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The effect of preemptive scalp block in supratentorial brain tumor excision surgery: A prospective randomized controlled double blinded study

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Abstract
Background: The primary function of scalp blocks in managing postoperative pain following the removal of supratentorial brain tumors primarily involves blocking pain signals to the central nervous system and improving the effectiveness of postoperative pain relief medication. The primary objective of this study was to evaluate the impact of preemptive bilateral scalp block on intraoperative anesthetic and analgesic needs, recovery features, and postoperative pain in supratentorial brain tumor resection operations.
Methods: In this prospective, randomised, double-blind trial, 72 patients of both sexes, ages 18 to 70, had general anaesthesia while having a craniotomy to remove supratentorial tumours.
The participants were split into two identical groups - Group I (comprising 36 individuals) received a sham scalp block, while Group II (also with 36 individuals) received a real scalp block.
Results: The outcomes showed that compared to group II, individuals in group I exhibited longer times to extubation, delayed spontaneous eye opening, obeying commands, reaching a modified Aldert's score of 10 minutes, first requests for pain relief, and significantly higher intraoperative fentanyl and propofol consumption ($p< 0.05$). Heart rate and mean arterial blood pressure recordings at 1, 3, 5, 15, 30, 45, and 60 minutes after pin insertion revealed a substantial decrease in group II compared to group I. Furthermore, a significant decrease in group II versus group I was observed on the numerical rating scale at 2, 4, and 6 hours postoperatively, with a probability of less than 0.05. The duration of ICU and hospital stays, as well as the occurrence of complications, were essentially equivalent in both groups.
Conclusions: Preemptive scalp block with 0.5% bupivacaine plus 1:200000 epinephrine allows smooth recovery by the end of surgery as early extubation, rapid spontaneous eye opening and obeying commands, shorter time for Aldert's score to reach 10.

Keywords: Supratentorial brain tumor, excision surgery, sham scalp block, real scalp block

Introduction
Intracranial surgery is a high-risk operation that can lead to severe complications following the procedure, including intracerebral haemorrhage, seizures, and elevated intracranial pressure (ICP). Postoperative consciousness changes are the most indicative clinical symptom of these complications. Following craniotomy surgery, a swift and complete recovery of consciousness post-operatively is preferable [1].
The main function of the scalp block in managing postoperative pain after supratentorial brain tumors removal primarily involves blocking the pain signals to the central nervous system and improving postoperative pain relief. Research has shown that scalp nerve block (SNB) offers advantages such as facilitating early postoperative recovery, reducing post-operative pain and maintaining stable blood pressure during painful procedures [2].
Local anesthetics for scalp blocks have been extensively investigated in terms of their choice and optimal dosage. The findings have not yielded definitive results so far. The optimal dose for perioperative craniotomy pain relief that avoids potential complications remains a topic of debate [3].
The pain is caused by the surgical incision and strain on peri cranial muscles and scalp soft tissues, which originates from the somatic system. Surgical approaches to the suboccipital and subtemporal regions, involving extensive dissection of significant muscles such as the temporal, splenius capitis, and cervicis, correlate with the highest rate of post-operative pain.

However, it is the extent of tissue damage rather than the specific area of the craniotomy that influences the severity of post-operative pain experienced by patients. Greater tissue damage is associated with increased levels of postoperative pain intensity [4].

Opioids remain the core component of treatment strategies for patients suffering from moderate to severe pain, despite ongoing debates about their application in neurosurgical settings. Opioid treatment is associated with potential complications including respiratory depression, excessive sedation, hypercarbia, increased intracranial pressure, prolonged ventilator dependence, and delayed patient recovery and discharge. The traditional views have restricted the widespread use of opioids after neurosurgeries [5].

It has been demonstrated that adding epinephrine to local anaesthetics lengthens the duration of block and lowers the systemic absorption of the anaesthetics, hence lowering the risk of systemic local anaesthetic toxicity. In regional blockade, it's particularly suggested for highly vascularised areas like the scalp [6].

This study aimed to evaluate the impact of preemptive bilateral scalp block on intraoperative anesthetic and analgesic needs, recovery traits, and postoperative pain in surgeries to remove supratentorial brain tumors.

