Inertial Sensors as Real-Time Feedback Improve Learning Posterior-Anterior Thoracic Manipulation: A Randomized Controlled Trial

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Abstract

Objective: The purpose of this study was to analyze the effect of real-time feedback on the learning process for posterior-anterior thoracic manipulation (PATM) comparing 2 undergraduate physiotherapy student groups.
Methods: The study design was a randomized controlled trial in an educational setting. Sixty-one undergraduate physiotherapy students were divided randomly into 2 groups, G_1 (n = 31; group without feedback in real time) and G_2 (n = 30; group with real-time feedback) participated in this randomized controlled trial. Two groups of physiotherapy students learned PATM, one using a traditional method and the other using real-time feedback (inertial sensor). Measures were obtained preintervention and postintervention. Intragroup preintervention and postintervention and intergroup postintervention scores were calculated. An analysis of the measures' stability was developed through an interclass correlation index. Time, displacement and velocity, and improvement (only between groups) to reach maximum peak and to reach minimum peak from maximum peak, total manipulation time, and stability of all outcome measures were the outcome measures.
Results: Statistically significant differences were found in all variables analyzed (intragroup and intergroup) in favor of G_2. The values of interclass correlation ranged from 0.627 to 0.706 (G_1) and between 0.881 and 0.997 (G_2).
Conclusions: This study found that the learning process for PATM is facilitated when the student receives real-time feedback. (J Manipulative Physiol Ther 2015;xx:1-9)
Key Indexing Terms: *Spinal Manipulation; Teaching; Kinematics; Feedback; Musculoskeletal Manipulations; Spine; Thoracic Vertebrae; Learning*

High-velocity thrust is a technique of manual application where a pulse, intended to alter the local balance of forces in the spine (acting on a spinal functional unit), is performed for a duration of 0.1 to 0.2 seconds, achieving a reduction of pain and patient discomfort.[1] Posterior-anterior thoracic manipulation (PATM), a form of high-velocity thrust, is a bimanual coordinated movement aimed at increasing the mobility of hypomobile joints and reducing pain.[2] The force is applied in different directions taking into account the spinal joint biomechanics that require mobilization,[3] so it is necessary for students to be well trained in mobilization techniques in order for them to learn how to properly perform spinal manipulations. Detecting and correcting errors during the learning of a motor skill allows a gradual improvement in the execution of the skill.[4,5]

Among physiotherapy and manual therapy students, PATM is commonly included as a tool for clinical use.[6] Physiotherapy students need to be autonomous and competent after graduation to ensure safe and high-quality clinical practice.[7–9]

The usual protocol when teaching mobilization and manipulation is to begin with a teacher demonstration, followed by student practice in which the teacher provides, on

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a regular basis (depending on the pupil-teacher ratio), subjective information on the implementation of the maneuver.[10,11] However, students rarely receive objective information on the basic parameters of manipulation,[11] which means that the student is unable to differentiate accurately during manipulations the correct or incorrect execution of it.[12] The use of real-time feedback tools for the student enabling them to receive objective information regarding the manipulation could complement traditional teaching methods of spinal manipulation and reduce the learning period.[13] In the training and study of mobilization and manipulation, the application of high-velocity–low-amplitude techniques was used recursively, with variables and kinetic parameters such as peak force (amplitude),[2,8,9,13–25] mean force,[8,9,13–21] time,[2,16–25] force direction,[8,9,13–15,18,19,25] or force production rate.[2,16,20–25] These parameters were set during cervical,[8,13–16,20,24] thoracic,[20,24,25] and lumbar manipulations,[2,9,16,19,20] and recorded using different instruments such as a hand-held force transducer,[16,18] an instrumented manikin,[22,23] or an instrumented treatment (Table 2).[8,9,13–16,21,24,25] However, considering the definition of thrust manipulation, kinematic variables could be used to analyze the movement. Inertial sensors are proven as a valid instrument for extracting kinematic variables, such as velocity, displacement, time, and acceleration, during the execution of both thoracic[26] and cervical[27–29] spine manipulations.

The authors could find no study analyzing the effect and influence of real-time feedback for physiotherapy students learning PATM using an inertial sensor to report on basic kinematic variables (velocity, displacement, time, and acceleration) during the execution of the movement. This study aims to examine the effect caused by real-time feedback on the learning process related to PATM, comparing 2 groups of students, in which one group learns the technique following traditional methods and the other uses an inertial sensor. A secondary objective of the present study was to compare the consistency of the measure obtained between the different groups. The hypothesis of the present study was that the learning process would be facilitated for those students who received the real-time feedback (experimental group) compared with those that did not (control group).

Methods

Design

This study was a randomized controlled trial (parallel) that compared the impact of real-time feedback on learning PATM (providing parameters of displacement, velocity, and time during spinal manipulation).

Setting

The present study was performed at the Faculty of Health Science (University of Málaga), between 13th January 2014 and 31st May 2014.

Participants

Sixty-one undergraduate physiotherapy students (in the third year of their studies) participated in this study. Participants were divided randomly into 2 groups through a system of sealed and opaque envelopes: G_1 (n = 31; control group: group without feedback in real time) and G_2 (n = 30; experimental group: group with real-time feedback; Fig 1).

The inclusion criteria used were that the students did not have any training in manual therapy techniques, especially those involving a PATM. The exclusion criteria used were that the participants refused to participate in the study or having been trained in manual therapy techniques.

Ethical Considerations

Ethical approval for the study was granted by the ethics committee of the Faculty of Health Sciences, University of Malaga. This study was conducted in accordance with Ethical Principles for Medical Research Involving Human Subjects (Helsinki Declaration).[30] The present study has been registered at ClinicalTrials.gov with the following identifier: NCT01911338.

Intervention

The students conducted PATM of the spine. In this technique, heuristically, the therapist performed a manipulation supporting the right-hand pisiform on the participant's right transverse apophysis, inducing a rotation and slippage of the joint immediately above. An instrumented manikin (Resusci Anne Full Body with signal box; Laerdal Medical AS, Wappingers Falls, NY) attached to an inertial sensor (Inertial Cube 3 [Intersense Inc, Bedford, MA]) was used to register the kinematic variables during execution of the PATM. The inertial sensor was placed on the thoracic spine (longitudinal center line of the frontal plane at T_7 level).

The manikin's ribcage had the natural deformation of a human thorax. A manikin was used to allow repeated thrusts on a mechanical object that maintains its physical properties. On the other hand, it would not be feasible to make numerous repeated on a single human, and if you used different humans, the physical properties would most likely be different from person to person making it difficult to do meaningful comparisons of the thrusts that were delivered.

None of the students had experience in PATM. The study procedure was divided into 4 distinct phases. (1) Explanation of the PATM: one of the teachers (physiotherapist with >15 years' experience in manual therapy) explained and demonstrated the manipulation and explained the graph parameters as real-time feedback to be taken into consideration when interpreting the graph, leaving the graphic as the benchmark execution. (2) First measure: the first time the student observed the PATM. Once all students had received an explication and demonstration of the PATM, but without any