Original Article

Sphenopalatine ganglion block: Intranasal transmucosal approach for anterior scalp blockade - A prospective randomized comparative study

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Abstract

Background and Aims: Peripheral nerve blocks in neurosurgical practice attenuate most stressful responses like pin insertion, skin, and dural incision. Scalp block is conventionally the blockade of choice. Further studies for less invasive techniques are required. Intranasal transmucosal block of the sphenopalatine ganglion has shown promising results in patients with chronic headache and facial pain. The primary objective of our study was to compare the gold standard scalp block and bilateral sphenopalatine ganglion block (nasal approach) for attenuation of hemodynamic response to pin insertion. Secondary objectives included hemodynamic response to skin and dural incision.

Material and Methods: After IRB approval and informed consent, a prospective randomized comparative study was carried out on 50 adult patients undergoing elective supratentorial surgery. The hemodynamic response to pin insertion, skin incision, and dural incision was noted in both the groups. The data was analyzed with NCSS version 9.0 statistical software.

Results: The HR and MAP were comparable between the groups. Following dural incision MAP was significantly lower at 1,2,3,4,5 and 10 min in group SPG whereas in group S it was significantly lower at 1 and 2min. ($P = 0.02$ at T1, $P = 0.03$ at T2).

Conclusions: Concomitant use of bilateral SPG block with general anesthesia is an effective and safe alternative technique to scalp blockade for obtundation of hemodynamic responses due to noxious stimulus during craniotomy surgeries.

Keywords: Block, craniotomy, hemodynamics, neurosurgery, pain, scalp block, sphenopalatine ganglion

Introduction

Skull pin application during neurosurgical procedure is an intense stressful period and is associated with application of almost a weight load of 30 lbs. It is accompanied by a sudden increase in heart rate (HR) and blood pressure (BP) due to stimulation of scalp and periosteal nerve endings.[1,2] Acute intraoperative arterial hypertension has been associated with intracranial hypertension in patients with intracranial tumors with peritumoral edema.[3] An abrupt hemodynamic fluctuation may lead to myocardial ischemia, cardiac failure, intracranial hemorrhage in high risk patients, and sometimes rupture of intracranial aneurysms.[4-6]

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Several techniques have been tried in neurosurgical patients to provide stable hemodynamics without sudden increase in intracranial pressure or acute brain swelling.[7] Peripheral nerve blocks have been shown to attenuate the hemodynamic response during the perioperative period and also facilitate a rapid and smooth recovery with less cognitive dysfunction in craniotomies.[8] Scalp blockade is the gold standard for peripheral nerve blockade in almost all neurosurgical craniotomies. Alternative techniques like bilateral sphenopalatine ganglion block are shown to be effective in anterior scalp blockade.[9] Scalp blockade involves multiple injections whereas sphenopalatine ganglion block is quite invasive. Bilateral sphenopalatine ganglion block via nasal route has been successfully used in patients with chronic headache and facial pain and for transsphenoidal pituitary and endoscopic sinus surgeries.[10-13] Intranasal transmucosal approach for SPG block is a less invasive technique. We designed this prospective randomized comparative study to test the hypothesis that bilateral SPG block along with greater and lesser occipital nerve block would be an alternative modality to anterior scalp block for attenuation of stress response to pin insertion in neurosurgical patients undergoing craniotomy. The primary objective of our study was to compare the hemodynamic responses following pin insertion. The secondary objectives included hemodynamic responses to skin incision and dural incision along with incidence of any other complications noted.

Material and Methods

A prospective randomized comparative study was planned after institutional ethics committee approval and informed consent. Fifty patients belonging to ASA grade I and II with GCS 15 undergoing craniotomy for suprasellar tumors were recruited for the study. All the patients were checked for patency of the nares in the preoperative checkup apart from the routine examination. Patients with nasal infection, deviated nasal septum, nasal polyps, traumatic CSF rhinorrhea, uncontrolled hypertensive patients, pregnant and lactating mothers, children, GCS less than 15, any infections of the scalp were excluded. Patients in whom there was difficulty in passing the nasal swab were excluded after inclusion in the study. All the patients received premedication with 0.5 mg of alprazolam and 150 mg of ranitidine in the night before and in the morning of surgery. All patients were randomly assigned by computer-generated randomization number to receive either of the two blocks along with posterior scalp blockade with 25 patients in each group: group S-scalp block, group SPG-sphenopalatine block. On arrival to the operating room noninvasive blood pressure, EKG, pulse oximeter was connected. Anesthesia induction was accomplished with fentanyl citrate 2 μg/kg, titrated dosage of thiopentone sodium 3--5 mg/kg followed by atracurium besylate 0.6 mg/kg for neuromuscular blockade. After standard induction and intubation, either of the procedures was performed as per the group. An intra-arterial catheter was placed in a radial artery for continuous monitoring of blood pressure. A peripherally inserted central venous catheter was secured for further management. All the patients were maintained with 0.8--1 MAC of isoflurane and systolic pressure variation (SPV) within normal limits throughout the procedure.

