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Balanced Anesthesia with Dexmedetomidine added Desflurane or Sevoflurane in Spinal Surgery

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Abstract

Objectives: Sevoflurane and desflurane inhalational anesthetics are used for fast-track neuroanesthesia. Dexmedetomidine is used to provide analgesia, sedation and hemodynamic stability. Other anesthetic and analgesic requirements decrease when dexmedetomidine is administered, thus it is an interesting option for intraoperative agent for general anesthesia. We aim to compare desflurane and sevoflurane with dexmedetomidine in the operating room (OR) and Post-Anesthesia Care Unit (PACU) by using Fast-Tract -Criteria (FTC) and Aldrete Criteria (AC) for spinal surgery patients.

Methods: A double-blind study was conducted. One hundred ASA I-II patients aged 18–65 were randomly divided into two groups. Following the standard anesthesia induction, Group (D+D) (n=50) received 2–4 % desflurane + 0.2 µg/kg/h dexmedetomidine and Group (S+D) (n=50) received 1-3 % sevoflurane + 0.2 µg/kg/h dexmedetomidine in 60 % N_2O for anesthesia management. Extubation times, and FTC and AC were evaluated in the OR at the 5th and 10th minutes and in PACU at the 5th, 15th and 25th minutes. P< 0.05 was considered significant.

Results: Demographic features of the patients in the two groups were similar. Extubation time in Group (D+D) was shorter than that in Group (S+D) (5.9 ± 2.4 and 8.3 ± 3.9 min respectively, p=0.001). In OR at the 10th min, and in PACU at the 5th min; Group (D+D) had a higher AC score than did Group (S+D) (p=0.001), and also at the 15th min., Group (D+D) had a higher FTC (P=0.01) and AC (p=0.007) scores than did Group (S+D). In all the patients, targeted discharge points were achieved at the 25th minute in PACU

Conclusions: Balanced anesthesia with desflurane / dexmedetomidine combination is superior to sevoflurane / dexmedetomidine in extubation time and time to reach an AC ≥ 9 and FTC ≥ 13 in spinal surgery.

Keywords: Anesthetics; Dexmedetomidine, Desflurane, Sevoflurane, Balanced anesthesia; Recovery Scores; Spinal surgery

Introduction

Spinal surgery patients frequently have significant co-morbidity. Surgery imposes the further stresses due to significant blood loss, prolonged anesthesia, and difficulties in acute postoperative pain management. Surgeons prefer patients to be conscious and able to respond to command immediately after anesthesia, for early neurological assessment [1]. Postoperative neurological assessment of a patient after an extensive spinal surgery plays a critical role in detection of new neurological deficits. Spinal surgery presents a number of challenges to the anesthetist.

α_2- agonists are a novel class of drugs with mechanisms of action that differ from other commonly used anesthetic drugs [2]. Especially dexmedetomidine has a multi factorial role as an adjunct for the care of a neurosurgical patient. Perioperative haemodynamic control, less respiratory depression, anxiolysis with no hangover effects and reduction of postoperative shivering are potentially beneficial in improving outcome. Dexmedetomidine acts pre- or post-synaptically via G-protein coupled mechanisms, has more rapid onset and shorter duration of action and is six times more selective for the α_2-receptor [3].

Desflurane and sevoflurane are both fluorinated inhalational anesthetics characterized by a low blood/gas partition coefficient that favors rapid emergence [4,5]. Both sevoflurane and desflurane inhalational anesthetics used in balanced neuro anesthesia provide adequate intraoperative hemodynamic stability and are suitable for fast-track neuroanesthesia [6].

The fast-tracking criteria suggested by White [7] appear to be a union of the Aldrete scoring system. To meet fast-tracking criteria, the patient must score a minimum of 12 points (maximum score is 14), with no score < 1 in any parameter. Not all patients are appropriate for fast tracking.

In the literature, there are no studies investigating balanced anesthesia performed by adding dexmedetomidine to the sevoflurane or desflurane in prolonged spinal surgery. Since dexmedetomidine has been increasingly used in the practice of anesthesia, in this study, we randomly divided the patients into two groups in order to compare early postanesthesia recovery scores with Fast-Tract Criteria (FTC) [8] and Aldrete Criteria (AC) in patients who underwent prolonged spinal surgery in prone position and had balanced anesthesia in which dexmedetomidine was added to desflurane or sevoflurane.

