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Research Article

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Sport Specific Adaptation in Resting Length of Pectoralis Minor in Professional Male Golfers

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Abstract

Objective: In professional male golfers the shoulder is the third most commonly injured area with the lead/non-dominant shoulder three times more likely to be injured than the trail/dominant shoulder. Resting length of pectoralis minor musculature influences scapular and glenohumeral orientation which when suboptimal is associated with shoulder injuries. This study investigates the resting pectoralis minor muscle length in professional male golfers.

Method: Forty five male golfers on European Challenge Tour and thirty six control volunteers met the inclusion criteria for the study. Resting pectoralis minor length was measured in the supine position with the Palmmeter device.

Results: Within groups: controls exhibited a significantly longer pectoralis minor muscle on the non-dominant side (p=0.01), and golfers had a significantly longer pectoralis minor muscle on the trail/dominant side (p=0.01). Between groups: controls exhibited a significantly longer pectoralis minor length on the non-dominant/ lead side when compared to golfers (p=0.01).

Conclusion: When compared to age-matched controls professional male golfers have a unique pattern of resting pectorals minor muscle length, with longer pectoralis minor length noted in the trail/ dominant shoulder. Comparison of the lead/non-dominant shoulder with controls highlights that golfers have a shorter pectoralis minor length which in turn affects scapular and glenohumeral orientation. This may place the golfer at greater risk of shoulder injury in the lead side.

Keywords

Pectorals minor; Palmmeter; Golf; Shoulder; Screening; Rehabilitation

Introduction

Sports therapists need to prevent shoulder injuries by implementation of exercise intervention to modify suboptimal physical characteristics [1]. Kinematic research has contributed to the understanding of sport and the load on the athlete's shoulder [2]. However, these studies looking at the physical makeup of the athlete using clinically measurable methods are equally important. The challenge for physiotherapists who treat the shoulders of sportsmen is to prevent injury, extend longevity, and enhance athletic performance [2]. Understanding the sporting activity, the anatomy of the shoulder girdle, and the biomechanics of the shoulder girdle is essential to restore normal anatomy and physiology [2]. Monitoring athletes' shoulders via repeated clinical evaluation throughout training and rehabilitation is necessary to enhance characteristics that improve sport performance and prevent those associated with injury. But screening and prehab of physical characteristics in the shoulder girdle need to be sport specific and the link between these physical characteristics and sport proficiency needs to be established [3]. Scientific evidence is necessary to produce normative data regarding what physical characteristics are present in the shoulder of the healthy elite athlete as this will give clinicians parameters for rehabilitation and prevention programs.

In professional golf, the shoulder is the third most commonly injured area [4] with the lead (non-dominant) shoulder three times more likely to be injured than the trail (dominant shoulder) [5]. In professional golfers, the swing, which is complex and repetitive, comprises about 200 revolutions per week [6]. The overall resultant torque (or angular velocity) and the length of the lever determine linear velocity and, in the case of golf, the club head speed and driving distance [7]. The golfer's arm length and the length of the club are finite [8] so in order to generate a longer lever during the backswing, the golfer uses the extremes of external rotation (in the trail/dominant shoulder) and internal rotation (in the lead/non-dominant shoulder) in the shoulder (Figure 1). This may require adaptive changes to the length of the pectoralis major and minor muscles in the golfer to permit extremes of shoulder range during the golf backswing. The pectoralis major and minor muscles are required to have both strength and flexibility in the golfer.

Figure 1: To generate a longer lever the golfer should use the extremes of external (in the dominant shoulder) and internal (in the lead/non-dominant shoulder) rotation in the shoulder during the backswing phase of the swing.

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The SSC (stretch shortening cycle) theory is that a short stretch followed by a contraction of the muscle increases elastic energy, enhancing the power of the concentric contraction [8]. During the backswing, the golfer capitalises on the SSC by elongating the hip, trunk and shoulder musculature [8]. The turn of the hip relative to the shoulder is referred to as the X-factor in golf. A longer X-factor is associated with a longer driving distance, greater power, and generation of greater club head speeds [8]. The pectoralis muscles forms part of this kinetic stretch. The range in which a muscle works can vary between full stretch and maximal shortening with contraction [9]. The full range of a muscle's contractions can be divided into inner range, mid-range and outer range. The position in range where the active length tension curve is optimal is known as the muscle's resting length, which is normally in mid-range [10]. The muscle is most effective in generating optimal force in a mid-range nearest the resting length [10,11]. The resting length of the pectoralis muscles may contribute to the available X-factor range in golfers, hence influencing the dynamics of the swing [12].

