



Postoperative Regional Scalp Block versus Intravenous Fentanyl for Postsupratentorial Craniotomy Analgesia in Adult Patients under General Anesthesia

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ABSTRACT

Majority of patients undergoing craniotomy experienced moderate to severe pain in surgical site after the procedure, and there is a reluctance to manage this pain with systemic opioids that is understandable as it may impair neurological assessment, that is crucial in the postoperative period. In addition to that, evidence concerning alternative analgesia techniques to manage post craniotomy pain is deficient. This research aims at evaluating the effect of postoperative regional scalp block (RSB) versus intravenous fentanyl for post-supratentorial craniotomy analgesia in adult patients under general anaesthesia. Patients were automatically divided into two groups with 15 patients in each, Group B: postoperative RSB was done after the end of skin closure and before emergence from general anaesthesia, Group C: control group: in which standard intraoperative analgesia was given in the form of intravenous fentanyl with no block. This study included patients with Supratentorial brain tumours were admitted to Zagazig University Hospitals. We gathered the cases in the time between March 2018 and March 2020. Results: the results displayed highly significant differences between RSB group and control group. Postoperative RSB showed advantages over standard analgesia in the point of more significant reduction of hemodynamic response to pain in the form of heart rate and blood pressure postoperatively, decrease opioid consumption, lower Visual Analogue Score (VAS), Postoperative RSB can be performed easily in a short time with very high success rate allowing better postoperative control of haemodynamics, less postoperative pain. We recommend using post-operative RSB in supratentorial craniotomy as a gold standard in our hospital to get the advantages as mentioned above.



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INTRODUCTION

Majority of patients undergoing craniotomy experienced moderate to severe pain in surgical site after the procedure, and there is a reluctance to manage this pain with systemic opioids that is understandable as it may impair neurological assessment, that is crucial in the postoperative period. In addition to that, evidence concerning alternative analgesia techniques to manage post craniotomy pain is deficient (Gottschalk *et al.*, 2007) and (Kotak *et al.*, 2009).

Sensory innervation of the scalp can be targeted at distinct anatomical locations by local anaesthetic infiltration (LA) in a technique known as regional scalp block (RSB) (Guilfoyle *et al.*, 2013) and (Akhigbe and Zolnourian, 2017).

Six sensory nerves are known to supply the scalp, and they arise initially from the trigeminal or the cervical nerve, include the following:

1. Supratrochlear nerve - from the ophthalmic branch of the trigeminal nerve; it innervates medial plane of the forehead, upwards to vertex area.
2. Supraorbital nerve - from the ophthalmic branch of the trigeminal nerve; it innervates the lateral plane of the forehead, upwards to vertex region.
3. Zygomaticotemporal nerve - from the maxillary nerve, which is a branch from trigeminal nerve; it innervates the area over temple and skin covering zygoma.
4. Auriculotemporal nerve - from the mandibular nerve, which is a branch from the trigeminal nerve; it innervates the area of scalp covering the temporal region.
5. Lesser occipital nerve - from the 2nd cervical nerve; it innervates occipital part of the scalp laterally.
6. Greater occipital nerve - from the 2nd cervical nerve; it innervates occipital part of the scalp medially, upwards to the vertex region (Stambolija *et al.*, 2015) and (Osborn and Sebeo, 2010).

There is a lack of consensus and evidence regarding the use of common systemic analgesics for post craniotomy pain. Analgesic adjuvants like Paracetamol, NSAIDs, gabapentin, COX-2 inhibitors and others can be used alone or in combination.

When various analgesic drugs of different classes, different mechanisms of action, and adverse-effect profiles are used in combination, this may result in the synergism of the analgesic effects (Vadivelu *et al.*, 2016).

This method is called *Multimodal analgesia*, it is considered very useful and optimum for management of post craniotomy pain, in addition to opioid-sparing effect, thus reducing adverse effects of opioids like postoperative nausea and vomiting (PONV) and excessive sedation, so it consequently improves the outcome (Hansen *et al.*, 2011).

Objectives

To assess postoperative cardiovascular response to pain in the form of postoperative hemodynamic changes. To evaluate postoperative pain by using a visual analogue scale. To assess the time of first rescue analgesic request in the postoperative period and to calculate the total amount of fentanyl consumption in the first day postoperative with its subsequent side effects may cloud neurological assessment and hide signs of intracranial complications in the first few hours after completion of surgery.

