Common Ankle Injuries in Basketball Training and Prevention Strategies

Bin Xiao, Haiyong Lu
College of Physical Education and Health, Guangxi Normal University, Guilin, Guangxi, China

Abstract: Ankle injuries occur frequently in basketball, and after the first injury, a considerable proportion of athletes develop chronic ankle instability, which seriously affects training participation, competitive performance, and long-term health. This paper systematically analyzes the main causes of ankle injuries in basketball training, including inherent anatomical asymmetry, periankle muscle strength imbalance and neuromuscular control deficits, improper landing and cutting techniques, inappropriate training load arrangement and external environmental factors such as playing surfaces and equipment, as well as psychological and behavioral factors including fear of reinjury, sleep deprivation, and neglect of early pain. Based on this analysis, a multi-level prevention strategy covering the entire training cycle is proposed from a multidisciplinary perspective: activating joints and nerves through a four-stage neuromuscular dynamic warm-up; reshaping safe movement patterns by correcting landing and cutting postures using real-time feedback technology; constructing a strength balance training program centered on the periankle muscles; optimizing footwear selection and court management to achieve shoe-court synergistic protection; managing training intensity through periodized load regulation and fatigue monitoring; and integrating psychological interventions into the prevention system to alleviate fear of reinjury. This paper also discusses practical challenges in strategy implementation, including time fragmentation, differences in coach cognition, facility constraints, and collaboration costs, and points out that intervention parameters need to be further refined for adolescent and female athletes. Research indicates that a comprehensive prevention strategy centered on neuromuscular control and integrating sports medicine, training science, biomechanics, and psychology can effectively reduce the incidence and recurrence rates of ankle injuries. It is recommended that basketball teams at all levels incorporate the above measures into their daily training protocols, establishing a whole-cycle, closed-loop ankle health management ecosystem to achieve safer training, improved performance, and extended athletic careers.

Keywords: Basketball; Ankle Injury; Technical Movement Optimization; Prevention Strategy

1. Introduction

Basketball is characterized by high intensity, multi-directional movements, rapid changes of direction, and intense physical confrontation. Athletes frequently perform technical actions such as abrupt stops, jumps, landings, lateral cuts, and body collisions during training and competition, which impose repeated and complex mechanical loads on the lower extremities, especially the ankle joint. As a core link connecting the lower limb and the foot, the ankle joint not only bears the functions of weight transmission and ground reaction force buffering but also must achieve fine postural regulation under dynamic conditions. However, precisely due to the inherent anatomical asymmetry of the ankle joint – the relative weakness of the lateral ligaments versus the strong medial deltoid ligament, and the anterior width and posterior narrowness of the talar trochlea leading to decreased stability in plantarflexion – combined with the extremely high demand for timely neuromuscular control during movement, the ankle joint has become one of the most vulnerable sites in basketball training. Clinical observations and epidemiological surveys consistently show that lateral ligament sprains are the most common type of ankle injury, and after the first injury, a considerable proportion of athletes develop chronic ankle instability, characterized by recurrent sprains, a feeling of the joint "giving way", decreased proprioception, and limited athletic performance. This problem is particularly prominent among adolescent and professional players and has long been a focus of attention in the fields of sports medicine and training science. the occurrence of ankle injuries is not caused by a single factor but results from the interaction of multiple factors including anatomy, physiology, technique, environment, and psychology. Intrinsic factors include periankle muscle strength imbalance and neuromuscular control delay, which prevent athletes from generating effective antagonistic responses in time under sudden inversion forces; improper landing and cutting techniques, such as insufficient knee flexion and deviation of the center of gravity from the safe range, further amplify injury risk. Extrinsic factors include inappropriate training load arrangement, fatigue accumulation, slippery or aged court surfaces, insufficient shoe support, as well as psychological and behavioral factors such as athletes' neglect of early pain signals and fear of reinjury. These factors interact and superimpose, leading to an exponential increase in injury risk. Although research on ankle injury prevention has grown in recent years, and various interventions – such as neuromuscular warm-ups, strength balance training, technical movement correction, equipment optimization, load periodization, and psychological interventions – have been proven effective to some extent, in actual training environments these strategies are often implemented in a fragmented manner without systematic integration, and are constrained by practical limitations such as training time fragmentation, differences in coach cognition, poor athlete compliance, and insufficient multidisciplinary collaboration. Moreover, athletes of different ages, genders, and skill levels show significant differences in injury risk profiles and intervention needs, and stratified, graded precision prevention guidelines have not yet been established. Therefore, systematically sorting out the main injury mechanisms of ankle injuries in basketball training and, based on this, constructing a comprehensive prevention strategy that covers the entire training cycle, integrates multidisciplinary perspectives, and addresses both physiological and psychological aspects has important theoretical value and practical significance for reducing injury incidence and recurrence rates, extending athletes' careers, and enhancing the safety and sustainability of training and competition.

