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Systematic review

Joint position sense error in people with neck pain: A systematic review

J. de Vries [a, b, *], B.K. Ischebeck [a, c, 1], L.P. Voogt [b, 2], J.N. van der Geest [a, 3], M. Janssen [a, 4], M.A. Frens [a, d, 5], G.J. Kleinrensink [e, 6]

[a] Department of Neuroscience, Erasmus MC, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands
[b] Department of Physical Therapy, Rotterdam University of Applied Sciences, Rochussenstraat 198, 3015 EK Rotterdam, The Netherlands
[c] Spine and Joint Centre, Noordsingel 113, 3035 EM Rotterdam, The Netherlands
[d] Erasmus University College, Rotterdam, P.O. Box 1738, 3000 BR Rotterdam, The Netherlands
[e] Department of Neuroscience-Anatomy, Erasmus MC, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands

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ABSTRACT

Background: Several studies in recent decades have examined the relationship between proprioceptive deficits and neck pain. However, there is no uniform conclusion on the relationship between the two. Clinically, proprioception is evaluated using the Joint Position Sense Error (JPSE), which reflects a person's ability to accurately return his head to a predefined target after a cervical movement.
Objectives: We focused to differentiate between JPSE in people with neck pain compared to healthy controls.
Study design: Systematic review according to the PRISMA guidelines.
Method: Our data sources were Embase, Medline OvidSP, Web of Science, Cochrane Central, CINAHL and Pubmed Publisher. To be included, studies had to compare JPSE of the neck (O) in people with neck pain (P) with JPSE of the neck in healthy controls (C).
Results/findings: Fourteen studies were included. Four studies reported that participants with traumatic neck pain had a significantly higher JPSE than healthy controls. Of the eight studies involving people with non-traumatic neck pain, four reported significant differences between the groups. The JPSE did not vary between neck-pain groups.
Conclusions: Current literature shows the JPSE to be a relevant measure when it is used correctly. All studies which calculated the JPSE over at least six trials showed a significantly increased JPSE in the neck pain group. This strongly suggests that 'number of repetitions' is a major element in correctly performing the JPSE test.

1. Introduction

The primary measure to clinically operationalize cervical proprioception is the Joint Position Sense Error (JPSE) (Armstrong et al., 2008; Strimpakos, 2011). Joint position sense, an individual's ability to reproduce and perceive previous predetermined positions or ranges of motion of a joint, is a major component of proprioception. The error people make whilst reproducing the predefined position is defined as the JPSE. Recently, several studies on the relation between neck pain and JPSE have been published (Woodhouse and Vasseljen, 2008; Cheng et al., 2010; Chen and Treleaven, 2013).

Cervical proprioception is the sense of position of the head or neck in space, describing the complex interaction between afferent and efferent receptors to monitor the position and movement

* Corresponding author. Tel.: +31 010 7945556; fax: +31 010 7946801.
E-mail addresses: j.devries.3@erasmusmc.nl (J. de Vries), b.ischebeck@erasmusmc.nl (B.K. Ischebeck), l.p.voogt@hr.nl (L.P. Voogt), j.vandergeest@erasmusmc.nl (J.N. van der Geest), m.janssen.1@erasmusmc.nl (M. Janssen), m.frens@erasmusmc.nl (M.A. Frens), g.kleinrensink@erasmusmc.nl (G.J. Kleinrensink).
[1] Tel./fax: +31 010 4642211.
[2] Tel.: +31 010 7945556; fax: +31 010 7946801.
[3] Tel.: +31 010 7043059; fax: +31 010 7044734.
[4] Tel.: +31 010 7043430; fax: +31 010 7044734.
[5] Tel.: +31 010 7043561; fax: +31 010 7044734.
[6] Tel.: +31 010 7043274; fax: +31 010 7044734.

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(Newcomer et al., 2000). In the cervical spine, this sense has its neurological basis in muscle spindles (Proske and Gandevia, 2012) and, to a lesser extent, in tendon organs (Golgi receptors) (Hogervorst and Brand, 1998), cutaneous receptors, and joint receptors (McCloskey, 1978; Grigg, 1994; Lephart et al., 1997; Proske et al., 2000). The cervical muscles provide information to (Bolton et al., 1998) and receive information from the central nervous system (Kalaska, 1994; Hellström et al., 2005). Afferent information from the cervical muscles converges in the vestibular nuclei, where the head movement-related information from the visual and vestibular system also converges (Corneil et al., 2002). Malmström et al. (2009) showed that accurate head-on-trunk orientation can be achieved without vestibular information. This suggests that proprioceptive information of the cervical spine is important for head-on-trunk orientation. The cervical JPSE is assessed by testing the ability of a blindfolded participant to accurately relocate their head to the trunk relative to a predefined target (often the neutral position of the head) after a cervical movement. Other examples of joint regions in which JPSE has been used for testing proprioception are the shoulder (Anderson and Wee, 2011), the knee (van der Esch et al., 2013), and the ankle (Nakasa et al., 2008).

