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A Comparative Study of Evaluating Effects of Dexmedetomidine and Buprenorphine as an Adjuvant to Bupivacaine in Scalp Block for Supratentorial Craniotomy Surgeries in a Tertiary Care Hospital

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KEYWORDS

Buprenorphine, dexmedetomidine, scalp block, supratentorial craniotomy.

ABSTRACT:

Background: Regional anaesthesia techniques have been shown to be effective in reducing intraoperative aesthetic requirement, provide intraoperative hemodynamic stability and postoperative analgesia requirement too. Scalp block when used in patients with craniotomy provides effective analgesia for short duration; however, addition of dexmedetomidine may prolong duration of analgesia and provide intraoperative hemodynamic stability. Similar effects may be observed with buprenorphine. Hence, we aimed to evaluate effect of scalp block with addition of dexmedetomidine and buprenorphine to bupivacaine on intraoperative hemodynamic parameters and postoperative analgesia in patients undergoing supratentorial craniotomy.

Methods: We enrolled 60 patients undergoing elective supratentorial craniotomy and divided into two groups; group B received 19ml of bupivacaine 0.25% with 2mcg/kg of buprenorphine making volume of 20 ml and group D received 19ml of bupivacaine 0.25% with 1 mcg/kg of dexmedetomidine with total volume of 20 ml. Patients hemodynamic parameters were recorded intraoperatively and VAS score, rescue analgesia requirement was noted postoperatively.

Results: We found that patients were more stable hemodynamically in intraoperative period in dexmedetomidine group compared to buprenorphine group. Duration of analgesia was significantly prolonged in dexmedetomidine group. Sedation score and postoperative analgesia requirement was more in buprenorphine group.

Conclusion: Our study found that addition of dexmedetomidine and buprenorphine prolonged duration of analgesia postoperatively and provided intraoperative hemodynamic stability. However, these effects were better with dexmedetomidine group and were without much sedation and other postoperative complications compared to buprenorphine group.

INTRODUCTION

Post craniotomy pain is pain of moderate to severe intensity usually of pounding or pulsatile in nature, occurring in 60-80% of patients in first 48 hours of surgery[1,2]. Managing this pain with traditional analgesics (opioids and NSAIDS) is challenging to anaesthesiologist because of associated adverse effects including sedation, respiratory depression and nausea and vomiting. Additionally, use of opioids may interfere

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with neurological assessment of pain. Non opioid analgesics may not provide adequate pain relief[3,4,5,6].

Pain following craniotomy has been shown to have superficial component in almost 75% of cases and superficial and deep component in 15% of cases. This suggests that pain is more of somatic in nature arising from soft tissue and muscles of scalp than from neural component of brain[7]**.** Hence, it can be taken care of by regional analgesia provided by scalp block. Scalp block forms essential component of multimodal analgesia following post craniotomy which not only provides adequate analgesia but also allows neurological assessment and reduces risk of neurological complications[8].

Scalp block given following intubation helps to reduce hemodynamic response to craniotomy and keeps hemodynamics stable intraoperatively. However, sensory block given using long acting local anaesthetics may not last more than six hours and hence it is necessary to prolong effect of this block using some additive [9, 10,11]. Various additives like clonidine and dexamethasone have long been studied and are found effective in prolonging duration of scalp block. Dexmedetomidine, having more selectivity towards alpha-2 adrenergic receptors is more likely to prolong effect of local anaesthetics and is studied extensively in peripheral nerve blocks. Effect of buprenorphine is also being studied extensively for peripheral nerve blocks. However, there is no study comparing these two drugs in scalp block. Hence, we designed this study to evaluate the effect of scalp block with dexmedetomidine and buprenorphine as an adjuvant to bupivacaine combined with general anaesthesia on hemodynamic stability and on postoperative pain in patients undergoing elective supratentorial craniotomy.

