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Research Article

Efficacy and effect of TIVA with propofol or dexmedetomidine versus sevoflurane without muscle relaxant during repair of the brachial plexus

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KEYWORDS

TIVA propofol;
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Abstract *Background:* Total intravenous anesthesia (TIVA) versus inhalational anesthesia was selected as the anesthetic method, in order to avoid the use of muscle relaxants during repair of brachial plexus injury. We designed this study to determine effect and efficacy of TIVA versus sevoflurane during repair of brachial plexus injury.

Methods: Sixty patients scheduled for repair of injured brachial plexus from January 2009 till December 2011 were enrolled in this prospective, single-blind, randomized study. They received either inhalation induction with sevoflurane and maintenance with sevoflurane and fentanyl (Group 1) or TIVA with, propofol and fentanyl (Group 2) or TIVA with dexmedetomidine and fentanyl (Group 3). Hemodynamics, intubation conditions, sedation score were assessed. Postoperative pain using visual analogue scale (VAS) was assessed. Discharge time, postoperative respiratory condition, any postoperative complications were recorded.

Results: All groups provided a similar significant reduction in hemodynamics compared with baseline values. Respiratory rate values of dexmedetomidine–fentanyl group were significantly higher

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than those in other groups. Oxygen saturation values of dexmedetomidine–fentanyl group were significantly higher than those of propofol–fentanyl group. Time to reach an Aldrete score of 10 was similar in all groups. Patients in sevoflurane–fentanyl group have significantly higher visual analogue score than other groups. Sedation score was higher in the dexmedetomidine–fentanyl group. *Conclusion:* TIVA with propofol and with dexmedetomidine was more effective and favorable anesthesia than sevoflurane anesthesia during repair of brachial plexus injury.

1. Introduction

Brachial plexus lesions are a tragic condition that usually affects young adults, with significant socioeconomic implications [1]. The reported incidence of peripheral nerve injury among the trauma population was 2% and it was 5% if plexus and root lesions were included [2]. Closed traction is the most common mechanism in adults, which is mainly caused by high-energy forces such as motorcycle accident, and trauma leads to section, contusion and/or stretch injuries of the neural elements. In addition, cervical nerve roots are frequently injured or avulsed close to or from the spinal cord [3].

Prevention of postoperative neurological deficits is a major concern of the neurosurgeons and has led to the increased need to use intra operative neurophysiologic monitoring. Among these monitoring, intra operative direct nerve stimulation had became popular. In our hospital, the neurosurgeons call for anesthesia without the use of neuromuscular blockers during repair of the brachial plexus injury. Direct nerve stimulation was used for detection of motor nerves as well as to distinguish the nerve from the surrounding tissues in a surgical situation of disturbed anatomy with brachial plexus trauma. Pain resolution should be the first priority, and root exploration and grafting helped to decrease or eliminate pain complaints within a short time of surgery.

Regional anesthesia is associated with multiple benefits compared to general anesthesia, including decreased morbidity and mortality [4,5], superior postoperative analgesia [6] and enhanced cost effectiveness [7]. However, general anesthesia still the most common used anesthetic technique for the repair of brachial plexus injury in our locality. This might be assumed to the medico legal aspect and involving the regional anesthesia as a cause of neurological injury postoperatively.

Dexmedetomidine (Precedex®), a pharmacologically active dextroisomer of medetomidine, is a selective α_2-adrenergic receptor agonist which may be a useful adjuvant during general anesthesia by promoting hemodynamic stability [8] and decreasing the doses of anesthetics and analgesics [9,10]. Little studies have been discussed the use of dexmedetomidine as an adjuvant for anesthesia without muscle relaxants. The purpose of this study was to compare the effect and the efficacy of dexmedetomidine as well as propofol total intra venous anesthesia without muscle relaxant with sevoflurane anesthesia in patients undergoing repair of brachial plexus injury.

2. Patients and methods

After obtaining approval of the hospital ethics committee and written informed consent, we recruited 60 patients, with American Society of Anesthesiologists (ASA) grades I and II, and diagnosed with brachial plexus injury, into the study from January 2009 till December 2011. All patients were scheduled for exploration of brachial plexus at Mansoura University Hospital under general anesthesia to participate in the current prospective, randomized study. Those with American Society of Anesthesiologists grade III or higher, bronchial asthma, anticipated difficult airway, and a history of allergy to opioids or to one of the used medications were excluded from the study.

All patients were thoroughly assessed preoperatively by history, physical examination and laboratory evaluations (complete blood picture, liver function and renal function tests).

