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## SCIENTIFIC ARTICLE

### Patient state index and cerebral blood flow changes during shoulder arthroscopy in beach chair position



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#### KEYWORDS

Patient state index;  
Cerebral;  
Cerebral blood flow;  
Beach chair position

#### Abstract

**Background and objectives:** The aim of the study were to demonstrate the possible hemodynamic changes and cerebral blood flow alterations in patients who were positioned from supine to beach chair position; and to detect if the position change causes any cortical activity alteration as measured by the 4-channeled electroencephalography monitor.

**Methods:** 35 patients were included. Before the induction, mean arterial pressure and patient state index values were recorded (T0). After the intubation, doppler-ultrasonography of the patients' internal carotid and vertebral arteries were evaluated to acquire cerebral blood flow values from the formula. In supine position, mean arterial pressure, patient state index and cerebral blood flow values were recorded (T1) and the patient was positioned to beach chair position. After 5 min all measurements were repeated (T2). Measurements of patient state index and mean arterial pressure were repeated after 20 (T3), and 40 (T4) min.

**Results:** There was a significant decrease between T0 and T1 in heart rate ( $80.5 \pm 11.6$  vs.  $75.9 \pm 14.4$  beats/min), MAP ( $105.8 \pm 21.9$  vs.  $78.9 \pm 18.4$  mmHg) and PSI ( $88.5 \pm 8.3$  vs.  $30.3 \pm 9.7$ ) (all  $p < 0.05$ ). Mean arterial pressure decreased significantly after position change, and remained decreased, compared to T1. The overall analysis of patient state index values (T1–T4) showed no significant change; however, comparing only T1 and T2 resulted in a statistically significant decrease in patient state index. There was a significant decrease in cerebral blood flow after beach chair position.

**Conclusion:** Beach chair position was associated with a decrease in cerebral blood flow and patient state index values. Patient state index was affected by the gravitational change of the cerebral blood flow; however, both factors were not directly correlated to each other. Moreover, the decrease in patient state index value was transient and returned to normal values within 20 min.

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**PALAVRAS-CHAVE**

*Patient State Index;*  
Cerebral;  
Fluxo sanguíneo cerebral;  
Posição de cadeira de praia

### ***Patient State Index* e alterações do fluxo sanguíneo cerebral durante artroscopia do ombro em posição de cadeira de praia**

**Resumo**

**Justificativa e objetivos:** O objetivo do estudo foi demonstrar as possíveis alterações hemodinâmicas e do fluxo sanguíneo cerebral (FSC) em pacientes que foram posicionados de supinação para cadeira de praia (CP) e detectar se a mudança de posição causa alguma alteração na atividade cortical como mensurado pelo monitor de EEG com 4 canais.

**Métodos:** No total, 35 pacientes foram incluídos. Antes da indução, os valores da PAM e do IEP foram registrados (T0). Após a intubação, ultrassonografias com Doppler da carótida interna e artérias vertebrais dos pacientes foram avaliadas para adquirir os valores do FSC a partir da fórmula. Em supinação, os valores da PAM, IEP e FSC foram registrados (T1) e o paciente foi posicionado em CP. Após 5 minutos, todas as mensurações foram repetidas (T2). As mensurações do IEP e PAM foram repetidas após 20 (T3) e 40 minutos (T4).

**Resultados:** Houve uma diminuição significativa entre T0 e T1 na FC ( $80,5 \pm 11,6$  vs.  $75,9 \pm 14,4$  bpm), PAM ( $105,8 \pm 21,9$  vs.  $78,9 \pm 18,4$  mmHg) e IEP ( $88,5 \pm 8,3$  vs.  $30,3 \pm 9,7$ ) ( $p < 0,05$  para todos). A PAM diminuiu significativamente após a mudança de posição e permaneceu diminuída em relação a T1. A análise global dos valores do IEP (T1-T4) não mostrou nenhuma mudança significativa, mas a comparação de apenas T1 e T2 resultou em redução estatisticamente significativa do IEP. Houve redução significativa do FSC após o posicionado em CP.

**Conclusão:** O posicionado em CP foi associado à diminuição do FSC e dos valores do IEP. O IEP foi afetado pela mudança gravitacional do FSC; no entanto, ambos os fatores não estavam diretamente correlacionados entre si. Além disso, a diminuição do valor do IEP foi transitória e voltou aos valores normais dentro de 20 minutos.

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**Introduction**

In shoulder arthroscopy surgeries beach chair position (BCP) is often used due to certain advantages<sup>1</sup>: combined with "controlled hypotension", it provides easier anatomic orientation and set-up, better visualization of subacromial space and glenohumeral structures, and it is a better choice than lateral decubitus position for open surgeries. It also provides optimal upper extremity rotation control,<sup>2</sup> and under normal circumstances many patients are operated in the BCP without any serious adverse events;<sup>3</sup> however, when the patients are positioned from supine to BCP under general anesthesia, a marked reduction in cardiac output, mean arterial pressure (MAP) and cerebral perfusion pressure (CPP) can be encountered.<sup>1,2,4</sup>

Following its relative recent introduction into the anesthesia practice, "Monitoring the depth of anesthesia" (DoA) is now becoming an important part of routine anesthesia monitoring. The Sedline electroencephalograph based monitor is one such DoA monitoring options, and is used to monitor the state of the brain by real-time data by processing a 4-channel EEG signals and providing numerical value termed the Patient State Index (PSI). PSI is processed quantitative EEG index to evaluate the degree of consciousness during both general anesthesia and conscious sedation.<sup>5</sup> The sensitivity of the PSI index depends on the neurometrics technology it is using, and it can evaluate both the background EEG and the brain's response to anesthetic agents.<sup>6-8</sup> Some clinical results suggest that there are differences between DoA monitoring devices

(including PSI) in evaluation of neurological data.<sup>6,9</sup> Several studies have shown that changes in both hemodynamic status and cerebral perfusion can affect the accuracy of DoA measurements.<sup>10-12</sup> In a recent study, effects of BCP on the bispectral index have been investigated;<sup>13</sup> however, the relation of BCP and cerebral blood flow (CBF) and their effects on PSI have not been investigated before.

The hypothesis of this prospective study was that BCP with controlled hypotension would cause a parallel decrease both in CBF and the PSI-value. The aims of the study were to demonstrate the possible hemodynamic changes and CBF alterations in patients who were positioned from supine to beach chair position (primary outcome); and to detect if the change from supine to beach chair position (BCP) causes any cortical activity alteration as measured by the 4 channelled sedation monitor (Sedline™) (secondary outcome). As a tertiary outcome we have investigated the time course of PSI and blood pressure.

**Methods**

Ethical committee approval was taken from İstanbul University ethical committee number 2012/1370-1195 and dated 31/08/2012. Sample size was calculated according to the pilot study (including 10 patients) which based the PSI values before and after beach chair position by G Power version 3.1.7. In this pilot study, we have found mean PSI values as  $30\% \pm 6\%$  and  $26.8\% \pm 7\%$  for before and after position respectively. Accordingly the power analysis suggested that at least 30 patients were necessary for 80% power to detect

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