Efficiency and Safety of the Vacuum and Needle Capsulorhexis in Cataract Surgery Using Anterior Chamber Maintainer

Katarakt Cerrahisinde Ön Kamara Koruyucu Kullanarak İğne ve Vakum Kapsuloreksisin Etkinliği ve Güvenilirliği

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ABSTRACT Objective: The aim of this study was to compare the outcomes of two different capsulorhexis techniques in the cataract surgery under an anterior chamber maintainer without using viscoelastic material. **Material and Methods:** This study included two hundred and four eyes of 189 patients (99 male and 90 female). Cataract surgeries were done in 102 eyes, phacoemulsification in 94 eyes and lens aspiration in 8 eyes by mini-nuc. The capsulorhexis eyes were divided into vacuum (group 1; 108 eyes) group and needle group (group 2; 96 eyes). **Results:** A successful capsulorhexis was achieved in 102 eyes in Group 1 and in 89 eyes in Group 2 (p= 0.41). The mean sizes of capsulorhexis achieved in Group 1 and 2 were 5.87 ± 0.30 mm and 5.90 ± 0.27 mm, respectively. During capsulorhexis enhancement, 6 eyes in Group 1 and 7 eyes in Group 2 had peripheral extension (p= 0.25). **Conclusion:** There was no significant difference between vacuum and needle groups. Use of an anterior chamber maintainer without using viscoelastic material allowed capsulorhexis through a 1 mm incision in all cases. Phaco devices and the developments in intraocular lens technology give the opportunity to use the same incision for capsulorhexis, phacoemulsification and intraocular lens implantation. Both methods had low cost, were safe and easy to apply for capsulorhexis.

Key Words: Cataract; capsulorhexis

ÖZET Amaç: Viskoelastik materyal kullanmadan ön kamara koruyucu ile katarakt cerrahisinde iki farklı kapsuloreksis tekniğinin sonuçlarını karşılaştırmaktır. **Gereç ve Yöntemler:** Bu çalışmaya 189 (99 erkek ve 90 kadın) hastanın 204 gözü dahil edildi. Katarakt cerrahisi 102 gözde mini-nuk, 94 gözde fakoemulsifikasyon ve 8 gözde lens aspirasyonu yöntemi ile yapıldı. Kapsuloreksis yapılan gözler vakum (grup 1; 108 göz) ve iğne (grup 2; 96 göz) grubu olarak ikiye ayrıldı. **Bulgular:** 1. grupta 102 gözde, 2. grupta 89 gözde kapsuloreksis başarılı oldu (p= 0.41). Elde edilen kapsuloreksisin ortalama açıklığı 1. ve 2. grupta sırasıyla 5.87 ± 0.30 mm ve 5.90 ± 0.27 mm idi. Kapsuloreksis esnasında 1. grupta 6 gözde ve 2. grupta 7 gözde perifere uzama görüldü (p= 0.25). **Sonuç:** Vakum ve iğne grubu arasında anlamlı bir fark bulunmadı. Viskoelastik materyal kullanmadan ön kamara koruyucu ile tüm olgularda 1 mm'den kapsuloreksis yapmak mümkündür. Fako cihazları ve göz içi lens teknolojisi gelişmesi ile kapsuloreksis, fakoemulsifikasyon ve göz içi lens implantasyonu için aynı insizyon kullanılabilir. Her iki metot kapsuloreksis için kullanımı kolay, güvenli ve düşük maliyetli bulunmuştur.

Anahtar Kelimeler: Katarakt; kapsuloreksis

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Up to date, a number of techniques have been used for cataract surgery. However, phacoemulsification is the most common method. Other methods such as mini-nuc, phacosection, sandwich and phaconit have also been used by many surgens.[1] Capsulorhexis is among the

major steps of cataract surgery. A strong and intact capsulorhexis is crucial for the safety and success of surgery, because it preserves the natural architecture of the capsular bag, resists the development of radial tear and facilities implantation of intraocular lens (IOL) in the bag posterior chamber.

