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Original Research Article

INTRAVENOUS DEXMEDETOMIDINE VERSUS BUPIVACAINE SCALP BLOCK IN ATTENUATING THE HEMODYNAMIC RESPONSE TO SKULL PIN HEAD HOLDER APPLICATION IN PATIENTS POSTED FOR NEUROSURGERY: A RANDOMIZED CLINICAL TRIAL

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Abstract

Background: Skull pin application leads to intense noxious stimuli and increase in heart rate, mean arterial pressure, and intracranial pressures. Newer alpha agonists like dexmedetomidine have shown to prolong the analgesic effect when given as additive to regional blocks. Scalp block blocks the afferent for scalp pin holder and thereby reducing the hemodynamic changes. Bupivacaine in prolog the analgesic effect of the scalp block. So we intend to compare intravenous dexmedetomidine and scalp block with bupivacaine in attenuating the hemodynamic responses to scalp pin application. The aim is to compare the efficacy of intravenous Dexmedetomidine infusion with 0.5% Bupivacaine scalp block in attenuating the hemodynamic response, to the skull pin head holder application in neurosurgical patients. **Materials and Methods:** A Randomized clinical trial was designed where sixty patients were selected based on computer generated random numbers of ASA I, II& III posted for elective craniotomy were included. Patients were divided into two study groups Group S(30) –Patients received scalp block with injection Bupivacaine0.5%30mlprior pin application Group D(30)-Patients received intravenous Dexmedetomidine 0.5mcg/kg iv loading dose and 0.25mcg/kg/hr. Hemodynamics are compared at baseline, before induction, after intubation, before pinning and after pinning and every minute for five minutes after pinning. Additional methods and adverse hemodynamics changes were noted between the groups. **Result:** Demographic parameters like age, sex and weight were comparable between two groups. Heart rate (HR) variation between Group S and Group D was comparable. Dexmedetomidine after intubation did not completely attenuate the cardiovascular response. The SBP & DBP & MAP between two groups was comparable Single bolus administration of injection Fentanyl 1mcg/kg was needed in 4/7 patients and increased inhalational concentration was needed in 1/7 patients in Group S, both methods were needed in 2/7 patients in adverse hemodynamic events were comparable. The 0.5% Bupivacaine (Rs 85) was cost effective when compared with the Dexmedetomidine 50mcg/ml (Rs 170) **Conclusion:** It can be concluded that the Scalp block with 0.5% Bupivacaine was better than Dexmedetomidine infusion in attenuating the hemodynamic response to skull pin head holder application in patients coming for neurosurgery.

INTRODUCTION

Neuro surgical trauma or tumors require good exposure depending on the position of the lesion. Craniotomy is needed to remove the tumor or to decrease the intracranial tension. Craniotomy causes severe postoperative pain 86% of which is somatic origin. Due involvement of pericranial muscles and soft tissues. Patients probably had the pain of somatic origin, with the involvement of soft tissues and pericranial muscles.[1] Pain is responsible for increase in oxygen consumption and increased catecholamine release which further lead to increase in intracranial tension further causes damage to brain tissue.[2–4] Pain management improves the outcome and allows early rehabilitation.[5,6] Besides, management of acute postoperative pain can prevent central sensitization and chronic pain states caused by surgical tissue damage.[7,8]

