Physical Therapy in Sport 16 (2015) 355–360

Contents lists available at ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Original research

Shoulder function and scapular position in boxers

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ARTICLE INFO

Article history:
Received 9 September 2014
Received in revised form
18 February 2015
Accepted 27 February 2015

Keywords:
Boxing
Combat sports
Scapular dyskinesis
Shoulder range of motion

ABSTRACT

Objectives: To investigate differences in strength, shoulder range of motion and scapula position in a cohort of boxers in comparison with a control group of non-boxers.
Design: Cross-sectional study.
Participants: 18 boxers with 3 or more years of experience (years = 5.5 ± 3.1, sessions per week = 4.3 ± 0.7, age = 27.0 ± 6.8) and 20 control participants (age = 28.3 ± 4.6).
Experimental protocol: The participants were tested for isometric internal and external rotation strength measured with a hand held dynamometer, passive internal and external rotation measured via 2D video using a digital camera, and scapular function measured with a scoliometer and visual inspection by a trained researcher. Both arms (dominant and non-dominant) were tested to allow for comparison. Magnitude based inferences were used to find meaningful differences intra and inter group.
Results: Boxers had greater scapular dyskinesis (hazard ratio (HR) = 2.73 ×/÷ 3.37) and increased external rotation in the dominant arm (effect size (ES) = 0.70 ± 0.68) when compared to the non-boxer group.
Conclusion: Boxers with 3 or more years of experience displayed symptoms that increase their risk of upper limb injury when compared to a control group.

1. Introduction

There exists a substantial amount of research into boxing related injury rates (Bledsoe, Li, & Levy, 2005; Brennan & O'Connor, 1968; Clausen, McCrory, & Anderson, 2005; Estwanik, Boitano, & Ari, 1984; Jordan, Voy, & Stone, 1990; Loosemore, Knowles, & Whyte, 2007; Pappas, 2007; Porter & O'Brien, 1996; Potter, Snyder, & Smith, 2011; Welch, Sitler, & Kroeten, 1986; Zazryn, Cameron, & McCrory, 2006; Zazryn, Finch, & McCrory, 2003; Zazryn, McCrory, & Cameron, 2009). Many of these reports have found that in comparison to other contact sports, boxing has lower or comparable injury rates (Estwanik et al., 1984; Pappas, 2007; Welch et al., 1986; Zazryn et al., 2006). Despite the substantial body of research into boxing injury rates and risks, no studies have explored factors that predispose boxers to musculoskeletal injury. This paper aims to investigate predisposing issues, specifically those related to injuries of the glenohumeral joint and scapula, which may occur as a result of long term boxing training and competition.

"Shoulder" injuries make up between 7.1% and 27.5% of the total injuries suffered by boxers (Jordan et al., 1990; Potter et al., 2011; Welch et al., 1986). The majority of injuries reported were to the head or hand/wrist area of participants. In the opinion of the authors, head and hand/wrist related injuries should be considered an inherent risk to boxing, caused by impact and equipment related factors (Murphy & Sheard, 2006). These factors could most effectively be addressed through rule or equipment changes (alteration in glove size, usage of head gear, reduced scoring of head shots, and hand wrapping strategies). When excluding these impact related issues, the primary injury site to boxers while training is the "shoulder". As such, these injuries should be the primary focus of injury investigation into the movements of boxing rather than the impacts produced while striking. This argument is strengthened by the findings of competition injury rates, which also suggest that the "shoulder" was the primary injury location (Bledsoe et al., 2005; Potter et al., 2011; Welch et al., 1986). It is noteworthy that the literature reviewed did identify which shoulder (dominant or non-dominant) sustained injuries more often.

Equally important to the prevalence of glenohumeral and scapular injuries in boxers is the reported days missed from training once an injury occurred. Porter and O'Brien (1996) reported that shoulder injuries resulted in the greatest total days

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http://dx.doi.org/10.1016/j.ptsp.2015.02.003
1466-853X/

missed of any injury type recorded with 14.2 days missed on average. Welch et al. (1986) found even higher numbers of days missed immediately post injury, with boxers missing on average 18 days from training induced shoulder injuries and 20 days on average from competition induced injuries.

Due to the prevalence and severity of glenohumeral joint and scapular related injuries in boxers this study will examine several key predisposing factors to injury. Specifically, we will investigate if boxers display similar issues to those who participate in overhead throwing sports, a group that is at an even higher risk of injury in the upper limbs than boxers (Kibler, Sciascia, & Thomas, 2012). To accomplish this, we will compare boxers to a control population via passive range of motion (ROM), internal and external isometric rotation strength, and scapular function. Using these measures we aim to determine if classic overhead throwing dysfunction such as scapular dyskinesis and increased external rotation exist in greater incidence in boxers than those who do not participate in the sport. It is worth noting that there exists no current unified theory on the physiological mechanism of upper limb injury in overhead throwing athletes (Thomas, Swanik, Swanik, & Kelly, 2010) and the goal of the authors is not to further the debate, only to use the existing information to inform injury reduction strategies in boxing populations.