Gimbel and Neuhann were the first to describe the method of a continuous curvilinear capsulorhexis (CCC).[2] We also used CCC in our study as a routine cataract surgery procedure. A successful and complete capsulorhexis has advantages not only in cataract surgery, but also in IOL implantation. In order to achieve a successful operation, the presence of a smooth and optimum size capsulorhexis is essential. For this procedure, specialized instrumentation and devices were developed as the surgeons found the CCC technique difficult.[3-5] The safer and easier procedures were defined by Tahi H et al (1999).[3] Following this, capsulorhexis could often be performed by a cystotome, a needle, capsulorhexis forceps or combination-type instruments and vacuum.[1,6-10] Regardless of which instrument is used, several principles can help the surgeon complete capsulorhexis successfully.[9,11] It is important to maintain the anterior chamber depth (ACD) during cataract surgery. Shallow chamber increases the tension on the zonules resulting in capsular tear formation running peripherally. While most surgeons use viscoelastic material to maintain a deep anterior chamber, other surgeons recommend the use of an anterior chamber maintainer (ACM) to maintain a consistently deep anterior chamber.[1,3,6,7,11-14]

The aim of this study was to compare the outcomes of two different capsulorhexis techniques in the cataract surgery under an ACM without using viscoelastic material.

MATERIAL AND METHODS

This study included two hundred and four eyes of 189 patients (99 male and 90 female). Mean age of the patients at the time of surgery was 63.97 ± 14.33 (SD) years (range 15 to 92 years). The study groups were identical in age, sex and race ($p > 0.05$, $p > 0.05$ and $p > 0.05$, respectively). Surgery was performed in eyes with up to 3+ nucleus hardness according to Lens Opacities Classification System II.[15] Patients with glaucoma, pseudoexfoliation syndrome, history of corneal and iris disease, small pupilla, high myopia and hyperopia, secondary or mature cataract, and iatrogenic anterior capsule tear during introduction into the anterior chamber were not included. The patients were divided into two groups; charleux as group 1 and needle as group 2.

A paracentesis was done at 6 o'clock position by a 20-gauge blade from temporal site and an ACM was introduced; continuous ACM infusion with a balanced salt solution (BSS) was used throughout this system. Then two side-port incisions for the capsulorhexis and the chopping instrument were also done at approximately 9 and 2 o'clock positions with blade.

An anterior capsule tear was made through the 9 o'clock incision with a cystotome and an anterior capsular flap was prepared. Then charleux cannula was introduced into the anterior chamber and some BSS was aspirated with syringe in case regurgitation was necessary (Figure 1). Anterior capsule was captured from under the formed flap and was aspirated until occlusion was formed. While vacuuming with an injector in the left hand, and capsular flap being held with a charleux cannula in the other hand, a capsulorhexis measuring about 5-6 mm in diameter was formed in the counter clockwise direction in accordance with the pupillary axis (Figure 2). With this procedure, the torn flap was grabbed by forming the va-

FIGURE 1: Injector in left hand, extension set and charleux cannula in the other hand.

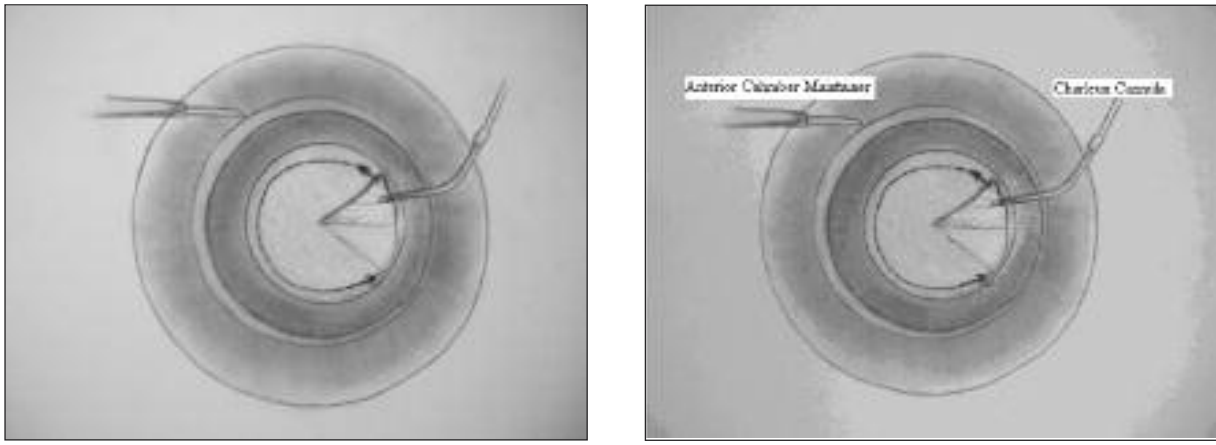

FIGURE 2: Anterior Chamber Maintainer on the left side and the occlusion of anterior capsule by charleux cannula on the right side.

cuum effect of syringe to aspirate, producing several successive tears.

