

Analysis of Biomechanical Characteristics of Volleyball Players' Ankle Joint Movement under Compound Sports Mode

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Abstract: The truth of winning a volleyball match at the level of pupil is always to jump higher, attack stronger and move faster. The basis of jump height, the rapid formation of offensive tactics and the fundamental of moving speed have an important impact on the performance of volleyball players. Combining with the characteristics of volleyball events, this paper chooses representative compound movements: running stop and then forward start, running stop and then lateral start, and running stop and then turning 180 degrees to start. The biomechanical study of ankle joint movement characteristics is carried out, to provide a theoretical basis for a comprehensive understanding of the related muscular participation mechanism of tennis players' ankle joint movement, and to reduce the incidence of ankle joint injury in sports, put forward methods to prevent and avoid injury, so as to provide a reference for the methods and means of daily training and competition of ankle joint.

1. Introduction

With the continuous development of volleyball technology, the attacking tactics of the world's top volleyball teams have undergone profound changes, such as the application of Jump Service technology, the back-row attacking tactics and the development from the front-row attacking and the back-row attacking to the three-dimensional attacking tactics. These major changes in skills and tactics make the ball faster and faster, and the strength is growing. This requires athletes to have superb skills, flexible use of various tactics, but also have good physical fitness, such as strong jumping ability, strong strength of lumbar and abdominal muscles and fast judgment ability. Ankle joint has great influence on athletes' training and competition. It is of great significance to analyze the kinematics, dynamics and electromyography characteristics of ankle joint in sports by using biomechanics, and to study the mechanism of ankle joint injury, preventive measures, training and how to exercise in competition.

2. Experimental subjects and method

2.1. Experimental subjects

In this paper, 30 male volleyball players were selected as the subjects of study. Health is required, and there is no significant difference in height and weight. The basic information of the subjects is shown in Table 1 below.

Table1. General situation of the experimental subjects

Gender	Age	Height/cm	Weight/kg	Sports level
Male	21±2	178±3	65±4	≥second level

2.2. Experimental method

There are Vicon motion capture system, Kistler three-dimensional force station 9281B, 8-channel telemetry surface electromyography, RGT-140 vernier weight body scale, TG-I height gauge, vernier caliper. This study was carried out in the Biomechanics Laboratory of Sports and Human Sciences, Institute of Physical Education. During the test, the data acquisition system triggered synchronously and collected data directly in the system, in order to analyze the three-dimensional dynamic characteristics of ankle joint under the compound movement mode.

3. Analysis of experimental results

3.1. The torque characteristics of running ankle joint in running stop and forward start

According to the anatomical structure of the foot, the ankle joint mainly does flexion and extension movement, but also can do lateral movement. As shown in Figure 1 below, x, y and Z represent the sagittal plane, frontal plane and horizontal plane, respectively. On the sagittal plane, the ankle joints do dorsiflexion and metatarsal flexion, while the ankle joints do dorsiflexion with valgus movement and the ankle joints do metatarsal flexion with varus movement. The whole movement process is divided into three stages: emergency stop stage, buffer stage and pedal-extension stage. There are troughs in ankle joint torque during emergency stop stage, peaks in buffer stage and another trough in pedal and extension stage. From the analysis results, the sagittal and plantar bending moments of the ankle joint are much larger than the frontal inversion, valgus and horizontal internal and external rotation moments, which are about four times as much as their values.

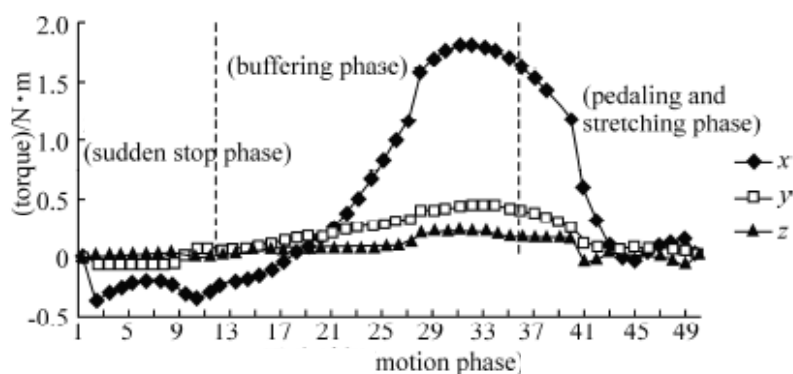


Figure1. The torque of the left ankle joint changes with the movement

3.2. Torque characteristics of running ankle joint in running stop lateral start

The right ankle joint has left the ground during the run-stop and lateral start-up stage; the moment values in the sagittal plane of the right ankle joint are larger than those in the frontal and horizontal planes; the fluctuation range of the moment curves in the frontal and horizontal planes is very small, and the absolute value of the moment values is small. In sagittal moment, the positive number represents the moment of ankle metatarsal flexion, while the negative number represents the moment value of ankle dorsiflexion. The back bending moment of ankle joint reaches the maximum value in the emergency stop stage, and the plantar bending moment reaches the maximum value in the buffer stage, which is less than the back bending direction moment.

