·Clinical Research·

Blood pressure change during phacoemulsification and femtosecond laser-assisted cataract surgery

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Received: 2015-11-28 Accepted: 2016-05-06

Abstract

• AIM: To evaluate blood pressure (BP) changes during phacoemulsification (PC) and femtosecond laser (FSL)-assisted cataract surgery.

• METHODS: A retrospective chart review was performed for all patients who received traditional phacoemulsification surgery (PC group) and FSL-assisted cataract surgery (FS group) from July 2013 to December 2014. Totally 206 eyes from 133 patients receiving the two types of procedures were included. Patient characteristics (age, gender, and hypertension history), pre- and post-operative BPs were collected.

• RESULTS: The pro-operative systolic and diastolic BPs (mm Hg) were 124.89±20.48 *vs* 126.98±16.85, and 71.88±9.81 *vs* 73.56±10.03, in PC and FS groups, respectively. While the post-operative systolic and diastolic BPs (mm Hg) were 130.13±22.59 *vs* 134.77±17.52, and 73.41±11.62 *vs* 78.89±12.2, in PC and FS groups, respectively. Paired-sample *t*-tests showed obvious systolic and diastolic BP elevations in FS group after surgery (P=0.001 and 0.007) and no reliability in PC group (P=0.094 and 0.359). A linear regression model revealed systolic and diastolic BP elevations, which were related to longer surgical times for FS group (P=0.008 and 0.021). Age, gender, and hypertension history were not correlated with blood pressure elevation in either group.

• CONCLUSION: BP increases but at a limited level after FSL-assisted cataract surgery compared to traditional phacoemulsification

• KEYWORDS: cataract surgery; blood pressure; femtosecond-assisted cataract surgery; phacoemulsification
DOI:10.18240/ijo.2016.11.12

Lin HY, Tung CJ, Xu GX, Wang CC, Chen HY, Chuang YJ, Li WF, Lin PJ. Blood pressure change during phacoemulsification and femtosecond laser-assisted cataract surgery. *Int J Ophthalmol* 2016;9(11):1614-1618

INTRODUCTION

The femtosecond laser (FSL) is useful in ocular surgery due to its ultrafast pulses (in the range of 10^{-15}s) and low energy requirements for tissue destruction, allowing for minimal unintended destruction of the surrounding tissues[1-3]. While the FSL was previously FDA-approved for use in lamellar corneal surgery, the modality was approved in 2010 for cataract surgery. Preliminary data for FSL-assisted cataract surgery have demonstrated safety and efficacy, and possible advantages over conventional cataract surgery, such as improvements in anterior capsulotomy, phacofragmentation and corneal incision.

Variations in blood pressure (BP) are affected by the patient's state of health, age, surgical techniques and the surgeon's skills. Elevations of BP have been associated with complications such as suprachoroidal haemorrhage and can cause mortality from stroke or even myocardial infarction. Additional surgical time is required for FSL-assisted cataract surgery compared with traditional phacoemulsification and this longer surgical time may be a risk factor for changes in BP. Despite several studies of cataract surgery have examined the perioperative anxiety-related BP changes[4], but FSL-assisted cataract surgery was rare. We evaluated the changes in BP of patients undergoing FSL-assisted cataract surgery and traditional phacoemulsification. Moreover, although there are several studies indicate that less effective phacoemulsification time is needed to emulsify the crystalline lens following pre-cut of fragmentation by the femtosecond laser [5], longer surgical time was needed in FSL-assisted cataract surgery, which may be a risk factor for BP elevation.

SUBJECTS AND METHODS

A retrospective chart review was performed for all patients who received traditional phacoemulsification surgery (Alcon Infiniti System) and FSL-assisted cataract surgery (Alcon-LenSx, combined with Alcon Infiniti System) during the period from July 2013 to December 2014. One hundred and thirty-three patients representing 206 eyes receiving the two types of procedures were included. To minimize sampling variability, cases may extend the operating time directly, or potentially uncontrollable surgical condition, such as the pupil size less than 2-3 mm diameter after mydriatic used, high myopia, zonular weakness and fragile suspensory ligament, posterior polar cataract, nystagmus, anterior segment structures deformity such as synechiae and history of ocular trauma were excluded from analysis. These status leads more steps in the operation procedure, and influences calculation of operation time. We set the sample filter criteria of study data enrolling, and exclude situations as mentioned above.

