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Research Article

Bilateral sphenopalatine ganglion block as adjuvant to general anaesthesia during endoscopic trans-nasal resection of pituitary adenoma

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Abstract *Background:* This study was conducted to investigate the anaesthetic, vasodilator, and post-operative analgesic sparing effect of bilateral sphenopalatine ganglion block (SPGB) in patients undergoing endoscopic endo-nasal trans-sphenoidal surgery.
Methods: Thirty adult patients of ASA (I, II), aged 20–60 years, were randomly allocated to either the block group or the non-block group ($n = 15$, for each). After establishment of general anesthesia with sevoflurane and 100% oxygen, the patients received bilateral SPGB with 1.5 ml of either 0.5% bupivacaine (block group) or 0.9% NaCl (non-block group). Intra-operative mean arterial pressure (MAP) was maintained at 60–65 mmHg by using nitroglycerine. End-tidal sevoflurane concentration required to maintain bispectral index values (40–50) throughout the operation was recorded. Nitroglycerine and propranolol consumption, blood loss, recovery profile, perioperative catecholamines, post-operative pain and meperidine consumption were evaluated.
Results: Block group showed significant decrease in sevoflurane and nitroglycerine consumption, blood loss, emergence time and time needed to achieve ⩾9 Aldrete score, $P < 0.0001$. All patients in non-blockade group (100%) were supplemented by nitroglycerine to achieve the target MAP versus 9 patients (60%) in the block group ($P < 0.01$). Propranolol administration was necessary in 9 patients (60%) in the non-block group versus 3 patients (20%) in the block group, $P < 0.05$. At

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PACU, visual analogue pain score and number of patients received meperidine analgesia were significantly less in the block group versus non-block group, $P < 0.0001$ and $P < 0.001$, respectively. Intra- and post-operative plasma epinephrine and nor-epinephrine levels were significantly higher in the non-block group than the block group, $P < 0.05$.
Conclusion: Bilateral SPGB has anaesthetic, vasodilator and analgesic sparing effect when combined with general anaesthesia during endoscopic endo-nasal trans-sphenoidal resection of pituitary adenoma.

1. Introduction

Microsurgical trans-sphenoidal approaches have been established as the standard surgical treatment for pituitary adenomas [1]. Improved endoscopes and the tendency of surgeons to advance surgical techniques have led to development of endoscopic trans-nasal applications in many pituitary surgical centres [2–5].

Although the endoscopic trans-nasal approach is minimally invasive and less traumatic procedure, it is associated with intense painful stimulation during the nasal, sphenoidal and sellar phases of the operation [6]. The magnitude of painful stimulation can fluctuate widely during the procedure leading to sudden increases in arterial pressure [7]. So control of intra-operative blood pressure is necessary to reduce bleeding and improve the quality of surgical field.

Many approaches have been used to attenuate the hypertensive response to such stimuli, including increase the depth of anaesthesia, infusion of vasodilators and infiltration of higher concentration of lidocaine in adrenaline solution [6–8].

It is assumed that the use of regional block, as an adjuvant to general anaesthesia, is effective during endo-nasal trans-sphenoidal surgery. Many regional techniques have been used during resection of pituitary adenoma including infiltration of local anaesthetics [7], bilateral maxillary nerve block [9] and bilateral infraorbital nerve block [10].

The sphenopalatine ganglion (SPG) is one of parasympathetic ganglia in the head. It is located in the pterygopalatine fossa, posterior to the middle nasal turbinate under a 1–5 mm layer of connective tissue and mucous membrane, anterior to the pterygoid canal and lateral to sphenopalatine foramen [11,12]. It has sensory effects through trigeminal and facial nerves, visceral motor function through parasympathetic activity of superficial petrosal nerve and sympathetic function through its connection to the cervical sympathetic chain via the great deep petrosal nerve [13]. The sensory fibers connect the maxillary nerve to the SPG by five branches that extend from the nasopharynx, nasal cavity, nasal sinuses, palate, and orbit [11]. Blocking the SPG relies on block of these branches of maxillary nerve [11].