All patients were made familiar with the use of 10 cm a visual analogue scale score (VAS) identifying 0 as no pain and 10 as the worst imaginable pain. All patients received 10 mg diazepam orally at the night of surgery. On arrival of the patients to theater suite, and after routine monitoring, peripheral intravenous cannula (18G) was inserted on the contra lateral forearm. Lactated Ringer's solution was infused at a rate of 8 ml/kg to replenish the overnight fasting hours. All patients were premedicated with fentanyl 1.5 μg/kg (Fentanyl®, Janssen-Cilag, Germany) and midazolam 0.05 mg/kg (Dormicum®, Roche, Grenzach-Wyhlen, Germany).

In this single-blinded prospective study, the patients were randomly allocated to one of three groups by use of sealed envelopes (20 patients each). Group I ($n = 20$) received sevoflurane–oxygen for induction and sevoflurane with fentanyl infusion for maintenance of anesthesia. Group II ($n = 20$) received propofol for induction followed by propofol–fentanyl (Diprivan®, Astra Zeneca, Wedel, Germany) for maintenance. Group III ($n = 20$) received dexmedetomidine (Precedex®, Dexmedetomidine HCl inj., Hospira, Inc., Lacke Forest, USA) for induction followed by dexmedetomidine–fentanyl for maintenance. All anesthetics were prepared and administered by an investigator not included in the study.

Induction of anesthesia in the sevoflurane group (GI) (via an Abbot vaporizer) using a face mask with sevoflurane in a circle system beginning with 8% with initial fresh gas flow (FGF) 6 l min^{-1} of oxygen in air 50% decreasing to a total FGF of 3 l min^{-1} of oxygen in air 50% during maintenance with 3% sevoflurane plus fentanyl infusion in a dose of 0.5 μg kg^{-1} h^{-1}.

Induction of anesthesia in propofol–fentanyl group (GII) was done by 1.5 mg kg^{-1} propofol. The patients of this group received a constant infusion of 2 mg kg^{-1} h^{-1} propofol and a constant infusion of 0.5 μg kg^{-1} h^{-1} fentanyl.

In dexmedetomidine–fentanyl group (GIII), dexmedetomidine was prepared by diluting 2 ml of dexmedetomidine ampoule (100 μg ml^{-1}) with 48 ml of normal saline to a concentration of 4 μg ml^{-1}. Syringe containing aqueous solutions of dexmedetomidine was prepared in a blind fashion by a team member who was not involved in data recording. A sin-

gle dose of dexmedetomidine 1 μg kg^{-1} was administered i.v. over 10 min using a syringe pump (Life Care 5000, Abbot) and followed by a continuous infusion of dexmedetomidine 0.6 μg kg^{-1} h^{-1} plus fentanyl infusion in a dose of 0.5 μg kg^{-1} h^{-1}.

Anesthetist blindly participated as the intubator for all patients in the three groups by direct laryngoscopy with a Macintosh blade3. Size 7.5 or 8.0 endotracheal tubes were used in female and male patients respectively. Degree of jaw relaxation, vocal cord position, and intubating responses were used for assessment of intubating conditions.

Jaw relaxation was described as fully relaxed (score = 1), mildly resistant (score = 2), tight but open (score = 3), and impossible (score = 4). Vocal cord position was described as widely open (score = 1), midposition (score = 2), moving but open (score = 3), and closed (score = 4). Intubating responses were described as none (score = 1), diaphragmatic movement (score = 2), mild/moderate coughing (score = 3), and severe coughing (score = 4). Intubating conditions were graded as excellent (total score [TS] = 3), good (TS = 4–6), poor (TS = 7–9), or impossible (TS = 10–12). If intubation was impossible, succinylcholine was administered to facilitate endotracheal intubation. The total score of 6 or less was classified as an acceptable intubation condition otherwise as unacceptable condition.

After successful intubation, controlled ventilation was achieved by (Drager-model Fabius GS-Germany) ventilator with tidal volume of 8–10 ml/kg and I/E ratio 1:2 to maintain end tidal carbon dioxide tension around 35 mmHg.

General anesthesia was tailored to allow intraoperative direct nerve stimulation to guide the localization and repair of the injured nerves. Consequently, muscle relaxants were avoided. The tissues suspected to be of nervous structure were stimulated during the surgery by the operator using bipolar stimulator (straight bipolar stimulating probe, Medtronic The NIM® 3.0-522 010 Micro fork probe) and motor responses were observed by the surgeon. The stimulus duration was 0.1 ms and the maximum stimulus intensity was 5 mA.

ECG, non invasive blood pressure, pulse oximetry and end tidal carbon dioxide ($EtCO_2$) were monitored throughout surgery by (Datex-Omeda model (S/5) AN. S. No: 3422715, Finland, 1998) monitor.

Heart rate (HR), mean blood pressure (MBP), pulse oximetry and $EtCO_2$ were monitored as preoperative (basal), 5 min, 30 min, 1, 2, 3, 4 h postinduction, then 1 h postoperatively.

