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Continuous neuromuscular monitoring during scoliosis correction surgery in a case of idiopathic kyphoscoliosis: A case report and anaesthetic challenges

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ABSTRACT

Scoliosis is a rotational deformity that affects the column in a sagittal plane, a coronal plane and an axial plane. It is a complicated condition that occurs in three dimensions. There are several possible causes, including congenital, neuromuscular or idiopathic. Back pain is the primary complaint; however, it is possible for it to be severe enough to induce additional symptoms, a deficiency in neurologic function or the requirement of surgical intervention. In situations like these, surgery poses a significant danger due to documented consequences, which include serious bleeding and harm to the nervous system, among other things. The preoperative assessment must be extremely thorough and the intraoperative preparation must concentrate on minimising the potential for complications. We present a case of a 20-year female with a complaint of idiopathic scoliosis with difficulty in walking and difficulty in breathing posted for scoliosis correction surgery. The patient was induced under general anaesthesia, the central and arterial line was secured and prone positioning was given, along with continuous neuromuscular monitoring during surgery, somatosensory evoked potential (SSEP) and motor-evoked potential (MEP) were used for monitoring in order to detect impending impairment of the functioning of cerebral and spinal cord motor pathways.

Keywords: Kyphoscoliosis, scoliosis correction surgery, neuromuscular monitoring, somatosensory evoked potential, motor-evoked potential.

1. INTRODUCTION

Cobb's angle, which is also known as the spinal curve angle, is used in the diagnostic process of scoliosis (Fernandes and Weinstein, 2007). Having a Cobb's angle that is more than 10 degrees is diagnostic of scoliosis. Idiopathic,

neuromuscular, pathogenic and degenerative forms of this illness, in addition to congenital, are the five basic subtypes that fall under this umbrella (Kuznia et al., 2020).

A physical exam, an X-ray of the spine, CT scan or an MRI scan is only a few of the diagnostic methods. Serious scoliosis is defined by having a Cobb's angle of 40 degrees or above. During the instrumentation phase of the scoliosis corrective surgery treatment, pedicle screws are often inserted into the bone of the patient who is having the operation to correct their scoliosis. Despite this, the fact that it is so near to the spinal cord means that there is a potential that it may disrupt the pathways that transport the information that governs movement and sensation. During surgery, there is a risk of injuring the lumbosacral nerve roots as well as the spinal cord due to ischemia, compression or strain. These risks may be mitigated by taking precautions. In addition to that, there is the chance that harm may be caused to the spinal cord. Because the anterior portion of the spinal cord is in charge of sending motor signals to various regions of the body, while the posterior portion of the spinal cord is in charge of conveying sensory information (Min et al., 2011).

Intra-operative neuromuscular monitoring is a technique that has been shown to be extremely reliable for measuring the functioning of the central and peripheral nerve systems during procedures involving the spine. The operating surgeon will get fast feedback from it and it will assist in determining whether or not the surgical treatment caused any iatrogenic brain damage to the patient. It is advantageous in terms of minimising the likelihood of postoperative surgical complications and completely avoiding the development of these difficulties as a direct consequence of this a multimodality approach to IONM that combines the train of four, somatosensory evoked potentials (SSEPs), transcranial electrical motor evoked potentials (MEPs) and triggered and spontaneous electromyography (s-EMG and t-EMG) (TOF). The major goal of anaesthesia is to keep the patient in a state of anaesthesia and analgesia while simultaneously concentrating on neuromuscular monitoring, hemodynamic management, central venous catheterization, invasive blood pressure monitoring and several other tasks related with anaesthesia.

2. CASE REPORT

A 20-year-old patient, weighing 28 kg presented to casualty with difficulty in walking and respiratory difficulties. On examination, the patient was found to have developed kyphoscoliosis which was gradual in onset since 2016. The patient gives a history of fall and a comminuted fracture to the right elbow which was corrected with open reduction and internal fixation. One year after this patient started complaining of deformity of the spine and slowly developed difficulty in walking due to the posture and gradual development of dyspnoea. The patient was referred to the orthopaedic department to be assessed by a spine surgeon. On examination, no specific cause was isolated for the deformity and the patient was diagnosed with idiopathic kyphoscoliosis of the thoracolumbar region (Figure 1) and was planned for scoliosis correction surgery.

