

Paraplegia After Corrective Scoliosis Surgery Accompanied By Abnormal Intraoperative Motor Evoked Potentials: A Case Report

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Abstract: Neurologic injury is one of the most serious complications from corrective surgery of severe kyphoscoliosis. To avoid this complication, optimal intraoperative neurologic monitoring is required, which should provide the information regarding spinal cord integrity as soon as possible. Recently, intraoperative motor evoked potentials monitoring has been used with increasing frequency to detect the spinal cord injury. We report a case of postoperative paraplegia following scoliosis correction surgery under motor evoked potentials monitoring, which was misrecognized as false-positive signals of motor evoked potentials by surgeons intraoperatively.

Keywords: Paraplegia, Scoliosis, Motor evoked potentials, Vertebral column, Posterior resection

INTRODUCTION

Spinal cord injury resulting in postoperative neurologic deficit is a fearful complication that may occur during the surgical correction of kyphoscoliosis [1]. The incidence of neurologic injury after posterior vertebral column resection (PVCR) is estimated to be 8% [2]. Prevention of postsurgical neurologic deficit is a major concern and has led to the introduction of intraoperative electrophysiological monitoring techniques such as somatosensory evoked potentials (SSEPs), motor evoked potentials (MEPs), and continuous electromyography monitoring [1]. Optimal intraoperative monitoring provides information regarding spinal cord integrity, including both the descending motor and ascending sensory pathways, which may prevent further irreversible spinal cord injury.

In this article, we intend to report a case of postoperative paraplegia following kyphoscoliosis correction surgery under MEPs misrecognized as false-positive signals by surgeons and intraoperatively.

CASE REPORT

A 44-year-old, 50 kg female with the clinical symptom of back pain for 30 years as the result of falling down was admitted with the chief complaint of symptom aggravation. Posterior spinal fusion was planned to relieve the patient's pain. On preoperative plain radiography, the Cobb angle of thoracic kyphosis between T9 and T11 was 81° (Fig. 1A). The preoperative neurologic examination revealed severe tenderness on the back with no neurologic symptoms,

including the presence of normal motor and sensory function. The patient demonstrated intact knee jerk reflexes with no ankle clonus on deep tendon reflex tests bilaterally.

Surgical deformity correction with PVCR of T9–T10 and posterior fusion from level T5 to L1 was planned. Since the range of surgery was extensive, monitoring the integrity of the spinal cord during the procedure by MEPs was required. General anesthesia was induced and maintained with total intravenous anesthesia (TIVA) using propofol and remifentanyl with a target-controlled infusion (TCI) device (Orchestra® Base Primea, Fresenius Vial, Brézins, France). The target effect-site concentrations (Ce) of propofol and remifentanyl were adjusted within the range of 2.0–4.0 µg/mL and 3.0–8.0 ng/mL, respectively. Intubation was facilitated using succinylcholine 60 mg intravenously, and additional muscle relaxants were not administered during the surgery in consideration of the effect on the MEPs monitoring. The patient's vital signs were stable after the induction of anesthesia, with a mean arterial pressure (MAP) of 70–80 mmHg.

Electrophysiological monitoring was performed after the induction of anesthesia using the NIM-SPINE™ System (MEDTRONIC SOFAMOR DANEK USA, INC., Memphis, TN, USA). Transcutaneous stimulation was made with two electrodes inserted into the scalp. Eight-channel MEPs monitoring was recorded from needle electrodes inserted in the left and right C8–T1, T6–T12, L1, and S1–S2 in each adductor digiti minimi muscle, rectus

abdominis muscle, internal oblique muscle, and abductor hallucis muscle. The baseline was measured with 100 mA of stimulation 1 hour after a bolus dose of succinylcholine during the induction phase. When the response became weaker, the surgeon raised the intensity of stimulation by 10 mA increments, up to 200 mA. A 50% or greater rise in threshold or an 80% or greater fall in amplitude were regarded as probable signs of neurologic injury.

