

DoubleExtraSharpChopperIncreaseEfficacyofPhacoemulsificationforHard

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Double Extra Sharp Chopper Increase Efficacy of Phacoemulsification for Hard Mature Cataract Surgery

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ABSTRACT

4 Objective: To assess the efficacy and safety of a modified double extra sharp chopper for removal of hard cataracts.

Design: Prospective 4 non-comparative interventional clinical study.

Participants: Forty eyes from 25 patients with hard mature cataract grades 3-4.

Methods: The pre-modified Koch chopper was sharp 4 ed under the slit lamp to become extra sharp at the tip and inside the edge and 2 mm in length. Patients with hard mature cataract grades 3-4 (grade 4 being the hardest) underwent phacoemulsification by single surgery and were analyzed prospectively.

Results: The mean effective phaco time was 23.73 ± 5.75 seconds. Minimal power was facilitated by using horizontal chopping using a self-made double extra sharp chopper. No resistance was encountered while moving the chopper, regardless of cataract persistency. Preoperative BCVA were count fingers (47%), hand movement (35%), and light perception (18%). Postoperative BCVA on day 1 and day 7 were 0.57 and 0.95, respectively. There was no difference of effective phaco time among nuclear hardness ($P = 0.467$), which represent the effectiveness of the extra sharp chopper.

Conclusions: The double extra sharp chopper facilitated a safe and rapid visual rehabilitation and maximal subject comfort when doing phacoemulsification for hard mature cataracts.

KEYWORDS: mature cataract; sharp chopper; topical anesthesia; horizontal chopping; phacoemulsification

INTRODUCTION

Cataract backlog is still a major issue in Indonesia as one of the countries with the highest incidence of cataracts in the world. Difficulties in reaching healthcare facilities in the archipelago caused many patients to present with hard mature cataracts. In spite of the persistence of their cataract, most of the patients still undergo small incision cataract surgery with phacoemulsification instead of a manual cataract

extraction. Purchasing a high-end phaco machine is impractical, especially in remote areas. Since it is difficult for patients to travel for follow-up visits, hard mature cataract surgery is still done with a previous-generation phaco machine. These are ordinary conditions that are commonly seen in Indonesia.

Several techniques for cataract surgery have been published with some modifications for hard cataract. They are phaco chop,¹ stop and chop with phaco in situ,² chopping in situ,³ or vertical chop⁴. However, while doing chopping with any chopper available commercially, the nucleus was rotated while being chopped, especially in cases of very hard cataracts such as nucleus grade 4, brown cataract, or black cataract. These difficulties later

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on inadvertently cause capsule rupture or zonolysis due to uncontrolled nucleus rotation or when the sharp end of the hard nucleus touches the posterior capsule.

Most older phaco machines have a maximum vacuum of 180 mmHg or less with a 19G phacotip, and with this amount of holding power the hard nucleus will be rotated while being chopped horizontally with the available chopper. To avoid the nucleus being rotated while chopping using this device, and to ease insertion of the chopper into the capsule, we designed a special, double extra sharp chopper. The device is used to help insertion of the sharp tip of chopper into the capsular bag, and to facilitate slicing the very hard nucleus using a horizontal movement while chopping (cracking) under limited vacuum. Here we report a study with hard mature cataract that underwent surgery with the double extra sharp chopper.

2 METHODS

The study was done at the Department of Ophthalmology, Christian University of Indonesia/Cikini Church Hospital, Jakarta, Indonesia. Informed consent was obtained from the study participants, and conducted following the tenets of the Declaration of Helsinki. The Christian University of Indonesia Institutional Review Board granted approval for this study. The study design was prospective non-comparative interventional clinical study. The inclusion criteria were: (1) adult hard cataract patients with best corrected visual acuity (BCVA) 1 meter finger counting or worse; and (2) grades 3-4 cataract. Cataract was graded as 0: soft, 1: semi soft, 2: medium to hard, 3: hard, 4: very hard.