Figure 1 Image showing the severe idiopathic scoliosis with 70-degree deviation. The image on the left shows the picture of patient's back and the image on the right shows the X-ray spine.

During the pre-anaesthetic, a pulmonary function test was performed which showed a restrictive pattern. 2d echocardiography was done which was found to be normal with an ejection fraction of 60%. A baseline ABG was done which was found to have a pH of 7.42, PCO2 of 36, P02 of 89 and HCO3 of 24.2. Room air peripheral oxygen saturation was 96%. Patient had tachycardia and tachypnea on examination. She had a history of developmental delay with walking at the age of 2.5 years and delay in attaining cognitive skill. The BMI of the patient was 16.8 and she was found to be underweight. A detailed neurological examination was conducted which was found to be normal. The motor and sensory functions of lower limbs were assessed in detail preoperatively so that any neurological damage post-surgery can be elicited and documented. The airway of the patient was found to be normal. On auscultation, the air entry was found to be decreased on the left side compared to the right. Chest x-ray shows crowding on ribs on the right side with a deviation of the spine toward the right.

After taking written and verbal high-risk consent patient was taken to the operating room and ASA standard monitors were connected. The patient was induced under general anaesthesia with routine induction drugs and vecuronium was administered for muscle relaxation. A 7.0mm endotracheal tube was taken and the airway was secured. The tube was fixed at 18 cm at the angle of the mouth. Cormack Lehane's grading was 2, indicating full exposure of the glottis. After induction, ultra 7 Fr central venous catheters were taken and the right internal jugular vein was canulated and the catheter was secured. It was used for blood transfusions and for the administration of ionotropic agents, if and when needed. A 20 G peripheral vascular catheter was taken and the right radial artery was canulated for continuous invasive blood pressure monitoring.

Post intubation, the ulnar electrodes for upper limb and posterior tibial electrodes for lower limb were attached. Both of these procedures were performed after the patient had been stabilised. In order to capture the electrical activity coming from the patient's nerves, this procedure was carried out. Electrodes were also inserted into the muscles of the lower extremities (Figure 2).

Figure 2 Image showing the attachments of electrodes and the graphs for neuro muscular monitoring.

Procedure was performed in prone position. Once neuromuscular monitoring was started injection of vecuronium was stopped and the patient was put on propofol infusion at 15mg/hour. MAP was kept above 75mmHg; MAC was kept at 0.5 throughout neuromuscular monitoring. (Images of graphs attached) (Figure 3, 4, 5, 6, 7). SSEP, MEP, TOP monitoring graphs are shown below:

