Desflurane as an Effective Anaesthetic Agent for Intra-Operative Neuro-Monitoring in Spine Surgeries

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Abstract

Background & Aims: Motor evoked potentials (MEP) have been widely used as intraoperative neuromonitoring in patients undergoing spine surgery to prevent neurological complications. The present study aims to show the significance of 6% desflurane as an effective agent in maintaining anaesthesia at a minimum alveolar concentration (MAC) of 0.8–1.0 in patients undergoing spine surgery with neuromonitoring.

Methods: This retrospective, cohort, single-centre study was conducted between 2016 and 2018. Patients who underwent spinal surgery along with intraoperative neuromonitoring were included. Anaesthesia was given with weight adjusted intravenous propofol (2-3 mg/kg) and maintained with Oxygen and air with inhalation desflurane (6%) with MAC of 0.8-1.0 and Bispectral index of 40-60. The data of MEP signals were collected at baseline, after instrumentation, decompression, and closure. The MEP data were correlated using Spearman correlation test and Wilcoxon rank test with minimum alveolar concentration, mean arterial pressure, temperature and bispectral index at different time intervals. P value <0.05 was considered statistically significant.

Results: A total of 37 patients (26 females and 11 males) were included in the study with the mean of 52.46±12.85 years. There was no statistically significant correlation between the variables at different time intervals. Although, a statistically significant negative correlation was observed between bispectral index and latency after decompression (p=0.006). A significant difference was observed in visual analogue scale and Oswestry disability index before and after procedure (p< 0.001).

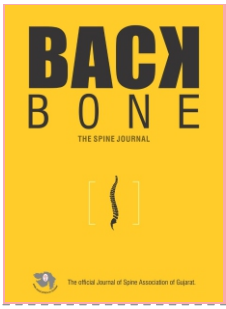
Conclusion: Anaesthesia with 6% desflurane in 0.8-1.0 MAC does not alter MEP signals in patients undergoing spinal surgery without any complication and with adequate recovery rate from anaesthesia.

Keywords: Anaesthesia, Desflurane, Motor evoked potentials, Propofol

Introduction

Intraoperative neuromonitoring (IONM) has been widely used in patients undergoing neuro and spine surgery, especially to those undergoing deformity correction cervical, thoracolumbar degenerative cases, spinal trauma, tumour resection and instrumentation, to prevent irreversible neural damage[1]. Somatosensory evoked potentials, transcranial electric motor evoked potentials, spontaneous and triggered electromyography are some of the widely used IONM modalities. It records the response of muscle or peripheral nerve after stimulation. Many anaesthetic agents have deleterious effects on electrophysiological signals used for IONM. Studies have suggested that the use of inhalation anaesthetics reduce the motor evoked potentials and advised to opt for intravenous agents [2-4]. Total intravenous anaesthetic agents like propofol are widely used; however, it possesses side effects including hypotension/peripheral vasodilatation. High doses accumulate over time resulting in slow emergence after surgery.

Desflurane can be used as a preferable inhalation anaesthetic agent for patients undergoing spinal surgery. Properties like shorter extubation and faster recovery than sevoflurane [5, 6], low blood-gas partition coefficient and rapid washing and washout property and cardio stable and cost effective during low flow anaesthesia. Somatosensory evoked potentials can be easily obtained but cannot detect changes in motor functions. In the present study, we aimed to show the significance of 6% desflurane as an effective agent in maintaining anaesthesia at a minimum alveolar concentration (MAC) of 0.8–1.0 in



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patients undergoing spine surgery with IONM.

Method

This was a retrospective, cohort, single-centre study conducted between July, 2016 and November, 2018. A total of 37 patients with 18 to 75 years of age undergoing spinal surgeries (cervical, dorsal or lumbar) along with IONM were included in this study. Patients with history of seizures, pacemaker, raised intracranial pressure, intracranial surgery or implants and ASA grade 4 and more were excluded. The study protocol was reviewed and approved by the institutional ethics committee (EC/ZHHRPL/002). As a generalised protocol at the institution, written and informed consent form was taken from all the patients undergoing spinal fixation and decompression. The anaesthesia was induced with injection fentanyl (2 mcg/kg), intravenous propofol (2-3 mg/kg), and injection suxamethonium 2 mg/kg to facilitate endotracheal intubation. A soft bite block was inserted to prevent tongue bite. Anaesthesia was maintained using low-flow anaesthesia using Oxygen, air and inhalational desflurane (6%). The MAC of desflurane was maintained at 0.8-1.0. Adequate analgesia achieved using opioid analgesic (fentanyl/pentazocine), paracetamol, and NSAIDS like diclofenac for postoperative analgesia was done as per requirement and anaesthetist's discretion.

