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Research Article

Rehabilitation Treatment and Monitoring of Ankle Achilles Tendon Ligament Injury in Athletes Repaired by Nanomaterials

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During sports, athletes' incorrect technical movements and direct physical confrontation can easily cause ankle injuries. Joint ligament injury is a common injury in sports. A ligament injury is an injury to the ligaments in a part of the body caused by varying degrees of injury. Clinical manifestations include localized swelling, pressure pain or joint instability, and pain that increases when pulled in the direction of violence. In order to further investigate the rehabilitation methods of nanomaterials for repairing the ankle Achilles tendon ligament injury in athletes, nanomaterials are materials in which at least one dimension in three-dimensional space is at the nanometer size (1-100 nm) or consists of them as the basic unit, which is approximately equivalent to the scale of 10 to 1000 atoms closely aligned together. In this paper, we found that the healing rate of patients was over 90% by the dynamic balance system combined with surface electromyography, surgical treatment, and extracorporeal shock wave. It can be seen that the dynamic balance system combined with surface electromyography (SEMG), surgical treatment, rehabilitation therapy of Taijiquan exercise, and extracorporeal shock wave therapy have significant effects on the rehabilitation of athletes' ankle and Achilles tendon ligament injuries and can effectively alleviate and resolve athletes' ankle Achilles tendon ligament injury.

1. Introduction

With the vigorous development of sports in China, people are more interested in participating in physical exercise. Not only professional athletes but also people who participate in physical exercise will inevitably suffer from ankle injury. Ankle sprain is a relatively common injury in sports, and injuries cause great pain to athletes. The saddle joint of the talus is wide in front and narrow in back, with the wider part entering the ankle point in dorsal extension and the narrower part entering the ankle point in plantarflexion. The anatomical and physiological characteristics of the ankle joint make it more prone to inversion and valgus sprains during plantarflexion. The ankle joint is composed of the articular surface of the lower end of the tibia and fibula and the talar pulley, so it is also called the talar calf joint. It is one of the important joints of the human body. It mainly depends on the ankle joint extension and plantar flexion.

The instability caused by ankle sprain is divided into lateral instability and medial instability. Clinical manifestations of ankle sprains include pain and swelling at the site of the sprain immediately after the injury, followed by skin bruising and, in severe cases, immobility of the affected foot due to pain and swelling. The incidence of lateral instability combined with articular cartilage injury is 55%. It is mainly talar cartilage injury, most of which are located on the medial talar articular surface. The rate also increased significantly, with a median instability associated with cartilage damage of 98%. Lateral collateral ligament injuries are common in the exercise population, and a comprehensive rehabilitation plan is a crucial outcome. Most literature on nonsurgical and postoperative rehabilitation includes observation reports and case studies, and primary studies comparing rehabilitation programs have not been published. The goal of an injured athlete is not only to return to the game without functional restrictions but also to address risk factors and prevent future injuries [1, 2].

Kyo Chul and others believe that nearly a century ago, a serious ankle sprain was considered to be an ankle ligament injury. With the advancement of imaging and surgical

techniques and the development of tools, the treatment of ankle sprains (including subtalar injuries) has greatly improved. The ankle ligament repair or reconstruction has been improved anatomically and has less trauma than before. Here, the term "'reconstruction" refers to nonanatomic reconstruction, which is a replacement reconstruction with a short fibular tendon, such as the Evans procedure, which significantly alters the biomechanical mechanisms of the ankle and subtalar joint under weight bearing. Rather, tendon transplantation to reconstruct ligaments has become the standard for treating severely injured ligaments, but it does not reproduce the original ultrastructure of the ankle ligaments [3]. The anatomical structure of the ligament includes a ligament with a distal end at both ends, and the structure should also have proprioceptive functions. To date, it is still impossible to reconstruct a fully functional anatomical ligament. The cooperation between regenerative medicine and surgical technology is expected to improve the reconstruction of ankle ligaments. However, we need more time to develop a technology to reconstruct the ideal ligament complex. Lee and Hogan believe that ligament sprain refers to the tearing of fibrous tissue in the ligament and is the main cause of foot and ankle complex injuries during field sports; external rotation of the foot is considered to be the main injury mechanism with ankle sprains. There are specific types of ligament damage; however, the effect of the magnitude and direction of the load vector on the in situ stress state of the ankle ligament has not been quantified in the literature. Finding the maximum injury tolerance of a human foot with an acceptable single ligament subfracture distribution, using a previously developed and fully validated foot and ankle joint model to reproduce a series of joint foot rotations experienced during high-risk athletic activities.

In view of the susceptibility of sprained ankle joints, on the basis of traditional treatment, special attention should be paid to prevention and rehabilitation during rehabilitation. This article analyzes and summarizes the causes, diagnostic methods, treatment measures, and prevention methods of athletes' ankle joint injuries, with a view to helping athletes train scientifically and actively cooperate with medical staff to effectively avoid and reduce the occurrence of ankle joint injuries and its adverse effects. Repairing ankle ligament injuries can relieve the patient's pain and for the athlete can lead to timely training and good performance.

2. Proposed Method

2.1. Reasons for Ankle Injury. Ankle sprains usually occur when our body loses its center of gravity, causing damage to the soft tissues on the outside or inside of the foot, such as ligaments and joint capsules, during sports such as walking or running and jumping.