After surgery, extubation was performed and patients were transferred to the postanesthesia care unit (PACU).

In the recovery area, modified Aldrete's score was recorded every 10 min until discharge. When patients attained score of 10, they considered ready for discharge (Table 5) [11].

Postoperative pain was assessed over 24 h using 10-cm visual analogue scale (VAS) where 0 = no pain and 10 = unbearable pain. VAS was recorded at times (early postoperative, 15 min, 30 min, 1 h, 2, 4, 6, 12, 18, and 24 h). When the patients experienced pain (VAS $\geqslant$ 4), they received rescue dose of nalbuphine hydrochloride.

Any postoperative events like nausea, vomiting, shivering or respiratory distress were recorded.

The statistical analysis of data was done by using excel program for figures and SPSS (SPSS, Inc., Chicago, IL) program statistical package for social science version 16.

To test the normality of data distribution K–S (Kolmogorov–Smirnov) test was done only significant data revealed to be nonparametric. N.B: all tested data revealed to be parametric. The description of the data done in form of mean (±) SD for quantitative data and frequency and proportion for Qualitative data.

The analysis of the data was done to test statistical significant difference between groups.

Chi square test was used for qualitative data. Any difference or change showing probability (P) less than 0.05 was considered statistically significant at confidence interval 95%.

A sample size of 20 patients in each group was calculated to have 80% power with a Type II error of 0.8 with $\alpha = 0.05$ using (G Power Analysis Program, version 3) in order to detect an incidence of difficult intubation of 25% of cases with a relative 20% change as being clinically significant between the two groups. These numbers are selected with the assumption that dexmedetomidine has the same effect as that in our pilot

Table 1 Patients characteristics and duration of surgery (min). Values are presented as mean ± SD, number and %.

		GI (n = 20)		GII (n = 20)		GIII (n = 20)		P value
		n	%	n	%	n	%	
ASA	I	15	75	16	80	16	80	
	II	5	25	4	20	4	20	0.90
Sex	M	16	80	16	80	17	85	0.89
	F	4	20	4	20	3	15	
Age (years)		30.60 ± 4.09		32.45 ± 4.34		32.00 ± 3.50		0.32
Height (cm)		166.55 ± 6.27		164.25 ± 6.32		162.10 ± 5.92		0.08
Wt (kg)		75.75 ± 7.65		73.95 ± 7.91		72.50 ± 8.93		0.45
BMI		27.41 ± 3.45		27.42 ± 2.67		27.77 ± 4.48		0.93
Duration of surgery (min)		220.65 ± 14.65		213.85 ± 20.30		216.45 ± 20.74		0.51
Time to reach an Aldrete score of 10(min)		40.63 ± 5.44		37.55 ± 8.60		40.53 ± 8.80		0.079
Type of injury								
N. avulsion		9		9		9		
N. ruptured		7		7		7		1.00
N. stretched		4		4		4		

