Influence of Fatigue on Variables of Performance in Tennis

Master's Degree in Sports Performance and Health

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Abstract

Background: It has been observed ROM, strength and service speed are related to shoulder risk of injury.

Purpose: The objective of the study is to prove the connection between fatigue and changes in glenohumeral ROM, strength and speed service.

Study Design: Experimental study.

Method: Seventeen male elite tennis players were instructed to do the same warm up, with the objective to measure internal and external shoulder ROM and strength, for both arms, and service speed. Later they played a simulated match, then same variables were measured again.

Results: All variables measured showed no significant changes comparing situation with and without fatigue.

Conclusion: These data show no significant changes of rotation ROM, strength and service speed, with fatigue procedure of one hour and seventeen minutes. So, playing a little more than one hour does not entail an injury risk for tennis player shoulder thanks to fatigue.

Keywords: Shoulder strength, injury, handball, baseball, pain, tennis, scapular, rotation, shoulder range of motion.

Resumen

Contexto: Se ha observado que el ROM, la fuerza y la velocidad de servicio están relacionados con el riesgo de lesión del hombro.

Objetivo: Probar la conexión entre la fatiga y los cambios en el ROM y fuerza glenohumeral y en la velocidad de saque.

Diseño del Estudio: Estudio experimental.

Método: Diecisiete tenistas de élite masculinos fueron instruidos para realizar un mismo calentamiento, con el objetivo de medir ROM y fuerza de rotación interna y externa del hombro para ambos brazos, y velocidad de servicio. Después los tenistas realizaron un partido simulado, para después volver a ser medidos.

Resultados: Todas las variables no mostraron cambios significativos comparando la situación con y sin fatiga.

Conclusión: Los datos muestran cambios no significativos de ROM y fuerza en la rotación del hombro, así como en la velocidad de servicio, con un procedimiento de fatiga de una hora y diecisiete minutos. Así que, jugando poco más de una hora no entraña riesgo de lesión de hombro para los tenistas por fatiga.

Palabras clave: Fuerza hombro, lesión, balonmano, beisbol, dolor, tenis, escapula, rotación, rango de movimiento hombro.

1. Introduction

Tennis is one of the most popular sports practiced over the world (Pluim et al., 2007), this consists of an intermittent sport practiced by two people or two pairs on a rectangular court, which is divided transversely thanks to a net. This exercise consists of hitting a ball with a racket over the net, trying to bounce the ball 2 times on the opposite part of the court before the rival could hit it.

In this sport, there are a lot of injuries because of physical demands, such as: ankle injury, shoulder injury, elbow injury and so on (Pluim, 2006). Specifically, shoulder injury is characterized by more than 75% of hits with concentric shoulder rotation (Ellenbecker T, Pluim B, Vivier S & Sniteman C, 2009), furthermore, shoulder injuries are usually caused by shoulder joint instability and bad coordination of these pieces. So, movements which are over the head produce stress at shoulder joint. Nevertheless, shoulder injury can appear by overuse too, including diseases at rotator cuff and biceps tendon (Ellenbecker & Roetert, 2004; Olsen, Fleisig, Dun, Loftice & Andrews, 2006).

According to some studies, shoulder injuries, apart from the previous studies, are produced by some factors such as shoulder rotators strength, shoulder range of motion (ROM), speed serve and so on (Moreno-Pérez et al., 2018).

Firstly, it has been shown that is so important to have a good level of muscle strength, because it is needed to help bony configuration to stabilize the glenohumeral joint, and so to prevent injuries (Jobe, 1998; Codine, Bernard, Pocholle, Benaim, & Brun, 1997). The literature shows that strength ratio of external and internal rotation in throwing shoulder decrease comparing to nonthrowing shoulder, observing in this occasion that baseball, more concretely pitch, just change strength ratio on the throwing shoulder (Cook, Gray, Savinar-Nogue & Medeiros, 1987). The fact that throwing shoulder had an imbalance is considered as a predictor to have an injury in future as exposed Edouard et al. (2013) in handball players.

It should be noted that a muscular shoulder weakness prompt a higher injury risk (Byram et al., 2010). Moreover, an optimal balance between external rotation strength and internal rotation strength muscles is needed to have a good stability of the glenohumeral joint and to maintain a central position of the humerus, that is to say, it is needed to have a strength muscle balance to avoid injuries (Edouard, Beguin, Farizon & Calmels, 2011; Wang & Cochrane, 2001).

Secondly, talking about ROM, there are studies that suggest shoulder internal rotation decrease with age and years of tennis practice, this is considered as a normal adaption for tennis players (Kibler, Chandler, Livingston & Roetert, 1996). Nevertheless, when a player shows a internal rotation deficit higher than 18-20º between dominant and non-dominant shoulder, beside a reduction of total ROM greater than 5º, the player has a high risk of injury; moreover, it has been exposed that a decrease of total ROM and a higher deficiency of 5º between dominant external rotation and non-dominant external rotation could be a predictor of future injury risk (Manske et al., 2013). In these sense, Wilk et al. (2010) expose similar results, like a shoulder ROM deficit of 5º, increase 2.5 times injury risk in baseball players. Furthermore, a reduction of shoulder internal rotation is associated with shoulder pain in tennis players (Vad, Dines, Gebeh & Norris, 2003).

