

# *Analysis of the Causes and Rehabilitation of Ankle Injuries in Basketball Players by Sports Rehabilitation in the Context of Sports-Medicine Integration*

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**Abstract:** Basketball is a sport with a high incidence of ankle injury because of the fast pace, fierce confrontation, and high bounce in the game. Therefore, the traditional rehabilitation method cannot meet the requirements of basketball players for rapid rehabilitation and returning to the competitive field. This study aims to gain an in-depth understanding of the current situation of rehabilitation sports for basketball players' ankle injuries, and then discuss the effect of sports rehabilitation on basketball player ankle injuries from the perspective of sports medicine integration, given the current social development and technological progress. The two intervention measures are compared and analyzed. To this end, mixed research methods have been adopted to further explore the current situation of the ankle injuries of basketball players and the factors of internal and external injuries and carry out biomechanical evaluation of their sports skills. The study also designed a series of combined physical and medical rehabilitation programs, which were compared with traditional rehabilitation methods. The angle of ankle joint motion, functional exercise screening score, injury recurrence rate and rehabilitation time after rehabilitation were compared. According to the results of the study, the angle of ankle joint motion, the functional exercise screening score and the injury recurrence rate of basketball players were better than those who underwent conventional rehabilitation treatment. The angle of ankle joint motion was in the range of 20.4 ° to 29.8 °. The best score of FMS was 20.7. It shows that the comprehensive physical and medical rehabilitation program can provide basketball players with three-dimensional and personalized rehabilitation services, help them recover more sports functions, and prevent the occurrence of events.

## **1. Introduction**

Basketball, as a globally popular high-intensity sport, its rapid movement and frequent jumping movements make ankle injury a common health problem for basketball players. Ankle joint injuries not only affect the athletic performance of athletes, but may also lead to long-term functional impairment and decreased quality of life. Therefore, in-depth analysis of the causes of ankle injuries in basketball players and exploration of effective rehabilitation strategies are of great significance for improving their health and performance.

The contribution of this study lies in the first application of the concept of integrating sports and medicine to the rehabilitation process of ankle injuries in basketball players. Through the comprehensive application of sports technology analysis, biomechanical evaluation, and personalized rehabilitation plans, this study aims to provide more scientific and accurate rehabilitation guidance for basketball players. In addition, this study also compares and analyzes the differences in effectiveness between the integration of physical and medical rehabilitation programs and traditional rehabilitation methods, in order to provide new theoretical basis and practical guidance for the field of sports rehabilitation.

The article first introduces the research background and necessity of ankle injury in basketball players; secondly, it elaborates on the methodology of this study, including research design, data collection, and analysis methods. Next, this article presents the research results and compares and analyzes the effectiveness of the integration of physical and medical rehabilitation programs with traditional rehabilitation methods. Finally, the research conclusions are summarized, and the significance, limitations, and future research directions of this study are discussed.

## 2. Related Work

With the popularization of various sports and the improvement of competitive level, the risk of injury for athletes during training and competition has also increased. Based on the common occurrence of ankle injuries in skiing training and competitions, Zhang Chunlei analyzed the current situation and internal and external injury factors of ankle injuries in skiers, in order to provide beneficial assistance for athletes and coaches in preventing and treating ankle injuries and providing medical support [1]. Chang Baochen used a three-dimensional motion capture system and a ground force measurement system to collect the movement trajectory of the ankle joint of the supporting leg of 23 martial arts sanda athletes using whip leg technique. He divided the movement trajectory into three periods of initiation, striking, and recovery based on the characteristics of whip leg technique, and analyzed the kinematic characteristics such as joint angle, angular velocity, displacement, and velocity [2]. In order to promote the development of campus football in higher education institutions and prevent athletes from sports injuries during training and competitions, Wang Wei analyzed the common locations and causes of ankle and knee joint injuries among female football players in universities. He proposed measures to prevent ankle and knee injuries in athletes, in order to reduce the occurrence of sports injuries in female football players and better promote the healthy development of campus football [3]. Zhang Haixin used research methods such as literature review, interview, questionnaire survey, and mathematical statistics to investigate the current situation of sports injuries among rowing athletes in Anhui Province [4]. Liu Haixiao first gave a brief introduction and types of ankle joint injuries. Analysis has found that the reasons for ankle joint injuries in basketball include insufficient warm-up preparation, lack of standardization in technical movements, low physical fitness levels of athletes, weak self-protection awareness, and insufficient training level. Therefore, he further proposed targeted preventive measures to reduce the probability of ankle injury in basketball [5].

