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Article

Factors and clinical characteristics of anterior cruciate ligament injury caused by basketball training injury based on multimedia visual images

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Abstract: With the coordinated development of China's national economy and the people's awareness of the importance of physical and mental health, people have become active in sports, and the development of sports medical care for athletes is particularly important. In training, athletes are likely to have ligament injuries, which makes athletes face rehabilitation, prevention and other problems. This paper describes the joint structure, injury factors and preventive measures of the anterior cruciate ligament, and compares the detection algorithm based on multimedia visual image with the traditional algorithm, focusing on the contrast between the clarity of the cruciate ligament injury image and the image information obtained. The results showed that the algorithm under machine learning improved 16.7% in the clarity of the athletes' ligaments compared with the traditional algorithm, and the amount of information obtained increased 0.168, which made it better to understand the situation of the basketball players' cruciate ligaments, so as to better prevent them, providing the best rehabilitation training for basketball players. This paper has a certain reference significance for basketball players in the research of cruciate ligament injury.

Keywords: anterior cruciate ligaments; basketball training; damage factors; sports medicine; edge detection algorithm

1. Introduction

In basketball training, players may have many movements. For example, in front of the defenders, if one wants to break through the defenders, he must suddenly slow down in front of the other side, and quickly change direction. In basketball games, the extension angle, valgus angle, bending moment and valgus moment of the knee have obvious changes. In the process of sports, the contraction of the quadriceps femoris and hamstring muscles is very different from that of the external muscles. Their bearing capacity is limited, which also increases the risk of injury of the anterior cruciate ligament (anterior cruciate ligament, ACL) in basketball training.

In basketball training, the injury of the anterior cruciate ligament of athletes is higher than that of ordinary athletes. Therefore, an in-depth analysis of it can effectively prevent its occurrence, ensure the health of athletes, and provide more high-quality backup force for the development of China's basketball cause. This has a very important significance and role in promoting and promoting the development of China's basketball professional technology.

Using machine learning technology to process the medical image of the injury of anterior cruciate ligament, and extract the medical data from the medical Internet of Things (IoT), the data can be intuitively displayed, thus guiding the basketball

players to carry out scientific training. At the same time, it can analyze the injury situation, and provide the athletes with the best rehabilitation training and guidance.

2. Related work

In order to reduce the cruciate ligament injury of athletes as much as possible, many scholars have studied the cruciate ligament. Prevention and management of anterior cruciate ligament injury from the biological perspective of gender. Parsons, Joanne L set up an injury model to explain that gender is only an external determinant through the analysis of men and women from the pre-competition, training and competition environment to the anterior cruciate ligament injury and treatment environment [1]. Sports medicine doctors have a strong clinical and research interest in anterior cruciate ligament. Raines, Benjamin Todd gave an overview of the management and prevention of ACL tearing, showing that biomechanical, biological and clinical data are helpful to promote global injury management and prevention practice, and research on ligament injury prevention was also deepening [2]. ACL graft failure and contralateral ACL tear are more common in children and adolescents than in adults. The reason for the high subsequent injury rate of this group is not completely clear. In this regard, Dekker, Travis J interviewed and tracked 112 subjects, analyzed their data, and used multivariate regression model to determine the predictive factors of the second ACL injury [3]. The psychological reaction after anterior cruciate ligament injury and reconstruction has been identified as a predictor of recovery exercise, but its relationship with further injury has not been investigated. In order to determine whether the psychological preparation for returning to sports is related to the second ACL injury, McPherson, April L carried out a research design. Their results found that among the patients who returned to exercise after anterior cruciate ligament reconstruction, 16% had a second ACL injury, and there was no difference in the degree of psychological preparation at the time point before operation [4]. Scholars have explored the anterior cruciate ligament, but not the anterior cruciate ligament caused by basketball training. In this regard, scholars have studied the cruciate ligament injury of basketball players.

In the training of basketball players, it is easy to cause ligament damage due to action mistakes, so scholars studied the cruciate ligament injury in basketball training. In order to determine the effectiveness of the hip ACL injury prevention plan for female basketball players, Omi, Yorikatsu conducted a 12-year prospective intervention study, which collected the incidence of ACL injury of female college basketball players in the first four years (observation period), and implemented the ACL injury prevention plan focusing on hip joint for eight years (intervention expectation). Its results showed that the incidence of ACL injury of female college basketball players was significantly reduced [5]. Athletes' injuries usually occur in training or competition, and are often easy to be injured in sports activities. Hadzovic, Miljan, in order to determine the effect of exercise plan on preventing the injury of anterior cruciate ligament of knee joint of young women basketball players, collected the existing research on the application of prevention procedures to prevent ACL injury of young women basketball players. Their results showed that the knee joint

injury training program improved the athletes' sports balance, flexibility and biomechanical ability related to anterior cruciate ligament injury [6]. In order to understand the internal risk of Italian excellent female basketball players, Benis, R designed a retrospective case series observational study to investigate the incidence of ACL injuries in Italian excellent basketball leagues. The results showed that in 74 cases of ACL injury, 65 basketball players (87.8%) were completely broken after surgical treatment, and 9 players (12.2%) had two or more lesions. It was also proposed that professionals must determine the different risk factors of ACL injury as soon as possible in order to provide preventive intervention to reduce the incidence of ACL injury in Italian elite female professional basketball league [7]. Scholars have studied the injury of anterior cruciate ligament in basketball training, but have not taken machine learning to explain the injury of anterior cruciate ligament or studied it through the medical IoT. In this paper, the factors and clinical characteristics of ACL injury caused by basketball training injury were studied through machine learning.

Numerous studies have shown that in basketball, football and other sports, the injury rate of the anterior cruciate ligament (ACL) in women is significantly higher than that of men, which has triggered scholars to explore the impact of gender differences. From a biological point of view, men and women have differences in anatomical structures such as pelvic width, Q angle, ACL size, and intercondylar incision size. These factors are regarded as the key to affecting the risk of ACL injury. The injury model constructed by Parsons and Joanne L reveals that gender is only a superficial factor, and the real cause of injury involves the intertwining of multiple factors such as biomechanics, training methods, and environmental conditions. Raines and Benjamin Todd emphasized that biomechanical, biological data and clinical data play an important role in global injury control and prevention. By formulating a scientific training plan and neuromuscular exercise, the probability of ACL injury in female athletes can be effectively reduced. The research of Dekker and Travis J pointed out that children and adolescents are more likely to suffer contralateral ACL tears after ACL reconstruction surgery, and the reasons for the high recurrence rate have yet to be explored in depth. Using multivariate regression models, scholars have found that postoperative rehabilitation training, graft selection and fixation techniques have a significant impact on the effectiveness of reconstructive surgery. In the research of ACL injuries in basketball players, there have been fruitful results. Prospective studies by Omi and Yorikatsu have shown that prevention programs with hip joints as the core can significantly reduce the ACL injury rate of women's college basketball players. At the same time, the research of Hadzovic and Miljan has also shown that injury prevention training for the knee joint can effectively improve the balance, flexibility and biomechanical performance of athletes, thereby reducing the risk of ACL injury.

