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Microincisional cataract surgery (MICS) with pulse and burst modes

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PURPOSE. *To compare the amount of ultrasound (US) energy and balanced solution (BS) required for burst mode and pulse mode during bimanual phacoemulsification surgery.*
METHODS. *One hundred cases were divided into two groups (the pulse mode Group 1 [50 eyes], the burst mode Group 2 [50 eyes]). One surgeon (M.B.) performed phacoemulsification procedures using topical anesthesia with the AMO Sovereign in all patients. The technique was based on the nuclear hardness and surgeon's criteria and performed bimanually. The surgery time, total ultrasound time (UST) and effective US power (USP), and used balanced solution (BS) were retrospectively compared.*
RESULTS. *The mean surgery time, mean UST, and mean used BS volume were not statistically different in both groups ($p>0.05$). The mean EPT was statistically highly different in both groups ($p>0.001$). There was a slight tendency toward more surgery time in Group 2 than in Group 1, although the difference was not significant ($p=0.146$). Statistically significant higher results (Group 1: $r=0,889$, $p<0.001$ and Group 2: $r=0,834$, $p<0.001$) were seen in Group 1 when both groups were evaluated for the surgery time and used BS volume. When UST and used BS volume were evaluated in Groups 1 and 2, significant relation was seen in both but the correlation is statistically higher in Group 1 (Group 1: $r=0,765$, $p<0.001$, and Group 2: $r=0,544$, $p<0.001$).*
CONCLUSIONS. *The very low energy modes with the WhiteStar technology are suitable for bimanual cataract surgery. (Eur J Ophthalmol 2006; 16: 804-8)*

KEY WORDS. *Ultrasound energy, Balanced solution, Bimanual cataract surgery, Phacoemulsification*

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INTRODUCTION

Cataract surgery has changed dramatically over the last 50 years, and new technologies and methodology guarantee further changes. Bimanual phacoemulsification through a 1-mm incision was first described by Shearing et al in1985. The procedure uses separate irrigation instruments and a sleeveless phaco tip to remove cataracts. Irrigation during the phacoemulsification is provided through an irrigating chopper or manipulator instead of through the phacoemulsification handpiece (1, 2). Now, this technique is called microincisional cataract surgery (MICS) (3). A recent upgrade in the AMO Sovereign (Advanced Medical Optics, Santa Ana, CA, USA) has been the addition of WhiteStar technology. It is a new technology in that an ultrapulse mode is able to modulate the delivery of energy by changing both the duration and the frequency of ultrasonic vibrations. Energy is delivered in extremely brief, microsecond bursts, interrupted by rest intervals. The burst length and rest period can be varied independently of each other, yield-

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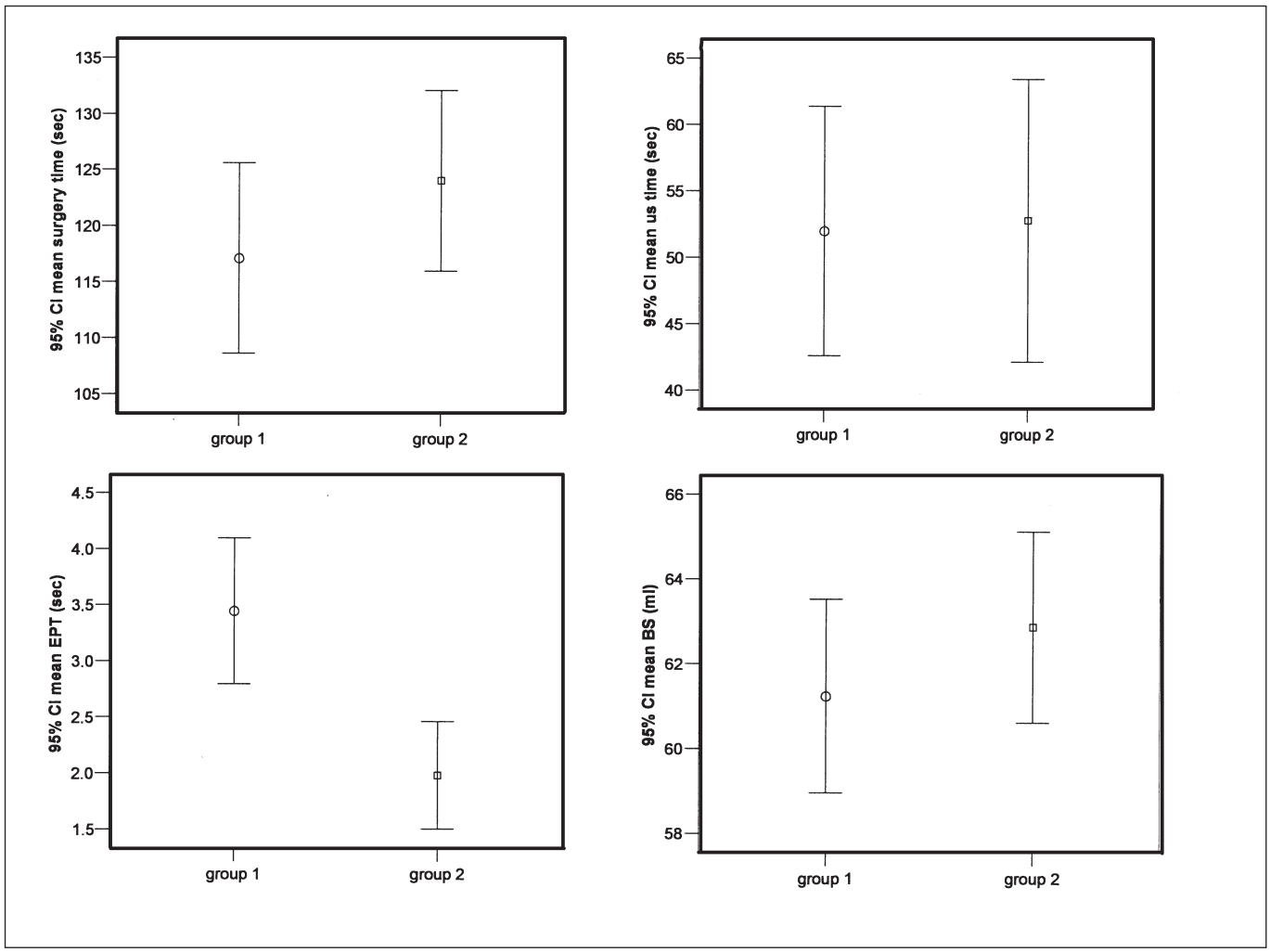