(1) More common in sports related to jumping

Sports events such as figure skating, alpine skiing, freestyle skiing, and basketball and gymnastics often require athletes to make jumping movements, and as the difficulty of the movement continues to increase, athletes engaged in these events have the possibility of ankle injury much higher than other athletes. The function of the ankle joint is mainly completed within a range of 70°-140° extension and flexion. When the ankle joint has excessive valgus and external rotation, varus and internal rotation, or the talus backwards, it violently impacts forward. When the tibial articular surface, the ankle joint is easily damaged, most of which are strains of the medial and lateral ligaments of the ankle joint [4]. The ankle joint is often subjected to excessive amplitude movements, so that the ankle points do not match the talar articular surface, which will cause ankle joint misalignment, which mainly refers to the medial and lateral or anterior and posterior displacement of the talus. Of these, the talar outward and forward are more common. When the ankle joint is sprained, the muscle ligaments are weak, and the joints are loose and unstable. During the activity, the lower end of the tibia and the inner and outer sides of the talus impact each other on the joints, which can also damage soft eyes, affect joint activities, and hinder normal activities.

(2) Insufficient preparation activities

The mechanism of ankle joint injury caused by insufficient preparation activities. In general sports, before doing exercises or competitions, do some activities that make the body heat and nervous system such as running and jumping, and then do some stretching of the limbs and joints. For amplitude activities, these activities can adjust the body parts to a state suitable for high-intensity exercise as soon as possible before normal sports training or competition. If the previous preparation activities are insufficient, the nervous system, the blood circulation system, and related muscle tissues are not fully mobilized, and the body lacks the necessary coordination, flexibility, and stretchability, and the ankle joint muscle ligament stretch may not be sufficient. Improved, the excitability of the nervous system is relatively low, the antagonist muscles cannot be fully relaxed in a timely manner, coupled with rushing into these exercises or competitions, sudden jump movements or landing instability; it is easy to cause ankle injury [5]. During training or competition breaks, sometimes due to venue, number of people, or other factors, the interval between two activities is longer, and athletes often ignore the proper preparation activities before entering the next exercise. The stretchability of the muscle has been reduced to a certain degree, but the physical strength has been restored to a certain degree. In the second exercise, the range and strength of the movement are relatively large and the speed is relatively fast. This has hidden the sprains of the ligaments of the joints or muscle tension. There is a high possibility of injury. In addition, a considerable part of the athletes only focused on improving the extensibility of large muscle groups and the amplitude of large joints in the preparation activities, while neglecting to improve the functional conditions of other small joints (such as the ankle joint) [6].

(3) Other factors

There are also other factors, such as training with injuries, excessive local load, paralysis of the mind, wrong technical movements, poor venues, excessive excitement, and

lack of protection, which can also cause ankle injuries. For example, the investigation center for the most common injuries in alpine skiing found that ankle ligament injuries were more caused by incorrect technical movements of athletes [7–9]. During training, if the venue is not good, it is easy to make the action fail. Poor weather conditions can also lead to injury accidents. In the summer, the temperature is too high, the athletes have difficulty concentrating, and their physiological adaptability is poor, which is prone to accidental injuries. In the cold winter, the muscles are stiff, the coordination of movements is not good, and it is easy to cause damage to the ankle muscle ligaments.

2.2. Rehabilitation Treatment of Ankle Achilles Tendon Ligament Injury. Rehabilitation gymnastics is a specially choreographed unarmed, or with the help of equipment, limb movement, and functional exercise gymnastics to enable the sick and injured to achieve the purpose of prevention, treatment, and rehabilitation.

(1) Rehabilitation gymnastic therapy

Action 1: take a sitting position and land on the edge of the calcaneus. Use the toe of the affected ankle to write 1 English letter at a time, and write 26 English letters once. Action 2: "Car windshield wiper" training. Take the seat with your feet flat on the ground, with your toes facing forward, and rotate the affected ankle to simulate the movement of the car's windshield wiper. Come out to touch the ground. Action 3: take a seated position to train the lower leg. In the sitting position, the ankle-limb limb is used for hoisting training. It is required to raise the calf as high as possible, and at the same time, keep the toes away from the ground. Then, put the heel back to its original position [10]. Action 4: stand on one leg (partially load-bearing). When standing, place one hand on the table, transfer part of the body weight to the side of the affected ankle, and hold it for 15 s. Increase the time for 15 s each time until you can use the ankle support for 45 s. Then, gradually increase the amount of body mass that can be supported until it can support all of its own body mass. Action five: training of varus and eversion of the affected ankle. Inversion training uses the outside of the affected ankle to rest on a fixed object, such as the edge of a table leg or door frame. Use the ankle to apply force for 2 s. Eversion training is to use the inside of the ankle's foot against a fixed object to push it inward for 3 seconds. Action six: use the training belt to train the ankle inside and out. Take a seated position, straighten your knees, use a training strap to fix one end to a heavy object (such as a table foot), and wrap one end around the inside of the ankle or the outside of the small toe. The ankle varus training is to rotate the foot away from the table foot with the foot, and then return to the initial position, count one training, be careful not to perform calf movements, external rotation training is to train the belt around the outside foot of the toe to turn out actions. Action seven: stand on one leg to support the whole, lifting training. Take the ankle-footed standing position, flex the knee on the healthy side, keep your feet away from the ground, and maintain a full body support for about 30s. Action eight: use a large towel to fold into a rectangle, the size is consistent with the size of the patient's feet. At the beginning of training, use both hands to support the support to ensure safety, gradually squat, and then stand up. With the progress of rehabilitation, gradually give up the help of supports, use their own muscle and nervous system to adjust the balance, and perform squat training. At a higher stage, the affected foot stands alone on the towel, and the rehabilitation teacher throws it to his body. Ball (you can change the direction and quality of the ball to increase the difficulty of training). For those athletes who are engaged in sports, conditions can be used for spa treatments, stepping, jumping, or kicking in various directions in waist-deep water [11].

