Gait & Posture 38 (2013) 1–7

Contents lists available at SciVerse ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Review

The assessment of cervical sensory motor control: A systematic review focusing on measuring methods and their clinimetric characteristics

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ARTICLE INFO

Article history:
Received 26 January 2012
Received in revised form 3 October 2012
Accepted 10 October 2012

Keywords:
Cervical sensorimotor control
Head repositioning accuracy
Reliability
Validity
Measurement

ABSTRACT

Background: Cervical sensorimotor control (CSMC) becomes increasingly important in the assessment and treatment of patients with neck pain. This review aims to compare commonly used CSMC measuring methods in terms of required tasks, measuring device and clinimetric properties.
Search methods: A systematic review of two databases, followed by methodological quality assessment (CBO guidelines).
Results: The methodological quality of 34 included articles was generally good (five to seven out of eight), the inter-rater agreement was excellent ($\kappa_w = 0.966$, $p < 0.01$). Following tasks were found: head repositioning accuracy to the neutral head position (HRA-to-NHP) and to a target position (HRA-to-target), a virtual reality test, a continuous linear movement technique (CLMT) and an object following non-linear movement technique (NLMT) (The Fly™). Test–retest reliability was fair to excellent (ICC 0.35–0.87) for the HRA-to-NHP, very bad to excellent (ICC 0.01–0.90) for the HRA-to-target, fair to good (ICC 0.25–0.77) for the virtual reality test and moderate to excellent (ICC: 0.60–0.86) for The Fly™. The reliability of the CLMT was not documented. The HRA-to-NHP, The Fly™ and the CLMT can discriminate between patients with neck complaints and controls (discriminant validity). Currently, only The Fly™ can discriminate between different patient populations (post-traumatic and non-traumatic neck pain). The sensitivity, specificity and responsiveness of the methods have to be assessed in future research.
Conclusions: The dynamic method The Fly™ appears to be more reliable than the HRA-to-NHP and is able to discriminate between different patient populations. The diagnostic potential is to be confirmed in future research.

1. Introduction

Cervical sensorimotor control (CSMC) becomes increasingly important in the assessment and treatment of patients with neck pain, since rehabilitation programs, including CSMC exercises, have resulted in an improvement of CSMC, but also in alleviation of neck complaints [1].

The sensorimotor system incorporates afferent, efferent and central integration and processing involved in maintaining functional joint stability [2]. Sensorimotor control depends on a continuous flow of sensory information to the different levels of the central nervous system [2].

To obtain a stable upright posture, one relies on afferent information from the vestibular, visual and proprioceptive systems, which converge in several areas throughout the central nervous system [3].

The importance of the cervical spine in providing proprioceptive input is reflected in the amount of cervical mechanoreceptors and their central and reflex connections with the vestibular, visual and central nervous system. Cervical muscles, and in particular the suboccipital muscles, contribute to the transmission of afferent and efferent information to and from the central nervous system [3].

In the past 20 years various measuring methods have been used to measure CSMC. These measuring methods seem similar, but differences in the required task or in the technique used to quantify the measurements make it hard to compare test results. Moreover, it is unclear whether the different measuring methods are equally reliable and valid and what would be the preferred method.

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http://dx.doi.org/10.1016/j.gaitpost.2012.10.007

2. Aim

The aim of this review is to compare commonly used CSMC measuring methods in terms of required tasks, measuring device and clinimetric properties.

3. Methods

3.1. Search strategy

An extended search strategy was developed by identifying all potentially relevant keywords, categorizing these terms into specific combinations. This search strategy was used in two different electronic databases: PubMed and Science Direct.

3.2. Electronic searches

PubMed and Science Direct were searched using the above mentioned search strategy. The search strategy was limited to human studies published between 1991 and 2011.

3.3. Selection criteria

The review was restricted to studies in English. Wide inclusion and exclusion criteria were used to avoid limitation of potentially relevant papers.