Pain in the golfer's shoulder is reported to be as a result of impingement, rotator tendinopathies or tears, shoulder instabilities, and arthritis [13]. Soft tissue and musculoskeletal injuries are reported in golfers as a result of overuse [13]. The hours of play can also result in 'imbalances' in the muscular system and further predispose the golfer to overuse syndromes [13]. Alterations in scapular kinematics associated with short pectoralis minor length have been noted by authors in patients with impingement syndrome [14-17]. Studies comparing healthy patients with those with impingement syndrome [15,16,18-21] report decreased posterior scapula tilt [14,20,22], decreased upward rotation [18,20,23,24], and increased internal rotation [15,18,21] in symptomatic groups. Abnormal muscular force couples of the scapula thoracic muscles can lead to faults in the path of instant center of rotation of the scapula, and thus affect scapular and glenohumeral joint kinematics [25]. For this reason clinical measurements of pectoralis minor, which is the only anterior scapulothoracic muscle, are important as they are used in sports medicine during screening to help to identify athletes who may be more injury- prone.

This study investigates the resting pectoralis minor length in professional male golfers on the European Challenge Tour and in age-matched male controls, to determine if the golfer's anatomical shoulder attributes differ from those of non-golfers.

Method

Participants

Forty six of 53 male golfers (mean age 27.91 years ± 4.74 years) met the inclusion criteria for the study. Thirty six of 46 control volunteers (mean age 24.28 years ± 6.81 years), who did not participate in sports and did not do manual work, met the inclusion criteria for inclusion in the study. All golfers were currently playing on the European Challenge Tour and evaluated during the 48 hours prior to start of tournament. Participants included in the study were of full musculoskeletal development, and had healthy shoulders. Participants were excluded from the study if they had: cervical, shoulder, or elbow pain or injury within six months before testing; previous shoulder girdle or spinal fractures; shoulder surgery; or dislocation of the upper limb; scoliosis; or a rheumatologic condition.

The University of Salford Ethics committee approved the study protocol. All participants were provided with a detailed information sheet, comprising details of the study and any associated risks. Participants gave written informed consent to testing and anonymised use of the data collected.

Measurement of pectoralis minor length

The authors conducted a pilot study in 20 control subjects establishing good reliability of the PALM (Palmmeter) device to quantify pectoralis minor length. Intra-rater inter-session (24 hours apart) reliability was established on 52 shoulders for the PALM device to measure pectoralis minor length ($ICC_{3,1}$=0.98. 95%CI=0.96-0.99). The PALM device (Performance Attainment Associate, St.Paul, MN, USA) shown in Figure 2, has calipers and an analogue inclinometer. The PALM device is portable, quick to use, inexpensive, and not influenced by contours of the chest [26].

Measurement of pectoralis minor length with the PALM device was done with the participant in the supine position on an examination plinth. A small pillow was placed under the participant's head for comfort, taking care to ensure that the pillow was not under the shoulder girdle. The participant's arm was passively placed along the side of the body in the neutral position resting on the plinth, ensuring that the participant was relaxed. The elbow was straight with the palm of the hand resting on the side of the participants' thigh, thus placing the thumb in the forwards pointing position. The PALM device was used to measure the distance between the two palpated landmarks of the anterior aspect of the coracoid and the ipsilateral fourth rib sternal notch (Figure 3).

Figure 2: Palpation Meter (PALM)(Performance Attainment Associate, St.Paul, MN, USA).

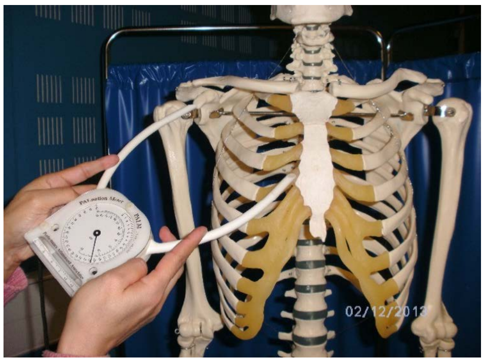

Figure 3: The PALM device was used to measure the distance between the two palpated landmarks of the anterior aspect of the coracoid and the ipsilateral fourth rib sternal notch.

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Table 1: Descriptive statistics and results of independent t-tests for pectoralis minor length.

	Golfers Mean (STD) cm	Paired t-test golfers p value	Controls Mean (STD) Cm	Paired t-test controls p value	Mean difference cm	Independent t- test p value
Dominant PM	16.67(1.13)	0.01*	16.30(1.30)	0.01*	-0.36	0.20**
Non-dominant/lead PM	15.80(1.25)		16.84(1.31)		1.04	0.01**

Abbreviations: PM=Pectoralis Minor; cm=centimetres; STD=Standard Deviation;*=significance within group; **=significance between groups.