The study consisted of 40 eyes from 20 patients with completed phacoemulsification performed by single surgeon (GWSS). Surgery was performed under topical anesthesia with unpreserved lidocaine 2%,⁵ given 4 times. The Ophys MMP™, with 15 degree 19G phaco tip, was used for all procedures. The chopper used was double extra sharp as shown in Figure 1. The chopper was self-made, modified from Koch chopper (Visitec™) with 2 mm in length, with an extra sharp edge and tip for slicing and then cracking the nucleus. The pre-modified Koch's chopper was sharpened at the tip and the inside edge under slit lamp using a dental micromotor handpiece. The chopper is distinct from other choppers such as Nagahara chopper because ours is longer and thin like a knife. As a comparison, the available Nagahara chopper is 1.5 mm and thicker with a blunted tip. The purpose of the extra sharp tip is to facilitate insertion of the chop-

per inside the capsular bag in hard mature cataract cases.

Surgery was done using a horizontal chopping technique with a maximum vacuum of 180 mmHg with 15 degree 19G tip. Vacuum was reduced to 100 mmHg when the remaining nucleus fragment was a quarter or less. Emulsification was done with a phaco tip beveled down or to any lateral side parallel with capsulorhexis, depending on nucleus fragment position. Aspiration of the cortex was done thoroughly with the I/A tip. A 6 mm foldable acrylic lens (NeoEye™, Rohto, Indonesia) was implanted in the bag for uneventful procedures. Alternatively, a PMMA lens was placed in the sulcus if the posterior capsule rupture occurred. The 2% hydroxypropylmethylcellulose was used for the whole surgical procedure.

Collected postsurgical parameters included visual acuity on day 1, day 3, week 1 and month 1; intraocular pressure day 3 and consecutive visits. Parameters collected during surgery included effective phaco time, nucleus sclerotic grade, wound status, and complications or any significant findings. SPSS version 15.0 (SPSS, Inc., Chicago, IL) was used for all statistical analysis, and $P < 0.05$ was considered significant.

RESULTS

Phacoemulsification was performed simply by a three-step upper temporal limbal incision regardless of keratometric reading, depth of orbita, or other conditions. The range of preoperative visual acuities vary from finger counting to light perception, indicating the representative nature of the samples in regards to the density of cataracts. Characteristics of the patients are shown in Table 1.

There was minimum resistance in spite of persistence of nucleus during horizontal movement of the

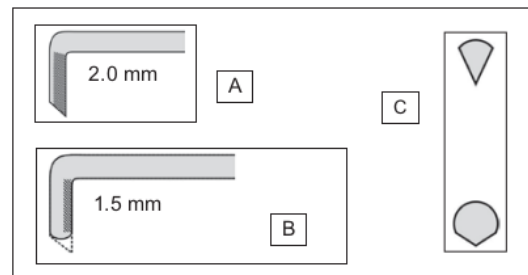


FIGURE 1 Double extra sharp chopper with longer and sharper tip (A) and conventional chopper (B), with horizontal section showing sharper inner side of double extra sharp chopper (C).

chopper. This finding was different from the use of the conventional chopper, as during inserting the sharp tip of the chopper there was no resistance of hard cortex. This sharp tip assisted the insertion of the chopper into the capsular bag when the capsulorhexis was not large (≤ 5 mm). The extra sharp inside edge also facilitated slicing rather than "forced" cracking such as that produced by the conventional chopper, even in the hardest cataract. None of the cases showed rotation of the nucleus during slicing with the chopper. The movement of the sharp tip also functioned

as a vertical chop. Therefore, using this chopper was similar to doing cataract surgery akin to the combination of vertical and horizontal chopping under limited vacuum.

The power used was minimal and short, which was facilitated by the extra sharp inside edge of the chopper. This was revealed by the mean effective phaco time (23.73 ± 5.75 seconds) in spite of the hard cataract. In other words, the fragmentation is mechanically done by the chopper rather than ultrasonographically done by the handpiece. There is no difference of effective phaco time among nuclear hardness (grade 3 and grade 4) ($P = 0.467$ Fisher's Exact Test), which represents effectiveness of the sharp chopper (Table 2). This finding is also in conformity with post-operative VA on day 1, day 3, and day 7, which showed no difference between nuclear sclerotic cataract grade 3 and grade 4 ($P = 0.985, 0.870$ and 0.773 , respectively, Fisher's Exact Test). Mean BCVA postoperatively day 1, day 3, day 7 and month 1 were 0.54, 0.82, 0.95 and 0.96, respectively (Figure 2). There were 2 cases with BCVA 0.4 and 0.5 due to epiretinal membrane and diabetic macular edema.