The inclusion criteria were: studies with adult populations ($\geq$18 years old), dealing with the assessment of CSMC.

Studies were excluded in case of patient reports, case studies and when focusing on treatment rather than on assessment. Articles dealing with evaluation of global sensory motor control during walking, standing balance or vestibular pathologies were excluded.

3.4. Data extraction and management

Two reviewers performed the search to avoid selection bias. The first is appointed as scientist (MSc in rehabilitation sciences, pre-doctoral student) and the second reviewer is a co-worker (BSc in rehabilitation sciences). Relevant studies where identified, using the a priori defined in- and exclusion criteria. After inclusion the articles' methodological quality was assessed by both reviewers independently.

First, articles were selected based on title and abstract. Second, the selected articles underwent a full text screening. Third, the methodological quality of the included articles was assessed using the CBO guidelines [4]. The results of both reviewers were compared and the inter-rater agreement of this comparison was calculated.

4. Results

4.1. Literature search results

After the initial search and selection based on title and abstract, 57 articles were retained. Based on the full text screening 34 articles were selected for inclusion (Fig. 1). The methodological quality of the selected articles was generally good with scores mostly ranging from five to seven out of eight. The inter-rater agreement was excellent ($\kappa_w = 0.966$, $p < 0.01$).

4.2. Study results

Five CSMC measuring techniques were found. Three methods can be considered as repositioning tasks and two methods can be considered as trajectory registrations.

4.2.1. Required task

The most commonly used procedure is the head repositioning accuracy to the neutral head position (HRA-to-NHP), first described by Revel et al. [5]. During this procedure the subject is seated with backrest. The subject is blindfolded to exclude visual input and wears a helmet with on top a light beam pointing at a target 90 cm in front of the subject. The subject is instructed to face the target straight ahead and to memorize this position, to

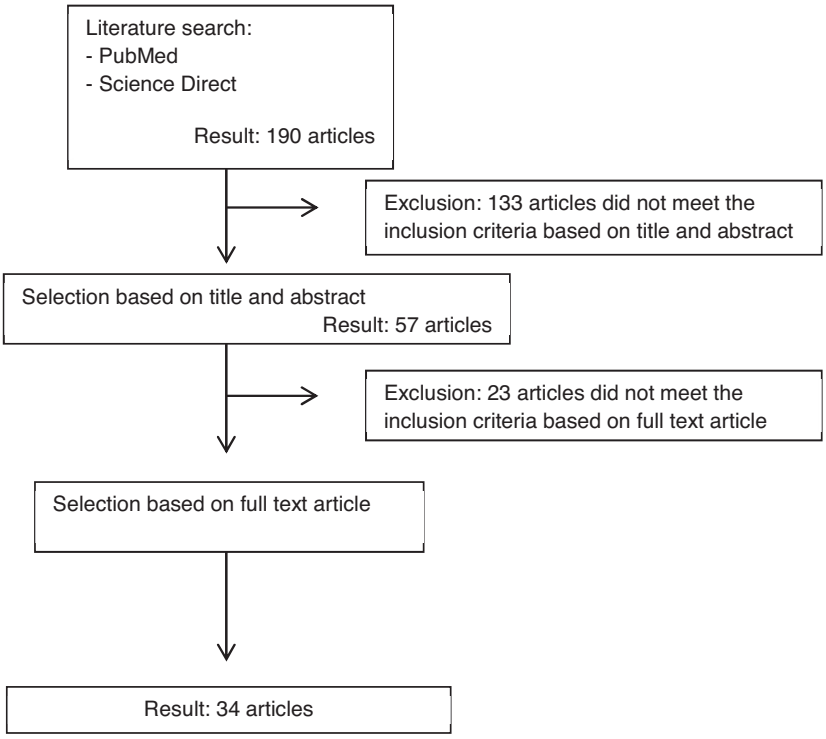

Fig. 1. Selection procedure articles.