Scalp nerve block blocks the afferent.[9–12] Analgesia could be achieved by blockade of the following nerves: greater and lesser occipital nerves, the supraorbital and supratrochlear nerves, the zygomaticotemporal nerve, the auriculotemporal nerve, and the greater auricular nerve. Scalp block with local anaesthetics played major role in attenuating the hemodynamic effects as well as the sympathoadrenal response to skull pin insertion1. The needle is introduced perpendicularly 1 cm medial to the supraorbital notch for blocking supratrochlear nerve and supraorbital nerve. Zygomaticotemporal Nerve was blocked by injecting point is at the outermost edge of the supraorbital margin and inserted deep to reach the outermost aspect of the zygomatic arch. Auriculotemporal Nerve was blocked by injecting approximately 3ml of LA 1 to 1.5 cm anterior to the ear at the level of the tragus above the level of the temporomandibular joint. The greater occipital nerve can be blocked by infiltrating LA subcutaneously halfway between the occipital protuberance and the mastoid process, 2.5 cm lateral to the nuchal median line. The block is made subcutaneously by injecting 5 ml of LA 2.5 cm lateral to the greater occipital nerve along the superior nuchal line an injection of 3 to 5 ml of LA subcutaneously between the skin and bone, Great Auricular Nerve1.5 cm posterior to the ear at the level of the tragus.[13]

Dexmedetomidine is more selective alpha2-agonist with a selectivity ratio for the alpha2 receptor compared with alpha 1 receptor 1600:1, as compared to ratio of 220:1 for clonidine which has been used as sedative, anaesthetic sparing and analgesic drug. It decreases the hemodynamic response in dose dependent fashion. Dexmedetomidine is used for prolonged sedation and anxiolysis in the ICU, including sedation and adjunct analgesia in the operating room and sedation in diagnostic and procedure units, as well as for other applications such as withdrawal or detoxification amelioration in adult and pediatric patients.[14] It can be used as adjuvant for maintenance of anaesthesia in neurosurgical patients. None of the previous studies had compared intravenous dexmedetomidine and scalp block so this study aims to compare the efficacy of intravenous dexmedetomidine infusion with 0.5% Bupivacaine scalp block in attenuating the hemodynamic response, to the skull pin head holder application in neurosurgical patients.

MATERIALS AND METHODS

This Randomized clinical study was a conducted between june to december (2022) on patients undergoing elective neurosurgery in Stanley Medical College and Hospital. Randomization was done using computer generated random numbers and group allocation by sealed envelope technique. Institutional ethical committee approval was obtained

Based on the study conducted by Krishna H,[15] adverse hemodynamic events in Dexmedetomidine group was 84.61% (ie,22/26). Sample size was calculated by formula

$$N = \frac{Z^2\ 1\text{-}a/2 * p * q}{L^2}$$

Z^2 1-a/2=1.96=95% confidence interval significant level =0.05

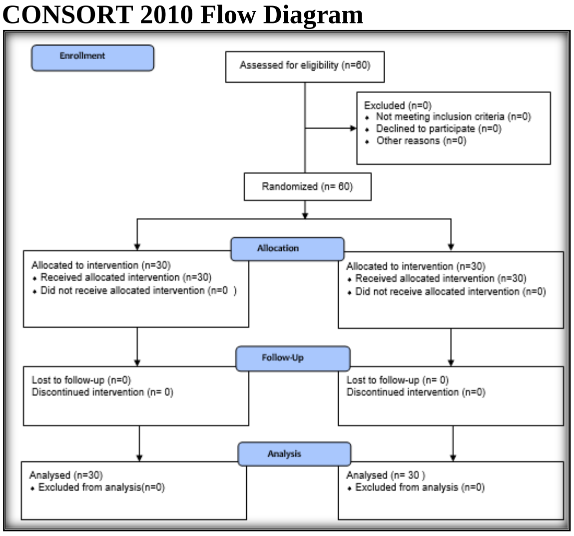
P=proportion of Dexmedetomidine adverse hemodynamic events=84.61% [15]

Q=100-p=100-84.61=15.39. With the relative precision of 17% of prevalence 84.61=14.38

$$N = \frac{4x84.61x15.39}{14.38x14.38} = \frac{5208.59}{206.8} = 24.31 = 25$$

Sixty patients of age15-75 yrs of both sexes posted for elective neurosurgery with ASA grading I,II and III with GCS of ≥ 8 were included. Patients with raised ICP, preexisting intracranial defect, known cardiac, renal or hepatic diseases and known allergy to the study drug were eliminated from the study. Patient were randomized based on computer generated random technique and allocated into two groups based on sealed envelope method. Group S – Patients received scalp block with injection Bupivacaine 0.5% 30ml prior pin application and Group D-Patients received intravenous Dexmedetomidine 0.5mcg/kg i.v loading dose and 0.25mcg/kg/hr.[14] [Table 1].