When corrective forces were applied to the convexity of the scoliosis, the amplitude in channel 4 was decreased more than 80% in the left lower limb immediately after compression and distraction compared to the baseline MEPs response (Fig. 2). We notified the surgeon of the abnormal MEPs response, and surgical manipulation was immediately stopped to allow evaluation of the problem in the surgical field. However, the surgeon was unable to identify any specific findings. From his extensive clinical experience, the surgeon had suspected that this abnormal MEPs response might be a false positive response. Finally, he made the decision to continue the remaining operation. No untoward surgical events were

noted and the MEPs remained decreased without any change throughout the remainder of the operation.

In the postoperative care unit (PACU), the patient was unable to move her lower limbs and could not feel any sensation in her lower limbs bilaterally. Deep tendon reflex tests showed no knee jerk reflexes and ankle clonus for 4 days after the surgery. Since there was no sign of improvement in motor function, the surgeon decided to perform hematoma removal and irrigation 6 days after the surgery. After the reoperation, the neurologic examination showed improvement in the patient's initial symptoms (tibialis anterior (0/1), extensor hallucis longus (0/3), flexor hallucis longus (1/2), knee extension (1/2), hip flexion (1/2)), but severe weakness of the left leg was still present (Table 1). Postoperative radiographs confirmed sound union at the operated levels of the spine, with no instability or movement (Fig. 1B). Two weeks after the surgery, the motor power of the patient's right lower extremity had recovered to grade 4/5, and after 3 weeks, that of both lower limbs had recovered to grade 4/5. The patient had mild sensation on pinprick and light touch testing. She was discharged, and had recovered almost completely from her paraplegic state after 8 months.

Table 1. Postoperative neurologic examination of the patient

	POD 1	POD 6	POD 12	POD 13	POD 19
TA	(0 / 1)	(0 / 2)	(0 / 4+)	(1 / 5-)	(4 / 4-)
EHL	(0 / 3)	(0 / 3+)	(0 / 4)	(0 / 3+)	(4 / 5-)
FHL	(1 / 2)	(1 / 2)	(2 / 3)	(2 / 4+)	(3 / 4)
HF	(1 / 2)	(1 / 2+)	(2 / 3)	(1+ / 3)	(2 / 3)
KE	(1 / 2)	(1 / 3-)	(3 / 3+)	(4+ / 4+)	(4 / 4+)

POD, postoperative day; TA, tibialis anterior; EHL, extensor hallucis longus; FHL, flexor hallucis longus; HF, hip flexion; KE, knee extension.

Numbers in parentheses are grades of muscle power: 0, no muscle contraction detected; 1, a barely detectable flicker or trace of contraction; 2, movement occurs only in the plane of gravity; 3, active movement against gravity but not against resistance; 4, active movement against resistance but less than normal strength (may be graded as 4+, 4, or 4-); 5, normal strength.