There were two cases (5%) with posterior capsule rupture. Both of these occurred as an aspiration-related complication. None of these reasons could be attributed directly to the surgical technique or chopper used. These cases occurred in the beginning

TABLE 1 Patient demography and cases description (n = 40)

Sex	Male 19 (47.5%) Female 21 (52.5%)
Age (years)	Mean = 69.1 years (range 61- 76)
Systemic disease	Diabetes 9 Hypertension 2
BCVA preoperative	Finger counting - light perception
BCVA postoperative 1 week	Mean = 0.95 (range 0.4-1.0)
BCVA postoperative 1 month	Mean = 0.96 (range 0.4 - 1.0)
PC rent	2 cases
Slight thermal injury	3 cases
Effective Phaco Time	Mean = 23.73 ± 5.75 seconds (range 14-42)
Cataract persistency	Grade 3 (25%) Grade 4 (75%)

TABLE 2 Effective Phaco Time (EPT) and Best Corrected Visual Acuity (BCVA) of cataract grade 3 and grade 4 (n = 40)

	Grade 3 (n = 10)		Grade 4 (n = 30)		p value
	X ± SD	Range	X ± SD	Range	
EPT	23.30 ± 4.13	17-30	23.86 ± 6.25	14-42	0.467
BCVA Day1	0.51 ± 0.22	0.2-0.8	0.55 ± 0.25	0.16-1.00	0.985
BCVA Day3	0.90 ± 0.18	0.5-1.0	0.81 ± 0.23	0.33-1.0	0.87
BCVA Day7	0.96 ± 0.08	0.8-1.0	0.94 ± 0.18	0.4-1.0	0.773

EPT=Effective Phaco Time
BCVA=Corrected Visual Acuity

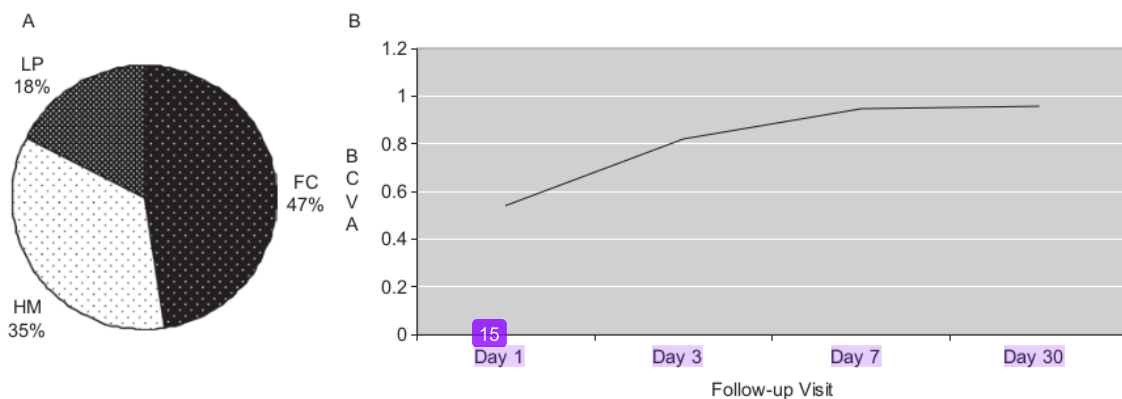


FIGURE 2 VA Pre-operatively [FC: 1 meter finger counting, HM: Hand Movement, LP: Light Preseption]. (A) In relation to VA; post-operatively (B).

of the learning curve of using the chopper. These 2 cases had lens implantation in the sulcus with PMMA lens after anterior vitrectomy, and had a BCVA of 1.0 in a week postsurgery. Other intraocular complications included incomplete capsulorhexis in 3 cases (7.5%) and pupillary miosis smaller than CCC in 1 case (2.5%).