Scalp block

The following solution was used for the scalp block: (40 ml 0.25% bupivacaine) 2 ml each for supraorbital and supratrochlear nerves (8 ml), 4 ml for zygomaticotemporal nerve (8 ml), 2 ml each for auriculotemporal and posterior auricular nerve (8 ml) in front of and behind tragus respectively, 4 ml of 0.25% bupivacaine each for lesser and greater occipital nerves (16 ml) along the superior nuchal line. A minimum time period of 20 min was allowed for the onset of the block to be established before proceeding with the insertion of pins.

Sphenopalatine ganglion block

Initially, both nostrils were cleaned with antiseptic solution using two sterile swabs. Then, another sterile 10-cm cotton swab dipped in the chosen anesthetic was introduced and slowly advanced along the superior border of the middle turbinate until it reached the posterior wall of the nasopharynx. Neck was extended, while giving the block. 5 ml of 0.5% bupivacaine was instilled in each nostril. The swab was left in place for approximately 20 min. Each greater and lesser occipital nerves were blocked with 4 ml of 0.25% bupivacaine (16 ml).

HR and MAP were noted at different time points at 1, 2, 3, 4, 5, and 10 min following pin insertion 1, 2, 3, 4, 5, and 10 min following skin incision and 1, 2, 3, 4, 5, and 10 min following dural incision. If the HR and MAP was higher by more than 20% of the baseline, anesthesia was supplemented with propofol 20 mg bolus. Any complications like nasal bleeding, allergy, seizures, bitter taste, and infection were noted. Observations for the study ended here. Further anesthetic proceedings were according to standardized institute protocol.

Statistical analysis

Sample size was calculated with PASS 13.0 software. A sample size of 40 (20 each) to achieve 99% power with an alpha error of 0.05 was required to detect noninferiority using a one-sided, two-sample t-test. The margin of noninferiority was taken as -15.0 (20% change of the MAP) and standard deviation of 10.0. The true difference between the means was assumed to be 0.0. To account for loss of accrual from inability to complete the protocol or technical difficulty, overall 50 cases (25 in each group) were recruited for the study. NCSS version 9 statistical software was used for the analysis. The normality of the data was tested using

Anderson Darling test. Continuous data was displayed as mean ± SD and categorical data as number with percentage. Categorical data was compared using Chi-square test and the continuous variables were compared between the groups using paired sample t-test. A two-sided P value of <0.05 was considered significant for all tests. Repeated ANOVA was tested for hemodynamic data at each measurement time points and Tukey post-hoc was used for within the group comparisons at different timings following pin insertion and dural incision.

Results

The data was collected from January 2016 to July 2016. None of the patients were excluded from the study.

Demographic data was found to be normally distributed in both groups without any variance. Both the groups were comparable in terms of age, gender, body mass index, baseline HR, and MAP [Table 1].

There was no significant change of HR and MAP at different time points in either group after pin insertion. The overall MAP was significantly higher in SPG group compared with group S [Figure 1].

There were no statistically significant hemodynamic changes following skin incision in both the groups at different time points [Figure 2].

The HR changes were not statistically significant within the group and were comparable between the groups after dural incision. However, the MAP changes in group S was statistically significant at 1 and 2 min after dural incision. In the SPG group, MAP was significantly lower when compared with baseline at 1, 2, 3, 4, 5, and 10 min after dural incision ($P < 0.05$). The overall HR and MAP were comparable between both the groups [Figure 3].

Table 1: Demographic data

Demographic Profile	Mean±S.D/Number (%)		P
Groups	Group S (n=25)	Group SPG (n=25)	
Age (years)	36.6±12.9	30.6±11.7	0.25
Gender	12:13 (48:52)	9:16 (36:64)	0.4
Weight (kgs)	58.6±9.1	58.7±9.2	0.98
Height (cms)	154.1±5.8	153.6±8.1	0.8
Body mass index (kg/m^2)	24.6±3.2	24.9±3.4	0.8
Baseline heart rate	85.0±20.2	76.5±13.2	0.08
Baseline mean arterial pressure (MAP)	94.4±16.5	97.2±15.9	0.55

S.D.=Standard deviation; Group S=Group Scalp block; Group SPG=Group Sphenopalatine ganglion block; P=Probability

In group SPG, 2 out of 25 patients had nasal bleeding which was stopped spontaneously and 3 patients complained of bad taste in mouth. No other complications were noted in either group.

