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Tennis Elbow Injuries in Recreational Tennis Players

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Abstract. Lateral epicondylitis (tennis elbow) has a prevalence rate of up to 50% among recreational tennis players, making it a common sports injury in this population. This paper systematically reviews relevant studies in recent years to analyze the pathological mechanisms, injury inducing factors, and prevention/control measures of tennis elbow in recreational players. The pathology of tennis elbow mainly involves degenerative changes and chronic inflammatory responses of the extensor carpi radialis brevis tendon. For recreational players, the high incidence of tennis elbow is attributed to abnormal elbow muscle activation patterns caused by incorrect technical movements, excessive compensation of muscle groups induced by forearm muscle fatigue, and neuromuscular control deficits. Based on the above mechanisms, comprehensive measures such as optimizing technical movements, scientifically managing training-induced fatigue, improving neuromuscular control, and strengthening core and shoulder girdle stabilizer muscles can be adopted to prevent injuries. Future research should strengthen comparative studies among populations with different sport levels to provide a basis for precise prevention and control.

Keywords: Tennis Elbow, Recreational Tennis Players, Injury Prevention.

1. Introduction

Lateral epicondylitis, also known as tennis elbow, is a common elbow injury that occurs more frequently in recreational tennis players. A follow-up study of 194 active recreational tennis players found that 50% of them had suffered from tennis elbow, indicating that this condition is highly prevalent in this group [1]. Repetitive wrist extension or gripping movements often trigger this injury, leading to pain on the lateral side of the elbow and impairment of normal limb function. Compared with the well-developed motor systems of professional athletes, recreational tennis players have not received standardized professional training, and their force-generating methods and technical movements are often incorrect. As a result, the forearm extensor muscles are subjected to excessive and prolonged stress, increasing the risk of tennis elbow.

The pathological mechanism of tennis elbow is complex. Traditional studies mostly considered this condition to degenerative changes of the extensor carpi radialis brevis tendon, with pathological manifestations including abnormal arrangement of collagen fibers and observable angiogenesis [2]. In recent years, researchers have found raised levels of macrophages and pro-inflammatory

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cytokines at the tendon origin in patients with chronic tennis elbow, suggesting that inflammation is also involved in the chronic pathological process [3,4].

Existing studies have mainly focused on the diagnosis and treatment of tennis elbow, or mechanical and technical analyses targeting professional athletes. Systematic reviews and analyses of the large group of recreational players are relatively scattered. Therefore, this paper intends to explore the differences in tennis technical movements, the mechanisms of tennis elbow in recreational players, analyze its particularities, and discuss prevention measures, in order to provide references for the healthy participation of recreational tennis players and clinical practice.

2. Differences in elbow muscle activation patterns

2.1. Technical differences lead to variations in elbow neuromuscular activation patterns

The muscle activation patterns and biomechanical loads vary across practitioners with different levels of skills as they perform important movements like forehand serve reception. There is also a possibility that the level of technicality of the recreational tennis players can influence the activation pattern of elbow muscles and, consequently, their vulnerability to tennis elbow injury [5]. In 2022, Zhang et al. assessed the kinematics of practitioners with a motion capture system. The results indicated that when executing serving motions, practitioners with greater technical skill could use all the available kinetic energy of their trunks and shoulders to lessen the burden on their elbow joints. When serving at high speeds, more advanced practitioners decrease the duration of the backswing time, rapidly raise the upper arm, internally rotate the forearm, increase the rate of wrist movement and coordinate the rate of adduction of the shoulder and internal rotation of the elbow to finish the follow-through. Such changes in movement are the main principles of biomechanical loading optimization. The efficiency of elbow muscles may be increased through kinematic adjustment and unnecessary muscle activation may be decreased.

A study selected ITN 3 professional players and ITN 8 recreational players as research subjects, and comparatively analyzed their forehand serve reception performance under two serving speeds: 130–140 km/h and 160–170 km/h. Surface electromyography was used to record the activity of eight muscles: biceps brachii, triceps brachii, brachioradialis, deltoid, trapezius, pectoralis major, external oblique, and latissimus dorsi.

