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Nerve block using local anesthetic and dexmedetomidine in patients undergoing functional endoscopic sinus surgery

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Abstract

Background: The main anesthetic goal in the postoperative period of functional endoscopic sinus surgery (FESS) is early and pain-free recovery, with return of protective airway reflex. The aim of this study is to evaluate the role of dexmedetomidine as an adjuvant to regional blocks in patients undergoing functional endoscopic sinus surgery.

Results: Group bupivacaine + dexmedetomidine (BD) showed statistically significantly lower postoperative pain measurements than group bupivacaine (B), longer time to the first request of rescue analgesia, less patients needing rescue analgesia, and less rescue morphine analgesic requirements. Other measurements were insignificantly different between both groups.

Conclusions: Dexmedetomidine can be used as an adjuvant to regional nerve block in patients undergoing functional endoscopic sinus surgery. It effectively prolonged postoperative analgesia, decreased postoperative opioid analgesic requirements, and reduced the number of patients needing rescue analgesia.

Keywords: Anterior ethmoidal nerve (AEN) block, Dexmedetomidine, Functional endoscopic sinus surgery (FESS), Nerve blocks, Postoperative pain, Sphenopalatine ganglion (SPG) block

Background

Functional endoscopic sinus surgery (FESS) is considered the least invasive surgery for management of sinus pathology (Kempen 2012). The main anesthetic goal in the postoperative period is early and pain-free recovery, with return of protective airway reflex (Paudel et al. 2018).

General anesthesia combined with regional analgesic block can be used to depress intra- and postoperative painful stimuli. Regional blocks are better than high doses of narcotics that have adverse effects, such as postoperative emesis, respiratory depression, and decreased alertness (Higashizawa and Koga 2001).

The anterior and internal portions of the nose are innervated by branches from the sphenopalatine ganglion (SPG) and the anterior ethmoidal nerves (AEN). Postoperative pain relief is mostly achieved by blocking these branches (Kim et al. 2013).

Dexmedetomidine (DEX) is a potent α2-adrenoceptor agonist. It was recorded that dexmedetomidine was effective in different regional anesthesia and neuro-axial block (Rao and Rajan 2021). The duration of sensory block is prolonged when dexmedetomidine is injected perineural in the peripheries (Hussain et al. 2017).

The hypothesis of the study was that addition of dexmedetomidine to bupivacaine in regional nerve blocks, including sphenopalatine block and anterior ethmoidal nerve block, in patients undergoing FESS, would decrease postoperative pain severity, prolong the postoperative analgesic duration of the blocks, and improve the surgical field quality. This study assesses the role of

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dexmedetomidine as an effective additive to regional anesthetic nerve block in patients undergoing FESS.

Methods

This prospective double-blinded, randomized study was conducted in Tanta University hospitals over a duration of 6 months from April to October 2020, on 60 adult patients of both genders. The patients were scheduled for functional endoscopic sinus surgery due to failure of medical treatment, were above 18 years old, and were classified as ASA I-II.

The exclusion criteria included the following: pregnant and lactating mothers; patients taking regular analgesia, antidepressants, and/or antiepileptic medications; patients with psychological problems who cannot comply with the protocol; patients with a systemic disease affecting the nose; patients with previous chronic facial pain of other reason; patients with history of drug allergy; and patients with coagulopathy disorders or receiving anticoagulant drugs.

The acceptance code given by the Research Ethics Committee of the Faculty of Medicine, Tanta University, was 33701/02/20, and the study was registered in the Pan African Clinical Trial Registry (PACTR202003734769032). Every patient signed a written informed consent after receiving detailed presentation of the goal of the research. The privacy of the participating patients and confidentiality of data were kept using a secret code number, and pictures taken were limited to the part of the body related to the research.

The independent data manager assigned the patients to their groups using a computer-generated randomization program, the results of which were delivered in a closed opaque envelope. The anesthesiologist who prepared local anesthetic solutions and the investigator who recorded the observations were blinded to each patient's randomization number and were not included in the study. The surgeon and anesthesiologist were blinded to the study groups and to the prepared solution for the blocks.