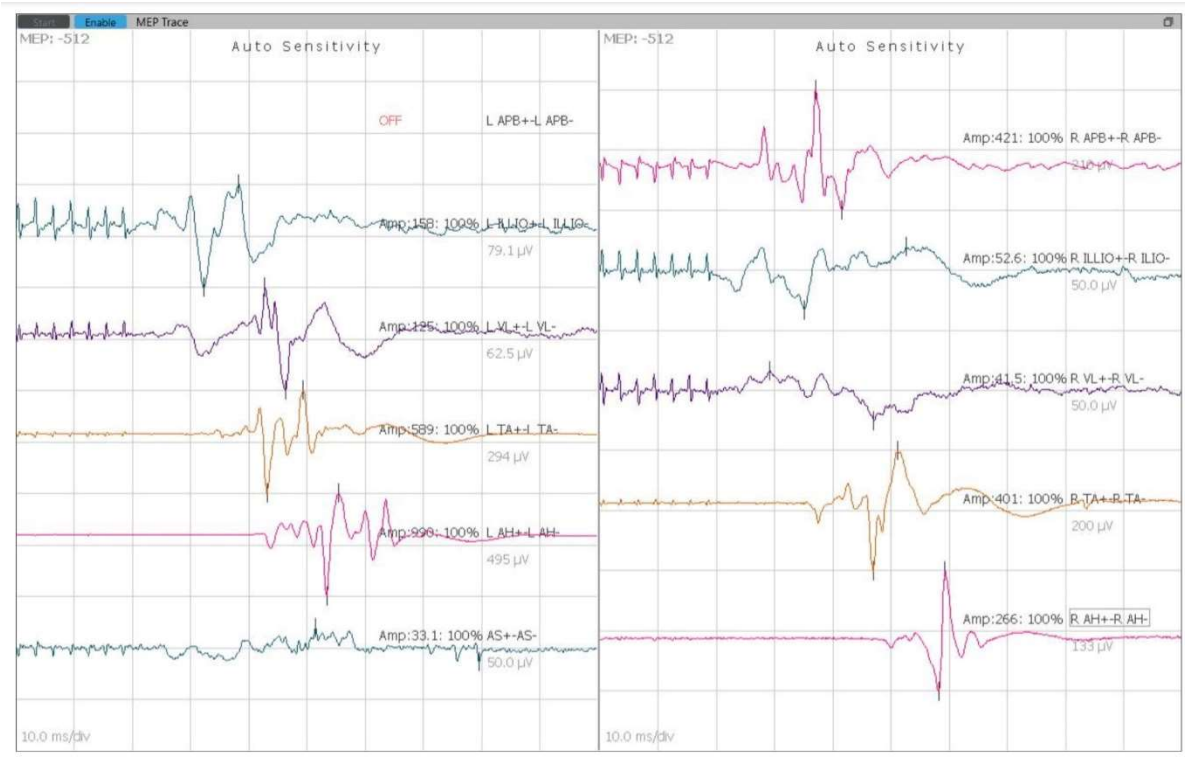

Figure 3 Image showing TOF response and baseline MEP deflections

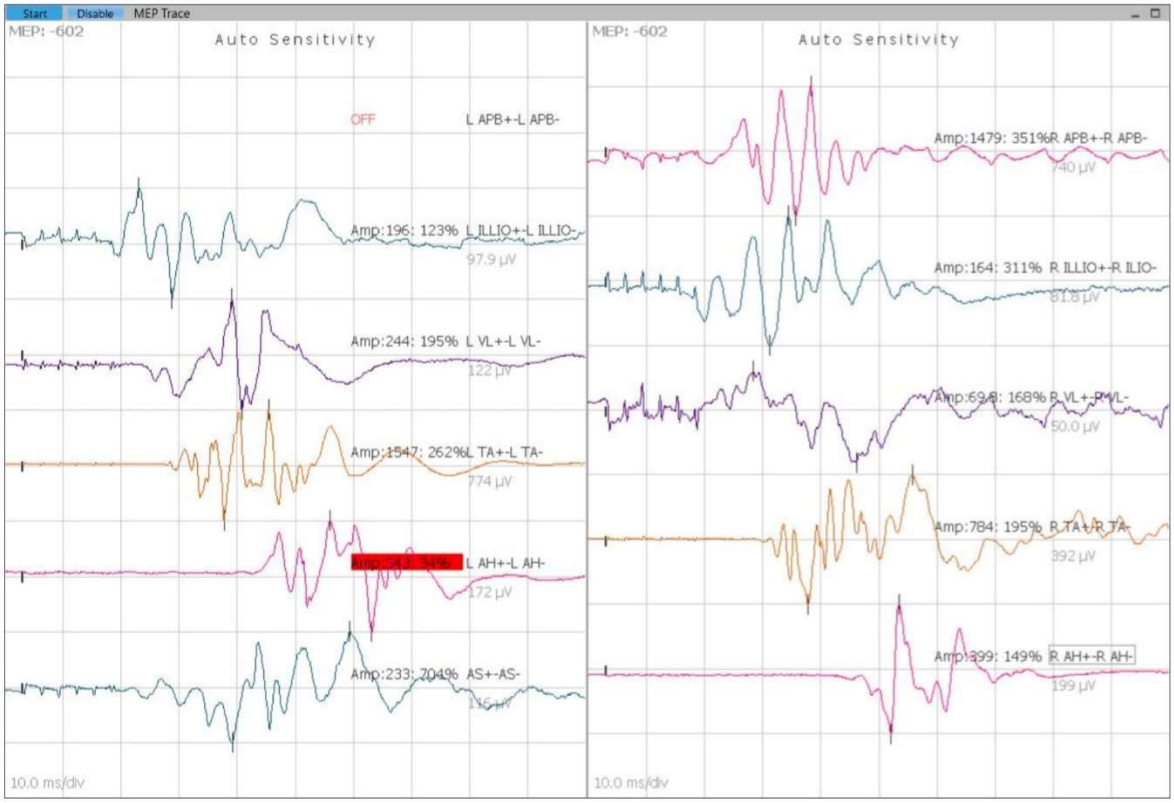

Figure 4 Image showing MEP deflections before instrumentation. The deflections were compared at the beginning, intraoperative and after instrumentation to see any changes in deflection