The results showed that the muscle activation levels of the professional group were significantly lower than those of the recreational group during the backswing, hitting, and follow-through phases (p 05). Despite the lower muscle activation, the professional group achieved significantly faster return speeds and higher placement scores ($p < 0.05$).It means that professional athletes are able to minimize non-essential muscle contractions during more fine-tuned technical actions, full swing with maximally efficient movement, and consequently, they can have higher return velocity and more accurate placement control. By contrast, the recreational group of ITN 8 showed increased muscle activity at serve reception and decreased regularity in the motor pattern of active muscles, which could not only interfere with hitting quality but could enhance the risk of overuse injuries [5]. In various conditions of serving speed, top-level players also had quicker rate of trunk rotation, larger range of shoulder joint motion, higher range of wrist flexion and extension and higher rate of forearm internal rotation and adduction. All these technical properties constitute the foundation to their effective and consistent serve reception performance. These differences in kinematics can optimize the efficiency of work of elbow muscles, decrease superfluous muscle activation, and reduce the likelihood of tennis elbow. It is advisable that recreational tennis players maximize the efficiency of serve reception movements through technical training, using a movement pattern that

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has minimal muscle activation and maximal kinetic energy of joints. In particular, it involves reducing the length of backswing, fast elevation of the arm and internal rotation of the forearm, increasing the speed of wrist movement, and regulating the rate of shoulder adduction and elbow internal rotation to finish the follow-through.

2.2. The impact of fatigue on elbow muscle activation patterns

A second major element of causing the elbow injuries among recreational tennis players is the forearm muscle fatigue, which may change the activation pattern of the elbow muscles and predispose the injury. Available evidence indicates that fatigue has an impact on dominant forearm of ITN 8-level recreational tennis players with substantial variations in the angle of the elbow joint and dominant arm syndrome. As part of the preparation stage in the tennis serve, the extensor carpi radialis (ECR) activity rises when fatigued, which might help in the completion of the grip release movement and stabilization of the wrist, but may also hinder the accuracy in controlling the ball in the overhand motion and raise the likelihood of possible injuries [6,7].

When the wrist is extended in the service, the contraction of the extensor carpi ulnaris (ECU) and extensor carpi radialis (ECR) muscles is very high, particularly when fatigued, which assists in stabilizing the wrist joint and racket handle, to assist in acceleration and striking [6]. An experiment was conducted with 12 professional players (ITN 3) and 11 non-professional tennis players (ITN 8) who undertook serving exercises in non-fatigued and fatigued states. It was found that in serving technology, the muscle activity of the extensor carpi ulnaris (ECU) and extensor carpi radialis (ECR) increased significantly during the extension phase (p 0.010); this increase was even more pronounced under fatigue. The dominant forearm of recreational tennis players was also affected greatly by fatigue, as indicated by the presence of significant differences in elbow joint angle and the dominant arm syndrome [6]. One other study demonstrated that in the preparation stage of serving in tennis, the extensor carpi radialis (ECR) activity significantly rose in conditions of fatigue and peaked at a higher level ($p = 0.022$) [7].

In fatigue, recreational tennis players have a tendency of over-activating particular muscle groups in order to keep up with their hitting performance. These kinds of compensatory actions raise the probability of overload on the elbow joint. Recreational tennis players should focus on fatigue-triggered alteration in activation patterns, plan training loads in an ascending way, provide sufficient rest, engage in appropriate muscle strength training that will enhance the fatigue resistance of the forearm muscles, optimize the levels of neuromuscular control, prevent the overloading of the elbow joint and minimize injuries [8].

3. Neuromuscular control deficits

Studies have shown that patients with chronic tennis elbow generally have neuromuscular control deficits, which can further amplify functional disorders and exacerbate pain perception. Clinical evaluation data indicate that patients have greater task errors and force fluctuations during force output, reflecting a significant decrease in the accuracy of muscle strength regulation [7]. Electromyographic data show that the amplitude of motor unit action potentials of the extensor carpi radialis brevis and extensor carpi radialis longus in patients is lower than that in the healthy control group, with a shift in motor unit composition: a higher proportion of low recruitment threshold motor units (corresponding to thresholds below 5% MVC) and a lower proportion of high recruitment threshold motor units (corresponding to thresholds above 40% MVC) [8]. This suggests that when patients need to output explosive force or large strength, they cannot effectively mobilize

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high-threshold motor units and can only rely on the overactivation and increased discharge rate of low-threshold motor units to generate compensatory strength [7]. Studies have pointed out that this abnormal force generation often stems from pathological changes in tendon structure, i.e., degenerative changes in the high-threshold motor units of the wrist extensors [7].

In tennis, repeated racket gripping and wrist extension are required to play the ball, which can further exacerbate such neuromuscular abnormalities. When high-threshold motor units are insufficient, small motor units need to compensate by increasing their discharge frequency, leading to an increased risk of injury [8]. Therefore, for recreational players, optimizing neuromuscular control through targeted training and avoiding overactivation of the extensor carpi radialis brevis is a key strategy to reduce elbow joint load and the occurrence of injuries [8].

Although neuromuscular control deficits have been widely recognized as an important inducement of tennis elbow, current research on differences in this deficit among populations with different exercise levels is still limited. Specifically, there is a lack of systematic direct comparative studies on whether there are essential differences in neuromuscular control characteristics between professional athletes and recreational players in the state of chronic tennis elbow, which also makes the formulation of targeted intervention measures lack empirical basis and requires further exploration in the future.