GI = Sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

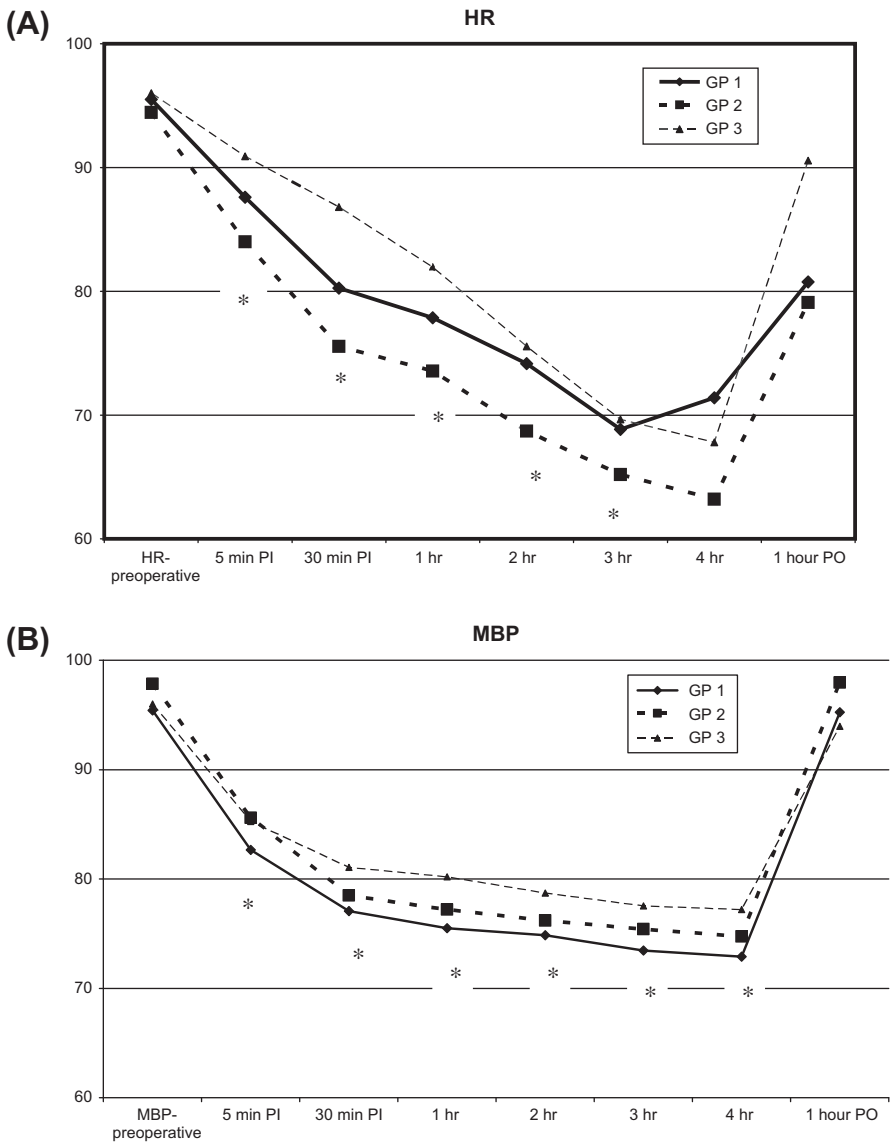

Figure 1 (A) HR of the studied groups (beat/min) (B) MBP of the studied groups (mmHg). *Statistically significant compared to the baseline value.

study, which was performed in a non blinded fashion using a few cases at our institution.

3. Results

There were no significant differences among the groups for age, sex distribution, body weight, height, BMI, the duration of surgery, and 47 of patients were ranked as ASA I while 13 were ASA II. 9 patients with nerve avulsion, 7 patients with nerve ruptured and 4 patients with nerve stretched were operated in each group (Table 1).

The time to reach a modified Aldrete' score of 10 displayed no significant difference between the studied groups (($P < 0.079$) (Table 1).

Heart rate showed no significant changes among the three studied group. In the three groups, there were similar significant reduction in HR and MBP compared with the basal values ($P < 0.05$) (Fig. 1A and B).

At 1 h postoperative, there was a similar significant increase of both HR and MBP returning towards the normal baseline (Fig. 1A and B).

Arterial oxygen saturation (SPO2) showed significant increase starting from 30 min. till 4 h postinduction reading in sevoflurane–fentanyl and dexmedetomidine–fentanyl groups compared with basal values. In comparison to propofol–fentanyl group, dexmedetomidine–fentanyl group showed significant differences in SPO2 at 1 h, 3 h and 4 h being higher in the latter group (Table 2).

Sevoflurane–fentanyl and propofol–fentanyl groups showed significant decrease in $EtCO_2$ at 1, 2, 3 and 4 h postinduction compared with basal values, while significant decrease displayed only at 30 min, 1 h, 2 h postinduction in dexmedetomidine–fentanyl group. $EtCO_2$ was significantly higher in propofol–fentanyl group compared with dexmedetomidine–fentanyl group at 30 min. However, $EtCO_2$ was within the nor-

Table 2 Arterial oxygen saturation (SPO2%) and end tidal carbon dioxide $EtCO_2$ (mmHg) of the studied groups. Values are mean ± SD.

	SPO2			$EtCO_2$		
	GI	GII	GIII	GI	GII	GIII
Preoperative	98 ± 1	98 ± 1	98 ± 1	34 ± 5	37 ± 5	34 ± 5
Postinduc.						
5 min	98 ± 2	98 ± 2	99 ± 1	35 ± 4	35 ± 6	32 ± 4
30 min	99 ± 1†	98 ± 1	99 ± 1†	32 ± 3	34 ± 5†	30 ± 4†,¨
1 h	99 ± 1†	98 ± 2	99 ± 1†,¨	31 ± 3†	33 ± 6†	30 ± 4†
2 h	99 ± 2†	98 ± 2	99 ± 1†	30 ± 4†	33 ± 6†	30 ± 3†
3 h	99 ± 2†	98 ± 2	99 ± 1†,¨	30 ± 3†	33 ± 6†	31 ± 4
4 h	99 ± 1†	96 ± 2	99 ± 1†,¨	30 ± 3†	33 ± 7†	32 ± 4
1 h post op.	99 ± 1	98 ± 1	98 ± 1	32 ± 2	34 ± 1	35 ± 1#

GI = Sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.
* Significant difference between GI and GII ($P < 0.05$).
† Intra group significant difference as related to basal ($P < 0.05$).
# Significant difference between GI and GIII ($P < 0.05$).
¨ Significant difference between GII and GIII ($P < 0.05$).

Table 3 Intubation conditions and responses. Values are in numbers (%).

