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Perioperative outcome of ultrasound-guided pterygopalatine fossa block in functional endoscopic sinus surgery: A randomized controlled trial

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ABSTRACT

Background: Ultrasound (US)-guided pterygopalatine fossa (PPF) block helps to improve the field of surgery and control hemodynamic fluctuations during functional endoscopic sinus surgery (FESS).

Patients and methods: 120 eligible patients (60 per group) members of the American Society of Anesthesiologists class I or II aged 18 to 50 were randomly classified by closed envelope method. Group C: Patients in the control group received only general anesthesia (GA). Group PFB: Patients received bilateral PPF block with 4 ml 0.25% bupivacaine after induction of GA.

Results: Heart rate (HR) was significantly lower in PFB than in the control group at 15 min after induction of GA to 105 min intraoperatively. Between the two groups, there was no statistically significant difference in mean arterial blood pressure (MABP). Fentanyl and propranolol were less significantly used intraoperatively in the PFB group. Nitroglycerine was not needed in the PFB group while ten patients in group C received it. The total intraoperative isoflurane consumption and the mean consumption per minute used intraoperatively were significantly higher in the control group. There was a significant statistical difference between the two groups at 15 min only where the endoscopic surgical field condition in group PFB was more visible than in group C. The mean time to extubation and recovery time in group C was significantly longer than in group PFB.

Conclusion: US-guided PPF block controls the hemodynamics and improves surgical field conditions during FESS, reduces perioperative anesthetics consumption, and enhances good recovery patterns.

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FESS; hemodynamics; bloodless field; ultrasound; pterygopalatine ganglion

1. Introduction

Rhinosinusitis is an inflammation of the mucous membranes of the nasal cavity and sinuses, chronic rhinosinusitis (CRS) is sinusitis lasting more than 12 weeks. Functional endoscopic sinus surgery (FESS) is a minimally invasive procedure done to treat CRS in which the Ostia and air cells of the sinuses are opened [1,2].

Intraoperative bleeding during FESS is a troublesome issue, as it hinders the ability to see the intranasal architecture. This could result in serious complications such as more tissue damage to healthy mucosa, skull base injury, Injury of the orbit, extraocular muscles, or the optic nerve [3,4].

To improve the operative field during (FESS), the following techniques could be applied: prior to the procedure, preparing the nasal mucosa using topical local anesthetics and vasoconstrictor nasal drop, the patient's head were elevated by 30 degrees to lower venous pressure, the surgeon employed a microdebrider and bipolar cautery throughout the procedure, and hypotensive medications were used to induce hypotension [5].

Pterygopalatine fossa (PPF) block is the regional analgesic technique that can be used as an alternative approach to reduce blood loss and improve the operative field during FESS without the need for hypotensive agents [6].

A pterygopalatine ganglion is a parasympathetic ganglion located in the PPF together with the maxillary nerve. Both provide parasympathetic and sensory supply to the mucosa of the nose and maxillary sinus. PPF block can be performed by the application of local anesthetic via the trans-nasal approach, intraoral injection through the greater palatine foramen, or transcutaneous approach [6].

2. Patients and methods

This prospective randomized study was reviewed and approved by the Ethics Committee of the Alexandria Main University Hospitals (IRB # 00012098) and written informed consent was obtained from each patient for

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participation in the study. The trial adhered to the principles of the Declaration of Helsinki and was registered before patient enrollment at the Pan-African Clinical Trial Registry (PACTR202202836176096). Eligible patients were 120 (60 per group) members of the American Society of Anesthesiologists class I or II aged 18–50 years old and scheduled for elective FESS as a day case surgery at Main University Hospital, Faculty of Medicine, in Kafrelsheikh University Hospital, Egypt, between May 2021 and September 2022. Patients with a history of allergy or contraindication to any of the studied drugs, patients for whom pterygopalatine fossa block was contraindicated, patients with invasive fungal sinusitis or revision surgery, obese patients with a BMI of more than 35 Kg/m^2, and patients with allergic polyps on systemic steroids were excluded.

During the preoperative visit, all patients were informed about the procedure of US-guided PPF block. They were instructed to fast overnight. After informed consent, the allocated patients were randomly assigned using the closed envelope method by an investigator not involved in the study to one of two equal groups: **Group C**: Patients in the control group received general anesthesia only. **Group PFB**: Patients received bilateral US-guided PPF block using 4 ml 0.25% bupivacaine after induction of GA. Patients and surgeons were blinded to the group allocation. Patients were admitted to the operative theatre. Patients were monitored with electrocardiogram, non-invasive blood pressure, temperature probe, entropy, capnography, pulse oximetry, End-tidal carbon dioxide monitoring ($EtCO^2$), and End-tidal anesthetic agent concentration using an anesthetic gas analyzer by GE Datex-Ohmeda. Propofol 1–2 mg/kg, fentanyl 1 µg/kg, and rocuronium bromide 0.6 mg/kg intravenously were used to induce anesthesia.

