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Anaesthesia For Spine Surgery with Neuromuscular Monitoring

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Abstract: Gold standard treatment modality for correcting spinal deformities is surgery. Many neurological complications are associated with spine surgeries.

The challenge to anaesthetist is to provide optimal surgical conditions ensuring adequate oxygenation to brain & spinal cord & facilitating use of intra operative neuro muscular monitoring (IONM)techniques to enhance safety of spine surgeries.

Methods: All patients received standard Anaesthetic protocol. After pre-oxygenation Inj.Propofol 2-3 mg/kg, inj suxamethonium 2 mg/kg, inj. dexmedetomidine 1-2 mcg/ kg iv given & patients were intubated. After that electrode were placed over head for SSEP monitoring & over Tibialis Anterior muscle for MEP monitoring. Basal SSEP, MEP & BIS readings taken. Continuous propofol infusion started at rate of 125ml/hr using 2mg/ml concentration of propofol & rate of drip changed according to have BIS value between 40-60 throughout procedure to provide adequate depth of anaesthesia. On completion of surgery propofol infusion stopped. Patients extubated; recovery time recorded & shifted to PACU & discharged according to modified alderete score.

Results: Total 50 patients were included in study for spinal surgeries under general anaesthesia with neuro muscular monitoring. We have observed for different parameters. Haemodynamic stability was maintained in all patients. IONM with SSEP showed no change in latency & amplitude while in MEP 4% patient showed increase in latency & decrease in amplitude & 8%

showed decrease in latency & increase in amplitude. Bispectral index was maintained between 40 to 60 at mean propofol infusion rate of 100-125ml/hr. Mean recovery time was 7.74 mins.

Conclusion: IONM is a rapidly evolving field with potential to improve the safety of spinal surgery. Preoperative discussion between the neurosurgeon, anes thesio logist & electrophysiologist is an essential for safe IONM usage. Further prospective studies are needed to establish the true efficacy of IONM, but when used properly, IONM represents a powerful tool for improving outcomes in spine surgery.

Keywords: Spine surgery, TIVA, continuous propofol infusion, intra operative neuro muscular monitoring (ION M) -SSEP, MEP, BIS monitoring

Introduction

The gold standard treatment modality for correcting spinal deformities is surgery. The risk of neurological complication remains present even though there are improvements in surgical technique. The complications can be caused not only by direct mechanical damage, strain or compression of neural structures, but also by disorders of the vascular supply of the spinal cord. Stabilization of the spine involves instrumentation above and below the unstable spinal level. The challenge to the anaesthetist is to provide optimal surgical conditions and ensuring adequate oxygenation to the brain and spinal cord, and facilitating the use of intra operative spinal cord monitoring techniques. To enhance the safety of spine surgery techniques, many surgeons use IONM. The intraoperative neurophysiological monitoring (IONM) helps to decrease the incidence of complications during spine surgeries by avoiding direct and indirect injuries of the spinal cord. IONM contains different modalities like electro encephalo gram (EEG), electro myography (EMG), somatosensory evoked potentials (SSEPs), and motor-evoked potentials (MEPs). In our study we are observing SSEPs and MEPs changes. Although this technology cannot directly prevent intraoperative neurological injury, but provides real-time feedback of critical neuro logical pathways to the surgeon which prevent or mitigate neurological injury.[8] There are challenges to the anaesthesio logist during IONM because all anaesthetics agents and neuromuscular agents affect synapses in the nervous system and neuro muscular junctions. After completion of the surgical procedure extubation also carries very critical part of airway management. Therefore, it is very important to strategize anaesthetics plan which provides haemo dynamic stability and keep the patient relaxed intra operatively and ensure smooth and early recovery from anaesthetics postoperatively.

Aims & objectives

1. Primary aim is to keep patient anaesthetized, relaxed and immobile during spine surgeries. To allow proper neuro muscular monitoring during intraoperative inter ventions and to prevent damage to the spinal cord.
2. Secondary aim is to keep intraoperative BIS (Bispectral index) 40-60, which provides deep plane of anaesthesia for surgery and to ensure smooth and early recovery from anaesthetics postoperatively.

Materials and Methods

With institutional ethics committee approval & written informed consent 50 patients as a grade I, II & III aged between 10 to 50 years who underwent elective spine surgeries were included in study. This study was carried out through a period of 2 years from November 2019 to November 2021.