Airway conditions and intubating responses	Score	GI ($n = 20$)	GII ($n = 20$)	GII ($n = 20$)	P value
Jaw relaxation					
Fully relaxed	1	11 (55.0%)	14 (70.0%)	14 (70.0%)	0.395
Mild resistance	2	6 (30.0%)	5 (25.0%)	6 (30.0%)	
Tight, but opens	3	3 (15.0%)	1 (5.0%)	0 (0%)	
Impossible	4	0 (0%)	0 (0%)	0 (0%)	
Vocal cord position					
Widely open	1	6 (30.0%)	2 (10.0%)	7 (35.0%)	0.238
Mid-position	2	10 (50.0%)	11 (55.0%)	9 (45.0%)	
Moving, but open	3	3 (15.0%)	5 (25.0%)	2 (10.0%)	
Closed	4	1 (5.0%)	2 (10.0%)	2 (10.0%)	
Intubating responses					
None	1	13 (65.0%)	10 (50.0%)	14 (70.0%)	0.196
Diaphragmatic movement	2	5 (25.0%)	7 (35.0%)	3 (15.0%)	
Mild/moderate coughing	3	2 (10.0%)	3 (15.0%)	2 (10.0%)	
Severe coughing	4	0 (0%)	0 (0%)	1 (5.0%)	

GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

mal accepted values (around 30 mmHg) in the three groups during operative period (Table 2).

Tracheal intubation was successful in all patients. Jaw relaxation, vocal cord position and intubating responses were similar in the three groups (Table 3).

Intubation scores showed no significant differences between the studied groups (Table 4).

Visual analogue scale score (VAS) showed no significant difference between propofol–fentanyl group and dexmedetomidine–fentanyl group throughout the 24 h postoperatively. Whereas both groups displayed significant lower VAS than sevoflurane–fentanyl group throughout the 24 h postoperatively ($P < 0.001$)(Fig. 2).

Respiratory rate values (RR) in the dexmedetomidine–fentanyl group were significantly increased ($P < 0.05$) compared with baseline value at 35 min postoperatively. RR valued in the dexmedetomidine–fentanyl group displayed significant increase than those in the other two groups ($P < 0.05$) at 15, 25 and 35 min postoperatively (Fig. 3).

Sedation score was significantly lower in sevoflurane–fentanyl group than propofol–fentanyl group throughout the recorded postoperative hours. Noticeably, all readings of sedation score in dexmedetomidine–fentanyl group were significantly higher than both other groups (Fig. 4).

Forty-five percent of the total number of the patients in the propofol–fentanyl group developed nausea and shivering which was significantly higher in compared with other two groups (P ranged from < 0.01 to < 0.001) (Fig. 5).

4. Discussion

In the present study, the three groups; sevoflurane–fentanyl, propofol–fentanyl and dexmedetomidine–fentanyl were compared as regard hemodynamics, intubation conditions, seda-

Table 4 Intubation score. Values are in numbers (%).

	GI (n = 20)	GII (n = 20)	GIII (n = 20)	P value
Excellent (3)	5 (25%)	5 (25%)	7 (33.75%)	0.394
Good (4–6)	10 (50%)	12 (60%)	12 (60%)	0.388
Poor (7–9)	4 (18%)	2 (8.75%)	1 (6.25%)	0.219
Impossible (10–12)	1 (6.25%)	1 (6.25%)	0 (0%)	0.932

GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

tion score, postoperative pain and any postoperative complications. Patients in all groups demonstrated comparable both demographic characteristics and hemodynamics. Also, dexmedetomidine–fentanyl group displayed significant increase in arterial oxygen saturation at 1, 2 and 4 h intraoperatively compared with propofol–fentanyl group, whereas it demonstrated a significant increase in $EtCO_2$ one hour postoperatively compared with sevoflurane–fentanyl group. Sevoflurane–fentanyl group demonstrated significant higher VAS than other two groups.

Anesthesia for patients with brachial plexus injury should provide safety for these patients primarily by anticipating and preventing situations which risk their deterioration in both sensory and motor ability. Based on this concept, general anesthesia was selected as an anesthetic method in the current study.

In the current study HR and MBP showed no significant changes among the studied groups throughout the study period. HR and MBP displayed significant reduction in the three groups compared with baseline values. The same results were reported by Kaygusuz et al. [12] those underwent their study on 46 patients allocated into two groups received either dexmedetomidine or propofol for elective shockwave lithotripsy. Previous investigations had demonstrated a powerful inhibitory effect of propofol on sympathetic outflow [13]. It was established that, dexmedetomidine also known to decreases sympathetic outflow and circulating catecholamine levels and therefore be expected to cause decrease of MBP similar to propofol [14]. Other studies have shown a greater decrease in MBP after induction of anesthesia with propofol than with sevoflurane [15]. It was documented that, a bolus injection of propofol could produce a 15–30% reduction in MBP [16]. Watson and Shah found a similar decrease in MBP with propofol and sevoflurane just before intubation [17]. This could be assumed largely to the fact that both agents decrease systemic vascular resistance through endothelium mediated vasodilation [18], which is further augmented when administered with an opioid [16].