After intubation, a bilateral US-guided PPF block was given, and patients were placed in the lateral head position. After standard sterile preparations, a high-frequency linear probe (Sonoscape model E1EXP) was positioned horizontally on the side of the face just below the zygomatic bone superior to the mandibular notch and anterior to the mandibular condyle (Figure 1) to visualize the maxillary bone, coronoid process of mandible, the lateral pterygoid muscle, the lateral pterygoid plate, and the maxillary artery deep entering the fossa. The needle was inserted in-plane parallel to the transducer probe and advanced from anterior to posterior toward the PPF. Following negative aspiration, the injectate was deposited deep into the lateral pterygoid muscle and plate. A total of 4 ml 0.25% bupivacaine was injected (Figure 1). Patients were placed in reversed Trendelenburg with an angle of 30 to enhance venous drainage. Oral packing was applied, and xylometazoline was administered intranasally.

Anesthesia was maintained and inhalational anesthetic agent concentration was adjusted to keep entropy between 40 and 60 [7] Intermittent boluses of rocuronium (0.1 mg/kg) were given guided by a nerve stimulator. Ventilation of the lungs was carried out to maintain the $ETCO^2$ 35–40 mmHg. All patients were given a strict fluid replacement based on the established guidelines for administering fluids during anesthesia.

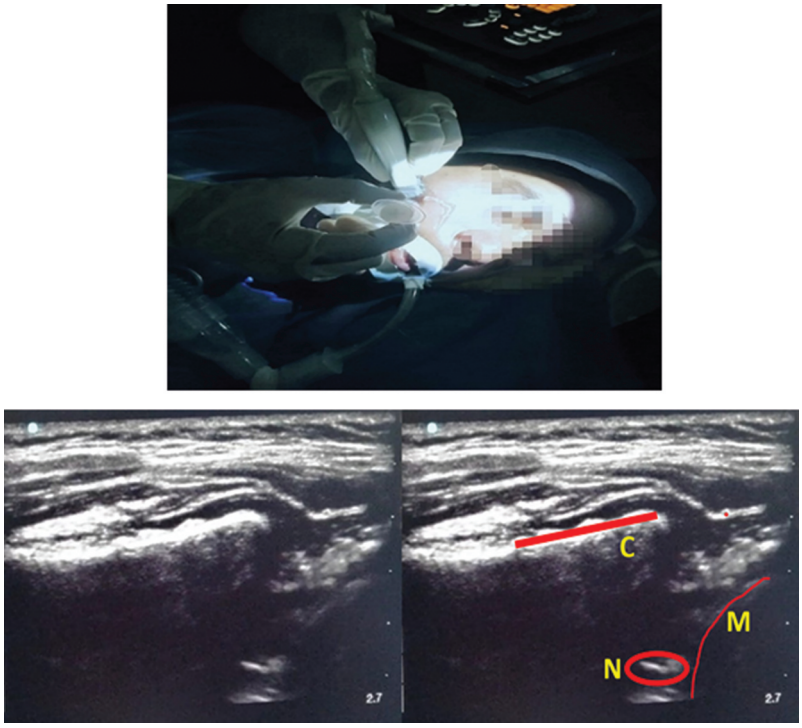

Figure 1. Linear probe placed horizontally below the zygomatic bone and needle inserted in-plane from anterior to posterior. C, coronoid process. M, maxilla. N, needle tip.

Paracetamol solution (15 mg/kg) was given as a 15-min intravenous infusion, and dexamethasone 0.2 mg/kg IV (maximum 16 mg) and ondansetron 4 mg were administered for the control of postoperative nausea and vomiting. To improve the conditions of the surgical field, hemodynamics were managed (A fixed target of mean blood pressure around 65 mmHg should be obtained) using these medications in the following order fentanyl 0.5 ug/kg IV if no response after 5 min propranolol was given intravenously at a dose of 0.5 mg over 1 min, and repeated up to 1 mg if required, If the surgical field is not satisfactory, nitroglycerin infusion at the rate of infusion (0.1-1mic/kg/min) was started. Episodes of hypotension (mean less than 60 mmHg) in both groups were treated by IV bolus of 5–10 mg ephedrine. Bradycardia (defined as heart rate <50 beats/min) was treated with atropine 0.01 mg/kg.

