

Functional rehabilitation after anterior cruciate ligament reconstruction

Yichen Wang

School of rehabilitation medicine, Nanjing Medical University, Nanjing, 211166, China

wangylchen@sina.com

Abstract. The function of anterior cruciate ligament is to limit the rotational force of tibia at knee joint to stabilize knee joint. Therefore, after the current cruciate ligament injury, the normal knee joint structure changes, and the knee joint loses its stability, which will inevitably have an impact on life. For example, if you can't walk independently, you need a wheelchair or a walker; Being unable to engage in high-intensity sports is especially fatal for high-level athletes. Reconstruction is the main way to treat severe anterior cruciate ligament injury. Although the anterior cruciate ligament reconstruction operation has been perfect, the reconstructed ligament will grow again at a very slow speed without any intervention after the operation and only relying on its own recovery. It can be said that rehabilitation is a process that must be experienced and a very long process. However, before rehabilitation, some potential problems that cannot be ignored need to be solved urgently. This paper will discuss three main problems: pain, abnormal gait and infection. By analyzing how they affect the process of rehabilitation, we will give targeted solutions and hope to give new ideas for clinical rehabilitation intervention.

Keywords: ACL, Rehabilitation, Sports Trauma Recovery, Rehabilitation Training.

1. Introduction

Anterior cruciate ligament (ACL) injury is one of the most common and serious knee joint injuries, and it is especially prone to sports and fitness people. The ligament tear will seriously affect the stability of the knee joint, which will lead to the inability to work and exercise normally. With the development of all-round fitness exercise, the incidence of sports injuries is also increasing rapidly. According to statistics, ACL is as high as 20.9% in trauma. Regarding the treatment of this injury, arthroscopic reconstruction is the most perfect treatment method at present, which can better restore the stability of the knee joint. However, some unavoidable complications after operation, such as quadriceps femoris muscular atrophy and decreased muscle strength, will directly affect the future functional training of patients and may cause early onset of osteoarthritis. At the same time, it is found that people with unstable knee joints such as knee hyperextension and hamstring weakness are particularly prone to ACL injury, and such problems can be solved by gradual load training in rehabilitation training. Therefore, muscle strength rehabilitation is the key and difficult point for patients after ACL surgery, and it is particularly important to carry out rehabilitation treatment in time after ACL surgery to restore their functions. However, at present, the clinical research on ACL reconstruction is constantly being carried

out, such as how to choose a more suitable graft and how to use computer navigation system to assist ACL surgery location.

However, there are few reviews and guidelines on postoperative rehabilitation guidance, and the research on the timing of rehabilitation intervention and individualized training plan is not perfect, and there is a lot of research space. Therefore, this paper mainly summarizes the causes of knee muscle atrophy after ACL surgery and the rehabilitation treatment methods in order to provide evidence-based reference for clinic.

2. Changes of muscle after ACL surgery

Anterior cruciate ligament reconstruction surgery is a knee joint surgery using autologous, allogeneic tendons or artificial tendons and arthroscopic techniques. With the continuous development and improvement of arthroscopy, anterior cruciate ligament surgery has become a minimally invasive surgery that can be completed in one to two hours, and the wound healing time is generally less than two weeks. However, even though the wound healing speed is considerable, there are many problems in the functional recovery of the knee joint. The first is the common phenomenon of muscle strength decline after surgery. The American Sports Medical Association used nuclear magnetic resonance technology to detect the cross-sectional area of quadriceps femoris muscle peak in patients after ACL surgery, and the results showed that the lateral leg decreased by 15% compared with the healthy side after ACL surgery [1]. In addition, Thomas and others found that the hamstring muscle strength decreased by 8%-29% after operation, and the quadriceps muscle strength decreased by more than 41% [2]. Many investigations and studies have found that the phenomenon of muscle atrophy and muscle strength decline after ACL surgery will not recover itself without the intervention of exercise training. In addition, because the knee joint can't move normally for a period of time after the operation, long-term braking will lead to muscle stiffness and joint adhesion, which will lead to the limited range of motion of the knee joint and affect its normal function in the future.

