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Research Article

Cerebral oxygen saturation monitoring during hypotensive anesthesia in shoulder arthroscopy: A comparative study between dexmedetomidine and esmolol

Khaled Mohammed Maghawry [a], Ashraf El Sayed El-Agamy [a], Wael Ibrahim Tahir [a,*], Ayman F. Zein [b]

[a] *Department of Anesthesiology, Faculty of Medicine, Ain Shams University, Cairo, Egypt*
[b] *Orthopedic Department, Prince Salman Hospital, Saudi Arabia*

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KEYWORDS

Cerebral oximetry;
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Abstract *Background:* Beach chair position (BCP) is used in arthroscopic shoulder operations for its advantages. The BCP together with deliberate hypotension used to decrease intraoperative blood loss during arthroscopic shoulder procedures, this may have risk to cause postoperative neurological insults. Dexmedetomidine and esmolol are used to induce deliberate hypotension. Near-infrared spectroscopy (NIRS) provides a non-invasive technique of continuous monitoring of regional cerebral tissue oxygen saturation ($rScO_2$). In this study we evaluate the prevalence of $rScO_2$ during hypotensive anesthesia induced by intra-operative infusion of either dexmedetomidine or esmolol in patients undergoing elective arthroscopic shoulder surgery in the BCP.

Patients and methods: Fifty patients scheduled for elective arthroscopic shoulder surgery under general anesthesia with hypotensive technique in BCP, randomly assigned into two equal groups, dexmedetomidine group (D Group) and esmolol group (E Group) according to the drug used for deliberate hypotension. MAP, HR, BIS and rS_cO_2 were recorded before induction of anesthesia T_0, post-induction of anesthesia T_1 as baseline, 5 min after BCP T_2, 5 min after starting the studied drug T_3, 30 min T_4, 60 min T_5, 90 min T_6, 5 min after stopping the studied drug T_7, 5 min after return to supine T_8 and after extubation T_9.

Results: In D group there was significant decrease in $Lt.rs_co_2$ and $Rt.rs_co_2$, at T2 to T7 compared to T1. In E group there was significant decrease in $Lt.rs_co_2$ and $Rt.rs_co_2$ at T2, to T7 compared to T1. In D group two patients had CDEs compared to five patients in E group.

Conclusion: In patients undergoing shoulder arthroscopic surgery under general anesthesia, the BCP significantly decreases rS_cO_2, with further slight decrease of rS_cO_2 with dexmedetomidine

* Corresponding author Address: King Abd EL Aziz Military city, P.O.: 100, Tabuk, Saudi Arabia. Tel.: +996 6557447367.

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and esmolol induced hypotension with no affection of postoperative cognitive function with both drugs. Dexmedetomidine and esmolol are safe drugs with better safety of dexmedetomidine over esmolol.

1. Introduction

In the last decades open anterior stabilization and capsular shift were traditionally considered to be ''mainstay and gold standard'' for anterior shoulder instability, however, most surgeons lately found that arthroscopic anterior stabilization has become the procedure of choice [1].

The beach chair (BCP) and lateral decubitus (LDP) positions are both reliable techniques to perform effective arthroscopic shoulder operations [2]. The use of BCP for shoulder arthroscopic procedures started from early 1980s [3]. The BCP advantages include lack of brachial plexus strain, proper intra-articular visualization, and ease of conversion to an open approach if necessary [4], depending on joint positioning and surgeon training [5].

The BCP in association with deliberate hypotension has been used to decrease intraoperative blood loss and provide a relatively blood-free surgical environment to improve surgical field [6]. However, this combination has the potential to affect cerebral perfusion pressure and oxygenation during surgery and induce cerebral ischemia [7].

Deliberate hypotension can be achieved by using anesthetics, direct acting vasodilators, β adrenergic blockers and calcium channel blockers. However, it may have the risk to cause postoperative neurological insults due to cerebral hypoperfusion [8], so ideal hypotensive agent should be easy administrated in titration without toxic side effect, have short term effect, no change in cardiac performance and maintaining cerbrovascular autoregulation [9].