Patients and Methods

72 male and female patients, ages 18 to 70, who were scheduled to have a craniotomy for the removal of a supratentorial tumour under general anaesthesia and who were categorised as having an American Society of Anaesthesiologists (ASA) II-III physical status, participated in this prospective, randomised, controlled, double-blind study.

The study was conducted between July 2021 and September 2023, following approval from the Ethical Committee at Tanta University Hospitals in Tanta, Egypt (approval code: 34752). Written consent informed by the patient's information was obtained.

Patients were excluded if they had a preoperative MRI showing a midline shift of more than 5 mm, were scheduled for electrophysiological monitoring, had a history of an allergic reaction to related anesthetics, scored less than 15 on the Glasgow Coma Scale, had a history of cerebral vascular disease or uncontrolled cardiopulmonary disease, had a contraindication for regional block such as a bleeding disorder, infection at the injection site, unstable cardiac condition, a body mass index of over 30 kg/m2, were scheduled to retain tracheal intubation postoperatively, or were unable to understand and cooperate with the examination.

Randomization and blindness

Computer-generated randomisation software was used to assign patients to two groups. The allocation for randomisation was then hidden in a sealed envelope. There were two equal groups of patients: Group I (n=36): 15 minutes before to skull pinning, general anaesthesia was induced, and a sham scalp block was carried out using 20 ml of normal saline. Group II (n=36): real scalp block was performed using 20 mL as total volume (10 ml of 0.5% bupivacaine plus 8 ml lidocaine 2% plus 2 ml of 1:200,000 epinephrine) after induction of general anesthesia 15 minutes before skull pinning. The anesthetic mixture was prepared by an anesthesia resident who didn't participate in either data collection or data analysis, neither the patient nor the anesthetist who performed the technique and data analysis knew the group assignment.

Prior to surgery, a comprehensive medical evaluation was conducted on all patients, including a detailed medical history, physical examination, and laboratory tests [complete blood count (CBC), coagulation profile, renal and liver function tests, and imaging studies].

Patients were allowed to skip two hours of clear liquids, four hours of semisolid meals, and eight hours of solid food. Following an explanation of the numeric rating system, the patients received extensive training on how to use it. They were asked to rate their degree of discomfort on a 10-point scale, where 10 represented "the worst imaginable pain" and zero represented "no pain."

Upon entering the operating theatre, an intravenous line was set up with an 18 G cannula for all patients, and standard monitoring equipment was attached which included five-lead electrocardiography, pulse oximetry, non-invasive blood pressure measurement, and a temperature probe for temperature measurement. Intravenous midazolam (0.05 mg/kg) was administered as a sedative agent, along with ondansetron (8 mg IV), given intravenously. Patients received a 5 ml/kg intravenous infusion of ringer's solution over a period of 20 minutes. General anesthesia was initiated by preoxygenating the patient with 100% O2 for 3 minutes, following which fentanyl (2 µg/kg IV) and propofol (1-2 mg/kg IV) were administered to induce anesthesia. Cisatracurium (0.1 mg/kg IV) was then given to facilitate muscle relaxation, and the patient was manually ventilated using a bag-face mask until complete relaxation was achieved. Ninety seconds before to endotracheal intubation, lidocaine (1.5 mg/kg) was given to reduce pain. After that, the patient was hooked up to a mechanical ventilator and a proper endotracheal tube was placed. The ventilator's parameters, which comprised a tidal volume of 6 ml/kg, a respiratory rate between 12 and 16 c/m, and a positive end-expiratory pressure (PEEP) between 5 and 10 cm H2O, were set to maintain an end tidal CO2 level between 30 and 34 mmHg.

In order to facilitate direct and continuous blood pressure monitoring and blood sampling, a central venous line was inserted under ultrasound guidance after general anaesthesia was induced. Additionally, a 20-gauge arterial line was placed in the radial artery on the nondominant hand following a negative Allen's test. The transducer was calibrated at the fourth intercostal space, located in the midaxillary line. Urinary bladder catheterization was implemented, and the use of capnography, bispectral index (BIS), and nasopharyngeal temperature probes was initiated.

