Global Journal of Neurology and Neurosurgery

ISSN: 2449-1942 Vol. 3 (1), pp. 047-050, February, 2015.

http://www.globalscienceresearchjournals.org/

Review

The prognostic value of transcranial electrical stimulation in cervicaldisc herniation surgery with non-myelopathic evidence: A systematic review.

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Accepted 29 January, 2015

Abstract

The study was to evaluate the prognostic value of Transcranial electrical stimulation (TES): including transcranial motor evoked potentials (TcMEPs) and continuous free running electromyography (EMG) monitoring, with the literature review, during anterior cervical discectomy and fusion (ACDF) in cervical disc herniation surgery with non-myelopathic evidence. Methods and results: This is a review article from the 1211 related articles at PubMed search andthe exact search was done using the term - Cervical and Intraoperative monitoring - (last updated on the 15 November 2013). This study investigates one hundred and ninety two (192) patients (97 male and 95 female) (1, 5, 22).The mean age was 47.95 ± 13.95, range: 3–84 years. Fourteen nine (49) were eligible for inclusion undergoing ACDF the treatment of cervical radiculopathy due to CDH with non-myelopathic evidence. A 41-50 % increase in TcMEP amplitude was the threshold for the discrimination of patients with excellent (Odom's scale I) postoperative outcome. When the increase of TcMEP amplitude was ≤ 10-11% the patient's outcome was fair. The pain was assessed preoperative and postoperative according to visual analog score (VAS). The present study considering the literature review, investigates the prognostic value of TES during ACDF in cervical disc herniation surgery with non-myelopathic evidence. TES not only ensure the neural structure integrity preventing intraoperative damages, but also may become an important instrument to a better clinical management. The possibility of getting clinical outcome information immediately after the procedure, may add to TES an important prognostic value along with the ensuring of the neural structure integrity.

Keywords: Cervical disc hearniation, intraoperative monitoring, MEP

INTRODUCTION

Cervical radiculopathy due to cervical disc herniation (CDH) is a common disorder and can be treated surgically when symptoms are refractory to the conservative management. As a result of the advances in surgical techniques, most patients with CDH can have a suitable improvement of neurologic status and return to normal daily life (1). Anterior cervical microdiscectomy and fusion (ACDF) has been established as a successful operative method for the treatment of cervical radiculopathy due to CDH (2).

Intraoperative neurophysiological monitoring has been proposed as a method to detect early neurological deficit caused by mechanical stress, surgical manipulation, as well as hypotension and is becoming a standard of care for many spinal cord surgeries (28-32,4-11) Also, the effectiveness of the trancranial electrical motor evoked

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Table 1: baseline characteristics of participants

	ACDF n=192	**ACDF with Non-myelopathic evidence** n=49
Age (years)	47.95 ± 13.95	45.8±14.2
Sex (male)	97	25

Table 2: Outcome

	Increase of TcMEP amplitude (%)	**Sensitivity (%)**	**Specificity (%)**
Quality of life Odom's scale (I-IV)			
Odom I n=15	41	77	89
Odom III n=5	≤11	100	94
Decrease of the Post-op. pain VAS (1-10)	2.39±1.17		

potentials (TcMEPs) and somatosensory evoked potential (SSEP) during spinal cord surgeries, has been established by several studies (12,13,33-40). The incidence of postoperative C-5 spinal nerve root palsy following decompressive cervical spine surgery has been reported to be as high as 12% for anterior procedures (3,23,41,42) but the precise etiology of this paralysis still remains unclear. The prevention and intraoperative detection of this palsy have been considered as major goals during cervical microdiscectomy (23). The exact time of recovery and pain relief after ACDF for treatment of cervical radiculopathy due to CDH is equally important and until now undetermined (12). Thus, most patientsvisit their doctor one or more times a month after surgery with residual symptomatology, without being given any reliable answer about their outcome.

The present systematic review, investigates the prognostic value of TES during ACDF in cervical disc herniation surgery with non-myelopathic evidence. The possibility of getting clinical outcome information immediately after the procedure, may add to TES an important prognostic value along with the ensuring of the neural structure integrity.

METHODOLOGY

Search Strategy for Identification of Studies

PubMed searches were performed using a wide array of terms pertinent to the cervical and MEP (motor evoked potential). The exact search was done using the term - Cervical and Intraoperative monitoring - (last updated on the 15 November 2013). We included all published studies over the last 39 years (from 1976). The reference lists of eligible articles and pertinent reviews were scrutinized. Retrieved articles were evaluated by two independent investigators for eligibility and disagreements were solved by consensus after discussion with a third investigator.

Data Extraction and Definitions

This is a review article. From each eligible study we extracted the following information: author; journal; year; design; age of the study population; racial descent; analyses had been adjusted for multiple comparisons; whether analyses were acknowledged to be post hoc; and details on the definitions of all reported analyses.

