WRIST POSITION AFFECTS HAND-GRIP STRENGTH IN TENNIS PLAYERS

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In tennis the wrist is required to be in different degrees of orientation at ball impact depending on the stroke and type of shot being hit. To date, little is known about the interplay between wrist position and grip strength, despite the fact that hitting the ball and firmly holding the racket when the wrist is flexed has been suggested as factor predisposing tennis players to lateral epicondylitis. The aim of this study was to investigate the effect of different wrist positions on isometric grip strength at self-selected grip size. Thirty-seven tennis players performed three isometric contractions at each of the following wrist positions: neutral, extension, flexion, ulnar deviation and radial deviation. Maximal isometric grip force was measured at each wrist position with the use of a hand-held grip dynamometer and then the highest value at each position selected for analysis. Our results are as follows: at neutral the force exerted was 80.2 ± 22.07 (mean ± sd) kg, at wrist extension 56.99 ± 18.40 kg, at wrist flexion 33.96 ± 9.47 kg, at radial deviation 56.26 ± 19.39 kg and at ulnar deviation 56.64 ± 17.60 kg. Our findings show that, compare to the position defined as neutral, the maximum isometric force exerted by the fingers' flexor muscles is significantly affected (lowered) by wrist position ($p<0.001$).

KEY WORDS: Tennis, grip strength, wrist position

INTRODUCTION: Tennis strokes are performed by holding the racket while the wrist is in different degrees of orientation and depending on the stroke and type of shot being hit players have to manage grip forces and racket control at ball impact. While there are only six main strokes in the game of tennis (serve, forehand/backhand groundstroke, forehand/ backhand volley and smash) there are multiple variations in technique within these strokes. Technique, as well as wrist position, will vary depending on the individual playing style, the type of ball received and the type of shot a player wishes to produce. The two major factors affecting wrist position on ball strike are 1) impact point and 2) grip technique chosen by a player.

As pointed out by Rettig (2002) at ball contact on the serve the wrist is in extension and ulnar deviation, while during the forehand groundstroke and volley the wrist is usually extended and in ulnar deviation on impact with more advanced players showing a greater degree of extension compared to beginner players. In addition, players using a 'western grip' technique have a greater degree of ulnar deviation on contact with the ball compared to those using an 'eastern grip'. On the backhand groundstroke and volley the wrist of experienced players is in extension and 2-5º radial deviation at ball impact compared to novice players who tend to contact the ball in wrist flexion, a faulty and potentially harmful backhand groundstroke technique (Blackwell 1994).

Grip forces exerted by fingers flexor muscles are isometric and accordingly to the force-length relationship a tennis player should hit the ball when the forearm muscles are at a quasi-optimal length in order to reduce the relative strength used, increase control and minimise muscles and soft tissues overload. Surprisingly, the amount of information available from the scientific literature is limited and little is known about the relation between wrist position and grip strength in tennis players. Therefore, aim of the present study was to measure maximum isometric grip strength at five different wrist positions: neutral, extension, flexion, ulnar deviation and radial deviation.

METHODS: Thirty-seven healthy tennis players (male, age range 16 to 52 years) with no current or recent (< 6 months) hand, wrist or elbow injury participated in the study. Subjects tested were tennis players of various playing levels ranging between international (10), advanced (13) intermediate (12) and beginner (2) standards. The instrumentation used to measure isometric grip force was a hydraulic hand-held dynamometer with a dual scale readout displaying grip forces in kg and lb. The dynamometer we used has only discrete adjustable sizes so, as additional inclusion criterium participants self-selected grip size had to be 4½ inches. Subjects were tested in five different wrist positions which included neutral, maximal extension, maximal flexion, maximal ulnar and maximal radial deviation. For each wrist position subjects were instructed to move their wrist into the “end active range of motion” position, while holding the hand-dynamometer. They were then required to produce three two second maximal isometric grip efforts. Before each trial, subjects were asked to further move their wrist, while keeping the end range of motion position, to check the position was maximal and the trial recorded only when subjects were unable to further move the joint. We then selected the highest value out of three trials.

Data Analysis: A one-way repeated-measures ANOVA and a Bonferroni post-hoc test were performed to compare neutral versus other wrist positions grip strengths. An alpha level of 0.05 was used to denote statistical significance.

RESULTS: At neutral, fingers flexor muscles isometric grip force was 80.2 ± 22.07 kg (mean ± sd). At wrist extension hand grip force was 56.99 ± 18.40 kg, at wrist flexion 33.96 ± 9.47 kg, at radial deviation 56.26 ± 19.39 kg and at ulnar deviation 56.64 ± 17.60 kg.
The results show that wrist position affects the isometric force exerted ($F = 80.12$, $p<0.001$)
Post-hoc analyses revealed that the force the fingers’ flexor muscles are able to exert isometrically, i.e. holding a hand grip of the same size of self-selected tennis hand grip, is lower at extension ($p<0.001$), flexion ($p<0.001$), ulnar deviation ($p<0.001$) and radial deviation ($p<0.001$) compared to the force exerted at neutral position. Wrist flexion was the position at which the highest force exerted was maximally lowered.