As primary outcome variables, we assessed extubation times and postanesthesia recovery scores. Secondary outcome variables included

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total doses of intraoperative dexmedetomidine and postoperative analgesic and antiemetic drug consumptions in both groups.

Materials and Methods

The present study was approved by the Ethical Committee of Celal Bayar University, Medical Faculty, Manisa, Turkey, approval number 0261//2009.

The study population included one hundred ASA I-II patients between 18 and 65 years of age who underwent elective surgery for lumbar disc disease the written informed consent was obtained from each patient before the enrolment. More than 100 minutes of surgical time was considered as prolonged surgical time, and the patients who had more than 100 minutes of surgical time were enrolled in the study. Emergency cases and patients with valvular heart disease, intracardiac shunts, hepatic or renal disease, severe pulmonary disease, pregnancy, chronic alcoholism, drug abuse and morbid obesity (Body Mass Index >35) were excluded. None of the patients was using beta- blockers or α_2-agonists, and there existed no history of exposure to dexmedetomidine.

Patients were randomly assigned into either the desflurane or the sevoflurane group using the closed envelope technique. Dexmedetomidine was diluted with 0.9 % NaCl to a concentration of 4 µg/ml in 50 ml. Dexmedetomidine was prepared and administered by using a syringe pump (Life Care 5000 Infusion System, Abbott). Perioperative monitoring included continuous 2-lead electrocardiogram, Heart Rate (HR), non-invasive systolic, diastolic and Mean Arterial Pressure (MAP), SpO_2, and end-tidal CO_2.

All patients were given 1 to 2 mg midazolam intravenously as premedication in the preoperative room. Anesthesia was induced with fentanyl (1 to 2 µg/kg), propofol (1 to 2 mg/kg) and rocuronium (0.6 mg/kg). Anesthesia was maintained in-group (D+D) with desflurane 2-4% or in group (S+D) with sevoflurane 1-3%, and 0.2 µg/kg/h dexmedetomidine infusion in addition to nitrous oxide 60% and oxygen in both groups. Both inhalational anesthetics were subsequently titrated and adjusted for age to maintain a Minimum Alveolar Concentration (MAC) up to 1.5% for sevoflurane or 3% for desflurane. 0.2 µg/kg/h dexmedetomidine infusion was applied both to sevoflurane and to desflurane groups and when necessary it was titrated and the dose was increased up to 0.7 µg/kg/h. Titration of dexmedetomidine was targeted to maintain MAP between 65 and 90 mmHg. In the circle system, positive pressure ventilation was employed. The lungs were ventilated by maintaining a tidal volume of 6-8 ml/kg, respiratory rate of 8-12 per minute and end-tidal CO_2 concentration of 30-35 mmHg. The patients were turned to a prone position on the standard operation table, and a pair of chest rolls was placed between the chest of the patient and the table. Inhalation agents and dexmedetomidine infusion were continued until the surgical dressing was removed. Fifteen minutes before the end of the surgery, 50 mg dexketoprofen trometamol i.v and 10 mg metoclopramide HCL i.v were administered to all patients. At the end of the surgery, neuromuscular blockade was reversed with 0.05 mg/kg neostigmine and 0.02 mg/kg atropine. When the TOF ratio of 0.90 was achieved, all the patients were extubated.

After the discontinuation of anesthetic agents, extubation times, FTC (8) [Table 1] and AC [Table 2] scores at the following 5^{th} and 10^{th} min were assessed in the OR. In the post-anesthesia care unit, a blinded observer monitored the patients for nausea and vomiting, any side effects, analgesic requirement, and vital signs. Postoperative nausea and vomiting were treated with 4 mg of i.v ondansetron. Rescue analgesia with 75 mg diclofenac Na was administered i.m after the operation in the presence of a pain score of > 3 or if the patient requested analgesia during pain assessment. FTC and AC were assessed at 5^{th}, 15^{th} and 25^{th} min in PACU stay. When FTC was ≥13 and AC was ≥ 9, patients were discharged from PACU. As primary outcome variable, FTC and AC were recorded in OR and PACU. As secondary outcome variables,

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 prssure 15% - 30 % of baseline MAP value	1
Blood pressure > 30 % of below baseline MAP value	0
Respiratory stability	
Able to breathe deeply	2
Tachypnea with good cough	1
Dyspneic with weak cough	0
Oxygen Saturation	
Maintains value > 90 % on room air	2
Requires supplemental oxygen to maintain oxygen saturation > 90%	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 / mild nausea with no active vomiting	2
Transient vomiting controlled with IV antiemetics	1
Persistent moderate to severe nausea and vomiting	0
Total Score	**14**

Table 1: Fast-Tract Criteria (FTC).