At the end of the surgery, anesthesia was discontinued and 100% oxygen was administered. neuromuscular blockade was reversed with an injection of neostigmine (0.04 mg/kg) with atropine (0.01 mg/kg), and extubation was performed awake after the return of protective airway reflexes. The timing of extubation was documented by an anesthesiologist who was blinded to the patient's group allocation. Transportation of patients to the post-anesthesia care unit (PACU) and to the ward when the patient achieved an Aldrete score >9. The surgical procedure was performed by three surgeons having experience of more than 5 years in FESS.

3. Measurements

Heart rate (HR) (beats per minute) and mean blood pressure (MABP) (mmHg) were continuously recorded, and intraoperative requirements of propranolol, fentanyl, and nitroglycerine were calculated. End-tidal expired isoflurane concentration was continuously monitored and recorded 15 min from the induction of anesthesia. The total volume of the anesthetic agent was measured at the end of the surgery (ml/min). Assessment of endoscopic surgical field condition by the Fromme-Boezaart scale [8]. Time to extubation (minutes): the time from discontinuing anesthesia to fulfilling extubation criteria, Recovery time (minutes): the time from extubation, till patients attain an Aldrete score >9 [9], were recorded

Data was fed to the computer and analyzed using IBM SPSS software package version 23.0. Qualitative data were described using numbers and percentages. The Kolmogorov–Smirnov test was used to verify the normality of distribution quantitative data were described using range (minimum and maximum), mean, standard deviation, and median. The significance of the obtained results was judged at the 5% level.

4. Results

A total of 140 patients scheduled for FESS were assessed for eligibility. Of these, 120 patients achieved all criteria, consented and were enrolled and divided into two equal groups (Figure 2)

Mean heart rate showed no significant statistical difference between the two groups at the preoperative time, after induction of anesthesia, just after the entrance of the endoscope, and at 120 min and 135 min intraoperatively with p values of 0.614, 0.259, 0.074, 0.107, and 0.910, respectively. However, it was significantly lower in PFB than in the control group at

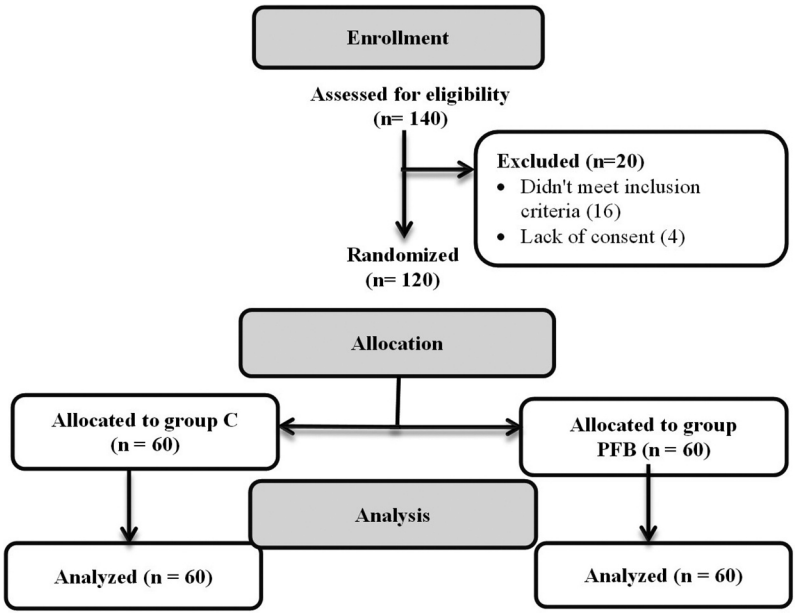

Figure 2. Flow chart.

15 min after induction of anesthesia to 105 min intraoperatively ($P < 0.001$) (Figure 3).

Between the two groups, there was no statistically significant difference in mean (MABP) preoperatively, after induction of GA, at entrance of endoscope, after 15 min, 30 min, 45 min, 60 min, 75 min, 90 min, 105 min, 120 min, and 135 min. *P* values were 0.919, 0.551, 0.306, 0.140, 0.482, 0.183, 0.275, 0.638, 0.560, 0.956, 0.316, 0.45, respectively (Figure 4).