Although scholars have conducted a lot of research on the gender differences and biomechanical factors of ACL injury, the understanding of its deep mechanisms has yet to be strengthened. The current prevention methods are mostly general recommendations, and there is a lack of customized prevention strategies for the characteristics of individual athletes and specific sports. At the same time, there is relatively little research on the impact of psychological response on recovery and

return to exercise after ACL injury, and it mainly focuses on preoperative psychological preparation, and research on psychological changes after surgery is relatively lacking. In addition, the application of cutting-edge technologies such as machine learning and the Medical Internet of Things in the prevention and treatment of ACL injuries has not yet been fully explored. In order to explore the specific mechanism of ACL injury in more depth, this research will integrate the perspectives of biology, biomechanics and psychology, so as to provide theoretical support for the formulation of more effective prevention and treatment strategies. At the same time, we will design personalized ACL injury prevention programs based on the personal characteristics of basketball players and the characteristics of sports to improve the prevention effect. In addition, we will also introduce advanced technologies such as machine learning and the Medical Internet of Things to achieve accurate prediction and personalized treatment of ACL injuries, aiming to improve treatment effectiveness and enhance patient satisfaction. In summary, this research will further expand and deepen the exploration of ACL injury on the basis of previous research, with a view to providing a more solid guarantee for the health and sports performance of athletes.

This article explains the factors that cause the injury of the anterior cruciate ligament of basketball players, mainly from the structure, causes and preventive measures. By comparing the edge detection method under machine learning with traditional methods, it has been found that the edge detection method under machine learning is more conducive to preventing injuries and providing better training methods for athletes.

3. Joint injuries in basketball training

3.1. Structure of anterior cruciate ligament of knee joint

The knee joint plays a role in buffering and supporting the body weight [8]. Because it is located between the thigh and lower leg, it is likely to be injured. For example, foot, basket, volleyball and other sports need fast speed, high intensity, strong antagonism, and the competition environment is changing rapidly. The athletes need to turn, change direction, accelerate, and break through quickly. These actions are easy to cause joint damage, such as ligament strain, joint dislocation, etc. Although in recent years, with the development of ACL reconstruction technology and rehabilitation technology, athletes can re-enter the arena, but they must be fully recovered, otherwise it is easy to cause the recurrence of old injuries, which is a big wound. In addition, due to the change of the instantaneous motion center of gravity of the knee joint after injury, the stability of the joint is affected, resulting in an increase in the valgus and varus torque of the front drawer force, which leads to the destruction of other joint tissues [9,10].

Cruciate ligament refers to the cross shaped cruciate ligament connecting two bones on the joint, also called cruciate ligament [11]. On both sides of the knee, two ligaments, one anterior and one posterior, are anterior cruciate ligament and posterior cruciate ligament. The structure of the cruciate ligament of the knee joint is shown in **Figure 1**.

The anterior cruciate ligament (ACL) is located in the internal measurement of

the femur, in the internal measurement space, and the posterior cruciate ligament (PCL) is located in the lateral space of the femur. The ACL is located at the medial side of the lateral femoral condyle, and the PCL is located at the lateral femoral condyle. Both ACL and PCL are in a tight state, no matter straight or curved. The former is used to prevent the forward movement of the femur, and the latter is used to prevent the movement of the tibia. These two ligaments are the key to ensure the stability of knee ligaments, especially when rotation is required during exercise. Because of the ligament damage, the direction of motion may change suddenly. If the leg muscles suddenly rotate outward and stretch or turn inward, it is likely to damage the ACL and medial collateral ligament [12,13]. From the preparatory state to different movements, the bending load of basketball players' knee joints is greater than that when they stand, and they often bounce when they land, so the weight of their knee joints increases. The athletes' knees are overloaded for a long time, resulting in excessive local load.

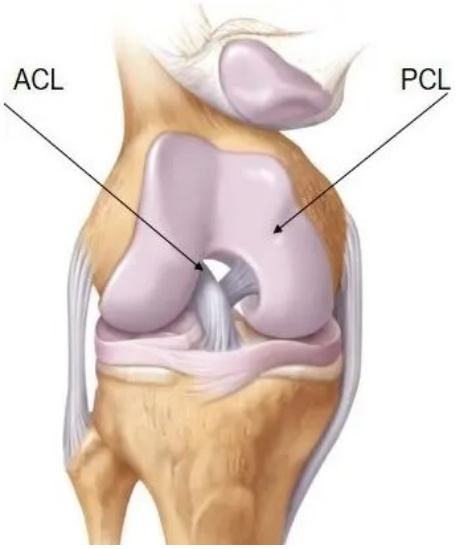


Figure 1. Structure of cruciate ligament of knee joint.

The hip joint is the most complex and destructive part of the body. Its bone structure is divided into ankle, lateral condyle, fibular stone, joint capsule, etc. [14,15]. The structure of the hip joint bone is shown in **Figure 2**. A thin, loose joint capsule is also formed around the sphere. In the space in front of the knee, a layer of muscle is formed. Many thigh and calf muscles develop from the stops of the knees [16]. The meniscus is composed of two crescent shaped small fiber pellets, which are located at the inner and outer sides of the femoral tibial plane. Its main function is to block the femur and ankle in the middle, increase the contact surface of the femoral tibial synovial joint, and generate a certain degree of elasticity. It can also buffer weight, maintain the balance between synovium and articular surface, help stabilize the femoral hip joint, transfer weight bearing capacity, and help lubricate joints. The femoral patella can not only protect the hip joint and prevent the impact with the quadriceps tendon layer and the femoral condyle cartilage surface, but also transmit the force to the quadriceps tendon layer and participate in the function of forming the hip extension mechanism. It can maintain the stability of the zero point five squatting