Respiratory stability	
Able to take deep breath and cough	2
Dyspnea/shallow breathing	1
Apnea	0
Oxygen Saturation	
Maintains > 92 % on room air	2
Needs O_2 inhalation to maintain O_2 saturation > 90%	1
O_2 saturation < 90 % even with supplemental O_2	0
Consciousness	
Fully awake	2
Arousable on calling	1
Not responding	0
Circulation	
BP ± 20 mmHg preop	2
BP ± 20-50 mmHg perop	1
BP ± 50 mmHg perop	0
Activity	
Able to move 4 extremities	2
Able to move 2 extremities	1
Able to move 0 extremities	0
Total Score	10

Table 2: Aldrete Criteria (AC).

	Group (D+D) (n =50)	Group (S+D) (n=50)
Age (yrs)*	41.2 ± 10.3	44.7 ± 13.4
Gender (F/M)**	26/24	20/30
Weight (kg)*	73.1 ± 12.5	69.7 ± 12.5
ASA I/II **	46/4	41/9
Duration of surgery (min)*	120.1 ± 40.4	129.7 ± 54.0
Duration of anesthesia (min)*	133.8 ± 39.9	138.7 ± 50.9

*p>0.05, Student's t test, **p>0.05, chi square test

Table 3: Patient demographics, duration of surgery and anesthesia (mean ± SD).

		Group (D+D) (n=50)	Group (S+D) (n=50)	P value (Student's t test)
Extubation time	Min	5.9 ± 2.4	8.3 ± 3.9	**P=0.001***
OR				
5th min	FTC	10.8 ± 2.0	10.5 ±1.8	P=0.5
	AC	7.3 ± 2.1	6.9 ± 2.0	P=0.3
10th min	FTC	12.7 ± 1.5	12.2 ±1.2	P=0.09
	AC	9.3 ± 0.9	8.4 ± 1.2	**P=0.001***
PACU				
5th min	FTC	12.9 ± 1.4	12.7 ± 0.9	P=0.5
	AC	9.7 ±0.6	8.9 ± 1.1	**P=0.001***
15th min	FTC	13.7 ± 0.5	13.4 ± 0.6	**P=0.01***
	AC	9.9 ± 0.3	9.6 ± 0.6	**P=0.007***
25th min	FTC	13.9 ± 0.2	13.8 ± 0.3	P=0.1
	AC	9.9± 0.2	9.9 ± 0.3	P=0.7

FTC: Fast-Tract Criteria, AC: Aldrete Criteria, OR: Operating Room, PACU: Post-anesthesia Care Unit

Table 4: Extubation times, FTC and AC in OR and PACU between the groups (mean ± SD).

intraoperative dexmedetomidine total doses and postoperative analgesic and antiemetic drug consumptions were assessed in both groups.

Statistical Analysis

We accepted a type I error of 0.05 and a type II error of 0.80 for detecting a true difference. A 0.5 or greater difference in dependent variables was considered clinically significant. An estimate of standard deviation in dependent variables was 1. As a result, we calculated that minimum 49 patients were needed in each group in order to obtain 5% type 1 error and an 80% power of detecting a difference of 0.5 or more [9].

All statistical analyses were performed using SPSS for Windows® 10.0. The χ^2 test was used to compare proportions. Student's t test was used to compare mean scores. Results were given as percentages or mean ± SD where appropriate. A P value < 0.05 was considered statistically significant.

Results

Patient demographics including age, weight, ASA status, gender, duration of surgery and anesthesia are shown in Table 3 and were similar for each group [Table 3].