Patients were evaluated preoperatively, including a full history review, clinical examination, and routine laboratory investigation. The visual analogue scale (VAS), expressed as 0 = no pain and 10 = intolerable pain, was used to evaluate the severity of pain. VAS of three or lower was defined as "pain relieved."

Intravenous midazolam (0.02 mg/kg) was given for sedation via a 20-G peripheral IV cannula. All patients were connected to a monitor presenting an electrocardiogram (ECG), peripheral oxygen saturation, noninvasive mean arterial blood pressure (MAP), end-tidal CO2, anesthesia depth by BIS, and temperature measurement.

All participants inhaled oxygen at a FiO2 of 100% for 3 min. Anesthesia was induced using intravenous fentanyl at a dose of 1 μg/kg (Sunny Pharmaceutical, Egypt), propofol at a dose of 2 mg/kg (Fresenius Kabi, Germany), and atracurium (Hamelin, Germany) at a dose of 0.5 mg/kg. The trachea was intubated, and then the mechanical ventilation started. The end-tidal CO2 values ranged between 34 and 36 mm Hg.

Transoral SPG and endonasal AEN blocks were performed for each side after induction of anesthesia. Sixty patients were randomly allocated into two equal groups (30 patients each) as follows.

Group B: The mixture of local anesthetic for this group consisted of 5 ml bupivacaine 0.5% (Al Debeiky Pharma, Egypt) and 1 ml 0.9% saline for a whole volume of 6-ml solution.

Group BD: The mixture of local anesthetic for this group consisted of 5 ml bupivacaine 0.5% and 1 μg/kg dexmedetomidine in a volume of 1 ml (Pfizer, USA) for a whole volume of 6-ml solution.

Endonasal anterior ethmoidal nerve block

Guided by endonasal endoscopy, submucosal infiltration of the agger nasi cell and middle turbinate region for each side resulted in AEN block. The submucosal infiltration blocked the anterior lateral nasal branch of the nerve. A total of 1 ml volume of desired solution was injected in each side (Shamil et al. 2018) (Fig. 1a).

Transoral SPG block

Sphenopalatine ganglion block was injected in the intraoral greater palatine canal. The location of greater palatine foramen is posteromedial to the third maxillary molar and anteromedial to the maxillary tuberosity and pterygoid hamulus. The safety and effective delivery of 2 ml of the desired solution for each side was ensured using a 25-G needle, which was inclined to an angle of 45°, 25 mm from the tip. The tongue was depressed using a tongue depressor or laryngoscope blade. The greater palatine foramen was identified by finger palpation, and then the needle was introduced through the mucosa until contacting bone. The needle was moved slightly to explore and localize the foramen until it pierced the canal with ease; the correct position was ensured by a negative aspiration to prevent piercing the nasopharynx or any vessel. Upon correct positioning, 2 ml of the desired solution was introduced on each side (Douglas and Wormald 2006) (Fig. 1b).

Every 30 min, or when need, incremental atracurium at a dose of 0.1 mg/kg was administrated. Sevoflurane (AbbVie Inc., USA) in 50:50% oxygen to air was used to keep the bispectral index (BIS) between 40 and 60.

