CLINICAL SCIENCE

MINI-RHEXIS FOR WHITE INTUMESCENT CATARACTS

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PURPOSE: To compare the intraoperative safety of two techniques of capsulorhexis for intumescent white cataracts: traditional one-stage continuous curvilinear capsulorhexis and two-stage continuous curvilinear capsulorhexis.
METHODS: This prospective comparative randomized study included two groups: the 1-CCC group (11 patients) received traditional one-stage continuous curvilinear capsulorhexis with 5-6 mm diameter, and the 2-CCC (13 patients) group received a deliberately small continuous curvilinear capsulorhexis that was secondarily enlarged, or a two-stage continuous curvilinear capsulorhexis. Patients were stratified according to cataract subset, which was characterized echographically. Six patients were considered as type 1, fifteen as type 2 and three as type 3. Type 1 included intumescent white cataracts with cortex liquefaction and extensive internal acoustic reflections, type 2 included white cataracts with voluminous nuclei, a small amount of whitish solid cortex, and minimal internal acoustic reflections, and type 3 included white cataracts with fibrous anterior capsules and few internal echo spikes.
RESULTS: With the one-stage technique, 46.15% of patients had leakage of the liquefied cortex; in addition, the surgeon perceived high intracapsular pressure in 61.53% of cases. Anterior capsule tears occurred in 23.07% of cases, discontinuity of capsulorhexis in 30.79% of cases and no posterior capsular rupture occurred. With the two-stage technique, leakage of the liquefied cortex occurred in 45.45% of cases; additionally, the surgeon perceived high intracapsular pressure in 36.36% of cases. No anterior capsule tears, discontinuity of capsulorhexis or posterior capsular rupture occurred. Considering each cataract subset, there was a higher incidence of leakage for type 2 as compared to types 1 and 3.
CONCLUSIONS: Two-stage continuous curvilinear capsulorhexis helps prevent unexpected radial tears of the initial capsulotomy from high intracapsular pressure, sudden radialization of the CCC and other intraoperative complications due to high intracapsular pressure, thus providing a safe cataract surgery in cases of white cataracts. These findings were supported by ultrasonography.

KEYWORDS: Cataract; Intumescent; Capsulorhexis; Minirhexis; Capsulotomy.

INTRODUCTION

Performing phacoemulsification in white cataracts is a challenge for the cataract surgeon that requires skillful technique and experience.[1-4] In white cataracts, the capsule is more fragile, and visibility of the red reflex may be obscured. Moreover, leakage of liquefied cortical material may occur, and capsulorhexis tears tend to extend to the periphery because of high intracapsular pressure.[1-5]

Gimbel and associates, in a prospective observational study of intumescent white cataracts, suggested the advantage of a deliberately small continuous curvilinear capsulorhexis, which is secondarily enlarged after aspirating the liquefied milky lens contents (two-stage continuous curvilinear capsulorhexis); it was suggested that this might be a safer approach when compared to one-stage capsulorhexis.[5] However, the results of that study may have some limitations, since this it was an observational, non-randomized clinical trial with uneven groups; this could lead to selection bias.

The aim of this study was to compare intraoperative difficulties between traditional one-stage continuous

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curvilinear capsulorhexis and two-stage continuous curvilinear capsulorhexis for intumescent white cataracts, the. In addition, this study assessed the safety of both techniques and aimed to develop a strategy for consistently achieving continuous curvilinear capsulorhexis (CCC).

PATIENTS AND METHODS

This randomized clinical trial included 24 patients (14 women and 10 men); patients with intumescent white cataracts who were over 50 years old were included. The average patient age was 62.5 years (range: 50 to 77 years). The mean patient age in each group was 65 years for group 1 and 60 years for group 2. Random assignment was performed according to www.randomized.com. The exclusion criteria were ocular diseases such as corneal opacities or irregularity, dry eye, amblyopia, anisometropia, glaucoma, retinal abnormalities, surgical complications, or lack of follow-up.

This study was conducted according to the established ethical standards for clinical research, and the internal review board of our hospital approved the study protocol.

The preoperative ocular examinations included the Snellen visual acuity exam, a detailed biomicroscopic examination, crystalline lens measurements using A-scan ultrasonography, Goldmann applanation tonometry and an axial length measurement (AL).

In addition, a B-mode ultrasonographic exam was performed with a pseudo-immersion technique. A saline-filled bladder was placed between the tube and the closed palpebra to maximize the image of the anterior ocular chamber; this allowed measurement of the nuclear diameter.[6]

The selected patients were randomly divided into two groups: Group 1 received traditional one-stage continuous curvilinear capsulorhexis with 5-6 mm diameter (1-CCC) and Group 2 received a deliberately small continuous curvilinear capsulorhexis that was secondarily enlarged [two-stage continuous curvilinear capsulorhexis (2-CCC)]. Depending on the liquidity of the lens material, the liquid cortex was aspirated using the I/A tip, through the small capsulorhexis.

