The Accuracy of Locating Lumbar Vertebrae When Using Palpation Versus Ultrasonography

Rune Mygind Mieritz, DC, PhD,[a] and Gregory Neil Kawchuk, DC, MSc, PhD[b]

ABSTRACT

Objective: The purpose of this study was to determine the accuracy of locating lumbar vertebrae using palpation vs ultrasonography.

Methods: In this study, ultrasonic imaging was used by 2 experienced clinicians to identify the third lumbar spinous process (target) of a female participant. The target was then located by 16 undergraduate chiropractic students using clinical palpation techniques learned in their academic program (with participant seated and prone) and ultrasonic imaging learned through a 5-minute training video. Presumed target locations identified by students were recorded by infrared motion capture equipment. The coordinates of the presumed target site were then compared statistically.

Results: There was no significant difference between the presumed target position identified by the students using sitting and prone palpation ($P = .346$). These positions were significantly different from the target location identified by expert clinicians using ultrasonic imaging ($P < .0001$ in both cases). The vertebra identified by ultrasonic imaging by the students was the same vertebra identified by the expert clinicians using ultrasound. This position error in the vertebra identified by palpation resulted in the students mistakenly identifying the L4 spinous process as the target vertebra.

Conclusions: This study found that ultrasonography provided more accurate identification of a lumbar spinal landmark when compared with palpation. In addition, our data suggest that ultrasonic imaging to identify spinal landmarks can be learned easily and can improve accuracy of landmark detection. Although the time to use ultrasonic imaging was greater than with palpation, these results suggest that this procedure could potentially be used in clinical practice to identify spinal landmarks. (J Manipulative Physiol Ther 2016;39:387-392)

Key indexing terms: *Ultrasonography; Palpation; Lumbar Vertebrae; Spine; Anatomic Landmarks*

INTRODUCTION

Accurate localization of bony landmarks is an important skill for many clinical disciplines (eg, anesthesiologists, orthopedics, chiropractors, and physiotherapists) in order to enhance diagnostic accuracy and reduce risk of injury.[1–3] For example, palpation of lumbopelvic landmarks is used commonly to identify spinal levels[4,5] and, in particular, the spinous processes. In this technique, palpation is used to identify the superior aspect of the posterior iliac crests. These 2 landmarks are then joined by an imaginary line that designates the fourth lumbar spinous process (L4) and/or the vertebral interspinal space L4/L5.[6,7] Although used commonly, a recent study demonstrated that this technique has a mean error of 18.8 mm. Consequently, the authors of the article suggested that manual palpation has limited validity in identifying spinal levels.[8–10] Another study examined different palpation techniques and concluded that no single technique was considered accurate. The accuracy of any single technique, including the iliac crest technique described above, ranged from 45% to 61%.[7] Other studies[11,12] have shown that the magnitude of the error from palpation may be so great that different spinal levels were identified when compared with a radiologic standard.[6]

Despite these known difficulties, identifying spinal landmarks by palpation remains an integral part of clinical practice.[7] Although direct imaging is an option to improve accuracy and reliability of paplation, imaging techniques that rely on ionizing radiation are not preferred for this application, whereas

[a] Clinical Biomechanics, Institute of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark.

[b] Faculty of Rehabilitation Medicine, University of Alberta, Edmonton, AB, Canada.

Submit requests for reprints to: Gregory Neil Kawchuk, DC, MSc, PhD, Professor, University of Alberta, Corbett Hall, 8205 114 St, Edmonton, AB, Canada T6G 2G4.
(e-mail: *greg.kawchuk@ualberta.ca*).

Paper submitted November 20, 2015; in revised form May 1, 2016; accepted May 1, 2016.

0161-4754

http://dx.doi.org/10.1016/j.jmpt.2016.05.001

noninvasive forms of imaging such as diagnostic ultrasound have previously been difficult to use and cost-prohibitive.[13,14] Recently, the cost and quality of ultrasonic imaging have improved substantially to the point where it may be a viable alternative to palpation. Ultrasonic imaging in medical specialties such as anesthesia is now common when determining the puncture level for spinal blocks,[3,15] and research has demonstrated poor agreement between spinal levels identified by anesthetists using palpation vs ultrasonic imaging.[3,16,17] Unfortunately, fewer studies have been performed to compare the accuracy between these techniques.