posture of the knee joint, and avoid the function of excessive adduction of the knee joint, abduction and extension and flexion, with the function of stabilizing the wheel supply chain to improve the rotation force of the knee. These factors constitute a capsule network formed by the ligament joint, which is the basic condition for maintaining the stability of the knee joint. Because of the structure of the knee, it lacks the inherent stability of the hip and ankle, so it needs muscles, ligaments and other structures to strengthen. The anterior cruciate ligament and posterior cruciate ligament can not only restrict the knee movement, but also make the knee joint move in a certain way. Anterior cruciate ligament can prevent tibia from moving. Posterior cruciate ligament can avoid tibia recession, strengthen the collateral ligament of the knee from the inside to restrain the excessive extension of the outside of the knee, and reinforce and restrain the excessive bending ligament of the knee from the front. Cruciate ligament injury is caused by a strong force and a tibial rotation force. In motion, especially in the motion requiring rotation and sudden turning, the knee bears inward rotation. At this time, the pivot fulcrum under the traction of the anterior cruciate ligament, biceps muscle and iliotibial band may cause fatigue of the lateral muscle group of knee joint rotation. If it cannot be adjusted in time, the anterior cruciate ligament may bear too much pressure, which can lead to ligament rupture.

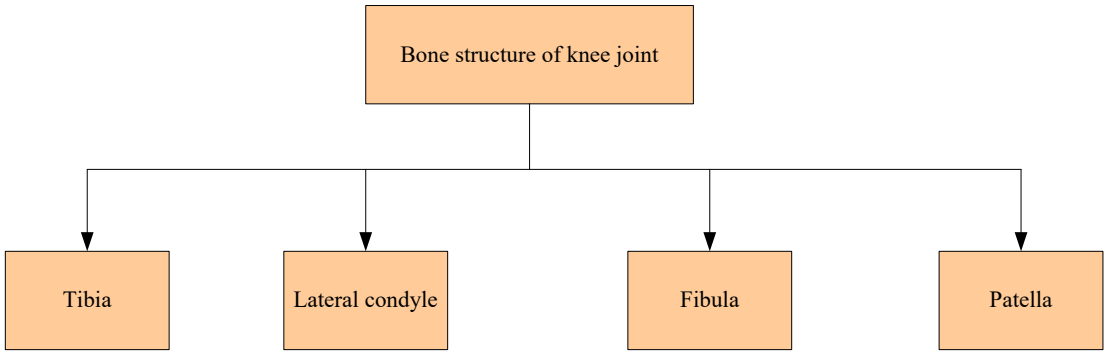


Figure 2. Bone structure of knee joint.

3.2. Factors and causes of anterior cruciate ligament injury

In basketball, due to the lack of control over muscles, ligament damage is caused. The causes of anterior cruciate ligament injury are shown in **Figure 3**. There are many muscles and tendons near the knee, and the bending and straightening of the leg is dominated by the hamstring muscle on the inside of the thigh. Basketball players' quadriceps muscles are generally stronger than thigh muscle. The hamstring muscles have the same function and direction as the anterior cruciate ligament. Therefore, the hamstring muscle can promote the movement of the cruciate ligament of the knee joint. However, basketball players in reality lack soft landing skills due to physical fatigue, or lack of attention to muscle training, muscle discordance, dynamic control of hip and knee joints, and stiffness of lower limbs [17,18]. It leads to the imbalance of thigh and calf muscle strength and excessive strength of ligaments, which increases the risk of injury. When basketball players grab rebounds, the muscle strength of their legs becomes weak due to overwork. When they land, the knee bends more, causing the thigh to rotate from the outside and the knee to turn

outward. This exceeds the bearing capacity of the cruciate ligament, resulting in knee sprain, anterior cruciate ligament injury, and lower limb strength tolerance. In basketball games, the probability of injury varies with different positions. **Table 1** is obtained by analyzing the injuries caused by 100 matches of CBA in China Professional Basketball League.

Table 1. Probability of damage at different parts.

position	knee	ankle	wrist	finger	shoulder	elbow
forward	49%	17%	12%	11%	4%	5%
Center-forward	22%	14%	9%	12%	25%	9%
guard	15%	14%	10%	15%	8%	12%

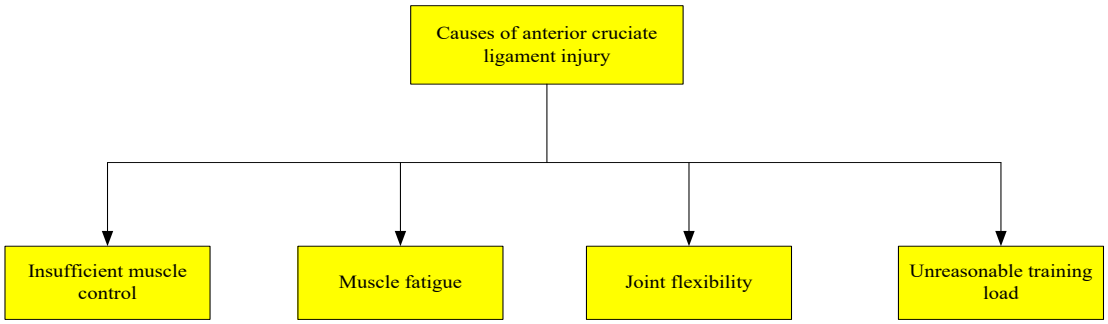


Figure 3. Causes of anterior cruciate ligament injury.

When taking off, the athlete's legs are subjected to several times of their own weight. In this process, the friction between the soles of the feet and the ground makes it impossible for the feet to complete rotation in just a few seconds, resulting in sprain [19]. If the muscles are tired or cannot be adjusted in time, the anterior cruciate ligament bears its full weight, while the cruciate ligament bears too much pressure, leading to the rupture of the cruciate ligament.

The flexibility of the knee joint has a great influence on the ligaments. When athletes turn their knee in or out, their knee gets a bending buffer. The so-called buffer zone is the meniscus outside the top of the tibia, which can move up to 14 mm. The medial meniscus can move 4 mm at most, and the center of rotation is at the intercondylar position. When the knee joint rotates outward, the anterior cruciate ligament should be pulled apart first, and then the cruciate ligament should be loosened. At the same time, the femur on the tibia should also slip slightly, so as to maintain balance [20]. However, when the internal and external rotation angles of the knee joint are too large, there is not enough flexibility, or the femur is not adjusted in time. Then the anterior cruciate ligament bears its weight. If it exceeds its bearing capacity, it may break. For people with low flexibility, the knee joint has a large abduction angle. For people with low flexibility, the angle of outward rotation becomes smaller due to the inward rotation of the knee. Therefore, the flexibility of athletes is insufficient, which limits the activities of the knee joint and is very easy to cause injury to the anterior cruciate ligament. The flexibility of the elderly decreases with age, so it is necessary to exercise the legs frequently to maintain flexibility.