Technique of the scalp block

The patient was positioned supinely before their skin was disinfected using a 10% povidone iodine solution and then covered. The following sterile supplies were utilised: towels, gauze packs, syringes containing 20 mL, either normal saline in group I or the local anesthetic combination consisting of 10 ml of 0.5% bupivacaine, 8 ml of 2% lidocaine, and 2 ml of 1:200,000 epinephrine in group II, and a 22-gauge needle for infiltration of local anesthetics. A 22-gauge needle was used to block the supraorbital and supratrochlear nerves as they left the orbit with two millilitres of a solution. The needle was put along the orbit's

top border, at a straight angle to the skin, approximately 1 centimetre closer to the midline than the supraorbital foramen. The finger was used to feel the supraorbital notch. It is possible to block the supratrochlear nerve as it emerges above the eyebrow or to be impacted by a medial extension of the supraorbital block. The supratrochlear nerve is derived from the superiomedial angle of the orbit and travels upward along the forehead parallel to the supraorbital nerve, one finger's breadth closer to the midline.

Two millilitres of a local anaesthetic combination were injected 1 to 1.5 centimetres in front of the ear, at the level of the tragus, to block the auriculotemporal nerve across the zygomatic process. Two millilitres of solution were used to anaesthetise the postauricular branches of the larger auricular nerves, which are located 1.5 cm posterior to the ear at the level of the tragus, between the skin and the mastoid process. A 2 ml local anaesthetic combination was injected 2.5 cm lateral to the nuchal midline, almost halfway between the occipital protuberance and the mastoid process, to block the greater occipital nerve.

The most significant landmark was palpating the occipital artery, followed by a medial injection after cautious aspiration to prevent the risk of intra-arterial injection.

A 2ml local anesthetic mixture was infiltrated along the superior nuchal line, approximately 2.5 cm lateral to the site of the greater occipital nerve block.

Anesthetic Management

Anesthesia was maintained using a mixture of 50% oxygen and air, in combination with a propofol infusion that ranged from 4 to 8 mg per kilogram per hour, and the dose was adjusted according to the BIS index, which was kept between 40 and 60, until wound closure. Additional doses of cisatracurium (2 mg each) were administered, and a further dose of fentanyl (0.5 micrograms per kilogram) was given before the skull was pinned in order to mitigate the hemodynamic stress response associated with this procedure. If the BIS index exceeded 60, or if there was an increase in heart rate or mean arterial blood pressure by more than 20% above baseline values, further intervention was taken.

The doses of fentanyl, propofol, and cisatracurium were documented for further analysis. Following anesthesia induction, mannitol was administered at a dose of 0.5 g per kilogram over a period of 20 minutes. Additionally, patients received ondansetron in a dose of 8 mg, and those who had previously been given a loading dose of 15 mg per kilogram of phenytoin also received an additional 5 mg per kilogram. Ringer's solution was administered at a rate of 3 ml/kg/h, and blood losses were replaced with an equal volume of blood or colloids. Additionally, intraoperative methylprednisolone, 500 mg, was administered via IV infusion over a period of 30 minutes.

Extubation and recovery

After the surgery was finished, the administration of anesthesia was stopped, and neostigmine (0.04-0.08 mg/kg) was used to reverse the effects of muscle relaxation, alongside atropine (0.01 mg/kg). A dose of 1.5 mg/kg lidocaine was given to enable a safe and trouble-free extubation process. Following the procedure, patient recovery metrics such as extubation time, spontaneous eye opening, and the ability to walk, along with an Alderet's score of 10, were then assessed. Once these requirements were fulfilled, the patients were relocated to the post-anesthesia care unit (PACU).

Patients were given standard postoperative pain relief involving a 1gm paracetamol infusion every 6 hours and 30mg ketorolac administered intravenously every 12 hours. When the pain rating reached a score of 4 or higher on the NRS, patients received 0.1mg/kg of morphine intravenously at a slow rate and this was repeated as necessary.

Records were kept of the time to the first request for rescue analgesics, the total dose of morphine administered, and any adverse events that occurred.

The primary outcome was recovery characteristics (time to modified Aldret's score to reach 10). The secondary outcome were total analgesic consumption and numeric Rating scale for pain assessment.

Sample Size Calculation

A sample size of 33 patients per group was needed to achieve an 80% power and a 95% confidence level, accounting for a 10% loss of follow-up; consequently, each group comprised 36 patients based on recovery characteristics requiring Aldert's score to reach 10 or more [7].