In addition, Zhihong Y analyzed how personalized treatment and techniques can improve exercise performance and minimize the risk of injury. Research has shown that sports rehabilitation requires personalized treatment plans and techniques to improve outcomes and prevent recurrence [6]. Zhou M conducted a study on 100 cases of arthroscopic anterior cruciate ligament reconstruction, using a random number table method to divide them into an observation group and a control group, and explored the impact of knee joint related training on knee joint related activities [7]. Far ìG explored musculoskeletal pain and delves into whether age and anatomical areas affect the appearance of pain associated with the four surfing disciplines. The conclusion shows that

rehabilitation treatment through special training can carry out painless activities to optimize its overall health benefits [8]. Ardern C L introduced the Prisma in Exercise, Rehabilitation, Sport Medicine and Sports science (PERSiST) guidelines, which aim to improve the quality of reports on systematic reviews in the fields of sports and sports medicine, musculoskeletal rehabilitation, and sports science [9]. Singleton K M aims to explore the effect of using imagery techniques in the rehabilitation process of sports related injuries on improving athlete self-efficacy, and evaluate its impact on athlete rehabilitation ability and satisfaction [10]. Although the above research provides valuable insights into the prevention, treatment, and rehabilitation of sports injuries, this study conducts an in-depth analysis of the causes of ankle injuries in basketball players from the perspective of integrating sports and medicine, and explores the role of sports rehabilitation in promoting their recovery.

### 3. Method

#### 3.1 Research Design

In the context of the integration of sports and medicine, the research design on the causes and rehabilitation analysis of ankle injuries in basketball players needs to be carefully planned to ensure the comprehensiveness and scientificity of the research [11-12]. The selection of research subjects is the basis of the study, and it is necessary to clearly define the group of "active basketball players" and ensure that the individuals included in the study have a history of ankle joint injuries. The types of injuries should be widely covered, including but not limited to acute sprains, chronic ankle instability, etc., in order to obtain a more comprehensive understanding of injury mechanisms. In addition, research designs should eliminate elements that may interfere with the interpretation of results, such as other lower limb injuries or systemic diseases present in athletes. The age, gender, and athletic level (amateur, university, professional level) of athletes are also factors that must be considered in the selection criteria to ensure the representativeness and wide applicability of research results. The time structure of the study covers the start and end times of the study, as well as the specific time period for data collection. This may be synchronized with the basketball season, such as extending the preparation phase before the start of the season to the rest period after the end of the season, or setting it for one year to observe and record the health and recovery progress of athletes throughout the year. The data collection method should integrate quantitative and qualitative research, and quantitative data should include but not be limited to basic information of athletes, such as age, gender, years of exercise, past injury history, training frequency, etc. Qualitative data is obtained through interviews and questionnaire surveys to gain a deeper understanding of athletes' feelings towards injuries, experiences and preferences during the rehabilitation process, and feedback on rehabilitation measures. Table 1 shows the collected ankle injury related data of basketball players [13-14]:

Table 1: Relevant data on ankle joint injuries of basketball players

Athlete ID	Age	Gender	Years in Sport	Previous Ankle Injuries	Training Frequency (times/week)	Training Duration (hours/session)	Height (cm)	Weight (kg)	Position
001	23	Male	8	2	5	3	195	95	Forward
002	25	Male	10	1	4	2.5	200	100	Center
003	22	Female	5	0	3	2	180	75	Guard
004	27	Male	12	3	6	4	198	90	Guard
005	21	Male	6	1	4	2.5	190	85	Forward
006	24	Female	7	0	5	3	175	70	Guard

The table displays key information of six basketball players, which is crucial for conducting research on the causes and rehabilitation analysis of ankle injuries in basketball players. Through these data, researchers can analyze which factors may lead to ankle injuries in basketball players and how to develop personalized rehabilitation plans to improve their recovery outcomes. In addition, this information can also help develop preventive measures to reduce future injuries.