Data analysis

Statistical Package for Student Statistics for Windows version 20.0 (SPSSinc., Chicago,IL), was used for statistical analysis. Shoulders included in analysis were sorted according to dominant and non-dominant (trail and lead shoulder in the golfer) sides. The mean of three measures was calculated. Outliers were removed pertaining to one golfer's data. Normality of distributions was ensured with Shapiro Wilk and Kolmogorov-Smirnow tests. Descriptive analyses were run and Paired t-tests used for within group analysis and Independent t-tests used for between group analyses (significance level set at 0.05).

Results

Demographic for the 36 controls and 45 male golfers were (mean age 24.28 years ± 6.81 years. Mean BMI=23.8), and (mean age 27.91 years ± 4.74 years. Mean BMI=23.8) respectively.

Within group analysis

Descriptive statistics and results from t-tests for both groups are reported in Table 1. Results from paired t-tests showed that golfers had a significantly longer pectoralis minor muscle on the trail/dominant side (trail side 16.89cm ± 1.14cm, lead/non-dominant side 15.82cm ± 1.20cm, p=0.01). Results from paired t-tests showed that controls had a significantly longer pectoralis minor muscle on the non-dominant side (non-dominant side 16.84cm ± 1.31cm, dominant side 16.30cm ± 1.30cm, p=0.01).

Between group analysis

Comparison of the lead/non-dominant shoulder with controls highlights that golfers have a significantly shorter pectoralis minor length (difference=1.04cm. p=0.01 Independent t-test). No significant length difference was noted between golfers and controls in pectoralis minor length on the dominant/trail side (p=0.20 Independent t-test).

Discussion

It was hypothesised that golfers would have a longer pectoralis minor length on the trail/dominant side in order to enhance the length of the backswing and so increase the amplitude of the X-factor stretch whereas controls would have equal length in pectoralis minor between sides. The hypothesis was upheld in golfers; within group, golfers had a significantly longer pectoralis minor muscle on their trail/dominant side when compared with their non-dominant/lead side. The hypothesis was not upheld in controls: within group, male controls exhibited a significantly longer pectoralis minor muscle on the non-dominant side compared with their dominant side.

It was hypothesised that the pectoralis minor length in the lead/non-dominant shoulder of golfers would be shorter than that of controls. This hypothesis was upheld when comparison of the lead/non-dominant shoulder with controls highlights that golfers have a shorter pectoralis minor length (difference= 1.04cm). It was likewise hypothesised that golfers would have longer pectoralis muscles than controls in the trail/dominant shoulder as a result of adaption to extremes of ranges required during the golf backswing. Between-groups analysis did not uphold this hypothesis, as the dominant side pectoralis minor length did not differ significantly between controls and golfers.

The finding in this study that golfers have a shorter pectoralis minor length in the non-dominant/lead shoulder may account for the threefold increase in injury rate on this side. This finding suggests that, in order to maintain muscle balance between the scapulothoracic muscles and thus to minimise shoulder pathology in golfers, regular monitoring of resting pectoralis minor length and prehab should take place [27]. Resting length of pectoralis minor musculature influences scapular and glenohumeral orientation [27] which, when suboptimal, is associated with shoulder injuries [28-31]. Lack of flexibility in the pectoralis minor muscle restricts upward scapular rotation and posterior tilt, which has been shown to be a factor in impingement syndrome [32,33]. Impingement syndromes are common causes of pain in golfers' shoulders [13]. Change in resting length of the pectoralis minor muscle may be prevalent in golfers owing to the repetitive nature of the swing. Regular monitoring and maintenance of pectoralis minor flexibility and prehab to maintain muscle balance between the scapulothoracic muscles is indicated to minimise shoulder pathology in golfers.

Limitations

Potential limitations of the study are that subjects may have altered their posture during measures of pectoralis minor length, which would cause greater measurement error. The ICC values and results from the pilot study indicate that the effect of these potential limitations was minimal. The samples of golfers included in this study were all playing on the Challenge Tour. Professional players, although exposed to intense period of play, are normally undergoing conditioning programs and have been reported to have better flexibility than recreational or high handicap players [3]. But what deviation in alignment will to lead to impairment is not known, and neither is the length of time an individual must sustain a deviation in alignment before dysfunction begins: time is not normally considered as a variable [34]. A long-term prospective follow up design study is necessary to determine this.

Conclusion

Screening and prehab of physical characteristics in the shoulder needs to be sport-specific. In contrast to findings in male controls, professional male golfers have a unique pattern of resting pectorals minor muscle length with longer pectoralis minor length noted in the trail/dominant shoulder, which may enhance the length of the back swing. Comparison with controls highlights that golfers have a shorter pectoralis minor length in the lead/non-dominant shoulder which in turn can influence scapular and glenohumeral orientation. This may place the golfer at greater risk of shoulder injury.

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