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Weak or Absent Ankle Dorsiflexion: The Most Sensitive Indicator of Motor Deficits Following Spinal Deformity Surgery

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Abstract

Study Design: A retrospective, single-center review of all spinal deformity surgeries at the authors' institution.
Objectives: To determine the most sensitive physical examination finding as a test for motor deficits after spinal deformity surgery.
Background: Despite both reported false negatives of neuromonitoring and the potential for development of delayed deficits, the literature has paid relatively little attention to the postoperative evaluation and monitoring of neurologic integrity after correction of spinal deformity.
Methods: A retrospective, single-center review of 1,274 consecutive spinal deformity surgeries from 2003 to 2011 was performed. Patients with limited neurologic function or an inability to undergo an examination preoperatively were excluded. A total of 1,023 patients were included in the analysis. Records were analyzed for postoperative motor deficit.
Results: A total of 12 patients had a motor deficit in the perioperative period. Eight had a deficit on the immediate postoperative exam; 6 had absent ankle dorsiflexion and 2 had weak ankle dorsiflexion; And 4 developed a delayed motor deficit: 3 with absent ankle dorsiflexion and 1 with weak ankle dorsiflexion. There were no cases of a motor deficit in which ankle dorsiflexion was not weak or absent. Of the 12 patients with a deficit, 8 had complete loss of motor function. Of the 4 patients with incomplete neurologic injury, loss of ankle dorsiflexion was the only common physical examination finding. In this review, ankle dorsiflexion was 100% sensitive (12 of 12) and 100% specific (1,011 of 1,011) for neurologic injury.
Conclusions: Ankle dorsiflexion was the most sensitive test for lower extremity motor function after spinal deformity surgery, both for immediate and delayed deficits. Without testing ankle dorsiflexion specifically, neurologic motor deficits may be missed.

Keywords: Neurologic injury; Spinal deformity; Neuromonitoring

Introduction

With correction of spinal deformity, there is a risk of the rare but devastating complication of neurologic injury. Reported prevalence of spinal cord injury after scoliosis surgery varies from .3% to 1.4% [1-3]. The etiology of these deficits includes direct trauma to the cord with placement of instrumentation, distraction or compression of the spinal cord with curve correction, cord ischemia from hypotension, and postoperative epidural hematoma [2,4,5]. Consequently, patients undergoing corrective surgery for spinal deformity are at risk for developing neurologic injury both intraoperatively and postoperatively.

Intraoperative monitoring for neurologic injury has been the topic of numerous articles and much debate. Since the Stagnara wakeup test was initially described in 1973 as an intraoperative assessment of neurologic function [7], there have been significant advancements in the field of neuromonitoring. Use of somatosensory-evoked potentials (SSEP) has been combined with monitoring of motor-evoked potentials (MEP), increasing the sensitivity and specificity of intraoperative monitoring and allowing timely intervention [2,6,8,9]. Nevertheless, neuromonitoring is not without potential pitfalls and remains reliant on the qualifications and experience of neuromonitoring personnel and effective communication of the surgical team [6,10].

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Despite both reported false negatives of these methods and the potential for development of delayed deficits, the literature has paid relatively little attention to the postoperative evaluation and monitoring of neurologic integrity after correction of spinal deformity [6,9,11-13]. In cases of adolescent idiopathic scoliosis, a complete neurologic examination of the lower extremities after surgery, particularly of the more proximal muscle groups, is often complicated by pain or by sedation from pain medication. In younger patients or those with developmental delay, difficulty with following commands and selective motor control make the examination more challenging. The purpose of this study was to determine the most sensitive physical examination finding as a test of neurologic injury after spinal deformity surgery.

Materials and Methods

The authors performed a retrospective, single-center review of 1,274 consecutive spinal surgeries from 2003 to 2011. Neuromuscular patients were included unless they were unable to comply with an examination because they had either 1) no or minimal purposeful movement of their lower extremities or 2) such limited cognitive ability that they could not reliably follow commands. One patient had an osteotomy of the clavicle at the time of the spinal deformity surgery and developed an isolated motor deficit in the upper extremity attributed to the effect of the correction of the Sprengel deformity on the brachial plexus, and so was excluded from analysis. The remaining 1,023 patients were included in this review. There were 772 posterior-only spinal fusions, 28 anterior-only spinal fusions, 39 combined anterior and posterior spinal fusions, 120 revisions, and 64 other procedures. The diagnoses for these patients were recorded (Fig. 1). There were 391 male and 632 female patients. All patients were cared for at the authors' pediatric hospital. Patients' age distributions were as follows: less than 5 years, 62 patients; 5 to 9 years, 104; 10 to 14 years, 529; 15 to 19 years, 312; and 20 or more years, 16.

Records were analyzed for the presence of dorsiflexion postoperatively and for the detection of any neurologic deficit during the postoperative course. At the authors' institution, a wakeup test at the conclusion of the procedure is part of the standard protocol before leaving the operating room, and was performed in all cases. In addition, in cases in which there was intraoperative loss of neuromonitoring signals that did not respond to modifications (decrease in correction, raising of blood pressure, etc), a wakeup test was performed during the procedure. During the study period, all procedures were performed with MEP and SSEP monitoring. The authors' standard postoperative motor examination consists of testing hip flexion, knee flexion and extension, ankle dorsiflexion, and plantar flexion. Sensation is tested in the thigh, medial knee, medial ankle, great toe, and lateral foot. In very young patients (generally younger than 3 years), this is modified to observing them demonstrating these movements actively, and the sensory examination is excluded. All patients were examined by attending surgeons. Patients with a neurologic deficit were reviewed further for the time at which the neurologic injury was first appreciated and whether there was complete or incomplete spinal cord injury. In the cases that were incomplete, the researchers reviewed notes regarding which muscle groups were affected, and to what extent. The clinical course was reviewed and any intervention that occurred was recorded. Notes from the hospital stay as well as clinic visits after surgery were reviewed, and the presence or absence of improvement was recorded.

Results

A total of 12 patients (1.2%) had a motor deficit in the perioperative period (Fig. 2) that was not present on the preoperative exam. Eight had a deficit on the immediate

Diagnostic Group	Number of Patients
Idiopathic Scoliosis	478
Congenital	148
Syndrome	124
Kyphosis/Kyphoscoliosis	82
Early Onset Scoliosis	58
Neuromuscular Scoliosis	57
Spondylolisthesis	37
Pathologic	21
Fracture/Trauma	18

Fig. 1. Diagnosis for patients undergoing spinal deformity surgery.

	Ankle Dorsiflexion Full	Ankle Dorsiflexion Weak	Ankle Dorsiflexion Absent
Neuro Intact	1011	0	0
Post-op Neuro Deficit: Immediate	0	2	6
Post-op Neuro Deficit: Delayed	0	1	3

Fig. 2. Postoperative (Post-op) neurologic deficits in the 1,023 cases reviewed: 12 developed a neurologic deficit.