PATIENTS AND METHODS

A total of 30 patients attending Zagazig University hospital from march 2018 to march 2020 included in a prospective study. All patients signed written informed consent, and the study was accepted by the ethical review team of the Faculty of Medicine, University of Zagazig. The research was carried out together with The World Medical Association's Code of Ethics (Helsinki Declaration) for human researches. Patients were divided into two groups regarding the type of anaesthesia the patient received:

Group B

Postoperative RSB were done after completion of surgery and before emergence from general anaesthesia by bupivacaine 0.5% / lidocaine 2% mixture and adrenaline 1:200,000.

Group C

Control group, patients received standard intraoperative analgesia in the form of intravenous fentanyl with no block.

Inclusion criteria

Patients aged 21 - 60 years of both Genders. And ASA grade I-II (American society of anesthesiologists) Prepared to undergo craniotomy under general anaesthesia for supratentorial tumours. Also Body mass index <35 kg/m².

Exclusion criteria

Disturbed conscious level (Glasgow coma score < 14) or Huge tumour with marked midline shift. And incision extending beyond the areas covered by regional scalp block.

LA Infiltration preoperatively along the planned scalp incision or postoperatively into the wound edges only.

Also, previous craniotomy and chronic use of analgesics or drug dependence and uncontrolled hypertension.

Finally, extensive surgeries lasting more than 6 hours or patient needing postoperative ventilatory support or any complications during the procedure such as massive intracranial haemorrhage.

Anaesthetic techniques

Preoperative Preparation

Patients were kept nil per orally according to standard protocol (6-8h for solids, and 2h for clear fluids). Routine monitors were applied to record: ECG, heart rate (HR), mean arterial blood pressure (MAP) "through arterial line", and peripheral oxygen saturation values as baseline readings. Intravenous 18 gauge cannula was inserted in addition to the central line. An arterial line was also needed. Induction of general anaesthesia with endotracheal intubation was done.

General anaesthesia

It was standardized for all patients in the two groups—preoxygenation with 100% oxygen for three minutes. Fentanyl 2 mcg/kg, propofol 2 mg/kg was intravenously injected for induction, and cisatracurium 0.1 mg/kg was given to help intubation of the trachea. Endotracheal tube with suitable size was used to intubate the trachea. Mechanical ventilation was instituted to keep PaCO₂ between 30–35 mmHg. Isoflurane/O₂ mixture MAC 1 with an incremental dose of cisatracurium was administered for maintenance. Mannitol (0.5 g/kg over 20 min after induction of anaesthesia), ondansetron (4 mg) and phenytoin (5 mg/kg if already loaded with 15 mg/kg) and dexamethasone 10mg IV then 4mg/6h intramuscular were given. Crystalloid was restricted to 3 ml/kg/h of normal saline while any blood loss was replaced with an equal volume of blood or colloids. If mean arterial pressure elevated by more than 15 mmHg or heart rate accelerated by more than ten beats/minute, MAC of isoflurane was increased until reach a maximal end-tidal concentration of 1.2%. If, the blood pressure and heart rate still higher as noted, an extra dose of 0.5 mcg/kg of fentanyl was administrated. After completion of the surgery, isoflurane was stopped; reversal of neuromuscular blockade was done with neostigmine 0.05 mg/kg in addition to atropine 0.02 mg/kg. Extubation was performed when patients were able to obey simple commands. Postoperatively all patients were given paracetamol (perfulgan) as standard intravenous analgesia (at a dose of 1gm for patients \geq 50 Kg weight or 15mg/Kg for patients \leq 50 Kg weight) every 6 hours. Visual analogue score (VAS) was assessed. If the patient reported VAS of 7 or more, we injected 1 μ g/kg of IV fentanyl. If the patient reported VAS 4-6, we injected 0.5 μ g/kg of IV fentanyl. If the patient reported VAS

2 or 3, we injected 30 mg of ketorolac slowly IV, and If the patient reported VAS of 0 or 1, nothing was given. The two groups were compared regarding patient characteristics and medical history, postoperative autonomic cardiovascular response to pain: heart rate and mean arterial blood pressure, pain score: using Visual Analogue Scale (VAS score), time from extubation to first need of rescue analgesia, the total amount of fentanyl consumption in the first day postoperative.

