A randomized prospective observational study compared the effects of dexmedetomidine against sevoflurane on motor and somatosensory evoked potentials following lumbar spinal cord tumor resection

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Abstract

Background: In the case of elective Lumbar Spinal Cord Cancer cell Resection surgery, we are comparing the effects of the aerosolized agent (Sevoflurane) at MAC 1.5 vs. Dexmedetomidine with a loading dose of 1 mcg/kg/hr for 10 minutes, followed by 0.5 mcg/kg/hr by an infusion pump, in addition to a fixed dose of propofol-based anaesthesia regimen.

Method:40 patients were randomly divided into two groups for this randomized comparative observational study. The investigator and patients were blinded, but the anesthetist could not be. All patients were aged 30 to 60 and had an ASA grade I or II.

Group DP: After a loading dosage of 1mcg/kg over 10 minutes, an intraoperative maintenance dose of anaesthesia was administered using an infusion pump in combination with 100mcg/kg/min of propofol.

Group SP: Propofol infusion was maintained at 100mcg/kg/min and inhalational sevoflurance was used to maintain an intraoperative mean alveolar concentrations (MAC) of 1.5.

In Group SP as a control, an infusion pump began injecting Normal Saline. Fentanyl was injected intraoperatively for both groups at a rate of 50 mcg/hr.

Results: The vital signs, demographic information, and preoperative strength of both lower limbs did not significantly differ between the two groups of patients (P>0.05), but intraoperative research findings recommended that sevoflurane does impact motor & somatosensory evoked potentials, causing a decrease in amplitude and raise in latency as compared to intravenous dexmedetomidine (P0.05).

Conclusion: Sevoflurane causes a reduction in amplitude and also an elevation in latency of Motor & Somatosensory Evoked Ability in Lumbar Spinal Cord Surgical Resection, but Dexmedetomidine had no discernible effect.

Keywords: Dexmedetomidine, Lumbar Spinal Cord Tumor, Sevoflurane, SSEP, MEP

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Introduction:

During spinal cord procedures, motor evoked potential (MEP) & somatosensory elicited potential (SSEP) were frequently employed. In sections of the spinal cord that are vulnerable to injury, the SSEP evaluates the health of the sensory pathways that cross it[1]. When lumbar spinal cord tumours are present, tibial SSEPs are tracked. The dorsal column serves as the SSEPs' conduction pathway. For the lower extremities, MEP are obtained from the distal tendons (Tibialis anterior & Abductor Hallucislongis). The anterior spinal artery's perfusion loss would have an impact on the blood supply of the lateral columns of spinal cord, where MEP recordings are performed. Transcranial electrical stimulation (TcMEP) is the most popular stimulation method [2, 3].

Anesthetic drugs have a dose-dependent impact on MEP and SSEP [4, 5, 6].

Dexmedetomidine is an alpha-2 selective agonist. Sedation, analgesia, sympatholysis, minor respiratory depression, and potential neuroprotection are its effects"[7-9].

All halogenated aerosolized agents cause cortically recorded SSEPs and MEPs to exhibit a dose-related rise in latency and decrease in amplitude [10, 11]. This resulted from a milder neuromuscular blockade [12]. Acceptable MEPs can be obtained by keeping the volatile anaesthetic concentration below 0.5 MAC [11].

When taken alone or in combination with opioids, halogenated aerosolized medications, or propofol, nitrogen dioxide (N2O) lowers the amplitude of the cortical SSEP yet increases latency[12,14,15].

Injection The induction & maintenance of general anaesthesia are accomplished with propofol. A 100 mcg/kg/min dose is used to keep the anaesthetic going.Propofol has no effect on latency, although it does reduce the amplitude of MEPs in a dose-dependent manner [16]. MEPs are only minimally affected by fentanyl. In this work, we test the hypothesis that whereas sevoflurane and propofol significantly diminish the amplitude and lengthen the latency of MEP and SSEP, propofol and dexmedetomidine have no negative effects on MEP and SSEP monitoring in patients with lumbar spinal cord tumours.

Materials and Methods:

Twenty patients from each group were chosen for the prospective double-blind randomised, single-center, comparative observational study. They ranged in age from 30 to 60 and were ASA grades I and II. The patients with Mallampatti grades I/II were chosen. In a prone position, the procedure was performed. After explanation of the procedure, consent was obtained.