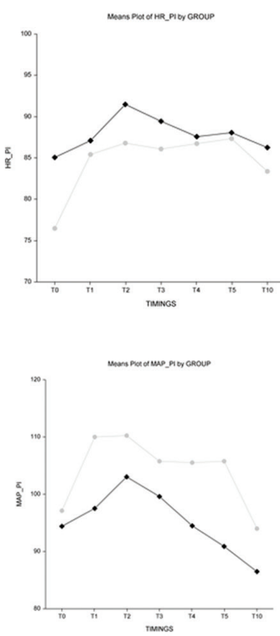
Discussion

Our study demonstrates that bilateral sphenopalatine ganglion block along with greater and lesser occipital nerve block provided comparable hemodynamics for attenuation of pin response as scalp block. After dural incision, the MAP was significantly lower compared with baseline at all measured time points ($P < 0.05$).

Scalp blockade promotes intraoperative hemodynamic stability,[8] and has been used as an adjunct to general anesthesia to maintain hemodynamic control. However, vascularity of the scalp, proximity of the arteries supplying cerebral circulation, large volume of local anesthetic requirement, presence of intracranial devices, or bony defects requires precaution for scalp blockade.[14] So, alternative methods are required for obtundation of the hemodynamic response to noxious stimulus.

The scalp is innervated by ophthalmic, maxillary, mandibular branch of trigeminal nerve anterolaterally, greater and lesser occipital branch of deep cervical plexus posteriorly. On the other hand, the duramater is innervated by three main branches of trigeminal nerve. So, blockade of the central ganglion and nerves will attenuate the hemodynamic response to dural incision.[15,16] Sphenopalatine ganglion is a parasympathetic ganglion located in the pterygopalatine fossa. It sends neural inputs to the lacrimal gland, glands of the nasal cavity, paranasal sinuses, palate and upper pharynx. The preganglionic parasympathetic axons synapse within the ganglion. The postganglionic parasympathetic and sympathetic neurons and somatosensory afferent branches of maxillary division of trigeminal nerve also pass through this ganglion. So, both the postganglionic parasympathetic, sympathetic neurons, and the somatosensory afferents can be inhibited by bilateral SPG block.[17]

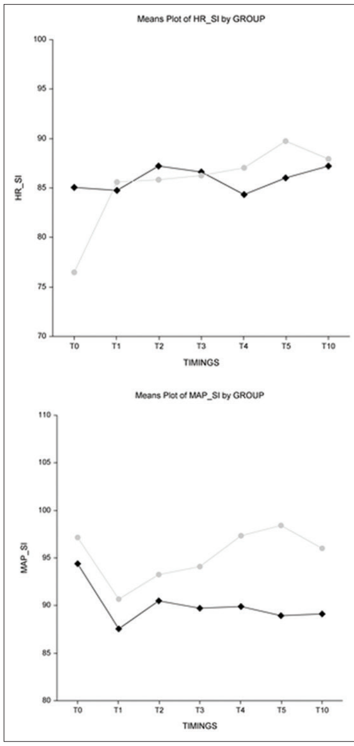
Most of the evidence shows scalp blockade can blunt the hemodynamic response due to Mayfield clamp placement and this benefit is continued until before dural opening. Only two studies have evaluated the effect of scalp blockade on hemodynamics during and after dural opening. They have shown that there is no clear benefit of this intervention.[18,19] A comparative study by Lee *et al.* for scalp blockade with bupivacaine 0.25% and saline group demonstrated better hemodynamic stability in bupivacaine group, without any difference between the groups with respect to MAP and



