The initial effects on pain, pain sensitivity, range of motion and muscle strength of an anteroposterior mobilization of the glenohumeral joint in overhead athletes with chronic shoulder pain

INTRODUCTION

Shoulder disorders are a common musculoskeletal condition, with an estimated lifetime prevalence of 42% in athletes performing highly repetitive overhead movements.[34] Shoulder symptoms are often persistent and recurrent, with 40-50% of patients reporting persistent symptoms after 6-12 months,[56] and 14% continuing care after 2 years.[28]

Mobilization techniques are commonly used by physiotherapists for reducing pain and disability in patients with shoulder musculoskeletal disorders.[5,9,17] One approach for mobilizing the shoulder joint is the Maitland'a approach, where passive rhythmic oscillatory mobilizations are applied anywhere within the shoulder joint range of movement (ROM) and graded according to force, amplitude, direction and duration.[30] When applied specifically over the glenohumeral joint, the Maitland's approach includes both angular and translational mobilizations, with these latter being classified in terms of direction as anteroposterior (AP), posteroanterior and caudal mobilizations.[29]

Humeral head AP mobilizations are often used with the intention to achieve mechanical effects on capsule extensibility, such as a stretching of posterior capsule tightness.[16,27] Indeed, they can induce either a temporary or sustained elongation of the posterior capsule depending on the applied force[36] and an increase in shoulder ROM (i.e. shoulder external rotation).[20] Besides these mechanical effects, the application of an AP mobilization to the glenohumeral joint produced sympathoexcitatory effects (i.e.

increase in skin conductance, reduction in skin temperature) in healthy people[47] and in subjects with posterior capsule tightness.[59] However, the potential neurophysiological effects of this mobilization technique on other pain and function-related outcome measures have not yet been investigated. A greater understanding of the mechanisms underlying the beneficial effects reported after the application of shoulder AP mobilization techniques,[10,20,31,40] would help clinicians for instance to identify those individuals more likely to respond to this manipulative intervention.[1]

Previous studies have demonstrated positive effects in terms of improvement of shoulder ROM, pain sensitivity and muscle function (i.e. reduction on rotator cuff muscle activity) when applying an AP mobilization to the humeral head in the form of a mobilization with movement (MWM).[43,51] Whether similar clinical effects might be obtained with an AP mobilization to the humeral head following Maitland's approach is unknown.

The aim of this study will be investigated the initial effects of a passive rhythmic AP mobilization applied to the glenohumeral joint on pain sensitivity and muscle function in overhead athletes with chronic shoulder pain. In addition, the effects of this technique on self-reported shoulder pain and disability and ROM will be also evaluated.

METHODS

A repeated-measures, double-blinded randomized, placebo-controlled study will be conducted to evaluate the initial effects of an AP mobilization of the glenohumeral joint on pressure pain threshold (PPT), muscle strength, self-reported shoulder pain and disability and ROM.

Participants

The overhead athletes aged between 18-60 years of age will participated in this study. Besides presenting with a history of chronic shoulder pain (i.e. lasting ≥3 months), athletes will required to play overhead sport regularly (at least once per week) in an organized way. Recruitment of potential volunteers will be conducted at the Student Sport Center *BLINDED* through poster advertisement. Volunteers who met the inclusion criteria will be then evaluated as they reached the laboratory.

Subjects will be excluded if they had a non-musculoskeletal origin of shoulder pain, previous surgery to the shoulder complex, frozen shoulder, any co-existing inflammatory, infectious or neurological condition that would exclude the patient from physiotherapy treatment, or any evidence of pain referred from the cervical spine to the shoulder.[55] In addition, they will be instructed to avoid any medication intake during the week prior to the study commencement and for the duration of the study.

Data collection took place at the *BLINDED* from february to march 2018. All participants will received an information leaflet and will gave written informed consent prior to the study beginning. The study was approved by the local Institutional Ethics Committee and all the procedures will be conducted according to the Declaration of Helsinki.

Outcome measures (dependent variables)

The outcome measures used in this study are: PPT, muscle strength, self-reported shoulder pain and disability, and shoulder ROM.