(2) Traditional Chinese medicine therapy

(1) Mild ligament damage

Immediately after the injury, apply cold compresses to reduce the formation of hematomas. Local swelling can obviously be infused with cold water or externally applied with ice cubes. Replace once every 3 minutes for 30 minutes to constrict blood vessels and relieve local congestion. After 24 hours of sprain, switch to hot compress therapy, soak the towel with warm water or hot vinegar, hot wine, etc., and put it on the wound for 30 minutes. It can improve blood and lymph fluid circulation 1-2 times a day, which is conducive to blood stasis on the wound. And exudative absorption, in addition to self-reinforcing muscles and tendons, first slowly pull out and stretch the ankle joint, after a short time to do varus and eversion movements, do not use local manual rubbing in the early stage of injury, you can use Chinese medicine external application The rice dumplings are crushed into fine powder and mixed with frankincense into milk powder, which is adjusted to a paste with wine or egg white and applied to the wound, and the dressing is changed once a day [12].

(2) Severe ligament injury

Closed sticky plaster fixation method: the local drug is closed with a 2% lidocaine needle 1.5 ml and prednisolone acetate 0.5 ml. The ankle joint is placed in a mild valgus position with viscous fixation. If there is damage to the anterior fibula ligament and then slightly extended, the viscous paste passes from the inside of the foot through the plantar and lateral malleolus to the mid-anterolateral midsection of the calf. -4 strips, then use bandages to strengthen the fixation, usually 3 weeks can be fixed. Can be used 2% procaine 2 ml, plus acetic acid and acetaminophen 2 ml, for pain point closure, once a week, 3 times a course of treatment. Massage and acupuncture combined with fixed methods: acupuncture points such as Fengshi, Zusanli, Taixi, Kunlun, Qiuxu, Jueju, Jiexi, Taichong, and Ashi can be selected. Acupuncture (retaining needle for 15-30 min), once a day, to clear the qi of the meridians [13]. Restriction of ankle motion can be fixed with adhesive tape (rubber plaster) or bandages for 1-2 weeks. Those with medial collateral ligament injury should be inverted and fixed, those with lateral collateral ligament injury should be inverted and fixed to reduce the

tension of the injured ligament and accelerate the injury of the ligament. Repair. If the lateral collateral ligament of the ankle is damaged, take 3 pieces of 2.5-3 cm wide tape to valgus the affected foot. The first piece of tape starts from the inside of the foot and passes through the front of the lateral malleolus to the front of the calf and then behind the tape. Adhere the second and third tapes in parallel, and then apply bandages outside. It can also be treated with proprietary Chinese medicines. Sanqi injury pills, betta pills, Yunnan Baiyao, Qilisan, and conventional administration are used. It usually recovers in about 15 days [14].

(3) Tai Chi exercise

Patients are organized to participate in the study and exercise of prescribed Taijiquan movements. During exercise, attention is required to focus on activities that hurt the ankle. In the early treatment stage, surgical therapy is the main part, and some rehabilitation exercises are performed at the same time as surgical therapy. The focus of rehabilitation treatment during this stage is to prevent symptoms such as ankle instability or recurrent dislocation. After 3 weeks, patients with ankle ligament injuries were trained in Taijiquan, ranging from small to large. When the ankle was active, the two strengths penetrated each other, embracing each other, and running in parallel. During this period of training, it is required to increase the body's center of gravity. The body's center of gravity projection should be as close to or around the injured ankle as possible to prevent the injury from getting worse. It is not required to do the complete movement of Taijiquan. After 5-6 weeks, with the gradual recovery of the ankle injury, the body's center of gravity should gradually decrease when performing Taijiquan exercises, so that the distance of muscle work will increase accordingly. When playing Taijiquan, there is no need to focus on mental concentration. Under the control of consciousness, the mind of the practitioner always focuses on the injured ankle and the whole set of movements, eliminates the interference of other thoughts, and focuses on directing the functions of all organ systems throughout the body to cooperate with the injured ankle. Movement effectively prevents repeated ankle ligament injuries [15]. In the later stage of rehabilitation, in order to increase the left and right ankle ligament activity, perform "left cloud hand" or "right cloud hand" and other movements. Such movements can be moved laterally. Through training, the left and right ankle ligament activities can be guaranteed. In order to increase the full range of motion, "Left and Right Knee Staggers" is used. This move includes back and forth movements, left and right movements, outward abduction, inner buckle, lifting, and other movements to fully move the ankle ligaments; in order to make the ankle ligaments, the increase in the range of activity should be practiced in spiral-type arc movements, such as "left and right mustang split mane." The angle of body rotation is large, and the center of gravity gradually transitions to one foot. Because the center of gravity of the entire body moves smoothly, a certain height moves at a constant speed or constant speed, so that the ankle ligaments can be safely and fully exercised [11]. Regular exercise of this kind can not only promote the healing of ligaments and shorten the recovery time but also enhance the flexibility and flexibility of the ankle ligaments.

