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Effect of Scalp Infiltration with Bupivacaine on Early Hemodynamic Responses during Craniotomy under General Anesthesia

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Abstract: The present study was conducted to evaluate the effect of scalp infiltration with Bupivacaine on hemodynamic responses during early stimulation in craniotomy under general anesthesia. Thirty six patients were prospectively randomized to receive Bupivacaine scalp infiltration (B group) or a saline control (S group) as an adjuvant to general anesthesia using isoflurane in 50% N_2O-O_2. Mean Arterial Blood Pressure (MAP) and Heart Rate (HR) were recorded as base line, after scalp incision or pin insertion and then every 3 min until 12 min. The measurements were repeated every 5 min till dura was opened. The mean difference between the two groups for HR during scalp incision or pin insertion was significant ($p = 0.03$). The mean MAP throughout the time intervals of preincision or pin insertion to 12 min postincision and then to dural opening were statistically different between the two groups ($p = 0.001$). No complications related to the technique of block or drugs were recorded. Scalp infiltration with Bupivacaine as an adjuvant to general anesthesia can provide more stable hemodynamics, as measured by HR and MAP changes during early stimulation in craniotomy.

Key words: Bupivacaine, scalp infiltration, hemodynamics, craniotomy

INTRODUCTION

Maintenance of stable hemodynamic responses is essential during anesthesia for neurosurgical procedures. Hypertension and tachycardia are the prominent hemodynamic responses observed during noxious stimulation of the skull. Such stimulation may be the result of scalp incision, skull pin fixation or opening of dura (Agarwal *et al*., 2001; Mathieu *et al*., 2003; Bithal *et al*., 2007).

These increases in blood pressure and Heart Rate (HR) can cause potential morbidity by further increasing in intracranial pressure (ICP) in patients with intracranial pathology. Therefore, a method to blunt these noxious stimuli would be valuable (Pinosky *et al*., 1996; Shiau *et al*., 1998).

Blockade of the scalp by local anesthetic infiltration may be effective in reducing hypertension, tachycardia and the requirement for an increased depth of anesthesia early in the surgical procedure, all of which may cause increased cerebral blood flow and an increase in ICP (Pinosky *et al*., 1996; Lee *et al*., 2006; Bithal *et al*., 2007).

This study was conducted to evaluate the effect of scalp infiltration with Bupivacaine 0.25% on hemodynamic responses during scalp incision or skull pin fixation and craniotomy under general anesthesia.

MATERIALS AND METHODS

This randomized clinical trial was performed in Dr. Shariati Hospital of Tehran University of Medical Sciences from April to August 2008. The study protocol conformed to the ethical guidelines of the 1989 declaration of Helsinki.

After Institutional Ethics committee approval, each patient's informed consent was obtained separately. Thirty six ASA II and III patients with elective supratentorial tumor or Arterio-Venous Malformation (AVM) were included in the study. Patients with a history of hypertension, diabetes mellitus, cardiovascular diseases and convulsion were excluded.

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The patients were randomly assigned to receive either 20 mL Bupivacaine 0.25% (Bupivacaine group, n =18) or 20 mL saline (control group, n =18). Randomization was based on computer-generated codes that were concealed until interactions were assigned.

On arrival in the operating room, ECG electrodes and Non Invasive Blood Pressure (NIBP) monitor were applied and oxygen saturation was monitored by pulse oxymeter. All patients were premedicated with 2 μg kg^{-1} fentanyl and 2 mg midazolam. Anesthesia was induced by thiopental sodium 5 mg kg^{-1} and atracurium 0.5 mg kg^{-1} for tracheal intubation and was maintained with isoflurane 0.6-1.2% and 50% N_2O in oxygen. After intubation, an intra arterial catheter was inserted in radial artery of non-dominant hand of the patient for invasive monitoring of blood pressure. End Tidal volume CO_2 concentration ($ETCO_2$) was monitored by capnograph and maintained between 25-35 mmHg.

Blockade was performed after induction of anesthesia by the surgeon who was blinded to the allocations. For infiltration of local anesthetic, a 23-gauge needle was introduced at a 45° angle to the skin of skull and then was gradually withdrawn with simultaneous injection of solutions throughout the entire thickness of the scalp along the skin incision or pin insertion site. The infiltration of the periostium was also necessary.

Heart Rate (HR) and Mean Arterial blood Pressure (MAP) were measured as base line (before induction of anesthesia), after scalp incision or pin insertion and then every three minutes until 12 min. The measurements were repeated every 5 min till dura was opened.

In all patients with more than 20% increase in HR and MAP compared with baseline, additional administration of the preselected anesthetic supplement (2.5 mg kg^{-1} thiopental and 2 μg kg^{-1} fentanyl) combined with increases in isoflurane dosage for further control of the elevated BP and HR were administered. In cases where the MAP or HR remained persistently greater than 20% above the baseline values despite the intravenous anesthetic supplementation, the isoflurane concentration was carefully increased to maintain arterial hemodynamics as stable as possible (Lee *et al*., 2006).

Statistical analysis: Sample size calculation was based on detection a 15% differences in the hemodynamic responses between the two groups with $\alpha = 0.05$, $\beta = 0.2$ and power = 80%. Normality of distribution was tested by Kolmogorov Smirnov test. Data were analyzed by SPSS version 11.5(SPSS Inc., Chicago,IL). Independent sample t-test and Chi-square were used for comparison of demographic data. Repeated measures ANOVA were used for comparing hemodynamic responses between the study groups. $p<0.05$ was considered statistically significant.