Hemodynamic Parameters	Time points	Group S	Lower 95% CI	Upper 95% CI	p Value	Group SPG	Lower 95% CI	Upper 95% CI	p Value
Heart Rate	T0	85.0				76.5			
	T1	87.1	- 17.7	13.5	1.00	85.4	-24.6	6.7	0.81
	T2	91.4	-22.0	9.2	0.98	86.8	-26.0	5.3	0.61
	T3	89.4	-20.0	11.2	0.99	86.0	-25.2	6.0	0.72
	T4	87.6	-18.1	13.1	1.00	86.7	-25.9	5.3	0.62
	T5	88.1	-18.7	12.6	0.99	87.3	-26.5	4.7	0.52
	T10	86.2	-16.9	14.4	1.00	83.4	-22.5	8.7	0.96
	Overall	87.8	-5.4	11.9	0.44	84.6	-11.9	5.4	0.44
Mean arterial Pressure	T0	94.4				97.1			
	T1	97.5	-19.4	13.0	0.99	110	-29.0	3.44	0.31
	T2	103.0	-24.9	7.6	0.88	110.2	-29.3	3.16	0.27
	T3	99.6	-21.4	11.0	0.99	105.7	-24.8	7.64	0.88
	T4	94.5	-16.3	16.1	1.00	105.5	-24.6	7.90	0.90
	T5	90.8	-12.6	19.8	0.99	105.7	-24.8	7.64	0.88
	T10	86.4	-8.2	24.2	0.93	94.0	-13.1	19.3	1.0
	Overall	95.2	-16.2	-1.4	0.02*	104.0	1.4	16.2	0.02*

GROUP
◆ SCALP BLOCK
● SPG BLOCK

Figure 1: Hemodynamic parameters following pin insertion. SPG-sphenopalatine ganglion, HR-heart rate, PI-pin insertion, MAP-mean arterial pressure; T0-Baseline; T1-1 min; T2-2 mins; T3-3 mins; T4-4 mins; T5-5 mins; T10-10 mins

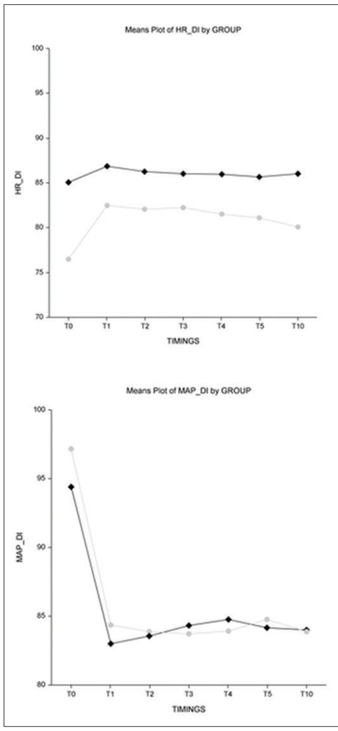


Hemodynamic parameters	Time points	Group S	Lower 95% CI	Upper 95% CI	p Value	Group SPG	Lower 95% CI	Upper 95% CI	p Value
Heart Rate	T0	85.0				76.5			
	T1	84.7	-13.8	14.4	1.00	85.6	-23.2	5.02	0.65
	T2	87.2	-16.3	12.0	1.00	85.8	-23.5	4.78	0.61
	T3	86.6	-15.7	12.5	1.00	86.2	-23.9	4.38	0.54
	T4	84.3	-13.4	14.8	1.00	87.0	-24.7	3.58	0.40
	T5	86.0	-15.1	13.1	1.00	89.7	-27.3	0.90	0.09
	T10	87.2	-16.3	12.0	1.00	87.9	-25.5	2.70	0.27
	Overall	85.9	-9.8	10.5	0.94	85.9	-10.5	9.8	0.94
Mean arterial pressure	T0	94.4				94.4			
	T1	87.5	-8.6	22.3	0.97	90.6	-9.0	21.9	0.98
	T2	90.5	-11.6	19.3	0.99	93.2	-11.6	19.3	0.99
	T3	89.7	-10.8	20.1	0.99	94.1	-12.4	18.5	0.99
	T4	89.9	-11.0	19.9	0.99	97.3	-15.6	15.3	1.00
	T5	88.9	-10.0	20.9	0.99	98.4	-16.7	14.2	1.00
	T10	89.1	-10.2	20.7	0.99	96.0	-14.3	16.6	1.00
	Overall	90.0	-14.1	3.6	0.23	95.2	-3.6	14.1	0.23

GROUP
◆ SCALP BLOCK
● SPG BLOCK

Figure 2: Hemodynamic parameters following skin incision. SPG-sphenopalatine ganglion, HR-heart rate, SI-skin incision, MAP-mean arterial pressure; T0-Baseline; T1-1 min; T2-2 mins; T3-3 mins; T4-4 mins; T5-5 mins; T10-10 mins

HR during dural incision. As scalp blockade does not anesthetize the dura, there was no significant difference between two groups.[20] Autonomic and nociceptive projections associated with SPG innervate supratentorial structures such as blood vessels, pia, and dura which are the components of trigeminovascular system.[21] This might be an explanation for the hemodynamic response in SPG group at dural opening.