There are many approaches to block this ganglion [11]. Trans-nasal endoscopic injection approach is the most recent one [14–17]. The blockade of this ganglion has been used to treat headache and facial pain [15]. However, there are limited clinical studies investigating its efficacy during and after surgery [18,19]. In the literature search, there was no data concerning its usage during endoscopic endo-nasal trans-sphenoidal resection of pituitary adenoma.

The present prospective randomized double blinded controlled study was designed to evaluate the anaesthetic, vasodilator, and post-operative analgesic sparing effect of bilateral trans-nasal sphenopalatine ganglion block (SPGB) combined with general anaesthesia during endoscopic trans-nasal resection of pituitary adenoma.

2. Methods

This study was conducted at Kasr El-Aini hospital, Cairo University, from February 2007 to September 2008. After approval of Local Ethical Committee, informed consents were obtained from all patients. Thirty adult patients of ASA physical status I and II, aged 20–60 years, who were scheduled for elective endoscopic trans-nasal excision of pituitary adenoma, were enrolled in this prospective, randomized, double-blinded, controlled study. Detailed endocrinal functions were evaluated preoperatively and all patients received the appropriate pre-operative therapy. Pre-operative assessment included complete blood picture, serum electrolytes, liver function tests, serum creatinine, blood glucose level, coagulation profile and a 12-lead ECG. Exclusion criteria included disturbed level of consciousness, bleeding disorder, elevated intracranial pressure, or history of hepatic, renal or cardio-pulmonary dysfunction. Patients receiving cardiovascular active medications or drugs influencing blood coagulation were also excluded.

The night before surgery, all patients were taught how to assess their pain using a 10-cm visual analogue score (VAS), with 0 representing no pain at all and 10 representing the worst imaginable pain.

In the holding area, a 20G radial artery Teflon® cannula was inserted under local anaesthesia after Allen's test for direct arterial blood pressure measurement and blood sampling. One 20G intravenous line was secured for administration of anaesthetic drugs and fluids. All patients were premedicated with i.v. 0.02 mg/kg midazolam.

On arrival to the operating room, routine monitors including pulse oximeter, five-lead ECG and invasive arterial blood pressure were instituted. (Infinity SC 8000, Dräger medical system, Avenue, Danvers, MA, USA). Standard BIS® monitor strip (BISX®, Aspect medical Systems, Norwood, MA, USA) was placed on the patients forehead of the dominant hemisphere according to the guidelines of the manufacture. General anaesthesia was induced with intravenous fentanyl 2 μg/kg, propofol 2–3 mg/kg and lidocaine 0.5 mg/kg to reduce pain on injection. Endotracheal intubation was facilitated with i.v. vecuronium 0.08 mg/kg and oropharyngeal pack was applied. General anaesthesia was maintained using sevoflurane in 100% oxygen, and vecuronium. All patients were mechanically ventilated to maintain end-tidal carbon dioxide between 35 and 40 mmHg. Depth of anaesthesia was controlled by Bispectral Index and sevoflurane concentration was titrated to achieve a BIS value between 40 and 50 throughout the intra-operative period.

Another large size 16G intravenous catheter (hot transfusion line) was secured.

After achieving satisfactory level of anaesthesia (BIS value between 40 and 50), patients were randomly allocated according to sealed envelope method to one of two groups, block group and non-block group (n = 15, for each). Both groups assigned to receive bilateral sphenopalatine ganglion block (SPGB) using 1.5 ml of either 0.5% bupivacaine in block group or normal saline (placebo) in non-block group. Both bupivacaine and placebo solution were prepared by anaesthesiology resident, who was blinded to the recorded data. The surgical team and the anaesthetist managing the patients intra-operatively, were blinded to the drug being administered.

2.1. Technique of SPGB

Patients were placed in 15 degree reverse Trendlenburg position and the nasal cavity, between the middle and inferior turbinates, from nares to posterolateral wall of the nasopharynx was anesthetized topically with 1.5% lidocaine + 1:200,000 epinephrine using cotton-tipped applicators. This passage was sterilized by an additional cotton-tipped applicator soaked with iodine solution. A 20-gauge/5-in. spinal needle was used after bending 2–3 mm of its tip along the port side with a sterile needle holder to form a 45° angle. The needle was lubricated with 5% lidocaine jelly, inserted into the nasal meatus and advanced with the bevel pointer facing laterally. Under endoscopic control (0° optics, 4 mm diameter), the needle was inserted between middle and inferior turbinate. About 1.5 mL of either 0.5% bupivacaine or 0.9% NaCl, according to group assignment, was injected after negative aspiration into the nasal mucosa just behind and over middle turbinate tail, where the pterygopalatine fossa is deeply located, (Figs. 1 and 2). The needle was flushed and removed. Dry cotton-tipped applicator was inserted down to assure no bleeding after needle removal [16].