Fentanyl and propranolol administration were significantly lower intraoperatively in the PFB group than in the control group. Nitroglycerine was not needed in the PFB group while ten patients in group C received nitroglycerin intraoperatively. Table 1

The total intraoperative isoflurane consumption and the mean consumption per minute in group C were 45.67 ml and 0.42 ml/min. This was significantly higher than group PFB where the total

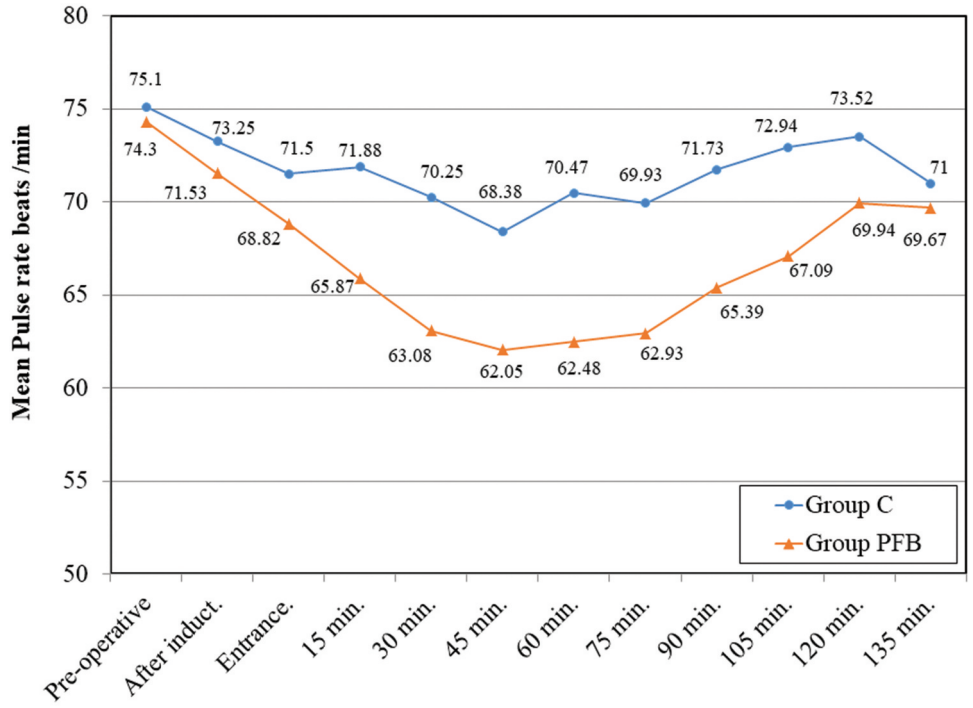

Figure 3. Preoperative pulse rate changes in the two studied groups.

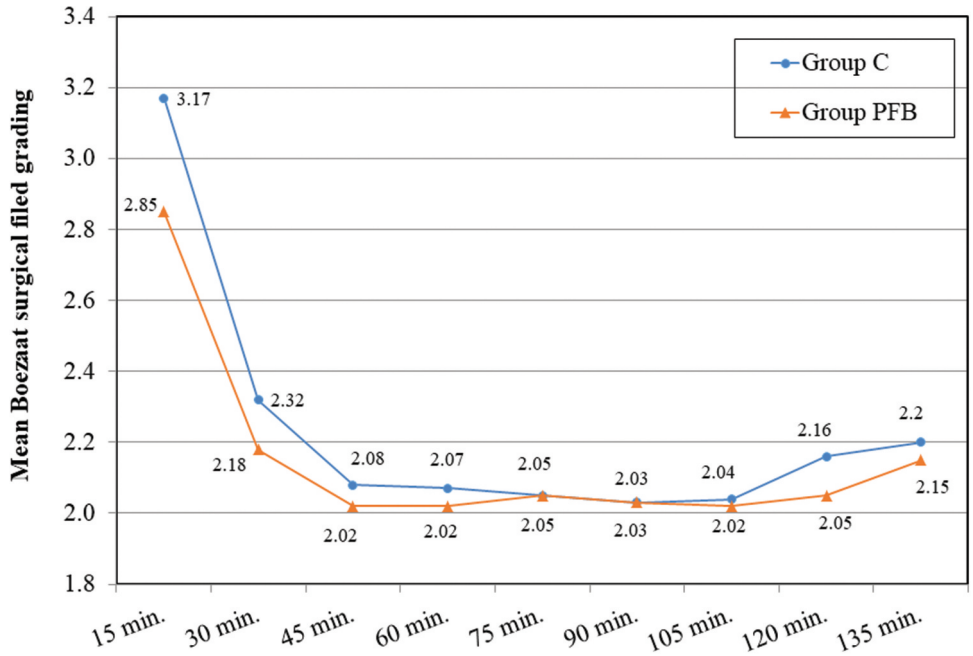

Figure 4. Perioperative mean arterial blood pressure changes in the two studied group.