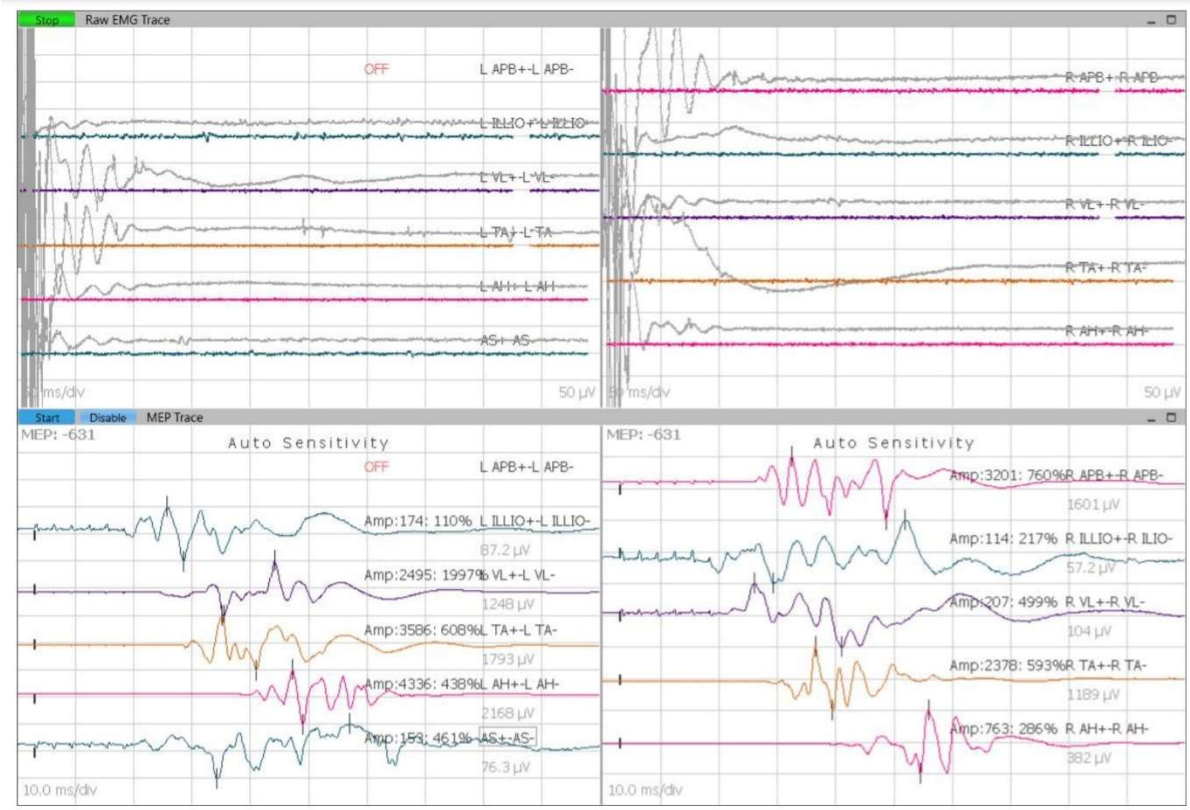

Figure 5 Image showing intraoperative MEP monitoring screenshots

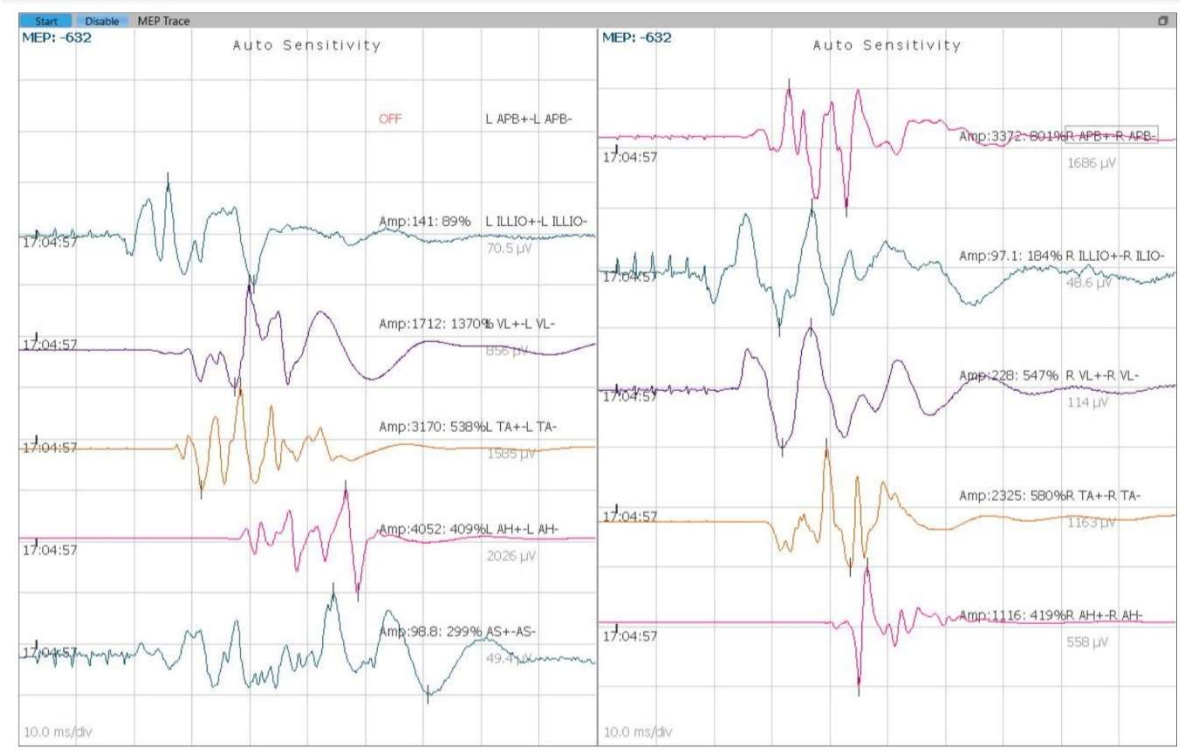

Figure 6 Image showing MEP deflections post instrumentations

Note: There was no change in defections before and after instrumentation

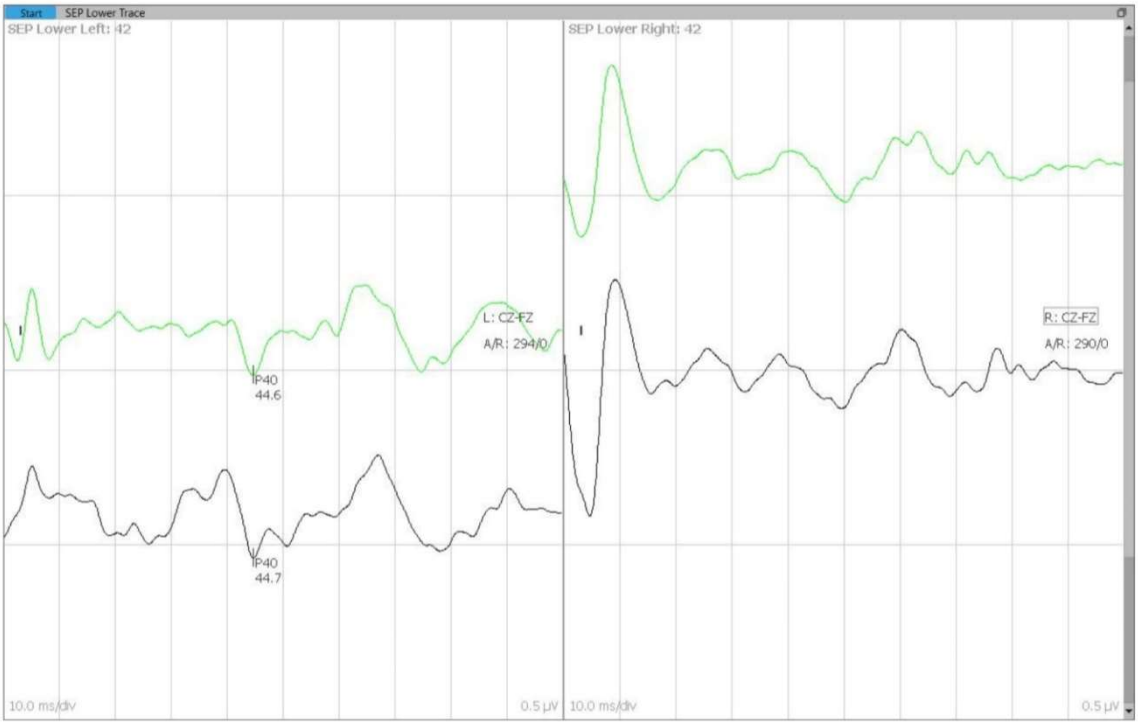

Figure 7 Image showing comparison between baseline SSEP graph deflections against the SSEP deflections after instrumentation. Again, we noticed no change in deflections pattern between baseline and end, indicating no damage to nerve

After exposure, the pedicle screws were placed (Figure 8). Rods were placed and it was tightened at the same time (Figure 9). The MEP, SSEP graphs were repeatedly checked for any change in the deflections.

