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Near-total posterior capsulotomy in congenital cataract surgery: a novel surgical approach

Konjenital katarakt cerrahisinde totale yakın posterior kapsülotomi: yeni bir cerrahi yaklaşım

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ABSTRACT

Background: To define near-total posterior capsulotomy instead of partial posterior capsulotomy with lens aspiration and anterior vitrectomy in congenital cataract surgery.
Materials and Methods: The research was carried out in a tertiary care center. Eleven patients who underwent near-total posterior capsulotomy, lens aspiration, and anterior vitrectomy surgery for treatment of congenital cataract between January 2010 and September 2018 were included in the study. Lenticular leukocoria was accepted as an indication for surgery. Patients who were older than six months at diagnosis and had a follow-up time of less than six months were excluded from the research. Surgical success was defined as the presence of a clear central visual axis in postoperative 6th months.
Results: The study included 22 eyes from 11 cataract surgery patients due to congenital cataracts. Both eyes of all patients underwent surgery in the same session. At the time of diagnosis, the average age of the patients was 2.89 ± 1.8 months, and at the time of surgery, the mean age of the patients was 3.70 ± 1.84 months. The average follow-up time was 16.54 ± 14.96 (8-48) months. Intraoperative complications did not occur in any patient. Visual axis opacification was not observed in any patient during the follow-up.
Conclusions: Near-total posterior capsulotomy is an easy and safe surgical technique. It could reduce the visual axis opacification.

Keywords: Anterior Vitrectomy, Congenital Cataract, Lens Aspiration, Posterior Capsulotomy, Visual Axis Opacification

ÖZET

Amaç: Konjenital katarakt cerrahisinde lens aspirasyonu ve anterior vitrektomiye ile birlikte uygulanan parsiyel posterior kapsülotomi yerine totale yakın posterior kapsülotomi yaklaşımını tanımlamak.
Materyal ve Metot: Bu çalışma üçüncü basamak bir merkezde yürütülmüştür. Ocak 2010-Eylül 2018 tarihleri arasında konjenital katarakt tedavisi için totale yakın posterior kapsülotomi, lens aspirasyonu ve anterior vitrektomi uygulanan 11 hasta çalışmaya dahil edildi. Ameliyat endikasyonu lentiküler lökokori olarak tanımlandı. Tanı anında altı aydan büyük olan ve takip süresi altı aydan az olan hastalar çalışmaya dahil edilmedi. Cerrahi başarı, postoperatif 6. ayda merkezi görmel aksın açık olması olarak tanımlandı.
Bulgular: Konjenital katarakt nedeniyle opera edilen 11 hastanın toplam 22 gözü çalışmaya dahil edildi. Tüm hastaların her iki gözüne aynı seansta ameliyat uygulandı. Hastaların tanı anındaki ortalama yaşı 2.89 ± 1.8 ay iken operasyon esnasındaki ortalama yaşı 3.70 ± 1.84 aydı. Ortalama takip süresi 16.54 ± 14.96 (8-48) aydı. Cerrahi esnasında hiçbir hastada komplikasyon izlenmedi. Takipler esnasında hiçbir hastada görsel aksı kapatan bir opasite izlenmedi.
Sonuç: Totale yakın posterior kapsülotomi kolay ve güvenilir bir cerrahi tekniktir. Bu teknik ile görsel aks opasiteleri azaltılabilir.

Anahtar Kelimeler: Anterior Vitrektomi, Görsel Aks Opasitesi, Konjenital Katarakt, Lens Aspirasyonu, Posterior Kapsulotomi