RSB Technique

For all patients in group B, all patients were positioned in supine or semi-sitting attitude. The skin was disinfected then a 22 gauge needle 3 cm length containing Local anaesthetic mixture (bupivacaine 0.5% / lidocaine 2% and adrenaline (1/200000 concentration) was inserted at multiple sites: The supraorbital nerve was blocked with 1.5 ml LA solution at the supraorbital notch, which is located at the supraorbital ridge above the pupil. The supra-trochlear nerve was blocked with 1.5 ml of local anaesthetic (LA) solution injected at the superior medial corner of the orbital ridge with the needle introduced at a right angle to the skin. The auriculotemporal nerve was anaesthetized by injecting 3 ml of local anaesthetic at 1.5 cm in front of the auricle at the same level as the tragus. With taking into consideration that the needle should be introduced at a right angle to the skin, 1.5 ml of LA was injected under the deep fascia. While, the other 1.5 ml was injected superficial to the temporal fascia while retracting the needle. The zygomaticotemporal nerve was anaesthetized by infiltration of LA lateral to the orbit by forming a bridge between the area already anaesthetized around the zygomatic arch to the supraorbital ridge using 3ml of local anaesthetic. The higher and lesser occipital nerves were anaesthetized using 5 ml of LA in a band-like extension from the posterior occipital protuberance to immediately behind the ear. The postauricular branches of the great auricular nerve were anaesthetized using 3 ml of LA, 1.5 cm behind the ear at the tragus line. The injection was given into the subcutaneous tissue. To avoid accidental intravascular injection, careful aspiration was obligatory before injection of local anaesthetic. RSB was carried out bilaterally. In group B the block was performed after completion of surgery and before recovery from general anaesthesia and extubation. Bilateral injection of 17 mL of local anaesthetic solution at six sites using a mixture of 1:1 bupivacaine 0.5% and lidocaine 2%. With taking into consideration not to exceed the maximum dose (3.5mg/kg for bupivacaine) and (7mg/kg for lidocaine).

RESULTS

Patient's characteristics and medical history

Non- significant differences were found among studied groups including age, sex, weight, height, BMI, ASA class and medical history preoperatively ($p>0.05$ for all) (Table 1).

Postoperative heart rate and mean arterial pressure changes

Regarding postoperative heart rate (HR) at 1h, 2h, 4h and 6h and 8h there was highly statistical significant higher HR ($p<0.001$) in group C (control group) than group B (postoperative regional scalp block), while statistical differences in HR were found to be non-significant ($p>0.05$) in the studied two groups at 10h ($p=0.8$), 12h ($p=0.6$), 14h ($p=0.9$), 16h ($p=0.4$), 18h ($p=0.9$), 20h ($p=0.9$), 22h ($p=0.06$) and 24h ($p=0.3$) (Figure 1).

Regarding postoperative mean arterial pressure (MAP), at 1h, 2h, 4h and 6h and 8h: there was highly statistical significant higher MAP ($p<0.001$) in group C (control group) than group B (postoperative regional scalp block), While, statistical differences in MAP were found to be non-significant ($p>0.05$) in the studied two groups at 10h ($p=0.6$), 12h ($p=0.07$), 14h ($p=0.1$), 16h ($p=0.8$), 18h ($p=0.06$), 20h ($p=0.6$), 22h ($p=0.4$) and 24h ($p=0.5$) (Figure 2).

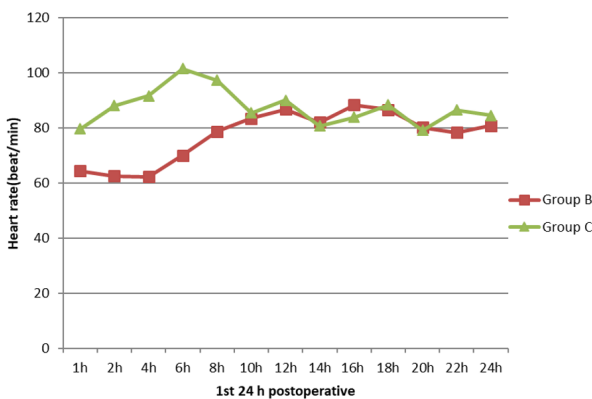


Figure 1: Comparison of Heart Rate measurements in the first 24 hours postoperative among the studied two groups (data were expressed as mean)

Visual analogue scale (VAS)

Among the studied two groups there was highly statistical significant higher Visual analogue scale (VAS) score ($p<0.001$) in group C (control group) than group B (postoperative regional scalp block) at 1h, 2h and 4h postoperatively.