In the current study, propofol–fentanyl group and dexmedetomidine–fentanyl group were equally effective with respect to pain control (VAS), with significant lower score compared with sevoflurane–fentanyl group throughout the postoperative 24 h. This result was in accordance with previous study that found the recovery of patients induced and maintained with sevoflurane were accompanied with restless or agitation upon awakening than those induced with propofol group, which was seen in the higher scores for pain in the recovery room and the increased incidence of emergence delirium and the high score of pain would account for the earlier administration of analgesics to the patients in the sevoflurane group [19].

In previous studies in children, awakening from sevoflurane anesthesia has been associated with discomfort, excitement or agitation, the mechanism of which is still unclear [20]. In our study, pain may have been a contributing factor. In an anecdotal reports describe the efficacy and the effect of dexmedetomidine versus propofol during intraoperative sedation, proved that dexmedetomidine had significantly reduced pain

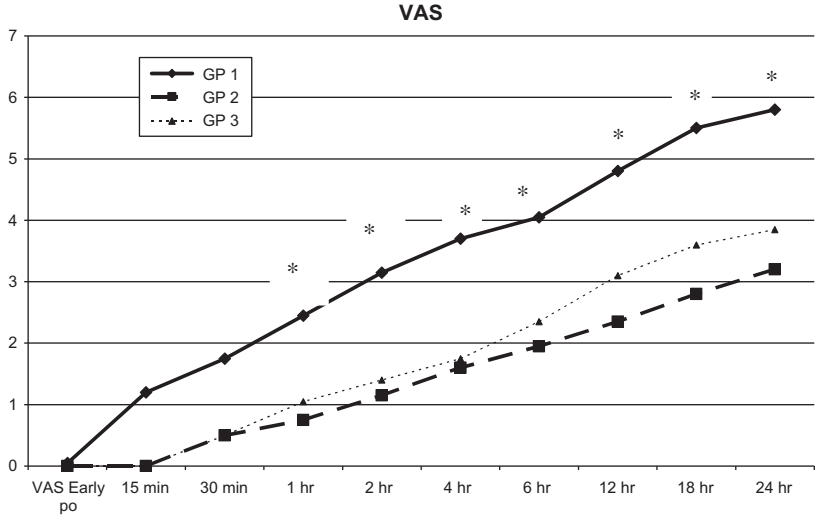

Figure 2 Visual analogue scale (VAS) of the studied groups. Values are presented as mean ± SD. *Statistically significant compared to other two groups. GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

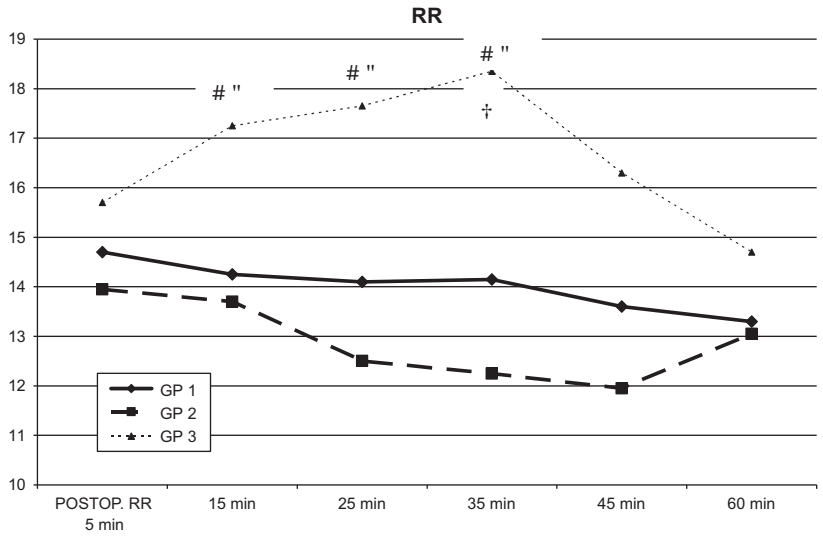

Figure 3 Respiratory rate of the studied groups. † = Intra group significant difference as related to basal ($P < 0.05$). # = Significant difference between GI and GIII ($P < 0.05$). " = Significant difference between GII and GIII ($P < 0.05$). GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