Hemodynamic parameters (arterial pressure and heart rate) were maintained within predefined limits from baseline values to minimize undue variations in anaesthetic depth. Blood pressure was maintained at +/-20 mmHg of patient's preoperative level, with any incidence of hypotension treated with vasoactive agents such as ephedrine mephentermine and any incidence of hypertension with Labetalol. Ventilation was adjusted to maintain end tidal carbon dioxide partial pressure (ETCO2) between 30-35 mmHg. All patients were kept normothermic with warming blanket and infusing warm fluids. Basic demographic details like age, gender, weight and duration of surgery of all the patients were collected. The IONM was analysed in the form of motor evoked potential (MEP) (Protektor32 IOM). Baseline MEP was taken and a single bolus dose of atracurium (0.3-0.5 mg/kg) was given to facilitate surgical exposure. The data of MEP was taken before incision, after exposure, instrumentation, decompression and closure of the wound at five different stages of surgery. If surgeon felt during surgery to take any additional MEP, it was taken during the surgery as well. Free-running EMG was carried out throughout the surgery monitored by one dedicated neurophysiologist during the surgery. Bispectral index, body temperature, mean arterial pressure and MAC were also recorded at above mentioned time points. Neurology of all the patients were also measured pre-operatively and post-operatively by manual muscle testing, visual analogue scale (VAS) for pain and Oswetry disability index (ODI). The MEP was co-related with the bispectral index, temperature, mean arterial pressure and MAC. VAS and ODI scores were also calculated before and after the procedure.

Continuous variables are presented as mean ± standard deviation and categorical variables are presented as frequency and percentage. Statistical comparison was done by Spearman correlation test and Wilcoxon rank test. P value <0.05 was considered statistically significant. Statistical Analysis was performed using SPSS software, version 15.00.

Results

A total of 37 patients, 26 were females while remaining 11 were males. The mean age of the study population was 52.46±12.85 years (range, 18-75 years). The most common comorbidity was hypertension (n=16, 43.2%) and diabetes mellitus (n=9, 24.3 %). A total of 15 (40.5%) patients required post-operative analgesia, of which 14 (37.8 %) received fentanyl infusion. The mean duration of surgery was 168.24±45.43 minutes. The demographic details are presented in [Table 1]. All patients operated were elective surgeries. Out of 37 patients, 9 had single or double level lumbar stenosis, 8 had multilevel lumbar stenosis with degenerative scoliosis, 6 had single or double level spondylolisthesis operated with open technique, 6 had single or double level spondylolisthesis operated with MISS surgeries, 2 had revision lumbar spine surgeries, 2 had dorsolumbar fracture with kyphotic deformity, 2 had spinal infections, 1 had cauda equina syndrome and 1 patient had upper lumbar disc herniation.

Details of variables like MAC, MAP, temperature, BIS, MEP amplitude and latency at baseline, instrumentation,

Table 1: Demographic details of the population

Characteristics	Patients (n = 37)
Age, (mean ± SD, years)	52.46 ± 12.85
Weight, (mean ± SD, kg)	69.53 ± 13.36
Duration of surgery, (mean ± SD, min)	168.24 ± 45.43
Female, n (%)	26 (70.3 %)
Hypertension, n (%)	16 (43.2 %)
Hypothyroidism, n (%)	4 (10.8 %)
Diabetes mellitus, n (%)	9 (24.3 %)
Obese, n (%)	4 (10.8 %)
Smoker, n (%)	2 (5.4 %)
Asthma, n (%)	1 (2.7 %)
Anaemia, n (%)	3 (8.1 %)
Ischemic heart disease, n (%)	1 (2.7 %)
CABG, n (%)	1 (2.7 %)
Creatinine, n (%)	1 (2.7 %)
Post-operative analgesia	
Fentanyl infusion, n (%)	14 (37.8 %)
Tramadol infusion, n (%)	1 (2.7 %)

SD: standard deviation

Table 2: Procedural characteristics of patients

Characteristics	Baseline (mean ± SD)	Screw insertion (mean ± SD)	Decompression (mean ± SD)	Closure (mean ± SD)
Minimum alveolar concentration	0.81 ± 0.08	0.84 ± 0.08	0.85 ± 0.09	0.80 ± 0.07
Mean arterial pressure, mmHg	78.92 ± 8.79	76.3 ± 8.88	78.76 ± 9.65	79.65 ± 9.18
Temperature, C	36.18 ± 0.44	35.95 ± 0.50	35.78 ± 0.58	35.78 ± 0.56
Bispectral index	42.14 ± 7.05	41.68 ± 7.09	40.78 ± 7.24	42.51 ± 8.16
Amplitude, (microVolt)	1.00 ± 0.00	3.95 ± 7.92	4.25 ± 7.41	6.42 ± 18.03
Latency, (millisecond)	1.00 ± 0.00	3.28 ± 8.69	1.34 ± 1.34	2.44 ± 7.35