They should pay attention to the physical ability, especially the strength of lower limbs and the flexibility of joints. At ordinary times, athletes should do a good job of flexion and extension exercises of the knee joint to enhance the stability of the joint and avoid injury. In addition, the flexibility of quadriceps femoris and hamstring is also important for the bending of knee joint and hip. The flexibility training of basketball players can not only stretch ligaments, but also exercise the flexibility of joint ligaments, and effectively improve the level of basketball technology.

It also shows that athletes pay more attention to a certain training or competition if they still participate after being injured in training or competition. Generally speaking, knee injuries take some time to fully recover. If basketball players participate in training or competition too early and often jump, it is likely to aggravate and cause secondary injuries. The order of ACL injury factors of basketball players is shown in **Table 2**.

Table 2. ACL injury factors of basketball players.

sort	reason	main causes	Secondary causes	General
1	Injured training	80%	19%	1%
2	Physical overstrain	61%	32%	7%
3	Insufficient muscle strength	56%	21%	23%
4	Improper load training	42%	40%	18%
5	Insufficient toughness	35%	49%	16%
6	Accidents	33%	34%	33%
7	Foul action	6%	15%	79%

Athletes' overwork can also lead to ACL damage. Athletes' physical fatigue is the so-called sports fatigue. Sports fatigue can be divided into mild, moderate and severe. Mild and moderate fatigue can be quickly relieved through some recovery measures without causing any harm to the body. However, severe fatigue is different. Severe fatigue has a certain negative impact on learning and life. Severe fatigue symptoms are slow reaction, excitement, irritability, resistance, etc. of the nervous system. The excessive physical consumption of mobilization leads to muscle tension, cramping, physical weakness, slow movement, inflexible technical movements, and decreased athletic ability, which also affects the athletes' mood and makes them lack of self-confidence. Moreover, these factors may also cause other sports injuries that often occur, such as muscle and ligament tears, knee and ankle sprains. Therefore, athletes should pay attention to the reasonable distribution of physical strength and take appropriate recovery measures when carrying out high-intensity training to prevent injuries caused by athletes' physical fatigue.

Sports injuries are caused by insufficient muscle strength. When the muscle strength is not enough in the basketball game, the following situations usually occur: passing with the ball, suddenly stopping and jumping to the ground, which are easy to cause injuries. When the strength of the knee muscle group is insufficient, they take side sliding steps, take-off and landing support, dribbling to avoid, bending and turning and other operations, causing the knee joint to twist, as shown in **Figure 4**. Moreover, muscle strength is not enough, and speed, flexibility and confrontation

ability are affected, which affects the play of technical movements. This leads to the nonstandard and wrong technical movements, thus increasing the athletes' sports injuries. Therefore, in normal training, basketball players need to exercise leg strength more, which is conducive to reducing knee injuries.

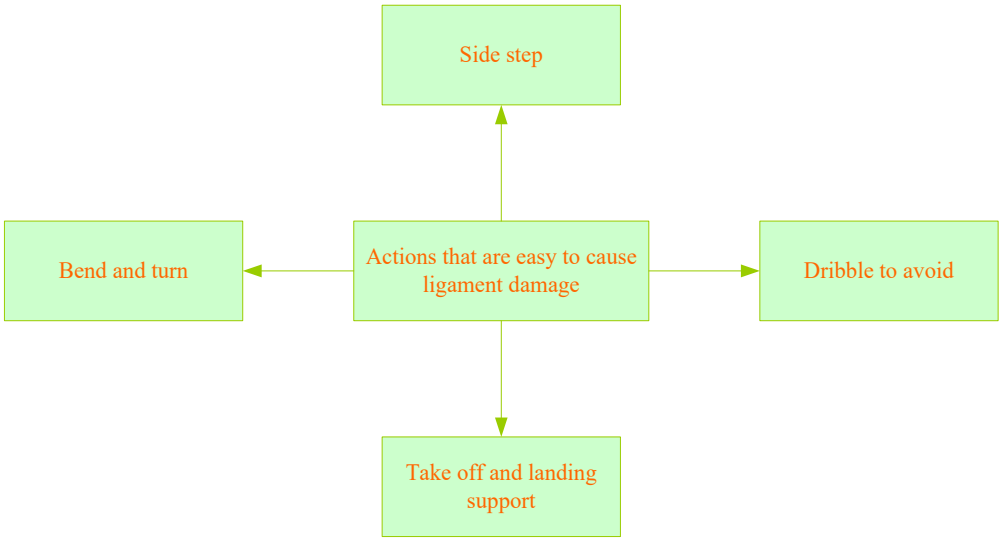


Figure 4. Actions that cause joint damage.

The training intensity of basketball players is on the high side. In basketball training, the reasonable allocation of sports load is related to the effect of physical training. Reasonable exercise can improve physical fitness. If they want to exercise skills, they should consider the reasonable distribution of exercise load intensity and timely training of skills. They should avoid excessive injury prone movements and overcome one-on-one training to improve the scientific nature of technical movements. Technical movements need to be improved to meet the requirements of human body mechanics.

3.3. Measures to prevent injury of anterior cruciate ligament and clinical manifestations

ACL injury not only has a negative impact on athletes' training and quality of life, but also has a certain impact on athletes' lives. In basketball, the incidence of ACL injury is very high. Therefore, it is necessary to prevent ACL damage. The starting point of the training program to prevent ACL injury is to reduce the risk factors of injury. The measures to reduce ACL damage are shown in **Figure 5**.

In order to reduce the injury of knee joint and anterior cruciate ligament, neuromuscular intervention is used. Super isometric training is the key to reduce the risk of ACL injury. Super isometric training is a comprehensive means of analysis and training, which combines verbal and visual feedback. When accelerating or decelerating, the load on the knee can be reduced, especially when the knee is extended outward. Super isometric exercise can reduce the reaction force on the ground, shorten the time for hip joint to extend and contract backward, increase the ratio of torsion torque of patellar cord and quadriceps femoris, and reduce the injury of knee joint. In the process of reducing ACL injuries, strength training is also

indispensable. It can enhance the stability of the knee and improve the strength of the muscle.