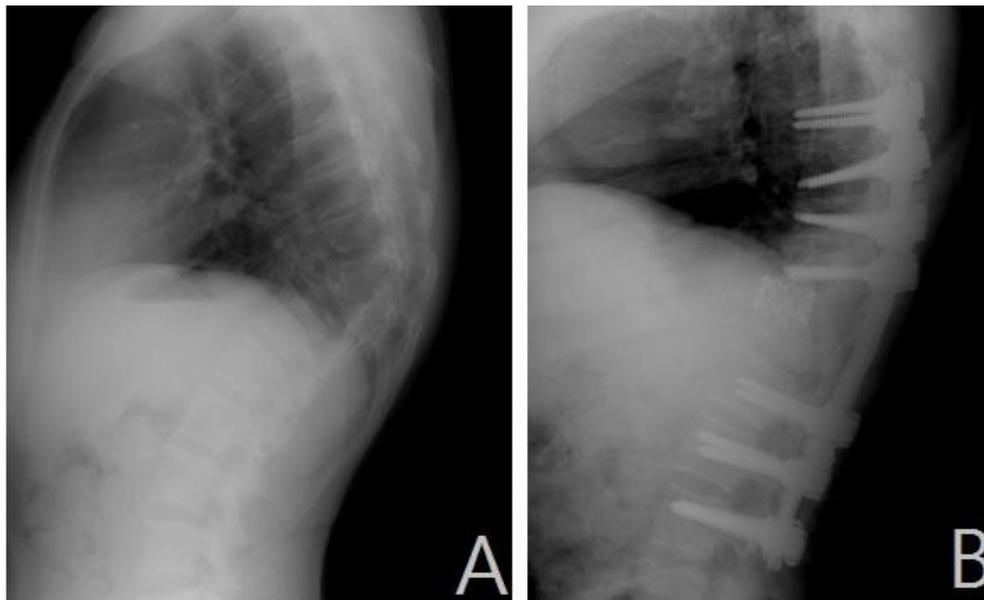


Fig-1: Plain radiograph. (A) Lateral radiograph showing a Cobb angle of thoracic kyphosis of 81° between T9 and T11. (B) Postoperative plain radiograph after decompression and posterior vertebral column resection.

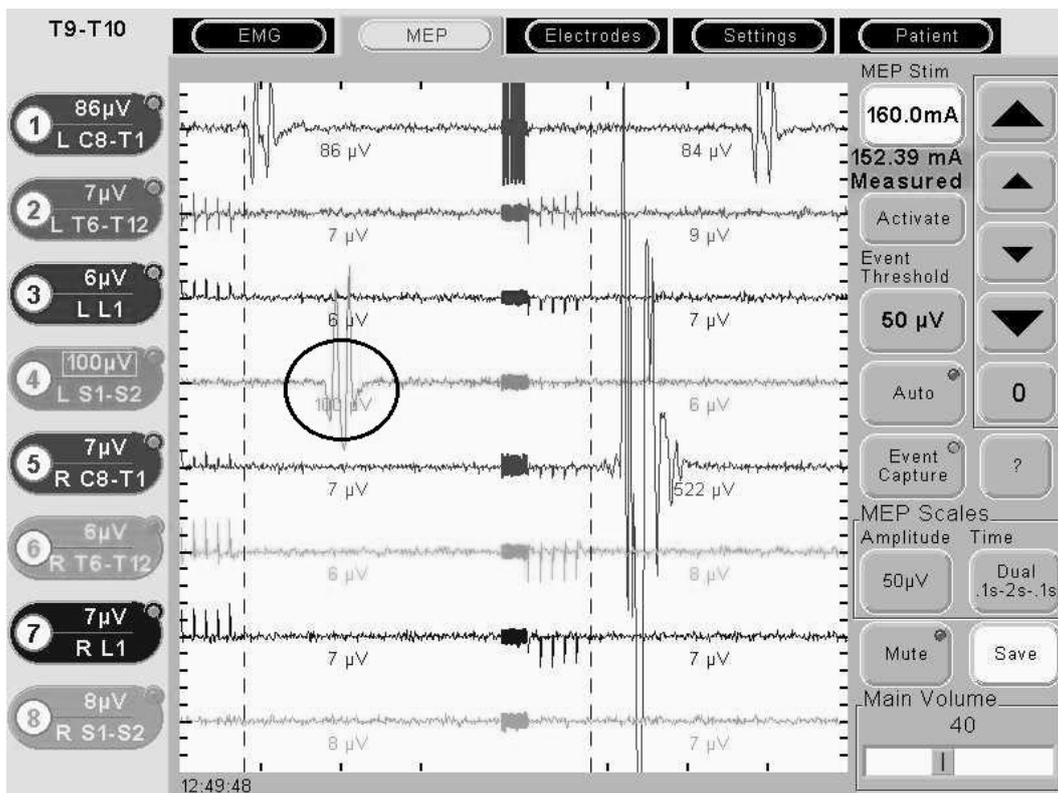


Fig-2: Channel 4 shows an amplitude of 100 µV, which is an 80% decrease in value (black empty circle) compared to the normal MEPs response before compression and distraction.

DISCUSSION

Spinal cord injury resulting in postoperative neurologic deficit is one of the feared complications that may occur during the surgical correction of kyphoscoliosis [1]. Early recognition of this injury allows the surgeons and anesthesiologists to take

appropriate corrective measures and to prevent further irreversible spinal cord injury. There are various intraoperative electrophysiological monitoring techniques such as SSEPs and MEPs that provide information on spinal cord integrity, including both the descending motor and ascending sensory pathways.