Target intra-operative MAP of 60–65 mmHg, was achieved by adjustment of nitroglycerine infusion from 0.5 to 10 μg/kg/min according to patient response.

In case of reflex persistent increase in HR > 100 beats/min, i.v. 0.2 mg increments of propranolol was given to maintain HR < 100 beats/min. Bradycadia (HR < 45 beats/min) was treated by i.v. 300 μg increments of atropine.

When MAP reached the required level (60–65 mmHg), and maintained for 15 min, the surgeon, blinded to group assignment and haemodynamic parameters, was asked to evaluate the quality of the operative field every 30 min intraoperatively using a pre-defined average category scale (ACS) (from 0 to 5) adapted from Fromme et al. [20] (Table 1). The ideal category scale values for surgical conditions were pre-determined to be 2 and 3. The same surgical team performed all operations to ensure consistency in evaluation of the operative field.

2.2. Surgical technique

Depending on the pre-operative assessment of the patients' nasal passageway either a 4 mm or 2.7 mm (StortzR, Culver City, CA) endoscope was used. The middle turbinate was resected using a 0° rigid endoscope. Under direct visualization, sphenoidal ostium was identified and enlarged with Kerrison rongeurs. The sphenoidal rostrum and posterior vomer were removed to open the whole anterior wall of the sphenoid sinus.

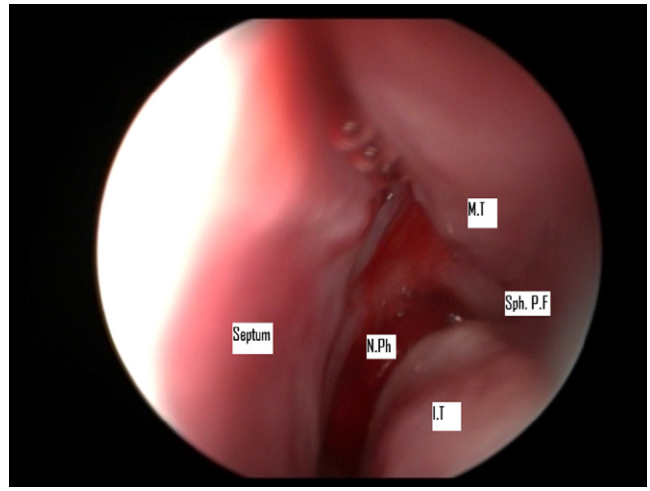

Figure 1 The endoscopic view showing the nasal cavity before needle insertion. M.T., middle turbinate; I.T., inferior turbinate; N.Ph, nasopharynx; Sph. P.F., assumed place of sphenopalatine foramen.

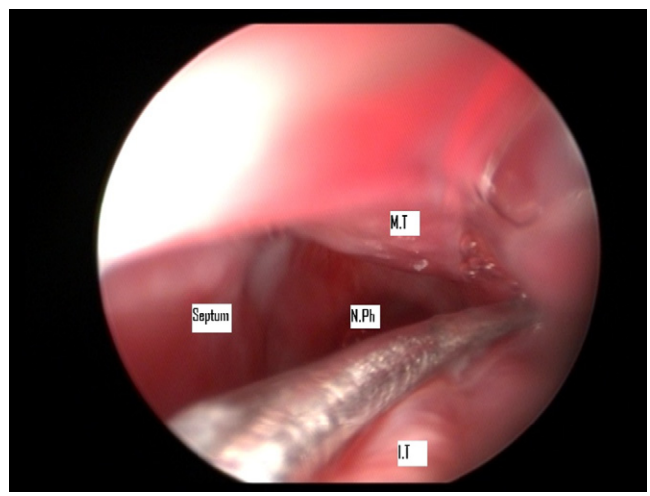

Figure 2 Under endoscopic control (4 mm, 0°), long, 20-gauge needle is passed between middle and inferior turbinate and inserted in mucosa just behind and over middle turbinate tail, seeking sphenopalatine foramen. M.T., middle turbinate; I.T., inferior turbinate; N.Ph, nasopharynx.