RESULTS

Demographic data and the duration of surgery were not significantly different between the study groups (Table 1) (independent sample t-test and Chi-square). Seventeen patients had supratentorial tumor and one one patient had AVM in each group. Fifteen (83.3%) patients in Bupivacaine group and 17 (94.4%) patients in control group required additional administration of the preselected anesthetic supplement or increase in isoflurane concentration for further control of the elevated BP and HR responses from the onset time of scalp incision to the completion of dural opening (Chi-square, p = 0.28).

Mean time to open dura was 61.33±18 min in Bupivacaine group and 56.33±12.24 min in saline group (independent sample t-test, p = 0.179).

The mean difference between the 2 groups for HR during scalp incision or pin insertion was significant (independent sample t-test, p = 0.03). There were not statistical difference in HR measurements in other intervals between the study groups (independent sample t-test, p>0.05, Fig. 1).

Table 1: Comparing demographic data between the study groups

Characteristic	Bupivacaine group (n = 8)	Saline group (n = 8)
Age (years)*	69.5± 6.5	70.2±11.2
Sex (M/F)	7/11	9/9
ASA (II/III)	11/7	10/8
Duration of operation*(h)	4.68±1.07	5.18±1.82

*Data are expressed as Mean±SD

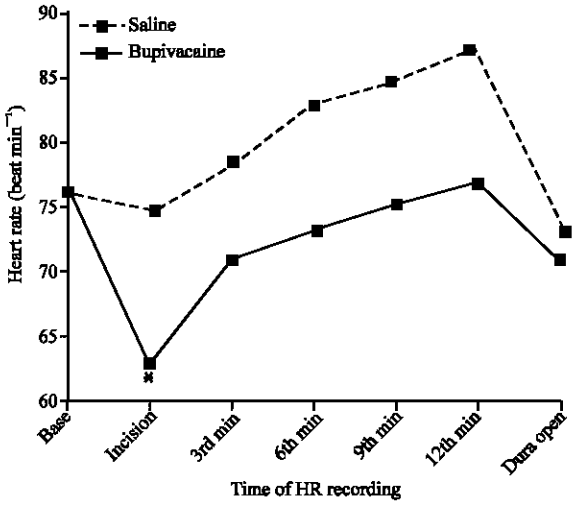

Fig. 1: Comparison of mean heart rate changes between the study groups at different times as base (before induction) incision 3, 6, 9 and 12 min after incision and during dural opening. The mean HR was significantly different between the groups only during scalp incision.*p = 0.03

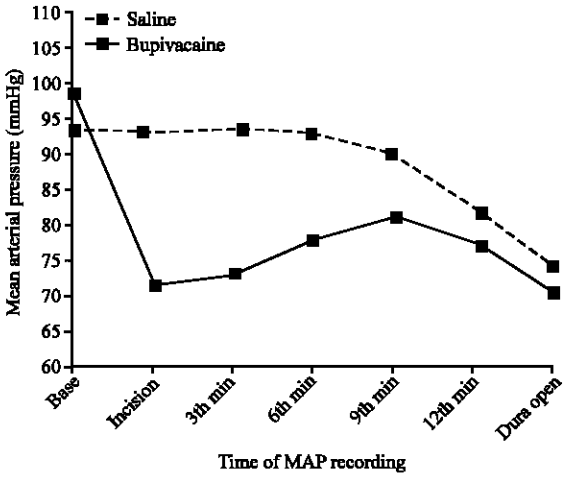

Fig. 2: Comparison of Mean Arterial Pressure (MAP) changes at different times as base (before induction), incision time, 3, 6, 9 and 12 min after incision and during dural opening. The mean MAP throughout the time intervals of preincision to dural opening were statistically different between the groups ($p<0.001$)

The mean MAP throughout the time intervals of preincision or pin insertion to 12 min postincision and then to dural opening were statistically different between the 2 groups (Fig. 2; $p<0.001$). No complications related to the technique of block or drugs were recorded.

DISCUSSION

Acute increases in blood pressure and HR most of which commonly occurred during scalp incision, pin insertion or dural opening, may increase risk for premature rupture of an aneurysm, venous hemorrhage, sudden increase in ICP and worsening brain edema (Murthy and Roa, 2001; Olsen *et al*., 2002).

This study showed that scalp infiltration with 0.25% Bupivacaine as an adjuvant to general anesthesia can provide more stable hemodynamics, as measured by HR and MAP changes during early stage of craniotomy.

In a study by Lee *et al*. (2006) on 16 ASA physical status II and III patients who were scheduled for fronto-temporal craniotomy, the effect of 0.25% Bupivacaine scalp block on alterations in hemodynamics and plasma catecholamine metabolites during general anesthesia were evaluated. They found that Bupivacaine scalp block appeared to be an effective adjuvant treatment for maintaining stable hemodynamics for patients undergoing craniotomy during general anesthesia especially at the time of skin incision and dural opening that was correlated to present study. Although, they can not find any correlation between elevation in hemodynamic parameters and a rise in serum catecholamine levels (Lee *et al*., 2006).

Bithal *et al*. (2007) studied the hemodynamic and bispectral index (BIS) changes in 44 patients undergoing cervical diskectomy with attachment of a Gardner-Wells tong (with two sharp conical pins) to the skull to facilitate intraoperative bone graft insertion. They found that there was an increase in the levels of the hemodynamic parameters and BIS when the skull pins of a Gardner-Wells tong are inserted without local anesthetic infiltration of the scalp; these changes were completely prevented by prior local anesthetic infiltration. Their findings were correlated to present study but we have limitations, like lack of facilities for measuring the plasma catecholamine levels and BIS monitoring (Bithal *et al*., 2007).

Since, all patients were admitted to ICU and did not extubated during first 12 h after operation, we did not evaluate the severity of early post operative pain in these groups of patients. Further study is recommended to evaluate the correlation between BIS, plasma catecholamine levels and postoperative pain in these types of surgeries.

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