Exclusion criteria:

- Epilepsy, cortical lesions, abnormalities in the skull, elevated intracranial pressures, implanted intracranial device, cardiac pacemakers, or other implanted pumps are contraindications to MEP.
- Diabetes Mellitus; Alterations in Renal and Hepatic Function Test
- Abuse of alcohol and obesity (BMI 30 kg/m2)
- Major organ dysfunctions (Hemoglobin 11 g/dl) and anaemia

A 1:1 ratio of patients was chosen at random. The anaesthetic substance used had no knowledge of the researcher or the patient. The anaesthetist cannot be blinded because the outcome was dependent on the electrophysiological monitoring results. Up until the study's conclusion, neurosurgeons plus patients were kept in the dark about the study group.

1. All patients were fasted for the whole night.
2. The IV line was secured
3. Individuals were split into Group DP and Group SP at random. All participants gave their consent in writing after being fully informed.

Group DP: Intraoperative management of anaesthesia was administered with 100mcg/kg/min of propofol and 0.5mcg/kg/hr of dexmedetomidine intravenously following a dosage of 1mcg/kg over 10 minutes.

Group SP: Propofol infusion was maintained at 100mcg/kg/min and inhalational sevoflurance

was used to maintain an intraoperative mean alveolar concentration (MAC) of 1.5.

An infusion pump began injecting Normal Saline as the controls in Group SP.

Both groups received the 100 mcg/kg/min therapeutic dose of propofol as well as 50 mcg/hr of intravenous fentanyl.

Three minutes prior to induction, a premedication of Inj. Glycopyrrolate 0.2mg + Inj. Fentanyl 2mcg/kg was administered.Rocuronium 0.6 mg/kg intravenous after 3 minutes of preoxygenation with oxygen; induction.

Oral cuffed tubes with inflated cuff numbers 7.0 for females and 8.0 for males were used for intubation.

The ventilator's volume A/C mode was kept in the controlled ventilation setting for the patient. In groups SP and DP, the anaesthesia was maintained using 50% oxygen + 50% air plus 3% sevoflurane (concentration adjusted to maintain MAC 1.5) and injections of 0.5 mcg/kg/hrdexmedetomidine, respectively.

In both groups, propofol injections were started and kept at 100 mcg/kg/hr.

Following T1 readings, Group DP and Group SP received a loading dose of Dexmedetomidine at 1 mcg/kg for 10 minutes, and Sevoflurane was administered after 30 minutes of endotracheal intubation for each group.

Both groups began receiving 100mcg/kg/min of intravenous propofol upon intubation. As a control, Inj. Normal Saline also started in Group SP.

Every hour, 50 micrograms of fentanyl were administered for analgesia.

Regular monitoring of intra-arterial blood pressure, SSEP,MEP, Bispectral index (BIS), & ASA monitors was carried out. Atropine (0.5 mg) was administered as a bolus to treat bradycardia, which is indicated when the heart rate (HR) is less than 50 bpm. Dopamine infusions were used to treat hypotension, which was defined as a mean arterial pressure (MAP) decrease of more than 20% from the baseline. The day before surgery, during the preoperative evaluation, the baseline blood pressure reading was taken. BIS was kept between 40 and 50.

On the basis of the train-of-four ratio, a restoration of the muscular strength of more than 90% was considered appropriate for the study. To prevent the confounding influence of the surgical stimulation on MEP and SSEP, measurements were performed with the patients in the prone position prior to making the skin incision.

The attending neurosurgeon, who was unaware of the randomization, evaluated the muscle strength of both lower extremity extremities using a 0–5 scale, with 5 denoting normal capacity and 0 denoting total paralysis.

To prevent neurodeficit after surgery, MEP & SSEP monitoring was done throughout surgery. Recordings of the MEP and SSEP were made at various times.

T1: The recording was performed at 100% O2 after 30 minutes of endotracheal intubation, after the patient was placed in the prone position, before the initiation of the Dexmedetomidine infusion & Sevoflurane inhalational agent, and before the patient had surgery. T2: Before beginning tumour resection with sevoflurane MAC 1.5 &dexmedetomidine infusion continued as 0.5 mcg/kg/hr following delivering loading dose by infusion pump and 100%O2, there was a period of time during which MEP and SSEP were monitored intraoperatively.

T3: Time of MEP & SSEP recording following tumour removal with Sevoflurane MAC 1.5, Dexmedetomidine infusion remained at 0.5 mcg/kg/hr, and 100%O2 Propofol infusion continued at 100 mcg/kg/min at all timings, T1, T2, and T3. Inj As a control, Normal Saline was begun in Group SP at T2 and T3.

Clinically significant alterations were defined as reductions in amplitude of >50% and increases in latency of >10% of both SSEP & MEP monitoring from baseline values. [17]

Neostigmine 0.05 mg/kg &glycopyrrolate 0.01 mg/kg were used in conjunction to undo the muscular relaxation after the procedure. After all extubation requirements were satisfied and

the subject was transferred to the post-anesthetist care unit, extubation was performed with moderate oral suctioning and full cuff deflation.