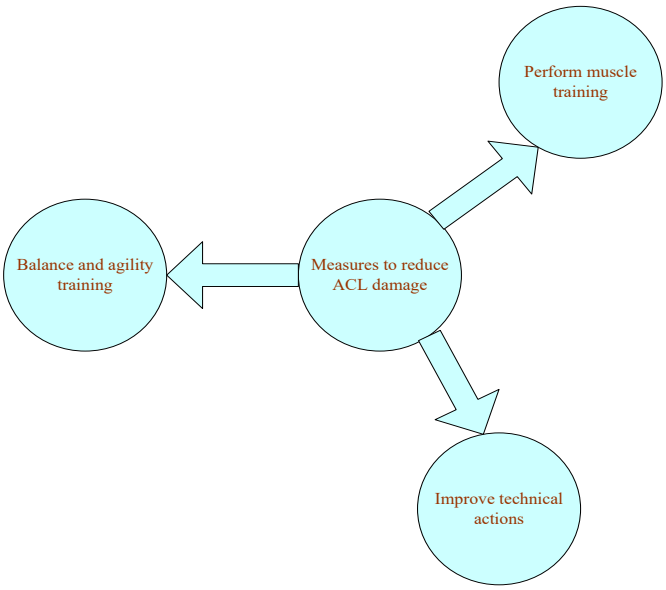


Figure 5. Measures to reduce ACL damage.

The improvement of basketball technical action can effectively reduce the occurrence of sports injuries. The method of neuromuscular perception is adopted to change the dynamic load of the tibiofemoral joint and improve the ability of landing and cutting. When landing, the athlete gently moves his forefoot back and slowly, bends his knees, and tries to land his feet on the ground. When the knee joint bending angle exceeds 45 degrees, the quadriceps femoris is the antagonistic muscle of ACL. Therefore, the athlete can let the quadriceps enter the state of stimulating ACL through knee squatting. Because knee bending is more dangerous, athletes can be trained to perform deep knee bending jump to shorten the time of knee standing. At the same time, athletes can improve the explosive force of deep flexion and quadriceps femoris by adjusting the explosive force mode of maximum flexion and extension, and play a better role in protecting ACL. In practice, the athletes should try not to bend down excessively, and the knees should be as high as possible above the toes when cutting in. Basketball players should keep the posture of bending knees and hips to reduce ACL injury. In addition, balance and agility training for athletes can also reduce ACL damage. Balance and agility training mainly includes the training of gluteus medius, hip extensors, abductors, hamstrings and core muscles, combined with agility, flexibility and balance of body feeling. The training focuses on the position of hip joint and knee joint, which can effectively improve the athletes' landing skills.

Knee joint pain, obvious swelling, intra-articular hematocele, and flexion and extension dysfunction are common symptoms of ACL injury. In the early stage of injury, the joint is stable and unstable in the late stage. When the knee is injured, it feels like the ligament is torn. The knee suddenly has sharp pain and soon swells, initially confined to the inside of the joint. When the joint capsule ruptures, the swelling spreads to the popliteal fossa and affects the back of the lower leg. Slowly,

there is congestion, which is a sign of intra articular bleeding. Patients with old injuries may show atrophy of the quadriceps femoris and weakness of the legs, greatly reducing the exercise ability.

3.4. Edge detection algorithm based on multimedia visual image

The change of image gray level can be expressed by gray distribution gradient. However, in the traditional edge detection methods, the adjacent area of a specific size of a pixel is generally used as the differential operator of boundary detection. The change rate and direction of gray scale are two main characteristics reflecting the change of gray scale. This paper introduces a machine learning algorithm for sports medical images to understand the injury of cruciate ligament. Using the edge detection algorithm, the injury of basketball players can be scientifically treated. This paper introduces a mathematical method based on edge detection.

The gradient operator is the simplest method of first order differential boundary detection, which can obtain the gray gradient of the original image through a differentiation. If the image is expressed by $H(x, y)$ function, the gradient operation can be defined as follows:

$$\Delta H(x,y) = \begin{bmatrix} H_x \\ H_y \end{bmatrix} \tag{1}$$

Among them:

$$H_x = \frac{\partial F}{\partial x} \tag{2}$$

$$H_y = \frac{\partial F}{\partial y} \tag{3}$$

The gradient amplitude can be expressed as:

$$G(H(x,y)) = \sqrt[2]{{H_x}^2 + {H_y}^2} \tag{4}$$

It can also be approximated during calculation. The estimation method is:

$$G_1 = |H_x| + |H_y| \tag{5}$$

The included angle θ of gradient is:

$$\theta(x,y) = arctan(\frac{H_x}{H_y}) \tag{6}$$

Gradient operator is the basic means of edge detection. Different edge detection algorithms can be obtained by using different neighborhoods and templates. In the digital image of sports medicine, higher methods are generally used to solve the partial derivative. The gradient operator is used to calculate the anterior cruciate ligament (ACL), and the basic parameters such as ligament extension angle and muscle strength are obtained. The quadratic operation is obtained by Laplace operator, and the center of its function is symmetric to zero, so it has rotation invariance. In this way, after processing the image with Laplace operator, the average gray level of the pixel points obtained is 0. In two-dimensional images, Laplace transform is a quadratic differential of isotropy. It is defined as:

$$\Delta^2 H = \frac{\partial^2 H}{\partial x^2} + \frac{\partial^2 H}{\partial y^2} \tag{7}$$

The sports medical digital image is composed of discrete points, which can be expressed in discrete format for ease of processing:

$$\Delta^2 H = [H(x+1,y) + H(x,y+1) + H(x-1,y) + H(x,y-1)]/4 \quad (8)$$

Laplace operation can make the dark part of the picture brighter. Because edges often occur at the place of gray level jump, Laplace operator can be used to extract edges well. However, since the algorithm has no directivity, the direction information contained in the edge is also lost. This easily leads to the existence of double pixels on the boundary, thus doubling the noise enhancement.

Therefore, in the image of ligament injury, noise must be removed. In this paper, a two-dimensional Gaussian function is adopted, and its formula is as follows:

$$S(x) = \frac{1}{2\pi\sigma^2} e^{\frac{x^2+y^2}{2\sigma^2}} \quad (9)$$

Gaussian de-noising of cruciate ligament image can obtain:

$$C(x,y) = S(x,y) \otimes H(x,y) \quad (10)$$

After processing the image of joint ligament injury, it can more clearly judge the condition of basketball players' ligament injury, and also can provide scientific medical care for athletes to help them recover as soon as possible.