Study design

It is observational type of analytical study. All data entered in Microsoft Excel and analysed. Continuous variables expressed as mean standard deviation. Non continuous data expressed as percentage.

Procedure

Preoperative evaluation was carried out a day before the surgery. A through history was taken and examination like CBC, renal and liver function tests, Random blood sugar, Chest X-ray, 12 lead ECG and reports were reviewed. Patients were kept nil per oral for 6 hours before Surgery. The procedure was explained to the patient and taken inside the operation theatre. All the mini mum mandatory monitors ECG, NIBP, pulse oxi metry was applied. Securing intravenous line with 18-20 G intravenous cannula.

Premeditation – inj glyco 0.004 mg /kg iv, inj ondansetron 0.15 mg/kg iv, inj. fentanyl 1-2 mcg/kg iv. All the patients will receive a standard prescribed anaesthetics protocol.

Pre oxygenation –100% oxygen for 3 minutes with facemask via bain's circuit with O2 at 10L/min

General anaesthesia –

Inj. Propofol 2-3 mg/kg iv, inj suxamethonium 2 mg/kg iv, inj. dexmedetomidine 1-2 ug/kg iv.

Intubation done with cuffed ET tube, cuff inflated, B/L Air entry checked and tube fixed after confirming successful intubation with end tidal CO2 monitor and clinical examination, anaesthesia will be maintained with O2. Electrode placement and positioning -

After inducing the patient electrode are placed over head for SSEP monitoring and over Tibialis Anterior muscle for MEP monitoring.

Basal SSEP, MEP and BIS readings taken

Figure 1: Waveforms during IONM

Continuous propofol infusion started at rate of 125ml/ hr using 2mg/ ml concentration of propofol and rate of drip changed according to level of sedation required after basal SSEP, MEP and BIS readings taken. These observ ations are done under guidance of neuro physio logist.

Patient kept in Prone position.

Patient are induced with BIS guided injection of propofol to have a BIS value about 50 and were maintained with continuous infusion of inj. Propofol to have BIS value between 40 to 60 throughout the procedure.

Monitoring

All the parameters selected (HR, SBP, DBP, MAP, SpO2) recorded on various specific timings & propofol infusion rate was also monitored. BIS, MEP, SSEP also monitored meanwhile & propofol infusion rate changed according to that.

On completion of surgery propofol infusion stopped.

Extubation

After through orotracheal suctioning cuff deflated and ET tube removed. Recovery time is recorded from cessation of infusion to eye opening on command and till regaining muscle tone and power. All the patients shifted to PACU (post anaesthesia care unit) and discharge criteria selected according to modified alderete score. Study end point is 2 hours after extubation.

Results and Discussion

Total 50 patients were included in the study for spinal surgeries under general anaesthesia with neuromuscular monitoring. We have observed for different parameters like haemo dynamic stability, intra operative neuro muscular monitoring with SSEP and MEP, Bispectral index, propofol infusion rate, Visual Analogue scale, Recovery time and modified alderete scoring system.

Table 1: Age distribution.

AGE	NO.	%
≤30	21	42%
31-40	12	24%
>40	17	34%
TOTAL	50	100%
MEAN	34.26	
SD	10.55	

Table 2: Sex distribution.

Sex	NO.	%
Male	29	58%
Female	21	42%
Total	50	100%

Table 3: BMI distribution.

BMI	NO.	%
Underweight (<18.49)	5	10%
Normal (18.50 to 24.99)	19	38%
Overweight (25 to 29.99)	26	52%
Obese	0	0%
Total	50	100%

Table 4: ASA Grading.

ASA	NO.	%
I	7	14%
II	29	58%
III	14	28%
TOTAL	35	70%

Table 1,2,3 & 4 shows distribution of patients according to sociodemographic characters. In my study mean age of the study patients is 34 years, with more than half of the male patients. Majority patients belong to ideal body weight and with ASA II grade.

Table 5: Haemodynamic parameters with SpO2 & EtCO2.