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INTRODUCTION

Pediatric cataract is a common cause of vision impairment and blindness in children, but it can be avoided (Taylor, 1998). Cataracts can occur as early as infancy, with an estimated incidence of 6 per 10,000 babies (Lambert & Drack, 1996). Congenital cataract often causes amblyopia and secondary strabismus (Gilbert, 2007; Zetterstrom et al, 2005). Early detection and treatment of congenital cataracts is critical for preventing lateral geniculate body atrophy during the critical period of visual development (Birch et al, 2009; Zetterstrom et al, 2005). Congenital cataract treatment necessitates early detection, a thorough surgical process, a simple aphakic correction method, and active amblyopia treatment (Petric & Lacmanovic Loncar, 2004). Primary intraocular lens (IOL) implantation is recommended for children older than two years (Lambert & Drack, 1996; Taylor, 1998). The implantation of IOL in infancy is still controversial (Petric & Lacmanovic Loncar, 2004). The main concerns with IOL implantation include poor IOL power prediction, increased inflammation, postoperative problems, and the technical complexity of surgery (Lambert et al, 2003). Spectacles and contact lenses are often used in children because of excessive reoperation rates and unpredictable visual outcomes of primary IOL implantation in the first year of life (Lambert et al, 1999).

The most common consequence that necessitates additional intervention following congenital cataract surgery is visual axis opacification (VAO) (Khokhar et al, 2015). The optimal surgical treatment of congenital cataracts must be a procedure that provides a clear optical axis. The VAO strikes during a critical time in a child's visual development, especially in infants, and amblyopia is the main concern (Petric & Lacmanovic Loncar, 2004). The visual axis may be blocked by posterior capsule opacification (PCO), the proliferation of lens epithelial cells (LECs), inflammatory membranes, thickening and opacification of the anterior hyaloid face (Nishi, 1988). In the treatment of congenital cataracts, primary posterior continuous curvilinear capsulorhexis (PCCC) with anterior vitrectomy has been well-recognized in the literature as a surgical approach to avoid or postpone the formation of VAO (Vasavada & Desai, 1997).

The aim of this study is to define near-total posterior capsulotomy instead of partial posterior capsulotomy in addition to lens aspiration and anterior vitrectomy in patients with congenital cataract, and also to assess the effectiveness of this technique, the rate of visual axis obstruction resulting from PCO or LECs proliferation.

MATERIALS AND METHODS

The research was carried out in a tertiary care center. Eleven patients who underwent lens aspiration, near-total posterior capsulotomy and anterior vitrectomy surgery for treatment of congenital cataract between January 2010 and September 2018 were included in the research. Written informed consent was obtained from the parents of each child before the surgery. The study protocol was approved by the Local Ethics Committee, and it adhered to the principles of the Helsinki Declaration.

The research comprised patients who had been diagnosed with congenital cataract. The indication for surgery was lenticular leukocorias. Patients with traumatic cataract or glaucoma, eyes with an ocular abnormality (e.g., microphthalmos, coloboma), non-lenticular leukocorias (retinoblastoma, retinopathy of prematurity, prelenticular leukocoria), and patients with lens subluxation were excluded from the study. Patients who were older than six months at the time of surgery and had a shorter follow-up period were also excluded from the research. Surgical success was defined as the presence of a clear central visual axis in postoperative 6th months.

All participants underwent a comprehensive eye examination, which included visual acuity testing (if possible), as well as evaluation of the anterior and posterior segments. If the lens opacity prohibited binocular indirect ophthalmoscopy from examining the ocular fundus, B-scan ultrasonography was performed. The age-paired tests assessed the visual acuity, Teller cards acuity test, or Snellen visual acuity test.

The following data were noted in all patients: gender, age at diagnosis and operation, laterality, etiology, morphology, intraoperative or postoperative complications, and follow-up time. All patients were referred to a pediatrician to investigate the etiology of congenital cataract and accompanying systemic diseases.

Surgical procedure

Adequate pre-operative pupil dilation was achieved by topical 0.5% cyclopentolate, 0.5% tropicamide, and 2.5% phenylephrine eye drops. All of the procedures were conducted under general anesthesia by the same surgeon. With the surgeon seated superiorly, corneal side ports were performed at 2 and 10 o'clock by a 20-G microvitreoretinal V-Lance knife (Alcon Surgical). Before 0.06% trypan blue dye injection, the air was injected into the anterior chamber to avoid staining of the endothelium by the dye. The excess dye was cleaned up using a balanced salt solution, and the anterior chamber was filled with sodium hyaluronate 2.3% viscoelastic (Healon 5, Abbott Medical Optics, Netherlands). An anterior continuous curvilinear

