Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 4 Issue 6 June 2021

Research Article

The Influence of Prone Position on Hemodynamic Function in Patients with Vertebrogenic Pathology

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Received: April 19, 2021

Published: May 06, 2021

Abstract

Introduction: A significant amount of surgeries, especially orthopedic, are provided in prone position. This position is accompanied by some physiologic changes, that may lead to complications during anesthesia and surgery. Postural hemodynamic reactions are well-known but their dependencies on anthropometrics are still not fully studied.

Aim: To study the influence of body mass index (BMI) and age on hemodynamics of patients after turning them from supine to prone position.

Materials and Methods: We examined 200 people with vertebrogenic pathology 18 - 75 yo; 118 male and 82 female. In group A there were people with BMI ≤ 25 kg/m^2 and in group B - people with BMI > 25 kg/m^2. Hemodynamics (blood pressure, peripheral vascular resistance, stroke volume) were examined by impedance thoracic rheography in supine position, in prone position 5 min after turning and in prone position 20 min after turning.

Results: It was shown that turning of the patient into prone position leads to statistically significant hemodynamic changes ($P < 0.05$). Peripheral vascular resistance increased by 13,4 ± 3,4% and stroke volume index (SVI) decreased by 14.8 ± 3.5%. These changes were mostly dependent from BMI. In patients with normal BMI, SVI decreased by 11,0 ± 3,0% 5 min after turning and in 20 min it returned to normal range. In obese patients SVI decreased by 18,3 ± 3,9% after turning and it did not return to normal range in 20 min.

Conclusion: Compensatory reactions of cardio-vascular system after turning to prone position depend on age and BMI. Dependence on BMI is more significant and anesthesiologist should be aware of these changes when planning anesthesia in prone position.

Keywords: Body Mass Index; Hemodynamics; Prone Position

Background of Study

Significant amount of spine procedures are performed in prone position. Data about hemodynamic changes secondary to prone positioning of patients are very controversial. Some authors found decreasing of cardiac output in prone position [1,2]. Another investigators did not find any hemodynamic changes [3]. Such data variations may be explained by heterogeneity of patients, different comorbidity and different types of prone position [4]. Significant influences on hemodynamic changes have drugs for anesthesia, as the majority of studies were performed on the anesthetized patients. Waste body weight is known to be a serious risk factor of perioperative morbidity and mortality. Typically, obesity leads to left ventricle hypertrophy with restrictive diastolic dysfunction,

increasing of preload and size of right atrium. We supposed that these peculiarities may influence postural hemodynamic reactions.

Aim of the Study

Aim of the study was to evaluate general principles of hemodynamic changes in patients with vertebrogenic pathology after changing of body position from supine to prone depending on and age.

Materials and Methods

Prospective study was performed in SI "Sytenko Institute of Spine and Joint Pathology NAMS of Ukraine". Two hundred patients aged 18 - 75 yo with degenerative lumbar spine disease were enrolled (Table 1). There were 118 male and 82 female patients. Exclusion criteria were: pain score according to VAS (Visual Analogue Scale) ≥ 4, NYHA (New York Heart Association Functional Classification) > 1, ASA (American Society of Anesthesiology physical status) > 2. According to BMI patients were divided into 2 groups: A - BMI ≤ 25 kg/m^2 and B - BMI > 25 kg/m^2. Increased BMI in all patients of group B was related to obesity.

	BMI, kg/m^2	Age, yo
Group A (n = 79)	23.3 ± 1.8	43.5 ± 12.0
Group B (n = 121)	30.5 ± 3.4	47.2 ± 11.9

Table 1: Demographic data of patients.

Hemodynamic parameters were investigated the day before elective surgery with method of thoracic impedance rheography by method of Kubicek WG [5]. We examined patients in 3 time periods: in supine position (T1), 5 minutes after turning to prone position (T2) and 20 minutes after turning to prone position (T3). Non-invasive blood pressure (BP) measurement was performed by patient monitor Mediana YM6000 (Korea). Obtained data were statistically analyzed by SPSS Statistics for Windows, Version 19.0. We used parametric Student test for normal data distribution and linear regression analysis. Data are presented as mean ± standard deviation.