	Hr mean± SD	Sbp mean±SD	Dbp Mean±sd	Map Mean±sd	Spo2 Mean±sd	Etco2 Mean±sd
PRE-OP	104.96±10.15	118.88 ± 8.05	76.00 ± 5.38	90.29 ± 3.48	98.76 ± 0.43	-
15min after premedication	97.96± 8.80	118.80 ± 8.77	75.52 ± 5.20	89.95 ± 3.50	98.76 ± 0.43	-
During Intubation	104.48±8.60	128.36 ± 7.21	82.12 ± 6.09	97.53 ± 4.71	98.92 ± 0.27	-
1 min after intubation	96.44 ± 8.31	130.20 ± 8.53	84.00 ± 6.77	99.40 ± 5.62	98.84 ± 0.37	37.54 ± 1.66
3 min	91.84 ± 7.10	124.52 ± 7.95	78.12 ± 11.73	93.15 ± 9.64	98.90 ± 0.42	37.80 ± 1.87
5 min	89.44 ± 6.36	120.76 ± 7.11	76.32 ± 5.92	91.13 ± 5.11	99.00 ± 0.00	37.76 ± 2.09
10 min	86.32 ± 5.46	119.74 ± 7.76	75.20 ± 5.97	90.05 ± 5.54	99.00 ± 0.00	37.36 ± 2.00
15 min	87.32 ± 7.56	117.60 ± 8.84	75.36 ± 5.17	89.44 ± 5.12	99.00 ± 0.00	38.28 ± 2.13
30 min	85.56 ± 4.77	107.76 ± 7.36	64.70 ± 4.23	79.05 ± 3.89	98.78 ± 0.55	37.46 ± 1.92
45 min	84.64 ± 4.97	99.68 ± 5.15	61.88 ± 3.17	74.19 ± 3.72	98.78 ± 0.51	37.88 ± 1.65
60 min	81.84 ± 4.10	100.40 ± 5.24	64.44 ± 5.02	76.43 ± 4.17	98.66 ± 0.63	38.56 ± 2.73
120 min	83.72 ± 3.68	101.60 ± 3.64	61.52 ± 2.27	74.88 ± 1.81	98.68 ± 0.62	39.18 ± 2.95
180 min	82.68 ± 3.85	100.76 ± 2.49	61.72 ± 2.39	74.73 ± 1.86	98.78 ± 0.51	39.38 ± 3.12
POST OP 30 min	81.48 ± 4.69	124.72 ± 12.23	84.28 ± 5.95	97.76 ± 6.02	98.68 ± 0.62	-
1 hr	80.40 ± 4.02	125.92 ± 11.57	85.20 ± 4.81	98.77 ± 5.32	98.66 ± 0.63	-
2 hr	79.88 ± 3.67	125.84 ± 10.50	86.08 ± 4.37	99.33 ± 4.59	98.58 ± 0.70	-

Table 5 shows haemodynamic parameters which shows no significant deviation of these

parameters during the surgery. It shows heart rate increases immediately during intubation. systolic blood pressure, diastolic blood pressure & mean arterial pressure increases immediately during intubation, then after it decreases gradually because of propofol infusion and returns to preoperative level post operatively. In my study inj Dexmedetomidine 1-2 mcg /kg given at the start of the surgery which provides good haemodynamic stability and stress response due to intubation is blunted. Propofol and dexmedetomidine decreases blood pressure, but MAP doesn't fall below 60 mmHg in any patient. There is decreased blood loss due to low BP which is necessary to provide good surgical field and for surgeon's satisfaction. Throughout surgery SpO_2 didn't fall below 97 % in any patient & mean $EtCO_2$ maintained between 35 – 40 mmHg in all patients

Table 6: Propofol Infusion Rate.

Propofol infusion rate	**Mean ± sd**
1 min min after intubation	125.00 ± 0.00
3 min	125.00 ± 0.00
5 min	125.00 ± 0.00
10 min	125.00 ± 0.00
15 min	125.50 ± 3.54
30 min	121.50 ± 16.76
45 min	125.00 ± 0.00
60 min	129.08 ± 9.34
120 min	104.00 ± 9.26
180 min	102.90 ± 11.78

Graph 1: Propofol Infusion Rate

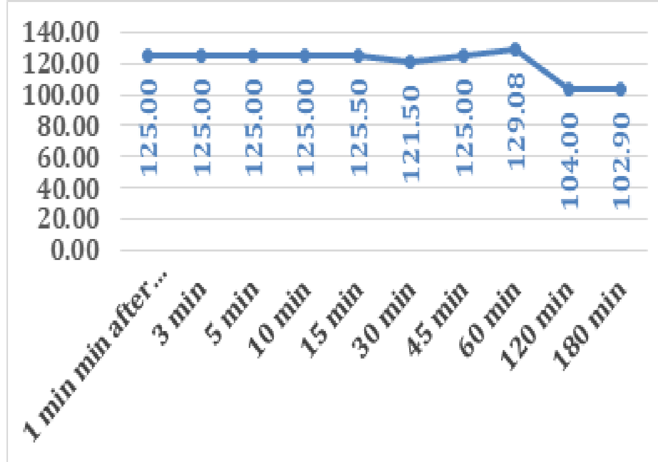

Table 6 and Graph 1 shows throughout surgery mean propofol infusion rate was maintained between 10-0– 125 ml/hr, which provides adequate depth of anaesthesia. .