METHODS

This was prospective randomized double blind study conducted in tertiary care institute after obtaining institutional ethics committee approval. Study was conducted during period of June 2022 to December 2023. This study was conducted in accordance with Good Clinical Practice and in a manner to conform to the Helsinki Declaration of 1975, as revised in 2013 concerning human rights. Well-being and safety of patients were maintained during study. Sixty patients of either gender of age group 18-60 years of ASA I and II receiving general anaesthesia for supratentorial craniotomy were randomly allocated in two groups of 30 each using block randomisation and computer generated sequence. Patients with expected surgical time around 4 to 5 hours, having tumours with low vascularity and anticipated less hemodynamic disturbances due to bleeding were preferred

Patients refusing to give consent, allergic to local anaesthetic, bleeding diathesis, patients with impaired higher functions, sensory or motor deficits, with severe co-morbidities like ischemic heart disease, cardiomyopathies, stroke, endocrine tumours, vascular lesions(aneurysms) ,patients requiring emergency surgery, pregnant and lactating mothers were excluded.

Patient were evaluated preoperatively including detailed airway examination and investigated according to institutional protocol. Study protocol was explained to patient and written informed consent was obtained. Patient was explained about VAS scale preoperatively.

A night prior to surgery, patient was given tab alprazolam 0.25 mg and tab pantoprazole 40 mg. On day of surgery, NPO status and consent was checked. An iv line was secured and NS was started. Patients were attached with standard monitors including ECG, SPO_2, NIBP, $ETCO_2$, temperature probe and baseline parameters were recorded. Patients were premedicated with midazolam 0.02mg/kg, pantoprazole 40mg and inj glycopyrrolate 4mcg/kg IV.

Anesthesia plan was standardized. Patients were preoxygented with 100% O_2 and inj fentanyl 2mcg/kg was given followed by propofol 2.5 mg/kg. After checking adequacy of ventilation, rocuronium 0.6 mg/kg was administered intravenously. Confirmation of tube placement was done with capnography and patient was maintained using oxygen: nitrous mixture 50:50% along with sevoflurane to maintain MAC of 1-1.2. Rocuronium was given intermittently as and when required while 20 mg propofol boluses were administered when there was increase in hemodynamic values i.e. rise in heart rate and blood pressure more than 20% from baseline values. If there was a reduction in mean arterial pressure greater than 20% from the pre-anaesthesia baseline, the flow of sevoflurane was reduced, and a bolus of intravenous fluids (2 ml/kg) was administered. Following intubation, a scalp block was performed under aseptic conditions

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Using computer generated randomization patients were randomly allocated to two groups ie group D receiving 19 ml of 0.25% bupivacaine with 1mcg/kg of dexmedetomidine which was diluted with normal saline to make a volume of 1 ml and total volume of solution 20 ml and group B was administered 19 ml of 0.25% bupivacaine with 2mcg/kg of buprenorphine which was diluted with normal saline to make a volume of 1 ml and total volume of solution 20 ml. Opaque sealed numbered envelopes were used to conceal randomization sequence which were opened by principal investigator just prior to block administration. A separate investigator was asked to prepare block solution who was not involved in case or study. An experienced anesthesiologist, who was unaware of drug in syringe, performed block and monitored patients' perioperatively.

Anaesthesia was maintained using nitrous oxide and oxygen on the circle absorber system, with top-ups of rocuronium. Sevoflurane administration began 10 minutes after the scalp block and was adjusted to maintain vital parameters within the required limits. Surgical positioning and insertion of headpins occurred 15 minutes after the completion of the scalp block. No additional scalp infiltration or marking was allowed. The incision was performed 15 minutes after pin insertion, and the timing of the incision, dura opening, and closure was noted.

If patients required an additional dose of propofol, fentanyl 1 µg/kg was administered. A reduction in heart rate exceeding 20% from baseline was managed with glycopyrrolate 0.2 mg, and an increase in heart rate exceeding 20% from baseline was treated with an increase in sevoflurane concentration and fentanyl 1 µg/kg if necessary.

Sevoflurane administration was discontinued immediately after skin closure. Nitrous oxide was stopped after headpin removal to allow patients to recover from anaesthesia. Neuromuscular blockade was reversed once the patient demonstrated spontaneous eye opening, adequate respiratory efforts, hemodynamic stability, response to commands, and a train-of-four (TOF) ratio of 70%. Extubation was only performed when the TOF ratio reached 90%. The patient was monitored in the operating room for 30 minutes and then transferred to the recovery room. Oxygen was administered via a venturi mask during the postoperative period. The patient was transferred to the ward if the recovery period remained uneventful for two hours.