Mild corneal edema was seen in 11 cases (27.5%), which occurred more in cases with prolonged surgery with effective phaco time of more than 30 seconds. This edema disappeared completely in a week and produced a BCVA of 1.0. Slight thermal wound injury occurred in three cases (7.5%), with effective phaco times of 26, 39 and 42 seconds, respectively. This corneal edema was more related to the excessively tight wound incision, as extra care was taken to prevent fluid leakage, and subsequent vacuum loss, as the machine can only provide 180 mmHg vacuum for the 19G tip. The wound edema resolved completely without any signs of scarring with prompt treatment, and within a week the suture was removed. Pre- and post-operative keratometric readings revealed that these mild wound burns did not induce high astigmatism (Table 3).

DISCUSSION

Increased safety, rapid visual rehabilitation, and maximal subject comfort have been important factors in the development of modern surgical technologies and techniques for cataract extraction.⁶ Small incisions in modern cataract surgery have driven the development of new phacoemulsification tips, probes, and choppers as well. Many kinds of surgical trauma during phacoemulsification have been reported to injure corneal endothelial cells.^{7,8} Some studies demonstrate that ultrasound energy and irrigation directly injure the endothelium,⁹⁻¹⁰ which meant more fear of complications while using the machine for hard cataracts. New machines that offer cold phaco, modification of phaco tip, and more optimal emulsification by changing the tip movement are not affordable in most eye hospitals in developing countries. Considering complications that might occur in hard cataracts, especially when using old generation machines, we attempted to keep power and vacuum as low and as short as possible. By using optimal ultrasound settings and assisted by the extra sharp chopper, the hard cataract was managed *mechanically* by slicing to become small splinters and then emulsifying with low power like the procedure in nuclear sclerotic grade 2-3+ cataracts. This extra sharp chopper is very important in these difficult cases, as it reliably slices or cuts even the hardest cataract. The minimum power used facilitated by the chopper is revealed by low effective phaco times as well as minimal wound burns, which resolved in one week in 3 cases. In

TABLE 3 Keratometric reading of patients with thermal burn, preoperatively and postoperatively (n = 3)

No.	Pre-operative		Post-operative	
	K1	K2	K1	K2
1	43.50	44.25	44.50	44.25
2	45.00	44.25	44.50	44.25
3	47.00	44.75	46.37	45.25

a case requiring a wound suture, corneal contour was restored, as shown by keratometric readings after suture removal.

The issues of improved safety, efficacy, and time efficiency of the procedure are the main concern when doing hard cataract surgery with phacoemulsification. These are represented by effective phaco time, complication rate, corneal edema, wound burn, and visual acuity, resulting in shortening of the rehabilitation period. Posterior capsule rupture was encountered in 2 cases. These represent a 5% capsule rupture in this study. These complications occurred during emulsification when a sharp fragment of the nucleus rotated and touch the posterior capsule (1 case) and during posterior capsule polishing (1 case). These cases do not represent complications due to the sharp and long tip of the chopper. In addition, all cracking and chopping procedures were performed centrally parallel to anterior capsule. These procedures will not touch the posterior capsule as long as the anterior chamber depth is maintained properly. It is necessary to reduce the vacuum when the size of the nucleus remained a quarter or less to avoid complications. Corneal edema was seen as mild to moderate (11 cases) due to less ultrasound being used. This is also due to the phaco tip bevel being directed downward or to any lateral side to the nucleus fragment and rarely directed upward facing the corneal endothelium as normally done in soft or medium hard cataracts. The ultrasound power used in very hard cataract cases (grade 4) is quite high, and to reduce the effect of the power on the endothelial cells, the phaco tip bevel must be rotated to any direction except upwards.

It should be noted that these cases of hard cataract surgery also represent some of the cases at the beginning of the learning curve. Therefore, the complication rates reported here are related to the hardness of cataract rather than the chopper used. Nevertheless, the complication rate compares favorably with that encountered in phacoemulsification for other hard cataract surgery¹¹. The limitation of this technique is that it requires significant dexterity and experience to use the chopper.

In conclusion, the double extra sharp chopper can facilitate a safe, rapid visual rehabilitation and maximal subject comfort while doing phacoemulsification

for hard mature cataract, even when used with older phaco machines.

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Declaration of Interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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