Table 1 Average category scale [20].

0	No bleeding
1	Slight bleeding – no suctioning of blood required
2	Slight bleeding – occasional suctioning required. Surgical field not threatened
3	Slight bleeding – frequent suctioning required. Bleeding threatens surgical field a few seconds after suction is removed
4	Moderate bleeding – frequent suctioning required. Bleeding threatens surgical field directly after suction is removed
5	Severe bleeding – constant suctioning required. Bleeding appears faster than can be removed by suction. Surgical field severely threatened and surgery not possible

The 0° endoscope was used to guide the intranasal dissection and initial tumour resection. Once tumor resection was completed or residual tumor was outside the field of view, the 0° endoscope was withdrawn and a 30° endoscope was inserted. Rotating the 30° endoscope clockwise and counter-clockwise provides visualization of suprasellar and parasellar tumor extension, including invasion into the cavernous sinus if present. The area was irrigated and haemostasis was obtained. An abdominal fat graft was harvested and used to reconstruct the sellar defect, which was then sealed using fibrin glue, fat, and fascia lata packing. No nasal packing was required, and only a small gauze dressing was placed below the nares to collect any residual blood or debris.

BIS value and end-tidal sevoflurane concentration were recorded intraoperatively every 5 min. At the conclusion of surgery, sevoflurane together with all infusions, were discontinued. The total amount of nitroglycerine administered to achieve the target MAP and frequency of propranolol usage were recorded. All patients received i.v. 15 mg/kg paracetamol (perfalgan 1 g) at the end of the surgery before extubation. Ondansetron (4 mg i.v.) as antiemetic agent was propholactically administered at the end of the surgery to all patients.

Residual neuromuscular block was antagonized with neostigmine (0.05 mg/kg) and atropine (0.01 mg/kg) and trachea was extubated. Emergence time, defined as the interval between the discontinuation of anaesthetics to response of eye opening to verbal command [21], was recorded for all patients.

Intra-operative blood loss (estimated by measuring the volume of the blood in the suction canister minus the normal saline used to wash the surgical cavity) was recorded.

After tracheal extubation, all patients transferred to the post-anaesthesia care unit (PACU) where they were closely monitored by research assistant, who was blinded to group allocation, for 3 h.

Table 2 Postoperative modified Alderet recovery score [22].

Description	Score
Consciousness	
Fully awake and oriented (name, place, date)	2
Arousable on calling	1
Not responding	0
Activity	
Moves all four extremities voluntary or on command	2
Moves two extremities	1
Unable to move extremities	0
Respiration	
Breathes deeply and coughs freely	2
Dyspnea, limited breathing or tachypnea	1
Apnea or on mechanical ventilation	0
Circulation	
Blood pressure ± 20% pre-anesthetic level	2
Blood pressure ± 20–49% pre-anesthetic level	1
Blood pressure ± 50% pre-anesthetic level	0
Oxygen saturation	
SpO_2 >92% on room air	2
Supplemental O_2 is required to keep saturation >90%	1
SpO_2 <92% with O_2 supplementation	0
Maximum score	10

Post-operative recovery was evaluated using a modified Alderet score (0–10) [22] (Table 2) and time needed to achieve ⩾9 was recorded. Post-operative pain was assessed by VAS (0–10) at PACU admission when the patient was able to communicate (T0), every 30 min for 3 h (T1–T6). VAS greater than 3 was managed with incremental i.v. doses of meperidine 10 mg. Number of meperidine doses in PACU was calculated. Number of patients who received meperidine in the PACU was also recorded. The incidence of post-operative side effects such as post-operative nausea and vomiting (PONV), headache, visual disturbances, agitation or somnolence were recorded.