2. Causes of Injury

2.1 Anatomical Vulnerability

The mortise-and-tenon structure of the ankle joint – the ankle mortise formed by the talus and the distal ends of the tibia and fibula – has inherent asymmetry. the medial deltoid ligament is thick and strong, composed of superficial and deep layers, and can effectively resist eversion stress. In contrast, the lateral ligament complex, consisting of the anterior talofibular ligament and the calcaneofibular ligament, is relatively weak. the thickness of the anterior talofibular ligament is only about 2 mm, while the calcaneofibular and posterior talofibular ligaments are approximately 6 mm thick, making the anterior talofibular ligament the most vulnerable component of the lateral collateral ligament. Furthermore, the trochlear surface of the talus is wider anteriorly and narrower posteriorly, so that the ankle mortise fits tightly with the anterior part of the talus in dorsiflexion, providing higher stability, whereas in plantarflexion, the narrower posterior part of the talus enters the mortise, increasing joint space and creating an inherent "loose zone". This structural feature determines that when the foot is subjected to inversion force, the lateral ligaments are the first to be overstretched or torn. Epidemiological data show that lateral ligament injuries are the most common type of ankle ligament injury, accounting for about 90% of all ankle ligament injuries, among which isolated anterior talofibular ligament injuries account for about 66%, combined anterior talofibular and calcaneofibular ligament injuries account for about 20%, and posterior talofibular ligament injuries are rare[1] . Among patients with acute ankle sprains, nearly 85% involve the lateral ligament complex, with about 65% being isolated anterior talofibular ligament injuries. After a first acute ankle sprain, approximately 20%–40% of patients develop chronic ankle instability, and this proportion is even higher among athletes[2] . Therefore, understanding the anatomical and biomechanical characteristics of the lateral ankle ligaments is of great significance for the prevention and treatment of ankle injuries.

2.2 Muscle Imbalance and Neuromuscular

Control Delay

Under normal conditions, lateral stability of the ankle joint depends on the rapid eccentric contraction of the peroneus longus and brevis muscles to antagonize inversion torque, while the tibialis posterior and tibialis anterior muscles coordinately regulate foot posture. However, when the eccentric contraction capacity of the peroneal and tibialis posterior muscles is insufficient, the concentric contraction of the tibialis anterior muscle lags, and the coordinated function of core muscles (such as the transversus abdominis and multifidus) is impaired, the foot cannot generate sufficient eversion torque to counter the inversion trend within the extremely short time window after the onset of inversion force. Neuromuscular control delay not only leads to loss of fine correction ability for joint position sense – blockage of proprioceptive signal transmission pathways – but also impairs dynamic postural regulation, manifested as decreased pre-activation levels of periankle muscles and prolonged reflex contraction latency. Injury disrupts the mechanoreceptors around the joint, causing a delay from signal output to the recruitment of correct muscle contraction, ultimately altering joint stability. This "edge-of-control" state is particularly prominent during landing or abrupt stop-and-cut maneuvers, making it impossible for the ankle joint to complete effective stabilization preparation before ground contact. After ankle injury, proprioceptive function is correspondingly reduced, leading to decreased perception of joint position, which in turn triggers disordered neural regulation and further increases the risk of recurrent sprains.