2. Methods

2.1. Study design

A cross-sectional design was used to investigate differences in shoulder strength and function, and scapula dyskinesis in boxers vs. non-boxers. Comparisons between dominant and non-dominant arms were performed for the boxer and control groups, as well as comparisons between differences between the two groups. Dominant arm was defined in the boxers as the rear arm when in the individualized, athlete preferred fighting stance and non-dominant was defined as the lead arm when in the fighting stance. In the control group the dominant arm was defined as the arm that the participant used predominantly for tasks such as writing or throwing a ball.

2.2. Participants

This study examined 18 healthy male and female boxers (professional, amateur, and recreational) with 3 or more years of experience, participating in training on average 3 or more times a week (years = 5.5 ± 3.1, sessions per week = 4.3 ± 0.7, age = 27.0 ± 6.8) and 20 healthy male and female (age = 28.3 ± 4.6) non-boxing participants (none completing more than three structured boxing classes in the last five years) volunteered to participate in this study. Criteria for exclusion consisted of a current upper limb injury. All participants were given information packets on the testing procedure and provided written consent before participating. Research ethics approval was provided by the Auckland University of Technology Ethics Committee (AUTEC).

2.3. Equipment

Glenohumeral internal and external ROM was measured via 2D video using a digital camera (Sony Cyber Shot DSC – WX5, Japan) and was analysed with Kinovea software (version 0.8.15). The participants had markings on the bony land marks at the ulnar styloid process and the olecranon for post data-collection measurement. Glenohumeral internal and external rotation strength was measured isometrically with an ABLE force hand held dynamometer (Industrial Research Limited, Christchurch, New Zealand), utilizing a ridged wooden box for the participant to exert force against. Scapular asymmetries were measured using Kibler's (Kibler, 1998) Lateral Slide Test (LST) with a scoliometer (Auckland University of Technology custom fabrication, New Zealand) as per the recommendations of Curtis and Roush (Curtis & Roush, 2006).

2.4. Experimental protocols

All participants reported for a single day of familiarization and testing, which lasted up to 1.15 h per participant. An additional testing session was performed by 10 members of the control group to examine test-retest reliability within a 1-week period. Participants performed each test three times, unless the assessment caused discomfort unrelated to exertion. The results of the three tests were averaged for statistical use. Passive glenohumeral measurements of internal and external ROM were measured in the prone and supine positions respectively, following the guidelines of Clarkson (Clarkson, 2000). End ROM (the first movement of the scapula) was identified by a trained tester and recorded to digital video (Fig. 1). Post data collection, the footage was analysed to find the total degrees of rotation similarly to Clarkson's (2000) use of a goniometer.

Glenohumeral internal and external isometric strength was measured with the participants in the supine position. The shoulder was abducted and the elbow flexed to 90°, with the hand held dynamometer placed as distally as possible (without participant reported discomfort) on the forearm. After familiarization the participants were instructed to apply maximal force against the dynamometer which was placed against the fixed box. Measurements of maximal force lasted until the participant self-selected to stop or the tester observed a drop of 30 percent from the peak force produced in that individual test. Peak force was recorded for each effort. This method of strength measurement follows the protocols of Donatelli et al. (Donatelli, Ellenbecker, Ekedahl, Wilkes, Kocher, & John, 2000), with the exception of the use of a wedge to elevate the arm, and the additional use of a solid wooden box to reduce variability from a tester held dynamometer.

Assessment for scapular dyskinesis followed a binary (yes or no) protocol established by Uhl et al. (Uhl, Kibler, Gecewich, & Tripp, 2009). The participants performed shoulder flexion while under observation by a trained tester. If evidence of a prominent inferior medial scapular border, prominence of the entire medial scapular border, or excessive superior movement of the medial scapular border were observed the participant was identified as positive for scapular dyskinesis on the limb side.

The LST was performed in 3 positions: relaxed, hands on hips and arms abducted to 90° with the arms internally rotated. Measurement with the scoliometer was taken from the inferior angle of the scapula to the nearest spinous process (Fig. 2). Thresholds for asymmetries follow Kibler (1998) with 1.5 cm difference between sides.

2.5. Statistical analysis

Mean and standard deviations (SD) were calculated for all dependent variables in both groups. All data was log-transformed for statistical analysis where appropriate (Hopkins, 2012b). Test-retest reliability was determined by retesting 10 participants of the control group within 5 days of the initial data collection. Reliability was calculated via intraclass correlation coefficients (ICC) for passive ROM and the LST (Hopkins, 2012b), while ICCs and coefficient of variation (CV) were reported for all other variables (Table 1). All measures were found to have acceptable test-retest reliability. Normal distribution of all the data was confirmed with a Sharpio-Wilk statistic.