PHACO EFFICIENCY OF A NEW ULTRASOUND MODULATION APM™ (ADVANCED POWER MODULATION) IN HARD NUCLEI

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Summary

Advanced Power Modulation (APM™) is a new ultrasound modulation which delivers Burst & Pulse ultrasound energy in one modulation pattern for better control of the energy entering the nucleus. As part of the new generation VISALIS 500 Family phaco system from ZEISS which combines a peristaltic and a Venturi pump this APM™ technology has been developed for achieving reduced phaco energy measured as Effective Phaco Time (EPT), an increased followability and anterior chamber stability. Results of this study in 48 eyes show that even in very hard cataracts EPT was significantly lower using moderate U/S power. Followability and holdability were excellent and with superior phaco efficiency no chatter or repulsion was noticed which is essential for effective chopping. As a consequence, less loss of endothelial cells and faster visual recovery can be expected.

Introduction

Hard nuclei are one of the major challenges for cataract surgeons. Besides the difficulties with the capsulorhexis due to the lack of a good red reflex and low visibility during nuclear emulsification, the higher density and volume of the nuclear material requires greater ultrasound power and time which might result in undesirable endothelial cell loss.

Interrupted phaco modes, improved pump systems, chopping techniques, and vacuum-assisted processes are some technological optimizations introduced in the currently available phaco systems that allow the clinician to reduce the amount of energy needed to remove cataract and therefore the potential risks associated [1].

A new ultrasound modulation, the APM™ has been developed by ZEISS. The APM™ is an intelligent way of automatically combining the burst and the pulse patterns in each modulation cycle which supports chop technique extremely well by impaling the nucleus with the power of the burst and removing the quadrants with the speed of the pulse. APM™ can also be programmed for efficient sculpting in Divide & Conquer techniques.

The objective of the current study was to evaluate effective phaco time (EPT), U/S efficiency, followability and holdability especially in hard nuclei using the VISALIS 500 Family phaco system with the new APM™ mode.

Methods

Patients:

In this prospective consecutive study, 48 cataractous eyes of 30 patients undergoing cataract surgery through 2.2 mm or 1.8 mm corneal incision were included. The inclusion criteria of this study were patients of 45 years or older and presence of a senile cataract. Nuclear density was quantified according to a scale from 1 to 5. The exclusion criteria were patients with glaucoma, corneal opacities, cornea guttata, abnormal iris, macular degeneration or retinopathy, previous posterior segment surgery, neurophthalmic disease, or history of ocular inflammation.

Surgical procedure

All surgeries were performed by the same surgeon (Dr. Prasad from India) using a small/micro-incision sutureless coaxial phacoemulsification technique. The phaco system VISALIS 500 Family from ZEISS was used in all cases for the phacoemulsification procedure. Two different ultrasound modes were utilized and their use was assigned randomly to each eye included in the study. Two groups were differentiated for phacoemulsification: a group of eyes with Normal Phaco Mode (Table 1) and a group of eyes with ultrasound APM™ mode. Emission in the Normal Mode was Pulse 40 Hz and in the APM™ group it was the APM™ set to the surgical technique. A moderate U/S power was used with both modes of ultrasound modulation.

Settings	Normal Phaco Mode	APM™ Mode
Equipment U/S-2		
IVP (cm^2 H_2O/mmHg)	109	109
Vacuum/Mode/Pump	240-260FV	240-260FV
Power/Mode	40-55L	40-55L
Emission	Pulse 40 Hz	APM™
Equipment I/A1		
IVP (cm^2 H_2O/mmHg)	109	109
Vacuum/Mode/Pump	350	320-325

Table 1. Phaco settings used in Normal Phaco Mode and APM™ Mode
Abbreviations: U/S, ultrasound; IVP, intraventricular pole; FP, fixed peristaltic; L, linear; FV, fixed venturi; LV, linear venturi.