Protocol for the Study and Statistical Analysis:

In order to detect significance, 40 patients were needed, assuming an 80% power and a 5% 2-sided alpha level. Each group received the recruitment of 20 patients. A normal distribution analysis was performed using quantitative data. The Mean SD of the Data represented the normal distribution of the data. It was compared, and M.S. Excel 2007's t-Test was used to determine significance. The statistical significance level was set at 0.05 using two-sided P-values.

Descriptions and Findings:

Age, gender, weight, & height did not significantly differ between the two groups (Table 1). The muscular strength of the left and right bottom extremities did not differ significantly between the two groups (Table 2).At various time points, neither group's MAP, HR, or BIS monitoring revealed any appreciable differences (Table 3). MEP and SSEP measurement at T2 and T3 timing revealed a significant difference between the two groups, with Group SP exhibiting a prolonged latency and reduced amplitude of MEP & SSEP in comparison to Group DP. (Table 4)

Table 1: There are no appreciable differences in either group's patients' age, sex, weight, or height, according to demographic data.

DemographicData				
Group	Age(yrs)	Sex(M/F)	Weight (Kg)	Height(cms)
DP(Dexmedetomidine-Propofol)	45±5	12/7	66±2	165±2
SP(Sevoflurane-Propofol)	46±4	11/9	65±2	164±2

Table 2: Before surgery, compares the strength of both lower limbs' lower extremities.

The muscular strength of the left and right bottom extremities did not differ significantly between the two groups.

MeanLowerExtremityPowerbeforeSurgery		
Group	Left	Right
DP(Dexmed-Propofol)	4.6	4.5
SP(Sevoflurane-Propofol)	4.7	4.6
P	>0.05	>0.05

Table 3: Patients in both groups' vital signs, exhibiting MAP, HR, and BIS

At various time points, neither group's MAP, HR, or BIS monitoring revealed any appreciable differences.

VitalMonitoring			**Group DP (Dexmedetomidine + Propofol)**	**Group SP (Sevoflurane+Propofol)**
	MAP	Baseline	82.7 ± 2.27	84±2.75
		T1	88.7 ± 2.27	87.4 ± 1.98
		T2	81.8 ± 2.23	81.5± 2.6
		T3	85.8 ± 2.23	81.4 ± 1.98
		P	>0.05	
	HR	Baseline	78.9± 7.9	78±7.07

		T1	83.7 ± 7.37	85.2± 4.5
		T2	75.5± 6.7	76.9±8
		T3	73.5± 6.6	72.8± 8.1
		P	>0.05	
	BIS	Baseline	44.2± 1.7	44±1.3
		T1	43.7± 1.6	43.4± 1.9
		T2	41.7± 1.7	41.2± 1.8
		T3	42.4± 2.2	42.2 ± 1.9
		P	>0.05	

Table 4 & 5 MEP & SSEP analysis at T2 and T3 timing showed a significant difference between the two groups, with Group SP showing a longer latency and lower amplitude of MEP and SSEP than Group DP.

Table 4: Recording of Motor Evoked Potential at various times Intervals

MotorEvokedPotential				
		Groups		
Time	Measurement	DP	SP	*P*
T1	LLA(mv)	0.5±0.06	0.4±0.07	>0.05
	LLL(ms)	4.9±0.15	4.9±0.3	
	RLA(uv)	0.4±0.04	0.4±0.06	
	RLL(ms)	4.9±0.2	4.7±0.3	
T2	LLA(mv)	0.46 ± 0.07	0.3±0.05	<0.05
	LLL(ms)	4.9±0.16	5.2±0.37	
	RLA(uv)	0.46 ± 0.05	0.28 ± 0.06	
	RLL(ms)	4.8±0.2	5.05± 0.3	
T3	LLA(mv)	0.43 ± 0.05	0.3±0.04	<0.05
	LLL(ms)	4.9±0.15	5.1±0.36	
	RLA(uv)	0.44 ± 0.04	0.3±0.06	
	RLL(ms)	4.87 ± 0.15	4.99 ± 0.34	

Table 5:Various Somatosensory Evoked Potential Time Intervals

SSEP				
Time	Measurement	Groups		
		DP	SP	*P*
T1	LLA(uv)	1.3±0.16	1.3±0.17	>0.05
	LLL(ms)	37.2± 1.5	36.9± 1.7	
	RLA(uv)	1.3±0.14	1.3±0.14	
	RLL(ms)	37.1± 1.6	36.8± 1.8	
T2	LLA(uv)	1.28 ± 0.18	1.06 ± 0.17	<0.05
	LLL(ms)	37.5± 1.3	38.8 ± 2.03	
	RLA(uv)	1.2±0.08	1.05 ± 0.17	

	RLL(ms)	37.4 ± 1.55	38.2± 1.9	
T3	LLA(uv)	1.3±0.14	1.05 ± 0.14	<0.05
	LLL(ms)	37.6± 1.5	38.6± 1.6	
	RLA(uv)	1.19 ± 0.14	1.02 ± 0.12	
	RLL(ms)	37.6± 1.5	38.2 ± 2.04	

At T2 and T3 levels, there was a significant (P0.05) drop in magnitude and also an elevation in timing of MEP and SSEP in Group SP compared to Group DP.