All surgeries were conducted without incident by the same surgeon (Lin HY) with the implantation of different intraocular lens under topical anesthesia. Mydrin-P (0.5% Tropicamide mixed with 0.5% Phenylephrine) was prescribed 30min before surgery. Patient characteristics (age, gender and hypertension history), pre-operative BP, and post-operative BP were collected before surgery 30min and after surgery 5min. Informed consents were obtained from the patients prior to participation in the study. All patients signed after reading the informed consents and understanding the purpose of the study, even no any stipend. To ensure that patients already prohibited drink coffee, smoke cigarettes, or engage in strenuous exercise for 60min before BP measurement, and for 5min before measurement, patients sit upright in a chair with one's feet flat on the floor and with limbs uncrossed. The same arm and sit positions be used for all measurements, either pre- or post-operatively. During the surgery, the intraoperative parameters of LenSx, corneal incision parameters were three plane of main incision (6 μJ) and 0.9 mm width side port incision (5 μJ); continuous curvilinear capsulorhexis (CCC) diameters was 5.0 mm by energy 6 μJ; The nucleus pre-cutting use the cross pattern in two cuts with length 5.2 mm and a cylinder by 10 μJ. The intraoperative parameters of the Infiniti System, the phaco power are 90% to 100%, which depending on the grade of the nucleus; vacuum 650 mm Hg, aspiration flow rate of 32 cc/min and bottle height 110 cm. Except for the femtosecond procedure, both of the groups were during same operation in phacoemulsification procedure. Generally, three methods for BP measurement are accepted to diagnose hypertension: ambulatory BP monitoring, office-based BP measurement, and home BP monitoring [6]. Despite advantages of ambulatory BP monitoring, office-based BP measurement will likely continue to be the primary technique for both the diagnosis and management of hypertension in the United States and elsewhere. However, both mercury and aneroid sphygmomanometers are less widely used, the former because of mercury toxicity, the latter because of frequent inaccuracies. The clinician usually selects home BP monitoring devices at a clinic in Taiwan. The advantages of home BP monitoring are its low cost and the fact that it is easy to measure BP immediately before and after surgery. In this study, we used home BP monitoring devices to monitor BP changes.

The BP was measured at the upper extremity with a cuff at a height equal to the level of the patient's heart. BP measurements were taken after the patients had been in a sitting position for five minutes before surgery. This was retrospective study, it has been approval by Taiwan Association of institutional review board (TAIRB), and all collected data were recorded on the period date of availability expiration date.

Statistical Analysis Data analyses were performed by SPSS (SPSS for Microsoft Windows, SPSS Sciences, Chicago, USA). The paired *t*-tests were used for data analysis, and general linear model for analysis of variance and regression were also used.

Table 1 The epidemiological data of cases

Parameters (eye *n*=206)	PC group (*n*=79)	FS group (*n*=127)	*t*; *P*
Patient, *n*	63	71	
Age (a)	64.0	61.6	1.390; 0.167
Gender (M/F)	29/34	33/38	0.006; 0.941
Hypertension history (Y/N)	19/44	23/48	0.098; 0.754
Surgical time (min)	13.74	25.48	6.654; 0.000[a]

FS group: Femtosecond laser-assisted cataract surgery group; PC group: Patients receiving the traditional manual phacoemulsification. [a]*P*<0.05.

RESULTS

This study enrolled 206 eyes of 133 patients, receiving two types of surgical procedures were included. In one patient, right eye was treated with traditional phacoemulsification surgery, and the left eye, with FSL-assisted cataract surgery. The average age of the patients was 62.6y; 41 patients (80 eyes) in the study had a history of hypertension and 35 patients (68 eyes) of them received control *via* regular medications. Totally 79 eyes of 63 patients received traditional phacoemulsification surgery (PC group) and the other 127 eyes of 71 patients received FSL-assisted cataract surgery (FS group). There are three patients did not receive regular medication control in PC group and four patients in the other group. The average surgical time was 13.74min in tPC group and 25.48min in FS group. There were no significant differences overall between the two groups, but among surgical time of FS group showed significantly greater than PC group (Table 1).