capsulorhexis with a diameter of 4.5 to 5 mm was created with a 26-G needle cystotome and capsulorhexis forceps. After multi quadrant hydrodissection, the lens materials were aspirated by bimanual irrigation/aspiration. A near-total or total posterior capsulotomy (larger than the anterior capsulorhexis) was performed with a vitreous cutter through the corneal side port incisions. Anterior vitrectomy was performed at a cutting rate of 1500 cuts/min and a vacuum value of 150 mmHg. After anterior vitrectomy (about 2-3 mm deep), the corneal side port incisions were closed with 10/0 nylon sutures (Figure 1). Furthermore, the corneal side port incisions were hydrated for better anterior chamber stability in the postoperative period. At the end of the surgery, a 2 mg dexamethasone was injected into the subconjunctival area of all eyes.

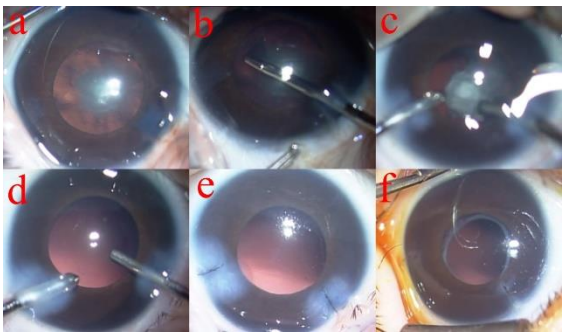

Figure 1. The surgical steps and postoperative first-month appearance in a patient, a: pre-operative appearance, b: anterior capsulorhexis, c: lens aspiration, d: posterior capsulotomy, e: postoperative appearance, f: postoperative first-month appearance.

Postoperative Evaluation

Postoperatively, all patients received topical dexamethasone eight times a day for a month, topical moxifloxacin eight times a day for a month, and cyclopentolate 1% once a day for two weeks. In the postoperative period, all patients were examined in 1st and 2nd days, 1st week, 1st month every two months for six months, and later every six months. At each postoperative examination, anterior segment evaluation by slit-lamp biomicroscopy and fundus evaluation by direct and indirect ophthalmoscopy were performed. After a week, spectacles were given, and patching for amblyopia treatment began. Ocular examination with an operating microscope and corneal sutures removal were performed in all patients under general anesthesia in the first postoperative month. Two patients who were four years old underwent IOLs (Acrysof multipiece intraocular lens, Alcon, Texas, USA) implantation to the ciliary sulcus, and the remaining nine patients younger than four years old were planned to undergo IOL implantation at the age of 4 years. All postoperative complications were noted (VAO, glaucoma, and synechia formation).

Statistical analysis

The analyses were conducted using IBM Corp.'s SPSS for Windows statistical software (version 22.0; Armonk, NY, USA). The data is presented as a mean and standard deviation (SD).

RESULTS

Eleven patients had bilateral cataract and operated in both eyes in the same session. The demographic and clinical characteristics of the participants were summarized in Table 1. The average age at the time of diagnosis was 2.89 ± 1.8 months, and the average age at the time of operation was 3.70 ± 1.84 months. The mean follow-up time was 16.54 ± 14.96 (8-48) months. No intraoperative complications were observed in any patient. Postoperative follow-up revealed that one patient had posterior synechia in both eyes, and one patient had glaucoma in the left eye. Visual axis opacification was not observed in any patient during the follow-up. No additional surgery was required for any patient. The postoperative best spectacle-corrected visual acuity of two patients (older than four years) who underwent IOL implantation to the ciliary sulcus was 0.7 in both eyes (Figure 2).

Figure 2. The images of aphakia and pseudophakia in a patient. a: aphakia, 42 months after the first surgery, b: pseudophakia in the dilated pupil, c: pseudophakia in non-dilated pupil.