4. Machine learning edge detection algorithm in ACL image

In this study, 104 patients were randomly selected from Hospital A as research samples. Before the start of the experiment, we collected basic information about patients through the hospital's information system, including age, gender, occupation, etc., and compiled clinical data such as their injury history and treatment records. During the experiment, we used the Medical Internet of Things platform to obtain the patient's ACL injury image data. It should be noted that due to personal reasons or accidental injuries, 3 men and 1 woman withdrew from the study, so in the end, there were 100 patients actually participating in the study, half of them men and women. Regarding the inclusion of patients, we have followed the following criteria: first, the patient must be between 20 and 25 years old and male; secondly, the weight is between 50 and 80 kg; moreover, the patient needs to have no history of spine or lower limb surgery and trauma, and no serious hypertension, heart disease, peripheral vascular disease, respiratory disease, etc.; finally, the patient needs to participate in physical exercise at least twice a week, and the duration of each exercise is not less than 30 minutes. At the same time, we have also set exclusion criteria: patients with obvious lower limb joint or muscle damage; patients who have recently taken medication; and patients who have failed to complete the entire test process are excluded from the study. In order to collect data more comprehensively, we also designed questionnaires to collect information on patients' basketball training habits, technical movements, physical fitness, etc., as a supplement to clinical data and image data. Basic information of the subjects is shown in **Table 3**.

The purpose of this research is to analyze the specific factors that cause anterior cruciate ligament injury during basketball training through multimedia visual image technology, and describe its clinical characteristics, so as to provide a scientific basis for prevention, early diagnosis and effective treatment. At the same time, explore the application effect of machine learning algorithms in ACL image analysis, and provide a reference for technological innovation in the field of sports medicine.

Table 3. Basic information of the subjects.

Information	Male (n = 50)	Female (n = 50)
Age (years old)	20.2 ± 1.8	20.6.2 ± 2.1
Height (cm)	176.2 ± 4.8	164.8 ± 5.1
Weight (kg)	70.6 ± 9.5	54.8 ± 8.2
Leg length (cm)	94.6 ± 4.8	88.6 ± 3.7

In order to quantify the difference between machine learning algorithms (ML) and traditional edge algorithms in ACL image sharpness, we used a number of image quality evaluation indicators, including average brightness, contrast, and sharpness. The following is the average image sharpness index of the two algorithms in the three experiments. The details are shown in **Table 4**.

Table 4. The comparative results of the two algorithms.

Algorithm type	Average brightness	Contrast	Clarity
Traditional algorithm	120 cd/m²	0.65	0.75
ML algorithm	122 cd/m²	0.70	0.88

As shown in **Table 4**, when comparing the sharpness differences of images processed by machine learning algorithms (ML algorithms) and traditional edge algorithms, we used multiple image quality evaluation indicators such as average brightness, contrast, and sharpness for quantitative analysis. According to experimental data, compared with traditional algorithms, ML algorithms have significantly improved image clarity. Specifically, the average clarity of the traditional algorithm is 0.75, while the ML algorithm reaches 0.88, which improves the clarity by about 17.3%.At the same time, we also noticed that the ML algorithm significantly optimizes the clarity of the image while maintaining a moderate increase in average brightness (122 cd/m^2) and contrast ratio (0.70), which provides doctors with more detailed and accurate ACL images, which is helpful for diagnosis and treatment in the field of sports medicine.

In this paper, through the medical Internet of Things, data from 100 patients with ACL injuries caused by basketball in a hospital is extracted, and their respective ACLs are obtained, which are equally divided into two groups of 50 people each. In order to better process the data, the statistics shall be conducted every 5 people. Totally 10 statistics are made. The age, gender and other variables of the two groups of patients are considered to ensure the consistency of the two groups as much as possible. One group uses traditional edge algorithm (hereinafter referred to as traditional algorithm) to analyze patients, and the other group uses machine learning edge detection algorithm (hereinafter referred to as machine learning algorithm) to analyze patient ACL images. The clarity of cruciate ligament images and the amount of information obtained are compared. In order to ensure the correctness of the experiment, three experiments are conducted, and the average value of the experimental data is taken. The contrast between the two methods is shown in **Figure 6**.