Table 1. Demographic, intraoperative, and postoperative data

	Group C ($n = 60$)	Group PFB ($n = 60$)	Test of sig. *=significant at P< 0.05	p
Demographic data in the two studied groups	29.47±4.29	29.68±5.02	t=0.254	0.800
Age (years)				
Sex				
Male	26(43.3%)	27(45.0%)	χ^2=0.034	0.854
Female	34(56.7%)	33(55.0%)		
Height (m)	1.69±0.10	1.68±0.10	t= 0.298	0.766
Weight (kg)	76.82±9.76	76.15±10.80	t= 0.355	0.723
BMI (kg/m2)	27.07±3.77	26.88±3.25	t= 0.300	0.765
ASA				
I	44(73.3%)	42(70%)	χ^2=0.164	0.685
II	16(26.7%)	18(30%)		
Duration of surgery (min.)	111.0±12.41	109.25±14.37	t = 0.714	0.477
Number of patients who received drugs				
Fentanyl	49(81.7%)	11(18.3%)	χ2=48.133*	<0.001*
Propranolol	33(55.0%)	4(6.7%)	χ^2=32.862*	<0.001*
Nitroglycerin	10(16.7%)	0(0.0%)	χ^2=10.909*	0.001*
The total volume of the anesthetic agent isoflurane (ml)	45.67±6.03	19.60±5.80	t = 24.140*	<0.001*
The total volume of the anesthetic agent isoflurane (ml/min)	0.42±0.08	0.18±0.05	t = 19.438*	<0.001*
Extubation time (min)	10.05±1.65	5.33±1.69	t =15.444*	<0.001*
Recovery time (min.)				
Min. – Max.	11.0–18.0	3.0–11.0		
Median (IQR)	13.0 (12.0–15.0)	7.0 (6.0–8.0)	U = 0.500*	<0.001*

χ2: Chi-square test; t: Student t-test.

consumption and the mean consumption per minute were 19.60 ml and 0.18 ml/min

Comparing the surgical field by the Fromme-Boezaart scale, Figure 5 illustrated that there was a significant statistical difference between the two groups at 15 min only where the endoscopic surgical field condition in group PFB was more visible than in group C but at 30, 45, 60, 75, 90, 105, 120, 135, and 150 min there were the insignificant difference between the two groups ($P < 0.006$, 0.093, 0.095, 0.172, 1.000, 0.973, 0.607, 0.159 and 0.924), respectively

Table 1 shows that the mean time to extubation in group C (10.05 ± 1.65 min) was significantly longer than group PFB (5.33 ± 1.69 min). Table [1] showed that recovery time in group C (13.92 ± 2.02 min) was significantly longer than group PFB (7.13 ± 1.73 min).

5. Discussion

Surgical field optimization is crucial for a successful FESS without side effects. US-guided techniques are widely used to reduce the need for pharmacological