Fig. 1 - *Variability of the parameters.*

ing numerous modes of duty cycles from which to choose. The addition of WhiteStar technology to the Sovereign machine reduces thermal escalation at the wound while maintaining the cutting efficiency seen with continuous mode ultrasound and improving nuclear fragment followability. Addition of this, standard pulse or burst modes available in Sovereign machine. Result of this, the microsecond ultrapulses of the Sovereign can be used in pulse and burst modes (3-5). The potential advantages of lens extraction through small stab incisions include a tightly closed system with the ability to use irrigation flow as a manipulation assistant to move lens material to the phacoemulsification tip rather than to push particles away (6).

We compared the phacoemulsification and aspiration-irrigation time (surgery time), total ultrasound (US) time (UST), effective phaco time (EPT), and used balanced solution (BS) volume required for phacoemulsification of nuclear fragments using different modes during the bimanual phacoemulsification.

PATIENTS AND METHODS

The surgical records of consecutive patients who had phacoemulsification cataract surgery were retrospectively reviewed. Patients were consecutively selected and divided into two groups. In Group 1 (50 eyes), the pulse mode was used, and in Group 2 (50 eyes), the burst mode was used.

Surgical technique

One surgeon (M.B.) performed all phacoemulsification procedures using topical anesthesia and two stab clear corneal incisions. Corneal incisions were prepared with 19 gauge MVR knife. One of the incisions was prepared at the steepest meridian. The nucleus was emulsified with the AMO Sovereign. The technique was based on the nuclear hardness and surgeon's criteria and performed bimanually, which is described by Paul and Braga-Mele (1). In most cases, quick and prechop techniques were used for nucleus removal. The chip-and-flip technique was used for soft cataracts with a nucleus hardness of 0 and 1 (6).

During the emulsification of the nuclear fragments, the machine settings were US, 20-40%; flow rate, 30 cc/min; vacuum, 350-450 mmHg; bottle high, 76 cm. Vacuum was during the irrigation and aspiration and 40 mm Hg during the viscoelastic aspiration. The burst was WhiteStar BL (14%) 4 ms in both groups. This mode is pulsed 6 per second in Group 1 and bursed in Group 2. Bimanual aspiration of the cortex was performed under the high vacuum (450 mmHg). The corneal incision prepared at the steepest meridian was used for intraocular lens implantation. Bimanual aspiration of the viscoelastic was performed under the 40 mmHg vacuum.

Postoperative visual acuity was measured at 1, 4, and 7 days. The presence of corneal edema, Descemet's striae, and anterior chamber flare and visual acuities during the follow-up was recorded.

Statistical analysis

Data were analyzed using SPSS® 13.0 program. Distribution of the groups' parameters was evaluated by Shapiro-Wilk test and nonparametric Mann-Whitney *U* test was used for comparison. Correlation between the parameters was evaluated by Pearson correlation coefficient and α was used as 0.05.

Statistical analysis of the following data was performed: total time for use to emulsify nuclear fragments and aspiration (surgery time), UST (total US time), effective phaco time (EPT-multiplying the phacoemulsification time by the average percentage power used) (6), and the used BS volume at the end of aspiration-irrigation.

RESULTS

One hundred eyes were enrolled in the study. The mean age of the first group of patients was 66 years ± 6.3 (SD). Fifty-two percent of the patients were men. The mean age of the second group of patients was 65 years ± 6.1 (SD). Fifty percent of the patients were men. There was no statically significant difference ($p>0.05$) in nuclear hardness between groups: 6 (12%) Grade 1, 10 (20%) 2, 15 (30%) 3, 19 (38%) 4 in Group 1 and 5 (10%) Grade 1, 11 (22%) 2, 16 (32%) 3, 18 (36%) 4 in Group 2.

