Original Article

Motor and Somatosensory Evoked Potential Monitoring Without Wakeup Test during Scoliosis Surgery

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Abstract

Background: Available evidence suggests that Transcranial electric motor evoked potentials and somatosensory evoked potential is safe methods to check the integrity of the spinal cord during spine deformity correction surgery. We compare the efficacy of Transcranial electric motor evoked potentials and somatosensory evoked potential to detect the nerve injury during Scoliosis surgery.

Objectives: To demonstrate the advantages of combined motor and sensory evoked potential monitoring during scoliosis surgery.

Methods: We analyzed records of 65 (48 female and 17 male) Scoliosis surgery cases of Transcranial electric motor evoked potential and Somatosensory evoked potential. The mean age was 15.6 years. Patients who showed significant (at least 55%) of unilateral or bilateral amplitude loss, for at least five to ten minutes during the intervention in scoliosis surgery under total intravenous anesthesia, will be included.

Results: From 65 patients during surgery seventeen patients have a significant or complete drop of baseline amplitude on transcranial electric motor evoked potentials. Thirteen patients have the complete return of baseline amplitude by surgeon intraoperative intervention, whereas four patients have a reversal of motor response after 8 hours post-operatively. Transcranial electric motor evoked potential monitoring was 100% specific and 100% sensitive, whereas Somatosensory evoked potential was 100% specific and 85% sensitive.

Conclusions: SSEPs and MEPs, in combination give accurate and quick information of nerve or spinal cord insult intraoperatively.

Keywords: Scoliosis, Somatosensory evoked potentials and Transcranial electric motor evoked potentials.

Introduction

Intraoperative neurophysiological monitoring (IONM) has an evolving part of Spine Surgery, Neurosurgery, Vascular surgery, Otologic Surgery, and other operative procedures. In order to get better patients outcome postoperatively, use of IONM is being enhanced for safety and care of the nervous system during surgical interventions.[1]

Nowadays many different modalities are used for intraoperative monitoring.[2] Every modality has different features, benefits, and limitations.[3] The most commonly used modalities in IONM are Transcranial Electrical Motor Evoked Potentials (TCeMEPs) [4] and Somatosensory Evoked Potentials (SSEPs).[5] The teamwork of Electrophysiologist, Surgeon, and anesthesiologist is needed to get the maximum benefit of IONM.[6,4]

Transcranial electrical motor evoked potentials (TCeMEPs) is more accurate in monitoring the ischemic changes and function of motor tracts during correction of the deformity.[7] Somatosensory evoked potentials (SSEPs) are more sensitive for identifying any change in sensory tracts.[8] Multimodality IONM approach provides more sensitive and specific quick feedback to the surgeon during surgery [9], help to reduce permanent postoperative surgical complications.[10]

We want to analyze the efficacy of Transcranial electrical motor evoked potentials (TCeMEPs) and Somatosensory evoked potentials (SSEPs) to detect the intraoperative nerve injury during Scoliosis Surgery. The main aim of this study was to demonstrate the advantages of Transcranial electrical motor evoked potentials (TCeMEPs) and Somatosensory evoked potentials (SSEPs) during Scoliosis surgery.

Methodology

We prospectively analyzed intraoperative neurophysiological monitoring records of 65 patients in Scoliosis surgery between March–December 2016 at Spine Center, Ghurki Trust Teaching Hospital Lahore after approval from Hospital Ethical Committee and consent from patients. All the patients who showed significant (at least 55%) unilateral or bilateral drop in amplitude, for at least five-ten minutes during the surgical intervention, were included. In order to asses Sensitivity and Specificity of Transcranial electric Motor Evoked Potential (TcMEP) and/or Somatosensory-Evoked Potential (SSEP) traces was design as false-positive, false negative, true-positive or true-negative. Three levels of loss of signal, namely more than 25%, 50% or 75% of the control were used to judge the significance of any reduction in amplitude during scoliosis surgery.