### 3.2 Causes of Ankle Joint Injuries

The rapid changes in direction, sudden stops, jumps, and landings in basketball cause great pressure on the ankle joint. Through video analysis and professional coach evaluation, it is possible to identify the improper performance of athletes in performing technical movements. For example, improper foot position or body center of gravity deviation during landing may lead to ankle sprains, and improper technical movements of athletes, such as incorrect foot posture when turning or changing directions, may also increase the risk of injury [15-16]. In addition, biomechanical evaluation involves studying the mechanical characteristics of athletes during exercise, including the range of motion, strength, stability, and coordination of joint movements. The quantification of joint range of motion  $ROM$  is:

$$ROM = \theta_E - \theta_O \quad (1)$$

$\theta_O$  and  $\theta_E$  are the initial and final angles of joint movement, respectively. The strength evaluation formula is:

$$F_{\max} = \mu \times F_N \quad (2)$$

$F_{\max}$  is the maximum friction force,  $\mu$  is the coefficient of friction, and  $F_N$  is the positive pressure.

The use of pressure sensors and motion capture technology can quantify the pressure distribution on the soles of athletes in basketball, analyze the movement mode and force situation of the ankle joint, and analyze the pressure distribution:

$$P = \frac{F}{A} \quad (3)$$

$P$  is the pressure at a certain point on the sole of the foot,  $F$  is the force acting on that point, and  $A$  is the force area.

After ankle sprains, the receptors around the ligaments may be damaged, which can obstruct the transmission of proprioceptive information. This means that the neuromuscular control ability can decline, and the possibility of recurrent sprain can increase [17-18]. Proprioception and muscle strength are the dominant factors in the occurrence and development of ankle joint injury, and testing the joint stability and movement control in patients during recovery can effectively reveal the causes, pathological basis, and the best treatment plan for ankle joint injury. This systematic review and Meta-analysis provide a theoretical basis for the formulation of scientific rehabilitation programs and guide the understanding of the mechanism of ankle joint injury. This can also promote the development of preventive measures, prevent the occurrence of ankle joint damage, and enhance the quality of health and sports life.

### 3.3 Rehabilitation Strategies for Ankle Joint Injuries

The rehabilitation strategies and intervention measures for ankle injury in basketball players are multifaceted. They include exercise therapy, physical therapy, functional training, psychological guidance, nutritional intervention, lifestyle adjustment, education, and prevention. Individualized exercise intervention was conducted according to the degree of injury and the general situation of individual athletes. At the beginning, the intensity was low, and then the intensity was gradually increased according to gradual pressure training. Meanwhile, the stretching and exercises of lower limb joints were combined, and special training for ankle joint stability muscle groups was organized to promote the recovery of ankle joint function [19-20]. Physical therapy utilizes methods such as alternating cold and hot therapy, electrical stimulation therapy, and ultrasound therapy to alleviate pain and accelerate muscle repair. Functional training enhances motor function through functional exercise screening and specialized training, simulating specific movements in basketball. Psychological support covers psychological counseling and goal setting, assisting athletes in coping with the psychological pressure caused by injuries. Nutrition guidance and lifestyle adjustment provide athletes with appropriate dietary advice and rest and sleep guidance during the recovery period. Education and Prevention: Through injury education and prevention strategies, athletes can enhance their awareness of preventive measures, teach correct sports skills and warm-up methods. In addition, the rehabilitation plan also includes continuous evaluation and adjustment, regular evaluation of the athlete's rehabilitation progress, adjustment of the rehabilitation plan based on actual conditions, and comprehensive rehabilitation services provided by multidisciplinary teams to ensure that the athlete can safely and effectively recover to the pre-injury level of exercise. The setting of rehabilitation goals should be divided into short-term goals, such as reducing pain, controlling inflammation, and improving joint mobility. The mid-term goal focuses on restoring muscle strength, improving joint stability and balance, and gradually increasing load-bearing capacity. The long-term goal is to fully restore the athletic function of athletes, including flexibility, endurance, speed, and explosiveness, ensuring that they can safely participate in basketball and prevent future injuries. The specific content of the rehabilitation plan includes protective weight-bearing and passive joint range of motion exercises in the initial stage, active joint range of motion exercises and mild muscle strength training in the transitional stage, balance training in the reinforcement stage, stability training and progressive weight-bearing training, directional training and exercise specific exercises in the functional recovery stage, as well as comprehensive physical fitness testing and functional assessment in the return to the exercise preparation stage.