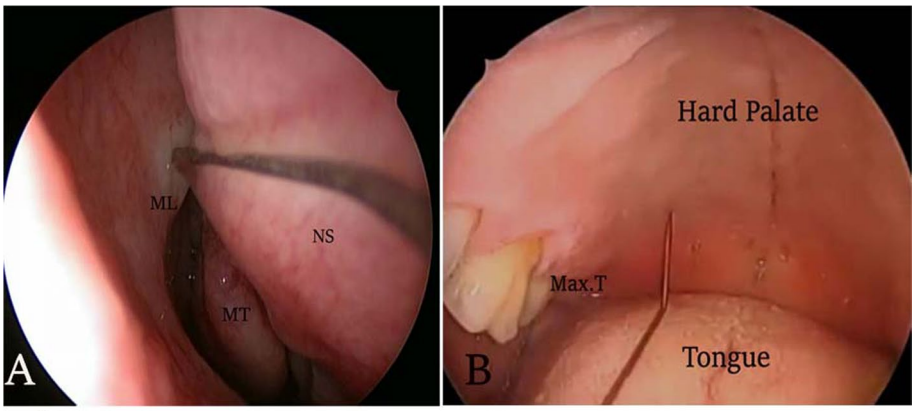

Fig. 1 Regional nerve block including **A** endonasal anterior ethmoidal nerve block. **B** Transoral sphenopalatine ganglion block. (ML, maxillary line; MT, middle turbinate; NS, nasal septum; MAX. T, maxillary teeth)

Fentanyl 0.5 μg/kg was given IV when there was an increase in heart rate and/or mean arterial blood pressure 20% above the baseline. The venous drainage was improved by supine position of the patient with the head up at about 30°.

At the end of surgery and after application of nasal packs, sevoflurane was turned off. Neostigmine 0.05 mg/kg and atropine 0.01 mg/kg were given to reverse the effect of neuromuscular block. The extubation was done, and the patient was shifted to the postanesthesia care unit (PACU).

Paracetamol 10 mg/kg IV was given every 6 h postoperatively. Morphine was given at a dose of 0.1 mg/kg IV as rescue analgesia if the VAS was more than 3 postoperatively.

Outcome assessment

Postoperative pain severity was measured using the visual analogue scale as a primary outcome. Secondary outcomes included baseline and intraoperative hemodynamic measurements, time of first request for rescue analgesia, number of patients requiring rescue analgesia, total amount of morphine used as rescue analgesia in 24 h, quality of the surgical field, quality of recovery, and postoperative side effects such as nausea, vomiting, hematoma, headache, and dental numbness.

The surgeons evaluated the surgical field at the end of surgery using the average category scale (ACS). ACS was firstly designed by Fromme et al. (Fromme et al. 1986) and then updated by Boezaart et al. (Boezaart et al. 1995). The quality of recovery was assessed by the Aldrete score (Dewi et al. 2016).

Statistical analysis

VAS was used for calculating the sample size. The G*Power 3.1 program was used for calculating the sample size: 27 persons per group, assuming SD of 0.9 from the previous study (Bhattacharyya et al. 2016), power of 80%, α error of 0.05, and β error of 0.2. Thirty patients were included in each group. To cover for dropouts, three extra cases were added to each group.

SPSS Version 24 program (IBM Corporation, Armonk, NY) was used for data analysis. Absolute numbers and percentages expressed categorical variables. Continuous variables were expressed as either mean values with standard deviation or medians with an interquartile range as appropriate.

The chi-square test, the Student *t*-test, and the Mann-Whitney *U*-test were used to assess the comparison between groups as appropriate. The paired *t*-test and the Wilcoxon test were used as appropriate to compare within the same group. A statistically significant difference was achieved when the 2-tailed *P*-value was lower than 0.05.

Results

Twelve out of 72 enrolled patients were excluded from the study. Seven patients did not satisfy the inclusion criteria, two had chronic facial pain of other etiology, one was on antidepressants, four were using chronic analgesic drugs, and five refused to participate. The