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). The normality of the data distribution was evaluated using the Shapiro-Wilk test and histograms. Quantitative parametric data were expressed as mean and standard deviation (SD) values, and a comparison between the two groups was performed using the unpaired Student's t-test. The median and interquartile range (IQR) were used to display quantitative non-parametric data, and further analysis was conducted using the Mann-Whitney test. Qualitative data were presented as frequencies and percentages, and were subsequently analyzed with the Chi-square test or Fisher's exact test where appropriate. A P value under 0.05 was deemed to be statistically significant.

Results

Sixty-four adults of both sexes ultimately participated in the study after excluding 18 individuals, with 10 failing to meet the required criteria and 8 opting not to participate. A total of 72 patients remained, who were subsequently randomly distributed into two groups, each consisting of 36 patients. The individuals participating in the study were later tracked and statistically analyzed. Figure 1

Regarding time to extubation, spontaneous eye opening, obey commands, modified Aldert's score to reach 10 mins, first request of analgesia, intraoperative fentanyl and propofol consumption were significantly higher in group I than group II ($p<0.05$). Regarding cistacuraium consumption and time to ambulation were insignificantly different between both groups. Table 2.

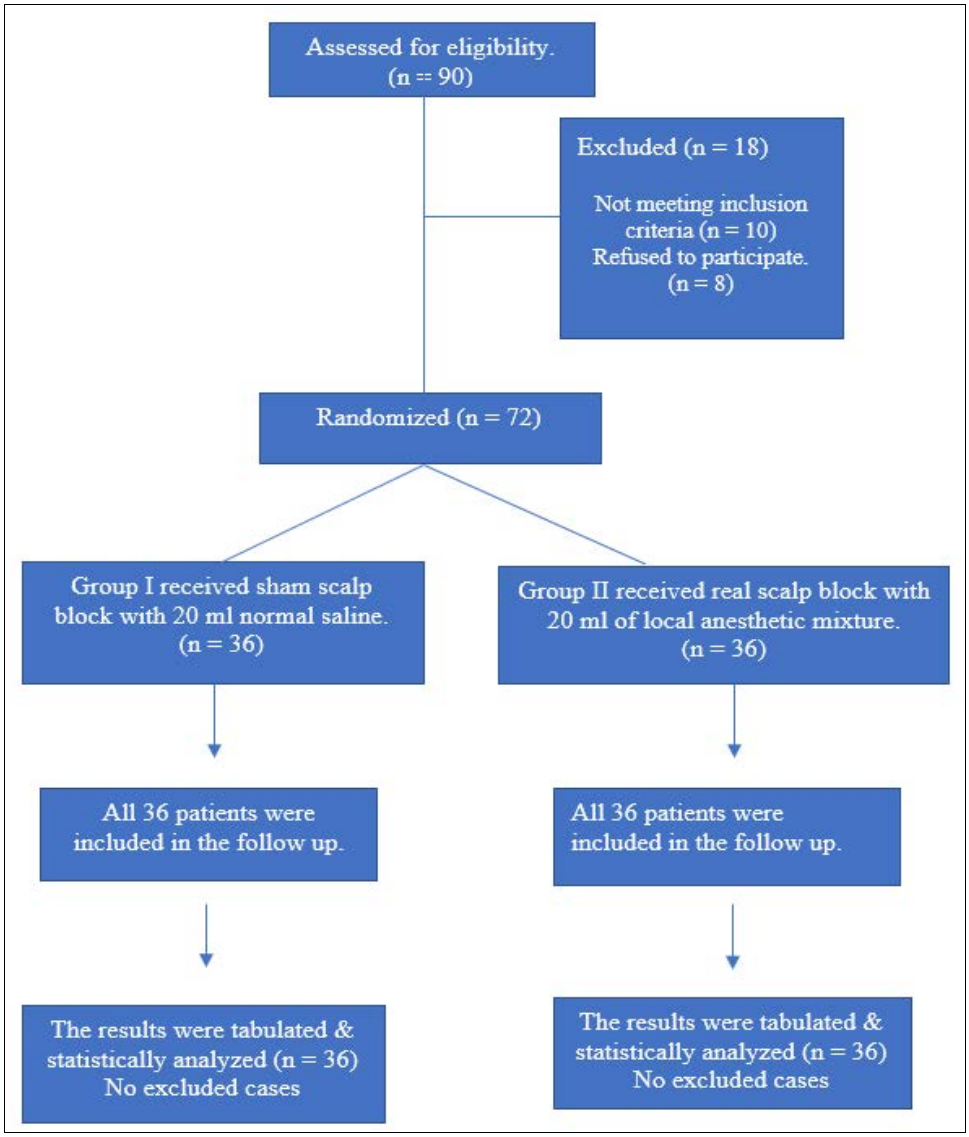


Fig 1: CONSORT flowchart of the enrolled patients

Demographic data and type of surgery were insignificantly different between both groups. Table 1.

Table 1: Demographic data and type of surgery of the studied patients

		Group I (n=36)	Group II (n=36)	Test of sig.	P
Age (years)		46.35±14.31	46.70±14.25	t=0.099	0.922
Sex	Male	19(52.7)	18(50.0%)	χ^2=0.017	0.895
	Female	17(47.3%)	18(50.0%)		