Signals through the descending motor pathway can be conducted by stimulation of the descending motor tracts, activation of the anterior horn cells, and transmission of the nerve action potential, while sensory pathway information is conducted rostrally through dorsal column pathways and the lateral funiculus for the upper extremity and lower extremity [3].

SSEPs and MEPs can be used for intraoperative spinal cord monitoring, each with its own advantages and limitations. SSEPs are used to assess the integrity of the sensory pathway through electrical stimulation of peripheral nerves and recording of the cortical or subcortical responses [4]. However, SSEPs can only assess the functional integrity of the dorsal column, and a few cases have been reported of postoperative paraplegia due to ischemic neurologic injury with normal intraoperative SSEP findings [5]. Biscevic et al. reported that the sensitivity of SSEPs was 92% and the specificity was 100% [6]. In another study using SSEPs in 477 patients undergoing surgery for idiopathic scoliosis, the results showed a sensitivity of 95% and a specificity of 99.8% with a false positive rate of 0.21% and a false negative rate of 0.21% [1].

MEPs are more widely used as a routine monitoring procedure for ensuring the integrity of the corticospinal tract and motor pathway during scoliosis surgery. Owen et al. reported that MEPs were a more valid indicator of postoperative motor status than SSEPs in a study of 300 cases [7]. MEPs changes without SSEP changes have been reported to be more common than SSEP changes without MEPs changes. However, special anesthetic techniques such as avoidance of inhaled anesthetics and neuromuscular blockade are required during MEPs monitoring [6]. MEPs have shown sensitivity and specificity of up to 100% [6]. In a study predicting postoperative paraplegia in thoracic and thoracoabdominal aortic aneurysm repair, MEPs showed a sensitivity of 100% and a specificity of 64.9% [8]. In addition, in a retrospective study of 33 patients undergoing spine surgery using MEPs in the Department of Spine Surgery in our institute from 2007 to 2009, the MEPs showed a sensitivity of 80.0% and a specificity of 96.4% with a false positive rate of 3.6% [9]. Zhuang Q et al. noted a false positive rate of MEPs monitoring of 0.26% in a study of 1162 patients undergoing surgical procedures to treat spinal deformity from 2010 to 2013 [10].

When there are signs of significant neurologic injury during MEPs monitoring, such as an 80% or greater fall in amplitude compared to the baseline or a 50% or greater rise in the threshold to induce an electrical potential, technical factors (electrodes or cable disconnection), anesthesia-related factors (inhalational agents, muscle relaxants, hypoxia, hypotension, hypothermia, etc.), and surgical factors

(misplacement of pedicle screws or bone fragments, tension of retractors) should be evaluated [6]. The surgical procedure should be stopped and the surgeon should make a decision immediately whether to perform a wake-up test in cooperation with the anesthesiologist or to revise the screw and explore the patient's nerve roots [11]. In our case, the operation was resumed with the possibility of a false positive result of the equipment. Unfortunately, the patient had lost sensory and motor function of the lower limbs postoperatively, although these had returned to normal after 8 months.

CONCLUSION

Intraoperative MEPs monitoring is a safe, reliable, and sensitive method to detect and reduce intraoperative neurologic injury during kyphoscoliosis surgery. Although there is the possibility of false positive findings in MEPs monitoring, positive signs should be dealt with more cautiously because lack of attention to these signs may lead to serious complications such as permanent neurological impairment. At the same time, several factors that may affect the results of MEPs monitoring should be checked to reduce the occurrence of false positive or false negative findings. We suggest that MEPs techniques should be used routinely during complex spine and/or spinal cord injury surgery, and the facilitation of communication between the anesthesiologist and the surgeon is crucial. Surgeons and anesthesiologists involved with MEPs monitoring should be aware that false-positive or false-negative results may occur with this technique.

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Author Disclosure

The author declares that there is no conflict of interest regarding the publication of this paper.

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