Last but not least, there are some articles that exposed service depends on shoulder strength and ROM to acquire an optimal service (Cohen, Mont, Campbell, Vogelstein & Loewy, 1994; Clements, Ginn & Henley, 2001; van der Hoeven, 2006). Talking about speed serve, it has been exposed that throw speed on pitchers is related to an increasing risk of injury (Olsen, Fleisig, Dun, Loftice & Andrews, 2006).

If tennis players have not a good balance, it is probably that they begin to feel a shoulder pain, because of a deficit in external rotation strength, an internal rotation deficit or an external rotation gain (Marcondes, Jesus, Bryk, Vasconcelos & Fukuda, 2013).

After a rigorous search process, there are not a lot of articles which show the effect of fatigue on some shoulder risk factors, specifically, only two were found about tennis. The first one exposes that after a fatigue process shoulder internal rotation, total rotation and serve speed decreased, so these tennis players had higher injury risk after the fatigue (Martin, Kulpa, Ezanno, Delamarche & Bideau, 2016). The second one shows a reduction of serve speed after a fatigue test too, but in this case is explain this decrease is because of muscular fatigue and not because of reduction of angular speed of service movement (Martin, Bideau, Delamarche & Kulpa, 2016). Nevertheless, it was impossible to find one that related fatigue and shoulder strength in tennis.

So, the aim of this work is to understand the effects of the fatigue on the variables, which could increase the injury risk on the tennis player shoulder.

The hypothesis to find out in the present study is to understand the effect of a specific fatigue process on the internal and external rotation shoulder strength, internal and external ROM and service speed of shoulder injury risk in professional tennis players.

2. Method

2.1. Participants.

Seventeen male elite tennis players (age; 21.57 ± 4.57: years; weight; 73.18 ± 10.17: kg; height; 1.81 ± 0.08: m; body mass index; 22.30 ± 2.54: kg/m2; years of tennis practice; 12.65 ± 5.53: years; week time training; 19.88 ± 12.30: hours) with an international level participated voluntarily in this study. Every tennis player was right dominant limb, except one of them that was left dominant limb.

In case that some of the participants were injured, he could not be part of the study, as well as, if some of the participants were injured during the study, he would not be a component of the present study.

Participants, and coaches too, were informed about the procedure of the current study, moreover, the coaches would be reported about some information of their own tennis players to improve their training or to know the condition of their players.

2.2. Data collection.

The exercise consisted of a single tennis match. It was let a warm up passing balls with a low intensity, which lasted around 5 minutes.

Once warm up had ended players started the match, which consisted of playing a match, which finished when the score showed 2 sets in the match, it does not mind who won or lost. The test was done in winter, to be more specific in February.

The tennis players played matches in two times, first time 11 players played their matches and later started the other 6 ones. The first group of players started at ten o'clock, whether the second group started when the others finished, the match time was 1.17 ± 0.22 hours. The players were paired with partners with a similar game level, to get fatigued at the end of the match, all of them. Finally, the players were instructed to play the best they could, to get a fatigue state.

The ways to measure the variables were repeated twice, that is to say, once they were done to the pre-test values, and the other time, at the end of the fatigue test, to obtain post-test values. To get the best possible values 2 measures were done in each time, with the objective of catch the greatest value of the measurements. In this way, it could be possible to compare the fatigue effects about shoulder ROM, shoulder strength and serve speed.