From the 1211 related articles at PubMed search, we excluded case reports analyzing less than 1 cases; non-English speaking publications and reports not related to the humans; traumatic injury to the spinal cord; cervical myelopathy; cancer affecting the cervical spine cord; peripheral vascular disease or peripheral neuropathy, hormonal and any other psychological disorders which can involve in cervical radiculopathy; diabet; rheumatoid arthritis. The clinical outcome was followed by the visual analog scale (VAS) at 12-month follow-up and Odom's scale elicited from any patient preoperative and the 1,6,12 months postoperative. Information was captured on all analyses performed and reported in any format and in any level of detail in the text, figures, tables, or supplementary material.

RESULTS

This study investigates one hundred and ninety two (n=192) patients (97 male and 95 female) (12-14).The mean age was 47.95 ± 13.95 years, range: 3–84 years. Forty nine (n=49) were eligible to undergo ACDF for treatment of cervical radiculopathy due to CDH with non-myelopathic evidence (Table 1). There was an increase in TcMEP amplitude after ACDF in all patients. The usage of the ROC curve showed that a 41-50 % increase (mean 45,5%) in TcMEP amplitude was the threshold for the discrimination of patients with excellent (Odom's scale I) postoperative outcome (sensitivity 77%, specificity 89%) (Table 2). When the increase of TcMEP amplitude was ≤10-11%

(mean 10,5%) the patient's outcome was fair (Odom's scale III) (sensitivity100%, specificity 94%) (Table 2). The pain was assessed -preoperatively and postoperatively- according to visual analog score (VAS). There was an improvement of VAS at 12-month follow-up, using the Wilcoxon signed-rank test. In these cases TcMEPs were recorded in order to identify changes in amplitude, but no change of TcMEPs, indicative of neurological harm, was detected. A transient or permanent motor deficit during ACDF was not observed at any case.

DISCUSSION

Neurophysiological monitoring techniques have been developed for intraoperative monitoring (15-17). The application of monitoring provides to the surgeon an efficient surgical instrument (15). Santiago-Pırez et al. found continuous EMG recording to be a simple technique that provided constant information about spinal root function (18). In the present study we assessed the prognostic value of combined TcMEP and EMG monitoring during ACDF for CDH without myelopathy evidence.

Neurophysiologic monitoring of TES has been performed during spine surgery to assess the function of the spinal cord and identify corticospinal tract cord injury (23-25). Somatosensory evoked potentials (SSEP) may also be used to monitor spinal cord function. SSEPs are simply recordable without adjusting the anaesthetic regimen; however there are reports of false negative results in up to 25% (19).

TcMEPs evaluate the pyramidal tract and, in combination with continuous EMG monitoring, can supply an immediate feedback of motor pathways reliability throughout the operation (20). Thus, with a electrically stimulation to the scalp, an electrical current within the brain's motor cortex is produced, which then activates or progresses through the motor pathways. These motor pathways primarily represent the lateral corticospinal tract, and are placed in the lateral and the ventral funiculi of the spinal cord. As the ventral and the dorsal spinal cords have separate blood supply, with very limited collateral flow, an anterior cord syndrome (paralysis or paresis with some preserved sensory function) is a possible surgical sequel (13, 26, 27). Despite that, the selection and management of anesthetic agents may prevent the diagnosis of intraoperative neural damage. TcMEPs are affected by the use of halogenated agents, nitrous oxide and the level of neuromuscular blockade (21). At a minimum alveolar concentration (MAC) of 1.0 or higher, TcMEP are often not valid.

In defining the level of increase, in some research the 50% criterion was proposed, meaning that TcMEPs are measured constant if changes are less than 50% in amplitude (22). In our study TcMEPs amplitude ranges from 41 to 50% and when the decrease of amplitude was ≤ of 10 to 11% the patient's outcome was fair.

This review study proposes an additional prognostic role for the estimation of a patient's clinical improvement at cervical disc herniation surgery with non-myelopathic evidence. TES including TcMEPs and continuous free running electromyography (EMG), with the information immediately after the procedure, except from preventing the neural structure damages, may also become an important 'consultant' to a better clinical management. The present study has several limitations. First, the number of patients was relatively small, despite the fact that a literature review in the large amount of related articles was conducted. Second, VAS score was not assessed in all included studies and neck pain from radicular pain were not differentiated.

CONCLUSION

TES including TcMEPs and continuous free running electromyography (EMG), with the information given immediately after the ACDF in cervical disc herniation surgery, not only ensure the neural structure integrity preventing intraoperative damages, but also may become an important instrument to a better clinical management. Thus, TES obtain a significant prognostic value of the clinical outcome. There is a need to verify these observations, despite the fact that a literature review in the big amount of related articles was performed, in a larger series, to further estimate the method's reliability.

Conflicts of Interest

The authors declare that they have no financial or other conflicts of interest in relation to this research and its publication.

Authors' Contributions

All authors read and approved the final manuscript.

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