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How effective is the local anesthetic infiltration of pin sites prior to application of head clamps: A prospective observational cohort study of hemodynamic response in patients undergoing elective craniotomy

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Abstract

Background: Use of Mayfield clamps is associated with potentially hazardous hemodynamic effects. Use of local anesthetic infiltration has yielded varying results in blunting of this response. The authors' objective was to study the effect of lidocaine with adrenaline infiltration at Mayfield pin sites on hemodynamic response in comparison with no intervention.

Methods: This was a prospective cohort study conducted at a tertiary care center from January 2012 to July 2012. Patents undergoing elective craniotomies over the study period were included and divided in two groups, Group A received lidocaine infiltration of the pin sites prior to insertion, while Group B did not. Hemodynamic response to pin application was then studied at various intervals.

Results: A total of 30 patients were enrolled in each group. The baseline mean arterial pressure (MAP) and heart rate prior to pin placement in Groups A and B were comparable ($P = 0.985$ and 0.313). The MAP at 60 seconds after application of skull pins was significantly different in the two groups; 86.13 (±9.73) mmHg versus 104.03 (±12.95) mmHg ($P < 0.001$). However, the MAP at 30 minutes after application of skull pins in both groups was comparable ($P = 0.585$). The mean heart rate measured at 60 seconds after skull pin insertion in Group A was 78.23 (±7.19)/min while in Group B, it was 103.07 (±6.98)/min, the difference being statistically significant ($P < 0.001$).

Conclusion: Hemodynamic changes due to the application of Mayfield clamps during elective craniotomies can be effectively prevented by prior lidocaine with adrenaline infiltration of the pin insertion sites.

Key Words: Hemodynamics, lidocaine, Mayfield clamp

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INTRODUCTION

Head holders such as the Mayfield head holder, have become an essential part of neurosurgical procedure, especially for brain tumors and vascular lesion. The head is held by the application of metallic pins [Figure 1a and b] deep into the pericranium, a step that has been shown to produce severe noxious stimulation and resulting hemodynamic effects.[7,9,13] Such a change in hemodynamics may be safe for majority of pathologies, however, for patients with ruptured intracranial aneurysms, intracranial hypertension, and/or cardiac premorbids; can be detrimental, especially if the patient has compromised intracranial compliance and auto-regulation, which is often the case.[7,12,13]

Various methods have been employed to blunt these responses including deepening the level of anesthesia, premedicating, infiltration with various types of local anesthetics, etc.[1,2,4-6,8,10,11,13,15-17] However, very little data exists in literature with regard to the hemodynamic response of these methods, or whether these are useful. The present study was carried out to document the immediate, and delayed hemodynamic response of local pin site infiltration. The study moreover compares perioperative anesthetic and analgesic requirements, as well as postoperative pin site complications, in adult patients undergoing elective primary craniotomy.

MATERIALS AND METHODS

The study design was prospective observational cohort, and it was conducted at the Aga Khan University Hospital, from January 15, 2012 to July 15, 2012, after approval from the Ethics Review Committee. Adult patients, undergoing elective craniotomy and cognizant enough for an informed written consent (which was acquired in each case) were suitable for inclusion. Patients undergoing reoperations, or who had significant premorbid conditions, or those on antihypertensive medication were excluded from the study. Figure 2 illustrates the patient selection.

Sample size was calculated using the software STATA (StataCorp LP) version 10, a sample size calculator for two sample means, using statistics from published literature.[3] The power of study was taken as 90% and significance as 5%. The sample size thus calculated was 36, with 18 patients in each group. To increase the strength of the study, the number in each group was increased to 30. Sampling technique was convenient sampling and randomization was not done. The practice of using pin site local anesthetic infiltration prior to applying head clamps is variable within consultants at our institution, which provided an opportunity to group these patients. Patients were therefore grouped on the basis of their operating consultant, and those under Consultant A were categorized as Group A and received pin site infiltration with local anesthetic (details of technique to follow). Patients under Consultant B did not receive any such intervention and were categorized as Group B. Both groups were closely monitored as elucidated ahead. Since this being strictly an observational study and the practices were prevalent prior to the same, hence no new practice was introduced and no patient received any form of management different from the routine, had he/she not been part of this study. All patients were admitted a day before surgery and managed uniformly according to routine protocols including standard anesthetic, nursing, and medical care. Demographic and operative characteristics of patients were recorded on case record form (CRF). Later, during surgery, all standard protocols were similarly followed.