The following variables were assessed:

1- The echographic appearance of the crystalline lenses.
2- Intraoperative difficulties during CCC including leakage of the liquefied cortex, the surgeon's perception of high intracapsular pressure, anterior capsule tears, centration of the continuous capsulorhexis, discontinuity of capsulorhexis, and posterior capsular rupture.

All surgeries were performed between March 2005 and July 2006 by the same senior surgeon using the same technique, and all surgeries included peribulbar anesthesia and eye drops (cyclopentolate 1% and phenylephrine 2.5%) for mydriasis, applied three times one hour before the surgery. A three-step clear corneal tunnel self-sealing incision was made with a 2.75 mm disposable metal blade on the steepest axis, and a side port incision was made with a disposable 15-degree metal blade. After the injection of cohesive ophthalmic viscosurgical devices (*Provisc, Alcon Labs*)[7] into the anterior chamber of the eye with white cataracts, 0.1 ml of trypan blue 0.1% was slowly injected into the anterior capsule. Utrata forceps were used to grasp the capsule and perform the capsulorhexis. If the capsulorhexis tear was directed toward the periphery, more viscoelastic was given to that part of the anterior capsule. Endocapsular phacoemulsification was performed in all eyes using the *Infiniti Vision System (Alcon Labs)* phacoemulsification unit. The corneal incision was enlarged to 3.2 mm, and a foldable hydrophobic acrylic MA60AC (Alcon Labs) intraocular lens was implanted intracapsularly; subsequently, the viscoelastic was removed. Starting on postoperative day 0, the patients were given topical fourth generation quinolones (gatifloxacin 0.1%) four times a day for 7 days and steroids (dexamethasone 0.1%) four times a day, with the decreased dosing over a 30 day period. The patients were scheduled for postoperative clinical evaluations on days 1, 3, 7, 30 and 90.

Data were analyzed using the Statistical Program for Social Sciences (SPSS), version 10.0 and Statistica version 5.1/97. The statistical analysis was performed using Fisher's test. Results were expressed as means ± SD. A P value of less than 0.05 was considered statistically significant.

RESULTS

Of the 24 patients in the study, 11 were assigned to the 2-CCC group and 13 to the 1-CCC group. The difference in participant number was due to individual random selection.

Biometric study of the white cataracts showed that the anteroposterior diameter of the crystalline lens was greater than or equal to 4 mm in 21 patients (85%) and less than 4 mm in 3 patients (15%) ($p = 0.065$).

The patients were categorized, according to the echographic appearance into three different types, as shown in Table 1. For the type 1 echographic appearance, there was no leakage in four eyes (66.7%); 1-CCC was performed in one eye and 2-CCC in the other three. For the type 2 echographic appearance, there was no leakage in six eyes (40%); both 1-CCC and 2-CCC were performed in three eyes each. For the type 3 echographic appearance, there was no leakage in three eyes (40%); 1-CCC was performed in two eyes and 2-CCC in one eye.

The results of the comparison between the two different techniques for continuous curvilinear capsulorhexis in white cataracts are shown in Table 2. Successful in-the-bag lens

Table 1 - Comparison of the echographic appearance of the crystalline lenses and the leakage of liquefied cortex during the continuous curvilinear capsulorhexis stage in white cataracts; the appearance may suggest high intracapsular pressure

Echographic appearance	No leakage N (%)	Leakage N (%)	P value
Type 1* (n=6)	4 (66.7%) 1 (1-CCC) 3 (2-CCC)	2 (33.3%) 1 (1-CCC) 1 (2-CCC)	0.268
Type 2** (n=15)	6 (40%) 3 (1-CCC) 3 (2-CCC)	9 (60%) 6 (1-CCC) 3 (2-CCC)	0.087
Type 3*** (n=3)	3 (100%) 2 (1-CCC) 1 (2-CCC)	0 (0%) 0 (1-CCC) 0 (2-CCC)	0.243

*Type I included intumescent white cataracts with cortex liquefaction and extensive internal acoustic reflections.
**Type II included white cataracts with voluminous nuclei, limited amounts of whitish solid cortex, and few internal acoustic reflections.
***Type III included white cataracts with a fibrous anterior capsule and few internal echospikes.

implantation was achieved in all cases.

No differences were observed between the two different techniques of continuous capsulorhexis in terms of leakage of the liquefied cortex.

No statistical difference was found in any of the intraoperative variables during CCC (Table 2). In approximately 61% of cases, the surgeon noticed high intralenticular pressure during capsulorhexis when performing the one-stage (1-CCC) technique; however, high intralenticular pressure was only noticed in approximately 36% of cases in which two-stage continuous curvilinear capsulorhexis (2-CCC) was performed. A tendency of the capsule to tear towards the periphery was observed in approximately 54% of cases in which 1-CCC was performed, while this tendency was only observed in 27% of cases in the 2-CCC group. In around 30% of cases with one-stage capsulorhexis, there was a discontinuity of the capsulorhexis; this did not occur with two-stage capsulorhexis.

