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Volleyball spike: common injuries and its rehabilitation

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Abstract. Volleyball is a globally popular sport, with spiking being a critical offensive technique that contributes significantly to scoring. However, spiking is also associated with a range of injuries due to repetitive motion, overuse, and sudden trauma. These injuries commonly affect various body parts, including the knees, ankles, shoulders, fingers, and wrists, and involve different tissues, such as bones, ligaments, and tendons. This review examines the mechanisms underlying spiking-related injuries and provides an overview of the common injuries sustained by volleyball players. It also discusses the rehabilitation principles used to promote recovery and prevent re-injury. Rehabilitation typically involves a multi-phase approach, starting with pain management and swelling reduction, followed by muscle strengthening, load progression, and functional training. The final stages focus on sport-specific movements to ensure athletes can safely return to play. A comprehensive understanding of injury prevention, along with proper training and rehabilitation, is essential for coaches and athletes to minimize injury risks and enhance recovery outcomes, ultimately ensuring a faster return to performance and reducing the likelihood of future injuries.

Keywords: Volleyball Injury, Spiking injury, Rehabilitation techniques: Return-to-sport training.

1. Introduction

Volleyball is a popular sport worldwide in all sexes and ages since it was invited. In 1997, more than 200 countries and 150million players are in the Federation Internationale de Volley-Ball (FIVB) [1]. From 1997 to nowadays, the popularity of this sport has been enduring and even increased as more people get to know volleyball.

Unlike many other ball games like basketball and football, volleyball is a non-contact team sport with six players on each side of the net. This whole game involves violent movements such as blocking and teamwork between players. Using these movements, athletes and coaches creates various combination and strategies for both defending and attacking, which make the competition more and more exciting.

Spiking, a critical offensive technique in volleyball, is one of the key factors contributing to the sport's growing popularity. This technique involves athletes jumping vertically and forcefully striking the ball over the net to make it land quickly in the opponent's court. Despite its apparent simplicity, spiking carries a relatively high injury incidence rate due to the significant forces generated on both the ball and the athletes. Among the essential movements in volleyball (blocking, spiking, setting, passing, and defensing), spiking accounts for the second-highest percentage of injuries (approximately 30%), which is significantly higher than other movements such as setting, passing, and defensing (each less

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than 5%) [2]. The most common injury locations are the knees (30%), ankles (26%), fingers (22%), and back (17%) [3]. Many of these injuries have the potential to significantly impact an athlete's career and on-court performance.

Therefore, it is crucial to understand the common injuries associated with spiking and the corresponding rehabilitation techniques to maximize the chances of full recovery, facilitate a return to play, and reduce the risk of reinjury over the subsequent years. With this objective in mind, this review aims to examine the common injuries associated with spiking and introduce recent rehabilitation techniques employed to treat these injuries, providing valuable insights for athletes and coaches.

2. Injuries

2.1. Knees

2.1.1. Patellar tendonitis (Jumper's knee). Patellar Tendonitis (PT) is an overuse injury resulting from the repetitive load on the patellar tendon due to the extensor mechanism during frequent jumping and landing, leading to inflammation in the tendon. The main symptoms of PT include a combination of pain, diffuse or localized swelling, and partial dysfunction in severe cases [4]. These symptoms can occur spontaneously without obvious signs of overuse and may also be associated with other medical or physical conditions.

According to Zwerver et al., the prevalence of PT in various sports is as follows: volleyball - 14.4%, handball - 13.3%, basketball - 11.8%, track and field - 6.9%, field hockey - 5.1%, korfball - 4.8%, and soccer - 2.5% [5]. Based on these data, it can be concluded that jumping activities are among the primary causes of PT. PT can be diagnosed using MRI or CT imaging of the knee joint, along with clinical examination through palpation [4].

2.1.2. Anterior cruciate ligament tear. The Anterior Cruciate Ligament (ACL) is a crucial ligament in the knee joint that prevents excessive forward and backward movement, providing stability to the knee. Since volleyball is a non-contact sport, ACL tears are typically caused by the knee experiencing multiplane loading during sudden acceleration or deceleration. Particularly during stop-and-jump movements, such as when athletes are preparing to spike, the direction of force changes from forward to perpendicular, creating a multi-angle load on the ACL [6].

ACL tears are often characterized by a popping sound in the knee joint, followed by immediate pain and swelling. Athletes may experience knee instability and limited mobility. The diagnosis of an ACL tear can be performed using several knee tests, including the Lachman test, Anterior Drawer test, and Pivot Shift test, along with medical imaging, such as MRI or CT scans, to assess the structure and tissues of the knee joint [4].

2.2. Ankles

2.2.1. Ankle sprain. Ankle sprain is a common injury in volleyball, typically caused by ankle inversion during jumping and landing. Major risk factors include playing positions requiring frequent jumping and landing (e.g., opposite hitter, 38.1%), wearing footwear without adequate cushioning (23.7%), left lower limb dominance in jumping (23.5%), and a peroneus brevis electromyographic response time greater than 80ms (11.8%) [7]. The presence of multiple risk factors increases the likelihood of ankle sprains during training and competition.