Dexmedetomidine (DEX) is an imidazole-derivative adrenoceptor agonist representing high selectivity for α_2 adrenergic agonist [10]. It has a sedative, analgesic and induces inhibition of central sympathetic outflow [11]. It specifically stimulates presynaptic α_2 receptors [12] with dose dependent decrease in arterial pressure, heart rate, cardiac output and norepinephrine release [13].

Esmolol is a cardio-selective β_1 blocker characterized by ultra-short half life of about 2 min. Its peak effect starts 6–10 min after IV injection. It is titrated easily with its short clearance time of average 9 min after stoppage of infusion. These special pharmacokinetic properties have led to the successful use of esmolol in deliberate hypotension [14].

The central nervous system (CNS) is considered to be the main end-point of most general anesthetics, however, it remains the least monitored organ during anesthesia [14]. Near-infrared spectroscopy (NIRS) provides a non-invasive technique of continuous monitoring of regional cerebral tissue oxygen saturation ($rScO_2$) [15]. This method has been demonstrated repeatedly to monitor changes in parenchymal and microcirculatory oxygenation of the frontal cerebral cortex reflecting tissue oxygen use [16] as a marker of the balance between oxygen supply and demand [17], which allow for the immediate recognition and management of cerebral desaturation events (CDEs) that would otherwise be undetected with other conventional intraoperative monitoring during procedures with a high risk of adverse neurological outcomes [18].

The aim of this prospective, randomized, double blind study was to compare the prevalence of regional cerebral oxygen desaturation during hypotensive anesthesia induced by intra-operative infusion of either dexmedetomidine or esmolol in patients undergoing elective arthroscopic shoulder surgery in the beach chair position with further detection of the occurrence of postoperative cognitive dysfunction (POCD).

2. Materials and methods

This prospective, randomized, double blind study was conducted in Prince Salman Hospital in Kingdom of Saudi Arabia after obtaining the approval of the ethical committee board of the hospital from February 2013 till December 2013.

A written informed consent was taken from fifty patients American Society of Anesthesiologists physical status (ASA) I or II, 20–55 years old scheduled to undergo elective arthroscopic shoulder surgery under general anesthesia with hypotensive technique in beach chair position (BCP). Based on a computer-generated randomization list, patients were classified into two groups, dexmedetomidine group (D Group) and esmolol group (E Group) according to the drug used for deliberate hypotension during general anesthesia.

Exclusion criteria included, patients with preexisting cerebral pathology (such as previous episodes of cerebral ischemia or stroke), patients clinically apparent to have neurological or cognitive dysfunction, cervical stenosis, cervical disk herniation, documented carotid stenosis, history of serious psychiatric illness, Mini Mental State Examination (MMSE) score of 23 or less and history of orthostatic hypotension, myocardial infarction or uncontrolled hypertension.

Anesthetic management was carefully standardized in all patients in both groups. Patients were premedicated with midazolam IV 0.02 mg/kg after insertion of a 22 G peripheral intravenous cannula 1 h before induction of anesthesia. Upon arrival to the operating room, standard monitoring (Aisys; Datex-Ohmeda, Inc., a General Electric Company, doing business as GE Healthcare, Madison, Wisconsin, USA) was applied; heart rate (HR), non invasive blood pressure, and oxygen saturation (SPO2) were continuously monitored. Standard Bispectral Index (BIS)® electrode montage (Aspect Medical Systems, Natick, MA) was applied to the forehead before induction of anesthesia, and BIS was measured continuously using an Aspect BIS® A-2000 monitor version 3.31 (Aspect Medical Systems).

Patients were actively warmed throughout the procedure using a forced-air warming system (Bair-Hugger, Augustine-Medical, Eden Prairie, MN) to maintain intraoperative normothermia as the esophageal temperature was monitored