Results and Discussion

Blood pressure in patients with different BMI

Systolic BP in patients of group A was 124.7 ± 20.6 mm Hg, 125.7 ± 15.9 mm Hg, 123.3 ± 14.4 mm Hg for T1, T2 and T3 examinations respectively without differences between groups. Systolic BP in patients of group B was higher at T2 (p < 0,001) and T3 (p = 0,002), than in patients of group A. Its level was 127.4 ± 13.2 mm Hg, 132.4 ± 14.4 mm Hg (p = 0.02 comparing with T1 level), and 130.8 ± 12.6 mm Hg respectively for T1, T2 and T3 (Diagram 1).

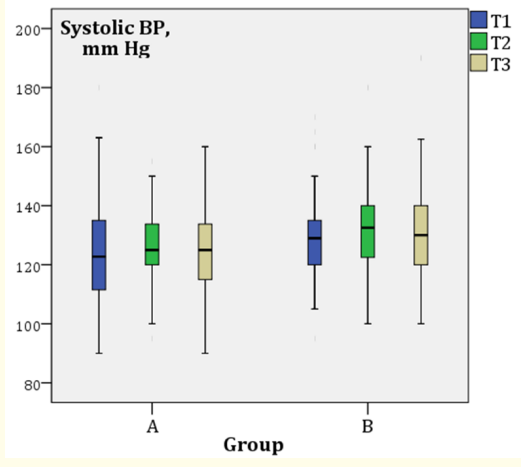

Diagram 1: Postural systolic BP changes in patients with different BMI.

Diastolic BP (Diagram 2) was different significantly in supine position in patients of both groups (77.3 ± 10.0 mm Hg in group A vs 85.0 ± 7.6 mm Hg in group B, p < 0,001). In prone position 5 minutes after changing position diastolic BP increased significantly in patients of both groups (up to 84.3 ± 8.2 mm Hg in patients of group A (p < 0,001) and 90.6 ± 10.6 mm Hg in patients of group B (p < 0,01)). In prone position 20 min after changing position diastolic BP decreased in patients of group A and remained on the increased level in patients of group B (80.3 ± 5.8 mm Hg vs 90.4 ± 10.6 mm Hg).

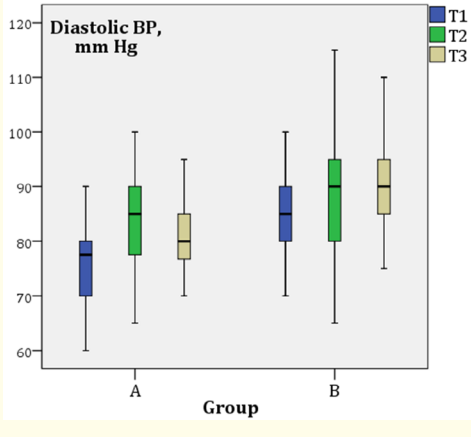

Diagram 2: Postural diastolic BP changes in patients with different BMI.

Mean BP changes were also significantly dependent from BMI (Diagram 3). In patients of group A at T1 stage its level was 93.1 ± 12.8 mm Hg, at T2 stage 98.1 ± 9.2 mm Hg, at T3 stage 94.7 ± 6.2 mm Hg without significant difference between stages. In patients of group B mean BP was higher, than in patients of group A at all stages. At T1 stage its level was 93.1 ± 12.8 mm Hg, at T2 stage 98.1 ± 9.2 mm Hg, at T3 stage 94.7 ± 6.2 mm Hg without significant difference between stages.

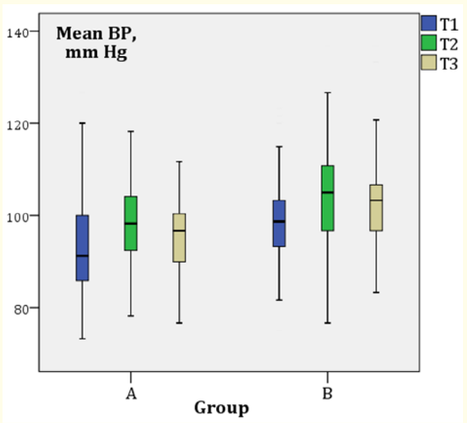

Diagram 3: Postural mean BP changes in patients with different BMI.

Central hemodynamics in patients with different BMI

Stroke volume index (SVI) in patients of group A at stages T1, T2 and T3 was 41.0 ± 5.4 ml/m^2, 35.6 ± 4.7 ml/m^2 and 37.3 ± 5.3 ml/m^2 respectively (Diagram 4). Difference between T1 and T2 stages were statistically significant (p = 0.02). In patients of group B at stage T2 SVI decreased significantly (p < 0.001) to 29.8 ± 3.3 ml/m^2, and it was significantly lower (p < 0.001) than in group A at the same stage. At stage 3 SVI was 30.6 ± 3.3 ml/m^2, and it was still significantly lower, than T1 level (p < 0.001).