In my study, propofol infusion made manually at the concentration of 2 mg/ml and drip rate was started at 125 ml/hr and changed according to BIS readings and surgeon's requirements to provide adequate depth of anaesthesia.

Propofol is a good drug for maintenance of anaesthetics depth, as it avoids the disadvantages of inhalational anaesthetics which significantly affects evoked potentials. The pharma cokinetic profile of propofol favours its use as a continuous infusion for maintenance of anaesthesia because its context sensitivity half llife is only 20 minutes even after continuous infusion for more than 6 hours. So we are using TIVA with propofol for maintenance of anaesthesia. TIVA has led to the development of target-controlled infusion (TCI) where by the anaesthesio logist chooses a target blood or brain drug concentration and the microprocessor-controlled infusion pump infuses the drug at the rate needed to rapidly achieve and maintain the desired concentration based on population pharmacokinetic data

Chueng-He Lu et al [7] supports my study which shows by providing more stable blood (and brain) concentration with a continuous i.v. infusion, it is possible to improve the anaesthesia condition and hemodynamic stability as well as decreasing side effects and recovery times with i.v. anaesthetics. However, the operating surgeons who were blinded to anaesthetics procedure, reported superior quality of surgical field with propofol infusion.

Nathan P Royan et al and Ahmed Abdelkhalek Abdullah et al also demonstrated superior surgical field with propofol in spine surgery. This may be due to steady state plasma level of propofol achieved by continuous IV infusion providing relatively low BP, resulting into less blood loss and lesser surgical field congestion.

Intra operative awareness is a distressing complication of general anaesthesia associated with post-traumatic stress disorders, so BIS monitoring during surgery provides information about depth of anaesthesia. So, in my study BIS score was maintained between 40 – 60 using propofol infusion. Drip rate of propofol infusion was changed throughout surgery to keep BIS score between 40 – 60.

Graph 2: BIS Index.

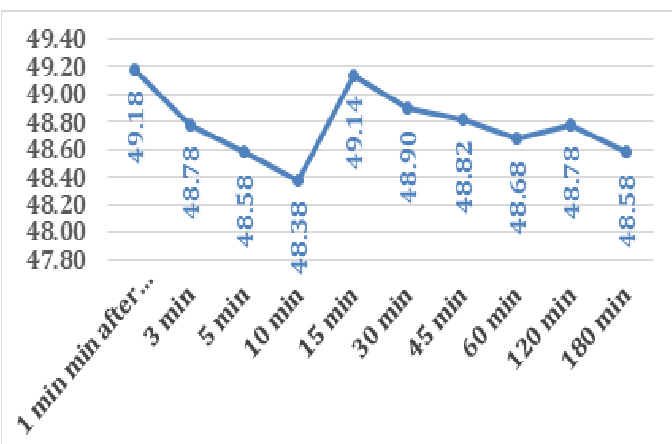

Table 7: BIS Index.

Bispectral index	Mean ± sd
1 min after intubation	49.18 ± 6.26
3 min	48.78 ± 6.27
5 min	48.58 ± 6.39
10 min	48.38 ± 6.50
15 min	49.14 ± 6.70
30 min	48.90 ± 6.19
45 min	48.82 ± 6.25
60 min	48.68 ± 6.29
120 min	48.78 ± 6.27
180 min	48.58 ± 6.39

Table 8: Findings at IONM

	Latency ↑ & Amplitude↓	Latency ↓ & Amplitude ↑
Findings At Ionm (Mep Change)	4%	8%

Table 7 and Graph 2 shows throughout surgery Bispectral index was maintained between 40 – 60, which suggests adequate depth of anaesthesia

Graph 3: Findings at IONM (MEP change)