Hemodynamic parameters	Time points	Group S	Lower 95% CI	Upper 95% CI	p Value	Group SPG	Lower 95% CI	Upper 95% CI	p Value
Heart rate	T0	85.0				76.4			
	T1	86.8	-15.1	11.5	1.00	82.4	-19.3	7.39	0.96
	T2	86.2	-14.5	12.1	1.00	82.0	-18.9	7.83	0.98
	T3	86.0	-14.3	12.4	1.00	82.2	-19.1	7.63	0.97
	T4	85.9	-14.3	12.4	1.00	81.5	-18.4	8.35	0.99
	T5	85.6	-13.9	12.7	1.00	81.0	-17.9	8.70	0.99
	T10	86.0	-14.3	12.3	1.00	80.0	-16.9	9.70	0.99
	Overall	85.9	-3.3	13.5	0.22	80.8	-13.5	3.3	0.22
Mean arterial pressure	T0	94.4				97.1			
	T1	83.0	0.79	22.0	0.02*	84.3	2.19	23.4	0.003*
	T2	83.5	0.23	21.4	0.03*	83.8	2.67	23.8	0.001*
	T3	84.3	-0.52	20.6	0.08	83.7	2.83	24.0	0.001*
	T4	84.7	-0.96	20.2	0.12	83.9	2.63	23.8	0.001*
	T5	84.1	-0.36	20.8	0.07	84.7	1.79	23.0	0.006*
	T10	84.0	-0.20	21.0	0.06	83.8	2.67	23.8	0.000*
	Overall	85.4	-6.0	5.0	0.85	85.9	-5.0	6.0	0.85

Figure 3: Hemodynamic parameters following dural incision. SPG-sphenopalatine ganglion, HR-heart rate, DI-dural incision, MAP-mean arterial pressure, T0-Baseline; T1-1 min; T2-2 mins; T3-3 mins; T4-4 mins; T5-5 mins; T10-10 mins

As scalp block is the gold standard to attenuate the hemodynamic response to Mayfield clamp placement, we compared it against SPG block which has been frequently used now for transsphenoidal pituitary surgeries and chronic headache and facial pain.[12,22] The incidence of systemic toxicity of local anesthetic (7.5 per 10,000) is higher with peripheral nerve blocks compared with plexus blockade as it requires lesser volume.[14] The sphenopalatine ganglion is located posterior to the middle turbinate and anterior to the pterygoid canal. There is no bony boundary between the nasal cavity and the SPG via the sphenopalatine foramen. This makes infiltration of the anesthetic agent into pterygopalatine fossa easier. This ganglion is covered by 1--1.5 mm thick layer of connective tissue and mucous membrane.[23] Thus, SPG block does not require invasive needle pricks and may be a safer alternative to anterior scalp blockade especially in patients with scalp infection and depressed fracture of skull without CSF rhinorrhea. Overall, bilateral SPG blockade along with posterior scalp blockade will decrease the number of needle pricks along with providing good dural analgesia compared with the conventional scalp blockade.

Depth of anesthesia and volume status too play an important role in the management of intraoperative hemodynamics. In most of the studies, the depth of anesthesia and fluid status were not standardized. In our study, we have standardized the depth of anesthesia with continuous monitoring of MAC isoflurane and volume status with SPV to avoid any confounding variable for the hemodynamics.

Only two patients who received SPG block had nasal bleeding that stopped spontaneously. The lesser invasiveness or relatively noninvasive procedure of transnasal SPG block has a great advantage over the lesser invasive procedures like maxillary block and the conventional multiple injection scalp block. It avoids local hematoma, nerve injury, intraarterial injection, and diplopia. Only three patients had bad taste in the mouth which was an insignificant finding and occurs mainly due to seepage of the local anesthetic solution into the oral cavity.

Postoperative VAS score was not taken into account as the block duration varies from 3-6 h. And the duration of neurosurgical craniotomy procedure varies from case to case. Observation of pain score in the postoperative period would vary accordingly. Hence this confounding variable and bias was avoided.

Limitations

The limitations of our study are: a. SPG block administration was a blind technique b. The study was not blinded and c. we did not quantify perioperative analgesic requirement. Further randomized blinded studies can justify the use of SPG block in craniotomy surgeries.

To conclude, concomitant use of bilateral SPG block with general anesthesia is an effective and safe technique during craniotomy surgeries for obtundation of hemodynamic responses due to noxious stimulus.

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Conflicts of interest

There are no conflicts of interest.

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