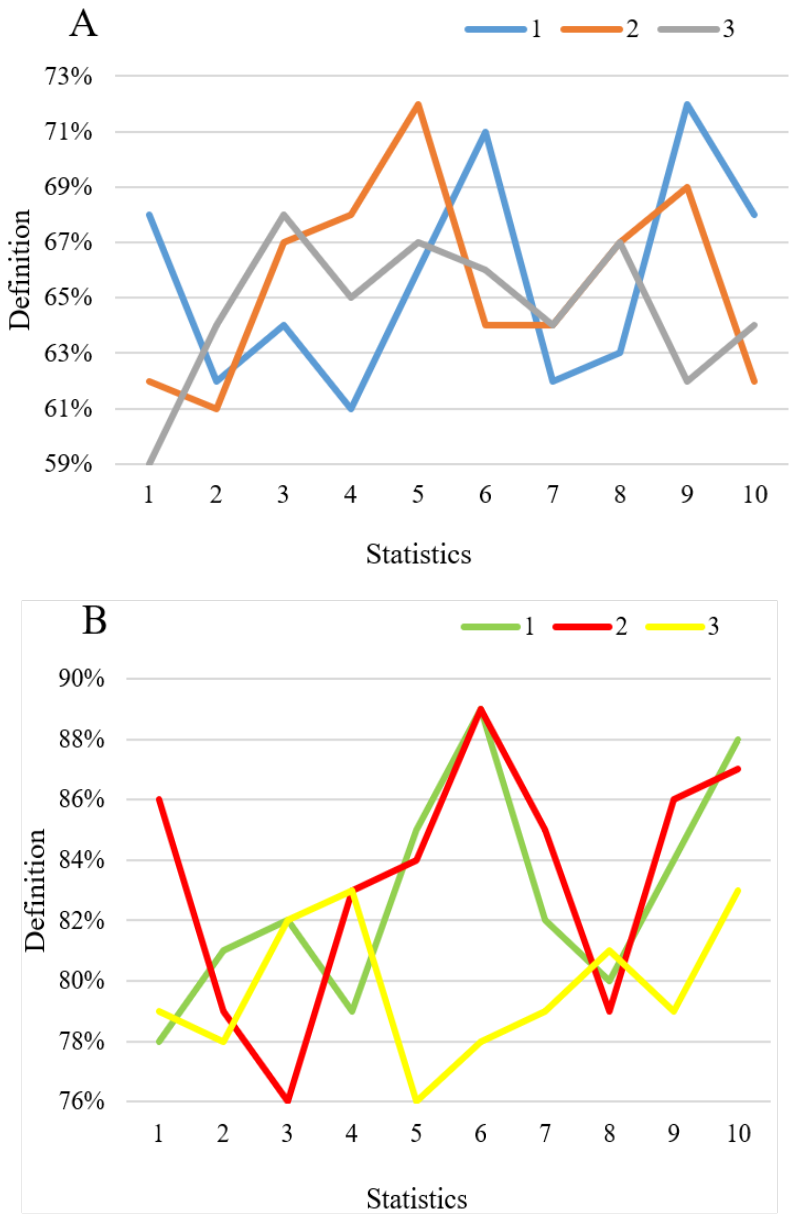


Figure 6. Clarity comparison of cruciate ligament images: **(A)** Definition of ligament damage by traditional algorithm; **(B)** Definition of ligament damage based on machine learning algorithm.

From **Figure 6A**, 10 times of statistics show that the average picture definition of the first experiment is 65.7%. The mean of the second definition is 65.6%. The mean of the third definition is 64.6%. The average comprehensive definition of the three experiments is 65.3%. In **Figure 6B**, the average sharpness of the three experiments is 82.8%, 83.4%, 79.8% respectively, and the average comprehensive sharpness of the three experiments is 82%. It can be seen from the two data that the machine learning algorithm has improved the ligament clarity of athletes by 16.7% compared with the traditional algorithm. It also shows that the machine learning algorithm is more conducive to the application in the medical Internet of Things, which can better understand the ligament injuries of basketball players.

The machine learning algorithm and the traditional algorithm are compared for the clarity of the cruciate ligament image. By showing the significant difference

between the two algorithms in the clarity of the ACL image and the amount of information, the significance between them is studied. The details are shown in **Table 5**.

Table 5. Correlation analysis of cruciate ligament image clarity of the two algorithms.

Indicator	Machine learning algorithms	Traditional algorithm
Image clarity	0.85 ± 0.05	0.68 ± 0.06
Amount of information	7.2 ± 0.8	4.5 ± 0.9
t value	5.87	2.32
p value	0.001	0.156

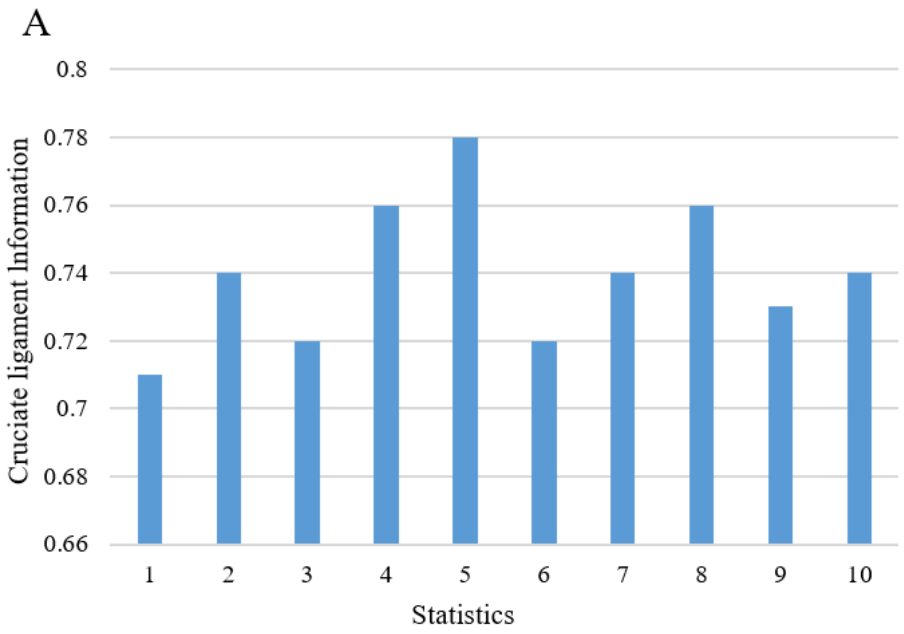
As shown in **Table 5**, the image clarity of the machine learning algorithm is 0.85 ± 0.05, which is significantly higher than the traditional algorithm of 0.68 ± 0.06. This means that the ACL image processed using machine learning algorithms is clearer, helping doctors to observe the details of the ligament more accurately. At the same time, in terms of information volume, the machine learning algorithm is 7.2 ± 0.8, which is significantly higher than the traditional algorithm of 4.5 ± 0.9, indicating that the machine learning algorithm can provide more valuable diagnostic information. Further analysis shows that the machine learning algorithm has a *t* value of 5.87 and a *p* value of 0.001 ($p < 0.05$), which is statistically significant; while the traditional algorithm has a *t* value of 2.32 and a *p* value of 0.156 ($p > 0.05$), there is no significance. These data fully show that compared with traditional algorithms, machine learning algorithms have significant advantages in improving ACL image clarity and information volume, and provide more accurate and rich visual support for sports medicine diagnosis.

In order to visually show the difference in clarity between the original image and the image processed by the two algorithms (traditional edge algorithm and machine learning algorithm), an ACL image was extracted for processing. The effect of the two algorithms is shown in **Figure 7**.

Figure 7. Comparison chart of the effects of the two algorithms on ACL image processing: **(A)** Original image; **(B)** The rendering after traditional algorithm processing; **(C)** ML algorithm processed rendering.

As shown in **Figure 7A–C** are the original image, the traditional algorithm processing renderings, and the ML algorithm processing renderings. Through **Figure 7**, it can be found that the ML algorithm is used to process the image with high clarity and more details can be seen. The image processed by the traditional edge algorithm has improved in edge detection, and the outline of the ACL can be more clearly outlined. However, due to the limitations of traditional algorithms, such as high sensitivity to noise and inaccurate edge positioning, the details in the image are still not clear enough. In contrast, after processing the image using machine learning (ML) algorithms, the clarity of the image is significantly improved. By learning and optimizing the features in a large amount of image data, the ML algorithm can more effectively suppress noise, enhance contrast, and accurately locate edges. Therefore, in **Figure 7C**, we can see that the outline of the ACL is clearer, and the detailed information such as the internal fiber structure has also been better preserved and displayed. This kind of high-definition image is of great significance for doctors to accurately determine the degree of ACL injury and formulate treatment plans.