DISCUSSION

To evaluate the intraoperative difficulties associated with phacoemulsification of white mature cataracts using a two-stage capsulorhexis technique, Vasavada et al. examined 60 eyes (60 patients) with senile white mature cataracts. A small capsulorhexis was attempted initially, and endophacoemulsification was performed. The capsulorhexis was enlarged before intraocular lens implantation. In that series, CCC was achieved in 57 eyes (95%); in addition, the intracapsular pressure rose in 24 eyes (40%). In our study, CCC was achieved in 89.90% of cases, and the intracapsular pressure was judged to be increased in 27.27% of cases when the two-stage capsulorhexis technique was used. These findings were different from the cases in which a one-stage capsulorhexis technique was used, where CCC was achieved in 53.80% of cases and the intracapsular pressure was judged to be increased in 45.16%. The higher success rate achieved for CCC with the two-stage capsulorhexis technique is assumed to result from increased safety when compared to the one-stage technique. We did not find any statistical differences in the leakage of the liquefied cortex, the surgeon's perception of high intracapsular pressure, anterior capsule tears, centration of the CCC, discontinuity of the capsulorhexis, or posterior capsular rupture. However, we believe there is a clinical difference between the two techniques.

Guimbel and associates analyzed 2,967 consecutive cataract cases in a prospective observational study of the incidence of intumescent cataracts and showed that 45.45% and 46.15% of the one- and two-stage groups had leakage of the liquefied cortex, respectively, with no statistically significant differences[5]; in addition, the surgeon detected high intracapsular pressure in at least 61% of cases in the one-stage group and 36% of the two-stage group. In our study, radialization of the CCC was detected in 54% of cases in the one-stage group and in 27% of cases in the two-stage group. There was no need to convert to a can-opener capsulotomy in our study. Guimbel and associates revealed that 11.7% of intumescent cases had anterior capsule tears during the first capsulotomy and 4% had to be converted to a can-opener capsulotomy.[5] Some white cataracts are associated with irregular capsular permeability. Damage to the ion pump and metabolic barrier may allow fluids to enter the lens nucleus with cortical hydration, resulting in high

Table 2 - Comparison of one-stage and two-stage continuous capsulorhexis techniques in white cataracts with presumably high intracapsular pressure

	One-stage group (N=13)	Two-stage group (N=11)	P value
Leakage of liquefied cortex	6 (46.15%)	5 (45.45%)	0.972
Surgeon's perception of high intracapsular pressure	8 (61.53%)	4 (36.36%)	0.414
Anterior capsule tears	7 (53.84%)	3 (27.27%)	0.423
Discontinuity of capsulorhexis	4 (30.79%)	0	0.185
Posterior capsular rupture	0	0	1.0
Centralization	10 (90.90%)	7 (53.84%)	0.078

intraocular pressure.[2,3] In such cases, the high intraocular pressure may lead to unexpected radial tears during the initial capsulotomy with sudden capsulorhexis radialization.[8-13]

In a retrospective study of 212 consecutive patients with white cataracts, Chakrabarti et al. showed incomplete capsulorhexis in 28.3% of cases, a posterior capsular tear in 1.9% of cases, and the conversion to a manual non-phacoemulsification technique in 1.9% of cases.[14] In our study, none of the eyes had posterior capsular rupture or incomplete capsulorhexis, and none of the eyes were converted to conventional extracapsular cataract extraction. General recommendations for the visualization of the anterior capsule in eyes with white mature cataracts include the following: dimming the operation room lights, increasing the magnification of the microscope, using oblique illumination, using an endoilluminator, and using capsule dyes. In our cases, staining the capsule with trypan blue under viscoelastic material enhanced the visualization of the anterior capsule during capsulorhexis.[15-19]

In the present study, capsulorhexis was continuous, curvilinear and centered in 44% of the 1-CCC group and in 95% of the 2-CCC group. Successful in-the-bag lens implantation was achieved in all cases. The same correlation was demonstrated by Guimbel and associates. There are several procedures that can be used to prevent milky liquefied cortical matter from obscuring the view of the anterior chamber as well as radial tearing caused by high intracapsular pressure in eyes with hypermature or intumescent cataracts; these techniques include the use of sealed anterior chambers,[19] automated irrigation/aspiration to aspirate the liquefied milky lens contents, aspiration of the liquefied milky lens contents before capsulorhexis using a 26 or 30 gauge needle or through a small CCC, preoperative capsulotomy using a YAG laser (Sinskey) and two-stage CCC.[5,15]

The two major limitations of our study are the small sample size and the fact that the observer was not masked for a subjective analysis. The study of this surgical treatment is complicated by the fact that intumescent cataracts are a relatively uncommon condition, since the introduction of phacoemulsification has made indication for surgery in early stages more frequent. Additionally, the observer cannot be masked and must be aware of which patient belonged to which group. A strong bias could therefore be introduced, especially because one of the variables (the surgeon's perception of high intracapsular pressure) was subjective. However, masking was obviously impossible in this trial.

This study suggests that the two-stage continuous curvilinear capsulorhexis technique helps to prevent unexpected radial tears of the initial capsulotomy due to high intracapsular pressure, the sudden radialization of the CCC and other intraoperative complications arising from high intracapsular pressure. This method thus provides a safe cataract surgery in cases of white cataracts, and its results were corroborated by ultrasonography.

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