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Effectiveness of Scalp Nerves Block in Reducing the Immediate Postoperative Pain in Patients Undergoing Craniotomy in Elective Neurosurgical Procedures

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Author`s Contribution

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ABSTRACT

Objective: To determine the usefulness of regional scalp block in controlling pain after craniotomy.

Methodology: This prospective, randomized, double-blind, placebo-controlled study was conducted at the Pakistan Institute of Health Sciences, Islamabad from November 2021 to April 2022. Adult patients aged 18 to 65 years, scheduled for elective craniotomy for neurosurgical procedures with an American Society of Anesthesiologists (ASA) physical status of I or II, of either gender, were included. Patients underwent craniotomy for their respective lesions. Patients were randomized into two groups: one receiving a regional scalp nerve block of 0.5% bupivacaine with 1:100,000 epinephrine after general anesthesia, and the other undergoing general anesthesia as a placebo. Pain intensity was assessed using the Visual Analog Scale (VAS) pain score at baseline (preoperatively), at 1 hour postoperatively, and at 6 hours postoperatively.

Results: The mean age of patients in the treatment group was 43.14 years, while in the control group, it was 42.55 years. The treatment group had 26 males (54.2%) and 22 females (45.8%), while the control group had 25 males (52.1%) and 23 females (47.9%). There was no significant difference in the VAS score preoperatively ($p > 0.05$). Patients undergoing surgeries lasting less than 3 hours showed that the treatment group had a significantly lower mean VAS score of 3.08 at 1 hour compared to the control group's score of 5.11 ($p = 0.027$), while at the 6-hour post-surgery it was insignificant ($p = 0.844$).

Conclusion: The administration of scalp nerve blocks using bupivacaine and epinephrine prior to surgical incisions has demonstrated notable advantages in terms of postoperative pain management. Such nerve blocks can offer superior postoperative analgesia compared to the control group.

Key Words: Craniotomy, nerve block, postoperative pain, scalp, bupivacaine, epinephrine.

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Introduction

Scalp is not only enriched with an abundant blood supply but also augmented with an ample network of nerves. Numerous references indicate that individuals who undergo craniotomies encounter substantial postoperative pain.[1] A prospective investigation revealed that as many as 80% of patients endure varying degrees of pain during the immediate postoperative phase.[1,2] Clearly, this postoperative pain is attributed to the generous nerve supply of the scalp. The skull bone is not pain-sensitive, so while raising the bone flap, patients usually do not feel pain. It is the skin flap that causes pain due to its plentiful nerve supply; branches of the trigeminal nerve and C2

spinal nerve supply most of the scalp region. Post-craniotomy pain is very disturbing. It is severe in 10% to 20% of patients and moderate in more than 30% of patients.[3,4] It not only lengthens the hospital stay and consumes resources but also brings about changes in heart rate and sleep patterns. Pain experienced by patients after undergoing a craniotomy for brain tumors was extensively recorded and linked to symptoms such as vomiting, nausea, alterations in blood pressure, and it had an effect on the duration of the patient's hospitalization.[5,6] Opioids are thought to be better analgesics with the potential to mask consciousness and delay postoperative recovery. Other harmful effects of opioids include nausea, vomiting, and respiratory depression.[7] Non-steroidal anti-inflammatory drugs are also avoided because they interfere with platelet function. Moderate analgesics like tramadol and codeine are routinely given with reasonable but not the desired results. Moderate analgesia, when combined with the scalp nerve block, is the ideal treatment modality for combating post-craniotomy pain.

A smooth recovery after craniotomy is the holy grail of the neurosurgical team. Postoperative pain is not routinely managed with opioids because of their unpleasant side effects. Hemodynamic stability and pain control are the two desired goals after the craniotomy. Recent advances in the adjuncts of anesthesia have made it possible to minimize post-craniotomy pain. Short-acting analgesic agents are being used during anesthesia, but to maintain a postoperative pain-free state, many adjuncts have been modulated. One such technique is scalp nerve block.[3,8] This method blocks the nerves of the scalp, providing a smooth postoperative period, a peaceful stay on the neurosurgical floor, and an early discharge of the patient. Many researchers have advocated the use of scalp nerve block to attain a smooth postoperative recovery and a pleasant hospital stay. This study has been conducted to evaluate the effectiveness of scalp nerve block in reducing immediate postoperative pain in patients undergoing craniotomy for elective neurosurgical procedures.