On the scalp, corkscrew electrodes were placed at C1/C2 and C3/C4 according to the ten-twenty formula of brain stimulation. SSEPs were recorded from there with Trains of 4-7 square wave stimuli (200-500µsec duration) with intensities ranging from 120-200 mA. The surface-adhesive electrode used for SSEPs tibial nerve in the lower limb and ulnar nerve in the upper limb. Sub-dermal needle electrodes were used for TCeMEP and EMG recording. In hand, thenar & hypothenar muscles used bilaterally and in bilateral lower limb rectus femoris, tibialis anterior, medial gastrocnemius and abductor hallucis were monitored. From the same upper and lower limb extremity muscles Spontaneous electromyography (s-EMG) was recorded. Baseline SSEPs and TCeMEP responses were got pre-operatively.

After making the position of the patient on the surgery table, TCeMEP and SSEPs baselines will take and the surgeon informed about the baseline. During the surgery, continuous median and tibial nerve stimulation performed for SSEPs recording. TCeMEPs stimulation gives with the permission of the surgeon because there should be stopped in any intervention during motor stimulation. A quick response is giving to the surgeon regarding any change in baseline amplitudes. The data was initially entered on a pre-formed performa and later on, SPSS 17.0 was used for analysis.

Result

From 65 patients during surgery seventeen patients have a significant or complete drop of baseline amplitude on transcranial electric motor evoked potentials. (Figure 1 and Table 1)

Thirteen patients have the complete return of baseline amplitude by surgeon intraoperative intervention, whereas four patients have a reversal of motor response after 8 hours post-operatively.

Somatosensory evoked potentials are late to recognize changes in 6 patients while on MEPs changes are significant. Meanwhile, changes in SSEPs lagged behind from MEPs changes by eighteen minutes. (Figure 2)

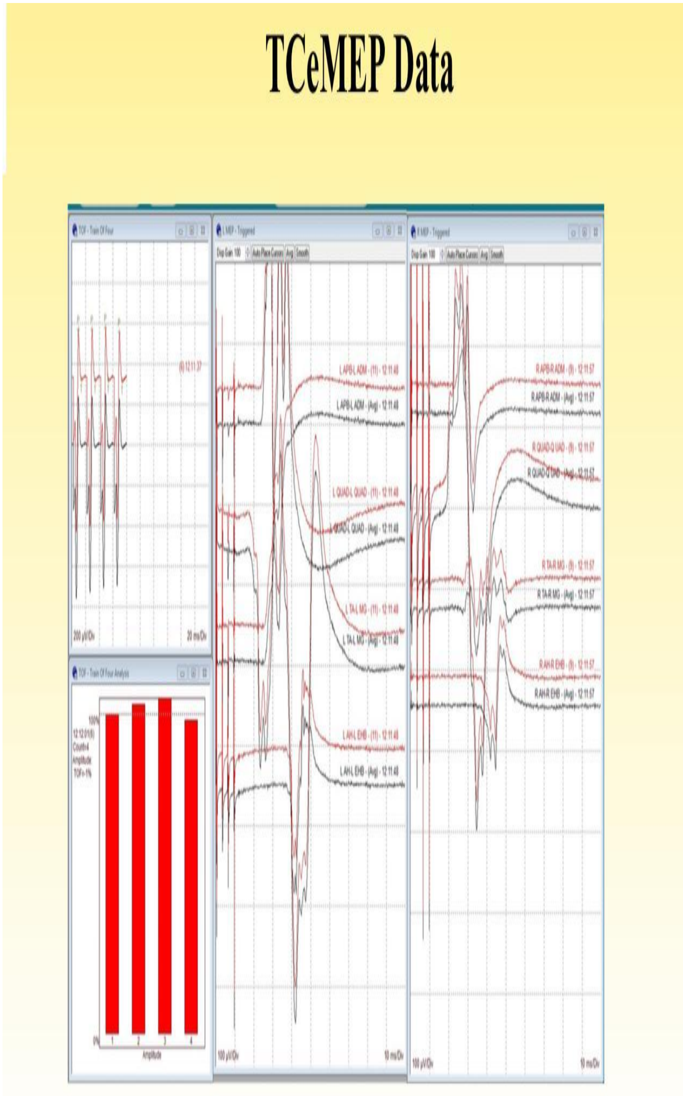

Figure 1: Graphical presentation of Alerts during scoliosis surgery.