Vital parameters were recorded at various points, including before securing the i.v. line and premedication after induction, after intubation, 5 minutes and 15 minutes after the completion of the scalp block, immediately after pin insertion, and 5 minutes after that. Vital parameters were recorded immediately after incision. Degree of pain was assessed by verbal pain scale and level of sedation was checked by Ramsay sedation score.

The data was collected, compiled, and analyzed using EPI info (version 7.2). The qualitative variables were expressed in terms of percentages. The quantitative variables were categorized and expressed in percentages or terms of mean and standard deviations percentages. The difference between the two proportions was analyzed using the chi-square or Fisher exact test. All analysis was two-tailed, and the significance level was set at 0.05.

RESULTS

Total 60 patients were enrolled in study with 30 patients in each group. All these patients completed study and they had comparable demographic parameters as shown in table 1.

Table 1: Comparison of Demographic parameters and baseline hemodynamic parameters in Two Groups

Parameter	Group B (Mean±SD)	Group D (Mean±SD)	P value
Age (years)	46.90±6.67	47.57±7.17	0.1393
Female: male (%)	4(13%):26(87%)	4(13%):26(87%)	1.000
Weight (kg)	67.73±7.11	66.27±4.76	0.3515
ASA 1: 2	14(46.7%):16(53.3%)	23(76.7%): 7(23.3%)	0.017

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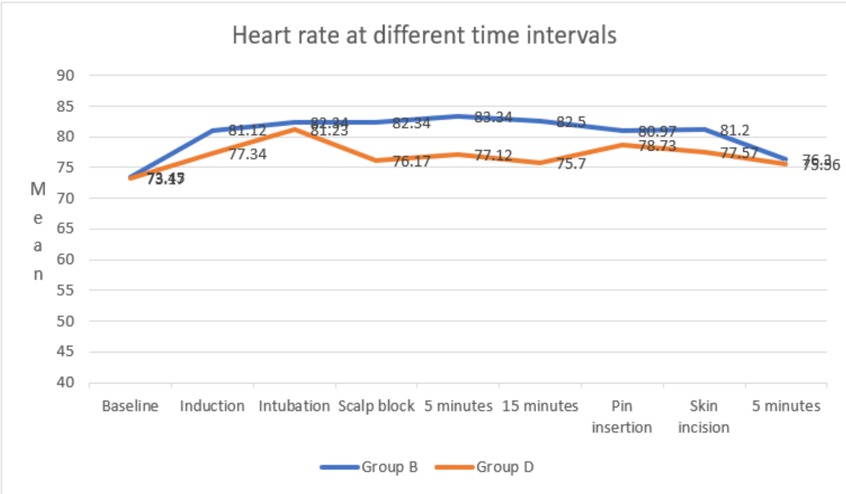
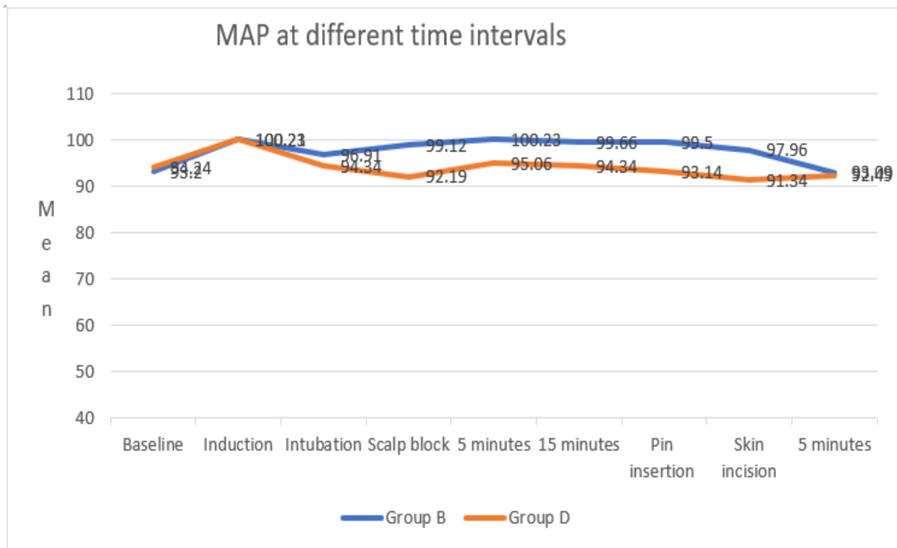
Duration of surgery	244±44.4	243±53.4	0.938
HR beats/minute	73.45±8.66	73.17±7.10	0.6912
MAP	93.20 ±6.79	94.24± 7.76	0.2910

HR: heart rate, MAP: mean arterial pressure, ASA: American society of anaesthesiologist P value<0.05 is considered as significant.