2.3 Technical Movement Deficits

Improper landing and cutting techniques significantly amplify the risk of ankle injury. Specifically, insufficient knee flexion angle during landing and delayed hip abduction prevent the proximal joints (hip and knee) from effectively absorbing and dissipating ground reaction forces, so that forces are transmitted directly to the ankle joint. After knee injury, compensatory phenomena occur, manifested as increased hip internal rotation angle and adduction moment on the injured leg, increased ankle internal rotation moment, and increased hip abduction angle on the healthy leg. Excessively large step width during cutting and too small a foot abduction angle further amplify the inversion torque at the time of foot push-off. When landing on one foot, if the center of gravity projection is significantly biased toward the lateral edge of the foot, the lateral ligaments will be stretched beyond their physiological elastic limit within a very short time. In inversion ankle sprains, the incidence of complete lateral ligament rupture is close to 10%–15%, but 50% of such cases are accompanied by other joint injuries[1] . These technical deficits are more likely to occur under fatigue and often interact with each other. Research indicates that jumping, sudden stops, and cutting runs in basketball pose a major test for the ankle joint, especially when the ankle joint is in a naturally inverted "J"-shaped position during jumping. If landing on an uneven surface or on another person's foot, the lateral ankle ligaments will be violently stretched, and injury occurs immediately.

2.4 Training Load and Environmental Factors

Acute increases in training load – such as a significant increase in weekly training volume with insufficient recovery time, as well as consecutive high-intensity games with inadequate sleep and nutritional supplementation – lead to the accumulation of neuromuscular fatigue. Under fatigue, the pre-activation level of the periankle muscles decreases, and the reflex contraction delay significantly increases. Injury statistics show that the injury incidence rate is higher during games than during training, with physical collisions in the key area being the primary cause. Regarding court factors, insufficient friction coefficient, localized slipperiness, or aging and peeling of the silicone PU surface all reduce the grip between the foot and the ground, increasing the probability of slipping and uncontrolled inversion. Prevention of ankle injuries can be achieved by strengthening the surrounding muscles, selecting appropriate sports equipment, ensuring safe playing environments, mastering correct movement techniques, and avoiding excessive fatigue; the outsole pattern should match the type of sport. Regarding equipment, insufficient ankle collar height, lack of a midfoot anti-torsion shank, and inappropriate sole hardness all weaken external support for the foot. Studies indicate that wearing appropriate, well-supportive shoes can provide good arch support and ankle stability, and special attention should be paid to avoiding slipping when moving on uneven or wet surfaces. the above environmental and equipment factors interact with training load factors, collectively weakening external support for the foot and increasing the probability of ankle injury. Repeated jumping in basketball poses an overuse injury risk to the lower limbs, especially the knee and ankle joints, and specially designed basketball courts that reduce impact force upon landing may help reduce lower extremity injuries.

2.5 Psychological and Behavioral Factors

Fear of reinjury is a common psychological disorder in ankle injuries. Athletes become hypervigilant due to previous injury experiences, contracting antagonist muscles (e. g., premature activation of the tibialis anterior) prematurely during landing or cutting, disrupting the normal muscle activation sequence and paradoxically reducing dynamic stability. Research shows that fear of re-injury also affects muscle activation patterns, thereby influencing muscle recovery, neuromuscular function, and rehabilitation outcomes, ultimately delaying return to sport. Chronic ankle instability affects about 40% of patients with ankle sprains, characterized not only by recurrent physical instability but also by deep psychological challenges – injury-related fear that goes beyond simple "fear of getting hurt", affecting rehabilitation progress, daily activity choices, and overall quality of life. Sleep deprivation and attentional distraction affect the sympathetic–parasympathetic balance, reducing the processing efficiency of proprioceptive signals and increasing errors in judging ankle joint spatial position. Furthermore, lack of team communication and a "play through minor pain" mentality prevent minor injuries (such as microscopic ligament tears and mild joint capsule sprains) from receiving timely rest and intervention, eventually evolving into overt ankle sprains under repeated stress.

3. Prevention Measures

3.1 Dynamic Warm-up: Awakening Joints and Nerves

Neuromuscular warm-ups have been widely proven to be one of the effective strategies for preventing lower extremity injuries in basketball. Before each formal training session or game, it is recommended to perform a four-stage warm-up protocol consisting of low-intensity aerobic activity, joint lubrication, dynamic stretching, and neural activation, with a total duration of no less than 10 minutes. Research indicates that systematic neuromuscular training warm-ups can significantly reduce the risk of ankle injury[3] .

