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Arterial pressure and heart rate changes in patients during "beach chair position" for shoulder surgery: comparison of the regional and general anesthesia techniques

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Abbreviations:
BCP – beach chair position
GA – general anesthesia
ISB – interscalene block
BP – blood pressure
Bpm – beats per minute

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Abstract

***Background and Purpose**: Patients scheduled to shoulder surgery are placed in a sitting position called "the beach chair position" during the operation. This type of surgery can be performed with two anesthetic techniques: general anesthesia or regional anesthesia (interscalene block). This patient positioning is characterized by changes in heart rate and systemic blood pressure. The aim of this study is to show whether the type of anesthetic technique influence the changes in systemic pressure and heart rate in this particular patient position.*

***Materials and Methods**: Retrospective clinical study with reviewed anesthetic charts and medical documentation of the patients scheduled for elective shoulder surgery. Point measurements of systolic and diastolic blood pressure and heart rate were: before surgery, after the positioning of the anesthetized patient, at the end of the operation (lodging of the patient) and then the lowest recorded pressure and heart rate during surgery.*

***Results:** The study included 66 patients in the sitting position for shoulder surgery. Positioning the patients in the beach chair position for shoulder surgery in a population of patients undergoing general anesthesia in relation to the population of patients treated under regional anesthesia, had a significant effect on the decline in systolic blood pressure ($p<0.001$) and dyastolic blood pressure ($p=0.008$).*

***Conclusion**: Regional anesthesia has proven again to be the superior technique over general anesthesia, including cardiovascular stability in patients subjected to shoulder surgery in the beach chair position.*

INTRODUCTION

Shoulder surgery is a common ortopaedics procedure, more often performed in the sitting position called "the beach chair position" (BCP). This position offers the surgeon a better shoulder joint access and visualisation, especially during shoulder arthroscopy. Nevertheless, this position from the anesthesiologist point of view, carries significant risks for the patient. It is known that positioning the patient which is anesthetised, raises a certain issues related to changes in arterial pressure and pulse regulation *(1)*. General anesthesia (GA) is an attenuating factor for physiological regulating mechanisms due to changes of the body position.

Muscular relaxation as well as analgesia and anesthetic drugs contibute significantly to cardiovascular instability *(2)* related to the modification of the autonomic nervous system activity *(3)*. Positioning the awake patient with interscalene block (ISB) performed, also changes the arterial pressure, because of the postural hypotension and the time needed for autonomic nervous system to adjust. It has been noted that some patients with ISB in BCP also have hypotensive episodes during the surgery, which are sudden and often accompanied with profound bradicardy *(4)*.

This type of surgery can be performed with two anesthetic techniques: general anesthesia with mechanical ventilation or regional anesthesia (interscalene block) with or without sedation. Sometimes, these two techniques can be combined. In this study, we compared two groups of the patients, general and regional anesthetic technique and their influence on the changes of heart rate and arterial pressure due to body positioning required for this type of surgery.

MATERIALS AND METHODS

A retrospective analysis of the medical documentation and anesthetic charts was performed for 66 patients undergoing elective shoulder surgery in the beach chair position. Shoulder arthroscopy was done in 46 patients, and open shoulder surgery in 20 patients. General anesthesia with mechanical ventilation was performed in 21 patients, and interscalene block with or without sedation in 45 patients. Every patient was sedated preoperatively with midazolam, with venous access and standard monitoring established (pulse oximetry, electrocardiography and noninvasive arterial blood pressure monitoring).

Induction to general anesthesia was done with thiopental or propofol and neuromuscular relaxation with vecuronium or rocuronium, with dose adjusted to body weight. After the tracheal intubation, the maintenance of anesthesia was done with sevoflurane (Sevorane , Abbot) or isoflurane (Forane, Abbot) in O_2:N_2O=35–40%:65–60%. Intraoperative analgesia was achieved either with fentanyl or sufentanyl.

Interscalene block was performed under the ultrasound guidance (ALOKA ProSound 3, Hitachi Medical Corporation and Hitachi Aloka Medical Ltd., Tokyo, Japan) with 0,5 % levobupivacaine or 0,75 % ropivacaine, with or without 2% lidocaine added, varying the local anestehetic dosage from minimum of 17 ml to maximum of 30 ml. After the skin preparation with chlorhexidine, the ultrasound guided interscalene block was performed. With ultrasound guidance cervical and brachial plexus nerves were visualised between the scalene muscles and the needle was directed towards with the injection of local anesthetic. After the procedure, sensory and motor blockade were evaluated in 10-minutes intervals (warm, cold, touch, pain, movement). During the operation some patients required additional sedation with midazolam, propofol, fentanyl or sufentanyl, but all of them were breathing spontaneusly during the operation.