In Group A patients, the pin insertion sites were infiltrated with injection lidocaine containing adrenaline in concentration of 1:1000, 2-3 ml at each pin site underneath the periosteum, 2 minutes before the insertion of pins, while in group B patients, no such infiltration was done. The area of infiltration was not prepared with Povidine–Iodine or any other solution. We would like to once again point out that these practices were part of the routine of the respective Consultants A and B, and as such no new intervention was introduced for the study, apart from a few extra hemodynamic observations. Pin insertion time was taken as the zero (0) hour or MAP0. Mean arterial pressure (MAP) was recorded by a radial artery arterial line 30 seconds prior to zero (0) hour (MAP0), and at 60 seconds after zero (0) hour (MAP60) in both groups A and B. Further readings were recorded at 30 minutes after skull pin insertion. The rest of the operations proceeded as per routine. After surgery, patients of both groups were managed according to the routine standards of care. Postoperative pin site

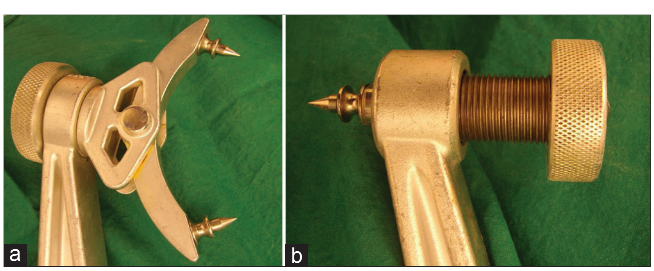

Figure 1: (a and b) Picture of pins on the Mayfield head clamps

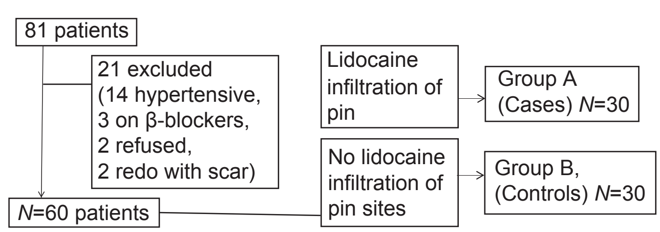

Figure 2: Study sample

pain was measured at 6 hours after extubation, using the Visual Analogue Scale (VAS) score and compared between the groups.

Statistical package for social science (SPSS-IBM v. 17.0) was used to analyze the data. Mean and standard deviation were determined for continuous variables like age, mean rise in the MAP. Proportion as percentages was determined for categorical variables like gender. The two groups were compared for demographic details, and for mean rise in heart rate (HR) and MAP. Chi-square test was applied for comparison between the two groups for categorical variables such as gender, and Student *t*-test was applied for comparison for continuous variables like age and mean rise in the MAP. The differences seen were further evaluated for significance, *P* value less than 0.05 was taken as significant.

RESULTS

A total of 81 patients were considered for the study. Of these, 14 patients were excluded due to hypertension, 3 patients were not hypertensive, but on beta-blockers, 2 patients refused consent for the study, and 2 were to have redo surgery with scar at pin application site, leaving the final sample size of 60. Twenty-seven patients were female and 33 were male. In group A, 17 were male and 13 were female, while in group B, 16 were male and 14 were female ($P = 0.795$). The mean age of patients in Group A was 43.47 (±17.89) years, while in group B was 48.43 (±12.48) years, the difference not being significant ($P = 0.215$). The two groups were compared for their mean baseline HR and MAP, before application of skull pins (HR0, MAP0), and these hemodynamic recordings were comparable [Table 1].

After application of skull pins (with premedication of local lidocaine with adrenaline in Group A and without it in Group B), hemodynamic responses were observed and compared again. The mean of the MAP measured at 60 seconds after skull pin insertion (MAP60) in Group A was 86.13 (±9.73) mmHg while in Group B, it was 104.03 (±12.95) mmHg, the difference being statistically significant ($P < 0.001$) [Table 1]. The difference between the two values of MAP (MAP60-MAP0) was also calculated for each individual patient and the mean of this difference was then compared between the two groups. For group A patients, the value was 3.67 (±8.39) mmHg, while for Group B patients, it was 21.53 (±10.36) mmHg, the difference being statistically significant ($P < 0.001$) [Table 1]. At 30 minutes, the mean MAP was 83.13 (±6.806) mmHg in Group A and 82.20 (±6.338) mmHg in Group B, the difference not being significant ($P = 0.585$).