Weight (kg)		78.86±16.75	76.83±10.84	t=0.152	0.529
Diabetic patients		6(17.6%)	8(24.2%)	t=0.077	0.781
Hypertensive patients		9(26.4%)	11(33.3%)	t=0.148	0.350
Cardiac patients		4(11.7%)	3(9.0%)	t=0.090	0.382
Duration of surgery		237.42±41.75	239.33±46.37	t=0.184	0.854
Type of surgery	Frontoparietal meningioma	11(32.4%)	14(42.4%)	χ^2=0.726	0.394
	Occipital glioma	6(17.6%)	6(18.2%)	χ^2=0.003	0.954
	Temproparietal glioma	5(14.7%)	6(18.2%)	χ^2=0.147	0.701
	Sphenoid meningioma	4(11.8%)	4(12.1%)	χ^2=0.002	1.000
	Frontoparietal glioma	5(14.7%)	2(6.1%)	χ^2=1.338	0.427
	Craniopharyngioma	3(8.8%)	1(3.0%)	χ^2=1.001	0.614
	Patients with raised ICP	25(73.5%)	24(70.5%)	χ^2=0.664	0.431

Data are presented as mean ± SD or frequency (%). t: Student t-test. X^2: Chi square test, ICP: Intracranial pressure.

Table 2: Time to extubation, spontaneous eye opening, obey commands, modified Aldert's score to reach 10 mins and first request of analgesia and ambulation, intraoperative fentanyl, propofol, cistacuraium and postoperative morphine consumption of the studied groups

	Group I (n=36)	Group II (n=36)	Test of sig.	P
Time to extubation (min)	12.06±1.93	8.92±2.25	t=6.363*	<0.001*
Time to spontaneous eye opening (min)	14.97±2.13	11.06±2.40	t=7.319*	<0.001*
Time to obey commands (min)	23.21±4.29	17.52±3.12	t=6.068*	<0.001*
Time to modified Aldert's score to reach 10/ mins	28.17±3.50	20.50±4.13	t=8.496*	<0.001*
Time to first request of analgesia	1.0 – 2.0	1.0 – 3.0	U=441.500*	0.012*
Time to ambulation (hr)	13.92±4.85	12.22±4.28	t=1.571	0.121
Intraoperative fentanyl consumption	137.06±33.26	61.03±14.02	t=0.751	0.042*
Intraoperative propofol consumption	2.438±0.766	2.129±0.539	T=3.982	0.043*
Intraoperative cistacuraium consumption	35.26±10.36	30.09±6.86	t=1.797	0.077
Postoperative morphine consumption	17.91±1.96	15.76±2.61	t=1.205	0.042*

Data are presented as mean ± SD or median (IQR). * Significant P value <0.05. t: Student t-test, U: Mann Whitney test.