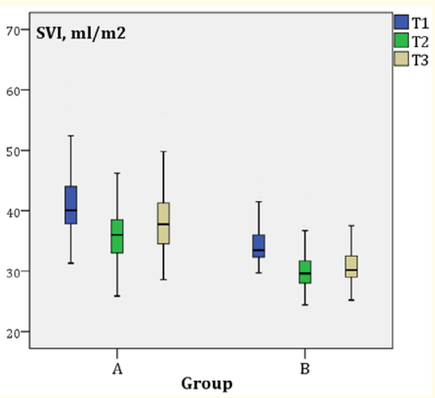

Diagram 4: Postural SVI changes in patients with different BMI.

Peripheral vascular resistance index (PVRI) in patients of group A was 2555 ± 335 din·sec·m^2·cm^5, 2943 ± 595 din·sec·m^2·cm^5, and 2706 ± 442 din·sec·m^2·cm^5 at stages T1, T2 and T3 stages respectively (Diagram 5). Difference between T1 and T2 stages were statistically significant (p = 0.02). In patients of group B PVRI was 3140 ± 476 din·sec·m^2·cm^5, 3616 ± 656 din·sec·m^2·cm^5, and 3575 ± 506 din·sec·m^2·cm^5 at stages T1, T2 and T3 respectively. Difference between T1 - T2 and T1 - T3 stages were statistically significant (p = 0.01 and p = 0.008 respectively).

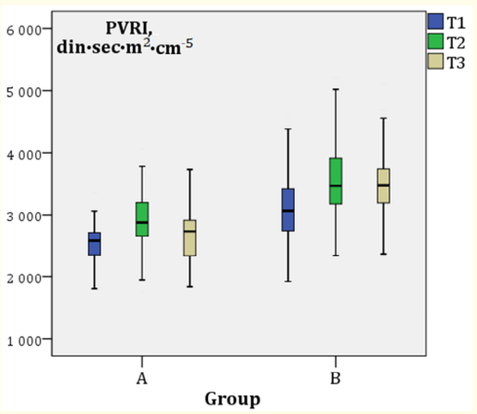

Diagram 5: Postural PVRI changes in patients with different BMI.

Integral reaction of circulatory system in human organism to many external factors, like changing of body position is known to be increasing of simpatico-adrenal activity, leading to increasing of peripheral vascular resistance. According to Frank-Starling law, this requires increasing of myocardial contractility. Healthy myocardium can overwhelm increased vascular resistance and maintain normal cardiac output.

The results of our investigation have shown that hemodynamic postural reactions depend on BMI. We have found that obese people are prone to have increased peripheral vascular resistance. The reasons of this factor are, probably, the same with hypertonic disease, that is typical for such patients. If compensatory reactions of myocardium are satisfactory, than cardiac output may remain in normal range.

In patients with normal BMI turning from supine to prone position leads to increasing of SVRI, but after 20 min its level did not differ from the initial level. In obese patients increased level of SVRI is not fully compensated even after 20 minutes of prone position. The similar dynamics were found in the level of diastolic BP.

We have found, that turning from supine to prone position lead to decreasing of SVI in all patients, but 20 min after turning in nor-

mal BMI patients it did not differ from initial level and in obese patients remained at low level.

Our investigation obtained very similar data with Shimizu M., *et al* [6]. They used SPECT (single-photon emission computed tomography) to assess cardiac function. Authors found decreasing of SVI by 14% after turning from supine to prone position in non-anesthetized people. However, their investigation did not BMI and did not measure SVRI that play important role in postural hemodynamic reactions.

Conclusion

Turning of patients with vertebrogenic pathology to prone position leads to compensatory reactions: increasing of SVRI by 13.4 ± 3.4% and decreasing of SVI by 14.8 ± 3.5%. These changes were significantly influenced by BMI. In patients with normal BMI SVI decreased by 11.0 ± 3.0% and after 20 min restored to initial parameters. In obese patients SVI decreased by 18.3 ± 3.9% and after 20 min it remained at the low level. These reactions should be considered when planning surgery in prone position.

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