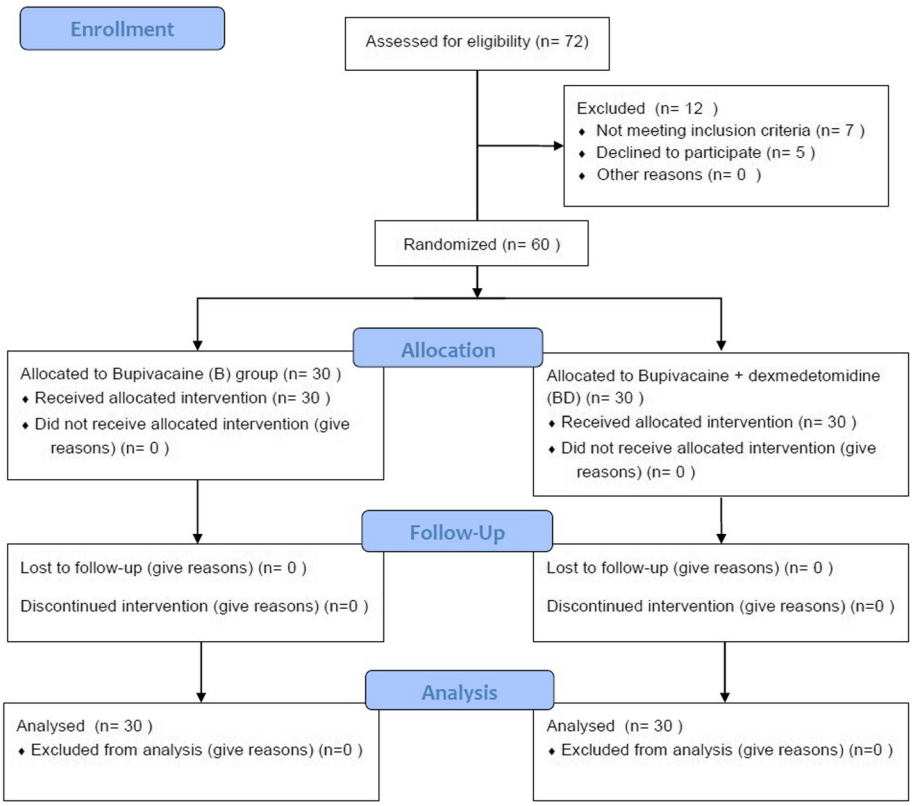

Fig. 2 Consort flow chart of both groups

Table 1 Demographic data of the studied groups

	Group B ($n = 30$)	Group BD ($n = 30$)	*p*-value
Age (years) (mean ± SD)	41.27 ± 12.55	36.83 ± 12.44	0.175
Weight (kg) (mean ± SD)	85.1 ± 13.47	81.9 ± 12.12	0.349
Gender (F/M)	10/20	8/22	0.573
Surgery time (min) (mean ± SD)	67.2 ± 12.6	66.3 ± 11.65	0.775

* Denoted significant difference between groups ($P < 0.05$)

remaining 60 patients were randomly distributed into two equal groups as presented in Fig. 2.

Demographic data such as age, gender, weight, and duration of surgery showed a statistically insignificant difference between the two groups (Table 1).

The visual analogue scale in group B was statistically significantly higher than in group BD, at 4, 12, and 16 h after surgery (*P*-value < 0.0001, < 0.0001, = 0.005, respectively). But there were statistically insignificant differences between the two groups (*P*-value > 0.05) after 30 min in the recovery room and 2, 8, and 24 h after surgery (Table 2).

Five patients (16.7%) in group BD required morphine as rescue analgesia, but in group B, all 30 patients (100%) needed rescue analgesia. The difference between both groups was statistically significantly higher in group B than group BD (*P*-value < 0.0001) (Table 3). Total consumption of morphine was statistically significantly higher in group B than in group BD (*P*-value < 0.0001) (Table 3). There was a statistically significant difference between both groups in the duration of postoperative analgesia; it was shorter in group B than in group BD ($P < 0.0001$) (Table 3). However, there was an insignificant difference between the two groups in terms of the number of patients who needed intraoperative

Table 2 Visual analogue scale (VAS) for postoperative pain measurement of the studied groups

VAS	Group B ($n = 30$)	Group BD ($n = 30$)	*p*-value
After 30 min in recovery room (median, Q1 and Q3)	2 (1, 3)	2 (1, 2)	0.432
2 postoperative h (median, Q1 and Q3)	2 (1.75, 2)	2 (2, 2)	0.539
4 postoperative h (median, Q1 and Q3)	3 (2, 4)	2 (2, 3)	< 0.0001*
8 postoperative h (median, Q1 and Q3)	2 (1, 3)	2 (2, 3)	0.723
12 postoperative h (median, Q1 and Q3)	4 (2, 4)	2 (2, 2.25)	< 0.0001*
16 postoperative h (median, Q1 and Q3)	2.5 (2, 4)	2 (2, 2.25)	0.005*
24 postoperative h (median, Q1 and Q3)	2 (2, 2.25)	2 (2, 3)	0.287

* Denoted significant difference between groups ($P < 0.05$)

fentanyl and the incidence of postoperative side effects (P-value = 0.301 and 0.554, respectively) (Table 3).