Four points for measurement of systolic and dyastolic blood pressure and heart rate were analysed: before surgery, after the positioning of the anesthetized patient to the BCP, at the end of the operation (positioning the patient supine) and then the lowest recorded pressure and heart rate during the surgery. Results are reported as mean ±SD and considered statistically significant at the $p<0.05$. Demographic data were descriptively analysed, whereas BP and heart rate values at dedicated time in study for both groups were compared using Two-way ANOVA repeated measures (RM) and Student's t-test for independent samples for comparison of the lowest recorded values of heart rate and BP. Data were analysed using the statistical program Prism 5.03, GraphPad Software Inc., La Jolla, USA).

RESULTS

The study included 66 patients in the BCP for shoulder surgery. Of these, 34 patients were men and 32 women. ASA I – 15 patients, ASA II – 42 patients, ASA III – 9 patients. In 46 patients shoulder arthroscopy was performed and open shoulder surgery in 20 patients. GA with mechanical ventilation was performed in 21 patient and ISB with or without sedation was done in 45 patients. There are no differences in age, weight, intraoperative fluid intake and duration of the operation between these two groups. The two groups of patients were comparable

TABLE 1

Data from 66 patients in the beach chair position. Values are mean ±SD for age, body weight, fluid intake and the duration of the operation and descriptive for sex, hypertension, smoking, and the need for atropine or ephedrine; * p=0.003, Fischer exact test.

	IBS group (n=45)	GA group (n=21)
Age (years)	53,56 ±9,45	51,48 ±11,29
Sex ratio (F:M)	21:24	9:12
Body weight (kg)	81,40 ±14,86	75,62±16,26
Intraoperative fluid intake (ml)	888,89±317,82	1047,62±218,22
hypertension	20	6
smoking	16	5
need for atropine	8	5
need for ephedrine*	2	7
duration of the operation	46,00 ±16,88	44,52 ±15,16

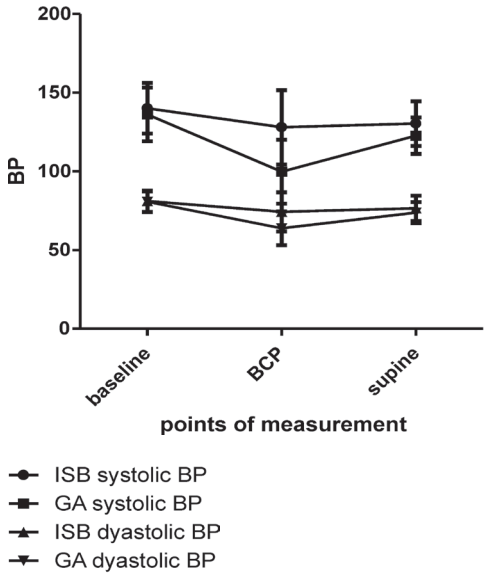

Figure 1. *Comparison of the systolic and dyastolic blood pressure at different points of measurement (baseline, after the positioning of the anesthetized patient in the BCP and at the end of the operation) between the group of patients undergoing GA to the population of patients treated under ISB during shoulder surgery, *p<0.001 (Two-way ANOVA RM)*

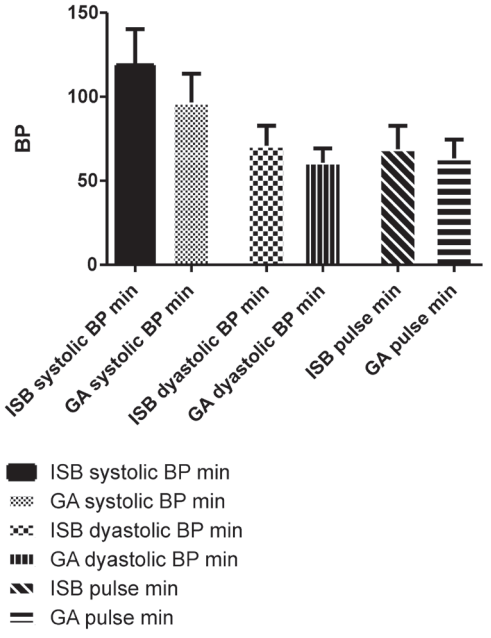

Figure 2. *Comparison between the GA and ISB group regarding the lowest recorded pressure and heart rate during the BCP (*p<0.001; **p=0.001, Student's t-test for independent samples).*

within baseline characteristics. There is a statistically significant difference in the need for ephedrine between groups; the GA group received more ephedrine (Table 1).

When these two groups (GA and ISB) were compared, positioning the patients in the BCP had a significant effect on the decline in systolic blood pressure in a population of patients undergoing GA (99.76 ± 20:28 mmHg) during shoulder surgery in relation to the population of patients treated under ISB (128.00 ± 23.61 mmHg; F (1,64)=14.01, p<0.001, Two-way ANOVA RM; Figure1.). As with systolic pressure, when we compared these two groups, positioning the patient in the BCP had a significant consequence to the dyastolic pressure decrease in the group with GA in comparison to the group with ISB (F (1,64)=7.41, p=0.008, Two-way RM ANOVA; Figure 1.).