SD: standard deviation

Table 3: Correlation of different variables with motor evoked potential

Characteristics	AMPLITUDE		LATENCY	
	Correlation	P-Value	Correlation	P-Value
After Screw Insertion				
MAC at screw insertion	0.03	0.85	-0.15	0.38
MAP at screw insertion	0.27	0.11	-0.02	0.91
Temperature at screw insertion	-0.07	0.66	0.12	0.49
BIS at screw insertion	-0.21	0.2	-0.1	0.58
After Decompression				
MAC at decompression	0.19	0.27	-0.11	0.51
MAP at decompression	0.02	0.9	0.02	0.91
Temperature at decompression	-0.02	0.89	-0.25	0.13
BIS at decompression	-0.28	0.09	-0.44	0.01
After Closure				
MAC at closure	-0.16	0.34	-0.01	0.95
MAP at closure	0.22	0.19	-0.11	0.51
Temperature at closure	0.07	0.66	-0.01	0.97
BIS at closure	-0.26	0.12	-0.26	0.12

MAC: minimum alveolar concentration; MAP: mean arterial pressure; BIS: bispectral index

Table 4: Correlation of pre- and post-surgery pain scores and functional disability score

Scoring system	Mean ± SD	P-value
Preop VAS	8.70 ± 0.62	<0.001
Postop VAS	2.10 ± 0.86	
Preop ODI	60.59 ± 13.19	<0.001
Postop ODI	13.68 ± 7.51	

VAS: visual analogue scale; ODI: Oswetry disability index

decompression, and closure are shown in [Table 2]. The MAC was maintained at 0.8-1.0 during the procedure without any major fluctuations [Table 3]. Depicts the positive and negative correlation of MEP with MAC, MAP, temperature and BIS at different time intervals during surgery. No significant correlation was found between the variables except BIS and latency at decompression (p=0.006). The details of VAS and ODI scores are shown in [Table 4]. The VAS and ODI scores showed statistically significant difference before and after surgery (p<0.001) suggesting significant clinical improvement.

Discussion

Due to its safety and effectiveness, IONM has become a popular and regular practice in patients undergoing spinal surgery. The findings from the present study suggest that addition of 6% desflurane in 0.8–1.0 MAC after induction with intravenous anaesthetic of propofol does not alter MEP. Other studies that we have come across have utilised desflurane in lower concentration (3% desflurane, 0.3-0.7 MAC). A study showing intra-operative MEP in spinal surgery also showed similar trends where female population was predominant than male population [7]. In present study, the mean duration of surgery was more than 2.5 hours. A previous study comparing different inhalation anaesthetic in patients undergoing major surgery lasting more than two hours showed better recovery was obtained in desflurane group [8]. In this study, average recovery time from anaesthesia after extubation was 15.4 ± 3.5 min after the surgery, which was lesser to what other studies have reported [9, 10].

There was a negative correlation between BIS and latency after decompression as shown in Table 3. The latency gets reduced as decompression of the pedicle reduces the impedance to conduction of MEP. Hence, time taken to generate MEP reduces. All the other parameters showed that anaesthesia induction with propofol and maintenance with 6% desflurane does no statistically significant change in amplitude and latency values. A previous study comparing total intravenous and inhalation anaesthesia in adolescent patients undergoing spinal surgery showed lesser deviation in inhalation anaesthetic (desflurane) group as compared to total intravenous group [11]. The statistical significant difference in VAS and ODI scores, before and after the procedure showed improvement owing to decompression of nerves and stabilization of spine following surgery. All patients who were operated for various pathologies had severe disabilities preoperatively, which made their normal daily activities difficult. Our indications for operation was severe disability and/or with no improvement with conservative treatment at least for six weeks. Therefore the VAS score were also on higher side before surgery. This indicated that although MEP signals showed improvements in IONM signals during surgery, anaesthesia levels were maintained and did not interfere with the final outcome. The present study lacked a second arm for direct comparison between inhalation and intravenous anaesthetics. However, this study provides an important information regarding maintenance of doses of inhalation anaesthetic agents during spinal surgery. A two-arm, prospective study with larger patient population can provide details of complications occurring at lower frequencies. The range of MEP amplitudes with the administration of an inhalational agent may indicate enhanced spontaneous fluctuation of motor neuron excitability [12]. This effect may persist even after drug administration but is unlikely to have clinically relevant effects due to the pharmacologic profile of desflurane.

Conclusion

Anaesthesia with 6% desflurane in 0.8-1.0 MAC does not alter MEP in patients undergoing spinal surgery without any complication. Thus, providing with safe inhalational anaesthetic agent in patients undergoing spinal surgeries with

intraoperative neuro monitoring as an alternative to traditionally used intravenous propofol.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

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