Annals of Case Reports
Carelli LE, et al. Ann Case Rep: 9: 101719
www.doi.org/10.29011/2574-7754.101719
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Case Report

Contralateral Response in Triggered Electromyography: Midline Touching Pedicle Screws

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Citation: Carelli LE, Cabrera JP, Taracena SMF, Khan AA, Almeida LE, Vital RT, et al (2024) Contralateral Response in Triggered Electromyography: Midline Touching Pedicle Screws. Ann Case Report. 9: 1719. DOI:10.29011/2574-7754.101719

Received: 19 March 2024, **Accepted:** 22 March 2024, **Published:** 26 March 2024

Abstract

Introduction: The use of pedicle screws is the treatment of choice in thoracic spinal deformity procedures but insertion and confirmation of well-placement of the screws is challenging due to the significant change of normal anatomy. Therefore, intraoperative neurophysiological monitoring with triggered-electromyography (t-EMG) is highly recommended in which if any pedicle breach is present an ipsilateral response is expected. The aim is to expose a cause of contralateral response in t-EMG.

Clinical case: Case of 14-year-old boy who underwent correction of a high-grade double thoracic curve with pedicle screw instrumentation from T2 to L4. After thoracic pedicle screw placement at T12 level, assessment by t-EMG was performed evincing a left-sided muscle response elicited stimulating the right-sided pedicle screw at 10 mA. Pedicle palpation was normal, fluoroscopy did not alert of any pedicle breach at both sides, somatosensory and motor evoked potentials did not change from baseline, and any mistake of montage was ruled out. Replacement of right-sided pedicle screw was carried out in a more lateral position and the evoked response disappeared using the same cut-off threshold. Postoperative computed tomography shown the first pedicle track of the right side having a midline touching pedicle screws with a 2 mm medial pedicle breach on the left side. The patient did not develop any neurological worsening or symptoms due to this mispositioning.

Conclusion: A contralateral response on t-EMG could have different causes but a less considered is due to midline touching pedicle screws consequent to contralateral medial pedicle breach explaining properly this phenomenon.

Keywords: Triggered Electromyography; Pedicle Screws; Scoliosis; Neuromonitoring; Thoracic Spine.

Introduction

Thoracic pedicle screws are widely employed in scoliosis surgeries being the treatment of choice in majority of cases [1]. Even having a low risk of neurological compromise the consequences of a misplaced pedicle screw can be devastating. Therefore, to minimize this risk of neurological damage intraoperative neurophysiological monitoring is recommended [2]. Multimodal neuromonitoring including somatosensory evoked potentials (SSEPs), transcranial motor evoked potential (TcMEPs), free-run electromyography and triggered electromyography (t-EMG) are the standard of care in scoliosis correction surgeries. A low threshold in t-EMG is an alarm of a possible misplaced pedicle screw in which a response is expected at the corresponding myotome, according to the nerve root or tract involved after the stimulation of the pedicle track or screw [3]. However, a contralateral response elicited by a pedicle screw stimulation is not an expected phenomenon needing recognition for decision-making, and having as possible causes an inadvertent mistake of neurophysiological montage, a rotated spinal cord, a centrally activated diffusion phenomenon, among others [4,5]. The aim is to expose another cause of contralateral response, which is the midline touching between the tips of thoracic pedicle screws with a concomitant contralateral breach of the medial pedicle wall.

Case Presentation

We present a case of a fourteen-year-old boy, with a high-grade double curve scoliosis secondary to lower lumbar myelomeningocele. Cobb´s method measurements showed 107° and 104° of thoracic and thoracolumbar curves, respectively. Although he was non-ambulatory, he had motor function on neurophysiological baseline until T12 myotome. A T2 to L4 posterior spinal fusion and pedicle screw instrumentation was performed. Pedicle screws were inserted by free-hand technique based on anatomic landmarks and pedicle palpation, using screws of diameters between 5.0 and 6.0 mm. The final position of the screws was checked by intraoperative fluoroscopy and the final correction by a postoperative radioscopy (Figure 1). The procedure was done with multimodal neuromonitoring including TcMEPs, SSEPs, free-run and t-EMG. During testing the screws with t-EMG, an unexpected response was elicited after 10 mA intensity in single-pulse pedicle screw stimulation of right-sided T12 screw, recoding a muscle response on the left-side on the compatible myotome, while a stimulation of 10 mA of left-sided T12 pedicle screw was able to evoke a response on the same sided stimulated. Changes in TcMEPs or SSEPs were nor observed evincing absence of responses of lower limb muscles except myotomes of T12. Anesthetics and technical neurophysiological mistakes were ruled out. The t-EMG continued showing response at 10 mA on the left myotome after stimulation on the right T12 pedicle screw and an ipsilateral response at 10 mA after stimulation of left-side screw. Check with anteroposterior and lateral views on fluoroscopy did not alarm of a pedicle breach in both sides but could be identified the tips of screws touching each other in the vertebral body. The right sided pedicle screw was pulled back some threads and retested again, demonstrating in t-EMG at 12 mA. Consequent to a biomechanical reason, the screw was replaced slightly in a more lateral trajectory, and the t-EMG on the contralateral side disappeared and therefore, the final position of the left pedicle screw was kept in the same position with a 10 mA threshold. Postoperative computed tomography scan showed the right T12 pedicle screw trajectory near to the anterior vertebral cortex and the T12 left pedicle screw with a mild breach of the medial pedicle wall, and the tips of both screws finally not touching each other (Figure 2).

