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SYSTEMATIC CRITICAL REVIEW

The assessment of the cervical spine. Part 1: Range of motion and proprioception

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Summary Neck pain and headache of cervical origin are complaints affecting an increasing number of the general population. Mechanical factors such as sustained neck postures or movements and long-term ''abnormal'' physiologic loads on the neck are believed to affect the cervical structures and compromise neck function. A comprehensive assessment of neck function requires evaluation of its physical parameters such as range of motion, proprioception, strength and endurance/fatigue. The complicated structure of the cervical spine however, makes it difficult for any clinician to obtain reliable and valid results. The aim of the first part of this systematic critical review is to identify the factors influencing the assessment of range of motion and proprioception of the cervical spine.

Clinical relevance of review findings

The assessment of neck range of motion and proprioception by researchers or clinicians can be influenced by many factors because of the complicated nature of the cervical spine. For this reason, examiners should use the same position (sitting or standing) for each subject, and should take care to control lumbar spine posture during any measurement. Torso stabilisation can overcome this problem. Ideally assessments should be performed after undertaking warm-up exercises and a full practice session at the same time of the day (preferably not early morning). For proprioception assessment, active movements give more information from muscle and joint receptors while fatigue and external influences such as noise and cutaneous stimulation should be avoided.

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Introduction

A comprehensive clinical evaluation of the cervical spine requires consideration of more than a single-factor and includes assessment of both symptoms and physical deficits. Pain is the primary complaint which has attracted the attention of most researchers and clinicians, however pain is only a symptom and not a cause. Also, pain, disability and other symptoms are subjective in nature and may depend on many other factors than the problem itself. The assessment of physical impairments of the neck has been proposed as a more objective measure for the diagnosis and prognosis of neck pain and headache as well as an essential part of their overall management (Strimpakos et al., 2005b; Jull et al., 1999; Hermann and Reese, 2001; Dumas et al., 2001; Nakama et al., 2003; Strimpakos et al., 2004; Strimpakos et al., 2005a; Strimpakos et al., 2006; Nordin et al., 2008; Vaillant et al., 2008).

Interest in the assessment and treatment of strength, endurance, range of motion and proprioception of the cervical spine has increased exponentially in the last two decades (Strimpakos et al., 2005b; Jull et al., 1999; Hermann and Reese, 2001; Dumas et al., 2001; Nakama et al., 2003; Strimpakos et al., 2004; Strimpakos et al., 2005a; Strimpakos et al., 2006; Nordin et al., 2008; Vaillant et al., 2008). To a large extent this appears to be linked to an increased incidence and recurrence of neck problems in combination with a growing dissatisfaction regarding the current methods of identifying the causative factors of cervical spine dysfunction. The objective assessment of several physical parameters has been proposed by many researchers and clinicians as important components of a thorough evaluation of the cervical spine that could possibly contribute to the ''cause and effect'' justification of neck disorders. It is widely accepted that structural pathology does not generally correlate with pain therefore many therapists have focused on restoring function. Strength, endurance, flexibility, proprioception and coordination are basic elements for performing activities of daily living (ADLs) such as sitting, carrying and posture therefore assessing and restoring their deficits have become a primary objective of many clinicians (Liebenson, 2002).

From a previous extended literature review, relevant studies demonstrated great diversity concerning the measurement tools, the methodologies undertaken and analysis of the data used (Strimpakos and Oldham, 2001). Unfortunately, many of these studies were shown to be methodologically flawed.

In order, therefore, to determine the best protocol for measuring physical deficits in the cervical spine this critical systematic review aims to identify the factors influencing their assessments and estimates. The first part of this review addresses the issues influencing ROM and proprioception measurements; and the second part, appearing in a subsequent paper, relates to the strength and endurance/fatigue measurements.

A computerized search was performed through the Medline, EMBASE, CINAHL and AMED databases from 1966 to December 2008 using broad as well as specific key words — individually or in combination. They included: cervical spine, neck, function, reliability, validity, intra-observer, inter-observer, strength, endurance, fatigue, range of motion, flexibility, proprioception and kinaesthesia. This was followed by a search through references cited in the retrieved articles. Only English language articles were included. Reliability and validity studies were included if they reported at least one measurement tool concerning cervical strength, endurance, ROM and proprioception, regardless of whether the studies were in healthy or symptomatic subjects. Studies were excluded if measurements were limited to an individual vertebra or focused on a small portion of the cervical spine, such as the upper cervical spine.

Range of motion

Measurement of cervical ROM has been used to evaluate the severity of impairment or disability in patients with work-related cervical disorders and whiplash injuries (Hagen et al., 1997; Hermann and Reese, 2001; Klein et al., 2001; Cagnie et al., 2007; Nordin et al., 2008). It has also been used as part of the clinical criteria in disease classification (Headache Classification Commitee of the International Headache Society, 1988) as well as to evaluate the efficacy of a rehabilitation programme (Hagen et al., 1997; Jordan et al., 1998; Huston et al., 2000; Wang et al., 2003; Nordin et al., 2008). Many systematic reviews on neck pain and headache have demonstrated that range of motion is the most frequently reported objective outcome measure in published trials (Aker et al., 1996; Borghouts et al., 1998; Kjellman et al., 1999; Nordin et al., 2008).

Although the terms range of motion (ROM) and flexibility have been considered synonymous by many authors they are not exactly the same (White and Panjabi, 1990); (Kriviskas, 1999). In this review flexibility is expressed in terms of ROM (passive or active). ROM is muscle and joint specific and is influenced by many factors such as age, gender, temperature and even the race of the individual (Kriviskas, 1999).

Furthermore, the present review reveals that measurements of neck function can be affected by intrinsic factors such as the joint complexity and diurnal variation of ROM. It may also be influenced by factors arising during the measurement procedure such as the position and posture of the subjects, the use of active or passive movement, whether the subjects have open or closed eyes, the use of stabilisation and isolation of the cervical spine. The importance of each of these factors and their influence in neck ROM assessment is discussed below.

Factors influencing range of motion measurements and estimates

Joint complexity and range of motion

Reliability of measuring ROM is specific to the action measured and to regional structure and function. For example, measurements of the elbow, generally considered a simple hinge joint, show less day-to-day variation in ROM than measurements of the wrist, the movement of which is affected by multiple joints and numerous muscles (Gajdosik