As primary outcome variables, the mean extubation time was shorter in desflurane / dexmedetomidine treated patients than in sevoflurane / dexmedetomidine treated patients (extubation time 5.9 ± 2.4 vs. 8.3 ± 3.9 min; respectively, p=0.001). In OR at the 10th min; Group (D+D) had a higher AC score (9.3 ± 0.9) than did Group (S+D) (8.4 ± 1.2) (p=0.001). In PACU at the 5th min; Group (D+D) had a higher AC score than did Group (S+D) (9.7 ± 0.6 vs. 8.9 ± 1.1, respectively, p=0.001), at the 15th min., Group (D+D) had a higher FTC (P=0.01) and AC (p=0.007) scores than did Group (S+D). In all patients, targeted discharge points were achieved at the 25th minute in PACU [Table 4].

	Group (D+D) (n=50)	Group (S+D) (n=50)	P value
Dexmedetomidine total dose (µg)	40.6 ± 30.6	28.9 ± 26.1	0.05
Antiemetic drug	11 (%22.0)	6 (%12.0)	0.18
Analjegic drug	2 (% 4)	11 (22.0)	0.007*

*chi square test

Table 5: Dexmedetomidine consumption dose (mean ± SD) and other drugs used (n %) in PACU in both groups.

Also, as secondary outcome variables, the amount of dexmedetomidine used for the maintenance of anesthesia was higher in the desflurane group (40.6 ± 30.6 µg) than in the sevoflurane group (28.9 ± 26.1 µg). There were no significant differences between the groups regarding the amount of dexmedetomidine (P=0.05).

The incidence of postoperative vomiting was 22.0 % in Group (D+D) and 12.0 % in Group (S+D) (p=0.18). The prevalence of consuming analgesic drug was 4 % in Group (D+D) and 22.0 % in Group (S+D) (p=0.007) (Table 5). None of the patients had postoperative shivering and none had neurosurgical complications requiring early postoperative reoperation. No allergic phenomenon was observed.

Discussion

We found that desflurane/dexmedetomidine balanced anesthesia had significantly faster extubation time and recovery profiles during lumbar discectomy in spinal surgery than did the sevoflurane/dexmedetomidine balanced anesthesia.

Previous studies have shown that patients under desflurane respond to verbal commands earlier, probably due to low solubility of desflurane compared to sevoflurane. If the extubation time and FTC/AC scores at a given period are taken into consideration, the results of this study were predictable.

Postoperative neurological assessment of a patient after spinal surgery is critical in terms of the possibility of additional neurological deficits. Therefore, appropriate anesthetic procedure should provide early extubation and recovery of cognitive functions. If the surgery patients in this group have enough clinical findings after early neurological assessments, they are considered suitable for spinal surgery.

In this study, as a primary outcome variable, desflurane / dexmedetomidine combination is superior to sevoflurane / dexmedetomidine in extubation time and time to reach an AC ≥ 9 and FTC ≥ 13 in prolong spinal surgery anesthesia. As secondary outcome variables, dexmedetomidine is a powerful analgesic drug depending on its dose, but it does not have antiemetic properties.

Dexmedetomidine has been successfully used as the primary sedative/anesthetic agent in various surgical, endoscopic and radiologic procedures [10]. It has a hypnotic effect through action on α2 receptors in the locus ceruleus and analgesic properties through receptor stimulation on the spinal dorsal horn. It may prove especially helpful during major spinal and intracranial surgery because it is not associated with respiratory depression and reduces anesthetic and analgesic

requirements [11]. This neuroprotective effect is mediated by α_2A-receptor subtypes [12].

No published studies have compared how balanced anesthesia with hypnotics' sevoflurane or desflurane with dexmedetomidine affects postoperative recovery scores in patients undergoing prolonged spinal surgery procedures.

Both sevoflurane and desflurane inhalational anesthetics used in balanced neuroanesthesia provide adequate intraoperative stability and are suitable for fast-track neuroanesthesia [5,13]. Dexter et al. [14] studied volatile anesthetic features of sevoflurane and desflurane on 32.792 patients and stated that extubation time is shorter by 20-25% when desflurane is administered than that when sevoflurane is administered. Moreover, they stated that desflurane is a more economical agent since it reduces the stay in the operating room.