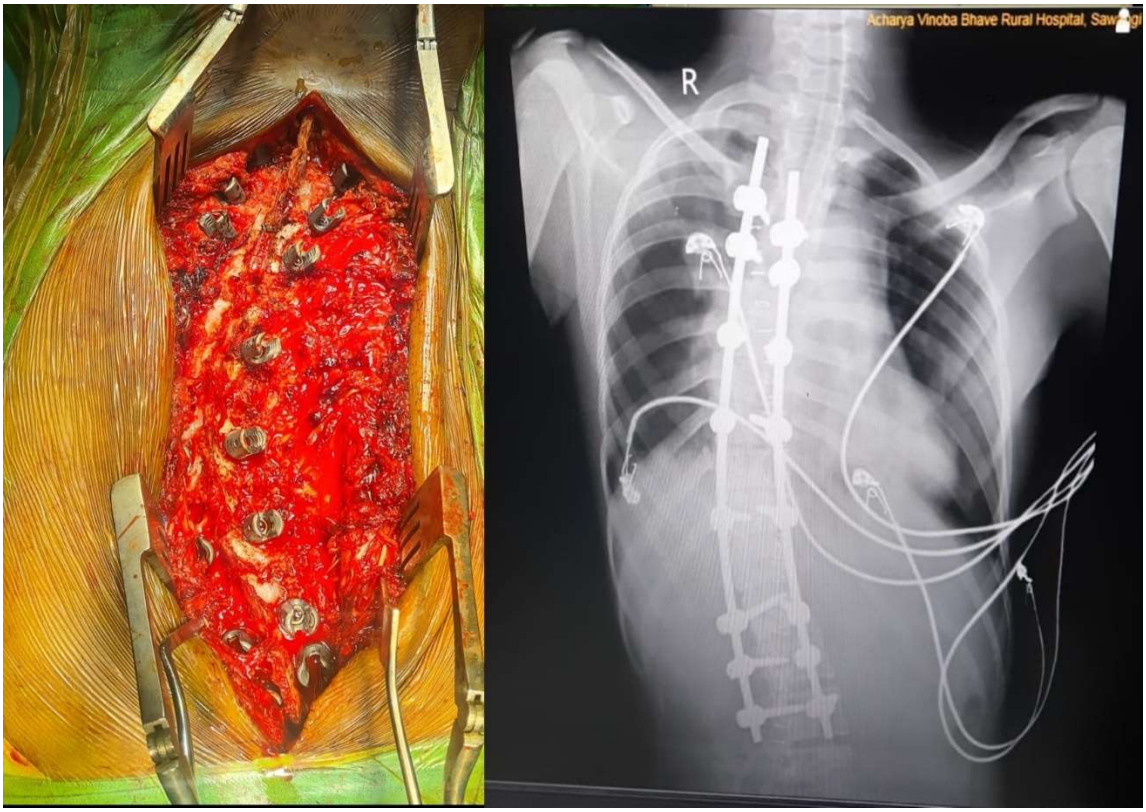

Figure 8 Image showing pedicle screw placements. Image on left shows the pedicle screw placement and image on the right shows the postoperative chest X-ray of patient

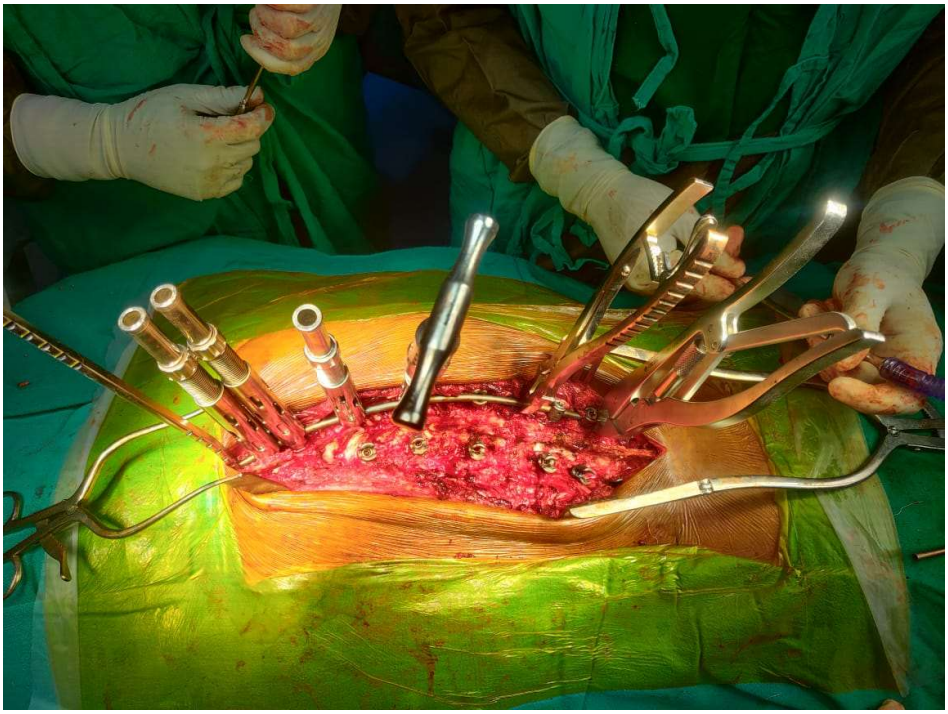

Figure 9 Image showing the rods attached

The total blood loss was 900 ml along with urine output of 500 ml, which was adequately replaced with two units of packed red blood cell (PRBC) and 2 units of fresh frozen plasma (FFP) and fluids. Post-procedure, the patient was not extubated and shifted to ICU with tube in situ. The patient was kept on injection of vecuronium at 2 mg/hour, injection of fentanyl 25mcg/hour and injection of tranexamic acid 50mg/hour. The next morning, sedation was stopped and the patient was extubated and maintained haemodynamics and peripheral oxygen saturation.

