Locating the Seventh Cervical Spinous Process: Accuracy of the Thorax-Rib Static Method and the Effects of Clinical Data on Its Performance

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ABSTRACT

Objectives: The aim of this study was to assess the thorax-rib static method (TRSM), a palpation method for locating the seventh cervical spinous process (C7SP), and to report clinical data on the accuracy of this method and that of the neck flexion-extension method (FEM), using radiography as the gold standard.

Methods: A single-blinded, cross-sectional diagnostic accuracy study was conducted. One hundred and one participants from a primary-to-tertiary health care center (63 men, 56 ± 17 years of age) had their neck palpated using the FEM and the TRSM. A single examiner performed both the FEM and TRSM in a random sequence. Radiopaque markers were placed at each location with the aid of an ultraviolet lamp. Participants underwent chest radiography for assessment of the superimposed inner body structure, which was located by using either the FEM or the TRSM.

Results: Accuracy in identifying the C7SP was 18% and 33% ($P = .013$) with use of the FEM and the TRSM, respectively. The cumulative accuracy considering both caudal and cephalic directions (C7SP $\pm$ 1SP) increased to 58% and 81% ($P = .001$) with use of the FEM and the TRSM, respectively. Age had a significant effect on the accuracy of FEM ($P = .027$) but not on the accuracy of TRSM ($P = .939$). Sex, body mass, body height, and body mass index had no significant effects on the accuracy of both the FEM ($P = .209$ or higher) and the TRSM ($P = .265$ or higher).

Conclusions: The TRMS located the C7SP more accurately compared with the FEM at any given level of anatomic detail, although both still underperformed in terms of acceptable accuracy for a clinical setting. (J Manipulative Physiol Ther 2016;xx:0-8)

Key Indexing Terms: *Cervical Vertebrae; Palpation; Physical Examination; Diagnostic Errors; Physical Therapy Specialty; Rehabilitation*

INTRODUCTION

The accurate recognition of inner body structures by palpation is advocated by health care professionals for optimal assessment and intervention in fields such as physiotherapy,[1] anesthesiology,[2,3] osteopathy,[4] chiropractic,[5] dentistry,[6] speech therapy,[6] and acupuncture.[7] Misrecognition of some inner body structures through palpation has little effect on some interventions. Segmental hypomobility or focal vertebral misalignment can be successfully restored despite recognition of the specific vertebral segment.[8,9] However, failure to accurately recognize inner parts through palpation might result in undesired outcomes. Interpretation of data from biomechanical models depends on the accurate placement of skin markers over inner body structures.[10] Moreover, misrecognition of cervical spine segments might cause side effects while performing nerve blocks without fluoroscopy or epidural catheter placement.[2,11] Several palpation methods exist for the location of inner body structures,[12-14] although there is little scientific appraisal of the diagnostic performance of those palpation methods despite their widespread use in clinical settings.[15]

The cervical region is a site of frequently perceived pain and discomfort in people of all ages and both sexes worldwide.[16] The seventh cervical spinous process (C7SP) lies at the cervical region that is the anatomic reference for

many applications ranging from kinematic analysis in biomechanics[17] to surgery involving thoracic spinal lesions.[18] A recent systematic review on the accuracy of palpation methods for evaluating anatomic landmarks of the cervical spine reported fair-to-good methodological quality, with accuracies in the range of 51% to 87.8%.[19] The neck flexion-extension method (FEM) is among the most commonly used methods for locating the C7SP, being widely used by orthopedists, anesthesiologists, and manual therapists.[1,2,20,21] Nonetheless, the reported accuracy of the FEM alone for recognizing the C7SP is low, suggesting new palpation methods are warranted to allow more accurate recognition of the C7SP.[1] Therefore, this study proposes a new palpation method for recognition of the C7SP, namely, the thorax-rib static method (TRSM), which was compared with the FEM by using radiography readings as the gold standard. The effects of clinical and anthropometric data on the accuracy of both methods are also reported. In a companion paper,[22] we have verified that this new palpation method can further improve accuracy in locating the C7SP by using a multivariate regression model that incorporated personal characteristics.