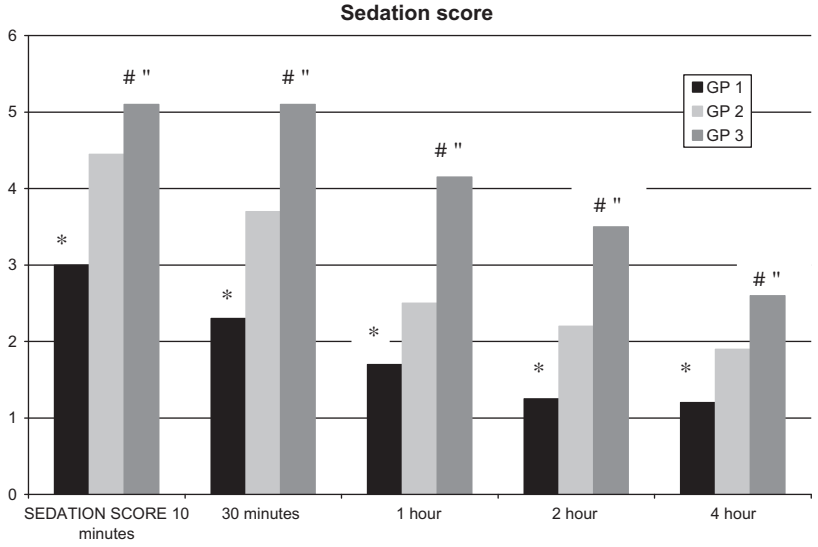

Figure 4 Sedation score of the studied groups. * Significant difference between GI and GII ($P < 0.05$). # = Significant difference between GI and GIII ($P < 0.05$). " = Significant difference between GII and GIII ($P < 0.05$). GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

score when compared with propofol [21]. Other study, proved better analgesic properties of the dexmedetomidine than propofol (lower VAS) which was not relevant clinically as both groups had VAS scores <4 [22]. It is now well described that dexmedetomidine has analgesia sparing components when used for sedation in the intensive care unit [23].

In the current study, respiratory rate (RR) and $SpaO_2$ displayed significant increase in dexmedetomidine–fentanyl group compared with the other two groups for RR and with propofol–fentanyl group only for $SpaO_2$, which pass in accordance with Ghali et al. on their study of conscious sedation during vitreoretinal surgery [22]. Hsu et al. reported similar effects on respiratory functions during dexmedetomidine sedation [24]. This might be explained by the increase in minute ventilation postoperatively coincided with the significant postoperative increase of CO_2 that observed with dexmedetomidine–fentanyl group leading to the arousal phenomenon secondary to the hypercapnia stimulation. In addition, it was reported that α-2 receptors are located at multiple places in the central nervous system. Hypercarpia activates the locus ceruleus, which is associated with increase apprehension which leads to the stimulation of the respiratory centers [25].

On the other hand, previous study confirmed a lack of a clinically significant respiratory effect of dexmedetomidine [26].

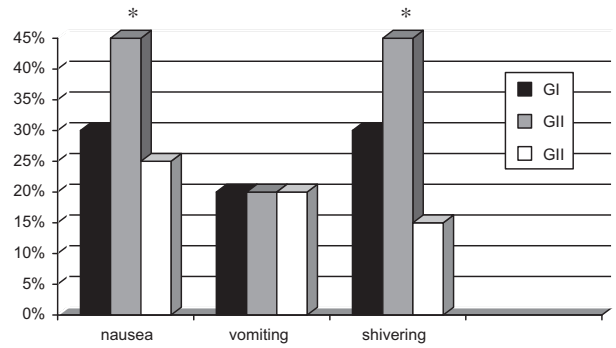

Figure 5 Postoperative complications of the studied groups. Values are presented as percentage of the patients. * Statistically significant compared to the other two groups. GI = sevoflurane–fentanyl group, GII = propofol–fentanyl group, GIII = dexmedetomidine–fentanyl group.

Lastly, the respiratory effects of dexmedetomidine have been greatly debated, but the consensus appears to be that dexmedetomidine is associated with little respiratory depression [27].

There was significant increase in sedation score throughout the postoperative period in dexmedetomidine–fentanyl group compared with other both groups, which might be attributed to the drug regimen (induction and maintenance) of dexmedetomidine as well as the augmenting effect of concomitant infusion of fentanyl with dexmedetomidine. On the other hand, Arain and Ebert in their study on intraoperative sedation using dexmedetomidine versus propofol proved that all patients in both groups achieved targeted sedation levels; however, patients receiving propofol for sedation achieved levels of sedation more rapidly than those receiving dexmedetomidine [21].

In another study, it was proved that dexmedetomidine group showed significant lower Observer's Assessment of Alertness/Sedation Scores (OAA/S score) than propofol group in patients underwent shockwave lithotripsy and it was observed that the OAA/S score values at 5–35 min. were significantly lower than those at baseline in both the dexmedetomidine and propofol groups [12].