Examination protocol

Intraoperatively, the following parameters were monitored and recorded: total phaco time, effective phaco time (EPT), total surgery time. Likewise, the following variables were assessed by means of a subjective scale ranging from 1 to 6 (1: excellent, 2: very good, 3: good, 4: normal, 5: bad, 6: very bad).

Statistical analysis

SPSS statistics software package version 19.0 for Windows (IBM, Armonk, NY, USA) was used for statistical analysis. Normality of all data samples was first evaluated by means of Kolmogorov-Smirnov test. When parametric analysis was possible, the Student t test for unpaired data was used for comparisons between groups. On the contrary, when parametric analysis was not possible, the Mann-Whitney test was used for the comparison between groups, using in all cases the same level of significance ($p<0.05$). Furthermore, an additional analysis was performed using the same statistical protocol to compare the performance of the APM™ and Normal Phaco Modes in eyes with hard or advanced cataract (grade 4 and 5) and in eyes with incipient or moderate cataract (grade 1 to 3).

Results

Mean nuclear density was 3.0 in the Normal Phaco Mode group and 3.2 in the APM™ group on a scale from 1 (low density) to 5 (high density) with the hardest cataract being grade 5.

Mean EPT was significantly longer ($p<0.001$) with the Normal Phaco Mode (Mean: 13.0; Standard deviation, SD: 6.0; Median: 12.0; Range: 6.0 to 28.0 s) compared to the APM™ mode (Mean: 6.0; Standard deviation, SD: 3.0; Median: 6.0; Range: 1.0 to 12.0 s) (Figure 1). Therefore, the APM™ mode reduced the EPT by 53.9% in the overall sample, by 63.6% in cataracts grade 4-5, and by 72.7% in cataracts grade 1-3. Likewise, total phaco time was also significantly longer with the Normal Phaco Mode in comparison with the new APM™ mode ($p=0.04$) (Figure 1). A significant difference in EPT as well as in total phaco time between APM™ and Normal Phaco Mode was also observed in the subgroups of eyes with hard (grade 4 and 5) (EPT $p<0.01$; Total phaco time $p=0.02$) and incipient to moderate cataract (grade 1 to 3) (EPT $p<0.01$; Total phaco time $p<0.01$) (Figure 1).

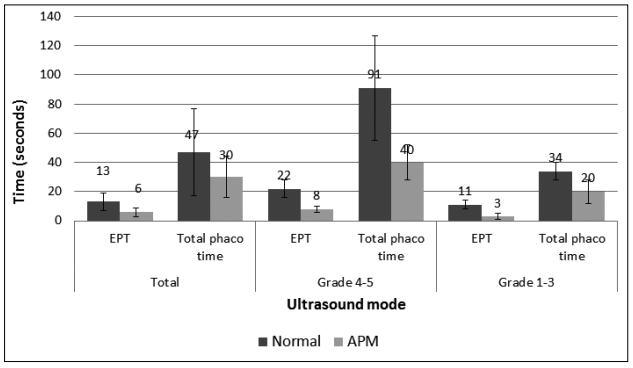

Figure 1. Comparison of effective phaco time (EPT) and total phaco time with Normal Phaco Mode and APM™ Mode of the VISALIS 500 Family phaco platform.

Figure 2 summarizes the results of the subjective assessment of the surgical procedure. As shown, all variables evaluated were found to be significantly better with the APM™ mode compared to the Normal Phaco Mode (followability $p<0.001$, holdability $p=0.001$, anterior chamber stability $p<0.001$, and U/S efficiency $p<0.001$), considering that the subjective scale used ranged from 1 representing an excellent outcome to 6 representing the worst result. Mean score for total performance was also significantly better ($p<0.001$) with the APM™ mode (Mean: 1.00; Standard deviation, SD: 0.00; Median: 1.00; Range: 1.00 to 1.00 s) compared to the Normal Phaco Mode (Mean: 2.68; Standard deviation, SD: 0.55; Median: 3.00; Range: 2.00 to 4.00 s).