Methodology

This prospective, randomized, double-blind, placebo-controlled study was conducted at the Pakistan Institute of Medical Sciences, Islamabad, from November 2021 to April 2022. Ethical approval was obtained from the Institutional Review Board (IRB). All adult patients aged 18 to 65 years, who were scheduled for elective craniotomy for neurosurgical procedures and had an American Society of Anesthesiologists (ASA) physical status of I or II, regardless of gender, were included. Exclusion criteria comprised patients with contraindications to scalp nerve block, a history of allergies to local anesthetics, coagulopathy or bleeding disorders, pregnancy or breastfeeding, a Glasgow Coma Scale score below 15, and a history of opioid dependence. Each participant received a written informed consent form after a comprehensive explanation of the study's purpose and objectives.

All patients underwent craniotomy for their respective lesions. This study employed a prospective design where patients were randomly assigned to one of two groups: one receiving a regional scalp nerve block consisting of 0.5% bupivacaine with 1:100,000 epinephrine after general anesthesia, and the other undergoing general anesthesia without a regional scalp nerve block, with 0.5% bupivacaine with 1:100,000 epinephrine administered as a placebo. The specific nerves targeted for the blocks included the greater occipital nerve, lesser occipital nerve, auriculotemporal nerve, supraorbital nerve, and supratrochlear nerve.

Pain intensity was assessed using the Visual Analog Scale (VAS) pain score, a widely recognized and validated pain assessment tool. Measurements were taken at various time points, including baseline (preoperatively), at 1 hour postoperatively, and at 6 hours postoperatively. Data collection was performed using a study proforma, and SPSS version 26 was utilized for data analysis.

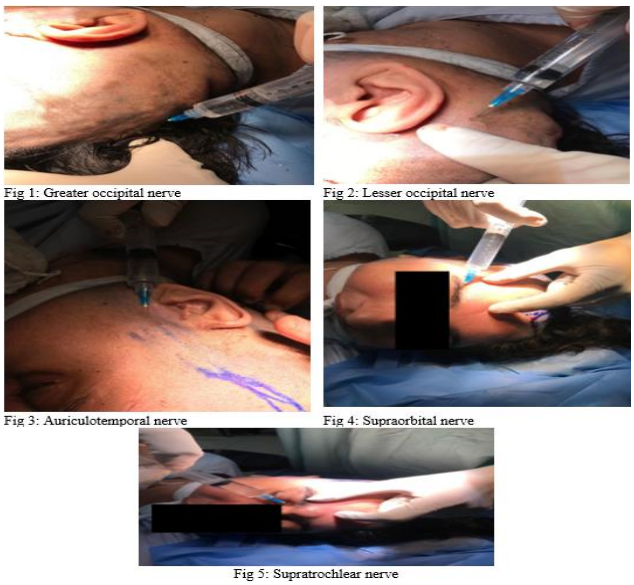
Fig 1: Greater occipital nerve
Fig 2: Lesser occipital nerve
Fig 3: Auriculotemporal nerve
Fig 4: Supraorbital nerve
Fig 5: Supratrochlear nerve

Figure: Targeted nerve blocks

Results

The mean age of patients in the treatment group was 43.14 years, while in the control group, it was 42.55 years. Mean

BMI of patients in the treatment group was 22.95 kg/m2, while in the control group, it was 22.31 kg/m2. The treatment group had 26 males (54.2%) and 22 females (45.8%), while the control group had 25 males (52.1%) and 23 females (47.9%). In terms of ASA classification, both groups had similar proportions of ASA I and ASA II patients. (p->0.05) indicating no statistically significant differences based on age, BMI, gender and ASA. However, with a significant difference p-0.036, showed that treatment group had a higher percentage of patients with tumors (62.5%) compared to the control group (87.5%). Conversely, the control group had a lower percentage of patients with aneurysms, abscesses, and AVMs compared to the treatment group. (Table I)