CONSORT 2010 Flow Diagram



In the operating room, standard monitors ECG, Noninvasive blood pressure, pulse oximetry and ETCO2 were placed in the patients. I.V access was secured. The baseline heart rate and blood pressure

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was recorded. General anesthesia conducted as follows Premedication with Inj. Glycopyrrolate 5mcg/kg i.v ,Inj. Midazolam 1mg i.v and Inj. Fentanyl 2mcg/kg i.v given.Induction with injthiopentone 4-5mg/kg and muscle relaxant Inj.Vecuronium 0.1mg/kg i.v given. After endotracheal intubation with appropriate size ETT, bilateral air entry checked and anaesthesia was maintained with nitrous oxide and oxygen 50:50 ratio with 1% of sevoflurane and muscle relaxation with Inj. Vecuronium 0.05mg/kg. Ventilation was maintained with tidal volume of 8- 10ml/kg and frequency of 12-15/mt.Group D (Dexmedetomidine) patients were given bolus dose of Dexmedetomidine 0.5mcg/kg as infusion over a period of 10mts, before induction of anaesthesia and continued as maintenance dose 0.25mcg/kg/hr from induction to 5mts after pinning. In Group S (Scalp block) patients, bilateral scalp block with 0.5% Bupivacaine 30ml – (15ml on each side) was given. Skull pins were applied 5mts after scalp block.

Patient's hemodynamics, saturation, heart rate and non-invasive blood pressure were monitored. All the parameters were measured before and after intubation: before pinning, immediately after pinning, 1 minute after pinning, 2 minutes after pinning, 3 minutes after pinning, 4 minutes after pinning and 5 minutes after pinning. Bradycardia heart rate <50/mt was treated with Inj atropine 10mcg/kg i.v. Hypotension MAP <20% from baseline was treated with Inj ephedrine. Tachcardia HR >20% from baseline and Hypertension MAP > 20% from baseline were treated in two successive step 1: Single bolus administration of Injection Fentanyl 1mcg/kg i.v Step 2: Increasing concentration of the volatile agent to 1.5-2 %.

Statistical analysis

Data were entered in Microsoft Excel sheet. Entered data were organized, vetted, grouped and analyzed. Non-Parametric tests were used to make statistical inference as data were not normally distributed. Chi-squared test was used to explore the Categorical data. Wilcoxon rank-sum test (Mann Whitney U test) was used to compare the two groups at each of the time points. Friedman test was used to explore the change within each group. Post-Hoc pairwise tests for Friedman test performed using Nemenyi test were used to explore the statistical significance of the change in hemodynamics from the Baseline time point to the various follow-up timpoints. Group comparisons for change in hemodynamics was performed using Wilcoxon t-test. The overall change in hemodynamics over time was compared in the two groups using the Generalized Estimating Equations method For all statistical purpose, the value of P<0.05 are considered as significant

RESULTS

Both the groups were comparable with respect to age, sex, ASA distribution and weight [Table 1].

The two groups differed significantly in terms of change in Heart Rate (bpm) from the Baseline time point to the following time points. The following table summarizes the mean change in Heart Rate (bpm) from the Baseline time point to the various follow-up time points [Table 2].

The baseline systolic blood pressure between the two groups was comparable. In Group: S, the mean SBP (mmhg) increased from 140.03 at the Baseline time point to a maximum of 143.90 at before pinning, and then decreased to 117.53 at the 5 Minutes After Pinning time point. This change was statistically significant. (Friedman Test: X^2 = 160.5, p = <0.001). The following table summarizes It also summarizes the statistical comparison of the two groups in terms of this difference [Table 3].