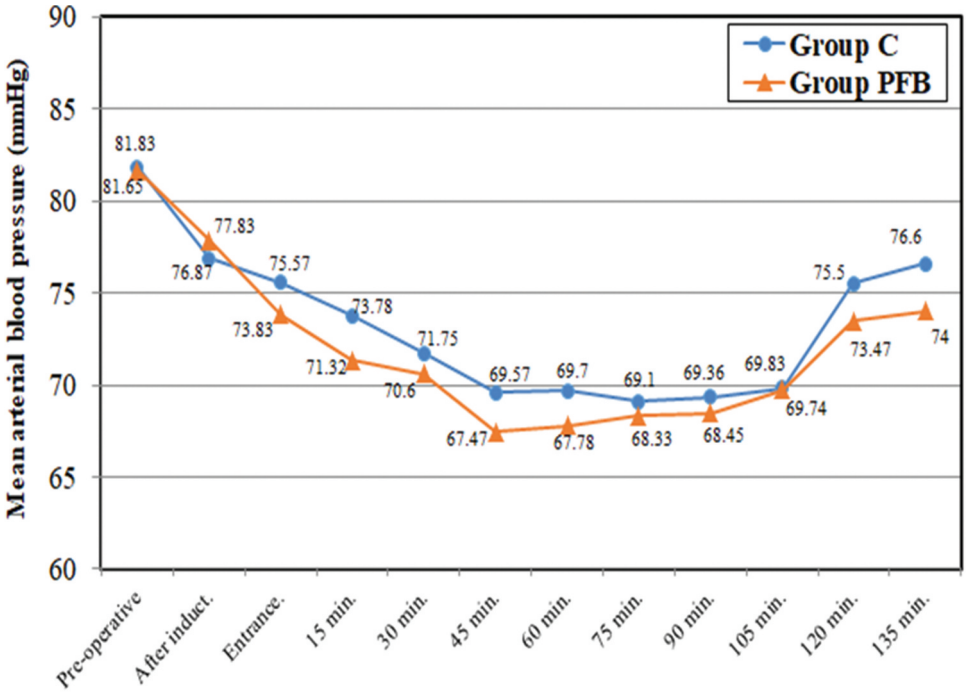

Figure 5. Surgical field condition in the two groups according to Fromme-Boezaart surgical field grading.

methods to regulate hemodynamics and offer sufficient perioperative analgesia.

PPF block is used to block the sphenopalatine ganglion and the maxillary nerve contained inside in group PFB hemodynamics were more controllable all over the surgery, Fentanyl and propranolol were less significantly used intraoperatively, less isoflurane was needed to keep entropy between 40 and 60. More pharmacological agents and inhalational anesthetics were used in the control group to create the optimum field. The use of more pharmacological agents led to a more prolonged extubation time and recovery time in the control group.

The preemptive inhibition of nociceptive impulses traveling through the sensory afferent branches of the maxillary nerve while passing into the PPF was likely the cause of these results. Moreover, injection of the sphenopalatine ganglion with a local anesthetic may reduce the mucosal blood flow of the nasal sinuses and turbinates. This is due to the sphenopalatine ganglion's vasodilatory parasympathetic effect on the mucous membrane of the nose being blocked, leading to unopposed sympathetic mucosal vasoconstriction and a better surgical field [10].

Early studies involving PPF block through the greater palatine foramen transorally were done by Ismail et al. [10] and Wormald et al. [11]. These studies documented a blunted response of the HR and MABP to surgical stimulus during FESS with a significantly better surgical field. This was confirmed later by Raisoni et al. [12].

Mathew et al. [13] demonstrated favorable surgical field conditions with less operative bleeding during FESS with a transoral injection of PPF through the greater palatine foramen. Similarly, Shanker et al. [14] and Kamel et al. [15] recorded the same.

Rezaeian et al. [16] performed PPF block transnasally by endoscopic injection through the sphenopalatine foramen at the deep attachment of the middle turbinate during FESS. Intraoperatively, no opioids were used to control HR and MABP with a better surgical field. Less analgesia and better patient satisfaction were recorded postoperatively in the intervention group. Mohamed et al. [17] found nearly the same results in patients undergoing elective endoscopic trans-nasal resection of pituitary adenoma under GA.

Abdelghafar et al. [18] approached the PPF transcutaneously via an infrazygomatic in-plane approach with a posterior-to-anterior needle path. Patients eligible were those with maxillofacial cancer. The interventional group needed lower inhalational anesthetics and fewer pharmacological agents (opioids, propranolol, and nitroglycerin) to control hemodynamics (HR and MABP), with a more rapid emergence and extubation.

Regarding the approach used to enter inside the PPF transcutaneous, the infra zygomatic in-plane approaches (the anterior to posterior or the posterior to anterior) were found to be more feasible and easy than the supra zygomatic out-of-plane approach, although the maxillary artery is found frequently in the needle path of the infra zygomatic approaches which can be avoided by real-time US identification. Every approach has its pros and cons whether in adults or children [19,20].

The limitations of this study include: there were discrepancies in the objective evaluation of the surgical field among the three physicians performing the procedures, the use of a fixed dose of local anesthetic, and hence, the exact dose that will produce the optimal effect remains unknown. This needs further investigation. Neither group received local anesthetic to the nasal mucosa, which could have potentially benefited the control group. Since general anesthesia was induced before the block was administered, sensory testing to verify the block's effectiveness was not done, and certain patients were excluded (age above 50, ASA more than 2, obese).

In conclusion, US-guided pterygopalatine fossa block provided more stable hemodynamics and a good operative field which improved visual field quality for the surgeon and decreased anesthetics consumption. Moreover, it improved recovery characteristics.

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Disclosure statement

The authors declare no conflict of interest.

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