3. The necessity of postoperative rehabilitation treatment

Continuous passive exercise (CPM) machine is an important machine for rehabilitation training. It can provide continuous and uniform passive activity training in the range of -5 to 115 degrees. By stimulating osteoblasts to differentiate into osteoblasts, the formation of articular cartilage can be accelerated, so as to promote the re-growth of ligaments and tendons in the target area. In addition, CPM machine can also accelerate local blood circulation, increase the metabolism of joint fluid, soften scars and release adhesion. Lin Yuan selected 62 patients after anterior cruciate ligament surgery, and randomly divided 63 patients into control group and observation group with 31 patients in each group [3]. The control group was given general postoperative care, while the observation group was trained with CPM machine combined with early rehabilitation guidance. The intervention time was one month, which was used to verify the effectiveness of CPM machine in improving joint mobility. The results show that after the intervention, compared with the control group, the observation group has greatly improved the Lysholm score and joint range of motion: the average joint range of the control group before the intervention was 28.41-5.22, and after the intervention was 101.25-12.14, an increase of about 75; The average range of the observation group before intervention was 28.39-5.18, and after intervention it reached 129.37-14.96, an increase of about 105, more than 30 compared with the control group. Lysholm score is eight scores for knee joint function, which are limping, support, noose, instability, pain, swelling, going upstairs and squatting, with a perfect score of 100, so as to evaluate the postoperative functional status of patients with knee joint. On the surface of the research results, the score of the control group was raised to 15, which was less than that of the observation group's 25, indicating that continuous passive exercise also played a significant role on restoring knee joint function. It can be seen that reasonable rehabilitation training means and correct early rehabilitation guidance play a significant role after ACL recovery. Therefore, rehabilitation training after ACL surgery is necessary.

4. Factors affecting postoperative rehabilitation

After the operation, timely intervention of rehabilitation is particularly important. Under normal circumstances, it belongs to the inflammatory reaction period within one week after the operation, and it is not suitable for rehabilitation. Therefore, a week later is usually the right time to intervene in rehabilitation. However, in actual clinical work, there are often many problems that interfere with the timely intervention of rehabilitation treatment. If these problems cannot be solved, rehabilitation treatment will not be carried out normally, the best rehabilitation period will be missed and the recovery time will be delayed. First of all, the most important issue is postoperative pain. This problem is often unavoidable, and it will have a great impact on rehabilitation training. Patients need to further carry out joint passive activity training or even resistance training on the basis of bearing knee pain, which not only may not guarantee the completion of training quality, but even aggravate the pain and cause side effects. Only after the pain is solved can the patient concentrate more on training. In addition, the problem that needs more attention is the abnormal gait pattern caused by the weakness of muscles around the knee joint. Rehabilitation training under the wrong gait will not only aggravate the instability of the knee joint, but also deepen the memory of the wrong walking muscles. At this time, it is a major mistake to carry out rehabilitation training. Therefore, if there are patients with abnormal gait, they should first correct their gait before training. Finally, although the anterior cruciate ligament surgery is very perfect and advanced now, there will still be the problem of graft infection, which can be completely prevented, but human must first have the awareness of preventing infection. Otherwise, once the infection occurs, it may cause more serious consequences. In the process of anti-infection, it not only damages the knee joint again, but also wastes a lot of time that can be used for rehabilitation treatment. To sum up, before the start of rehabilitation, it is necessary to fully consider the factors that will affect rehabilitation and solve them in time before entering the next step, otherwise it will be counterproductive.

4.1. Pain and osteoarthritis

Pain is the most common and unavoidable symptom after ACL surgery. Osteoarthritis usually occurs after the injury of ligaments and meniscus tear. Tearing can cause acute inflammation, and the main symptom is joint swelling. When the injury occurs, many inflammatory mediators, such as IL-6, will be produced soon. Moreover, no matter whether the torn ligament is repaired or not, the probability of osteoarthritis after tearing will not decrease, and even rebuilding the ligament may not stop the process of osteoarthritis. Studies have shown that the incidence of osteoarthritis after anterior cruciate ligament surgery reached 87% [4]. However, the most important symptom of osteoarthritis is pain, which is divided into three stages. They are the predictable sharp pain in the first stage, the more lasting pain in the second stage, which begins to affect daily life, and the persistent dull pain in the third stage, which is usually described as unbearable intense pain. Therefore, when considering the pain problem, consider the pain problem caused by osteoarthritis. Severe pain may lead to limb immobilization, which may lead to the atrophy of quadriceps femoris due to long-term cessation of exercise [5]. At the same time, if the problem of osteoarthritis is not solved, it will further aggravate the pain and affect the exercise training.