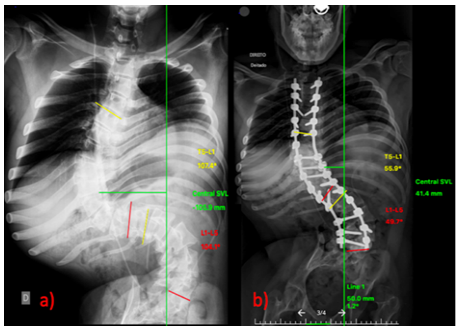

Figure 1: Preoperative (a) and postoperative (b) plain anteroposterior radiographs showing a double curve scoliosis and the surgical correction.

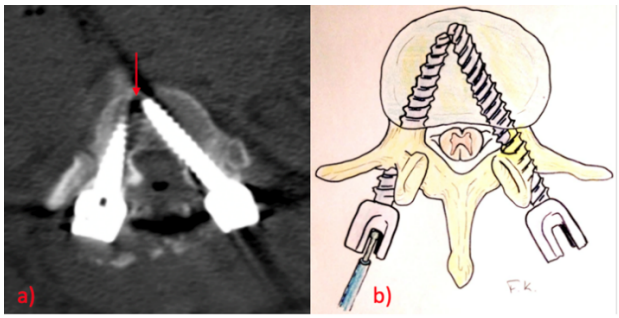

Figure 2: a) Postoperative axial CT scan showing the first (arrow) and final trajectories of the right T12 pedicle screw, and tip of the left pedicle screw with a medial breach and crossing midline which was initially touching the tip of contralateral screw. b) Schematic representation of the phenomenon explaining a contralateral t-EMG response.

Discussion

In spine deformities, consequently to a significant distortion of the spine anatomy, an increased technical difficulty during

thoracic pedicle screws placement is seen carrying an inherent risk of breach of the medial wall in the thoracic pedicle. Therefore, additional safety tools to increase accuracy are desired being the multimodal intraoperative neurophysiological monitoring the standard of care for scoliosis surgery [2,6]. Calancie et al. firstly described the use of electrical stimulation of pedicle screw trajectories for evaluation of placement of screws in an animal model [7]. Nowadays, t-EMG has been shown to be an effective tool for detecting pedicle breaches in the thoracicm [3,8] and lumbar spine. Furthermore, after a pedicle track or screw stimulation an ipsilateral side response from the myotome involved is expected having variability in threshold according if the convexity or concavity is being stimulated [9]. However, a contralateral response in t-EMG even is not usual has been previously described in animals as a stimulus diffusion phenomenon to contralateral intercostal muscles in the thoracic spine with a significant higher threshold compared to the necessary threshold for eliciting an ipsilateral response [10]. In fact, this diffusion phenomenon occurred in almost 50% of the medial cortical breach and it was observed in more than 80% of screws when they were violating the pedicle`s medial wall and it is in encroaching the dura-mater. Therefore, in our case, having a similar threshold at both sides, and after stimulation of a well-positioned right sided pedicle screw, this could not be the most appropriate explanation of contralateral response.mVertebral rotation in scoliosis [11] can be contributing to this bilaterally evoked response by a medialized pedicle screw stimulated as another possible cause. However, this theory lost support after a well-placed pedicle screw. In addition, independent of the degree of vertebral bodies rotation in scoliosis, a spinal cord rotation, so called spinal cord tilt assessed and demonstrated in magnetic resonance studies could explain some cases of bilateral response, but not at this case for the reason already mentioned [5]. Our case is unique in a way that the pedicle screw was not in the foramina rather it was breaching the medial wall of the pedicle and the t-EMG response of 10 mA was seen in the contralateral side. The midline touching pedicle screws should be part of the differential diagnosis on abnormal t-EMG response, and as an alarm criteria of contralateral pedicle breach. An abnormal response in t-EMG should not be missed or misunderstood and must be added to the information provided by fluoroscopy [11]. This case showed another differential diagnosis which can be encountered in spinal surgeries where pedicle screws instrumentation is performed. Ideally, when a surgeon experiences any warning criteria on t-EMG, all the possible causes should be thought and ruled out carefully. Unfortunately, in this case the stimulation of the left-sided pedicle screw having a compatible ipsilateral response at 10 mA did not alarm, and the pedicle palpation as well as the radioscopy looked normal. A contralateral response after right-sided stimulation was unexplained and therefore was more investigated.

Conclusion

A contralateral response on t-EMG could have different causes but a less considered is due to midline touching pedicle screws consequent to contralateral medial pedicle breach explaining properly this phenomenon.

Acknowledgments

Authors Contributions: all authors contributed equally to this work. The authors would like to thank Fernando M. Krywinski for the schematic representation performed, and to Felipe Sarto for his neurophysiological support in data acquisition.

Ethical considerations and informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Conflicts of Interest: None.

Funding: This research received no external funding.

Disclosures: The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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