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Prone Position–Induced Quadriceps Transcranial Motor Evoked Potentials Signal Loss—A Case Report

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Abstract

Background: Transcranial motor evoked potential (TcMEP) is widely used intraoperatively to monitor spinal cord and nerve root function. To our knowledge, there is no report regarding TcMEP signal loss purely caused by patient positioning during the spinal procedure.
Purpose: The objective of this article is to report an intraoperative TcMEP signal loss of a patient with fixed sagittal imbalance posture along with mild hip contractures.
Study Design: A retrospective case report.
Methods: A 57-year-old man had fixed sagittal imbalance and flexed hip contractures. For a reconstruction surgery of T10 to the sacrum/ilium and L5 pedicle subtraction osteotomy (PSO), he was put in a prone position on a Jackson table. In order to accommodate his fixed hip flexion contracture, thigh pads were not used and pillows were placed under his bilateral thighs for cushioning. TcMEPs were used to assess lumbar nerve root function. Ten minutes after incision, bilateral vastus medialis TcMEPs were lost during spine exposure whereas all other data remained normal at baseline. The bilateral lower extremities were repositioned, with the knees flexed into a sling position to increase hip flexion. Five minutes after repositioning, the bilateral vastus medialis TcMEPs gradually improved and maintained baseline amplitude during the remainder of the surgery.
Results: No muscle weakness was detected immediately after surgery. The patient was discharged day 6 postoperatively with markedly improved posture and alignment.
Conclusion: Insufficient hip flexion in patients with fixed sagittal imbalance and hip flexion contractures may cause TcMEP signal changes in the quadriceps response. TcMEP monitoring of bilateral lower extremities is highly recommended for patients with sagittal imbalance and hip contractures, with consideration for lower extremity repositioning when data degradation does not correlate with the actual spinal procedure being performed.

Keywords: Hip contracture; Spine deformity; Neuromonitoring

Introduction

For deformity surgery, positioning is an important surgical step that should be exploited to achieve maximum postural correction [1-3]. The efficacy of transcranial motor evoked potentials (TcMEPs) in detecting isolated nerve root injury for surgery below

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the conus has been demonstrated [4]. There was a report of position-induced TcMEP change of a patient who underwent an L3 pedicle subtraction osteotomy (PSO) [5]. The patient had an acute loss of TcMEP amplitudes of the left rectus femoris, adductor muscles, vastus medialis, vastus lateralis, and tibialis anterior during wound closure. After the patient was turned to the supine position, TcMEPs rapidly recovered. To our knowledge, there is no report of TcMEP signal loss purely caused by patient positioning occurring prior to spinal deformity correction.

Materials and Methods

The patient was a 57-year-old man who had undergone more than 10 lumbar surgeries. On physical examination, he had a pitched forward posture (Fig. 1A). He was unable to stand upright, with flexed hips measuring approximately 45 degrees. Laying supine, he could get his hips down to approximately 20 degrees.

The C7–sagittal vertical axis (SVA) measured a +265 mm (Fig. 1B). He had implants posteriorly from T10 to S1 with 2 degrees of lumbar kyphosis and a pelvic incidence of 51 degrees and a pelvic tilt of 30 degrees. The surgical plan was for a revision posterior spinal reconstruction from T10 to the sacrum and ilium, with an L5 PSO.

Fig. 1. Clinical picture (A) and lateral total body radiograph (B). Note that the patient had a pitched-forward posture with hip flexion of approximately 45 degrees.

Fig. 2. Patient was positioned in a prone position on a Jackson table without thigh pads, but with a cushioned pillow placed under his thighs to accommodate his flexed hip contracture.

In the operative room, he was positioned in a prone position on a Jackson (OSI) frame. In order to accommodate his fixed hip flexion contractures, thigh pads were not used and pillows were placed under the thighs bilaterally (Fig. 2). Blankets and pillows were placed around his knees to support his legs. For TcMEP monitoring, subdermal needle electrodes were placed into the iliopsoas, quadriceps femoris, tibialis anterior, medial gastrocnemius, abductor halluces brevis, and extensor hallucis longus muscles. Preoperative neuromonitoring showed well-formed TcMEPs in the bilateral lower extremities (Fig. 3A). Ten minutes after the incision, bilateral vastus medialis TcMEP responses were lost during spine exposure whereas all other data remained normal including the tibialis anterior responses (Fig. 3B). After the electrode placement was checked and confirmed to be in good position, the bilateral lower extremities were repositioned. His knees were flexed into a sling device that allowed for a marked increase in hip flexion. Five minutes after the repositioning, bilateral vastus medialis TcMEPs gradually improved (Fig. 3C) and maintained baseline amplitude during the rest of the surgery.