The intraoperative readings of hemodynamics (HR and MAP), the surgical field quality (ACS), and the quality of recovery (Aldrete score) were found to be statistically insignificantly different between both groups (P-value > 0.05, = 0.287, and = 0.873, respectively) (Figs. 3 and 4) (Table 3).

Discussion

To our knowledge, this research is the first to estimate the effect of dexmedetomidine as an adjuvant to regional anesthetic nerve block in patients undergoing FESS.

The peripherally or centrally mediated action of dexmedetomidine enhances the local anesthetics action and their duration. Sedation and analgesia resulted from the central stimulation of the α2-adrenoreceptor and depression of substance P secretion by α2-agonists at the level of the dorsal root neuron in the nociceptive pathway (Guo et al. 1996; Eisenach et al. 1996; Prabhakar et al. 2019; Lönnqvist 2012). The peripheral mechanism of action is explain by stimulation of the peripheral α2-adrenoreceptor. This stimulation increases after hyperpolarization (Gaumann et al. 1994).

Hussain N et al. conducted a systemic meta-analysis including ten studies that investigated intravenous and perineural dexmedetomidine as peripheral nerve block adjuvants to upper limb blocks (seven), lower limb blocks (two), and truncal block (one). They concluded that intravenous dexmedetomidine is an inferior peripheral nerve block adjunct compared to perineural dexmedetomidine. Perineural dexmedetomidine provides longer duration and faster onset of sensory and motor blockade (Hussain et al. 2021).

The main result of the current study is that adding dexmedetomidine to bupivacaine for SPG block and anterior ethmoidal nerve block prolonged the duration of postoperative analgesia, reduced the number of patients requesting rescue analgesia, and reduced the needed doses of rescue analgesia (morphine) compared to bupivacaine alone. This result comes in line with the result reported by Obayah GM et al. (Obayah et al. 2010), who found that adding dexmedetomidine 1 mic/kg to plain bupivacaine to block the greater palatine nerve in cleft palate surgery prolonged the duration of analgesia. In group B (block with bupivacaine alone), the duration of analgesia was 8.9 h, but it increased about three times when dexmedetomidine was added in group BD.

Casati et al. (Casati et al. 2000) reported that the duration of postoperative analgesia increased by 20% upon using α2-agonists (clonidine) and ropivacaine to block the sciatic and femoral nerves, but our study showed that postoperative analgesia duration increased about three times. This difference could be attributed to using different α2-agonists and different surgeries. Our result agrees

Table 3 Intra and postoperative data of the studied groups

	B group ($n = 30$)	BD group ($n = 30$)	*p*-value
Surgical field quality (ACS) (median, Q1 and Q3)	1 (0.75, 1)	1 (0, 1)	0.287
Aldrete score (median, Q1 and Q3)	9 (9, 10)	9 (8.75, 10)	0.873
Number of patient needed intraoperative rescue fentanyl (no., %)	3 (10%)	1 (3.3%)	0.301
Number of patient needed rescue analgesia (no., %)	30 (100%)	5 (16.7%)	< 0.0001*
First time of rescue analgesia (h) (mean ± SD)	8.97 ± 4.57	25.8 ± 2.9	< 0.0001*
Total postoperative morphine consumption (mg) (mean ± SD)	12.76 ± 2.7	1.18 ± 2.7	< 0.0001*
Incidence of side effects (no., %)	1 (3.3%)	2 (6.7%)	0.554

* Denoted significant difference between groups ($P < 0.05$)