In Group: S, the mean DBP (mmhg) increased from 86.43 at the Baseline time point to a maximum of 90.23 before pinning time point, and then decreased to 74.17 at the 5 Minutes After Pinning time point. This change was statistically significant (Friedman Test: X^2 = 167.0, p = <0.001).

In Group: D, the mean DBP (mmhg) increased from 85.43 at the Baseline time point to a maximum of 90.before pinning time point, and then decreased to 74.20 at the 5 Minutes After Pinning time point. This change was statistically significant (Friedman Test: X^2 = 121.9, p = <0.001).

The overall change in DBP (mmhg) over time was compared in the two groups using the Generalized Estimating Equations method. There was a significant difference in the trend of DBP (mmhg) over time in both the groups (p = 0.007) [Table 4].

In Group: S, the mean MAP (mmhg) increased from 104.60 at the Baseline time point to a maximum of 108.03 at the After Intubation time point, and then decreased to 87.37 at the 5 Minutes After Pinning time point. This change was statistically significant (Friedman Test: X^2 = 187.1, p = <0.001).

In Group: D, the mean MAP (mmhg) increased from 101.80 at the Baseline time point to a maximum of 106.33 at the After Intubation time point, and then decreased to 85.53 at the 5 Minutes After Pinning time point. This change was statistically significant (Friedman Test: X^2 = 143.0, p = <0.001). The mean MAP was comparable lower in Group D than Group S after pinning at 1,2,3,4 and 5 minutes. The overall change in MAP (mmhg) over time was compared in the two groups using the Generalized Estimating Equations method. There was no significant difference in the trend of MAP (mmhg) over time in both the groups (p = 0.225).

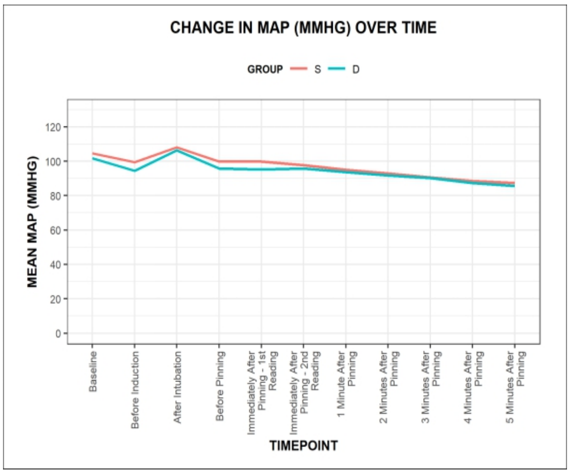

Figure 2: Difference in MAP of the two groups.

[Figure 2] is a line diagram depicting the change in MAP (mmhg) over time in both the groups.

Saturation was comparable between the group except second reading after pinning which shows significant difference between the groups but the mean was within 99% indicate no clinically significant desaturation. [Table 4]

Additional methods were required for 23 patients in Group S and 20 patients in Group D

There was no significant difference between the various groups in terms of distribution of Hypotension ($X^2 = 2.069$, $p = 0.492$).

There was no significant difference between the groups D and S in terms of distribution of hypertension ($X^2 = 0.089$, $p = 0.766$).

The cost of injection Dexmedetomidine 50mcg/0.5ml was Rs 170 whereas Bupivacaine

Vial 0.5% concentration 30ml was Rs 85. Therefore, the 0.5% Bupivacaine was cost

Effective when compared with the Dexmedetomidine 50mcg/ml.