Graph 1: Heart rate changes at different time intervals

The mean heart rate baseline was 73.45 bpm and 73.17 bpm in Group B and Group D respectively. (p>0.05) The heart rate rose immediately after intubation in both the groups. In Group B, the heart rate was higher after intubation while in Group D, the heart rate dropped to normal levels after pinning and remained stable till skin incision. The heart rate among Group B was significantly higher compared with Group D. (p<0.05).(Graph 1)



Graph 2: MAP changes at different time intervals

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The mean arterial pressure baseline was 93.20 mmHg and 94.24 mmHg in Group B and Group D respectively. ($p>0.05$) The mean arterial pressure rose immediately after intubation on both the groups. In group B, the mean arterial pressure remained elevated after intubation and in group D, the mean arterial pressure dropped to normal levels after pinning and remained stable throughout the surgery. The mean arterial pressure in group B was significantly higher compared with Group D. ($p<0.05$).(Graph 2)

Table 2: VAS scores post-operative period

VAS score	**Group B (Mean±SD)**	**Group D (Mean±SD)**	**P value**
Immediately	2.07 ±0.58	2.17±0.70	0.5867
30 minutes	2.67±0.55	1.40±0.60	0.0321
1 hour	2.90±0.48	1.97±0.49	0.0356
6 hour	3.93±0.87	1.87±0.73	0.0221
12 hour	3.07±1.01	1.17±0.57	0.0261

P value<0.05 is considered as significant

As seen from table 2, VAS score in group D was much lower at all times postoperatively compared to group B and this difference was statistically significant(P value<0.05).

Sedation scores as seen using Ramsay sedation score was much lower in group D than in group B (Table 3). Although, this difference was statistically significant but was not significant clinically.

Table 3: Ramsay sedation scores post-operative period

Ramsay sedation score	**Group B (Mean±SD)**	**Group D (Mean±SD)**	**P value**
Immediately	2.67±0.48	2.87±0.43	0.4574
30 minutes	2.60±0.50	1.87±0.51	0.0341
1 hour	2.17±0.55	1.07±0.52	0.0321
6 hour	2.80±0.41	1.97±0.41	0.0211
12 hour	2.10±0.61	1.27±0.52	0.0318

P value<0.05 is considered as significant

Duration of analgesia as seen from table 4, was much prolonged in dexmedetomidine group compared to buprenorphine group (P value<0.05). Although more number of patients required rescue analgesia in group B compared to group D, this was not significant statistically.

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Table 4: Duration of analgesia

Parameters	Group B (Mean±SD)	Group D (Mean±SD)	P value
Duration of analgesia In minutes	482.93 ±13.45	567.88±8.62	0.0432
Number of patients requiring additional dose of analgesia required(%)	7 (23.34%)	5(16.57%)	1.000

P value<0.05 is considered as significant

DISCUSSION

Scalp block forms an essential part of multimodal analgesia while dealing with postsurgical pain following craniotomy. Scalp block given before incision additionally may prevent hemodynamic response to incision and skull pin insertion as well as provides hemodynamic stability intraoperatively. Apart from this, regional anaesthesia techniques also reduce anaesthetic consumption, reduce pain postoperatively, allow neurological assessment and reduce systemic adverse effects.

Further, addition of additives like dexmedetomidine and buprenorphine prolongs duration of analgesia thereby reducing consumption of systemic analgesics. Dexmedetomidine when added to local anaesthetic agent blocks hyperpolarization activated cation current (I_h) activation of which is done by initial hyperpolarisation of nerve. I_h current is responsible for bringing nerve back to normal resting potential blockage of which by dexmedetomidine results in prolongation of action local anaesthetic agents on nerve. Further, this effect appears to be more prominent on C fibres carrying pain than alpha fibres of motor response and hence sensory effect is more prolonged. As scalp has rich supply with C fibres addition of dexmedetomidine appears to prolong sensory effect of local anaesthetic agent[12, 13, 14].

