateral congenital cataract. The indication for cataract surgery was lens opacity that caused decreased visual acuity to 20/60 or worse or if undilated retinoscopy gave no clear light reflexes. Informed consent was obtained from the parents prior to surgery, and the possibility of a secondary procedure was discussed with them. The minimum follow-up was 3 months in all patients (ranging from 3 to 12 months).

In four of the children (29 %), the etiology of the congenital cataract was autosomal dominant inheritance. In three children (21 %), persistent fetal vasculature and minimal fetal vascular remnants were associated with unilateral congenital cataract. In seven children (50 %), etiology was open. Eyes with cataract resulting from a syndrome (e.g., aniridia, Downs), traumatic cataracts, and eyes with previous ocular surgery were excluded from the analysis.

Preoperatively, all eyes had a thorough visual assessment. In children between 2 and 5.9 years, visual acuity was tested with Cardiff Acuity cards or, when applicable, with Lea Hyvärinen symbol charts. In the older children, acuity was assessed using Snellen charts. The presence of squint (3/14 children, 21.4 %) and nystagmus (0/14 children) was recorded. Manifest and cycloplegic refractions, a complete slit-lamp examination and fundoscopy were performed. In eyes with total cataract, ultrasonography was performed to evaluate the posterior eye segment.

All eyes received an AcrySof SN60WF IOL (Alcon®) with an optic diameter of 6.0 mm and a haptic diameter of 13.0 mm. The IOL power was determined using the modified SRK formula; the emmetropic power was under-corrected by 10 % in children between 2 and 5.9 years. In cases of ametropia and unilateral cataract, measurements in the fellow eye were taken into consideration in determining IOL power. In younger or uncooperative children, axial length measurement and keratometry with a handheld keratometer (Alcon®) were performed preoperatively under general anesthesia.

Surgical technique

In all eyes, micro-incision cataract surgery with lensectomy, bimanual aspiration or phacoemulsification and implantation of an intraocular lens (Acrysof SN60WF, Alcon®) was performed under general anesthesia by an experienced surgeon (MA). The pupil was dilated on the day of surgery with tropicamide 1 %, phenylephrine 2.5 %, and cyclopentolate 1 %. A clear corneal incision was performed in all cases. The incision length was measured and recorded in all cases.

After sodium hyaluronate 1.4 % (Healon GV®) was injected, an anterior capsulorhexis was created with a capsulorhexis forceps. Two paracentesis incisions were made. Bimanual phacoemulsification and aspiration of the lens material was performed.

In 17 of the operated eyes (77.3 %), a primary posterior capsulorhexis was performed: a posterior capsulotomy was made with a 27-gauge needle and then enlarged to 3.0 to 4.0 mm, creating a posterior continuous curvilinear capsulorhexis (PCCC) (Raina et al 2002).

An anterior vitrectomy was done in 14 eyes (63.6 %) additionally through the posterior capsulotomy site. It was confirmed that no vitreous was present at the level of the pupillary area. After viscoelastic material was injected, the AcrySof® SN60WF IOL (Alcon) was implanted in the capsular bag. No posterior capture of the IOL optic was done in any of the operated eyes.

In all eyes, the incisions were hydrated and then inspected carefully for tightness for more than one minute. After waiting for another minute, the incisions were carefully tested for a second time. Only in 6 eyes, a radial 10-0 nylon suture was necessary for tight wound closure; in all other eyes, the incisions kept tight and remained sutureless (16/22; 73 %). The cases were all video documented.

Postoperative topical treatment comprised dexamethasone eye drops 8 times a day and then tapered over 4 weeks and diclofenac sodium eyedrops and tropicamide 1 % eyedrops, both 3 times a day for 1 month.

Postoperative follow-up

The visual development documented in the medical records was analyzed retrospectively. The patients fulfilled at least 3 months of follow up (mean \pm SD: 4.6 ± 3.1 months). Children with unilateral cataract received preoperative and postoperative occlusion therapy. All children were routinely examined on the first postoperative day, at 1 week and 1, 3, and 6 months, and then every 6 months. At each visit, the children received a complete ocular examination and the following observations were recorded: visual axis clarity, presence of deposits (cells and pigment), presence of complications (fibrin and/or epitheloid cells on the anterior IOL surface, primary fibrosis of the posterior capsule, postoperative uveitis) before 6 weeks postoperatively, presence and degree of posterior capsule opacification (PCO), IOL centration, and presence of glistening in the IOL. Older children were examined at the slit-lamp and younger and uncooperative children, with a handheld slitlamp (Clement Clark 904).