Arterial blood samples were taken immediately pre-induction (T0), 1 h after start of surgery (T1), 2 h postoperatively (T2) for measurements of epinephrine and nor-epinephrine. The samples were collected into prechilled tubes containing EDTA–Na and immediately centrifuged at 3000 rpm for 15 min at 4 °C. The plasma was stored at −70 °C until assayed for catecholamine concentrations. Plasma epinephrine and norepinephrine were separated using a Bio Rad column chromatography (150 × 4 mm, Part No. GSOD40512S2504) by isocratic elution with a mixture of 6.9 g sodium phosphate, 37 mg EDTA, 150 mg sodium octane sulfonate, 60 mL acetonitrile, 5 mL of THF and the rest made up to 1000 mL with water in around 20 min and detected by electrochemical detection. The results of epinephrine and nor epinephrine were analysed and the assay sensitivity was 10.0 pg/ml and within non-precision coefficient of variation were 13.5% and 14.2% for nor epinephrine and epinephrine, respectively.

The primary outcome of the present study was assessing the effect of SPGB combined with general anaesthesia in sevoflurane and nitroglycerine consumption to control the intra-operative fluctuation of haemodynamics and to achieve intra-operative MAP between 60 and 65 mmHg during trans-nasal trans-sphenoidal resection of pituitary adenoma.

Initial sample size estimation showed that approximately 12 patients should be included in each group to ensure a power of 0.80 for detecting a 25% or more decrease in end-tidal sevoflurane consumption between the two groups. The standard deviation of end-tidal sevoflurane, estimated from initial pilot observation was approximately 0.38%. The α error assumed to be 0.05. We made *a priori* decision to evaluate 15 patients in each group.

2.3. Statistical analysis

Data were presented as mean (SD) median (25–75th percentiles) or number (%) as appropriate. Comparison between the two groups was performed using unpaired student's t test. Intra-group comparisons of stress hormone relative to baseline were performed using repeated measure analysis of variance (ANOVA) with post hoc Dunnet's test if ANOVA results were significant. Ordinal data were compared using Mann–Whitney *U* test. Categorical variable were compared using Chi-squared or Fisher's exact tests as appropriate. A *P* value less than 0.05 was considered statistically significant.

3. Results

Forty two patients were assessed for study eligibility (8 patients failed to meet the inclusion criteria and 4 patients refused

Table 3 Demographic and operative data. [mean (SD), ratio or number].

	Non-block group (n = 15)	Block group (n = 15)
Age (years)	48 (7)	44 (4)
Sex (M/F)	10/5	9/6
ASA status (I/II)	6/9	7/8
Weight (kg)	79 (6)	82 (7)
Types of pituitary adenoma (n)		
Non-functioning adenoma	7	9
Functioning adenoma	8	6
Duration of surgery (min)	151 (18.4)	149 (19.1)

ASA, American society of anaesthesiologists.

to sign the consent form). The remaining 30 consenting patients who fulfilled the entry criteria were enrolled in this study. All patients were able to complete the entire study and their data were included in final analysis. Patients in the two groups of the study were comparable with respect to demographic data and duration of surgery (Table 3).

Mean end-tidal sevoflurane concentration required to maintain BIS value between 40 and 50 was significantly higher in non-block than block group [1.8 (0.32)% versus 1.3 (0.27)% in respectively, $P < 0.0001$]. All patients in non-block group (100%) were supplemented by nitroglycerine to achieve the target MAP versus 9 patients (60%) in the block group, $P < 0.01$. The mean nitroglycerine dose required for patients who needed supplementation in the block group was significantly lower than that required in non-block group [1.02 (0.22) µg/kg/min versus 3.1 (0.82) µg/kg/min, respectively, $P < 0.0001$]. Propranolol administration was necessary for 9 patients (60%) in the non-block group versus 3 patient (20%) in the block group, $P < 0.05$.

The average category scale (ACS) for quality of surgical field was comparable in both groups in the range of MAP 60–65 mmHg at all studied time interval [2 (2–3) in block group versus 3 (2–3) in non-block group, $P = 0.105$].

Intra-operative blood loss was significantly less in the block group [215.9 (28.7) ml] when compared to non-block group [352.6 (32.4) ml], $P < 0.0001$. No patients required blood transfusion or presented with excessive blood loss.

Emergence time and time needed to achieve ⩾9 of modified Aldrete score were significantly shorter in block group than non-block group [5.4 (1.21) min and 7.2 (1.4) min versus 7.92 (1.88) min and 10.9 (2.9) min, respectively], $P < 0.0001$.