(4) Extracorporeal shock wave therapy

Extracorporeal shock wave is a mechanical pulsed pressure wave transmitted through the medium of physics mechanism, which can produce good therapeutic effect on a wider range of human tissues where pain occurs through the positioning and movement of the treatment probe. Cavitation is the basis of ESW's effect on soft tissues. In the process, shock wave bubbles will be generated. Such bubbles will rapidly expand within a few microseconds and then burst after 100 μs, resulting in secondary, spherical shock waves, shearing. Tissue, release free radicals, target soft tissues that impinge on the lesion, resulting in axial damage, local bleeding, ecchymosis, hematoma, etc. When the energy of ESW is lower than 0.12 mJ/mm^2, the permeability of the cell membrane can be triggered, while when the energy of ESW is 0.5 mJ/mm^2, the changes of cytoplasm and mitochondria are mainly caused. Although the role of ESW in the treatment of soft tissue injuries is relatively clear, its mechanism of action is uncertain. Studies have found that ESW can promote the formation of new blood vessels, improve microcirculation, and promote the recovery of neural tissues by directly activating the healing process of soft tissues. Hausdorf et al. called the application of different ESW to the rabbit femoral end 10 days later and observed a decrease in local blood flow and bone metabolism. They believed that the process of ESW stimulation and promotion of tendon healing may be through local microfracture and damage to promote local growth factors and NO release to achieve tissue repair [12].

2.3. Nanomaterials. Nanomaterials are materials with nanoscale structures, which can be divided into zero-dimensional nanomaterials and one-dimensional nanomaterials according to their specific dimensions, and it has been asserted that when one can arrange and combine substances on very small dimensions, various materials of novelty will be obtained. The ratio of the number of surface atoms to the total number of atoms in a nanocrystal particle increases dramatically as the particle diameter becomes smaller. For example, at a particle diameter of 10 nm, the particle contains 4000 atoms and the surface atoms account for 40%; at a particle diameter of 1 nm, the particle contains 30 atoms and the surface atoms account for 99%. It was not until the end of the last century when the first International Conference on Nanoscience and Technology was held in the United States that theoretical research and contemporary science and technology were formally combined, which marked the official birth of nanotechnology. When the size of a material is at the nanometer level, the number of atoms on the surface of the material will increase dramatically, and this number will far exceed the number of ordinary materials, when the chemical activity of the material will be greatly increased. At the same time, nanomaterials are comparable to or smaller than the wavelength of light waves, the wavelength of de Broglie and the coherence length of superconducting

states, and the periodic boundaries of the materials are destroyed, resulting in "novel" optical, electrical, magnetic, acoustic, and thermodynamic properties; in addition, nanomaterials have quantum size effect and macroscopic quantum tunneling effect. These unique characteristics provide the conditions for the wide range of applications of nanomaterials. With the continuous in-depth development of theory and practice, nanostructures not called systems have been established at present. Along with the maturity of application, the uniqueness of nanomaterials plays a pivotal role in the field of biotechnology and advanced manufacturing.

3. Experiments

3.1. Dynamic Balance System Combined with Surface Electromyography (SEMG) Experimental Monitoring

(1) Wu, the research subject, suffered severe strain on the right ankle Achilles tendon, and developed strained periarthritis, which was manifested as local thickening, tenderness, and a feeling of induration. The right Achilles tendon still had a thickening of 5 cm in length. According to the degree of soft tissue damage, it was II degree, and some ligaments were lacerated. Zhang, the Achilles tendon side collateral ligament excessive pull, acute sprain, I degree injury, slight swelling, physical examination and early isokinetic strength test, neither of them suffered severe pain in the ankle, joint effusion and other phenomena. Wu's wound suture is located in the posterior midline incision. The tendon sheath has been separated and the degenerative tissue has been removed. The scar has a slight swelling. The pain arc is located at the fibula long and short muscle stops. Wu's pain point is located at the tibialis anterior muscle stop. The symptoms of the two patients were similar. Both suffered from weakness of the posterior ankle muscles, the range of motion of the joints and dorsiflexion was small, and there was a large difference in the muscle strength of the left and right ankle joints. Myasthenia gravis is mainly characterized by partial or generalized skeletal muscle weakness, easy fatigue, aggravation of symptoms after activity, and reduction of symptoms after rest and is generally serious, long-lasting, and difficult to treat

(2) Research method: the Biodexpro3 isokinetic force measurement system (according to the test standards specified by the Chinese Medical Association) was used to orient the heart slowly 60%/s X5 times, mainly to test the ankle joint dorsiflexor maximal muscle strength index; 180% fast/s X25 times, the main test of muscle endurance indicators, a total of 4 tests before and after rehabilitation treatment, and the comparative analysis of the measurement indicators. In the test, the two people stood with the affected leg in turn, flexed their knees about 90° on the healthy leg, and stood continuously for 30 seconds. According to the stability program set by the system, they performed "8-1" levels in order from easy to difficult, with the soles of the feet as much as possible. It moves close to the center of the display screen and moves in the same part. It can perform various actions such as front collar back and back, inversion, and eversion as the platform rotates. Tested 2 times before and after treatment

3.2. Surgical Treatment Monitoring

(1) General information: 16 cases of ankle fractures with triangular ligament rupture were surgically treated, including 10 males and 6 females. X-ray examination of the ankle joint laterally and ankle points was performed routinely before operation. After the internal fixation of the lateral malleolus fracture is completed during the operation (if the posterior malleolus fracture needs to be fixed as well), if the ankle perspective shows that the ankle joint is in good position, the external rotation stress test of the ankle joint should also be performed, and those with negative tests do not need surgery. Triangular ligament. If it is positive, it needs to be explored to repair the triangular ligament. This group accounts for 14 cases; if the intraoperative perspective shows that the medial malleolus talar space has not recovered, it is considered that the insertion of the gap after the rupture of the triangular ligament results in poor reduction. Triangle ligament, this group accounted for 2 cases