Similarly, buprenorphine also has strong affinity for mu opioid receptors present on peripheral nerve fibres in particular C fibres carrying pain and this is key mechanism involved in prolongation of analgesia. Apart from this, it also inhibits voltage gated sodium channels similar to local anaesthetic agents.

In our study, we found that addition of dexmedetomidine to scalp block had prolonged duration of analgesia (Table 4), had better VAS scores (Table 2) and better hemodynamic stability (Graph 1 and 2) intraoperatively compared to bupivacaine-buprenorphine group. Further, Ramsay sedation scores observed postoperatively was also on lower side in dexmedetomidine group compared to buprenorphine group. Although number of patients requiring additional analgesia were higher in buprenorphine group this difference was not significant statistically (Table 4).

The improved hemodynamic stability observed in the dexmedetomidine group suggests that this medication may have a more favourable impact on cardiovascular function, maintaining a balance in the body's vital parameters. This can be particularly important during surgical procedures or other situations that may cause blood pressure and heart rate fluctuations.

Stachtari *et al.* conducted a study to assess the impact of scalp block, with or without dexmedetomidine in combination with general anaesthesia, on the stability of hemodynamics, opioid consumption, and postoperative pain in patients undergoing elective craniotomy[15]. They found that the mean arterial pressure was significantly lower at the time of skin closure compared to the baseline in both the group receiving scalp block alone (group R) and the group receiving scalp block with dexmedetomidine (group RD). Patients in group RD also showed significantly lower heart rates compared to the baseline, pin fixation, and skin incision time points, as well as compared to group C and group R during dura matter incision, dura matter closure, and skin closure time points. Additionally, patients in group RD required significantly lower amounts of fentanyl than group R.

Our findings with dexmedetomidine were consistent with this study.

A study by Vallapu *et al.* also demonstrated that scalp block gave better analgesia when local anaesthetic was added with dexmedetomidine. However, scalp block performed by them was at the time of closure of skin incision and hence it lasted for longer duration. However, we chose to give scalp block before incision which not only gave us stable hemodynamics throughout procedure but also had prolonged period of analgesia postoperatively[16].

Similar study was conducted by Carella *et al.* using levobupivacaine in patients undergoing supratentorial craniotomies. They found that scalp block used before incision had better hemodynamic control during painful stimuli including skull pin insertion and had prolonged postoperative analgesia compared to placebo. They also had reduced consumption of opioids perioperatively and had lower heart rate and mean arterial pressure[17].

Study by Chen *et al.* also demonstrated that applying scalp block reduces pain intensity as judged by VAS score, reduces analgesic consumption during first 12 hours and reduces need for rescue analgesia. However, they did not find any difference in intensity of pain with respect to time of application of block before or after incision. However, we found significant difference in pain scores in both groups as well as better hemodynamic stability after scalp block application, although hemodynamics were much better and duration of analgesia was also prolonged in dexmedetomidine group[18].

In our study, none of the patients developed any complication including hypotension and bradycardia requiring any treatment. Sedation scores were also not significant in both groups although these were much lower in dexmedetomidine group. However, none of the patients developed episode of desaturation due to airway compromise following sedation. This could be due to property of dexmedetomidine producing arousable sedation. Further, incidence of PONV was also not significant which may be expected to be higher in patients where buprenorphine was used as an adjuvant.

Despite all above, we had several limitations in our study. First, we had small group of population enrolled in study and which was specific surgical group. Hence, to generalize these findings, we need to conduct the study on large group of surgical population. Second, we used landmark guided technique for giving scalp block which certainly has some degree of failure. Third, we did not take into consideration of history of headache in preoperative period which may have increased requirement of analgesics due to prior sensitization. Fourth, we did not followed up patients for long term. So whether prevention of postoperative pain by these two drugs can prevent development of chronic pain following craniotomy need to be evaluated

CONCLUSION

our study concluded that, dexmedetomidine and buprenorphine when used as an adjuvant to bupivacaine in scalp nerve block in patients undergoing supratentorial craniotomy are effective in managing postcraniotomy pain. However, dexmedetomidine offers better hemodynamic stability and more reduction in analgesic consumption compared to craniotomy without much sedation. However, study needs to be conducted on large size to generalize effects of scalp block on neurosurgical population.

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