Both in MEP and SSEP, the group SP amplitude declined by about 30%, and the latency increased by roughly 6%. However, whenever the MAC ratio of sevoflurane were lowered to 0.5, the amplitude and latency barely changed.

All MEP and SSEP recordings at various times T1, T2, and T3 were performed while Propofol was administered at a maintenance dosage of 100 mcg/kg/hr and 100%O2.

No patient in either group experienced postoperative weakening or worsening of muscle spasms and feeling.

Discussion:

Randomised A comparative observational research in lumbar spinal cord tumours found that employing an inhalational drug like sevoflurane had worse outcomes than adding dexmedetomidine to propofol for MEP and SSEP monitoring. When used at a MAC of 1.5, inhalational anaesthetic drugs have a strong impact on the monitoring of MEP & SSEP, causing a decrease in amplitude of around 30% and an increase in latency of about 6%. However, when used at a MAC of 0.5, there is barely any change in amplitude & latency (4,5,6)

The latency and magnitude of cortically recorded SSEPs are both dose-relatedly affected by all halogenated aerosolized agents [23, 24].

"Electromyographic responses generated by the activation of the lumbar nerve roots have only been weakly impacted by 1.5 minimum alveolar concentration halothane," Joseph Zentner et al. demonstrated [24].

Sevoflurane "depresses magnitude of MEP in such a dose-dependent manner," as demonstrated by Chong CT et al [25]. Sevoflurane alters SSEP in a dose-dependent way, as demonstrated by Boisseau N et al in their study [26]. While propofol has little influence on SSEP recording, sevoflurane causes a drop in magnitude and an elevation in latency. "Intraoperative baseline data ranged from 70 to 98% for SSEP and 66 to 100% for MEP in the lack of neural axis abnormalities," according to Malhotra et al. [17].

Two occurrences of MEP amplitude decrease after dexmedetomidine-assisted paediatric spine surgery were described by Mahmoud et al [18]. Child with obesity was one instance. The dosages of propofol and dexmedetomidine were determined using actual body mass.

In adult patients having thoracic spinal cord tumour excision, Yan Li et al [22] observed that "addition of dexmedetomidine onto propofol-remifentanil regimen doesn't really impose a detrimental effect on MEP and SSEP monitoring."

MEP & SSEP are well sustained with ivDexmedetomidine following spine surgery, according to Endrit et al [27].

Dexmedetomidine is potentially effective for including in a TIVA regimen in managed situations due to its many beneficial characteristics [18-21].

Propofol "produces a dose-dependent decrease in the magnitude of MEPs, but has no influence on the latency," as demonstrated by Nathan et al. in their study [16].

Propofol had a negligible impact on SSEP monitoring, as demonstrated by N. Boisseau et al. in their study [28].

In our work, we also measured the MEP and SSEP after lowering the MAC of sevoflurane to

0.5 at T2 and T3, which revealed a minor increase in latency and a negligible drop in amplitude, but it also results in a lighter plane of anaesthesia and raises the BIS value.

Additionally, none of the patients in either group of our patients had any post-operative neuro deficits.

Conclusion: Instead of employing an aerosolized agent like sevoflurane, the current anaesthetic approach of choice is a TIVA regimen employing dexmedetomidine + propofol for neuromonitoring. When compared to Dexmedetomidine, Sevoflurane causes a considerable drop in MEP and SSEP amplitude as well as an increase in latency.

Abbreviation:

MEP: Motor Evoked Potential
SSEP: Somatosensory Evoked Potential
DP: Dexmedetomidine + Propofol
SP: Sevoflurane + Propofol
MAC: Mean Alveolar Concentration
N2O: Nitrous Oxide tc
MEP: Transcranial Motor Evoked Potential
C/I: Contraindication
BMI: Body Mass Index
SD: Standard Deviation
P: Probability
T-Test: Student T-Test
LLA: Left Lower Limb Amplitude
LLL: Left Lower Limb Latency
RLA: Right Lower Limb Amplitude
RLL: Right Lower Limb Latency
M/F: Male / Female
Inj: Injection
NS: Normal Saline

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