Table 2 The comparisons of SBP and DBP before and after surgery in two groups $\bar{x} \pm s$ (range); mm Hg

Parameters	Pre-operative	Post-operative	Differences	*t*; *P*
PC group (*n*=79)				
SBP	124.89±20.48 (82, 167)	130.13±22.59 (85, 165)	5.24±17.72	1.716; 0.094
DBP	71.88±9.81 (52, 92)	73.41±11.62 (42, 90)	1.54±10.52	0.926; 0.359
FS group (*n*=127)				
SBP	126.98±16.85 (86, 161)	134.77±17.52 (96, 177)	7.79±16.67	3.363; 0.001[a]
DBP	73.56±10.03 (50, 94)	78.89±12.2 (33, 98)	5.33±13.02	2.805; 0.007[a]

FS group: Femtosecond laser-assisted cataract surgery group; PC group: Patients receiving the traditional manual phacoemulsification; SBP: Systolic blood pressure; DBP: Diastolic blood pressure. [a]P<0.05.

Table 2 showed the comparison of pre- and post-operative values in the two groups. In PC group, the average pre-operative systolic BP and diastolic BP were 124.89 mm Hg and 71.88 mm Hg; post-operative systolic BP and diastolic BP were 130.13 mm Hg and 73.41 mm Hg. In the FS group, the average pre-operative systolic and diastolic BP were 126.98 mm Hg and 73.56 mm Hg; post-operative systolic and diastolic BP were 134.77 mm Hg and 78.89 mm Hg, respectively. To compare the BP parameters between two groups, we also found significant greater post-operative diastolic blood pressure in FS group (P=0.043).

Further, paired t-tests (Table 2) showed obvious systolic and diastolic BP elevations after FSL-assisted cataract surgery (P=0.001 and 0.007) and no reliability in PC group (P= 0.094 and 0.359). A linear regression model revealed systolic and diastolic BP elevations, which were related to longer surgical times for FS group (P=0.008 and 0.021). Besides, age, gender, and hypertension history were not correlated with BP elevation in either of the two groups.

DISCUSSION

The new FSL procedure may be safer than traditional manual procedures. This technique is able to decrease potential superfluous pressure within the capsular bag caused by entrapped gas created during the femto-dissection and the rush of fluid needed to accomplish hydrodissection. The FSL procedure also has the potential to reduce tears and rents of the capsular bag [3]. The safety and efficacy of FSL-assisted cataract surgery has been demonstrated in several previous studies, with improvements in anterior capsulotomy, phacofragmentation and corneal incision. However, these studies had limitations such as fluctuations of vital signs and painful sensations during surgery. These may have been factors resulting from elevations of BP. Long-term studies to compare the complication rates and visual outcomes between the laser and conventional cataract surgery are warranted.

Hypertension is the most common and most important risk factor for ischemic stroke, the development of intracerebral hemorrhage, chronic kidney disease, and end-stage renal disease[7-8]. The risk of heart failure increases with the degree of BP elevation [9-10]. Prehypertension is defined as a systolic BP of 120 mm Hg to 139 mm Hg or a diastolic BP of 80 mm Hg to 89 mm Hg. National estimates show that 27 million women and approximately 42 million men in the United States may have prehypertension [11-12]. Evidence is growing that people with prehypertension have more cardiovascular risk factors and cardiovascular events compared with those with normal BP [13-15]. Even patients suffering from prehypertension before surgery, BP elevation during surgery still increased risks of intracerebral hemorrhage and acute myocardial infarction.

