Proceedings of ICBioMed 2024 Workshop: Workshop on Intelligent Medical Data Analysis for Precision Medicine
DOI: 10.54254/2753-8818/50/2024AU0111

How to effectively prevent hamstring injury and acute treatment measures

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Abstract. Hamstring injury (HSI) is one of the most common injuries in competitive sports, the recurrence of this injury is high, which has a huge impact on the athlete's return to the game. Muscle strength, flexibility, muscle fatigue and age may contribute to damage to the hamstring. Current studies have shown that some static stretching, proprioceptive neuromuscular facilitation (PNF), warm-up and rest before and after the game, and the use of equipment such as foam shaft can effectively improve flexibility and prevent injuries, and hamstring strength training can also prevent injuries. The acute phase after injury can be managed by P.R.I.C.E principle to avoid aggravation of injury. This paper describes the dissolving structure, injury mechanism, risk factors, preventive measures and treatment of the hamstring muscle by citing literature and has a more comprehensive understanding of the prevention and treatment methods of hamstring muscle injury and provides some suggestions for athletes and rehabilitation therapists.

Keywords: Staticstretching, Proprioceptive Neuromuscular, Facilitation, flexibility, Hamstring injury

1. Introduction

Hamstring injury (HSI) is a common lower limb injury in the game, usually occurring in football, rugby and sprinting. The second most common injury in rugby union matches and training in England, with around 6.4 injuries per 1,000 hours [1]. Through the investigation of elite track and field athletes and ordinary college athletes, it is found that most athletes have hamstring injury [2]. In football, it accounts for 12%-16% of all injuries [3]. At the same time, the recurrence rate of this injury is very high. Among sprinters, the recurrence rate of hamstring injury within one year reaches 48%, with 52% of sprinters experiencing secondary injury, mainly occurring in the first three months of recovery [4]. Therefore, injuries to the hamstring muscles prevent athletes from returning to the field in the short term, resulting in losses in training time and economic aspects, and even affecting their career. Hamstring injury is usually caused by excessive passive stretching of muscles or an imbalance between active and antagonistic muscle forces, resulting in tearing of muscle fibers and some connective tissue.

However, the mechanism and factors of damage to some hamstrings are still unclear and require further exploration. The current intervention treatment includes surgical treatment and non-manual surgical treatment, which is particularly important for acute phase intervention. The price principle can effectively reduce the progression of injury and facilitate rapid recovery of injury. This article mainly summarizes the measures and partial treatment principles for preventing injury to the hamstring muscle,

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providing more specific theoretical basis for preventing injury and treatment from the aspects of dissection, injury mechanism, risk factors, etc.

2. Anatomical structure

The hamstring muscle is composed of three muscles behind the bone and thigh, which are semitendinosus, semimembranosus and biceps femoris. The semitendinosus muscle accounts for the largest part of the hamstring muscle group. The semitendinosus and semimembranous muscle start from the ischial tubercle, the semitendinosus muscle ends at the medial condyle of the upper tibia, and the semimembranous muscle ends behind the medial ankle of the tibia. The function of the semitendinosus and semimembranous muscles is to extend the hip and bend the knee with slight internal rotation, while the biceps femoris muscle is accompanied by external rotation in addition to hip extension and knee flexion, the hamstrings span both joints, across the knee and iliac joints. The semitendinosus and semimembranosus muscles are innervated by the sciatic nerve, while the biceps femoris is innervated doubly: the long head of the biceps femoris is partially innervated by the sciatic nerve, and the short head is partially innervated by the common peroneal nerve. When the hamstring muscle contracts, it can promote the flexion of the knee joint and the extension of the hip joint. According to research, injuries to the hamstring muscle are mainly concentrated around the long head of the biceps femoris and the ischial tuberosity [4]. The hamstring muscle forms an antagonism with the quadriceps, maintaining and coordinating the stability of the joint and the balance of muscle strength, which plays a great role in the stability of the knee joint.

3. Strain mechanism

During intense or sudden movements, muscles contract or stretch with a lot of force, which acts suddenly on muscles and tendons. Hamstring muscles will suddenly bear a huge load, beyond the normal range, easy to cause injury. Wang Hui et al., by citing a large number of scholars' literature, proved that excessive local stress of muscle fibers is most likely to cause damage during centrifugal contraction [2]. From the perspective of the displaning characteristics of the hamstring muscle, the body volume of the hamstring is smaller than that of the antagonistic muscle, and the muscle strength is larger than that of the quadriceps muscle. At the same time, excessive passive extension of the hamstring muscle during high-speed exercise is also one of the causes of hamstring injury, which usually occurs in the final stage of the sprint swing stage. At this point, the hamstring is quickly extended, and the heel is ready to hit the ground and absorb most of the leg strength. With the increase of speed, the amount of absorption increases exponentially, which is easy to cause the tear of the hamstring muscle fiber and connective tissue [5]. At present, however, the mechanism of hamstring injury is still controversial and need further investigation.