The first stage begins with 3–5 minutes of low-intensity aerobic activity, such as jogging around the court, high knees, or skipping rope, aimed at increasing core body temperature and optimizing muscle elasticity and synovial fluid viscosity. Subsequently, circular swings of the ankle, knee, and hip joints, as well as active contractions of the anterior and posterior tibial muscles, ensure full lubrication of the joint capsules and ligaments. Next, dynamic stretching exercises such as walking knee hugs, spider-man crawls, and high knees with abrupt stops are used to gradually increase hip extension range and ankle dorsiflexion angle. Finally, neural activation exercises such as single-leg stance with eyes closed, balance board catches, and elastic band inversion/eversion are performed to mobilize proprioceptor sensitivity, laying a precise and rapid control foundation for the upcoming high-intensity movements.

3.2 Technical Correction: Reshaping Landing and Cutting

Fine-grained correction of technical movements is critically important for preventing ankle injuries. It is recommended to use high-definition video recording, wearable sensors, or smartphone slow-motion playback to provide real-time feedback and motion analysis for every jump landing, lateral cut, and step-back stop. Three high-risk signals – "knee valgus, ankle inversion, center of gravity lateral shift" – need to be specifically corrected. Athletes are required to achieve a triple synchronous posture of "knee pointing toward the second toe – hip sitting back – uniform foot arch loading" at the instant of landing. Through a micro-habit of repeating "empty jump landing self-checks" many times daily, the correct movement pattern is gradually internalized into the cerebellar motor program, ultimately achieving safe automatic execution without conscious intervention.

3.3 Strength Balance: Strengthening Periankle Muscles

Building a "periankle strength loop" centered on the peroneal muscles, tibialis posterior, soleus, gastrocnemius, tibialis anterior, and intrinsic foot muscles is a foundational strategy for preventing ankle injuries. Recommended targeted exercises include single-leg heel raises, multi-directional elastic band resistance, seated weighted dorsiflexion, and toe towel curls, with 4–6 exercises performed for 3 sets of 12–15 repetitions each, 3–4 days per week. Research indicates that neuromuscular control training is the most comprehensive intervention for improving symptoms of chronic ankle instability, with optimal improvements achieved with an intervention period of 12 weeks and a certain weekly training volume. At the same time, static stretching (3 sets of 30 seconds) and dynamic swinging (3 sets of 15 repetitions) of the triceps surae, tibialis posterior, and peroneal muscles should be performed to maintain joint range of motion, creating a tension balance where strong muscles and flexible ligaments protect each other.

3.4 Equipment Optimization: Shoe-Court Synergistic Protection

Rational equipment selection and environmental management constitute an important external protection barrier for the ankle joint. In terms of footwear, it is recommended to follow the comprehensive protection principle of "high-top ankle protection, lateral support straps, midfoot anti-torsion shank, and rearfoot cushioning pad. " Sole hardness should match the characteristics of the playing surface. Research shows that external ankle supports effectively reduce the incidence of ankle sprains in athletes with a history of injury. Regarding protective gear, semi-rigid ankle braces or figure-eight taping can be used on game days, while kinesio tape spiral application can be used on training days; alternating between the two provides reliable eversion resistance. the literature suggests that ankle braces may be more advantageous than taping in preventing ankle sprains. Regarding the court, it is recommended to inspect the playing and training courts daily for slipperiness, sand particles, and damage, and to clean or close off hazards within a timely manner to ensure consistency of the friction coefficient. It is important to note that no equipment can replace systematic strength training and proprioceptive training.

3.5 Periodization Regulation: Managing Training Load

Scientific load management is a core element in preventing overuse injuries and fatigue-related sprains. It is recommended to adopt a progressive periodized training model and arrange the frequency of high-intensity games appropriately. Daily monitoring using dual indicators such as the Rating of Perceived Exertion (RPE) and morning heart rate variability (HRV) should be performed; when fatigue indicators reach warning levels, the next day's training load should be adjusted accordingly. Training load monitoring can combine internal load (e. g., RPE, heart rate) and external load (e. g., running distance, acceleration changes). Load management plays an important role in injury prevention in basketball, and rational training load planning helps optimize performance and reduce injury incidence[4] . After games, static stretching and foam roller relaxation should be arranged to help athletes recover heart rate and promote metabolite clearance; adequate nighttime sleep and deep sleep time should be ensured to maintain normal neuromuscular function. Through a closed-loop management model of "training – monitoring – adjustment, " precise load regulation is achieved.