Table I shows the surgery time (phacoemulsification and aspiration-irrigation time), UST, EPT, and used balanced solution for phacoemulsification of nuclear fragments by groups. The mean surgery time, mean UST, and mean used BS volume were not statistically different in both groups ($p>0.05$). The mean EPT was statistically highly different in both groups ($p>0.001$). There was a slight tendency toward using more surgery time in Group 2 than in Group 1, although the difference was not significant ($p=0.146$).

TABLE I - POSTOPERATIVE PARAMETERS

Groups	Mean surgery time (sec±SD)	Mean UST (sec±SD)	Mean EPT (sec±SD)	BS (mL)
1				
(50 eyes)	117±29.8	52±33	3.4±2.2	61.2±8
	(79–174)	(1–110)	(0.1–9)	(51–79)
2				
(50 eyes)	124±28.6	52.8±33	1.9±1.6	62.9±7.9
	(88–187)	(1–142)	(0.08–7.4)	(50–82)

Surgery time = Phacoemulsification and cortex aspiration time
UST = Total ultrasound time; EPT =Eeffective phaco time
BS =Used balanced solution during all surgery time

The values of all parameters (surgery time, UST, EPT, and used BS volume) were higher at the harder nucleus because of the longer procedure in both groups.

The correlation between the surgery time and used BS volume were evaluated in Groups 1 and 2; a highly significant relation was seen in both (Group 1: r=0,892, p<0.001 and Group 2: r=0,836, p<0.001). When UST and used BS volume were evaluated in Groups 1 and 2, a significant relation was seen in both but the correlation is statistically higher in Group 1 (Group 1: r=0,767, p<0.001 and Group 2: r=0,546, p<0.001) (Fig. 1).

DISCUSSION

The main evolution that cataract surgery has experienced during the last decades has been parallel to the decrease in the incision size. Today, MICS offers an excellent alternative for cataract removal, with a significant decrease in incision size, total UST, and EPT when compared with coaxial phacoemulsification (2, 3).

When Shearing et al (2) first attempted bimanual phacoemulsification in 1985, there were significant concerns that the bare phaco needle would generate corneal wound burns. In general, when the phaco tip is not occluded with nuclear material, fluid flows freely through the phaco needle and over the needle through the corneal incisions. This fluid adequately cools the cornea and prevents corneal burns. As phacoemulsification gained popularity in the 1990s, newer power modifications such as burst and hyperpulse with variable duty cycles became available to provide phacoefficiency to emulsify hard nucleus and at the same time limit the amount of ultrasound energy delivered to the eye to prevent endothelial damage and reduce injury to surrounding structures. One of these new technologies was WhiteStar (Advanced Medical Optics), which marked a significant advance in phacoemulsification. WhiteStar prevents temperature elevation by using microbursts of phacoemulsification energy. During the off-cycle of the phaco energy bursts, the heat generated in the previous cycle has an opportunity to dissipate, which prevents the temperature of the phaco needle from rising (1, 6-9). Phaco chop is one of the leading methods for faster surgery (8-10). In our study, WhiteStar mode was used combined with quick and prechop techniques in all cases. In Group 1 WhiteStar is used as a pulse and as a burst mode in Group 2. EPT is statistically lower (p<0.001) in Group 2 (1.9±1.6 sec) than 1 (3.4±2.2 sec) and corneal wound burn and endothelial loss was not seen in both groups because of the very lover total 100% used US (EPT). The EPT is lower than the dangerous limits in both groups (6). Because of this, we did not see any postoperative difference between the groups.

A common difficulty experienced during bimanual phacoemulsification is maintaining anterior chamber stability. The small irrigating choppers and manipulators limit the amount of infusion. Thus, during high vacuum, the anterior chamber has a tendency to become unstable (9). Surgeons have used a variety of methods: pole extenders to obtain very high bottle heights to maximize the infusion rate, tight incision that limits the out flow of fluid to maintain anterior chamber stability, new irrigating choppers capable of delivering irrigation at 40 mL/min, anterior chamber maintainer, Agarwal's pressurized devices to inject air into the bottle to improve the amount of fluid delivered to the eye, and pressurized inflow (1, 10-13). In our study, we prepared tight stab incisions, used maximum bottle high (76 cm) for the stabile anterior chamber during the high vacuum, and we did not see surge problems during surgery. The used BS volume is similar in both groups related to the similar nuclear hardness and surgery time.

In conclusion, the WhiteStar mode combines good fluid management with US power, which makes phacoemulsification more efficient and decreases the amount of energy delivered to ocular tissues. This would result in stable anterior chamber and safe surgery, clearer corneas, and better visual acuity for the surgeon and patient.

The authors have no proprietary interest in any of the instruments or products mentioned in the article.

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