Therefore, the objective of this study was to determine the accuracy of landmark identification using palpation techniques vs ultrasonic imaging in a cohort of clinical trainees. We hypothesized that when locating the third lumbar spinous process (L3) in a human participant, students would have greater accuracy when using ultrasonic imaging compared with manual palpation.

Methods

This validation study was declared exempt by the Regional Scientific Ethical Committees for Southern Denmark.

Participants

Participants were recruited in February of 2016 through advertisement on an electronic network for chiropractic students enrolled at the University of Southern Denmark. Inclusion criteria were that the participants be current chiropractic students at University of Southern Denmark who had previously passed a palpation examination within their regular studies. For all willing and able to participate, written informed consent was obtained.

Data Collection

Data were collected on 2 consecutive days in the movement laboratory at the Department of Sport Science and Clinical Biomechanics, University of Southern Denmark, Odense campus. A single human female participant (body mass index [BMI] 19.4 kg/m^2) was assessed by all 16 participants with the goal of locating the L3 spinous process (target) through 3 methods: palpation with the participant seated, palpation with the participant prone, and ultrasonic imaging. Because we were unable to ascertain from the literature if one palpation technique was superior to another, we elected to test both in this study. All participants used these 3 methods in the same order. Randomization between these methods was not used to prevent students who used ultrasonic imaging before palpation having an unfair advantage in knowing where vertebrae were located. Prior to testing on both days, a 3 × 2 grid of reflective markers was placed on the female participant's back and served as a 2-dimensional local coordinate system visualized by an optical tracking system consisting of 8 MX-T20 cameras, 8 MX-T40 cameras, and 2 Bonita digital cameras driven by Nexus software (version 1.8.5) at a sampling rate of 200 Hz (Vicon Motion Systems Inc, Los Angeles, CA). Within this coordinate system, each of 16 participants located the presumed target by palpation (with participant sitting or prone) or by ultrasonic imaging (with participant prone). When the target was located by each method, the students placed their finger on the skin at this location and a reflective marker was placed on the finger by the investigators to obtain the location coordinates. Sufficient time passed between participants so that any temporary redness on the skin caused by examination disappeared before the next participant was tested.

Palpation and Training

Before palpation, each participant watched a 5-minute video that outlined a set of instructions on how to assess the subject. Specifically, the instructions were (1) that the examiner may use any technique they were taught within their training program; (2) when the target was located, the examiner was to place his/her finger on the skin overlying the target; and (3) the time to localize the target was limited to 1 minute. The time to complete palpation was recorded, as was the specific palpation technique used by each participant.

Ultrasonic Imaging and Training

Before ultrasonic imaging (Logiq S7 Expert, General Electric, Chicago, IL), each participant watched a 5-minute video that outlined a set of instructions on how to image the subject.[14] Specifically, the instructions were designed to teach the participants how to orient the transducer, how to find spinous processes, and how to count spinous processes.[14] At each step, a clip was shown illustrating how the participant should operate the transducer followed by an example of the desired image. At each step, the video was paused and the participant allowed to practice the described task.

Participants were taught to locate and count spinous processes using the following technique. Students started by locating the first sacral vertebra (S1) using a video sequence of where to place the transducer and the appearance of the resulting image. The video was paused and the participant was instructed to reproduce these steps. Then, the students were instructed on how to rotate the transducer to find the junction between S1 and the fifth lumbar vertebra (L5). The video was then paused while they reproduced these steps to achieve the desired image. Finally, participants were shown how to move the transducer superiorly to identify spinous processes along the spine. With the video paused, students then used these instructions to replicate the resulting images they were shown on the video. Each participant was then asked to locate the spinous process of L3. The time to complete ultrasonic localization was recorded.