Table 1 : Details of Scoliosis Patients

	Group		
	Idiopathic	**Congenital**	**Miscellaneous**
Mean Age at Operation(range)	15.03(11 to 17)	13.9 (11 to 14)	14.6 (12 to 15)
Mean of Cobe angle in degrees(range)	61.34(43 to 90)	93.57(65 to 130)	71.87(50 to 110)
Number of Vertebrae Instrumented (Mean)	11.09	12.5	8.95

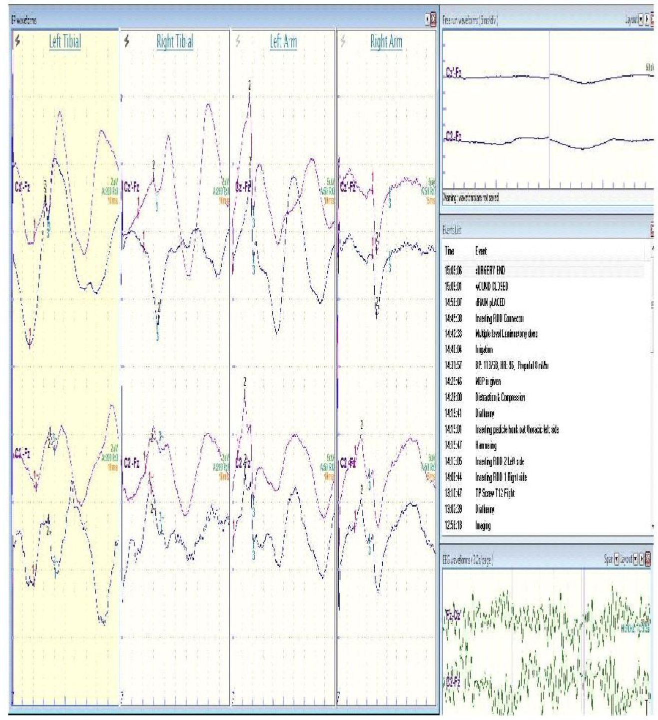

Figure 2: Data Showing Left Tibial, Right Tibial, Left Arm and Right Arm Shows Somatosensory Evoked Potential (SSEPs)

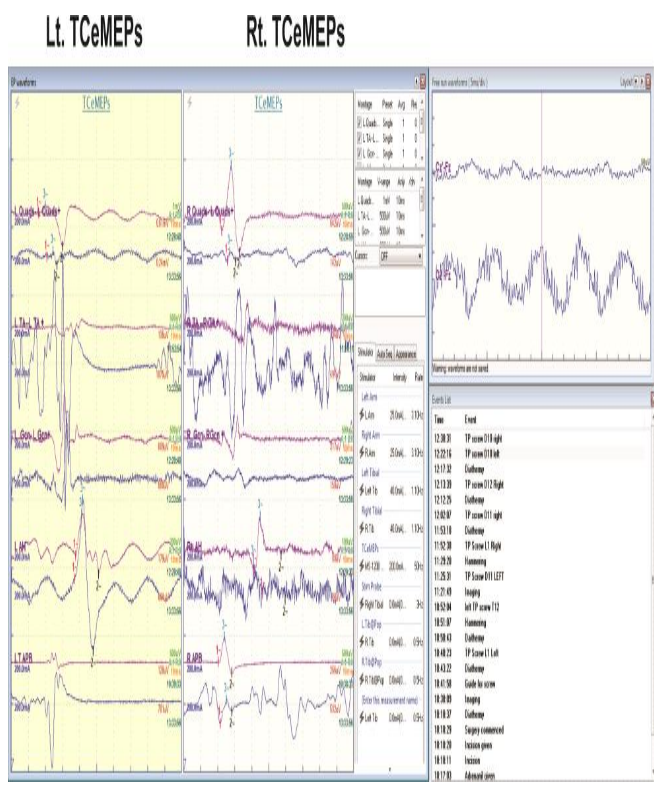

Figure 3: The baseline of Motor Evoked Potentials

The transcranial electric motor evoked potential monitoring was 100% specific and 100% sensitive, whereas Somatosensory evoked potential was 100% specific and 85% sensitive. (Figure 3)