In some studies evaluating spinal surgery patients, it was reported that sevoflurane / opioids [15] or desflurane / opioids [16,17,18] combinations were appropriate techniques.

Ozkose et al. [19] found the extubation time with desflurane / dexmedetomidine as 3.9 ± 1.5 min, and the AC value at the 10th min as 9.2 ± 2.1. In our study, while the extubation time in group (D + D) was longer (5.9 ± 2.4 min), the AC value at the 10th min was similar (9.3 ± 0.9). In Ozkose's study [19], anesthesia time was shorter, and the total dexmedetomidine dose was not indicated. The difference between extubation times may result from these.

Turgut et al. [20] administered TIVA together with dexmedetomidine / propofol and found the extubation time as 5.4 ± 2.4 min, and the discharge time from PACU as 31.9 ± 4.1 min according to AC. Their extubation time is very similar to that of group (D + D), but PACU time is shorter since the AC at the 15th min was 9.9 ± 0.3 in our study.

The use of sevoflurane / dexmedetomidine combination in spinal surgery was evaluated for the first time in this study. When the extubation time and recovery time are considered, statistical results show that desflurane / dexmedetomidine combination is better. However, we have the opinion that sevoflurane / dexmedetomidine combination at 25th min in PACU is compatible with the recovery scores.

While the AC is used as the recovery scale in many studies [6,19,20,21], FTC was used in neuroanesthesia for the first time in this study. Different from the AC, in FTC, pain, nausea and vomiting parameters were also evaluated, and calculated by 14 points. FTC was applied without any difficulty in this study. We suggest that FTC should be used widely since it includes the evaluation of the features of all new anesthetic agents.

There are some studies indicating that dexmedetomidine has the antiemetic effect.

Massad et al. [22] evaluated the effect of adding dexmedetomidine to a balanced technique on postoperative nausea and vomiting after surgeries. The total incidence of postoperative nausea and vomiting decreased significantly in the dexmedetomidine group. Of the 42 patients in the dexmedetomidine group, 13 (31%) experienced nausea and vomiting.

In patients who underwent spinal surgery and whose anesthesia propofol / dexmedetomidine was compared with propofol / fentanyl, nausea and vomiting were found to be 32% - 72% and 12% - 48% (p=0.005) respectively [19]. The rate of antiemetic drug use in our cases was found to be 12% in the sevoflurane / dexmedetomidine group and 22 % in the desflurane / dexmedetomidine group. There was no statistical difference between the two groups. These results suggest that dexmedetomidine does not have anti-emetic properties. We considered that the low rates we found were due to the standard application of antiemetic just before the surgery ended.

The analgesic effects of dexmedetomidine have been demonstrated in numerous studies [23,24]. Similarly, in the present study, dexmedetomidine reduced analgesic requirement especially in group (D+D) without respiratory depression. Postoperative analgesic use in group (D+D) is statistically less than that in group (S+D) (p=0.007). On the other hand, extubation time is shorter in-group (D+D). This may be due to the fact that the elimination of desflurane is a lot faster and that dexmedetomidine elimination does not lead to dose dependence. During the perioperative period, that dexmedetomidine use was higher in the same group is in line with the postoperative results. In this study, we too found that better treatment can be achieved with dexmedetomidine depending on its dose. Other findings in the literature support our results too. It is emphasized that when dexmedetomidine is used in spinal surgery patients during the surgery, the need for analgesics during the postoperative period is less [19] and later [20].

In summary, both FTC and AC can be easily used in all patients in the operating room and in the PACU. Unlike AC, since FTC evaluates pain, and nausea and vomiting during the postoperative period, it should be included in the routine use more often. In addition, extubation time and recovery time in our results are shorter, which may be related with the use of the perioperative volatile anesthetic agent in lower concentrations since it is added to dexmedetomidine infusion. Therefore, although using dexmedetomidine as an adjuvant agent helps to achieve the depth of anesthesia and hemodynamic stability, it provides shorter extubation and recovery times due to its shorter plasma half-life. This result is the most important condition especially early neurological assessment necessary in patients as spinal surgery.

We conclude that desflurane / dexmedetomidine combination is superior to sevoflurane / dexmedetomidine in extubation time and in time to reach an AC ≥ 9 and FTC ≥ 13 in spinal surgery anesthesia.

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