At the same time, there was a statistically significant higher score ($p<0.05$) in group C compared to group

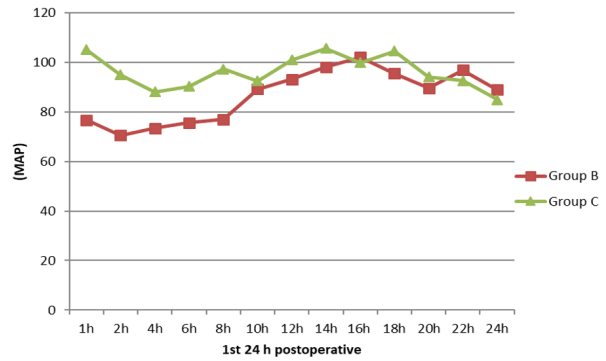


Figure 2: Comparison of mean arterial blood pressure (MAP) measurements in the first 24 hours postoperative among the two studied groups (data were expressed as mean)

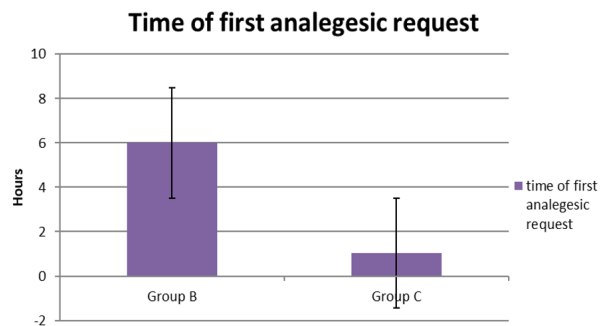


Figure 3: Comparing the time of the first request of rescue analgesia in the first 24h postoperative among the two studied groups (error bars represent the standard error)

B at 30 min, 8h, 16 h and 24 h postoperatively.

It was found that VAS couldn't be assessed in less than 50% of cases in group B and more than 50% of cases in group C at 30 minutes postoperative.

At 1 hour postoperative VAS Couldn't be assessed in 13.3% of patients in group B but 0% in group C (Table 2).

Time from extubation to the first request of rescue analgesia and total amount of postoperative Fentanyl (μg) consumption in the first 24 hours

Regarding time from extubation to the first request of rescue analgesia, it was highly statistical significant longer ($p<0.001$) in group B (postoperative regional scalp block) compared to group C (control group) (Table 3 & Figure 3).

As regards total dose of postoperative Fentanyl (μg) consumption in the first 24 hours, it was highly statistically significant ($p<0.001$) lower in group B than group C (Table 3).

Table 1: Patient's characteristics and medical history among studied groups

	Group B (n=15)		Group C (n=15)		t-test	P-value
Age(years) Mean \pm SD Min-max	42.33 \pm 13.5 20-58		42.07 \pm 11.1 20-59		0.05	0.95
Weight(kg): Mean \pm SD Min-max	80.9 \pm 10.83 65-100		82.9 \pm 10.2 60-100		0.5	0.59
Height(cm): Mean \pm SD Min-max	169.67 \pm 8.94 155-185		170.7 \pm 9.6 155-188		0.3	0.75
BMI(kg/m ²): Mean \pm SD Min-max	23.3 \pm 3.7 18-29		23.9 \pm 3.47 18-29		0.4	0.65
Sex:	N	%	N	%	Fisher's	0.69
Male	10	66.7	11	73.3	Exact	NS
Female		33.3	4	26.7	Test	
	5					
ASA classification	N	%	N	%	X ²	0.46
I	7	46.7	9	60.0	0.5	
II	8	53.3	6	40.0		
Medical history:	N	%	N	%	X ²	0.7 NS
NHMD	8	53.3	9	60.0	0.1	1 NS
Hypertension on ACE I	1	6.7	1	6.7	0	0.6 NS
Hypertension on B blocker	2	13.3	3	20.0	0.2	0.3 NS
Hypertension on indipamide	1	6.7	0	0.0	1	1 NS
DM on insulin	2	13.3	2	13.3	0	0.6 NS
DM on oral hypoglycemic	3	20.0	2	13.3	0.2	

We presented data in terms of mean \pm standard deviation (SD) and range (min-max), X²: chi-square test. Group B: postoperative group, Group C: control group. NS: non-significant difference.