3.6 Psychological Intervention: Alleviating Fear of Reinjury

Fear of reinjury is an important psychological factor affecting athletes' performance and reinjury risk upon return to sport. Research shows that injury-related psychological trauma responses may hinder the rehabilitation process and increase the likelihood of re-injury after return to sport. Fear-induced avoidance behavior causes athletes to hesitate when performing key movements, thereby affecting movement patterns and confidence recovery. Therefore, psychological interventions should be incorporated into the prevention system: regular injury awareness workshops using video playback, scenario simulations, and peer sharing to enhance athletes' risk recognition ability for high-risk movements; 5 minutes of mindfulness breathing or progressive muscle relaxation before and after training to reduce sympathetic overexcitation; establishment of a real-time "athlete – coach – team physician" communication mechanism for timely assessment and intervention of early pain signals. the literature indicates that imagery training, goal setting, and social support are the most commonly used psychological techniques in sports injury rehabilitation. Integrating these methods into daily training management helps transform the psychological burden of "fear of re-injury" into positive behaviors of "timely reporting and active prevention, " making psychological safety a booster for physical agility.

4. Discussion

The multi-level prevention strategy proposed in this paper integrates, in theory, the multidimensional perspectives of sports medicine, training science, biomechanics, psychology, and equipment engineering, and, in practice, covers the whole-cycle scenarios of pre-training, during training, post-training, competition, rehabilitation, and daily management. the construction of this strategic framework is based on the following core evidence: neuromuscular training warm-ups have been proven to effectively reduce lower extremity injury risk and serve as a fundamental intervention for ankle injury prevention; comprehensive programs combining neuromuscular and strength training are most effective for improving ankle function; external ankle supports have a clear protective effect for athletes with a history of injury; and psychological interventions for fear of reinjury have positive effects on rehabilitation progress and return to sport. However, implementation of the strategies still faces practical barriers such as fragmentation of training time, differences in coach cognition, facility constraints, fluctuations in athlete compliance, and high costs of multidisciplinary collaboration. In the future, these bottlenecks can be gradually addressed by developing portable monitoring devices, establishing digital load management platforms, formulating stratified and graded intervention guidelines, and strengthening continuing education for coaches and athletic trainers. At the same time, due to the specificity of their anatomical structures, hormonal profiles, and psychological characteristics, adolescent and female athletes require further refinement of intervention parameters and evaluation indicators to achieve precision prevention.

5 Conclusion

Ankle injuries in basketball training are characterized by high incidence, high recurrence rates, and a tendency toward chronicity. Their mechanisms result from the multiple superimposition of anatomical asymmetry, muscle strength imbalance, neuromuscular control delay, technical movement deficits, external environmental factors, and psychological factors. A multi-level prevention strategy centered on neuromuscular control can effectively reduce the incidence and recurrence rates of ankle injuries and improve athletes' long-term health and competitive performance. It is recommended that basketball teams at all levels incorporate systematic neuromuscular warm-ups, real-time technical movement feedback, periodized load management, equipment standardization, and psychological behavioral interventions into their daily training protocols, forming an interdisciplinary, whole-cycle, closed-loop ankle health management ecosystem, thereby truly achieving the goals of "safer training, better performance, and longer careers. "

References

[1] Zheng J F, Sun Q. Current status of research on lateral ankle ligament injuries [J]. Chinese Journal of Postgraduates of Medicine, 2009, 32(z1):165-166.
[2] Peng Y W. Surgical treatment of chronic lateral ankle instability [J]. Orthopaedics, 2010, 01(3):162-164.
[3] Davis A C, Emptage N P, Pounds D, et al. the Effectiveness of Neuromuscular Warmups for Lower Extremity Injury Prevention in Basketball: A Systematic Review [J]. Sports Medicine - Open, 2021, 7.
[4] López-Sierra P, Gómez M Á, Feu S, et al. A comprehensive analysis of internal and external load monitoring systems in basketball [J]. Scientific Reports, 2025, 15(1):41851.