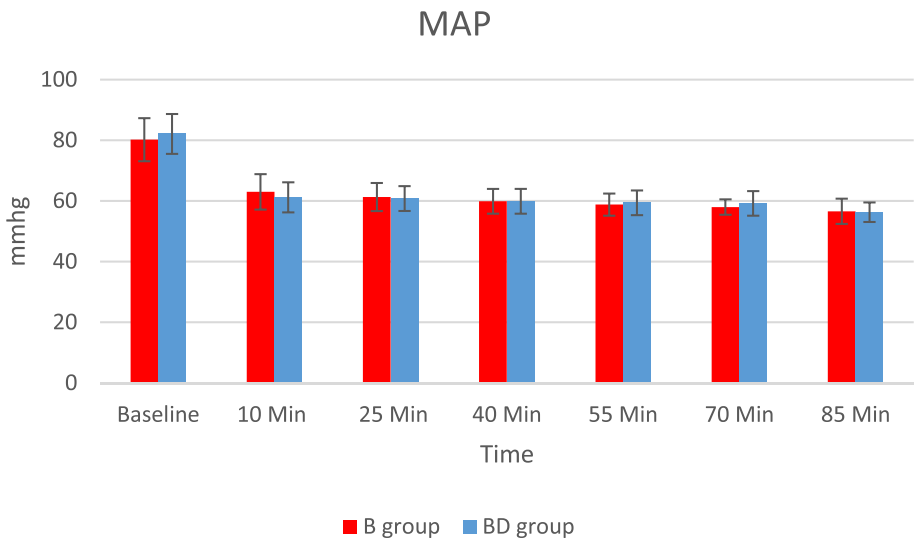

Fig. 3 Intraoperative mean arterial blood pressure (MAP) readings comparison of both groups (mean ± SD)

with the result obtained by Rancourt MP et al. (Rancourt et al. 2012), who showed that the sensory block time was prolonged without affecting the onset time upon using 1 µg/kg dexmedetomidine added to10 ml of 0.5% ropivacaine for tibial nerve block with ultrasound guidance. Another study showed that the duration of analgesia increased by 200 min when 20 µg dexmedetomidine was added to 3 ml of ropivacaine 0.75% to block the ulnar nerve (Marhofer et al. 2013).

Our result showed that the visual analogue scale (VAS) was statistically significantly higher in group B than in group BD at 4, 12, and 16 h after surgery. This is supported by the result reported by Obayah GM et al. (Obayah et al. 2010) who found that, during the first day, the postoperative pain score was lower in the group receiving bupivacaine and dexmedetomidine than in the group receiving bupivacaine alone, with no systemic sedative effects or intraoperative hemodynamic effects. The result of the current study is also in line with a study done by Almarakbi WA and Kaki AM. (Almarakbi and Kaki 2014), where transversus abdominis plane block with ultrasound (using 0.5 µg/kg dexmedetomidine and 0.25% bupivacaine) was done for postoperative analgesia after abdominal hysterectomy. They found that postoperative pain was lower in the dexmedetomidine group than in the control group.

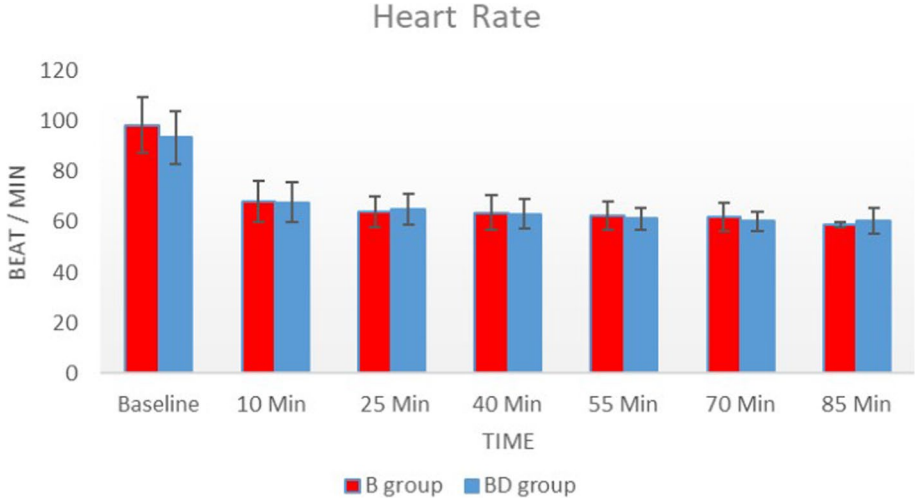

Fig. 4 Intraoperative heart rate (HR) readings comparison of both groups (mean ± SD)