4.2. The influence of abnormal gait patterns on walking training

When the anterior cruciate ligament of knee joint is injured, it will cause the change of reflex arc, which will lead to compensatory changes in the muscles around knee joint. According to the escape theory of quadriceps femoris, the knee flexion completed by gravity and the knee extension completed by the contraction of muscles around the knee joint can maintain balance under normal circumstances [6]. However, after the patients escape from gait formation, the nerve reflex still exists in the early stage of injury, and the body will undergo adaptive changes with great individual differences, resulting in abnormal gait that affects normal walking.

4.3. Knee joint graft infection

Infection after ACL reconstruction is a common postoperative complication, which seriously affects the rehabilitation process. Palazzolo and others reported that the overall incidence of postoperative infection

was 1.5%-17%, including rare bacteria, mycobacteria, mold and other infections [7]. Cvetanovich and others followed up 4932 patients after ACL reconstruction, and the incidence of complications after 30 days was 1.34%, including deep venous thrombosis, deep infection and superficial infection in different degrees [8]. The occurrence of such complications will lead to the failure of rehabilitation treatment, so it is an urgent problem to be solved after operation.

5. Postoperative rehabilitation intervention

5.1. Osteoarthritis and its pain management

There are many factors leading to osteoarthritis, among which IL-6 is considered to be the most important one. Studies have shown that IL-6 has a great influence on bone structure and function, which mainly interferes with the normal development of cartilage by mediating related signal pathways, leading to its damage and even apoptosis [9]. However, arthritis caused by such proinflammatory cytokines cannot be solved by drug intervention. At present, the clinical use of non-steroidal anti-inflammatory drugs, painkillers and other methods can only slow down the development of osteoarthritis, or only relieve pain, but may not solve the problem of cytokine imbalance, and may not cure the disease.

5.1.1. Physical factor therapy. If it is only to relieve pain, low-frequency electrical stimulation therapy is a common physical factor therapy in clinic at present, which has great advantages because of its low side effects. Low-frequency electrotherapy refers to the application of pulse current with frequency lower than 1000Hz to the painful part, which plays the role of analgesia and promoting local blood circulation, and is safe and non-invasive [10].

5.1.2. Traditional Chinese medicine therapy. At present, non-steroidal anti-inflammatory drugs commonly used in western medicine may not effectively prevent the occurrence of osteoarthritis, however, acupuncture therapy has shown excellent effect in inhibiting dysfunctional cytokines. Qiangjun et al. selected 80 patients with osteoarthritis for a control group and gave the study group warm acupuncture therapy [11]. On the surface, the levels of bone alkaline phosphatase (BAP), osteoprotegerin (OPG) and osteocalcin (OC) in the acupuncture group were higher than those in the control group (BAP 42 vs. 38; OPG 330 vs 308; OC 8.6 vs 7.3), indicating that acupuncture therapy can improve bone metabolism and have an excellent effect on joint function recovery. Therefore, when dealing with the problem of osteoarthritis, acupuncture therapy is worthy of clinical promotion, and in terms of relieving pain, physical factor therapy such as low-frequency electrotherapy shows greater advantages than drug therapy such as painkillers.

5.2. Improve gait

The abnormal gait problem caused by insufficient muscle strength of quadriceps femoris should be improved by isokinetic muscle strength training. Isokinetic muscle strength training refers to the training mode in which the speed is constant and the muscle length and strength are constantly changing during the exercise. In sports training, isokinetic muscle strength training can improve the effectiveness of training by changing the compliance resistance, so that muscles can carry out weight training in the whole range of sports. This method has a significant effect on improving muscle state and relieving joint dysfunction, muscle atrophy, muscle weakness, apraxia and other problems.