3.3. Joint torque characteristics of running stop lateral start running left ankle

The back bending moment of the left ankle is very small in the emergency stop stage, and the toe bending moment of the left ankle increases rapidly in the buffer stage, and reaches the peak value. The frontal valgus moment is wavy, which increases first and then decreases, and gradually transits to the direction of inversion. The frontal valgus moment increases first and then decreases. The frontal valgus moment increases two peaks during the acute stop of the ankle joint, indicating that it turns out when the left ankle joint stops suddenly. The ankle moment increases in the direction of rotation and decreases rapidly after reaching its peak value. The maximum external rotation moment was achieved in the ankle pedal-extension stage.

3.4. Torque characteristics of running ankle joint motion with running stop and turning 180 degree start

As a whole, the duration of plantar flexion moment in sagittal plane accounts for 70% of the total moment time. There are two peaks of plantar flexion moment, and the maximum of plantar flexion moment is larger than that of other movements. There are three peaks in the frontal valgus moment. Among the three movements, the longest duration and three peaks of the valgus moment in the frontal plane of the 180 degree turning start run indicate that the 180 degree turning start run has a long working time and great changes in the valgus muscles, i.e. the support foot is the most active in the 180 degree turning motion, which shows that the requirement for the flexor plantaris and flexor dorsi muscles to support the foot is the highest, and this movement is also the most likely to cause ankle injury, as shown in figure 2.

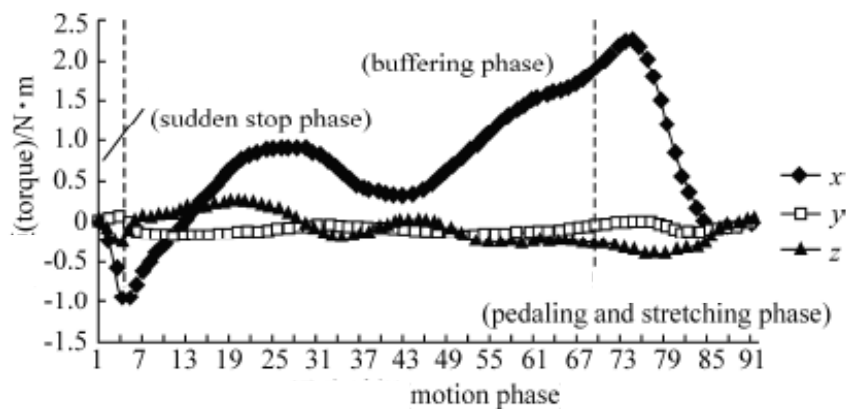


Figure2. The torque on the left ankle during sudden stop with the motion phase

The greatest difference between the curves of the start running at 180 turning around and the start running at 180 and the start running at forward or lateral stop is that the sagittal plantar flexion

moment has two peaks, a platform appears between the peaks and the sagittal dorsiflexion maximum moment. In addition, the moments of the frontal and horizontal planes vary greatly when the running stop turns 180 degrees, but the values of the moments of these two planes are not very large, as shown in Figure 3 below.

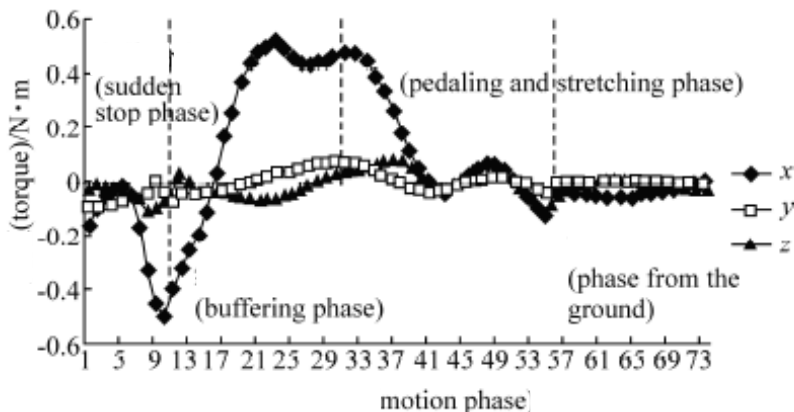


Figure3. The torque on the right ankle during sudden stop with the motion phase

4. Conclusions

From the above results, it can be seen that among the three movement modes, the most likely action to cause ankle joint injury is running sudden stop and lateral start. It is suggested that volleyball players should strengthen the centripetal contraction strength training of calf metatarsal flexors such as gastrocnemius muscle and tibialis posterior muscle in the course of daily training. Strengthen the ankle muscle strength training, but also to strengthen the ankle muscle group's stretchability, flexibility, stability training. The extensibility of flexor plantaris and flexor dorsi determines the stability of the body. The flexibility of valgus and internal and external rotator affects the flexibility of ankle joint. It is necessary to train the flexibility of ankle joint related muscles.

Acknowledgement

Measurement, Evaluation and Cause Analysis of Sports Injury of Knee and Ankle Joint Muscle in National Male Volleyball Athletes(2017HT092)

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