4. Factors of injury

4.1. Flexibility of the hamstrings

When not fully warmed up or the muscle itself is very poor flexibility, when the muscle is stretched by excessive centrifugation and exceeds the maximum length of the muscle centrifugation, the muscle fibers are prone to tear leading to injury. At the same time, the muscle tissue has a certain level of viscosity at rest, and the flexibility has not been extended at rest. Once you do strenuous exercise in this situation, it is very likely that the core muscle will be strained, especially the femoral hamstring muscle is prone to sudden strain [6].This injury often occurs at the end of the swing phase during sprints, due to sudden rapid elongation of the hamstring muscle, poor flexibility, short maximum length of the muscle, and rapid tearing of the hamstring muscle. In summary, poor flexibility may be one of the reasons for hamstring strain.

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4.2. Muscle strength in the hamstrings

Hamstring muscle strength is one of the important reasons for injury. Hamstring injury may due to the imbalance of strength between hamstring and quadriceps muscle. When the strength of the hamstring muscle and the strength of the quadriceps muscle is less than 3:5, the imbalance between the two forces is easy to cause hamstring injury [6]. In the study on injury risk factors, Li Donghe et al. compared the strength of quadriceps muscle and hamstring muscle in injured and uninjured people and found that the strength imbalance between the two was one of the causes of injury [7]. In addition, some scholars pointed out that when the heel contacts the ground, the centrifugal force of the hamstring muscle needs to counter the force of the quadriceps muscle as well as the ground against the reaction force of the heel [8]. Therefore,when the quadriceps muscle strength is not enough to counter the two forces, muscle damage usually occurs.

4.3. Muscle fatigue

From a physiological point of view, muscle fatigue is caused by the production of a large amount of lactic acid or the consumption of a large amount of energy compounds in the muscle cells used. However, when the muscles used intensely for a long time do not get enough rest, a large amount of lactic acid will accumulate and the muscles may not continue to maintain the original strength. Tiago Penedo et al found that muscle fatigue will lead to the weakening of joint stability. Instability of posture may cause muscle strain [9]. In general, muscle fatigue is most likely to occur at the end of sprinting or football, so hamstring injuries often occur at this stage. In the case of muscle fatigue, attention should be paid to muscle rest to prevent the severity of fatigue from increasing and reduce the risk of strain.

4.4. Age

The older the muscle, the higher the degree of muscle loss, muscle strength, flexibility is poor, which is also indirectly leading to hamstring muscle injury factors. An analysis of studies showed that athletes over the age of 23 were four times more likely to suffer hamstring injuries than athletes under the age of 23[10]. Therefore, age may be a cause of injury, but further experiments are needed to prove it.

5. Prevention

5.1. Strengthening the hamstrings

Since hamstring injury is related to the imbalance between the strength of the quadriceps muscle, strengthening the hamstring muscle may effectively prevent the hamstring muscle strain [6]. Centrifugal training is a training method that increases the strength of the hamstrings by making the muscles contract against a suitable centrifugal load, which increases the activity of the neuromuscular system compared to isometric and centripetal contraction patterns [11].

The centrifugal training of hamstring muscle mainly includes hip flexion and knee extension centrifugal training. Hip flexion centrifuge training: the patient kneels and the therapist assists with calf compression. Use the centrifugal muscle of the rope muscle to resist the body gravity and slowly lower the body to bend the hip, keep the knee flexion, when it is impossible to maintain the position, the hands can support the prone position. Then quickly push the ground, and with hip extension to quickly return to kneeling position, 5-8 times per set, do five sets. Knee extension centrifugal training:The patient is in a kneeling position, with the therapist assisting in pressing the calf. The patient uses rope muscle centrifugation to counter body gravity and slowly lowers the body to extend the knee joint until the hip joint is straight. When this position cannot be maintained, support with both hands, and quickly push off the ground and bend your knees to quickly return to the kneeling position, again 5-8 times per set, do five sets. In addition, the rope muscle knee extension centrifugation training and hip flexion centrifugation training can be combined, each group 5 times 5 sets.

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5.2. Improve flexibility

5.2.1. Static stretching. Static stretching is to increase the muscle and soft tissue origin and insertion points of the hamstring muscles in order to improve their flexibility. The main clinical method is the supine straight leg raise technique, with the patient lying supine, keeping the ankle joint in a neutral position, passively flexing the hip and extending the knee to lengthen the hamstrings as much as possible for thirty seconds per set. 1-3 sets of pre-stretching are recommended before exercise. Research has shown that continuous static stretching has a more significant effect on improving flexibility than intermittent static stretching, so it is advisable to stretch the hamstrings for thirty seconds per set whenever possible [12].