People with neck pain originating from trauma and people whose neck pain has developed more gradually both seem to have a higher JPSE than people without neck pain (Feipel et al., 2006; Cheng et al., 2010). This implies that an increase in JPSE may not be caused solely by soft tissue damage or neurological impairments following trauma (Revel et al., 1991; Sterling et al., 2003).

Narrative reviews of the literature on cervical JPSE have been published (Armstrong et al., 2008, Strimpakos, 2011). Both reviews give conflicting conclusions concerning the presence of a higher JPSE in people with neck pain. The present study is a comprehensive, systematic overview according the PRISMA guidelines of the literature. It presents the data of the JPSE of the cervical spine caused by neck pain of traumatic and non-traumatic origin in comparison of the JPSE in healthy controls.

2. Methods

The PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009) were used in this systematic literature review to report the method of literature search, appraisal, and presentation of evidence.

2.1. Eligibility criteria

To be included in this systematic review, studies had to report on joint position sense error of the neck (O); and, include participants with neck pain (P), compared to healthy controls (C). It is important to compare the JPSE of people with neck pain with the JPSE of healthy controls because it is assumed that a higher JPSE test reflects aberrant afferent input from the neck (Revel et al., 1991; Heikkilä and Wenngren, 1998; Treleaven et al., 2003; Malmström et al., 2009). Therefor a reference score form healthy controls is a necessity.

2.2. Information sources and search parameters

In order to be as comprehensive as possible, the following databases were searched on December 17th 2014:Embase, Medline OvidSP, Web of Science, Cochrane Central, CINAHL and Pubmed Publisher. Keywords were derived from the research question and transformed to associated “Emtree” terms and free-text words. For Embase, the following Emtree terms were used: sensorimotor integration, sensorimotor function, somatosensory system, somatosensory cortex, balance impairment, motor control, proprioception, body equilibrium, eye movement, proprioceptive feedback, cornea reflex, neck pain, and whiplash injury.

The free-text words were as follows: deep sensitivity, kinesthe*, propriorecep*, propriocep*, kinesio NEXT/1 percept*, cornea*, eye* OR ocular OR cervicoocul* NEAR/3 reflex*, movement*,body, musculoskelet*, postural, NEAR/3 balanc*, equilibr*, sway, control, joint position, head position, neck position, NEAR/3 error*, sense*, reproduc*, abilit*, inaccura*, accura*, replicat*, head NEAR/3 steadiness, balance NEAR/3 impair*, difficult*, neck, cervic* NEAR/6 pain*, hyperextension*, ache, neckache*, Cervicalgia*, Cervicodynia*, whiplash. In addition, Medline, OvidSP, Web of Science, Cochrane Central, CINAHL and Pubmed Publisher were similarly searched with their own thesaurus used for indexing studies and free entries, in order to be as comprehensive as possible.

2.3. Study selection

In order to be included, studies had to meet the following criteria: (1) Participants in the study had to be over 18 years old; (2) Participants had to suffer from neck pain; (3) The outcome measures in the study had to be the JPSE; (4) Control subjects had to be healthy individuals; and (5) The study had to be written in English. Initially, the search results were screened based on title and abstract. The studies that fulfilled all inclusion criteria were evaluated in full-text, and included in the systematic review.

2.4. Data items and collection

Information was extracted from the included studies and presented in three evidence tables (Tables 1–3). This information is presented in the evidence table regarding (1) study, (2) sample size, (3) characteristics of the participants, (4) JPSE testing instrument, (5) JPSE testing protocol, and (6) results. Data extraction was executed by author JV and checked by author LV.

2.5. Risk of bias in individual studies

The validity and risk of bias of the remaining studies was checked by using the “Methodology Checklist 4: Case-control studies” version 2.0, provided by the Scottish Intercollegiate Guidelines Network (SIGN) (www.sign.ac.uk). The SIGN-group develops evidence-based clinical practice guidelines in order to translate new knowledge into clinical action. One aspect of the work of this group is the development of critical appraisal checklists. Studies were scored on a clearly focused research question, on the description of the internal validity: *i.e.* the selection of subjects; exclusion of selection bias; clear definition of outcomes; blinding of assessors; reliable assessment of exposure; identification of potential confounders; and provision of confidence intervals. For the studies, the grading score has been set from “Low quality” (0), to “Acceptable” (+), to “High quality” (++). In the present review, only studies graded as “Acceptable” (+) or “High quality” (++) were included. This criterion was set a priori.

Methodological quality of the included studies was assessed blindly and independently by authors JV and LV. After both researchers had appraised the selected studies, results were compared and any differences discussed after screening the studies a second time. In the event of disagreement a third opinion was provided by author GK.

2.6. Summary measures

The principal outcome measure of this review was the JPSE, which was the main issue to be researched in the included studies. In 9 of the 14 included studies, JPSE was defined as “the ability to