The mean HR measured at 60 seconds after skull pin insertion (HR60) in Group A was 78.23(±7.19)/min while in Group B, it was 103.07 (±6.98)/min. The difference

Table 1: Comparison between groups A and B for demographics, mean arterial pressure, mean heart rate, and postoperative pain

	Group A (local infiltration)	Group B (no local infiltration)	*P* value
Demographics			
No. of patients	30	30	
Mean age	43.47 (±17.89)	48.43 (±12.48)	0.215
Gender			
Male	17	16	0.795
Female	13	14	
Mean arterial pressure in mmHg			
0 seconds	82.47 (±6.70)	82.50 (±6.75)	0.985
60 seconds	86.13 (±9.73)	104.03 (± 12.95)	<0.001
Rise in 60 seconds (60-0)	3.67 (±8.39)	21.53 (±10.36)	<0.001
15 minutes	82.70 (±6.32)	83.27 (±7.40)	0.484
30 minutes	83.13 (±6.806)	82.20 (±6.338)	0.585
Mean heart rate per minute			
0 seconds	77.23 (±7.23)	79.30 (±8.44)	0.313
60 seconds	78.23 (±7.19)	103.07 (± 6.98)	<0.001
Rise in 60 seconds (60-0)	1.13 (±0.93)	23.77 (±4.87)	<0.001
15 minutes	77.80 (±6.99)	80.00 (±8.27)	0.271
30 minutes	77.63 (±5.13)	80.20 (±7.99)	0.195
Postoperative pin site pain (visual analogue scale score)			
6 hours postextubation	4.70 (±2.2)	4.67 (±2.4)	0.906

between the two groups was found to be statistically significant ($P < 0.001$) [Table 1]. The difference between the two values of HR (i.e. HR60-HR0) was also calculated for each individual patient and the mean of this difference was then compared between the two groups. For group A patients, the value was 1.13 (±0.937)/min, while for Group B patients, it was 23.77 (±4.87)/min, the difference being statistically significant ($P < 0.001$) [Table 1]. At 30 minutes, the mean HR was 77.63 (±7.13)/min in Group A and 80.20 (±7.99)/min in Group B, the difference not being significant ($P = 0.195$). These trends have been shown in Figures 3 and 4. The mean VAS score seen at 6 hours after extubation, was 4.70 in Group A, and 4.67 in Group B patients, also not significant ($P = 0.906$). No immediate or delayed pin site complications such as infection, oozing, swelling, paresthesias, etc., were noticed in either group at more than 2 weeks follow up.

DISCUSSION

The application of Mayfield pins onto the skull involves penetration of the pointed pins through the layers of scalp and into the periosteum, wherein it is locked at a pressure of around 30 lbs in adult patients. The procedure is carried out manually and after application, the entire weight of skull is held by these pins for as long as the surgery lasts. This is obviously a painful procedure and unless the pain is controlled by either local or systemic methods, can potentially lead to a sympathetic response including rise in HR and MAP, which in certain neurosurgical cases, may be dangerous especially if the patient has compromised intracranial compliance and auto-regulation.[12,13] The potential complications of these hemodynamic responses in neurosurgical patients include intracerebral hemorrhage, rupture of intracranial aneurysms, and rise in intracranial pressure, which may lead to cerebral herniation. These complications are thankfully rare.

Lidocaine is a widely used local anesthetic, which when combined with adrenaline, doubles its duration of action due to the vasoconstrictor effects of adrenaline, which limits its systemic absorption. It is easily available, inexpensive, and despite being an antiarrhythmic, when used as a local anesthetic, has very little potential side effects, especially when used with adrenaline. In neurosurgery, the addition of adrenaline also reduces blood loss from the otherwise vascular scalp, which makes this infiltration a common practice, over long scalp incisions. In the present study, we have shown that lidocaine infiltration of pin sites prior to skull pin application significantly blunts the rise in HR and MAP ($P \leq 0.001$) without complimenting with any systemic methods and without causing any wound related or systemic side effects. The effects were not noticeable 30 minutes after the infiltration, and at that point the hemodynamic response had normalized. Previous investigators have also explored these potential benefits of local infiltration and have found that it blunts the hemodynamic response and the rise in cerebrospinal fluid pressure more effectively than that achieved through deepening the level of anesthesia with propofol or thiopentone.[2,5,13,16] Bupivacaine infiltration (another local anesthetic with a relatively longer duration of action) was also found to have similar hemodynamic effects.[4,13,10,15] Use of 2% lidocaine has been shown to be more useful than intravenous fentanyl in terms of ameliorating hemodynamic changes by Zohri *et al*.[17] Combining intravenous fentanyl and local infiltration with lidocaine was reported to produce a better hemodynamic effect than lidocaine alone, although the latter was still more effective than intravenous fentanyl alone.[14] Premedication has also been shown to be important in attenuating hemodynamic response. Agarwal *et al*. described maximum attenuation of the hemodynamic response to pin placement when patients were premedicated with ketamine (0.5 mg/kg) and the scalp was infiltrated with lidocaine.[1] It may be of note here that a few other drugs have also been tried to prevent the hemodynamic