DISCUSSION

In children with congenital cataract, a more severe inflammatory response is observed in the postoperative period when compared with adult patients, and complications such as PCO, fibrinous uveitis, pupillary membrane formation, posterior adhesion are more frequent and severe. The visual axis opacification is still a prominent consequence of pediatric cataract surgery. A clear visual axis must be kept to permit vision to develop and to avoid amblyopia. Because the anterior surface of the vitreous acts as a scaffold for the LECs to migrate towards the visual axis, posterior capsulorhexis alone does not ensure a clear visual axis (Petric & Lacmanovic Loncar, 2004). To keep a clear visual axis, posterior capsulotomy with anterior vitrectomy is required in younger children (Petric & Lacmanovic Loncar, 2004).

Table 1. Demographic and clinical features of patients.

Patient	Etiology of cataract	Morphology of cataract	Age at diagnosis (month)	Age at Operation (month)	Follow-up time (month)	Surgical success (R/L)	Complication
1	Idiopathic	Lamellar	0.6	1.5	8	Yes	None
2	Idiopathic	Lamellar	1.1	1.8	12	Yes	Posterior synechia in both eyes
3	Infectious	Total	5.5	6	48	Yes	None
4	Idiopathic	Nuclear	3	6	8	Yes	None
5	Idiopathic	Nuclear	0.6	2	45	Yes	None
6	Hereditary	Total	5.5	6	14	Yes	None
7	Idiopathic	Nuclear	3	3.5	9	Yes	Glaucoma in the left eye
8	Idiopathic	Total	5	5.5	8	Yes	None
9	Hereditary	Nuclear	2.7	3	10	Yes	None
10	Idiopathic	Lamellar	1.8	2	8	Yes	None
11	Idiopathic	Nuclear	3	3.5	12	Yes	None

In children with a PCO, Nd: YAG laser capsulotomy is not a highly favored method because of the disadvantages such as increased intraocular pressure, excessive inflammation, retinal detachment, re-opacification of the posterior capsule and requiring sedation or anesthesia (Raina et al, 2002).

Despite improvements in surgical approaches, patients who undergo congenital cataract surgery still have a high incidence of PCO (Petric & Lacmanovic Loncar, 2004). PCO was found to be between 11.8% and 15% in patients who had anterior vitrectomy and posterior capsulotomy, and between 40% and 76.9% in patients who had congenital cataract surgery without anterior vitrectomy and posterior capsulotomy, according to prior investigations (Jensen et al, 2002; Luo et al, 2008; Ram et al, 2003). The LECs show more aggressive behavior in younger ages, thus a higher incidence of PCO is observed in patients who underwent congenital cataract surgery. Petric et al (2004) suggested that the shallow anterior vitrectomy and the size of posterior capsulorhexis may be associated with the proliferation of LECs.

In patients with congenital cataracts, leaving the posterior capsule intact results in an unacceptable high rate of PCO, thus posterior capsulotomy is a critical step in the surgery. When the posterior capsule is intact, the incidence of PCO can be as high as 100% according to the literature (Knight-Nanan et al, 1996; Ram et al, 2003). Although the authors agree on the importance of posterior capsulotomy, they still do not agree on its size. Most of the previous studies suggested that the size of the posterior capsulorhexis must be between 3.0 and 4.0 mm or smaller than the anterior capsulorhexis (Khokhar et al, 2015; Kochgaway et al, 2013; Petric & Lacmanovic Loncar, 2004). In our study, we aimed to perform a near-total posterior capsulotomy (larger than the anterior capsulorhexis) to avoid PCO in the optic axis. In our patients, PCO did not obstruct the optic axis by remaining in the periphery. We think that this favorable outcome is due to the absence of a posterior capsule, which acts as a scaffold for LECs in the equator.

In the literature, there are a limited number of studies demonstrating the frequency of VAO. Murphy et al (2019) reported that the rates of VAOs were lower in aphakic patients (40.9%) compared to pseudophakic patients (69.3%). The majority of patients in this research had a posterior capsulotomy with or without anterior vitrectomy, and all were under the age of one year when they were operated. Borghol-Kassar et al (2012) reported that the rate of VAO was 23% in patients who underwent PCCC with anterior vitrectomy. The average age of the patients in this research was 24 months, and only 33% of the patients were aphakic. In our study, none of the patients had VAO during the follow-up.