The PCO was graded semi-quantitatively as follows: MILD = peripheral mild opacification; MODERATE = proliferation of Elschnig pearls near the optic center or moderate fibrosis of the posterior capsule; SEVERE = proliferation of Elschnig pearls over the

entire posterior capsule or dense fibrosis of the posterior capsule.

Statistics: The analyses were performed using SPSS, version 10.0. A P value less than 0.05 was considered statistically significant.

Results

In all operated eyes, micro-incision cataract surgery could be performed without serious intra-operative complications. No intra-operative bleeding or severe vitreous entanglements occurred. Lensectomy was safely combined with a primary posterior capsulorhexis and anterior vitrectomy in 17 of 22 eyes (77.3 %). There were no cases of secondary vitrectomy or Nd:YAG laser vitreolysis. No retinal complications (e.g. retinal rips, retinal detachment, cystoid macular edema) occurred in any of the evaluated congenital cataract eyes. In only one eye, the IOL was implanted in the sulcus, because of an enlarged PCCC. In all other eyes (21/22), the IOL was implanted into the capsular bag without complications.

Corneal incision length ranged between 2.2 mm and 2.6 mm (mean: 2.3 ± 0.2 mm). During surgery, the incision tightness and anterior chamber stability was acceptable in all operated eyes. At the end of surgery, the incisions were hydrated and inspected carefully for tightness after waiting for at least one minute. Incision tightness was tested by direct and indirect pressure on the globe. After this time period, only in 6 eyes (27 %), a radial suture was necessary to obtain tightness of the incision; in all other eyes (16/22, 73 %), the incisions kept tight even under exposure of pressure and no cases of postoperative hypotony were noticed during the postoperative follow-up. Also no cases of severely increased intraocular pressure (>35 mmHg) were noticed.

No severe corneal complications were observed in any of the study eyes during follow-up.

Postoperatively, no cases of increased intraocular inflammation were observed in any of the treated eyes. There were also no signs of increased presence of deposits (e.g. cells and pigment), fibrin and/or epitheloid cells on the anterior IOL surface, or a postoperative uveitis.

The postoperative anti-inflammatory topical treatment was well tolerated in all patients.

In all eyes, the IOL was well centered and no relevant glistening in the IOL was noticed.

One month postoperatively, visual axis was completely clear in 19 of 22 eyes (86 %). In 2 eyes mild primary fibrosis of the posterior capsule was found, but with good visual acuity Nd:YAG laser capsulotomy was not yet indicated. In one eye, the capsular bag was filled with fluid, indicating the performance of Nd:YAG laser capsulotomy. During follow-up, laser capsulotomy for posterior capsular opacification had also to be performed in 2 of the evaluated 22 study eyes (9 %) postoperatively: in one eye 3 months postoperatively, in the other eye one year postoperatively.

At month 7 after cataract surgery, primary fibrosis in one eye had increased relevantly and obscured the visual axis. Therefore, operative after-cataract removal had to be performed (1/22, 4.5 %). In all other eyes (17/22, 77.3 %), visual axis remained free. With respect to the semi-quantitative PCO grading, mild PCO was noticed only in 2 of these 17 eyes indicating mild peripheral opacification. No cases of moderate or severe PCO were observed.

Considering the presence of amblyopia at the beginning of postoperative occlusion treatment, visual development was generally satisfying in most patients (Table 1). However, eyes with unilateral cataracts had a generally worse visual acuity postoperatively when compared to bilateral cataract patients.

One week after surgery, the mean spherical correction obtained by dilated retinoscopy was $+0.2 \pm 1.01$ diopters (D) and the mean cylindrical correction was 1.05 ± 1.06 D. At month 1 postoperatively, the mean spherical correction was -0.35 ± 0.89 D and the cylindrical correction was 1.59 ± 0.9 D. At month 3, the mean spherical correction was -1.54 ± 1.29 D and the cylindrical correction was 1.75 ± 1.89 D. The mean deviation between refraction at month 3 from the initial preoperative target refraction was -0.14 ± 0.45 D ($p > 0.05$).