DISCUSSION

Majority of patients undergoing craniotomy experienced moderate to severe pain in surgical site after the procedure, and there is a reluctance to manage this pain with systemic opioids that is understandable as it may impair neurological assessment, that is crucial in the postoperative period. In addition to that, evidence concerning alternative analgesia techniques to manage post craniotomy pain is deficient (Gottschalk *et al.*, 2007; Kotak *et al.*, 2009). So we tried to perform bilateral, regional scalp block (RSB) for adult patients undergoing supratentorial craniotomy to reduce postoperative systemic opioid requirements so avoiding its side effects like sedation and allowing adequate assessment of neurological status in postoperative period aiming at early detection and management of postoperative complications.

The scalp block plays an essential role in obtunding surgical stress response, thus reducing morbidity

following craniotomy (Jayaram *et al.*, 2016). Many previous types of research investigated the potency of many local anaesthetics, like lidocaine and bupivacaine, regarding its role in reducing the hemodynamic response and facilitating postoperative pain management.

Our results suggest that there is a strong correlation between RSB and reduction of post craniotomy pain.

We enrolled a total of 30 adult patients who underwent an elective craniotomy to remove supratentorial masses in the research and distributed them into two equal groups; group B received regional scalp block (RSB) postoperatively after the end of surgery and before emergence from general anaesthesia, and group C received conventional general anaesthesia with fentanyl without RSB. The two groups were compared regarding patient characteristics, medical history, postoperative autonomic cardiovascular response to pain: heart rate and invasive blood pressure (mean arterial blood pressure),

Table 2: Visual analogue scale at different times among the studied groups

Visual analogue scale (VAS)	Group B (n=15)		Group C (n=15)		MW	P-value
At 30 min postoperative:	0.75±0.46		2.5±2.07		9	0.02
Mean ±SD	1		1.5			S
median	0-1		1-6			
Min-max						
Couldn't be assessed	N	%	N	%		
	7	46.7	9	60.0	-	---
At 1hour postoperative	0.46±0.51		3.33±2.02		15.5	<0.001
Mean ±SD	0		3			HS
median	0-1		0-7			
Min-max						
Couldn't be assessed	N	%	N	%		
	2	13.3	0	0.0	-	-
At 2 hour postoperative	0.53±0.52		3.8±2.04		4	<0.001
Mean ±SD	1		3			HS
Median	0-1		1-8			
Min-max						
At 4 hour postoperative	1.53±1.06		5.2±1.56		9	<0.001
Mean ±SD	1		6			HS
median	0-3		2-7			
Min-max						
At 8 hour postoperative	3.4±1.29		4.73±1.09		46.5	0.004
Mean ±SD	4		5			S
median	1-5		2-7			
Min-max						
At 16 hour postoperative	2.73±1.22		3.67±1.18		55.5	0.01
Mean ±SD	2		4			S
median	2-6		1-6			
Min-max						
At 24 hour postoperative	1.93±0.7		2.6±0.99		68.5	0.05
Mean ±SD	2		3			S
Median	1-3		1-4			
Min-max						

We presented data in terms of mean ± standard deviation (SD), median and range (min-max). Group B: postoperative group, Group C: control group. (MW):Mann-Whitney test. NS: non-significant, S: significant, HS: Highly significant.

postoperative pain score: using Visual Analogue Scale (VAS score), time from extubation to the first request of rescue analgesia, the total amount of postoperative Fentanyl (μg) consumption in the first 24 hours.

Lidocaine 2% / bupivacaine 0.5% 1:1mixture and epinephrine 1/200000 has been used in our study instead of lidocaine alone; that was used in the research introduced by [Yang et al. \(2019\)](#); to avoid the occurrence of local anaesthetic toxicity and prolong the duration of analgesia.

We found in our study that postoperative hypertension and tachycardia (increase in MAP and HR) in response to craniotomy were significantly atten-

uated for long duration during the postoperative period in group B compared to group C where there was a more prominent hyperdynamic response. Our results were in agreement with the research introduced by [Yang et al. \(2019\)](#). In which the hemodynamic response and postoperative pain were assessed after regional scalp block in patients performing craniotomy for the repair of cerebral arteriovenous malformations, but it was different from our study in terms of that the local anaesthetic used was ropivacaine instead of lidocaine/bupivacaine mixture in our study. However, another research was carried out by [Ayoub et al. \(2006\)](#), testing the efficacy of transient analgesia in 50 patients performed craniotomy with employing regional scalp