Table 1: Demographic details of the study population

	Group S	Group D	P value
Age in years Mean (SD)	45.17 (13.53)	44.93 (11.62)	0.706 (Wilcoxon Test)
Male	22(73.3%)	22(73.3%)	1.000 (Chi-Squared Test)
Female	8(26.7%)	8(26.7%)	
Weight in kgs Mean (SD)	60.57 (8.23)	60.13 (6.26)	0.566 (Wilcoxon Test)
ASA I/II	24/6	23/7	1.000 (Chi-Squared Test)

Table 2: Comparison of Heart rate between the groups. *=indicates p value <0.05

Time points	Heart Rate (bpm) from Baseline to Follow-up Time points		
	Group: S Group: D		
	Mean HR	Mean HR	P value (Wilcoxon Test)
Before Induction	89.23 (14.14)	91.10 (17.18)	0.970
After Intubation	84.57 (13.51)	81.87 (15.63)	0.668
Before Pinning	95.33 (12.43)	94.63 (14.66)	0.733
Immediately After Pinning - 1st Reading	88.07 (12.39)	87.43 (14.08)	0.836
Immediately After Pinning - 2nd Reading	89.43 (14.99)	92.83 (16.86)	0.403
1 Minute After Pinning - Baseline	88.60 (14.68)	91.63 (17.39)	0.492
2 Minutes After Pinning	85.67 (13.20)	88.27 (15.90)	0.579
3 Minutes After Pinning	84.43 (13.24)	85.90 (14.68)	0.652
4 Minutes After Pinning	83.57 (13.14)	82.47 (14.13)	0.615
5 Minutes After Pinning	81.83 (12.87)	80.33 (13.86)	0.539

Table 3: The mean change in SBP (mmhg) from the Baseline time point to the various follow-up time points. *indicates p value <0.05

Time points	SBP (mmhg) from Baseline to Follow-up Time points		
	Group: S Group: D		
	Mean difference in SBP (mmhg)	Mean SBP (mmhg)	P value (Wilcoxon Test)
Before Induction	140.03 (17.81)	134.13 (16.76)	0.171
After Intubation	132.70 (17.14)	122.73 (16.19)	0.031
Before Pinning	143.90 (15.12)	137.87 (14.16)	0.214
Immediately After Pinning - 1st Reading	133.00 (15.52)	125.73 (14.48)	0.058
Immediately After Pinning - 2nd Reading	132.60 (19.23)	126.57 (20.50)	0.193
1 Minute After Pinning	130.23 (18.48)	126.57 (21.02)	0.264
2 Minutes After Pinning	126.37 (17.47)	123.43 (19.60)	0.314
3 Minutes After Pinning	120.40 (26.50)	119.67 (16.27)	0.395
4 Minutes After Pinning	120.27 (18.09)	117.80 (15.02)	0.684
5 Minutes After Pinning	117.53 (16.59)	114.23 (13.30)	0.464

Table 4: Comparison of Groups in Terms of change in DBP (mmhg) over time)

Time points	DBP (mmhg) from Baseline to Follow-up Time points		
	Group: S Group: D		P (student t tset)
	Mean DBP (mmhg)	Mean DBP (mmhg)	
Before Induction	86.43 (10.79)	85.43 (9.93)	0.673
After Intubation	82.60 (9.12)	80.50 (10.79)	0.367
Before Pinning	90.23 (7.29)	90.77 (9.88)	0.722

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Immediately After Pinning - 1st Reading	83.87 (8.72)	80.77 (8.52)	0.190
Immediately After Pinning - 2nd Reading	83.67 (10.16)	80.63 (11.40)	0.261
1 Minute After Pinning	81.53 (10.90)	81.17 (10.09)	0.976
2 Minutes After Pinning	79.60 (10.81)	79.07 (11.51)	0.842
3 Minutes After Pinning	77.67 (11.29)	77.70 (10.29)	0.877
4 Minutes After Pinning	75.30 (10.58)	76.80 (9.92)	0.455
5 Minutes After Pinning	74.17 (9.44)	74.20 (9.28)	0.994

Table 5: Comparison of Groups in Terms of change in mean saturation(%) over time)