Three physical examination techniques can be used to diagnose the severity and ligament involvement of an ankle sprain: the anterior drawer test, the crossed-leg test for high ankle sprains, and the inversion stress test [8]. These tests are specific for diagnosing different types of ankle sprains. Additionally, ankle sprains are classified into three grades of severity: Grade I involves no ligament tear, minimal dysfunction, and mild pain and swelling; Grade II includes partial ligament tears, moderate

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dysfunction, and pain and swelling; Grade III features complete ligament tears, significant dysfunction, and severe pain and swelling [8].

2.2.2. Ankle fracture. Ankle fracture is a musculoskeletal injury that contribute to a great part in ankle injury. The injury typically results from a rotational movement with external force transmitted through the foot to the malleoli, such as when planting the foot and changing direction on the ground. There are two main types of ankle fracture: ankle fracture-dislocation and non-dislocated ankle fracture. Both types share a similar mechanism of injury, but fracture-dislocations occur when the deforming force continues to act on the ankle's soft-tissue stabilizers [9].

The physical test for ankle fracture can be examined from neurovascular evaluation and the signs of open wounds, swelling, blanching, and so on. Additionally, pre-reduction imaging such as CT or MRI scans can be used to assess the severity of the fracture, the structural integrity of the ankle, and any associated trauma [9].

2.3. Shoulder

2.3.1. Rotator cuff injuries. Rotator cuff injuries are a primary cause of shoulder pain among volleyball athletes. These injuries are caused by repetitive overhead movements, leading to impingement between the acromion and the humeral head. Various types of rotator cuff injuries exist, including tendinopathy, impingement, and dysfunction. According to Ann M.J. Cools and Jonathan C. Reese, shoulder impingement is the most common chronic overuse injury in athletes [10]. Typical symptoms of shoulder impingement include restricted shoulder movement, leading to pathological changes that may result in conditions such as rotator cuff tendinopathy. Impingement is classified into two types: external and internal. External impingement involves compression of the area around the subacromial space, causing a painful arc during abduction. In contrast, internal impingement is a secondary symptom that will lead to a chronic shoulder pain in overhead movement [10].

Volleyball players with rotator cuff injuries typically experience shoulder pain during overhead activities, particularly in the painful arc of abduction between 70˚ and 120˚. However, abduction below 90˚ is usually pain-free. Diagnosing rotator cuff injuries typically involves MRI and ultrasonography, especially when performed by an experienced clinician [10].

2.3.2. SLAP lesions. SLAP lesions, an acronym for Superior Labrum Anterior to Posterior lesions, are a common injury among overhead athletes. These lesions are classified into four main categories based on the severity of the labral tear, with further subtypes identified as research has progressed [11]. During spiking, the eccentric deceleration of the biceps following a spike generates a torsional force at the anchor point in external rotation, contributing to the development of SLAP lesions [11].

The classical symptoms of SLAP lesions are pain localized to the posterior or posterior-superior joint line during abduction, overhead movements and behind-the-arm motions. This injury might also be associated with catching sensation around the shoulder in a static stage [10]. According to Wilk et al., there are several physical examination methods proposed by different researchers and physical therapists. Overall, it should include a complete evaluation around the bilateral range of glenohumeral motion and emphasizes the arc of pain in different shoulder movement [11]. To improve the accuracy of diagnosing, imaging techniques such as MRI and arthroscopy can be employed as supplementary tools.

2.4. Fingers and wrists

2.4.1. Finger ligament injury/contusion. Even though finger injuries are less likely to happen in spiking (5.7%) compare to other movements in volleyball, it still happened and used to be ignored during the play [12]. These injuries are generally caused by insufficient preparation when the fingertip contact with the ball, especially when the finger is not strengthening or when the athletes are doing drop shot, which is a movement of hitting the ball with a relatively less power. These injuries usually caused a pain in the

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finger joint, and might lead to further disfunction and joint instability if the condition is severe. It is crucial to evaluate for fractures and tendon injuries when a contusion occurs, as untreated minor injuries can progress to tendinopathy, potentially causing further damage to the affected fingers [4].

2.4.2. Finger ligament injury/contusion. Metacarpal fracture is a common injury in many ball games, including handball, volleyball and American football. This injury can result from acute trauma that forces the fingers to bend or from direct impact with the ball [4]. Most of the cases will cause pain and inflammation around the injured area, and might be associated with joint deformation or swelling. Metacarpal fractures can be diagnosed by X-rays, which is a classical examination technique used in many fracture cases.