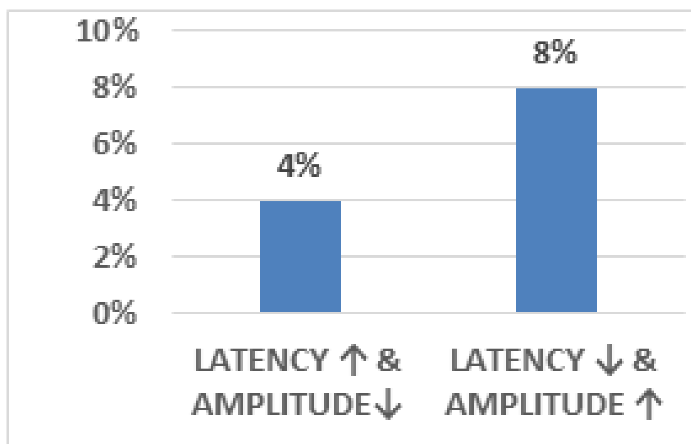

Table 8 and Graph 3 shows findings at IONM. In SSEP there was no change in latency and amplitude in any patient. While in MEP 4% patients showed increase in latency and decrease in amplitude. All these readings are observed under guidance of neurophysiologist and it interprets that there is some spinal cord insult during surgery. And 8% of patients in MEP showed decrease in latency and increase in amplitude which interprets there is improvement in neurological condition after surgery. Propofol anaesthesia causes less suppression and better preservation of SSEP and MEP waveforms

Table 9: Recovery Time

	MEAN ± SD
Recovery time (min)	7.74 ± 1.95

Table 9 shows mean recovery time that is 7.74 mins. Using TIVA with propofol provides early recovery from anaesthesia.

Early awakening is required in spine surgery to perform neurological examination in the early post operative period and Extubation is also a vital event and need to manage carefully because of hemodynamic changes, bucking and coughing. MAP, heart rate might get increased and if there is incomplete recovery SpO2 might be decreased. It leads to raised intra cranial, intra thoracic and intra-abdominal pressure and all these changes are distressing to patient. So early and smooth emergence from anaesthesia is very important.

M. Hohlrieder, W et al., Chueng-He Lu et al. supports findings of early and smooth recovery with my study. In my study I observed that TIVA with Propofol for maintenance of general anaesthesia in spine surgery patients provided early and smooth recovery with mean recovery time of 7.74 min

Table 10: VAS score

VAS	**MEAN ± SD**
POSTOP 30 min	5.48 ± 0.76
1 hr	4.60 ± 0.70
2 hr	4.04 ± 0.70

Table 10 shows Visual Analogue Pain Scale during post operative period. It shows decreasing trend with average score of 4 out of 10. My study showed that patients receiving propofol for maintenance of general anesthesia in spine surgery reported significantly less pain and less requirements of opioids post operatively as VAS score is in decreasing trend post operatively. It is important to achieve good acute pain control to prevent progression to chronic pain to facilitate early mobilization.

Table 11: Modified Alderete score

Modified alderete scoring system	NO.	%
9	2	4%
10	48	96%

Table 11 shows modified alderete score. In which 4% had score of 9 and the rest had 10. All patients had score of ≥9 so all patient shifted toward from PACU.

In my study 50 patients aged 10-50 years of either sex having ASA gradin of I, II and III who underwent for spinal surgery under general anaesthesia were selected. In whom intraoperative neuromuscular monitoring (SSEP and MEP) done using Total intravenous anaesthesia with propofol. IONM during surgery provides real time information about integrity of spinal cords at various level of surgeries like at the start of pedicle screw insertion, at the time of rod fixation etc. Neuromuscular monitoring reduces the incidence of postoperative neuro logical deficits. SO it is utmost important to provide anaesthesia which keeps the patient relaxed, anaes thetized and immobile during surgeries and allows proper neuro muscular monitoring intraoperatively without affecting its evoked potentials or minimally affect this potentials.

Conclusion

Intra operative neurophysiological monitoring is a rapidly evolving field with the potential to greatly improve the safety of spinal surgery. A thorough appreciation of the strengths and weaknesses of each monitoring modality is critical for the optimal use of

IONM. Pre operative discussion between the neuro surgeon, anaesthesio logist, and electrophysiologist is an essential component of safe IONM usage, and topics should include anaesthetics requirements for IONM, alarm criteria to be used, and steps to be taken in response to a positive alarm. Further prospective studies are needed to establish the true efficacy of IONM, but when used properly, IONM represents a powerful tool for improving outcomes in spine surgery.

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