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Clinical Study

Rare true-positive outcome of spinal cord monitoring in patients under age 4 years

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Abstract

BACKGROUND CONTEXT: Intraoperative monitoring (IOM) is becoming an essential component in spinal surgery, but there are many different viewpoints about it in patients under age 4 years.
PURPOSE: This study aims to report some IOM features in children under age 4 years.
DESIGN/SETTING: This is a retrospective cases study.
PATIENT SAMPLE: A total of 37 children (35.76 months±1.47) and 120 patients with adolescent idiopathic scoliosis (AIS, 14.2 years) were recruited between September 2012 and December 2014.
OUTCOME MEASURES: Relevant monitoring changes were identified as transcranial motor evoked potentials (MEP) or somatosensory evoked potentials (SEP) loss associated with high-risk surgical maneuvers.
METHODS: Motor evoked potential, SEP, and free-run electromyography (free-run EMG) were used for IOM. The IOM parameters (amplitude, latency, and waveform) and monitoring outcomes (signal changes, true positive, and false positive) were mainly analyzed in the patients under age 4 years.
RESULTS: All young patients presented stable MEP (90.6 μV±20.3) and SEP (1.01 μV±0.3) baseline. The baseline success rate (100%) was the same as that in patients with AIS; however, the MEP amplitude of young patients was significantly lower than that of patients with AIS (90.6 μV±20.3 vs. 312.1 μV±25.2, n=120; **p<.01) under the same stimulus parameters. Moreover, children under age 4 years have more monitoring changes (18.9%, 7 of 37), but true-positive findings are rare (0%) in our population.
CONCLUSIONS: Intraoperative monitoring baseline can be obtained satisfactorily in children under age 4 years, but true-positive findings are rare; meanwhile, low MEP amplitude and poor waveforms are common.

Keywords: Intraoperative monitoring; MEP; Monitoring baseline; SEP; Spinal deformity; True-positive findings

Introduction

Intraoperative monitoring (IOM) is becoming an essential component in spinal surgery. Among many monitoring methods, transcranial motor evoked potential (MEP), somatosensory evokedpotential (SEP), and free-run electromyography (free-run EMG) have been proven to be effective techniques to prevent spinal cord injury during spinal deformity surgery [1–7]. However, the obtained rate of MEP baseline including 86% [8] even 55% [9] for young children has not been satisfactory. These data may mislead us into thinking that reliable MEP signals are unlikely to be recorded in very young children. In addition, the Stagnara wake-up test is often used as the "gold standard" to corroborate IOM changes, but it is difficult to get children less than 4 years to cooperate during surgery. Here we will explore the features of IOM in pediatric patients.

Patients and methods

Patients

A consecutive series of 37 young children (14 girls and 23 boys; from 24 to 47 months) between September 2012 and

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EVIDENCE & METHODS

Context

Intraoperative spinal monitoring has gained popularity in recent years and is used extensively in complex spinal procedures with high risk for iatrogenic neurologic injury. The authors maintain that the utility of this procedure in very young patients (age < 4) has yet to be ascertained.

Contribution

This was a retrospective review of 37 young children as compared to 120 adolescents. Patients less than 4 seem to have had a number of concerning monitoring changes, including low MEP amplitude and poor waveforms. No true positive findings were detected per the authors' report.

Implications

This study demonstrates that monitoring can be used in patients under the age of 4 but may also serve as a caution to clinicians to expect monitoring changes that may not be indicative of impending neurologic injury. The fact that no true positive findings were detected speaks against the generalization of these study results and is likely due to the small number of patients in the young age group. Based on methodology and limitations, this study presents Level IV data.

—The Editors

December 2014 were enrolled in this study. All patients, composed of congenital kyphoscoliosis (n=10), congenital kyphosis (n=2), and congenital scoliosis (n=25), underwent posterior spinal osteotomy surgery (hemivertebra column resection or vertebral column resection). The general data were presented in Table 1. To analyze the evoked potential waveform and IOM results further in those young children, we also investigated 120 patients with adolescent idiopathic scoliosis (AIS; mean age, 14.2±0.41 years) as a control group.

Intraoperative monitoring

We referred to previous reports for the stimulus and recording parameters of MEP and SEP [10,11]. The IOM were performed using a commercially available neurologic monitoring workstation (Axon Systems Inc., Hauppauge, NY) and subcutaneous needle electrodes. Free-run EMG may be a potential tool for detecting early spinal cord injury [12,13]; thus, bilateral free-run EMG was recorded at abductor hallucis muscles in our patients.

Anesthesia management

General anesthesia was induced with a bolus dose of propofol (3 mg/kg) and fentanyl (2.5 μg/kg) combined with a short-acting muscle relaxant and inhalation agents (sevoflurane or nitrous oxide). No muscle relaxants or sevoflurane agents were given after induction and intubation. Subsequently, maintenance of anesthesia was propofol (5–8 mg/kg/h) based on hemodynamic response; remifentanyl (0.1 μg/kg/min); and a total dose of 5–6 μg/kg fentanyl (intermittent infusion) was used during the whole operation.

Data analysis

The patients' basic characteristics and MEP amplitude were shown as mean±standard error of the mean. One-way analysis of variance was performed to explore the statistical differences. All statistical data were analyzed by using SPSS Statistics software (SPSS version 17.0; SPSS Inc., Chicago, IL, USA) and $p<.05$ was defined as statistically significant difference.

Results

In this study, all patients had stable SEP and MEP baseline (Table 1). Fig. 1 (A–E) shows a representative case of a 26-month-old boy with T12–L1 hemivertebra deformity for con-

Table 1
Demographic and monitoring data for all young patients

Demographic	Mean±SEM	Range (min-max)
Age	35.76±1.47	24–47 mo
Height	96.26±1.66	82–106 cm
Weight	16.94±1.35	9–32 kg
BMI	18.17±1.21	12–31
Operation time	175.08±8.85	120–240 min
Bleeding volume	303.91±30.96	150–600 mL
Male:Female	23:14	

BMI, body mass index.

Table 2
The patients with monitoring changes from our 37 young cases

Pat.	Age (mo)	Gender	Diagnosis	Surgical procedure	Monitoring changes	Monitoring recovery	Monitoring result
1	43	M	CS	T8–L3 T10 and T12 HVR	MEP	Partial	Negative
2	46	F	CS	T5–T10 T7–T8 HVR	MEP	Complete	Negative
3	25	M	CKS	T7–T12 T8–T9 HVR	MEP and SEP	Partial	Negative
4	39	F	CKS	T1–T9 T5–T6 HVR	MEP	Partial	Negative
5	37	F	CS	T4–T10 T7 HVR	MEP and SEP	Complete	Negative
6	40	M	CS	T8–T12 T10 HVR	MEP	Complete	Negative
7	35	M	CKS	T8–L2 T10 HVR	SEP	Partial	Negative

All the seven young patients have valid monitoring baselines (SEP and MEP) without neural axis abnormal or preoperative spinal function deficits. No postoperative neurologic deficits were found.

CS, congenital scoliosis; CKS, congenital kyphoscoliosis; HVR, hemivertebra column resection.