Comparing the heart rate values recorded at these four points of measurement, there were no significant difference between groups at any time. (F(1,64)=7.41, P=0.2313, Two-way ANOVA RM). Hypertensive patients were compared with non-hypertensive patients in GA and in ISB group, within the group, and there were no significant difference in BP (both systolic and dyastolic) in any point of measurement, as well as in hypertensive patients compared between the groups.

Comparison betwen the GA and ISB group was done regarding the lowest recorded pressure and heart rate during the BCP . There is a statistically significant difference between the GA and ISB group with both, systolic (t (64) = 4.125, p=0.000) and dyastolic pressure t(64) = 3.429, p=0.001 (Student's t-test for independent samples). There is no statistically significant difference in heart rate between these two groups (t(64) = 1.566, p=0.122, Student's t-test for independent samples) as shown in Figure 2.

DISCUSSION

This study demonstrates significant changes in the blood pressure variations observed during the elective shoulder surgery in BCP, between the two groups of patients (regional or general anesthesia). Patients in this particular position during the surgery are prone to hypotension due to venous pooling and postural hypotension. General anesthesia has a tendency to blood pressure and heart rate variations due to the blunting of the sympathetic nervous system. But, it is not always so easy to find the balance between avoiding too harmful surgical stimuli and keeping the protective role of the sympathetic nervous system for patients.

It is very well known that peripheral nerve blockade offers more cardiovascular stability that general anesthesia, which is again proved in our study. That is not entirely true. There are numerous reports of vehement, profound bradycardia and hypotension which can progress to cardiac arrest *(4),* particularly in patients during shoulder surgery in BCP performed in ISB. This is called the Bezold-Jarisch reflex, and there are many attempts to explain this event. Some authors however doubt that the-

se dramatic events are related to this reflex *(5).* There are some possible explanations in the recent literature related to this occurence: adverse effects of interscalene brachial plexus block, vasovagal syncope, carotid sinus hypersensitivity or orthostatic syncope. Other proposed mechanisms to explain the bradycardia, hypotension, and peripheral vasodilation are that this triad is mediated by activation of some inhibitory reflexes, which have origin with cardiac sensory receptors which leads to stimulation of the parasympathetic and inhibition of the sympathetic activity. This vasovagal reaction could be related to venous pooling (because of the sitting position and epinephrine-induced beta-adrenergic effect) and increased heart inotropy (also beta-adrenergic effects of epinephrine). Epinephrine may be released endogenously due to the reduced venous return and carotid baroreceptor stimulation, or exogenously from epinephrine sometimes administered by the surgeon due to wound infiltration or via the irrigation solution. An empty hypercontractible ventricle, due to increased sympathetic tone, causes stimulation of intramyocardial mechanoreceptors C fibers, withdrawal of sympathetic outflow induces vasodilation and vagal overbalance which leads to bradycardia and hypotension and may be then followed by syncope *(3).* In this study four patients in IBS group had this sudden bradycardia or hypotension. They were all treated with atropin, two of them required repeated doses and one patient lost consciousness, so he had to be intubated. After the operation they all recovered without any neurological deficits.

Questions are raised about the influence of hypotension on cerebral perfusion in these patients during the BCP *(6)* Many authors suggest the additional monitoring in the perioperative period for cerebral perfusion and oxygenation *(7)* in order to anticipate and prevent possible brain damage *(5).*

There are also some proposed maneuvers how to attenuate these events: slowly increasing the angle of the operating table for the elevation in the BCP, allowing the time for the cardiovascular system adaptation. Several studies have shown that if blood vessels can be compressed from the outside (using tight compression garments or military anti-shock trousers), the abnormal heart rate and BP changes can be reduced or eliminated. Surgeons often ask for help from anesthesiologist to induce hypotension for better visualisation and bleeding control, but the safer option is to raise the arthroscopic pump pressure, rather than risk the inadvertent cerebral hypoxia. There is also an issue on blood pressure measurements: how and where to measure the arterial blood pressure in patients which are positioned in BCP. Some authors suggest that measurements should be performed at the level of the brain, for that purpose, because of the large hydrostatic gradient existing between the brain and the site of BP measurement *(1, 8).* According to them, there is a decrease of approximately 2 mm Hg for every inch (2,54 cm) of height difference between the blood pressure cuff and the brain. So, the conclusion drawn from this is that a blood pressure measurement taken with cuff at brachium does not accurately reflect the actual values at the brain level *(9).*

There are some limitations regarding to this study: the major drawback is its retrospective character following different medications used in different dosages, unequal number of participants between the groups and credibility of the recorded BP and heart rate data in the anesthetic medical chart.

To conclude, the regional anesthesia has proven many times to be superior technique over GA during the whole perioperative period for many reasons, including: cardiovascular stability, analgesia, faster recovery and fewer complications. With ultrasound guidance and direct visualisation of the nerves potential neurological damage is minimal. Even though, during the shoulder surgery in the BCP, both in GA or ISB, one must be careful, due to events described in this paper. Monitoring the regional cerebral oxygen saturation in patients undergoing shoulder surgery in the upright (BCP) position, could be an useful tool during routine anesthesia management in order to prevent possible catastrophic events.

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