In previous studies, BP elevations seem to be more prevalent in those individuals with higher levels of anxiety and elevation of systolic BP is more significantly influenced by anxiety than is diastolic BP [16-17]. Symptoms of anxiety and depression in the national health and nutrition examination survey follow-up study and hostility and depressive symptoms in the coronary artery risk development in young adults were shown to be associated with incident hypertension in previously normotensive persons [18]. Anxiety has been associated with decreased autonomic nervous system function and disrupted sympathetic activity in patients with hypertension[19-22]. Physiological patterns such as elevated cardiovascular reactivity during stress and poor cardiovascular recovery following stress are predictive factors for increased BP levels.

This study showed a greater increase in BP after patients received FSL-assisted cataract surgery, we believe this is due to extra step of laser pretreatment for the femtosecond-assisted procedures. Patients may feel anxious and stressed on a longer surgical times. In high-risk patients, we should monitor closely the intraoperative high BP to prevent perioperative hemodynamic instability. Besides, maybe it is necessary to exclude patients with high potential cardiovascular risk before femtosecond-assisted procedures. A previous study, Norden [23] has reported the FSL corneal surgery, laser-assisted *in situ* keratomileusis (LASIK), he considered the suction ring fixed the eyeball by vacuum, this procedure will be bringing one of the stress factor for patient. In our study, we also observed patients had anxiety during the docking and application of FSL procedure, but these status were only during the slight and very short time, the cardiovascular risk almost can be ignore. Another important point in this study, the BP increase 10-20 mm Hg in amplitude change with FS group, on the other side, this

compared to PC group, the manual corneal incision create, manual capsulorhexis and manual nucleus chopping and cracking, these operative procedure quires additional risk management of intraoperative complications. In brief, this means that the two surgical methods, surgeon needs to be assessed the individual conditions and choose the proper surgical method. Although the aim of this study was not designed to investigate the effect of anxiety on systemic BP, this factor should be taken into consideration since stress is known to elevate BP. As we known, the anxiety also is a kind of stress can affect BP changes, there is a validated questionnaires for measuring patient subjective feelings of anxiety during threatening situation, such as Dutch version of the Spielberger State-Trait Anxiety Inventory (STAI)[24], but there are no effective methods to provide evidence of psychological and physical stress linking to the intraoperative specific surgical procedures details. The anxiety is an emotion, which also affect by many factors such as medical services, doctor-patient relationship, environmental characteristics, patient's individual personality and other subjective factors [24]. Because of these conditions, it is difficult to analysis the relationship between BP and cataract surgery with local anesthesia.

There are two limitations of the study. Firstly, the small number of patients recruited with BP measurements taken by just before and after FSL-assisted cataract surgery and traditional phacoemulsification. It would be good to include monitoring of BP during different stages of the procedure with the involvement of more patients in future studies, and included perioperative monitoring of BP. In addition, BP changes were measured by home BP monitoring device in our study instead of office-based BP measurement. Secondly, we did not investigate the effect of commonly used mydriatic agents. Kenawy and Jabir's study[25] showed that patients who received phacoemulsification under topical 2.5% and 10% phenylephrine doses experienced a significantly rise in systolic BP, and Lambert *et al* [26] also further found the maximal systolic BP rise occurs approximately 10±20min after 10% phenylephrine eye drops. In our study, we administered 0.5% tropicamide and 0.5% phenylephrine 30min before surgery. The influence of these agents on systolic BP may be insignificant. Although the study limitations may cause the bias in results, but according to our study purposes, we believe that the BP changes not only associate with the potential cardiovascular risk factors with cataract surgery, but also include the patient's mental state and even physicians' surgical operation process. This means the overall treatment procedure can be assessed by two time points set of BP measure at pre- and post-operative, respectively. We believe this can be used as a convenient, intuitive, and easy to understand method to evaluate the surgical quality and features, especially of reference value in clinical practices of primary medical institute.

Understanding the variation of BP between FSL-assisted cataract surgery and traditional phacoemulsification and identification of at-risk patients should help to make the procedure safer.

ACKNOWLEDGEMENTS

Conflicts of Interest: Lin HY, None; **Tung CJ,** None; **Xu GX,** None; **Wang CC,** None; **Chen HY,** None; **Chuang YJ,** None; **Li WF,** None; **Lin PJ,** None.

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