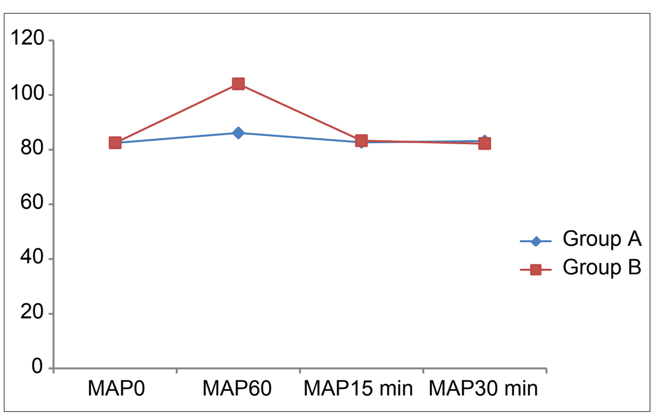

Figure 3: Comparison between Groups A and B for mean of MAP values at 0 second, 60 seconds, 15 minutes, and 30 minutes

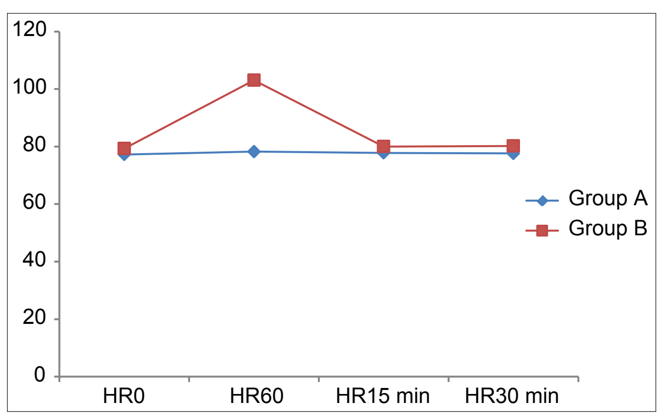

Figure 4: Comparison between Groups A and B for mean of HR values at 0 second, 60 seconds, 15 minutes, and 30 minutes

response to pin insertion, with varying success.[5,6,8,11,16,17] While opioids and clonidine were sometimes shown to prevent this response, they can be associated with relative hemodynamic instability as compared with the lidocaine infiltration.[6,17]

This, to the best of our knowledge, is the first prospective cohort study on this very important topic from Pakistan. Although the sample size was adequate for the purpose there are certain limitations to our study, which could have been improved by incorporation of the following: The methodology could have been improved by randomization of subjects and conducting it in the form of a clinical trial or a case control study. Another group could have been added wherein lidocaine was used alone, without adrenaline, to see which component of the combination is more effective. The anesthetist could have been blinded to the local infiltration to remove bias from recording the hemodynamic responses. Further monitoring of intracranial pressure could also have been employed. These potential improvements to the study design, however, required logistic arrangements and were not possible in our setting without compromising on patient safety. Despite these limitations, the results clearly show the benefit of local infiltration in effectively blunting the hemodynamic response associated with the insertion of skull pins in patients undergoing elective craniotomy, without any anesthetic or systemic premedication. A larger study, with a more heterogeneous case load and incorporation of afore mentioned suggestions, would nevertheless be the step forward.

CONCLUSION

We have shown the association between pin site application and hemodynamic response, and have proven that lidocaine with adrenaline infiltration of the skull pin sites prior to application of pins blunts this response, without any complications. However, similar benefits were not observed at 15 and 30 minutes intervals. We conclude that it is an easy, safe, and effective method, and recommend its standard use for all craniotomies where skull pins are applied.

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