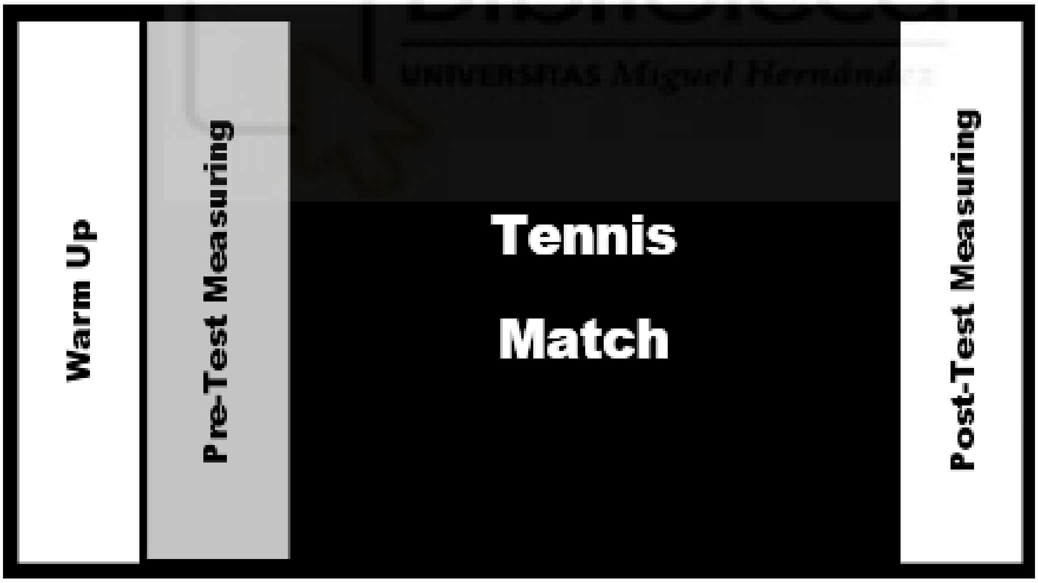

Figure 1. This image exposes the procedure of the process of measurements and fatigue test.

2.3. Measurements.

Questionnaire.

A questionnaire was passed to participants to collect different characteristics such as upper limb dominant side, experience of tennis practice, age, hours per week of training, and body constitution, por example, weight, height and body mass index. Moreover, it was written down the time that the test lasted.

Warm-Up.

The warm-up was based on some dynamic stretching, such as, straight leg march, forward lunge with opposite arm reach, forward lunge with an elbow instep, lateral lunge, trunk rotations, multidirectional skipping. The procedure lasted 6-8 minutes and consisted of performing 3 sets, starting with low intensity to higher, with a 15 second to rest between each set. Furthermore, the way to do the exercise was performed in a controlled manner, doing it always with a ROM required in the sport (Ayala et al., 2016; Thompsen, Kackley, Palumbo & Faigenbaum, 2007).

Shoulder ROM test.

Using a manual inclinometer (ISOMED inclinometer, Portland, Oregon) of the dominant and non-dominant limbs, the passive shoulder IR and ER ROM were measured. The player had to be in supine on a bench with the shoulder abducted and elbow flexed to 90º. Sort of the mid-point of the distal end of the forearm, the inclinometer was placed to measure the IR and ER ROMs. The forearm had to be in a pronated position all the time. From this position, a researcher held the participant's clavicle and scapula against the bench to stabilize the scapula while the humerus rotate in the glenohumeral joint to obtain maximum passive IR and ER.

The test of IR and ER ended when the scapula was felt to move following the methodology explained by Clarsen et al. At the end, subjects did two maximal trials of IR and ER ROM test for each limb, that were recorded and the mean score for each one was used in the analyses.

Shoulder strength test.

Shoulder ER and IR strength were measured with a hand-held dynamometer (HHD) (Nicholas Manual muscle test, Co, Lafayette IN; range 0–500 N, sensitivity 0.2 N) in a supine position on the bench with the arm in 90º of abduction and 0° of rotation, in the scapular plane. The elbow was flexed in 90° and the examiner stabilized the humerus by pressing it down towards the bench, then the angle was checked by a visual inspection. On the one hand, the player externally rotated the shoulder against the HHD, for ER strength, whereas the HHD was located proximal to the ulnar styloid process. On the other hand, for IR strength, the player internally rotated the shoulder, against the HHD, whereas the HHD was located proximal to the radius styloid process. The dynamometer was fixed to a structure with wall support so as to avoid any interference in the stabilization, as explained Saccol et al. The isometric strength test consisted of 3 ER and IR repetitions of a 5s maximal effort, with 30 s rest between each trial. The peak of each repetition was considered. The mean of the three repetitions was calculated and normalized respect to their body mass and was used to assess ER, IR strength and ER/IR strength ratios. The HHD was calibrated according to the manufacturer's specifications prior to each test.

Serve speed.

The serve speed was measured by a radar gun (model SR3600, Homosassa, FL, USA; range 80 to 232 km/h, sensitivity ± 0.44 m/s). The radar gun was used in mode "Peak" to locate maximal ball speed. Before each session, the radar gun always had to be calibrated in accordance with the manufacturer's specifications. The radar was settled down on the center of the baseline, 4 m behind the server, aligned with the height of ball contact approximately (~ 2.2 m), and pointing down the center of the court. Before each player served 10 times to the advantage court with a 30 s rest between each of them, they did a brief warm-up for the joints involved in the service motion (i.e., dynamic movements in the shoulder, plus five slow services. To be admitted, serves had to fall into the service box. Finally, the fastest service was chosen to make analyses.

2.4. Statistical analysis.

Standard deviations and means were calculated for all variables in this study. Strength ratios were calculated automatically by the computer. T-tests were used to compare the data before the fatigue test and the data after the fatigue test, as well as, the data between both shoulders. Statistical significance was accepted at $P < .05$. The statistical analysis was undertaken by using the IBM SPSS Statistics 24 software.