Pressure pain threshold (PPT)

A standardized protocol for evaluating PPT will be used.[44] One test site on the affected and non-affected shoulder (mid belly of the anterior deltoid, 5 cm caudal to the anterior border of the acromion) and one remote site on the ipsilateral tibialis anterior (5 cm inferior and 2.5 cm lateral to the tibial tubercle) will be selected for PPT measurement. All these points will be marked with a permanent marker and photographed so that the same points could be used for pre-and post-condition measures.

The PPT will be measured using an analogue Fisher algometer (Force Dial model FDK, Wagner Instruments) with a surface area at the round tip of 1cm^2. The algometer probe tip will be applied perpendicular to the skin at a rate of 1$kg/cm^2/s$ until the first onset of pain.[12] PPT will be measured three times on each site with a 30 s rest period between each repetition. The mean of the three measurements will be used in the statistical analysis.

Pressure algometry is a valid and reliable method to measure PPT with studies showing good repeatability of measurements on the shoulder.[21,41]

Shoulder muscles strength

Isometric strength of the shoulder internal and external rotator musculature will be measured using a portable hand-held dynamometer (Nicholas Manual Muscle Tester, Lafayette Instruments, USA).

For external rotation testing, participants will be positioned in sitting with the shoulder in 0º of abduction and medially rotated 45º and the forearm in its mid-range of motion between supination and pronation.[24] The dynamometer will be placed on the lateral surface of the distal forearm just proximal to the ulnar styloid process and anchored by a belt to the handlebar of a glass suction cup on the wall. This ensured reliability when quantifying external rotation strength.[25] Subjects will be instructed to push in the direction of shoulder external rotation while maintaining the trunk in a stable position.

Shoulder internal rotation testing will be performed in standing using the Gerber lift-off position.[13] The dynamometer will be placed on the distal aspect of the ventral forearm, between the patient forearm and the wall, which provided in this case the stabilization counterforce. Subjects will be instructed to lift the dorsum of the hand off the mid-lumbar region against the wall.

Participants will be instructed to exert as much force as possible against the dynamometer during six seconds (*make test*).[49] This process will be repeated three times with a 30-s rest period between measurements and the mean will be used in the statistical analysis.

Hand-held dynamometry by using fixed instrumentation is a reliable method for measuring strength of the internal and external rotator shoulder musculature.[25]

Self-reported shoulder pain

Participants will be asked to indicate the intensity of their current shoulder pain using a numeric rating pain scale (NRPS). The NRPS has demonstrated good test-retest reliability and responsiveness to treatment in patients with shoulder pain.[33]

Shoulder disability

The Spanish version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire will be used to record shoulder disability.[15] The DASH is comprised of 30 items (disability/symptom section) and two optional sections related to the impact of pathology on work and sports.[32] Each item is scored from 1 to 5 with increasing values representing more severity of symptoms. The total score for the disability/symptoms section ranges from 30 to 150, but it is then transformed to a scale from 0 (better score possible) to 100 (worse score possible).

The Spanish version of the DASH has shown high internal consistency, excellent test-retest reliability, good construct and criteria validity and excellent responsiveness to treatment.[15]

Shoulder range of movement (ROM)

Active elevation in the scapular plane and passive glenohumeral internal and external rotation will be measured using a Standard BASELINE ® 12-inch plastic goniometer following previous guidelines.[26,39]

For measuring active elevation in the scapular plane, participants will be in a standing position. A flat stiff board will be positioned 30º anterior to the frontal plane (scaption plane) to control the plane of elevation of the affected arm.[42] Participants will be instructed to move the affected arm into full elevation while maintaining contact with

the stiff board. The goniometer will be positioned with the fulcrum placed at the midpoint of the central aspect of the glenohumeral joint, the stable arm parallel to the trunk, and the moving arm parallel to the longitudinal axis of the humerus.[26]

For assessment of passive glenohumeral internal rotation, participants laid supine with 90º of shoulder abduction in the frontal plane and the elbow flexed at 90°.[11] The examiner stabilized the scapula with one hand by applying mild pressure to its anterior aspect (coracoid process), while applying with the other hand a passive movement of shoulder internal rotation to its maximal point. An assistant read the measurement placing the goniometer with the stationary arm parallel to the floor and the mobile arm in alignment with the forearm starting at the olecranon.[39] The same starting posture and goniometer positioning will be used for measuring passive glenohumeral external rotation.