Visual analogue pain scale was significantly lower in block group than non-block group till the 2nd post-operative hour, $P < 0.0001$ (Fig. 3). Twelve patients (80%) in non-block group compared to only two patients (13.2%) in the block group received supplementary meperidine analgesia at the PACU, $P < 0.001$. The number of meperidine doses was significantly less in the block group versus non-block group, $P < 0.01$ (Table 4).

Concerning the plasma epinephrine and nor-epinephrine levels, the non-block group showed statistically significant increase in the intra and post-operative measurements compared to their baseline values ($P < 0.01$) and to the corresponding measurements in the block group, ($P < 0.05$). However in the block group, there was not any significant difference in the intra or post-operative measurements comparing to their baseline values (Figs. 4 and 5).

Table 4 Postoperative analgesic requirements at PACU [mean (SD), or number (%)].

	Non-block group (n = 15)	Block group (n = 15)
No. of patients received meperidine (percentage)	12 (80%)[†]	2 (13.2%)
No. of patients required different meperidine doses at PACU (percentage)		
1 dose	0 (0%)	0 (0%)
2 doses	0 (0%)	0 (0%)
3 doses	0 (0%)	1 (6.6%)
4 doses	1 (6.6%)	1 (6.6%)
5 doses	6 (40%)[*]	0 (0%)
6 doses	5 (33%)[**]	0 (0%)

[†] $P < 0.001$.
[*] $P < 0.01$.
[**] $P < 0.05$ compared to the block group.

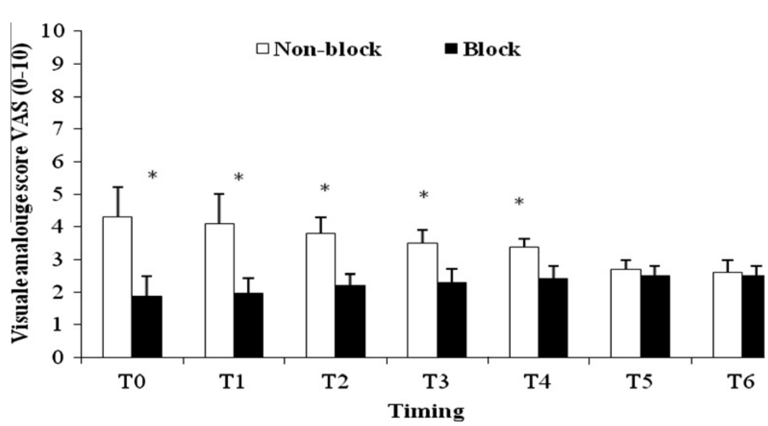

Figure 3 Postoperative visual analogue pain score in both groups. Values are means and error bars represent standard deviation. T0 = PACU admission when the patient was able to communicate, T1–T6 = every 30 min at PACU. $^{*}P < 0.0001$ versus non-block group.

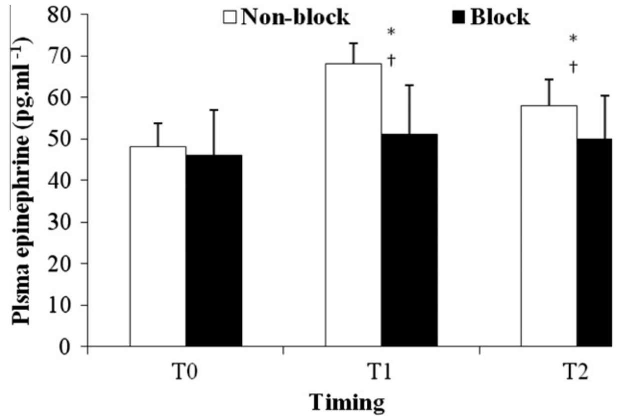

Figure 4 Perioerative plasma epinephrine concentrations in both groups. Values are means and error bars represent standard deviation. T0 = baseline (immediately before induction), T1 = 1 h intraoperatively, T2 = 2 h postoperatively. $^{*}P < 0.05$ versus baseline. $^{\dagger}P < 0.05$ versus the block group.