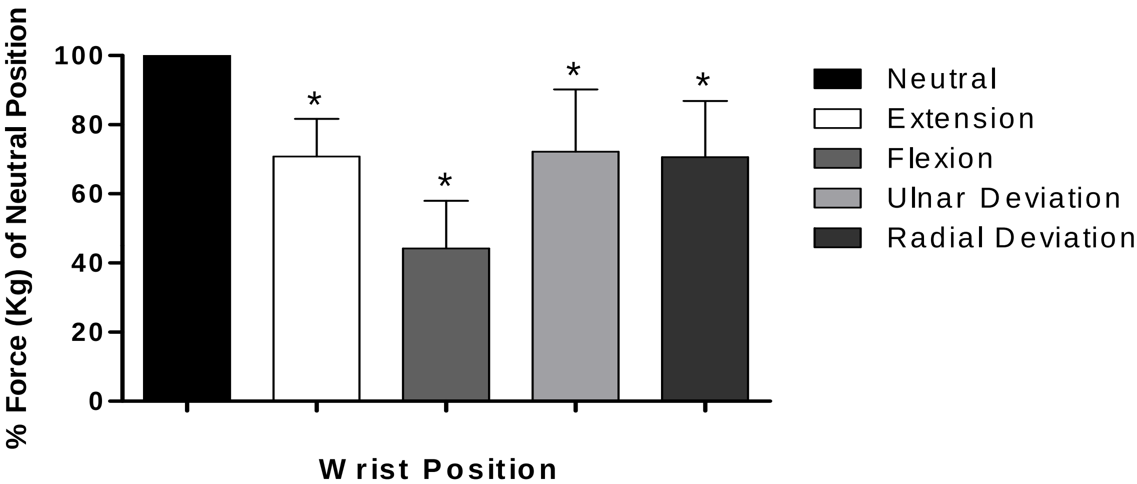

Figure 1: Grip strength at different wrist positions expressed as percentage of the maximum force produced with the wrist joint in neutral position.

DISCUSSION: Overuse of the extensor carpi radialis brevis (ECRB) muscle, one of the muscle determining wrist joint extension, can result in lateral epicondylitis by repetitive overloading microtraumas (Kraushaar, 1999). In a tennis player lateral epicondylitis is believed to result from the force of repetitive impacts between the racket and the ball, combined with a lack of wrist stability during the backhand stroke (Hatch, 2006). In the present study grip strength of male tennis players of various standards was significantly lower at all the wrist positions compared to neutral. The main possible explanation of these findings is that, taking for example wrist flexion, the position at which the grip strength showed the lowest values, the fingers flexor muscles are at a length which is not optimal to develop the highest force. Additionally, the wrist and fingers extensor muscles could play a role in limiting the force exerted by fingers flexors due to their length: when the wrist joint is in maximal flexion (and fingers flexed) wrist and fingers extensor muscles are almost at their physiologically maximal length and the fingers' flexors have to overcome this passive resistance to develop force. It's is likely that such a reduced strength could result in poor racket control and grip stability, which could be key factors in predisposing novice tennis players to repeated overloads whilst, for example, performing one-hand backhand strokes. Therefore, it is reasonable to suggest that at ball impact, being 'extreme' wrist positions associated with higher vulnerability, wrist position should be close to neutral, the position allowing to produce the highest hand grip force, in order to minimise soft tissues overloading. For these reasons, the results of the present study may have implications for a better understanding of the mechanism of wrist and forearm soft tissues injuries in tennis. Our findings adds further weight to previous studies which have proposed faulty backhand technique, i.e. with the wrist in flexion at ball impact, as a possible mechanism determining a sudden ECRB elongation, and provides a useful information to plan a training programme aimed at improving strength (and racket control) when the player has to hold the racket with the wrist in flexion, extension, radial deviation and ulnar deviation.

CONCLUSION: Our results showed that wrist position significantly affects the hand grip force that tennis players are able to produce and this reduced strength might play an important role in predisposing tennis players to repeated overloads, by decreasing racket stability and control. The information provided by our study is especially useful to novice tennis players or to those with poor backhand technique, i.e. prone to hit the ball when the wrist is in a position which is not neutral. Our findings also suggest that a specific training aimed at increasing forearm muscles strength at different wrist positions could be helpful and should included in tennis conditioning programmes to reduce the risk of soft tissues overloading.

Further research should investigate the effects of a different grip size on the hand grip strength exerted to hold and control a tennis racket.

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