(2) Surgical methods: after the ligament was exposed in 16 patients in this group, the fracture sites were as follows: 5 cases at the medial malleolus rupture, 6 cases at the middle rupture, and 5 cases at the talar rupture. The person who broke at the medial malleolus was screwed in two 2.8 mm absorbable anchors or metal anchors at the center of the malleolus for repair; the middle fracture was sutured directly with l-0 absorbable suture; screw in two 2.8 mm absorbable anchors or metal anchors at the dead center for repair. When knotting sutures, you should pay attention to shortening the length of the original ligament slightly. Observe under direct vision to maintain the appropriate medial space of the ankle joint. Do not overtighten the ligament to shorten too much and affect the later function recovery. For type AO type C fractures, the preoperative judgment may be associated with lower liver fat combined injury, and the lower liver fat combined should be fixed. In this group, 4 patients with type C fractures were still positive after the deep repair of the triangular ligament was completed. Therefore, the liver fat joint is fixed under the liver fat hook. Finally, the superficial layer of the fractured triangular ligament was sutured with 2-0 absorbable sutures, and the incision was closed layer by layer

3.3. Rehabilitation Monitoring of Taijiquan Exercise

(1) Research subjects: the research objects came from different groups such as teachers, students, and

workers in a university, and 76 patients with ankle ligament injuries were selected (average age: 30.47 ± 9.05 years). And randomly selected 41 cases (average age 31.42 ± 8.35 years old) as the experimental group, mainly Taijiquan exercise. The remaining 35 patients (mean age 29.35 ± 9.45 years) were used as the control group for routine rehabilitation training

(2) Research methods: the subjects were randomly divided into the control group and the experimental group and organized to participate in the study and exercise of the prescribed Taijiquan movements. During the exercise, the rehabilitants were required to focus on the activities of injured ankles. In the early treatment stage, both groups are mainly surgical treatment, and medical staff assists in some rehabilitation exercises at the same time of surgical treatment. At this stage, the focus of rehabilitation treatment is to prevent symptoms such as ankle instability or recurrent dislocation. After 3 weeks, 41 patients with ankle ligament injuries in the experimental group performed Taijiquan exercise, with a small amount of exercise. During the early training, the patient exercised under the guidance of an expert. With the help of Tai Chi during the ankle movement, the two strengths penetrated each other, embracing each other, and running in parallel. During this period of training, it is required to increase the body's center of gravity. The body's center of gravity projection should be as close to or around the injured ankle as possible to prevent the injury from getting worse. It is not required to do the complete movement of Taijiquan. During this period, the control group mainly carried out some conventional rehabilitation training, began to perform standing posture exercises, and then carried out partial weight-bearing exercises. After 5-6 weeks, with the gradual recovery of ankle injuries, the body's center of gravity during the Taijiquan exercise in the experimental group should gradually decrease, so that the distance of muscle work will increase accordingly, and the physiological pressure on the ankle ligaments will gradually increase. The control group began to carry weight-bearing walking training; and gradually extended the training time (maximum 45 minutes) and performed exercises such as running, jumping, and stepping up and down in the later stage of rehabilitation

3.4. Extracorporeal Shock Wave Therapy Monitoring

(1) Research subjects: 40 athletes with ankle ligament injuries were selected, including 22 males and 18 females; the course of disease was 3 months and 1 year. They were randomly divided into an external shock wave (ESW) treatment group of 25 cases (14 men and 11 women) and a closed control group of 15 cases (8 men and 7 women). Both groups were diagnosed by physical examination and ankle MRI before treatment. Inclusion criteria are as follows: (1) aged 16 years or older, (2) no history of surgery and cardiovascular and cerebrovascular diseases, (3) the contralateral ankle is normal, (4) the range of motion of the ankle joint is the same on both sides before the injury, (5) preoperative X-ray examination confirmed no history of fractures, (6) local skin was free of infection, necrosis, allergies and other symptoms, and (7) all athletes had no midfoot and forefoot ligament injuries

(2) Treatment method

(1) ESW group: DolorClast radiation shock wave therapeutic apparatus produced by Swiss EMS company is used for treatment. The patient was placed in supine position, and the pain points at the ankle ligament injury were identified by palpation, and the blood vessels and nerve distribution areas were avoided. Then, the coupling agent was locally applied, and the ESW treatment head was vertically aligned with the tenderness site, and the pressure was set to 2.0-4.0 bar, impact frequency 6 Hz, impact pulses 2000 times at each part, handle pressure is medium. The impact energy is adjusted according to the patient's tolerance, and the impact treatment is performed with a larger pressure tolerated by the patient. 3 to 4 times is a course of treatment, with a maximum of no more than 2 courses, and the interval between the two treatments is 7 days

(2) Closed group: the same position as above, after the pain point of the ankle ligament was determined, the pain point was injected with triamcinolone 1 ml and 2% lidocaine 1 ml suspension, closed once every 5-7 days, 3 times as 1. The course of treatment should not exceed 2 courses at most, in order to prevent the accumulation of medicinal fluid in the local tissue and damage to the local tissue

4. Discussion

4.1. Dynamic Balance System Combined with Surface Electromyography (SEMG) Experiment Monitoring and Analysis

(1) Comparison of healthy and affected calf circumference and joint activity before and after treatment

Comparison of calf circumference and joint mobility between the two before and after rehabilitation is shown in Table 1:

It can be seen from Table 1 that the ankle and calf circumference of the two people increased rapidly in more than one month, while the range of joint activity increased significantly, almost doubled. Over time, it can withstand the normal amount of training, no adverse reactions, swelling at the Achilles tendon subsided, and pain has been significantly reduced. Comparative examination found no significant difference in calf circumference, and the sides tended to balance.

Table 1: A comparative study of leg circumference and joint mobility between the two before and after rehabilitation.