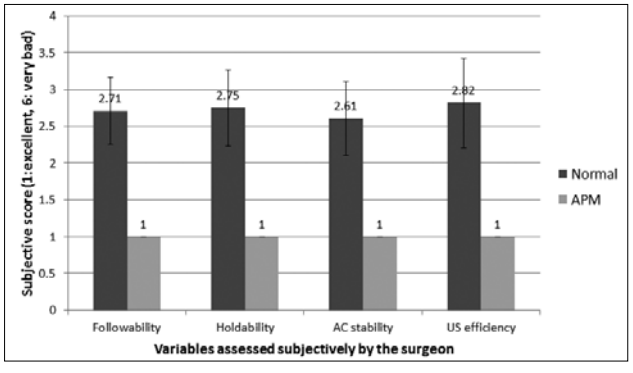

Figure 2. Comparison of followability, holdability, anterior chamber (AC) stability and U/S efficiency assessed by the surgeon with Normal Phaco Mode and APM™ Mode of the VISALIS 500 Family phaco platform.

Discussion

Longer absolute phaco time and higher cataract density have been shown to be independent predictors for endothelial cell loss [2]. Furthermore, the reduction of the EPT has been shown to be in relation with a higher percentage of postoperative clear corneas and better uncorrected visual acuity [3]. In our study we could show extremely short EPT and total phaco time with the new APM™ system, even in very hard cataracts. This seems to be related to the new ultrasound modulation which provides the efficiency of the Burst to impale the nucleus and speed of pulse to remove quadrants. The reduction in phaco time promotes a more significant protection of the corneal endothelium and anterior chamber stability. Indeed, higher percentages of clear postoperative corneas were observed clinically one day after surgery. Therefore, the performance in terms of surgical time was superior with the new APM™ mode of ultrasound modulation for phacoemulsification.

The function of followability is to bring free nucleus fragments close to the phaco tip for continuous and smooth progressive emulsification and aspiration. A high level of followability implies less turbulence in the anterior chamber and less stress on the internal structures of the eye, resulting in a high level of capsular bag safety and an overall increase in phaco efficiency. In the current series, followability was scored as excellent with the APM™ mode in all cases whereas it was scored as good on average with the Normal Phaco Mode.

The better followability and the reduced phaco time achieved with the APM™ mode were the main factors leading to the higher level of anterior chamber stability observed in our study, even in the rather dense nuclei found in the current study. This better followability is also an advantage in terms of posterior capsule safety because there is less movement and turbulence in the anterior chamber. The average anterior chamber stability was scored as excellent with the APM™ mode in all cases and good on average with the Normal Phaco Mode.

Besides followability, holdability was also evaluated, which represents the force with which the nuclear fragment is firmly attached to the phaco tip and which depends, among other factors, on the geometry of the phaco tip. As happened with followability and anterior chamber stability, a better scoring was obtained with the APM™ mode compared to the Normal Phaco Mode. This improved holdability is a result of the excellent followability resulting in reduced turbulences in the anterior chamber, lack of chattering of the fragments and high vacuum efficiency.

Other studies showed similar outcomes with the new APM™ system. Mehta [4] was able to perform faster surgeries with shorter phaco times, better followability and holdability promoting a faster postoperative visual stability. A study of Talal [5] showed that EPT was reduced across all grades of cataract and followability was improved. Koerber [6] found clear corneas without any hydration marks in all eyes. He reported on excellent fluidics and cutting along with a significantly reduced U/S power and a very high speed of surgery.

Conclusion

In conclusion, the new APM™ U/S mode of the VISALIS 500 Family phaco platform brings phaco efficiency to a new level, especially in hard cataracts. Significantly reduced EPT and total phaco time shall result in less endothelial cell loss and faster visual recovery. Even in the hardest cataracts, EPT was much lower. The new system provides excellent followability without chatter or repulsion and excellent holding, both being essential for effective chopping.

References

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Surgeries performed using
ZEISS VISALIS 500 Family system.