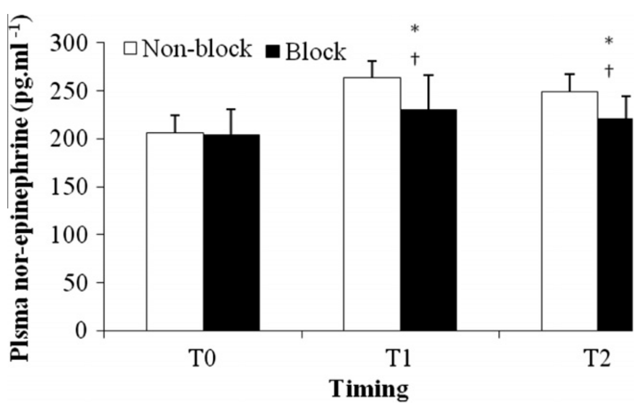

Figure 5 Perioerative plasma nor-epinephrine concentrations in both groups. Values are means and error bars represent standard deviation. T0 = baseline (immediately before induction), T1 = 1 h intraoperatively, T2 = 2 h postoperatively. $^{*}P < 0.05$ versus baseline. $^{\dagger}P < 0.05$ versus the block group.

Table 5 Incidence of post-operative side effects in both groups at PACU. [number (%)].

	Non-block group (n = 20)	Block group (n = 20)
Incidence of post-operative side effects [n (%)]		
Nausea & vomiting	3 (20%)	2 (13.2%)
Agitation	2 (13.2%)	1 (6.1%)
Headache	1 (6.1%)	0 (0%)
Somelance	2 (13.2%)	1 (6.1%)
Visual disturbances	0 (0%)	0 (0%)
Nasal bleeding	0 (0%)	0 (0%)
Patients received supplemental antiemetic [n (%)]	2 (13.2%)	2 (13.2%)

The incidence of post-operative complications and number of patients received supplemental antiemetic were comparable in both groups (Table 5).

4. Discussion

In the endoscopic endo-nasal trans-sphenoidal surgical approach, the general aims of anaesthesia include optimizing the intra-operative surgical condition, preventing intra-operative complications and providing rapid emergence to facilitate neurological assessment. The present study shows that bilateral sphenopalatine ganglion block (SPGB) is an effective and safe technique when combined with general anaesthesia during endoscopic endo-nasal trans-sphenoidal resection of pituitary adenoma. Blocking the SPG provided reduction of sevoflurane and nitroglycerine consumption, suppression of haemodynamic fluctuation during surgical stimulation, less intra-operative blood loss, faster recovery and suppressed catecholamine (epinephrine and norepinephrine) response as well as reduction of post-operative pain and analgesic requirements.

There are three approaches to establish the blockade of SPG, trans-nasal, transoral and lateral approaches [11]. The trans-nasal injection technique either blindly or with assistance of nasal speculum carries the risk of nasal mucosa sloughing during injection [11,23]. This led to the development of the trans-nasal endoscopic technique in which the needle infiltration was performed under direct vision using rigid sinuscope [24]. In the present study the endoscopic guided trans-nasal injection technique was chosen to block the SPG to ensure the safety and accuracy of the block.

The bispecteral index (BIS) monitor is a valuable objective tool to measure anaesthetic depth [25]. It is used to guide administration of anaesthetics to reduce the risk of intra-operative awareness, faster the emergence and improve the recovery [26,27]. In the present study the sevoflurane was titrated guided by BIS monitor to achieve an adequate level of hypnosis (BIS between 40 and 50) in both groups.

The mean end-tidal sevoflurane consumption in the current study was significantly lower in block group compared to non-block groups. This finding coincides with the results of previous studies in which the combination of regional blockade with general anaesthesia was proved to decrease the anaesthetic requirements [19,28,29]. Guignard et al. [30] and Ropke et al. [31] have reported that BIS value increases in response to nociceptive stimulation during anaesthesia. Another study done by Hodgson and Liu [32], demonstrated that the deafferentation induced by regional anaesthesia results in supraspinal effects that change hypnotic anaesthetic requirement [32]. This may explain the significant difference in end-tidal sevoflurane requirement between the two groups in the current study.

The use of SPGB in combination with general anaesthesia in the present study successfully blocked the intense fluctuating painful stimulation occurring during different phases of surgery and controlled the intra-operative hemodynamics. This effect was evident as, the target MAP was achieved with significantly less sevoflurane, nitroglycerine and propranolol consumption in the block group than non-block group.