The amount of information obtained from different images of cruciate ligament damage is also different. The more picture information obtained, the more conducive to scientific medical methods for sports patients, as well as reasonable rehabilitation training for athletes. The comparison of the information amount of the cruciate ligament images obtained by the two methods is shown in **Figure 8**.



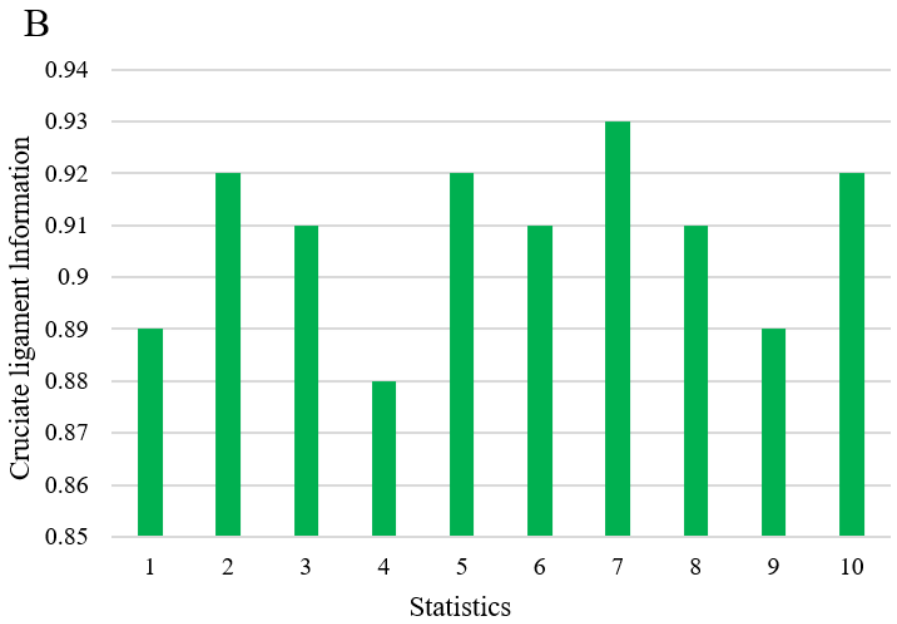


Figure 8. Comparison of cruciate ligament information: **(A)** Traditional algorithm cruciate ligament information; **(B)** Machine algorithm cruciate ligament information.

In **Figure 8A**, the average of the 10 times of statistics of the cruciate ligament information of the traditional algorithm is 0.74. However, in the cruciate ligament information volume of the 7B machine algorithm, the average information volume is 0.908, which is 0.168 more than the information volume obtained by the traditional algorithm. It shows that the machine algorithm is more conducive to understanding the cruciate ligament injury of athletes. The more information about ligament injury of basketball players, the more conducive to treatment measures for athletes.

5. Discuss

With the rapid development of science and technology, the combination of Medical Internet of Things (IoMT) and multimedia vision technology has opened up a new world for sports medicine. This study paid special attention to the common anterior cruciate ligament (ACL) injury in basketball training. Through in-depth comparison of the performance of traditional edge algorithms and advanced machine learning edge detection algorithms in ACL image analysis, we have discovered the significant advantages of modern technology in improving diagnostic accuracy and efficiency. Especially with the help of multimedia vision technology, especially the excellent use of machine learning algorithms, the accuracy and speed of image analysis have been greatly improved. Compared with traditional edge algorithms, machine learning algorithms show their unique self-learning ability, which can accurately capture and recognize complex features in images, thus effectively avoiding the subjective errors and limitations caused by artificially setting thresholds. Our research data show that compared with traditional algorithms, machine learning algorithms have improved the clarity of ACL images by 16.7%. This remarkable improvement not only allows doctors to more clearly observe the subtle structural changes in the ligaments, but more importantly, it significantly reduces the time required for diagnosis and wins valuable treatment and rehabilitation opportunities

for athletes. In addition, the efficiency and accuracy of machine learning algorithms in processing massive amounts of data have also laid a solid foundation for large-scale screening and the formulation of personalized treatment plans in the field of sports medicine.

Basketball is known for its high intensity and high confrontational nature, which has also led to the frequent occurrence of ACL injuries in basketball training. In order to explore this issue in depth, this study conducted a detailed analysis of the ACL injury data of 100 basketball players, which revealed the multiple causes of such injuries and provided a scientific reference for prevention and treatment. At the level of technical actions, actions such as emergency stops, rapid changes of direction, and jumps in basketball have caused a huge burden on the ACL. It is particularly worth noting that some incorrect technical actions, such as the inner buckle of the knee when landing, and the excessive outward expansion of the leg, will greatly increase the risk of ACL damage. In addition, from the point of view of physical fitness, athletes' flexibility, muscle strength and balance are also key factors affecting the condition of the ACL. Related studies have shown that athletes with poor flexibility, insufficient muscle strength, and poor balance face a higher risk of ACL injury. Therefore, the formulation of a set of scientific and reasonable physical training programs to comprehensively improve the physical fitness of athletes has become a key measure to prevent ACL injuries.

In summary, through the study of anterior cruciate ligament (ACL) injury in basketball training through multimedia visual image technology, we not only have a better understanding of the injury mechanism of ACL, but also provide scientific basis and technical support for prevention and treatment. With the continuous progress of medical Internet of Things and multimedia vision technology, we firmly believe that sports medicine will move towards a more accurate, efficient and personalized new era.

6. Conclusion

This article mainly explained the factors of cruciate ligament injury caused by basketball players in training and their clinical manifestations. The structural characteristics of the knee cruciate ligament were analyzed. Combined with the mechanical factors in basketball training, the causes of ligament injury were analyzed. Through the edge detection algorithm and traditional algorithm under multimedia visual image, the image of cruciate ligament injury of athletes is analyzed, mainly from the clarity of cruciate ligament image and the amount of information obtained. The results showed that the edge detection algorithm based on machine learning was more conducive to just medical detection of basketball players. It can also take more targeted medical rehabilitation measures to improve the data information of the medical Internet of Things. The inadequacy of this paper is that it has not been studied in biomechanics. It did not consider the impact of basketball players' endocrine on cruciate ligament, and did not take a variety of methods to analyze the situation of athletes. With people's living environment getting better and better, the medical care of athletes also needs to be paid attention to. Only with more perfect medical and health care measures can athletes better prevent injuries during

basketball training.

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