There are several techniques for performing a posterior capsulotomy in pediatric cataract surgery. A vitrectomy cutter, diathermy, or forceps can be used for the posterior capsulotomy. Some authors suggested that posterior capsulorhexis using a forceps (manual) is the gold standard because it gives a smooth, round edge and also offers resistance to capsule tearing (Andreo et al, 1999; Nischal, 2002). However, performing manual PCCC is technically challenging (Andreo et al, 1999; Nischal, 2002). Furthermore, anterior vitreous face disturbance and vitreous traction are potential complications associated with this procedure (A Dholakia et al, 2006; Praveen et al, 2008). In our study, we used a vitrectomy cutter to adjust the capsulotomy size accurately and avoid vitreous traction.

There is currently no consensus on the optimal time for IOL implantation in the congenital cataract surgery. After IOL implantation at first age, unacceptably

myopic shifts and high complication incidences can be observed (Weakley et al, 2017). Lim et al (2017) suggested that IOL implantation should not be performed in patients younger than six months and always be performed in patients at least two years of age. They also suggested that patients who left aphakic must be corrected with either spectacles or contact lenses, and secondary IOL implantation can be performed at 4–5 years of age (Lim et al, 2017). In our study, all patients were six months of age or younger, so secondary IOL implantation was planned to be performed at four years of age. During this period, synechiae, which develop between the anterior and posterior capsules do not allow IOL implantation to the capsular bag. In our previous cases who underwent a smaller posterior capsulotomy than the anterior capsulorhexis, we had to performed secondary IOL implantation to the ciliary sulcus due to the synechiae between anterior and posterior capsules. Therefore, we aimed to keep the optic visual axis open by making the posterior capsulotomy near-total.

Postoperative complications, such as PCO, posterior synechia, open-angle glaucoma, fibrinoid reaction, and pupil decentration, are more common in pediatric cataract surgery than the adult cataract surgery (Zetterstrom et al, 2005). In our study, none of the patients had LECs proliferation or PCO to obstruct the visual optic axis. Fibrinoid reaction may result in the formation of posterior synechia. Vasavada et al (2000) reported posterior synechia in 34.6% of eyes, which underwent posterior capsulorhexis with anterior vitrectomy. In the current study, posterior synechia was observed in both eyes of a patient (9.0%). Our low result on the frequency of posterior synechia may be due to the larger posterior capsulotomy. In previous studies, the incidence of open-angle glaucoma following pediatric cataract surgery reported being between 3% and 41% (Mills & Robb, 1994; Simon et al, 1991). In our study, open-angle glaucoma developed in one eye of a patient (4.5%). The low incidence of open-angle glaucoma in our study may be due to the short follow-up period.

Our study has some limitations. Firstly, it has a limited number of cases because of the low prevalence of congenital cataracts. Secondly, it does not have a control group to make a comparison. Thirdly, the minimum postoperative follow-up time was short and a longer follow-up is required to determine postoperative complications such as glaucoma.

CONCLUSION

In conclusion, this study showed that near-total posterior capsulotomy instead of partial posterior capsulotomy with lens aspiration and anterior vitrectomy might reduce PCO and LECs proliferation in congenital cataract surgery. Also, we demonstrated that additional surgical interventions due to VAO could be minimized by near-total posterior capsulotomy in patients who underwent congenital cataract surgery. Further prospective and controlled studies with more cases and longer follow-up time are required to confirm our results.

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Author Contributions:

Study concept and design: Abuzer GÜNDÜZ, Emrah ÖZTÜRK; **Acquisition of subjects and/or data, analysis and interpretation of data;** Abuzer GÜNDÜZ, Emrah ÖZTÜRK, Ercan ÖZSOY; **Preparation of manuscript:** Abuzer GÜNDÜZ, Emrah ÖZTÜRK, Ercan ÖZSOY

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