3. Rehabilitation

3.1. Knees

The primary goal of patellar tendonitis rehabilitation is to enhance load tolerance on the tendon and to strengthen the leg and hip muscle groups. The first stage of rehabilitation focuses on pain modulation and load management. During this phase, patients should concentrate on addressing biomechanical impairments of the knee and improving overall flexibility. Patients should engage in self-loading activities that prevent further reduction in the patellar tendon's load capacity [13]. The second stage of recovery emphasizes load progression and muscle strengthening. Research indicates that heavy, slow resistance training and eccentric exercises are effective in enhancing leg and hip muscle strength and improving the mechanical properties of the tendon (De et al., 2020). The final stage of patellar tendonitis rehabilitation involves functional training and a gradual return to sports. At this stage, movements that impose a higher load on the tendon can be reintroduced, and sport-specific activities should be incorporated to facilitate a safe return to athletic participation [13].

Rehabilitation for an ACL tear follows a similar progression but can be divided into non-operative and post-operative rehabilitation. Non-operative treatment primarily focuses on muscle strength recovery and reducing knee instability to prevent re-injury, while post-operative rehabilitation aims to restore muscle control and knee range of motion after reconstruction [14]. As neuromuscular control improves, body-weight exercises can be introduced to further strengthen muscles.

3.2. Ankles

The rehabilitation of ankle injuries typically addresses tendons, ligaments, bones, and muscles. During recovery, ankle bracing or orthotic intervention may be used to maintain stability, provide support, and compress the injured area. Orthotics are particularly important post-surgery, especially when rearfoot motion is altered [15].

The initial goal is to restore the ankle's range of motion through stretching and clinician-assisted manual resistance training under pain-free conditions. According to Mattacola and Dwyer, stretching should begin 48 to 72 hours post-injury to preserve the ankle's weight-bearing capacity. Once swelling is controlled and range of motion is restored, strengthening exercises should focus on weakened ankle muscles, targeting all lower extremity muscle groups.

Once patients can perform these exercises pain-free, balance and postural control training should begin. Equipment like a wobble board, which challenges stability, is useful for this purpose. Exercises that shift from non-weight-bearing to weight-bearing and transition from stable to unstable surfaces further aid in balance training [15]. Finally, return-to-sports training incorporates sport-specific exercises to facilitate a safe return to play.

3.3. Shoulder

The first stage of rotator cuff rehabilitation targets swelling reduction and tissue healing. Techniques like low-level laser therapy, cryotherapy, and therapeutic heat are used to manage pain and inflammation

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in soft tissues. Water therapy can also aid in rehabilitation by providing natural compression during movement [16].

Once pain is controlled, shoulder stretching is introduced to restore range of motion and prevent contractures. These stretches must be gentle and progressive, tailored to the level of impingement and recovery stage. The second stage focuses on improving muscle strength and scapular stabilization before beginning more aggressive rotator cuff strengthening. Muscle-strengthening exercises should not only focus on the scapula but also engage surrounding muscles to restore full range of motion [16].

When full range of motion is achieved, sport-specific movements and resistance training (e.g., using elastic bands) should be incorporated. Push and pull exercises that involve the shoulder facilitate strength recovery, followed by a return-to-sport program.

Rehabilitation for a SLAP lesion closely resembles that for rotator cuff injuries. Conservative treatment should focus on endurance and strength training of the rotator cuff and scapular stabilizer muscles. Posterior shoulder stretching, limiting internal rotation, should also be part of the rehabilitation plan [17].

3.4. Fingers and wrists

Rehabilitation for finger and wrist injuries emphasizes functional recovery and restoring full range of motion. Heat therapy, cold therapy, and electrotherapy are commonly used to address pain and swelling while stimulating tissue repair [18]. Once pain subsides and tissue heals, strength training begins, focusing on exercises that restore range of motion in the fingers and wrists. Resistance exercises, such as ball grip training, help regain strength [18]. Finally, sport-specific exercises, such as spiking practice, are reintroduced to help athletes return to the court.

4. Conclusion

The injuries discussed above can occur not only during spiking but also in other volleyball activities and athletic exercises. They may result from overuse of specific joints, sudden impacts or directional changes during a game, inadequate warm-up exercises, and various other factors. It is crucial for both coaches and athletes to be aware of the potential risks associated with spiking and to understand the mechanisms, prevention strategies, treatment, and rehabilitation techniques for different injuries. This knowledge can significantly minimize the risk of injury during play.

The primary goals of injury rehabilitation are to facilitate full recovery of joint function, ensure a timely return to sport, and reduce the risk of re-injury. Typically, rehabilitation begins with pain management and swelling reduction, followed by progressive strength recovery and resistance training. The final stage focuses on functional training and sport-specific exercises to prepare the athlete for a safe return to competition. Throughout this process, it is important to correct high-risk movements and positions that could contribute to further injury.

Post-recovery, athletes should be educated on injury prevention strategies and encouraged to maintain a healthy routine that includes adequate rest and scientifically designed training programs. By doing so, the likelihood of future injuries can be reduced, ensuring long-term athletic performance and well-being.

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