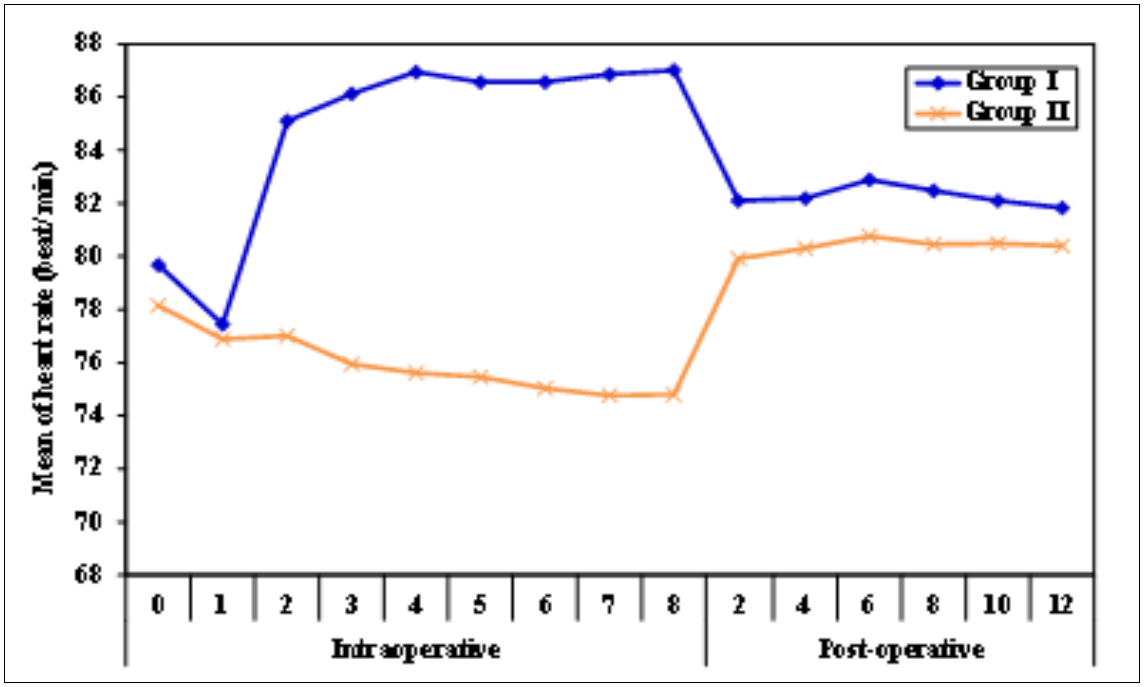
NRS showed a significant increase at 4h, 6h, 8h, 12h, 24h and 48 h compared to value of NRS at 2 hours (p<0.05), while There was no significant difference of NRS at 4h, 6h, compared to value of NRS at 2 hours postoperatively. Table 3.

Table 3: Changes in NRS in group I and II

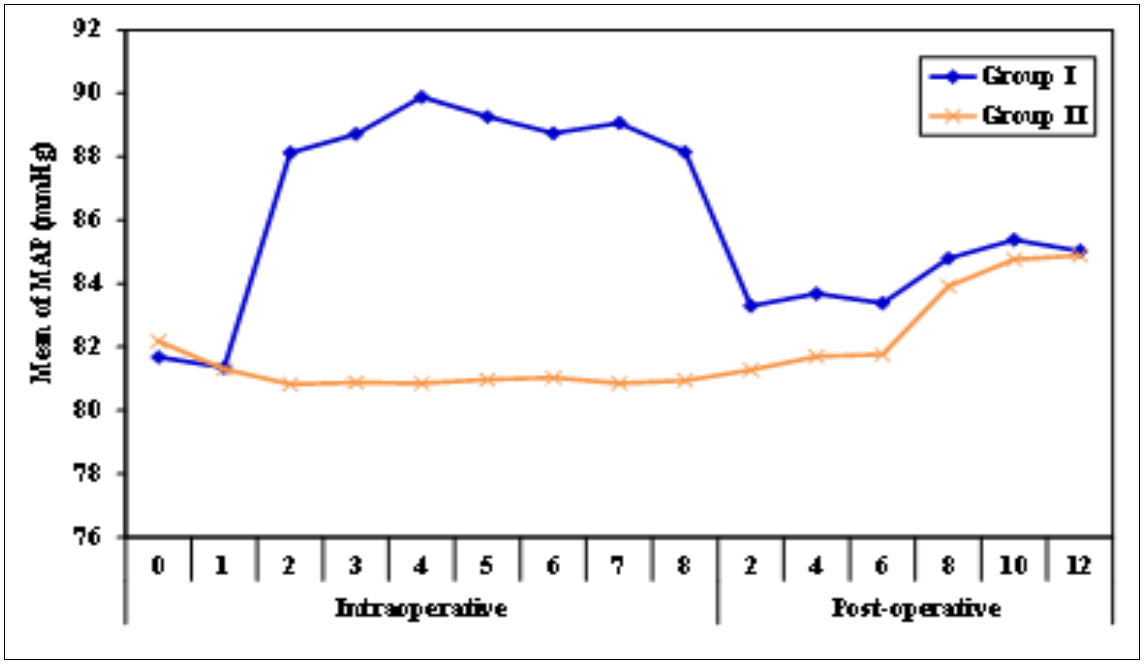
	Group I (n=36)	P	Group II (n=36)	P
2nd	5.0–7.0	-	2.0–4.0	-
4th	3.0–5.0	<0.001*	2.0–4.0	0.567
6th	3.0–6.0	<0.001*	3.0–4.0	0.230
8th	3.0–6.0	<0.001*	3.0–5.0	0.002*
12th	4.0–6.0	0.015*	4.0–5.0	<0.001*
24th	4.0–6.0	0.007*	4.0–7.0	<0.001*
48th	5.0–6.0	0.036*	4.0–7.0	<0.001*