This result showed that there was an insignificant difference between the two groups, in terms of the Aldrete recovery score. This means that adding dexmedetomidine to bupivacaine for sphenopalatine ganglion and anterior ethmoidal nerve block will not affect the recovery criteria nor increase the level of sedation. This is important in FESS, as oversedation in the postoperative period may lead to airway obstruction (Kandinov et al. 2021; Owais Amin et al. 2020).

The results of the current study also showed that there was an insignificant difference between both groups in terms of intraoperative surgical field quality (ACS). The reason for this is that blocking SPG abolishes the parasympathetic fibers mediated vasodilation, which leads to a decrease in blood flow to the nasal sinus mucosa and turbinates and decreases bleeding.

The result of the current study showed that there was insignificant differences between both groups in terms of MAP and HR, but the intraoperative readings of MAP and HR were significantly lower than the baseline values of the same groups. However, in a study conducted by Helal SM et al. (Helal et al. 2016), adding 100 mic dexmedetomidine to 0.5% bupivacaine for combined sciatic and femoral nerve block in patients who underwent below-knee surgery caused significant bradycardia.

Other researchers performed interscalene nerve block in patients who underwent shoulder surgery, with 150-μg dexmedetomidine added to 0.5% ropivacaine, and recorded decreased postoperative pain and prolonged time of nerve block but decreased heart rate without affecting blood pressure (Fritsch et al. 2014).

Regarding postoperative side effects, only 1 (3.3%) patient in group B in our study and 2 (6.7%) in group BD complained of dental numbness, which improved within hours, without treatment. In another study, two patients reported sensing high pressure behind their eyes, and four patients complained of dental numbness when sphenopalatine ganglion was blocked. Both side effects subsided without treatment (Bhattacharyya et al. 2016).

One limitation of the current study is the absence of a control group. Another limitation is the use of a fixed dose of dexmedetomidine, and hence, the exact dose that will give the best response remains unknown. This needs further investigation.

Conclusions

Using a mixture of bupivacaine and dexmedetomidine for sphenopalatine nerve block and anterior ethmoidal nerve block in patients undergoing FESS prolonged the duration of postoperative analgesia, with fewer patients requesting rescue analgesia and less postoperative morphine consumption.

Abbreviations

BD: Bupivacaine + dexmedetomidine; B: Bupivacaine; FESS: Functional endoscopic sinus surgery; AEN: Anterior ethmoidal nerves; DEX: Dexmedetomidine; ASA: American Society of Anesthesiology; PACTR: Pan African Clinical Trial Registry; VAS: Visual analogue scale; ECG: Electrocardiogram; MAP: Mean arterial blood pressure; HR: Heart rate; BIS: Bispectral index; SPG: Sphenopalatine ganglion; ACS: Average category scale; SD: Standard deviation.

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None

Authors' contributions

TM: concepts, data acquisition, statistical analysis, manuscript editing and manuscript review. MT: definition of intellectual content, literature search, data analysis, manuscript preparation and manuscript review. NKh: design, clinical studies, experimental studies, data acquisition, manuscript review and guarantor.

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Availability of data and materials

The data and the materials sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Tanta University (approval code of 33701/02/20), and written informed consent was obtained from the patients. The trial was registered in the Pan African Clinical Trial Registry with a unique identification number for the registry which is PACTR202003734769032. Every patient signed a written informed consent before inclusion after complete presentation of the goal of the research with full details of the study.

Consent for publication

Consent for publication was obtained from all the participants

Competing interests

The authors declare that they have no competing interests.

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