Table I: Demographic and clinical characteristics of the patients (n=96)

Variables		Study groups: Treatment group	Study groups: Control group	p-value
Mean age		43.14+3.12 years	42.55+4.11 years	0.774
Mean BMI		22.95+1.44 kg/m2	22.31+2.51 kg/m2	0.855
Gender	Male	26	25	0.838
		54.2%	52.1%	
	Female	22	23	
		45.8%	47.9%	
ASA	I	30	32	0.670
		62.5%	66.7%	
	II	18	16	
		37.5%	33.3%	
Diagnosis	Tumor	30	42	0.036
		62.5%	87.5%	
	Aneurysm	13	5	
		27.1%	10.4%	
	Abscess	3	1	
		6.3%	2.1%	
	AVM	2	0	
		4.2%	0.0%	

There is no significant difference in the VAS preoperatively, it was slightly higher in treatment group both at admission and just before the surgery (p=>0.05). (Table II)

Patients undergoing surgeries lasting less than 3 hours showed that the treatment group had a significantly lower mean VAS score of 3.08 at 1 hour compared to the control group's score of 5.11, (p-0.027), while at the 6-hour post-surgery it was insignificant (p-0.844). Conversely, for surgeries lasting more than 3 hours, the treatment group had a significantly lower mean VAS score of at 1-hour and at 6-hour post-surgery compared to the control group (p-<0.05). Postoperative pain, nausea and vomiting have a very close association with each other. Scalp nerves block not only resulted in curtailing the postoperative pain but also abated the associated nausea and vomiting in post craniotomy patients. (Table III) During the surgery, there were no recorded scalp hematomas resulting from the administration of bupivacaine or epinephrine. Additionally, there were no post-operative skin or subgaleal infections. Furthermore, there were no overall complications associated with the subcutaneous injection of epinephrine and bupivacaine in blocking the scalp nerves.

Table II: Mean VAS comparison in both groups preoperatively. (n=96)

VAS	Study groups: Treatment group	Study groups: Control group	P-value
At admission	2.17+1.22	2.02+2.13	0.672
Before surgery	2.51+1.57	2.35+1.71	0.844

Discussion

Pain after undergoing a craniotomy has often been overlooked due to the misconception that individuals who have had this procedure do not typically suffer from intense pain.[9] A concept of regional anaesthesia is being forwarded these days to reduce the side effects of systemic anaesthesia. Scalp is composted by the branches of the C2 spinal nerve and the trigeminal nerve. Post-craniotomy pain results from the dissection and manipulation of the scalp and muscles, while the elevation of the bone flap and brain dissection do not contribute significantly to postoperative pain. A desired anaesthetic effect can be achieved by blocking these nerves which are supplying the layers of the scalp.

However, this study was designed to evaluate the efficacy of 0.5% bupivacaine with 1:100,000 adrenaline for postoperative pain relief after craniotomy. According to

Table III: Mean VAS comparison at 1 hour and 6 hours postoperatively. (n=96)

Variables		Study groups: Treatment group	Study groups: Control group	p-value
<03 hour of surgery (VAS)	At 1 hour after surgery	3.08+1.55	5.11+2.50	0.027
	At 6th hour after surgery	4.18+1.77	5.32+2.33	0.844
>03 hour of surgery (VAS)	At 1 hour after surgery	3.83+1.21	6.11+2.81	0.001
	At 6th hour after surgery	4.85+1.09	6.80+2.50	0.047
Vomiting	At 1 hour after surgery	4(8.3%)	8(16.7%)	0.217
	At 6th hour after surgery	5(10.4%)	9(18.8%)	0.247

the findings of our study, scalp nerve block with bupivacaine and epinephrine relieved postoperative pain for up to 6 hours following elective craniotomy under general anaesthesia. The addition of epinephrine to bupivacaine extended the analgesic effect for up to six hours postoperatively. The treatment group experienced mild pain one hour after surgery, whereas the control group experienced moderate pain. at 06 hours after surgery. In the treatment group, pain intensity ranged from mild to moderate, whereas it ranged from moderate to severe in the control group. Patients experienced pain as the analgesic effect wore off over time. Another important consideration was the length of the surgery. When compared to prolonged surgery, quick and safe surgery resulted in ancillary pain. Patients in the treatment group