Data are presented as median (IQR). * Significant P value < 0.05. NRS: Numeric rating scale.

The baseline heart rate and mean arterial pressure during surgery were similar between the two groups at the start of the procedure, but decreased significantly in group II at 1, 3, 5, 15, 30, 45 and 60 minutes after the pin was inserted, compared to group I. The postoperative heart rate and mean arterial pressure were not significantly different between the two groups being compared. Figure 2.



(A)



(B)

Fig 2: (A)Heart rate and (B) mean arterial blood pressure between the studied groups

The group II experienced a substantial decline in the NRS compared to group I at 2, 4, and 6 hours post-surgery ($p< 0.05$). However, there was no significant disparity between the two groups concerning the NRS at 8, 12, 24, and 48 hours post-operatively. Table 4.

Table 4: Comparison between the two studied groups according to NRS, HR and MAP:

	Group I (n=36)	Group II (n=36)	Test of Sig.	P
2nd	6.14±1.57	2.69±1.12	U=53.00*	<0.001*
4th	4.08±1.08	2.89±1.24	U=314.50*	<0.001*
6th	4.61±1.96	3.25±0.87	U=389.50*	0.003*
8th	4.53±1.59	3.86±1.07	U=494.00	0.075
12th	5.17±1.13	4.6±1.13	U=487.50	0.060
24th	5.0±1.01	5.44±1.48	U=538.50	0.204
48th	5.14±0.93	5.39±1.64	U=588.00	0.485

Data are presented as mean ± SD. * Significant P value < 0.05. NRS: Numeric rating scale, HR: Heart rate, MAP: Mean arterial blood pressure, U: Mann Whitney test, t: Student t test.

There was no significant difference between the two studied groups regarding length of ICU and hospital stay and complications. Table 5.

Table 5: Comparison between the two studied groups according to length of ICU and hospital stay and incidence of complications

		Group I (n=36)	Group II (n=36)	Test of Sig.	P
Length of ICU stay (day)		4(3-5)	4(2-5)	U=600.50	0.587
Length of hospital stay (day)		7(4-13)	7(3-12)	U=622.0	0.767
Complications	Seizures	14(43.2%)	16(48.5%)	X^2=0.362	0.548
	PONV	9(26.5%)	4(12.1%)	X^2=2.205	0.138
	Headache	8(23.5%)	3(9.1%)	X^2=2.544	0.111
	Infections	4(11.8%)	5(15.2%)	X^2=0.165	0.734
	Bleeding	8(26.5%)	5(15.2%)	X^2=1.752	0.155

Data are presented as mean ± SD or median (IQR) or frequency (%). ICU: Intensive care unit. PONV: Postoperative nausea and vomiting, t: Student t test, U: Mann Whitney test. X^2: Chi-square test.

Discussion

The supratentorial tumors includes tumors arising from the following structures: the cerebrum, lateral ventricle and third ventricle, choroid plexus, pineal gland, hypothalamus, pituitary gland, and optic nerve [8].