Experimental conditions (independent variables)

There are two independent variables in the research design: treatment condition and time (pre-, post-application). Treatment condition has three levels, which include the AP shoulder mobilization, a manual contact and a no-contact condition.[47] These experimental conditions will be administered in random order in three separated sessions to all participants, with each session separated by 48 h in order to control for carry-over effects.[35] The treatment allocation sequence will be randomized using sealed envelopes and concealed from the investigator who took the outcome measurements. An experienced physiotherapist with a Master degree on manual therapy and more than 10 years of working experience will apply all conditions. This physiotherapist will be blinded to the results of the measurements and questionnaires used as outcome measures.

All conditions will be applied for a total of 10 min, comprising three sets of 3 min, alternating with 30-s rests. Verbal instructions and positioning will be strictly standardized during all the sessions.

Treatment condition

The treatment condition consist on the application of a passive rhythmic AP mobilization to the glenohumeral joint of the affected shoulder. In particular, a Grade III AP glide to the humeral head with the arm positioned in 90º of glenohumeral abduction and full internal rotation was used.[47] The posterior gliding force to the humeral head was applied maintaining the glide at right angles to the plane of movement and at a frequency of 2 Hz which will be controlled by means of a metronome. The arm will be returned to its original position between each set.

Manual contact condition

During the manual contact condition the therapist positione the patient in a mid-range position of glenohumeral abduction and internal rotation and apply the hands to the same contact point as in the treatment condition. However, a simulated posterior glide will be performed but with minimal pressure actually applied.[47] The number of repetitions and sets were as per the treatment condition.

No-contact condition

During the no-contact condition, the subject remain in the initial starting position thorough the entire session but there are no manual contact between the therapist and the participant.[47] The total treatment time will be the same as per the other conditions.

Procedure

At the first session and after recording demographic data, the NRPS and DASH will be administered followed by PPT, ROM and muscle strength measurements in a standardized order. Subjects then will received the assigned intervention for that session and, immediately afterwards, all outcome measures will be reassessed following the same order as before. The only exception was the DASH, which will be assessed before and 24 hours after each experimental condition. This procedure will be repeated for all the three test sessions.

An investigator, will blinded to the allocated intervention, performed all the outcome measures before and immediately after the application of the three experimental conditions. Discussion between researchers and subjects will be minimized during treatment in order to facilitate subject blinding and reduce potential interactions. No feedback will be given on performance until after the final session. The extent of subject blinding will be assessed through a short, self-administered, post-experiment questionnaire, where participants will be asked to indicate whether they have experienced a physiotherapy treatment in any of the sessions and, if so, in which session.[35]

Statistical analysis

Data will be analysed using SPSS 22 for Windows. Statistical significance will be set at $p < 0.05$.

Two independent variables will be incorporated into the research design: treatment (AP mobilization, manual contact, no-contact) and time (pre- and post-intervention). Five dependent variables will be considered including PPT, muscle strength, NRPS, DASH (disability/symptom section) and ROM.

Descriptive statistics will be calculated to describe baseline data. A two-way analysis of variance (ANOVA) through a General Linear Model and appropriate post-hoc tests of simple effects will be used to evaluate hypothesis that AP mobilization produced more changes than manual contact and no-contact conditions from pre- to post-intervention ($P=0.05$). The between subject factor will be treatment condition (AP mobilization, manual contact, no-contact) with time (pre and post-intervention) as within subject factors.

Esphericity will be confirmed by means of Mauchly's test. Bonferroni test will used for multiple comparisons and the effect size will be estimated using Eta square (η^2) when significant. An effect size of 0.01 will be considered small, 0.06 medium and 0.14 large.[7]

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