These procedures were repeated for three or more times until the capsulorhexis with an approximate diameter of 6 mm was completed. CCC was measured vertically and horizontally and the mean was calculated from the two diameters.

Chi-square and the independent-samples t-tests were used for statistical analyses. Normality of data distribution was tested using One-Sample Kolmogorov-Smirnov test. A p value less than 0.05 was considered statistically significant. All statistical analyses were performed on SPSS/10.1 for windows.

RESULTS

The characteristics of patients were given in the table. The mean age of the patients was 63.06 ± 14.70 (SD) years in Group 1 and 65.01 ± 13.91 (SD) years in Group 2. Overall, the first few cases had CCC that was not completed with primary techniques; capsulorhexis was not completed in 6 of the first 30 eyes in Group 1 and in 6 of the first 20 eyes in Group 2. Of 204 eyes, vacuum and needle capsulorhexis were performed in 108 and 96 and a complete capsulorhexis was achieved in 102 eyes and 89 eyes in Group 1 and Group 2, respectively. This difference between groups was not significant (p= 0.41). The mean size of achieved capsulorhexis was 5.87 ± 0.30 (SD) mm and 5.90 ± 0.27 (SD) mm in Group 1 and 2, respectively; this difference between groups was not significant (p= 0.25).

Six eyes in Group 1 had peripheral extension during capsulorhexis enhancement. Since three eyes out of these six had peripheral extension in only one quadrant, a complete capsulorhexis was not achieved. In two of the remaining eyes, the capsulorhexis was completed by using Charleux cannula with flap performed by cystotome in the other quadrant and IOLs were implanted in the bag. Limited vitreous loss developed in a case due to a peripherally extended tear during surgery.

As for Group 2, capsulorhexis had peripheral extension in one quadrant in seven eyes. In four eyes of these, since capsulorhexis was completed in the other quadrants, the radial tear didn't enlarge and IOLs were implanted. In two eyes, capsulorhexis extended to the periphery; it could be completed by using charleux cannula with flaps performed in the other quadrant and IOLs implanted in the bag. In an eye with posterior capsular tear due to peripheral extension and vitreous loss, IOL could be fixated by sutures.

There was no significant difference between two groups in terms of preoperative intraocular pressure, pupil dilation, cataract type and nucleus hardness, and time to capsulorhexis (p> 0.05). Time elapsed between CCC initiation and completion

TABLE 1: Characteristics of study groups.

Characteristics	Groups		
	Group 1 (n= 108)	Group 2 (n= 96)	p
Age (years) Mean ± SD	63.06 ± 14.70	65.01 ± 13.91	0.34*
Sex (M/F)	52/49	46/42	0.26 **
Achieved/not achieved CCC (%)	6/102 (5.55)	7/89 (7.29)	0.41 **
Mean size of CCC (mm) Mean ± SD	5.87 ± 0.30	5.90 ± 0.27	0.25 *
Initiation and completion of CCC (sec) Mean ± SD	72.90 ± 15.92	76.61 ± 17.32	0.08 *

* Independent-samples t*test, ** Chi-square test.

was also measured as 72.90 ± 15.92 sec versus 76.61 ± 17.32 sec in Group 1 and Group 2, respectively ($p > 0.05$).

DISCUSSION

Cystotomes and various models and sizes of forceps are used to perform CCC. If a forceps is used, a viscoelastic material is needed to maintain ACD.[7,8] This is achieved through 2.00 to 3.25 mm incisions, which make opening and closing the forceps possible.[8] High-viscosity viscoelastic material, such as sodium hyaluronate, has been used by many surgeons, which significantly facilities the capsulorhexis performed with a forceps. One bolus of sodium hyaluronate is retained in sufficient quantities to allow the entire capsulorhexis to be completed. However, sodium hyaluronate is an expensive viscoelastic material and is thus not readily accessible to surgeons very well; 2% hydroxypropyl methylcellulose is an alternative. During capsulorhexis with a forceps, the problem with this dispersive viscoelastic material is that it is not retained well in the anterior chamber. The viscoelastic material continuously escapes from the clear corneal incision, leading to shallowing of the anterior chamber and an increased risk of extension of the capsulorhexis.[7] Using an ACM provides better control of the CCC with elevated anterior chamber pressure, which is adjusted by the height of the BSS bottle.[6,14]