	Calf girth	Range of joint activity
Before treatment	−1.6 ± 0.5	46.8° ± 1.2
After treatment	0.8 ± 1.0	85.3° ± 1.6

Note: the positive sign indicates that the affected side is thicker than the healthy side, and the negative sign is opposite.

(2) Changes in muscle function before and after rehabilitation training

Due to the influence of individual differences, the maximum strength index mainly takes the ratio of peak torque to weight, also known as relative peak torque (PT/BW), which represents the relative muscle strength of muscle contraction; strength endurance is mainly through work fatigue (ER, unit (%)) to reflect its ability. It specifically represents the fatigue resistance of muscles during repeated contractions. The lower the endurance index, the stronger the muscle's resistance to fatigue, indicating that the endurance is better. Then, observe the two people's long-term muscle work to maintain muscle tension and stress. The maximum strength and strength endurance indicators are shown in Table 2 and Figures 1 and 2. Muscular endurance is the ability of the body to perform sustained muscular work for long periods of time, i.e., the ability to fight fatigue. Endurance includes two aspects, namely, muscular endurance and cardiovascular endurance.

From Table 2 and Figures 1 and 2, it can be seen that with the passage of time, the relative peak torque values of the right ankle plantar flexor muscle groups continued to increase, the dorsiflexor muscles were basically flat, and the work fatigue index decreased gradually, indicating that the strength level of the right ankle was significantly improved, and the antifatigue ability was improved. The right ankle even surpassed the uninjured left ankle in some strength levels.

In summary, after the rehabilitation treatment cycle, the calf muscle fibers of the two people increased, and the corresponding strength and muscle fatigue resistance were significantly improved, indicating that better results were achieved through rehabilitation treatment.

4.2. Surgical Treatment Monitoring Analysis

(1) All fractures have healed. The average healing time of fractures is l2.8 weeks (10 to 14 weeks). There were no cases of delayed fracture healing and fracture nonunion, and no wound complications occurred

AOFAS ankle-hindock function score: excellent in 8 cases, good in 8 cases, excellent and good rate was 100%, with an average of 93 points (85-100 points). The VAS pain score was 0.94 points (0-2 points). Specific patient information is shown in Table 3.

(2) Anatomy of the triangular ligament: the triangular ligament is a fan-shaped complex structure composed of multiple ligaments. The deltoid ligament is the main ligamentous structure that stabilizes the medial aspect of the ankle joint and functions to maintain the normal anatomical position of the talus and prevent its exostosis and dislocation. The anatomy of the triangular ligament is still controversial. It is generally believed that the triangular ligament is composed of shallow and deep layers. Milner et al. believe that the main basis for distinguishing deep and shallow layers is the number of joints they cross. A joint, but sometimes it is not absolute

4.3. Monitoring and Analysis of Rehabilitation Treatment of Taijiquan Exercise

(1) Rehabilitation assessment results

After 76 patients with ankle ligament injury were subjected to follow-up, investigation, and statistics for 12-15 months (average of 12.5 months in the experimental group and 13.8 months in the control group), the following criteria were used to evaluate the effect of rehabilitation treatment shown.

As can be seen from Figure 3, the rehabilitation assessment results are as follows: excellent: no reinjury, no pain during walking, ankle dorsiflexion angle of 20°-30°, plantar flexion of 40°-50°, no lameness, easy squatting, and normal joint function; good: no reinjury, good function of the joint cavity and tendon sheath, back extension of 10°-20°, plantar flexion of 25°-40°, mild swelling and pain after walking a long distance, slightly lameness, more convenient to squat, and can maintain normal work; poor: there is reinjury, the injury recovers slowly, pain and lameness are obvious during walking, the ankle is swollen and unstable, back extension is 0°-5°, plantar flexion is 5°-15°, and it is inconvenient or difficult to squat.

(2) Comparison of rehabilitation effects

Compare the curative effect of the experimental group with the curative effect of the control group. The evaluation results are tested by x2, as shown in Figure 4.

As can be seen from Figure 4, the healing effect of the experimental group was significantly better than that of the control group ($P < 0.05$) (see Table 4). Tested by x2: $P < 0.05$.

The results show that the exercise of Taijiquan allows the ankle ligament to be exercised, which effectively prevents the occurrence of contracture, ankle instability, and recurrent dislocation. When playing Taijiquan, there is no need for mental attention. Under the control of consciousness, the mind of the practitioner always focuses on the injured ankle and the whole set of movements, eliminating the interference of other thoughts, and focusing on directing the functions of all organ systems throughout the body to cooperate with the injured ankle. Performing activities effectively prevents repeated ankle ligament injuries.

4.4. Monitoring and Analysis of Extracorporeal Shock Wave Therapy

(1) Comparison of VAS scores

The comparison of VAS scores is shown in Table 5.

Table 2: Comparison of four tests of right muscle strength (affected side) before and after two persons.