Other interesting study on clinical comparison of single agent anesthesia with sevoflurane versus target controlled infusion of propofol, sedation was assessed by measuring time intervals between discontinuation of drugs and eye opening, extubation and stating name and date of birth for each patients. It was proved that, all these times were similar in both groups and there were no differences in subsequent recovery events [17].

Tracheal intubation was successful in all patients. Jaw relaxation, vocal cord position and intubating responses were similar in the three groups indicating that the use of this combination of the drugs could be effective for intubation in such group of patients. In the current study, sevoflurane–fentanyl group showed 25% of patients had excellent and 50% of patients had good intubating conditions. Thus 75% of patients had clinically acceptable intubating conditions. Whereas, in propofol–fentanyl and dexmedetomidine–fentanyl groups 85% and 93% of patients had clinically acceptable intubating conditions respectively. There were no previous studies discuss the comparison between these three groups of drugs as regard the intubation conditions, but there were a lot of studies that discussed the intubation conditions with varying doses of propofol without muscle relaxants. In one of these studies, it was proved that, ideal intubating conditions without using muscle relaxants are possible with 3 mg kg^{-1} propofol with 2 μg kg^{-1} fentanyl and 1.5 mg kg^{-1} lignocaine and the stress response to laryngoscopy and intubation gets attenuated well [28].

In other study, that did not use muscle relaxant for intubation, authors concluded that endotracheal intubation was better with the dexmedetomidine–lidocaine–propofol combination than with the fentanyl–lidocaine–propofol combination. However, side effects such as bradycardia should be considered when using dexmedetomidine. This pass in accordance with our result that proved dexmedetomidine–fentanyl had acceptable intubation conditions [29].

Sevoflurane 8% can be as satisfactory as neuromuscular blocking drugs for producing the necessary conditions for intubating the trachea, but cannot achieve the speed of onset of effect for rapid sequence intubation and it has a lower blood gas solubility and less likely to cause cardiac depression or arrhythmias than halothane. This has made it an attractive alternative for use in the difficult airway [30]. A potential limitation of the inhaled induction technique for tracheal intuba-

Table 5 Modified Aldrete's score.

	Score
Level of consciousness	
Awake and oriented	2
Arousable with minimal stimulation	1
Responsive only to tactile stimulation	0
Physical activity	
Able to move all extremities on command	2
Some weakness in movement of extremities	1
Unable to voluntarily move extremities	0
Hemodynamic stability	
Blood pressure ,15% of baseline MAP value	2
Blood pressure 15–30% of baseline MAP value	1
Blood pressure .30% below baseline MAP value	0
Respiratory stability	
Able to breathe deeply	2
Tachypnea with good coughs	1
Dyspneic with weak cough	0
Oxygen saturation status	
Maintains value .90% on room air	2
Requires supplemental oxygen (nasal prongs)	1
Saturation ,90% with supplemental oxygen	0
Postoperative pain assessment	
None or mild discomfort	2
Moderate to severe pain controlled with IV analgesics	1
Persistent severe pain	0
Postoperative emetic symptoms	
None or mild nausea with no active vomiting	2
Transient vomiting or retching	1
Persistent moderate to severe nausea and vomiting	0
Total score	14

MAP = mean arterial pressure.
Score $\geqslant$10 was needed for PACU discharge.

tion is hypotension associated with delivering a large concentration of sevoflurane [31].

Postoperative complications were more significant with propofol–fentanyl group (nausea and shivering) which might be attributed to the significant hypotension that could be occurred in more pronounced manner in propofol–fentanyl group compared with basal values. Watson and Shah observed the occurrence of nausea and vomiting in their comparative study between sevoflurane and target controlled infusion of propofol [17].

There is strong evidence to suggest that propofol has intrinsic anti emetic properties that may persist into the postoperative period even when it is used solely as an induction agents [32]. With an equipotent dose of dexmedetomidine used in our study, Kaygusuz et al. found no differences in the incidence of postoperative nausea and vomiting between dexmedetomidine and propofol used in their study [12].

The current study has certain limitations which includes, the double blinding can not be achieved. The increasing pattern of visual analogue scale with all groups, indicating insufficient analgesia. Although the dose of fentanyl used is lower than its standard use, our data suggest that this combination of dexmedetomidine–fentanyl or propofol–fentanyl provides better pain relief during repair of brachial plexus injury than in sevoflurane–fentanyl group.

5. Conclusion

In conclusion, the three groups demonstrated equivalent hemodynamic effect. Although infusion of sevoflurane, propofol and dexmedetomidine anesthesia provided safe and adequate induction and maintenance of anesthesia in the repair of brachial plexus injury procedure, analgesia and respiratory variables were better with propofol than either dexmedetomidine or sevoflurane. Further studies are needed to determine the optimal pain control for this group of patients for long time postoperatively.

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