A large number of literatures show that there is a certain relationship between the motor system and the myofascial network system. Anatomically, the superficial posterior line connects the hamstrings to the thoracolumbar fascia, the vertical spinal muscles, and the supracranial tendons. The dysfunction of one muscle can affect the whole system [13]. Aybuke ERS N et al. divided 120 patients with tight hamstring muscle into study group and control group, 60 patients in each group. The study group received chest training and the control group received active stretching, and both groups showed significant improvements in flexibility through active knee flexion testing [10]. In addition, a randomized comparative study, conducted of lumbar tendon stretching on 41 healthy women aged 18-39 and finally measured the flexibility through straight leg elevation test and passive knee extension test. The result suggested that the stretching of lumbar muscle can improve the flexibility of hamstring muscle in healthy people [14].Since there is no significant difference in the structure of the hamstring muscle between men and women, chest training and waist muscle stretching may be used to prevent hamstring injuries.

5.2.2. Proprioceptive neuromuscular facilitation. Proprioceptive Neuromuscular Facilitation (PNF) may improve muscle flexibility. The training method of active contraction and relaxation of antagonist muscle was adopted. The patient took a standing position, actively elevated one lower limb and pronated, then actively extended the knee and flexed the hip joint forward, stretched the hamstring muscle until slightly uncomfortable, then isotonic contraction of the opposing quadriceps muscle and actively extended the knee for about 30 seconds, then relaxed, and repeated the same training back and forth. E Mani et al. compared the effects of PNF and static stretching on hamstring flexibility in a randomized comparison of 36 male patients. Then the knee extension range of motion was used to measure flexibility and the isokinetic dynamometer was used to assess muscle perception. The trial found that both PNF and static stretching improved the flexibility of the hamstring muscle, but in the long term, PNF may improve the flexibility better [15].

5.2.3. Using of vibrating foam shafts. The use of foam axis can improve the range of motion of the muscle, improve the blood circulation of the muscle part, the use of foam axis before exercise can improve the stiffness of the muscle, reduce the occurrence of muscle spasms, and prevent the hamstring injury. Using a foam shaft after exercise can relieve muscle pain and speed up muscle recovery. The usual method of using the foam shaft is to place the hamstring muscle on the foam shaft and roll back and forth with the center of gravity of the body, 40 times per minute for 5 minutes.

5.2.4. Warm up. It is especially important to warm up properly before exercise. Warm up can raise the temperature of the muscles, increase the muscle elasticity, and resist absorbing more force from the ground and quadriceps when running or exercising, so as to prevent injury. Studies have shown that warming up can improve the performance and ability of table tennis and has a certain impact on injury prevention [16]. Meanwhile, Ali et al. found that warming up during track and field sprints can effectively reduce the probability of muscle injury [17]. Massage can be performed after exercise, and hot compress can promote lactic acid into the blood to reduce muscle fatigue, accelerate muscle recovery and prevent strain.

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6. Treatment

Generally, most hamstring injuries do not require surgical treatment and can return to normal within a few days to weeks. The recovery time depends on the degree of injury, physical fitness and nutritional supply. In the acute phase, initial treatment followed P(protection).R(rest). I(ice).C(compress).E(elevation). After protecting and resting the injured hamstring, ice compress can control inflammation, relieve pain, reduce bleeding, and has a good local anesthetic effect. Two to three hours at a time for 15 to 20 minutes. Don't apply ice directly to the skin, because it will damage the skin. Using elastic bandages to compress the injured area is beneficial for relieving swelling and also helps to fix muscles. Raising the injured area above the heart and maintaining support may reduce blood flow in the injured limb, reduce bleeding, promote blood and lymphatic circulation, and accelerate the resolution of swelling. At the same time, some anti-inflammatory drugs can be used to help alleviate inflammation and symptoms, such as using non agarose anti-inflammatory drugs for one to two weeks. But it only alleviates symptoms and cannot have the effect of stopping pain before continuing to exercise. After the pain is relieved, hot compress can be used to relax muscle tension, and tools such as crutches can be used to reduce the pressure load on the hamstring muscle.

7. Conclusion

By sorting out relevant literature on preventing hamstring injury, this paper has a better understanding of the mechanism, risk factors, preventive measures and related treatment in the acute phase of hamstring injury. Let therapists and athletes understand the importance of injury prevention, through a series of measures to minimize the probability of hamstring injury and rapid recovery and return to the game. At present, the injury factors of hamstring muscle are still controversial, and more research on injury factors is needed in the future to clarify the causes of injury and better reduce the injury rate.

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