Test target	Flexor plantaris at 60°/s				Flexor dorsal at 60°/s			
	Right 1	Right 2	Right 3	Right 4	Right 1	Right 2	Right 3	Right 4
Peak moment (Newton A kind of rice)	75.7	97.9	111.1	116.3	52.1	41.9	49.0	56.8
Peak torque/weight (%)	94.6	122.4	138.9	145.4	65.1	52.4	61.3	71.0
Total work (joules)	136.5	224.5	260.9	270.9	157.1	140.6	181.7	218.0
Average power (Watts)	49.9	74.4	86.9	75.8	55.3	45.8	54.5	60.4
Work fatigue (%) (180°/s)	56.2	29.8	28.0	13.7	26.5	16.3	19.3	21.2

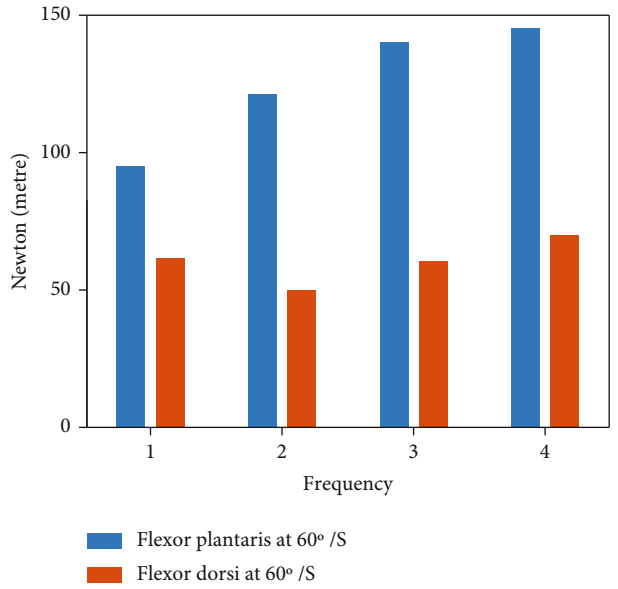

Figure 1: 4 relative peak moment changes before and after.

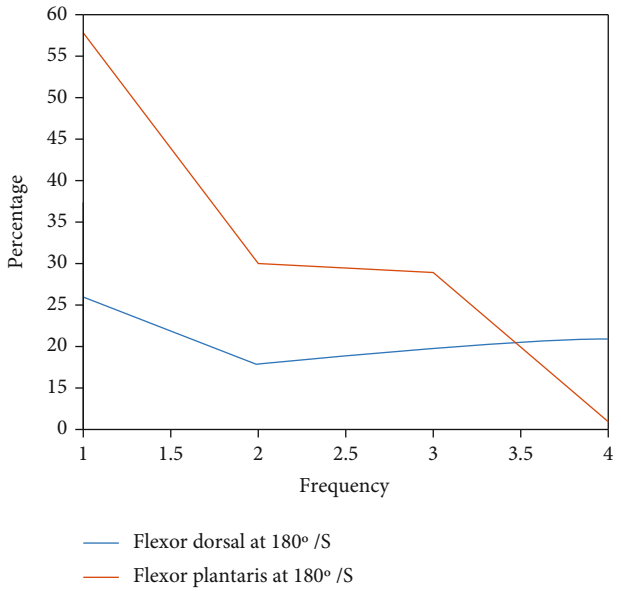

Figure 2: Change of fatigue degree before and after 4 times of work.

Table 3: Materials of 16 patients.

Case	Age (years)	Involved side	AOFAS score (pre/post)	VAS score (pre/post)	Follow-up Time/months
1	22	Left	100/100	0/0	30
2	35	Left	100/97	0/1	38
3	42	Left	90/90	0/1	48
4	48	Left	100/87	0/2	84
5	52	Left	100/97	0/0	32
6	68	Right	90/85	0/2	72
7	38	Right	100/97	0/1	64
8	52	Right	100/90	0/1	42
9	40	Left	100/97	0/0	34
10	40	Left	100/90	0/2	40
11	31	Right	100/97	0/1	65
12	64	Right	90/87	0/2	32
13	40	Right	100/90	0/1	36
14	41	Left	100/90	0/1	41
15	38	Left	100/97	0/0	40
16	30	Right	100/97	0/0	52

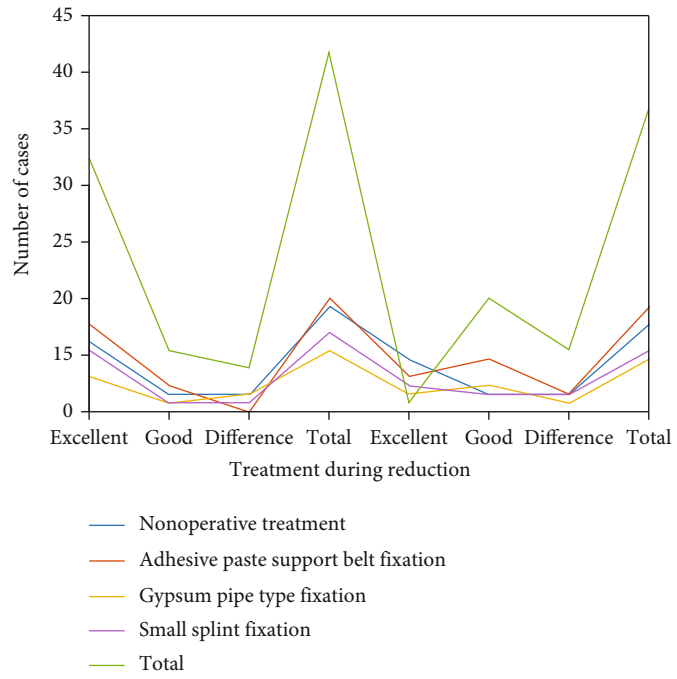

Figure 3: Rehabilitation evaluation results of the experimental group and control group.

As can be seen from Table 5, there was no significant difference in VAS scores between the two groups before treatment, at the end of treatment, and 4 weeks after treatment ($P > 0.05$), and there was a significant difference in VAS scores at 8 weeks after treatment ($P < 0.05$). At the same time, the VAS scores of the two groups before treatment were significantly different from those at the end of treatment, 4 weeks, and 8 weeks after treatment ($P < 0.05$).

(2) Kofoed score comparison

Kofoed score comparison is shown in Table 4.