Discussion

Xu R, Witham TF, et al, retrospectively stated that Somatosensory Evoked Potentials/(SSEPs) and Transcranial electric Motor Evoked Potentials (TCeMEPs) give more accurate and safe results whenever used in combination.[11] According to Mikula AL et al, In deformity correction scoliosis surgery intraoperative monitoring gives confidence to surgeons throughout surgery about the integrity of peripheral nerves and spinal cord.[12] This advance multimodality system has many advantages and benefits in favor of patient outcomes.[13] Chang-Hyun Lee et al concluded that Baseline traces should be taken before making the patient's position on the surgery table.[14] Because during positioning on the surgery table it may put extra pressure on brachial plexus or any nerve, which may cause false-positive result and become wastage of time for the surgeon.[15]

Schwartz DM et al report a retrospective review on Intra Operative Neurophysiological Monitoring is quite a useful and accurate way of recognition of spinal cord insult in real-time during surgery without performing a wake-up test.[16] As we noted that changes in Transcranial electric Motor Evoked Potentials(TCeMEPs) are more quick and noteworthy within time, Bayard Wilson et al also concluded the same findings during intraoperative neurophysiological monitoring in lateral mass plating surgery on the cervical spine.[17] Somatosensory Evoked Potentials (SSEPs) is also helpful to monitor the integrity of dorsal root ganglion in real-time.[18] Calancie B et al performed a blinded and randomized study and concluded that Intraoperative Neurophysiological Monitoring Transcranial electric Motor Evoked Potentials (TCeMEPs) give quick results within few seconds while on the other hand Somatosensory Evoked Potentials (SSEPs) lag behind about 15 minutes during any insult or damage in surgical intervention.[19] We are using total intravenous anesthesia, it is also recommended for excellent amplitude without any noise and interference in Intra Operative Neurophysiological Monitoring.[20] Malcharek MJ et al compare Desflurane gas with TIVA and concluded that desflurane reduces the TceMEP amplitude markedly as compare to use propofol during surgeries. The Use of propofol should be noted regularly as excessive use will promoting muscle to be more relaxed during surgery.[21] During Distraction and Compressions of Rods, there is quite a variation with the mean arterial pressure of the patient, it should be noted and informed the surgeon & anesthetic as well.[22] There are a few limitations of our study. Electrical interference by C-arm imaging using in operation room causing more five-hertz interference for real-time monitoring of SSEPs. So, Imaging must be used for a selective period of time and its excessive use should be avoided. There are many factors that may give false-positive alerts for MEPs like, anesthesia dose, patient body temperature, mean blood pressure, positioning, and electrical interference. So TceMEP monitoring is more challenging. SSEPs are more sensitive to using propofol in TIVA because of the unavailability of remifentanil in the market. So, we have to rely only on TceMEPs during alert in surgery for any quick release or reverse of damage. So, further studies needed it for better results. There should be a trained electrophysiologist, who monitors all the events during surgical interventions.[23] We strongly suggest the use of Transcranial electric Motor Evoked Potentials (TceMEPs) and Somatosensory Evoked Potentials (SSEPs) monitoring in combination during spine deformity correction and Scoliosis surgeries.[24]

Conclusion

Combined SEPs and TcMEPs provide an accurate, perfect and quick method to avoid any permanent damage to the spinal cord and peripheral nervous system during Scoliosis surgery. This advance multi-modality method is higher to single modality techniques, both for quick detection of any injury, for improving the patient's functional outcome during deformity correction surgeries like Scoliosis.

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