Discussion

Micro-incision cataract surgery is an interesting new alternative for pediatric cataract surgery. In a first series of 22 congenital cataract eyes reported in the present study, the technique of performing micro-incision cataract surgery with lensectomy, bimanual phacoemulsification and implantation of an intraocular single-piece lens was performed safely without serious intra-operative complications. Also during short-term follow-up, the technique was apparently as safe as conventional cataract surgery in children with congenital cataracts.

Incision stability is particularly crucial in pediatric cataract surgery, since the incisions should be as astigmatically neutral as possible to prevent amblyopia development during the postoperative follow-up. In addition, the incisions have also to be resistant to deformation in order to avoid postoperative leakage with the risk of postoperative endophthalmitis. With incision lengths ranging from 2.2 to 2.6 mm, incision stability was optimal during cataract surgery and also for the implantation of the foldable intraocular lens. At this incision length, no stress or trauma was caused to the clear corneal incision. Incision length may be possibly reduced to 1.8 - 2.0 mm by docking the cartridge to the incision for implanting the intraocular lens.

At the end of surgery, in 16 of 22 eyes, the incisions kept tight even without the necessity of sutures. This may be a real benefit of this technique, since suture-related complications after congenital cataract surgery may be completely prevented. Suture-related complications have been predominantly observed for polyester sutures (e.g. Mersilene®), but may also occur when absorbable polyglactin sutures (i.e. Vicryl®) are used (Bar-Sela et al 2007). In any case, the prevention of suture removal may be favourable for

Table 1
Visual acuity during follow-up

Best-Corrected Visual Acuity	Preoperative	1 month postoperative	3 months postoperative
Not determinable	6/22 (27.3 %)	5/22 (22.7 %)	4 /22 (18.2 %)
Visus 0.05 - 0.1	4/22 (18.2 %)	2/22 (9.1 %)	2/22 (9.1 %)
Visus 0.16 - 0.5	7/22 (31.8 %)	4 /22 (18.2 %)	4 /22 (18.2 %)
Visus 0.5 - 0.7	5/22 (22.7 %)	3/22 (13.6%)	4 /22 (18.2 %)
Visus 0.8 - 1.0	-	4 /22 (18.2 %)	4 /22 (18.2 %)
Visus 1.25	-	4 /22 (18.2 %)	4 /22 (18.2 %)

children patients by avoiding pain and anxiety. Moreover, there have also been reports of incident cases of endophthalmitis after suture removal (Bar-Sela et al 2007). However, a small first series of micro-incision cataract surgeries cannot bring enough evidence to assess a valid risk-benefit ratio. Therefore, future studies are necessary to evaluate if sutureless MICS incisions do not increase the risks for intraocular inflammatory reactions.

For the present study, the single-piece foldable AcrySof SN60WF (Alcon) intraocular lens was chosen, because this IOL may be implanted through micro-incisions and provides a blue-light filter for retinal protection, which is particularly important for pediatric pseudophakic eyes. In addition, the SN60WF is an aspheric IOL indicating that the front surface of the optic is not curved as part of a sphere but is relatively flatter in the periphery and may consequently provide superior contrast sensitivity over the more traditional spherical IOLs (Pandita et al 2007). With respect to the single-piece design, previous studies have shown that one-piece AcrySof SA30AL IOL provided satisfactory visual axis clarity, produced an acceptable inflammatory response and maintained centration in pediatric eyes (Nihalani & Vasavada, 2006).

Visual development was satisfying in most patients (Table 1). However, the presence of deprivation amblyopia reduced visual outcome particularly in the eyes with unilateral congenital cataracts (Müllner-Eidenböck et al 2004). The refractive outcomes were also acceptable: target refraction was attained to a high degree and no statistically significant deviation was observed between the spherical equivalent at month 3 after surgery and the calculated target refraction. The mean astigmatism was 1.75 ± 1.89 D ranging from 0 to 3.5 D (median = 1.0 D). These values are slightly higher than previous reports of Bradfield et al (2004). Their retrospective chart review comprised pediatric patients having cataract surgery with IOL implantation through a 3.0 mm clear corneal incision from 1997 to 2002. The mean postoperative retinoscopic cylinder in all patients was 0.63 D (range 0.0 to 4.50 D) at 1 month, 0.40 D (range 0.0 to 1.75 D) at 6 months, and 0.51 D (range 0.0 to 2.50 D) at 1 year. For a final interpretation of the astigmatism neutrality of micro-incisions < 3.0

mm further studies and longer follow-up examinations are required.

Conclusion

The micro-incision cataract surgery showed promising results for pediatric cataract surgery.

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