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Clinical Study

Neurophysiological changes during shortening osteotomies of the spine

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Abstract

BACKGROUND CONTEXT: Kyphotic deformities with sagittal imbalance of the spine can be treated with spinal osteotomies. Those procedures are known to have a high incidence of neurological complications, in particular at the thoracic level. Motor evoked potentials (MEPs) have been widely used in helping to avoid major neurological deficits postoperatively. Previous reports have shown that a significant proportion of such cases present with important transcranial MEP (Tc-MEP) changes during surgery with some of them being predictive of postoperative deficits.

PURPOSE: Our aim was to study Tc-MEP changes in a consecutive series of patients and correlate them with clinical parameters and radiological changes.

STUDY DESIGN/SETTING: Retrospective case notes study from a prospective patient register.

PATIENT SAMPLE: Eighteen patients undergoing posterior shortening osteotomies (nine at thoracic and nine at lumbar levels) for kyphosis of congenital, degenerative, inflammatory, or post-traumatic origin were included.

OUTCOME MEASURES: Loss of at least 80% of Tc-MEP signal expressed as the area under the curve percentual change, of at least one muscle.

METHODS: We studied the relation between outcome measure (80% Tc-MEP loss in at least one muscle group) and amount of posterior vertebral body shortening as well as angular correction measured on computed tomography scans, occurrence of postoperative deficits, intraoperative blood pressure at the time of the osteotomy, and hemoglobin (Hb) change.

RESULTS: All patients showed significant Tc-MEP changes. In particular, greater than 80% MEP loss in at least one muscle group was observed in five of nine patients in the thoracic group and four of nine patients in the lumbar group. No surgical maneuver was undertaken as a result of this loss in an effort to improve motor responses other than verifying the stability of the construct and the extent of the decompression. Four patients developed postoperative deficits of radicular origin, three of them recovering fully at 3 months. No relation was found between intraoperative blood pressure, Hb changes, and Tc-MEP changes. Severity of Tc-MEP loss did not correlate with postoperative deficits. Shortening of more than 10 mm was linked to more severe Tc-MEP changes in the thoracic group.

CONCLUSIONS: Transcranial MEP changes during spinal shortening procedures are common and do not appear to predict severe postoperative deficits. Total loss of Tc-MEP (not witnessed in our series) might require a more drastic approach with possible reversal of the correction and wake-up test. © 2014 Elsevier Inc. All rights reserved.

Keywords: Spinal osteotomy; Kyphosis; Spinal deformities; Intraoperative monitoring; Sagittal imbalance

FDA device/drug status: Approved for this indication (pedicle screws).

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EVIDENCE & METHODS

Context
Surgeries for kyphosis that result in shortening of the spine risk neurological injury. The authors present their experience.

Contribution
In this case series report of 18 cases, the authors report TcMEP changes in all patients and >80% loss in at least one muscle group in half of the patients. Half of these had post-op radicular deficits (4 of 18 total), only one of which persisted over time.

Implications
TcMCP changes were common but did not appear to predict severity of post-op deficit. Their use and the implications of changes on surgical practice will need to be further defined for this patient population.

Introduction

Kyphotic deformities with sagittal imbalance of the spine can have a significant impact on function and quality of life [1]. Correction of such deformities can be performed with posterior osteotomies, usually in the form of a pedicle subtraction osteotomy (PSO) procedure. Such procedures are nevertheless linked to neurological risks [2–5]. For that reason, intraoperative neurophysiological monitoring is perceived by most surgeons as a necessary security measure. Although several publications looked at neurological and neurophysiological changes during this type of procedure [2–5], to our knowledge the relation of acute cord shortening and neurophysiological changes has not been reported in vivo but only in an animal model [6].

The aim of our study was to examine transcranial motor evoked potential (Tc-MEP) changes in a series of patients undergoing posterior spinal shortening osteotomies and correlate them with radiological measures and clinical parameters.

Materials and methods

Eighteen consecutive patients undergoing shortening osteotomies for sagittal imbalance within a 3-year period were prospectively followed for an average of 24 months. Male-to-female ratio was 0.64. Mean age was 64 years.

Diagnosis included post-traumatic, congenital, and inflammatory kyphosis cases (for full details, see the Table). Surgery was performed at lumbar level in nine patients and thoracic level in further nine patients. Only patients undergoing correction at a single level were included. Multiple Smith-Peterson or Ponte-type osteotomies were not included in this data set. Institutional review board approval was sought for this study.

Anesthetic technique

Anesthesia was induced with intravenous propofol. Nondepolarizing muscle relaxants were used for intubation only. Anesthesia was maintained using continuous propofol infusion. No wake-up test was performed.

Surgical technique

All surgeries were performed as single-stage procedures by a single surgeon (CS) through a posterior incision in a prone position with the head stabilized with a Mayfield clamp (Integra LifeSciences Corporation, Plainsboro Township, NJ, USA). The spine was instrumented with pedicle screws cranially and caudally before the osteotomy procedure. Pedicle subtraction osteotomies were performed after complete removal of the posterior arch of the level involved as well as generous superior and inferior levels of decompression. The spine was stabilized with a short rod unilaterally before the osteotomy, thus avoiding translation during the reduction maneuver. The reduction was assisted by extension of the operating table while simultaneously applying pressure on the spinal processes on either side of the osteotomy until closure was obtained. Any remaining gap was closed through compression on the rods whenever possible depending on the bone quality so as to avoid implant loosening. Two patients underwent posterior vertebral column resection osteotomies and insertion of a 10-mm interbody cage through the same posterior approach. All patients underwent postoperative computed tomography scan examinations of the spine.

Intraoperative monitoring technique

Transcranial muscle motor evoked potentials were recorded from two lower limb muscles (tibialis anterior and gastrocnemius) and one upper limb muscle (first interosseous) as an internal control. Transcranial electrical stimulation consisted of a 500-Hz train of five to seven 1-millisecond biphasic stimulations applied using two corkscrew electrodes placed at C3 and C4 derivations. Stimulation amplitude (50–150 V) was chosen to evoke a consistent motor response as measured using the area under the curve. In most cases, Tc-MEPs were combined with somatosensory evoked potentials (SSEPs) of the lower limbs but not analyzed for the purpose of this study, given their known limitations. In addition, Tc-MEP signal was recorded at a hand muscle in 10 patients.

Radiological measurements

Shortening of the posterior vertebral wall was measured at the level of the osteotomy for each case and expressed both as an absolute value and a percentual change related to the vertebral height. All measurements were digitally carried out on the PACS of our institution with the help of the relevant software tools (Client Carestream PACS; Carestream Health Suisse SA, Gland, Switzerland).

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