It can be seen from Table 4 that there was no significant difference in the scores of the Kofoed observation indexes before treatment between the two groups ($P > 0.05$); the scores of pain, function, and activity of the ESW treatment group after treatment were significantly higher than those of the closed treatment group, with significant differences.

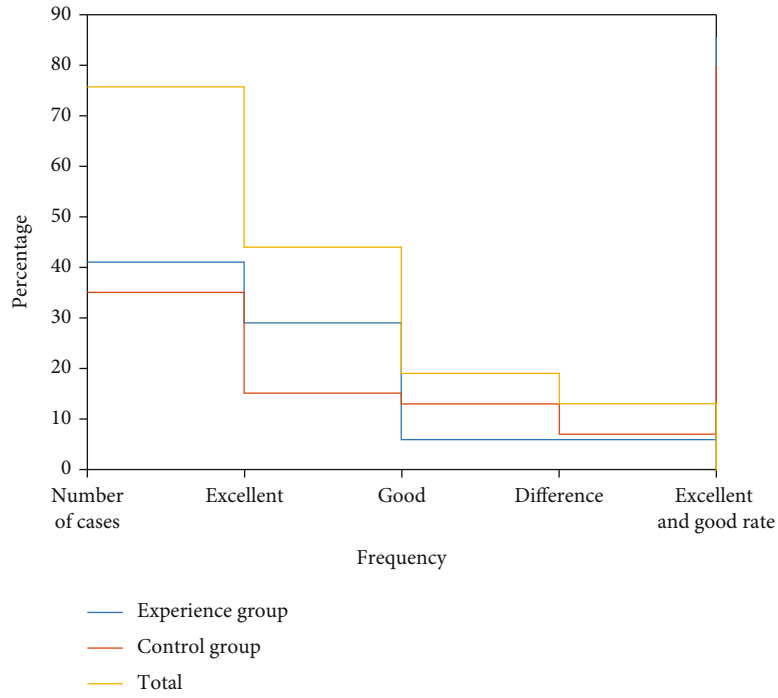

Figure 4: Comparison of rehabilitation effect between experimental group (41 cases) and control group (35 cases).

Table 4: Comparison of Kofoed scores between the two groups before and after treatment.

Kofoed observation index	Group ESW		Closed group	
	Preoperative	Postoperative	Preoperative	Postoperative
Pain	12.00 ± 8.66	40.60 ± 8.46	14.00 ± 10.56	26.67 ± 11.29
Function	7.08 ± 4.14	23.52 ± 3.64	8.40 ± 4.84	17.00 ± 4.63
Activity degree	4.52 ± 1.90	16.60 ± 2.47	5.07 ± 2.34	13.13 ± 3.00
Total	23.60 ± 14.70	80.72 ± 14.57	27.47 ± 17.74	56.80 ± 18.92

Table 5: VAS scores of patients in both groups before and after treatment.

Group	Number of cases	Before treatment	At the end of treatment	4 weeks after treatment	8 weeks after treatment
Group ESW	25	8.40 ± 1.19	3.72 ± 1.40	2.72 ± 1.37	2.40 ± 1.44
Closed group	15	8.53 ± 1.12	3.40 ± 1.12	3.33 ± 1.11	4.73 ± 1.98

Sexual significance ($P < 0.05$). The shortest recovery time for recovery training after treatment in the two groups: The shortest recovery time (5.52 ± 1.36 weeks) for athletes after training in the ESW treatment group was significantly shorter than that in the closed treatment group (6.60 ± 1.76 weeks) ($P < 0.05$).

5. Conclusions

For a long time, many sports workers and athletes have believed that "sports injuries are inevitable" and that "without sports injuries, high-level sports performance cannot be achieved," which has no scientific basis. The fundamental way to reduce exercise operations is to adhere to the principle of prevention. We must carefully analyze and study the various factors that are likely to cause injuries, summarize our experience, and gradually form the concept of injury prevention in ideology. With sufficient attention, the illness must not be delayed, and the acute injury gradually evolves into a chronic injury. To this end, this paper presents a study on rehabilitation and monitoring of Achilles tendon ligament injuries in athletes based on nanomaterial repair.

In this paper, we found that the dynamic balance system combined with surface electromyography (SEMG) experimental monitoring, surgical treatment monitoring, rehabilitation therapy monitoring of Taijiquan exercise, and monitoring of extracorporeal shock wave therapy. The dynamic balance system combined with surface electromyography (SEMG) treatment can increase the calf muscle fibers, increase the corresponding strength and muscle

fatigue resistance, and achieve good curative effects. Surgical treatment can accelerate fracture healing, with a cure rate of 93%. It has a significant effect on the rehabilitation of ankle ligament sprains; Taijiquan exercises can exercise the ankle ligaments and effectively prevent the occurrence of contractures, ankle instability, and recurrent dislocations; the analgesic effect of extracorporeal shock wave treatment on patients with ankle ligament injuries Compared with the traditional closed treatment, the effect is more durable and effective.

The results of this study indicate that ESW also has a strong analgesic effect on pain after soft tissue injury. In this article, immediately after treatment and 4 weeks after treatment, the VAS scores of the ESW group and the closed group were significantly lower than before the treatment, indicating that the two treatment groups had better analgesic effects in the early stage and there was no difference. The VAS score of the ESW group at 8 weeks after treatment was significantly lower than that of the closed group, indicating that the effect of closed treatment was less than 8 weeks after treatment, and the analgesic effect of ESW lasted longer. In addition, the total effective rate in the ESW group was also significantly higher than that in the closed group after treatment. Therefore, we believe that the analgesic effect of ESW on patients with ankle ligament injury is more durable and effective than traditional closed treatment.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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