The scalp block group exhibited clinically substantial hemodynamic stability, characterised by consistent MAP and HR, and remained unchanged in response to painful stimuli, such as head pinning and skin incision, without significant fluctuations. There was a notable reduction in the overall intraoperative use of propofol and fentanyl. Findings were consistent with those reported by TONKOVIĆ D *et al.* [9], who demonstrated excellent hemodynamic stability in all patients undergoing combined regional anesthesia with scalp block and general anesthesia. Pin-on P *et al.* [3] discovered that administering a scalp block before incision

can decrease the hemodynamic stress reaction experienced during the insertion of skull pins, which is considered the most intense stimulus before craniotomy. Additionally, the amount of fentanyl used during the operation was significantly lower in the group that received the scalp block. In contrast to our study, Gazoni *et al.* [10] discovered a substantial disparity in MAP and HR between the study groups.

Regarding the recovery characteristics it was found that patients who received real scalp experienced early postoperative recovery as early extubation, spontaneous eye opening, obeying commands and shorter time to modified Aldert's score to reach 10. In agreement with our results Can B O [11] found that scalp block that was performed 5 min before head pinning either using 0.5% bupivacaine or 0.5% levobupivacaine immediately after induction of general anesthesia resulted in a better postoperative recovery profile. Moreover, Mostafa R H *et al.* [12] discovered that the use of scalp block in conjunction with general anesthesia resulted in stable blood pressure and an improved post-operative recovery during craniotomy procedures. Contrary to the findings of our research, Gazoni FM *et al.* [10] have shown that employing a skull block offered no benefit in terms of early recovery and extubation compared to the use of remifentanil infusion alone.

This study provided effective post-surgical pain relief, demonstrated by a notable decrease in NRS scores within the initial 6 hours following surgery, longer intervals before patients required additional pain medication, and reduced total morphine usage post-surgery. Our research is supported by the findings of Carella M, *et al.* [13], who discovered that patients who underwent a scalp block experienced less severe postoperative pain and required significantly more morphine overall than those in the control group. A study conducted by Rigamonti A *et al.* [14] found a decrease in the average pain score, as reported on the Visual Analog Scale, within the initial post-surgical period, specifically before the 12-hour mark. In the first 12 hours following surgery, VAS scores were higher in the control group than in the treatment group. At 12 hours, the groups displayed no differences. In contrast to our results, Gazoni FM *et al.* [10] discovered that no disparity existed in 1, 2, 4 hour or maximum overnight VAS scores between the groups.

The investigation revealed no substantial disparity between the researched groups in terms of time to walking, duration of ICU stays, length of hospital stays, and incidence of complications. Our study supports the findings of Rigamonti A *et al.* [14], who found no significant difference in hospital discharge times and PACU times between the two groups. Hagan KB *et al.* [15] disputed our findings, showing that pain management leads to enhanced functional recovery and shorter hospital stays for patients undergoing craniotomy.

The study found no statistically significant disparities amongst the groups examined in relation to postoperative complications such as headache, seizures, postoperative nausea and vomiting, infection, and bleeding. Our study is in line with the findings of Rigamonti A *et al.* [14], who discovered no substantial distinction between the two groups. Similarly, Law-Koune JD *et al.* [16] noted that there were no statistically significant disparities among the groups concerning postoperative complications, such as PONV.

Limitations of the study included that the sample size was relatively small. The study didn't evaluate different local anesthetics. The study didn't evaluate different concentrations of local anesthetics. No different additives were added to the local anesthetic mixture and evaluated. The study didn't measure intraoperative ICP. Intraoperative surgical circumstances as blood loss and surgical field weren't taken into consideration.

Conclusions

Preemptive scalp block with 0.5% bupivacaine plus 1:200000 epinephrine allows smooth recovery by the end of surgery as early extubation, rapid spontaneous eye opening and obeying commands, shorter time for Aldert's score to reach 10. Also, it blunts the stress response to noxious stimuli as during insertion of cranial pins and skin incision leading to more hemodynamic stability intraoperatively. Also, it lowers the total intraoperative anesthetics and postoperative analgesic requirements, delay the onset of rescue analgesics and offers adequate postoperative analgesia.

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Conflict of Interest: Nil

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