Table 3: Time of the first request of rescue analgesia and total amount of postoperative Fentanyl (μg) consumption in the first 24 hours among the studied two groups

Variables	Group B (n=15)	Group C (n=15)	Test	P-value
Time from extubation to the first request of analgesia (hours):	6 \pm 1.96	1.03 \pm 0.44	MW	<0.001
Mean \pm SD	5	1	0.0	HS
median	4-8	0.5-2		
Min-max				
A total dose of Fentanyl (μg) consumption in the first 24 hours:	366.7 \pm 24.39	540.0 \pm 57.3	t-test	<0.001
Mean \pm SD	350-400	450-650	10.7	HS
Min-max				

We presented data in terms of mean \pm standard deviation (SD), median and range (min-max). Group B: postoperative group, Group C: control group. (MW): Mann-Whitney test, HS: Highly significant.

nerve block technique or injecting IV morphine following anaesthesia using remifentanyl; however, morphine group was linked to a higher prevalence of postoperative nausea and vomiting.

With talking about pain severity following craniotomy; however, the best analgesic agent for post craniotomy pain is still not available (Imaev *et al.*, 2013). regarding Visual Analogue Scale (VAS score), it was higher in group C than group B at all times of assessment due to the effect of the block in addition to multimodal analgesia. In addition to that, it was found that VAS couldn't be assessed in less than 50% of cases in group B and more than 50% of cases in group C at 30 minutes postoperative, this was due to high consumption of fentanyl and high MAC of isoflurane used intraoperatively in both groups. At 1 hour postoperative VAS couldn't be assessed in 13.3% of patients in group B but 0% in group C, this was attributed to post craniotomy pain that was severe enough to make patients of group C more awake compared to patients in group B with minimal post craniotomy pain left them more sedated.

Our results were in agreement with the results of Nguyen *et al.* (2001). In research that included 30 patients distributed into two groups, one of them underwent regional scalp block using ropivacaine and the other group employed normal saline. After observing patients for the 48 next to surgery, pain scores were found to be lower following ropivacaine infiltration. They observed that pain-free time was significantly longer than the predicted duration of action of ropivacaine (3 to 4 hours). Significant reduction in pain scores was found in ropivacaine groups than in saline group for a duration lasting up to 24 hours, adding to that; the analgesic potency lasted for up to 48 hours after surgery. This unpre-

dicted analgesic effect was explained by pre-emptive analgesia phenomenon. Such finding was also found in our research, but the analgesic effect lasted up to 16 h in some cases. Also, it might be attributed to the multimodal analgesic strategy used. In research carried out by Bala *et al.* (2006). Who randomly divided the cases planned for supratentorial craniotomy into two groups. One received bupivacaine while the other was injected with placebo following completion of surgery; the rescue analgesic plan following surgery was either diclofenac IM or tramadol IV. It was found that patients who did not receive a block of the scalp felt mild to extreme pain more often and thus needed in a larger dose and earlier than other groups; 6 hours after surgery.

In the view of time from extubation to the first need of rescue analgesia and total amount of systemic Fentanyl (μg) consumption in the first 24 hours, it was longer in group B compared to group C. This was attributed to scalp block effect. Our results were in concordance with the study conducted by Yang *et al.* (2019). In the mentioned research a total number of 75 patients planned for supratentorial craniotomy aiming at repair of brain aneurysm were allocated and distributed automatically into three groups: Group S (received scalp block using 0.75% ropivacaine 15 mL volume), group I (received scalp local infiltration along future incision using 0.75% ropivacaine 15 mL volume) and group C (employed classic systemic IV analgesia). Group S experienced less pain after surgery, a long time before the initial rescue dose of oxycodone. Also, oxycodone administration was reduced, and nausea and vomiting were less prevalent in the 48 hours following surgery than other groups. But in contrary to our study, the local anaesthetic used was ropivacaine instead of lido-

caine/bupivacaine mixture in our study oxycodone was used instead of fentanyl.

CONCLUSION

The present study showed that postoperative RSB with lidocaine 2% bupivacaine 0.5% mixture 1:1 with epinephrine 1/200000 (group B) was better than standard analgesia with IV fentanyl (group C) in better control of postoperative haemodynamics (MAP and HR), reduction of post craniotomy pain, fewer opioids administration in the first 24 hours following surgery and delayed the first request of rescue analgesia.

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Conflict of interest

The authors declare that they have no conflict of interest for this study.

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