who were operated on in less than three hours had less pain than those who were operated on in more than three hours. Several studies have confirmed that scalp nerve block has benefits for reducing post-operative pain and maintaining hemodynamic stability during noxious procedures. Bala I et al[10] analyzed the role of 0.5% bupivacaine with adrenaline in reduction of post craniotomy pain. pain scores were notably lower in the treatment group. Most of the patients in the treatment group were pain free or experienced very mild pain up to 6 hours as compared to control group. They summarized that Scalp nerve block using 0.5% bupivacaine with 1:400,000 adrenaline abated the severity of postoperative pain in craniotomies. There were two differences from our study, first we enrolled 96 patients and Bela et al10 enrolled 40 patients. We used 1:100,000 adrenaline while they used adrenaline 1:400,000. Akcil EF et al[11] carried out a prospective study included forty-seven patients. One group received only

local anesthesia while the second group received both local anesthesia as well as the scalp nerves block. Later group showed lesser frequency of pain post operatively and lesser consumption of morphine. They also observed that scalp block reduced the hemodynamic response to the pin head holder application and the skin incision in infratentorial craniotomies. Interesting thing about this study is that it was carried out in infratentorial brain surgeries.

In our routine surgeries, we give intravenous steroids to all patients undergoing brain tumor excision surgery. Gaudray E et al[12] analyzed the role of intravenous steroid administration in addition to scalp nerve blocks. They found that postoperative pain was significantly reduced in patients receiving both treatments, leading to a 40% reduction in the need for rescue analgesia. Approximately 60% of patients in the scalp nerve block group remained pain-free after surgery and did not require systemic analgesic drugs. They also noted improved hemodynamic stability.

Their observation was that Scalp nerves block along with intravenous dexamethasone was a methodical analgesic approach for craniotomies. Jose R et al[13] consented 90 patients for scalp nerves block. They added dexamethasone along with the local anaesthetic agent in one group for blocking the scalp nerves while the other group received the normal saline with local anesthetic agent. They concluded that Addition of dexamethasone as an adjuvant to local anesthetics in scalp nerve blocks in the setting of perioperative steroid therapy did not appear to provide any additional benefit with respect to prolongation of the duration of the block. However intraoperative opioid requirement and the incidence of postoperative nausea and vomiting was appreciably less documented. However, there is a study performed by Rigamonti A et al[14] who determined the effectiveness of scalp nerves block with 0.5% bupivacaine with 1:200,000 epinephrine. Eighty-nine patients were enrolled. There was no difference in the mean VAS score at 24 hours postoperatively between the treatment group and the control group. Their data shows that bilateral scalp blocks using bupivacaine with epinephrine did not reduce mean postoperative VAS score or overall opioid consumption at 24 hour nor the time-to-discharge from the post anesthesia care unit or from hospital.

Our findings are in line with other studies[15-17], suggesting that post-craniotomy pain primarily results from skin incision, muscle disruption, periosteum separation, and manipulation of dura, rather than parenchymal resection. Scalp nerve block plays a vital role in controlling postoperative headache by blocking pain afferent pathways to the central nervous system and enhancing postoperative analgesic efficacy. We chose bupivacaine for the study due to its superior safety profile, low toxicity, and shorter duration of action, providing a long-lasting analgesic effect. The vasoconstrictive effect was enhanced by the addition of epinephrine.

Conclusion

The administration of scalp nerve blocks using bupivacaine and epinephrine prior to surgical incisions has demonstrated notable advantages in terms of postoperative pain management. This conclusion is drawn from a growing body of evidence indicating that such nerve blocks can offer superior postoperative analgesia

compared to alternative methods. Additionally, the technique of scalp nerve blocks allows for targeted pain relief, focusing precisely on the area where the surgical incision is made. This precision minimizes the systemic distribution of analgesics, potentially reducing side effects and complications associated with widespread drug administration. Further research and clinical trials are essential to validate these findings and establish precise protocols.

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