The effect of SPGB regarding haemodynamic in the present study could be attributed to the adequate and extensive anaesthesia achieved to the nasal cavity and paranasal sinuses. This finding coincides with the results of previous two studies which evaluated the efficacy of bilateral maxillary nerve block during trans-sphenoidal surgery [9] and endoscopic endo-nasal SPGB during sinonasal surgery [19]. Another study evaluating the effect of regional nerve block combined with general anaesthesia during oral surgery, reported that the dose of adenosine required for inducing and maintaining hypotension was reduced under stabilized hemodynamics achieved by nerve blocks [33].

The main purpose of blood pressure control during endoscopic trans-sphenoidal surgery is to provide a dry field for the surgeon to improve visibility and facilitate the surgical approach. To achieve these goals attention to surgical field might be a better monitor than absolute MAP [8].

In the current study, with the same level of MAP (60–65 mmHg); the surgical field was comparable in both groups. However the ACS in block group reached ideal levels (2–3) with no or minimal consumption of hypotensive agents compared to non-block group.

The blood loss was significantly less in blockade group compared to non-blockade group. These findings are in line with results of previous study evaluating bilateral SPGB combined with general anaesthesia during endoscopic sinus surgery [19]. Parasympathetic block allowing unopposed sympathetic activity may be the mechanism of haemostasis obtained with SPGB [23].

Although the organic nitrate vasodilators inhibit platelets via production of nitric oxide [34], it is unclear whether this is the contributing factor in the increased bleeding in the surgical field for the non-block group as nitroglycerine consumption was significantly higher than in the block group.

Complete awakening and orientation immediately after the termination of surgery is highly desirable when early neurological evaluation is needed [8]. The emergence time (time to respond to verbal command) and time needed to achieve Aldrete score $\geqslant 9$ in the current study were significantly shorter in the block group when compared to the non-block group. This difference could be attributed to the significantly less sevoflurane consumption in the block group compared to non-block group.

In the present study VAS pain score was significantly lower in the block group than the non-block group during the immediate post-operative period. In non-block group paracetamol alone was insufficient, as 16 patients (80%) had a score of pain > 3 and required meperidine in the first 2 h at PACU. At 150 min, the VAS score between the two groups was comparable. However meperidine consumption was significantly higher in the non-block group.

Regional anaesthesia is an appropriate component of multimodal analgesia in this setting. Furthermore, SPG blockade may also contribute to decreased mechanical hyperalgesia induced by inflammation [35,36].

This finding is in line with previous studies, where post-operative pain intensity was lower in the block group than in the non-block group [18,19].

The surgical stress response includes a complex series of neuro-endocrine response. Stress response hormone levels can serve as an objective method to assess the analgesic efficacy of various regional techniques [37]. Reduction of the stress response is highly dependent on the surgical site, and the analgesic technique [37].

In the current study, the SPGB had suppressed the catecholamine response to surgical stimulus and post-operative pain in the block group while the non-block group showed significant increase in plasma epinephrine and nor-epinephrine during the intra- and post-operative periods. Similar findings were reported in previous clinical studies investigating the effect of combination of nerve block with general anaesthesia in oral surgery [29,33]. The suppressed catecholamine response in the block group is probably related to the blockade of the afferent nociceptive impulses from the surgical site to the hypothalamus, which in turn inhibits the pituitary adrenocortical axis stimulation [37].

These findings coincides with the other findings of the present study regarding, the intra-operative haemodynamic stability and less post-operative pain scores in the block group. Moreover it reflects the intra- and post-operative analgesic effect of SPGB during trans-sphenoidal surgery.

Further studies are required to evaluate the opioid-sparing effects of this block in the intra-operative period.

In conclusion, concomitant use of bilateral SPGB with general anaesthesia is effective and safe technique during endoscopic endo-nasal trans-sphenoidal resection of pituitary adenoma. It provides adequate intra- and post-operative analgesia which led to stable hemodynamics during surgery with less sevoflurane and nitroglycerine consumption, less intra-operative blood loss, faster recovery and suppressed catecholamine response in addition to decrease in post-operative pain and analgesic requirements.

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