3. DISCUSSION

In addition to difficulties with postural alignment, social interaction and respiratory function, untreated kyphoscoliosis may progress to conditions that are potentially life-threatening. Scoliosis can cause difficulty in breathing for the affected person, especially in the chest area. The insertion of pedicle screws is only one of the various methods that orthopaedic surgeons have at their disposal for treating scoliosis. Orthopaedic surgeons have a variety of options available to them for treating patients who suffer from scoliosis. As a therapy for the treatment of scoliosis, pedicle screw implantation has been more common in recent years, which has led to an increase in the number of surgical complications that have arisen as a consequence of this trend. Injuries to the spinal cord, which can be brought on by ischemia and strain, are the most common and potentially fatal of these complications. Paralysis of the muscles, which can be brought on by damage to the nerves in addition to the spinal cord, is another potential complication that can be brought on by these injuries. Ischemia and strain are two of the most prominent factors that might contribute to severe problems. One of the probable causes of issues of this sort is incorrectly positioned pedicle screws, which have a failure rate of up to 15.7% (Hicks et al., 2010).

One benefit of utilising this technique is the capability of multimodal IONM to monitor the sensory and motor functions of the spinal cord in addition to the nerve function of nerves that are susceptible to injury during therapy. Another advantage is that this technique can monitor the nerve function of nerves that are at risk of being injured during therapy. The use of SSEP makes it possible to monitor the sensorineural pathways that are situated in the dorsal section of the spinal cord, which helps to ensure that these pathways are in good working order and are functioning properly. In addition to this, traction may result in injuries such as ischemia of the nerves and strain injuries, both of which can be detected by the aforementioned tests. In a study that Thirumala et al., (2014) carried out on 477 corrective spine operations for scoliosis, the sensitivity and specificity of SSEP were found to be 95% and 99.8%, respectively. This research was done on patients with scoliosis (Thirumala et al., 2014). Pedicle screw stimulation thresholds for a continuously compressed root have been shown in the study to range from 6mA to more than 10mA, but the threshold for a normal nerve root is just 2mA (Thirumala et al., 2017).

When carrying out these procedures, patient posture can be challenging for a variety of reasons, including the atypical body habitus of patients whose diseases have progressed and the requirement to expose a sizeable portion of the spine. Both of these factors can make it difficult to access certain areas of the spine. During the procedure, it is vital to pay the utmost attention to ensure that the eyes are not subjected to any pressure of any kind in any manner. During the course of the case, it is very necessary to make preparations for considerable bleeding to occur. There is the potential for institutions to take into account the option of autologous blood donation when such facilities are equipped to do so. Intraoperative acute normovolemic haemodilution is a technique that is utilised on adult patients on an as-needed basis. It is often reserved for situations in which the patient has severe blood loss. Individuals whose forms of scoliosis are less severe may have a better baseline respiratory condition than those patients whose versions of the disease are more severe. It is quite unlikely that this condition would improve while you are undergoing therapy for scoliosis or in the immediate aftermath of the procedure. Be prepared for considerable postoperative atelectasis and in extreme cases, controlled breathing may be required postoperatively. This is something that needs to be anticipated and prepared for.

4. CONCLUSION

Scoliosis is a rotational deformity that affects the column in three dimensions. Pedicle screws are often implanted into the bone of the patient undergoing corrective surgery. During surgery, there is a possibility of harming the lumbosacral nerve roots. When operations involving the spine is performed, it has been shown that intra-operative neurophysiological monitoring, also known as IONM for short is an exceedingly reliable method for assessing the functioning of the central and peripheral nerve systems. This technique is advantageous in lowering the risk of postoperative surgical complications. In our case, continuous neuromuscular monitoring helped us avoid undue complications associated with scoliosis correction surgery. Also, a thorough pre-operative evaluation and intraoperative management helped us manage the case with ease and without any complications.

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Informed Consent: Informed Consent was obtained from the patient.

Author's contribution: All the authors contributed equally to the case report.

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Conflict of interest
The authors declare that there is no conflict of interests.

Data and materials availability
All data sets collected during this study are available upon reasonable request from the corresponding author.

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