Vacuum capsulorhexis using ACM was first described by Brierley.[19] The instrument is composed of an aspiration device consisting of a syringe attached to a catheter.[10] A modified vacuum capsulorhexis procedure, described by Andrioli,[9] has advantages over the vacuum capsulorhexis since only 2 incisions are needed. This method was modified to make vacuum capsulorhexis by using a chopper of irrigation and aspiration of phaco. As this technique requires high technology and is not cost effective, its use is limited in mini-nuc and some other surgeries.

During the learning period, complications of procedures were more frequent than that expected. It is very important to pass this step easily and safely for surgeons in training hospitals or surgeons who are self-learning the techniques. I used the two techniques with other capsulorhexis methods to compare the difference between these two methods easily. If a capsular tear made by needle method continues, the anterior cortex under the capsule may become flighty and the support of the needle is lost. This is one of the major problems if the surgeon has limited experience. However, this problem did not develop in the charleux group since cortical support was not necessary in that group.

Currently, cataract surgery is appreciated as phacoemulsification only. However, there are also other extracapsular cataract surgeries such as mini-nuc, phacosection, phacotrisection, sandwich methods and lens aspiration.[1,15-17] One of the aims in this study was to assist the critical steps of capsulorhexis in the mentioned surgical techniques, by making a small incision without using viscoelastic material.

The ACM is inexpensive and can be reused after sterilization[18,19] As with any surgical instru-

ment, it has disadvantages. An additional paracentesis is required, and there is a potential for invreased endothelial cell loss if insufficient viscoelastic material is used.[19] The potential for postoperative intraocular pressure (IOP) elevation due to retention of viscoelastic material in the anterior chamber, even after effective irrigation and aspiration, is well known.[20] The ACM cannula used in the present study was selected because it was easy to insert and remove through a 1.0 mm paracentesis created with a single stab incision with MVR blade. The design was self-retaining, caused minimal wound distortion, and did not result in postoperative wound leaks or hypotony.[18] The significance of an ACM is not limited to CCC; it also allows irrigation during the entire anterior segment surgery, a closed-system intraocular surgical procedure, and a hydropressurized condition from the beginning to the end of surgery. The ACM can be used in many types of intraocular surgery to eliminate the risk of suprachoroidal hemorrhage, reoperations, secondary IOL implantation, and posterior segment surgery. With the ACM, you control surgery rather than the surgery controlling you.[6]

Theoretically, the fluctuation due to fluid leak could be expected in AC, since capsulorhexis is made by an incision with 20 G and the thickness of the apparatus used in two methods was different. This may be attributed to the fresh fluid supplied to the AC equal to the amount leaving. The capsulorhexis was safely performed because AC was stable. During the capsulorhexis, no fluctuation was observed in ACD because the bottle height used in ACM created enough pressure to push the lens towards the back of the eye.

As the search for smaller phaco incisions progress, the surgeons can face challenges such as performing CCC through very small incisions. On the other hand, the evolution of IOLs that enable better folding and the possibility of injecting collagen polymers or other substances into the capsular bag through minimal incisions make smaller incisions a major goal.[9]

Needle CCC was rather difficult initially. Cortex behind the capsule started moving and visibility of the capsule distorted because a gap was formed during capsule formation. However, these difficulties were later overcome. Our results suggested that there was no significant difference between the two methods studied here. Since phacoemulsification devices are frequently upgraded and the number of supplementary materials in surgery is increased, the cost of cataract surgery is constantly increasing. This increases the burden of the social health security systems.

In conclusion, this study showed the possibility of capsulorhexis through a 1 mm small incision using ACM without viscoelastic material. At present, while sleeveless or cold phaco surgery is possible through a small (1.7 mm) corneal incision,[21] capsulorhexis with forceps is made through a 2 to 3 mm incision. IOL implantation is still made through a diameter of 1.7 to 2.0 mm. If the technological developments and novel IOL designs allow the procedure through 1 mm incision, I believe that the method selected for capsulorhexis can find wide areas. Same incision can be used for capsulorhexis, phacoemulsification and IOL implantation. In addition, these methods have low cost, and are effective and safe, which is particularly useful for clinics that have residency programs.

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