### 4. Results and Discussion

The purpose of this study is to compare the effectiveness of sports rehabilitation plan and traditional treatment in the recovery of basketball players' ankle injury through comparative experiments. The research focuses on improving ankle joint mobility, increasing FMS score, reducing injury recurrence rate and rehabilitation time, so as to provide more professional and accurate rehabilitation guidance for basketball players, improve the speed of return, and improve the safety and sustainability of their follow-up sports level. In this study, 20 basketball players with the same physical condition were selected and treated with traditional therapy and special sports rehabilitation plan. In the process of rehabilitation, it is necessary to record the changes of ankle joint activity and FMS score, the recurrence of injuries and the time for each player to return to his previous activity level. Finally, the differences in ankle joint mobility, FMS score, injury recurrence rate and recovery time between the two groups were compared.

### 4.1 Ankle Joint Range of Motion

The comparative experiment on ankle joint mobility aims to evaluate and compare the effects of conventional treatment and exercise rehabilitation on improving ankle joint mobility in basketball players, and explore better rehabilitation strategies. The normal range of motion for ankle dorsiflexion is approximately 20 °to 30 °. The range of motion of the ankle joint is shown in Figure 1:

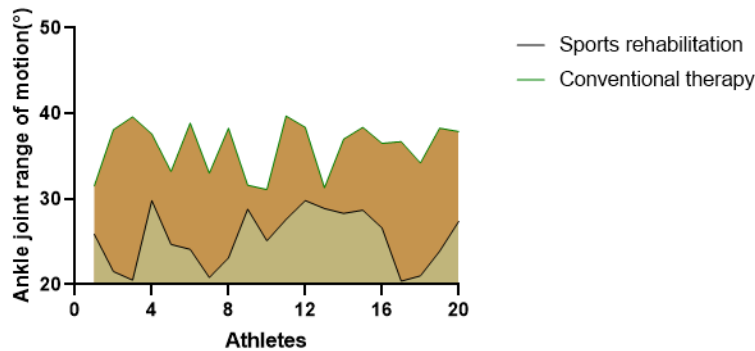


Figure 1: Comparison of ankle joint mobility

According to the data analysis in Figure 1, it can be found that the ankle joint range of motion of athletes remains between 20.4 and 29.8 degrees after exercise rehabilitation treatment, but after routine treatment, the ankle joint range of motion of athletes remains between 31.1 and 39.7 degrees. This may mean that rehabilitation treatment has a positive effect on improving ankle stability and reducing excessive mobility, while conventional treatment performs poorly on the ankle mobility of athletes.

### 4.2 FMS Score

FMS is a widely recognized evaluation system used to identify the movement control ability, flexibility, stability, and overall movement ability of athletes during basic movement modes, as shown in Figure 2:

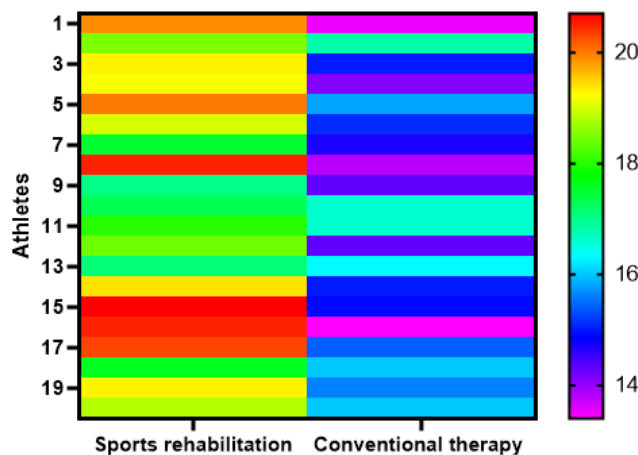


Figure 2: Comparison of FMS scores

As shown in Figure 2, the highest FMS score of athletes under sports rehabilitation reached 20.7, close to the full score of 21. However, at the same time, the maximum FMS score for conventional

treatment was only 16.8, far lower than the FMS score for exercise rehabilitation. This indicates that these athletes perform better than conventional treatment in terms of functional movement control, flexibility, stability, and overall athletic ability under exercise rehabilitation therapy.