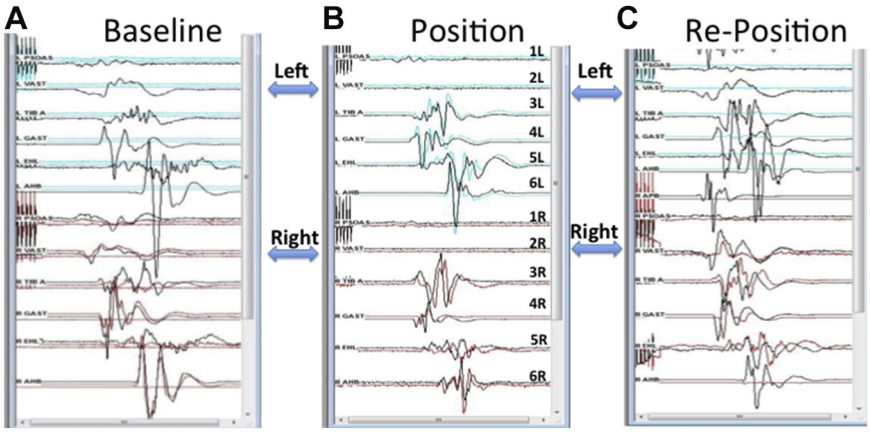

Fig. 3. Intraoperative TcMEP neuromonitoring. (A) Preoperative TcMEP baseline. (B) Loss of bilateral vastus medialis TcMEP signals about 10 minutes after incision. (C) Regain of vastus medialis TcMEP signals after bilateral thigh were positioned into more hip flexion. Double arrow: vastus medialis signal. Signals from the top to bottom: (1) iliopsoas; (2) left vastus medialis; (3) left tibialis anterior; (4) left medial gastrocnemius; (5) left extensor hallucis longus; (6) left abductor hallucis brevis.

Results

No muscle weakness was observed on the immediate postoperative wake-up test. He was discharged postoperative day 6 with intact neurologic examinations and markedly improved posture and alignment (Fig. 4).

Fig. 4. Postoperative clinical picture (A) and total body lateral radiograph (B).

Discussion

Intraoperative prone positioning with hip extension may posturally increase lumbar lordosis [6]. One group confirmed that adult spinal deformity patients had an enhanced lumbar lordosis averaging 18 degrees via prone positioning alone with hip extension [2]. But the hips positioned in extension may cause femoral nerve traction, especially for patients with hip contracture preoperatively, such as the patient in this case report. Even though we did place thigh pads and placed pillows to accommodate the flexed hip contractures, the femoral nerve was still in tension causing the TcMEP signal loss of vastus medialis. Thus, one should consider the balance between obtaining more lordosis with hip extension and relaxing the femoral nerves with hip flexion in these types of patients.

Positioning-related neuromonitoring change not only occurs from nerve roots traction such as the patient in this case report but also from spinal cord stretch, especially relevant for angular kyphosis patients positioned prone [7] during surgery as well as those with any preexisting instability such as ankylosing spondylitis patients with an unstable fracture requiring posterior stabilization.

TcMEPs provide a direct assessment of motor function and are most reliable in detecting ischemic changes to the motor tracts during deformity correction [8-11]. TcMEP is also a reliable and accurate method to detect a single nerve root problem. In animal studies, TcMEP monitoring was sensitive to compressive and retraction force [12-14].

The majority of deformity spinal surgeons now use intraoperative neurophysiological monitoring during spinal reconstructive procedures to limit the risk of inadvertent neurologic injury. However, there are still a lot of variations in the neuromonitoring protocols. Some do not get preoperative baselines [15]; some only monitor one limb; and some only monitor the distal muscle groups such as extensor hallucis longus and tibialis anterior but leave the more proximal

muscles like the iliopsoas or quadriceps unmonitored. From this case report, we understand the importance of monitoring the proximal muscle groups, especially for patients with severe sagittal imbalance and hip flexion contractures.

In conclusion, we present a case of pure position-induced quadriceps TcMEP signal loss of a patient with severe sagittal imbalance and hip contractures. Surgeons should pay more attention to lower extremity and hip positioning in this kind of patients and TcMEP monitoring of bilateral proximal thigh muscles is highly recommended.

Key points

- For patients with fixed sagittal imbalance and hip contractures, attention needs to be placed for hip and lower extremity positioning.
- Insufficient hip flexion can cause increased femoral nerve tension, leading to TcMEP signal loss in the muscles supplied by the femoral nerve.
- TcMEP monitoring of bilateral proximal thigh muscles is highly recommended with consideration for hip and lower extremity repositioning intraoperatively when data degradation does not correlate with intraoperative procedures.

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