According to a set of controlled trials conducted by Capital Medical University, the three study groups were trained in isokinetic muscle strength from three different angles at 0-30, 31-60 and 61-90 respectively, and the sample numbers of the three groups were 34 cases, 32 cases and 34 cases respectively [12]. Footscan and D3D systems were used to evaluate the training effect, and the isokinetic muscle strength of quadriceps femoris, hamstring muscle of tibialis anterior muscle and triceps surae of three groups of patients was measured. The reference indexes were three items: peak torque, power and maximum work done by extensors and flexors. In addition, the gait parameters of three groups of patients were measured: joint flexion and extension angle, supporting phase angle at the beginning,

middle and end, and swinging phase angle at the beginning, middle and end. The results show that the training at the angle of 0-30 is higher than the other two groups in gait parameters, but the training at the angle of 31-60 has the best effect in enhancing the muscle strength of quadriceps femoris. It can be concluded that isokinetic muscle strength training from different angles can promote the rehabilitation of patients after orthopedic surgery in many ways, which is worth further application.

5.3. Graft anti-infection

According to the related research, using antibiotics to disinfect the graft can reduce the infection rate from 2.1% to 0.8%, which shows that this method has good clinical value [13]. However, Ekdahl and others investigated 115 Swedish surgeons who underwent ACL reconstruction and found that this method was not recognized [14]. The survey reported that only 8% doctors used it as a routine clinical method. In addition, although it has been found that using vancomycin to soak the graft can prevent postoperative infection, it is not common to use antibiotics to prevent infection in incision surgery, but ACL reconstruction, as a kind of incision surgery, may use antibiotics to prevent graft infection. On the other hand, in China, the use of vancomycin for graft disinfection is not its indication, so its clinical use in China is more limited. If the infection is controlled in time after ACL reconstruction, there will be no cartilage damage and no need to take out the graft, which is an ideal result of infection treatment. Kursumovic et al. analyzed 16 related studies and 147 cases of ACL reconstruction patients were treated systematically after infection, and the graft retention rate was 86%, suggesting that once infection occurs after ACL reconstruction, it should be diagnosed and treated in time to avoid catastrophic consequences [15]. An important principle of ACL postoperative rehabilitation is to protect the graft from damage, which first needs to ensure that the graft site is not infected. Therefore, using antibiotics to resist graft infection is a necessary measure before rehabilitation.

6. Discussion

Clinically, the methods of rehabilitation after ACL surgery have been thorough, but it is not advisable to blindly carry out rehabilitation training without considering postoperative complications. Starting from three main complications, this paper discusses the problems that need to be dealt with before rehabilitation in order to get a more accurate opportunity for rehabilitation intervention. The limitation of this paper is that the sequence of gait repair and muscle strength training is not discussed. Whether there is not enough muscle strength support to restore normal gait, or whether muscle strength training will aggravate gait abnormality when gait is abnormal, there is still much room for research on this issue. In addition, there are few related studies on the use of vancomycin in graft anti-infection, and it is recommended as a standard to the routine rehabilitation after ACL surgery, and more high-quality multi-sample and multi-center studies are needed to confirm its safety and effectiveness. At the same time, this paper also obtains methods to deal with these complications by means of rehabilitation, such as physical factor therapy and traditional Chinese medicine therapy to intervene osteoarthritis, continuous passive training to improve muscle strength, and finds that the use of non-steroidal drugs and painkillers is not as effective as exercise training in dealing with osteoarthritis, which reflects the high status of rehabilitation in practical clinical application, which is enough to show that rehabilitation plays an important role after ACL surgery.

7. Conclusion

To sum up, when dealing with the complications after anterior cruciate ligament reconstruction, appropriate rehabilitation measures can effectively solve these problems, such as using isokinetic muscle strength training to improve gait problems, using physical factor therapy to relieve pain problems, and using antibiotics to solve the risk of graft infection. However, there are still few surgical complications involved in this study, and more comprehensive risk factors need to be considered when we really enter the clinic, so there is still much room for research in the discovery and solution of other complications.

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