### 4.3 Injury Recurrence Rate

The comparative experiment on the recurrence rate of ankle joint injuries among basketball players can reveal the effectiveness of different rehabilitation strategies in preventing recurrent injuries, as shown in Figure 3:

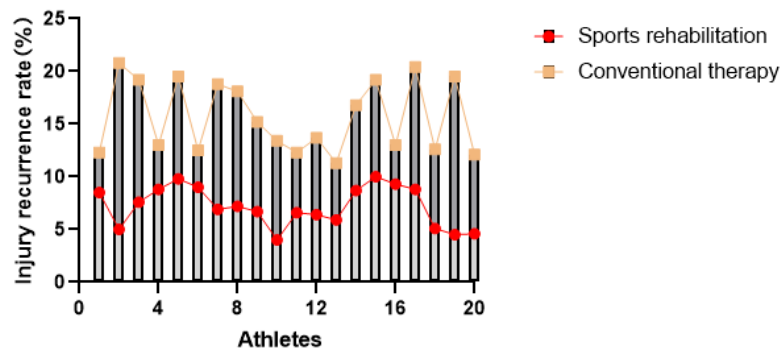


Figure 3: Comparison of injury recurrence rates

As shown in Figure 3, this article found that the injury recurrence rate of athletes under sports rehabilitation is much lower than that under conventional treatment. The maximum injury recurrence rate of athletes under sports rehabilitation is 10%, and the minimum is only 4%. However, under conventional treatment, the highest is 20.8%, and the lowest is 11.3%. The injury recurrence rate of athletes under sports rehabilitation is much lower than that under conventional treatment, indicating that sports rehabilitation may be more effective in enhancing muscle control, balance ability, and overall functional stability of athletes.

### 4.4 Rehabilitation Time

In basketball players, a comparative experiment on rehabilitation time can reveal the impact of different rehabilitation strategies on the recovery process, as shown in Figure 4:

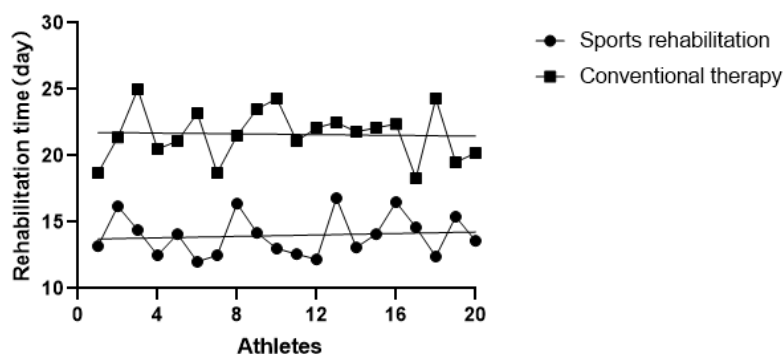


Figure 4: Comparison of rehabilitation time

According to the data in Figure 4, the recovery time of athletes under exercise rehabilitation is significantly lower than that under conventional treatment. According to linear regression analysis, the longest rehabilitation time for athletes under sports rehabilitation reached 17.7 days. However,

under conventional treatment, the maximum duration reached 25 days, which further confirms the potential advantage of exercise rehabilitation in shortening rehabilitation time.

## 5. Conclusions

This study conducted an in-depth analysis of the causes of ankle injuries in basketball players through the use of a rehabilitation plan that integrates physical and medical methods, and scientifically evaluated their rehabilitation effects. Research has found that compared with traditional rehabilitation methods, the integrated physical and medical rehabilitation program has significant advantages in improving ankle range of motion, FMS score, reducing injury recurrence rate, and shortening rehabilitation time. These results emphasize the importance of personalized rehabilitation plans in sports injury management. In addition, the biomechanical evaluation of this study revealed the correlation between non-standard technical movements and ankle joint injuries, providing empirical evidence for coaches and athletes to improve techniques and prevent injuries. Through the comprehensive application of 3D motion capture technology and ground force measurement system, this study provides a new technical analysis method for the field of sports rehabilitation.

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