4. Prevention and recommendations

4.1. Improve technical proficiency

Technical training can reduce unnecessary muscle tension, develop more efficient kinetic chain transmission, improve joint kinetic energy, and cultivate stable dominant muscle activation patterns [9], thereby reducing the risk of tennis elbow. Specific technical adjustments can be carried out in multiple dimensions: shortening the duration of the backswing movement, quickly lifting the upper arm and internally rotating the forearm, accelerating wrist movement speed during the hitting phase, and adjusting the speed of shoulder adduction and elbow internal rotation to complete the follow-through [9,5].The changes described may decrease the burden on the elbow joint and create a more effective pattern of activation. The clinical research conducted by Gutiérrez-Espinoza et al. in 2024 proved that the exercise training of the scapular stabilizer muscles could enhance the perception of pain and optimize the functioning of the limbs in patients with chronic lateral epicondylitis (tennis elbow) [1], which suggests there is a strong correlation between the ability to control the proximal limb and the health of the distal elbow. The injury prevention training arrangement must not be confined to the forearm alone, but may contain information on the overall neuromuscular control of the core and shoulder girdle.

4.2. Address fatigue issues

Training loads may be gradually added to daily training schedules to prevent dramatic increases in the level of exercise intensity and length, and it is important to provide enough rest between training sessions and competitions [9]. The training may aim at strengthening the muscles of the wrist extensors so as to reduce fatigue. Adjustment of muscle coordination and control skills can be done through neuromuscular control methods [9].

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4.3. Correct neuromuscular control deficits

Enhanced playing skills may also minimize the presence of these problems. The whole-body strength can be exercised when performing the hitting movements without necessarily using the upper limb strength alone. Under professionals instructions adjust the movements to reduce unnecessary muscle tension, involve larger muscle groups like the trunk and legs more actively in force generation and unload the forearm [9]. Attempt to reduce the time spent on the preparation of the swing, raise the upper arm rapidly, coordinate with the internal rotation of the forearm, apply explosive force during the hit, and not continuous rigid force, smooth shoulder and elbow movements are maintained in the follow-through stage, and abrupt stops are avoided [9]. Such modifications could assist practitioners in developing an effective and consistent muscle strength utilization pattern and in carrying out specialized training with good fatigue control. There should not be a sudden increase in training intensity and adequate time should be given to allow the muscles to adapt and heal. Add slow and precise exercises, low-load, to develop the ability to control fine muscles, enhance muscle coordination and stability and decrease abnormal tremors during force generation [9]. Control the number of times you use the extensor carpi radialis brevis (ECRB) and extensor carpi radialis longus (ECRL) in your daily training, and address the bad habits of incorrect muscle recruitment [8]. According to the findings of a randomized controlled trial, the intervention of â€œtendon neuroplastic trainingâ€ is a neuromuscular intervention that can relieve pain and improve functional strength in patients with tennis elbow. Following this training, patients demonstrated quantitative changes in pain scores (Visual Analogue Scale, VAS) and functional scores, such as grip strength and specific sports performance. The trial outcomes support the usefulness of neuromuscular training in the prevention and management of tennis elbow in their daily lives [10].

5. Conclusion

This paper systematically reviews the causes, mechanisms, and prevention/control strategies of the high incidence of tennis elbow in recreational tennis players, reaffirming the core issue that this group has a significantly higher prevalence of tennis elbow than professional athletes due to the lack of professional training and incorrect movements. The innovation of this paper lies in focusing on the specific group of recreational tennis players, identifying three key pathogenic mechanisms (technical differences, muscle fatigue, and neuromuscular control deficits), and constructing a comprehensive prevention system combining technical standardization, load management, and precise control, breaking through the limitations of existing studies that mostly focus on diagnosis and treatment or professional athletes. The research value is reflected in clarifying the special pathogenic logic of tennis elbow in recreational players, proposing actionable comprehensive prevention and control plans, and providing theoretical support for the public to participate in tennis healthily and for clinical formulation of targeted rehabilitation strategies. The study has certain limitations. Currently, direct comparative studies on the pathogenic mechanisms and neuromuscular control characteristics of tennis elbow among populations with different exercise levels are still lacking. In the future, large-sample, multi-angle controlled studies need to be conducted to further reveal group differences and provide more sufficient empirical basis for personalized and precise prevention, control, and rehabilitation of tennis elbow. In summary, tennis elbow in recreational tennis players is the result of the combined effect of multiple factors, and its prevention strategy should be a comprehensive intervention system integrating technical standardization, scientific load, and precise control. Future research should further carry out direct comparisons between

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professional athletes and recreational players, explore in depth the differences among populations with different exercise levels, and provide a solid empirical basis for formulating more targeted and personalized precise prevention and rehabilitation plans.

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