Time points	**saturation from Baseline to Follow-up Time points**		
	Group: S Group: D		**P Value of Comparison of the Two Groups**
	Mean saturation	**Mean saturation**	
Before Induction	99.66667	99.83333	0.2069
After Intubation	99.76667	99.8	0.8077
Before Pinning	99.76667	99.73333	0.8234
Immediately After Pinning - 1st Reading	99.5	99.9	0.0248**
Immediately After Pinning - 2nd Reading	99.76667	99.76667	1
1 Minute After Pinning	99.72414	99.82759	0.425
2 Minutes After Pinning	99.69231	99.80769	0.4541
3 Minutes After Pinning	99.88	99.84	0.6629
4 Minutes After Pinning	99.66667	99.83333	0.2069
5 Minutes After Pinning	99.76667	99.8	0.8077

Table 6: Additional methods for pain relief

Additional methods Group S Group D			**P value(Chi suared test)**
Additional methods	23	20	0.7657
Inj. Fentanyl	6	8	0.5416
Increase conc. % inhalational agent	3	7	0.1659
Both	2	5	0.4238

DISCUSSION

Anaesthetic challenge in neuro surgery is maintaining intracaranial pressures during the procedure especially during scalp pin placement. Blocking the nerves innervating the scalp block the afferent for pain pathway thereby avoiding the pain induced changes in hemodynamics and intracranial pressures. Scalp block with Bupivacaine was found effective in attenuating the hemodynamic response to pinning.[10] Intravenous drugs have been used to attenuate hemodynamics response to scalp pin placement. Dexmedetomidine have been studied to maintain the hemodynamic responses during intubation and maintenance of general anaesthesia.

This study compares the Intravenous dexmedetomidine and scalp block with bupivacaine for hemodynamics control during scalp PIN application. Geze S et al,[13] showed that 0.5% Bupivacaine scalp block with alfentanyl blunts hemodynamic response and sympathoadrenal response to pinning compared with local infiltration. Uyar AS et al,[16] study showed attenuation in hemodynamic and neuroendocrinal response to skull pin insertion with single bolus dose of Dexmedetomidine before induction compared with that of the placebo. Dawlatly AB et al,[17] study showed that 0.25mcg/kg infusion of Dexmedetomidine attenuates the hemodynamic response to skull pin insertion similar to lidocaine infiltration.

Age, sex, ASA distribution and Weight was comparable between the groups. Heart rate attenuation to pin insertion occurred immediately in P0 in Group S. Pinosky ML et al,[18] study showed scalp block with 0.5% Bupivacaine blunts the stress response to pinning. This was similar to Can BO et al,[19] study where scalp block showed HR decrease in both groups at pinning and Overall change in HR over time was compared between two groups using Generalized Estimation Equation method and was significant. The MAP between two groups was comparable. After intubation mean MAP increased from 94.53 to 106.33 in Group D compared to Group S which increased from 99.43 to 108.03, but was not statistically significant. Both groups showed decreasing trend in DBP post pinning. This was shown by AB Dalwatly et al,[17] where use of small dose of Dexmedetomidine 0.25mcg/kg results in attenuation hemodynamic response to skull pin placement similar to lidocaine infiltration. Krishna H et al.[15] Study showed overall incidence of adverse hemodynamic effects was greater in Dexmedetomidine group than lignocaine infiltration at pin site This study showed that adverse hemodynamic responses were comparable between the group

Limitation of the study

Neurosurgical patients ASA class I-III was only included in present study. Patients with GCS <8/15 was not included in present study. Thereby study on patients with raised ICP would show benefit of the techniques one over the other. Estimation of ICP was not done in response to pinning only hemodynamic parameters were measured. Plasma catecholamine levels were not evaluated, in response to pinning in assessing difference between two groups reducing the sympathoadrenal response. We had not included placebo group, which is ideal to reveal difference in hemodynamic response to pinning.

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CONCLUSION

The present study concludes that the Scalp block with 0.5% Bupivacaine has similar effects as Dexmedetomidine infusion in attenuating the hemodynamic response to skull pin head holder application in neurosurgical patients.

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