MATERIALS AND METHODS

Ethics and Study Design

The Research Ethics Committee of Centro Universitário Augusto Motta approved this study protocol (CAAE 42535215.3.0000.523) designed in accordance with resolution 422/2012 from the National Health Council and the Declaration of Helsinki. This single-blinded, cross-sectional study was designed following the Standards for Reporting Diagnostic Accuracy Studies (STARD).[23]

Training and Expertise of Examiners.   A single examiner (A.P.A.F.) performed all clinical assessments. This examiner obtained a bachelor's degree in physiotherapy in 1991 and a diploma in osteopathy in 2002, and has 24 years of clinical experience in a manual therapy field. A single radiologist (J.F.C.Z.), who has 38 years of experience, was blinded to the palpation methods used in this study and analyzed the radiographies.

Sample Size Requirements.   To compare the diagnostic performance of the new method, a sample size of 100 participants was required, considering the highest accuracy previously reported[21] for a combination of the FEM and counting the spinous processes and a significant level (α) of 5% and power (1-β) of 80%.[24] In addition, to assess the test-retest reliability of the radiologist, the radiography readings required a sample size of 36 participants for observing $\kappa_1 = 0.81$ versus $\kappa_0 = 0.60$ with the same α and β.

Participants

Study Population, Participant Recruitment, and Sampling.   Data collection was performed at the radiology diagnostic department of a primary-to-tertiary health care center (Hospital Universitário Pedro Ernesto, Universidade do Estado do Rio de Janeiro/UERJ, RJ, Brazil). A nonprobabilistic (convenience) sampling scheme was adopted with prospective admission of participants. Inclusion criteria comprised adults ($\geq$18 years) with a prior prescription for chest radiography. Informed consent was obtained from all participants.

Test Methods

Location of the C7SP Using Palpation Methods.   Two palpation methods were applied in a random sequence following a list previously generated by using an online sequence number generator (http://www.random.org) and the prior estimated sample size as described in the sections below.

Flexion-Extension Method.   The examiner simultaneously palpated the 2 uppermost prominent cervical spinous processes by using the index and middle fingers while the participant sat comfortably with his or her cervical spine in flexion. Through an assisted movement of the cervical spine into extension, the movement of the upper spinous process was perceived: If it moved in an anterior direction while the lower spinous process remained static, the lower spinous process was labeled as C7SP; otherwise, if both spinous processes remained static, the upper spinous process was assumed to be the C7SP. In the latter case, this process was repeated after moving to the next spinous process in the cephalic direction for confirmation.[2,21] The final location of the C7SP as identified with the FEM was marked on the skin with an "X" by using an ultraviolet ink pen (Blacklight ink marker; DirectGlow, Dayton, OH).

Thorax-Rib Static Method.   The rationale of the new method was to use bony inner structures in the thorax to guide the location of the C7SP (Fig 1). The first rib serves as an attachment for several muscles and comprises the floor of the thoracic outlet space; it is located through the trapezius muscle at the lateral width of the mastoid process and is the structure that distinguishes the cervical from the thoracic spine.[25] The examiner located the posterior arch of the first rib that departed from a vertical line from the mastoid process while the participant remained in a standing position; the spinous process of T1 was located following the posterior arch of the first rib, and the examiner moved his fingers to the next spinous process in the cephalic direction to locate the C7SP. Analogously, the final location of the C7SP as identified with the new method was marked on the skin with an "O" using the same ultraviolet ink pen.

Immediately after application of both palpation methods, radiopaque markers (major axis = 15 mm; minor axis = 11 mm) were placed at the center of each "X" and "O" (markers #1 and #2, respectively) with the aid of an ultraviolet lamp and were immediately fixed with hypoallergenic tape. Such a marker was chosen simultaneously to best represent the shape and size of a thumb used for