

# Research Status of Combined Treatment of Lower Limb Orthosis in Patellofemoral Pain Syndrome (Treatment)

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**Abstract:** Patellofemoral pain syndrome (PFPS) is a chronic pain that occurs on the anterior side of the knee joint or on the posterior side of the sacrum. It can be induced during knee flexion and extension, and there is no structural pathological change of the knee joint [1] is a very common knee joint disorder in clinical practice. pfps is one of the most common causes of anterior knee pain, which can be caused by increased pressure on the patellofemoral joint from squatting, sedentary, and descending stairs. It is also called "runner's knee" among teenagers, athletes and sports enthusiasts.

Traditional pfps treatment methods include surgery, drug treatment, intramuscular patch, acupuncture treatment, physical therapy, etc. In addition, through the search of various literatures, it has been shown that the intervention of rehabilitation engineering is effective for pfps, but there is currently no professional Rehabilitation engineering literature is researched from the perspective of knee joint orthopedics combined with orthopedic insoles, that is, combined treatment of lower limb orthosis. Therefore, this article focuses on the pathogenesis of pfps, the principles of combined treatment of lower limb orthosis, wearing methods and principles.

## I. PRINCIPLES OF LOWER LIMB ORTHOSIS FOR PFPS

### A. Pathogenesis of pfps

At present, the specific pathogenesis of pfps is still unclear, but most scholars support that abnormal patella motion trajectory is an important cause of pfps. The causes of abnormal patella motion trajectory are: abnormal anatomical structure, decreased quadriceps muscle strength, Weakened gluteus glutes and gluteus minor muscles, overloaded exercise and trauma [2][3]

Due to the poor control of the sacroiliac joint, mainly the sacral adduction, internal rotation and abnormal foot control will cause the relative position of the femur and tibia to change. Generally speaking, the femur will generate internal rotation, adduction, and the tibia will be relatively external At this time, the changes in the tensile strength of the quadriceps and patellar tendons will increase the combined force of the two towards the patella, causing a change in the position between the patella and the femoral block, that is, the relative displacement of the patella, which increases the patella. Pressure under the bones and joints, which can lead to knee valgus.

One of the erroneous mechanical factors of patellofemoral joint pain is "dynamic knee valgus". The knee valgus will

move the whole body and cause abnormalities in the biomechanics of the entire lower limb of the human body, which will cause foot valgus, arch collapse, Ankle instability, etc.

### B. Principles of lower limb orthosis combined with patellofemoral syndrome

The patellofemoral syndrome is mainly conservative and surgical treatment, but the risk is high, the treatment time is long, there is chronic injury, and the treatment effect is not ideal. As a new technology for the treatment of patellofemoral syndrome, rehabilitation engineering has been studied abroad. Lower limb orthosis is predominant, including knee orthosis and orthopedic insoles.

#### 1. Principles of knee joint orthosis for patellofemoral syndrome

The main mechanism of knee orthosis for treating patellofemoral syndrome is to fix the patella in the femoral block to prevent abnormal movement of the patella and produce neuromuscular changes, increasing the stability around the knee joint. Michael et al. [4] Human studies have found that djo knee orthosis can improve the kinematics of patellofemoral joint abnormalities in patients with patellofemoral syndrome by correcting the abnormal movement trajectory of the patellar femoral syndrome, and eliminate peak foot stress, enhance proprioception, and improve neuromuscular feedback. Achieve therapeutic effect. Other studies have proven [5][6], a knee orthosis similar to a metatarsal stent, can reduce pain in patients with patellofemoral pain syndrome by reducing lateral movement of the metatarsal and abnormal metatarsal trajectories, and can control excessive reaction forces of the patellofemoral joint To reduce the stress of the patellofemoral joint. Studies have shown that orthopedic appliances as an emerging conservative treatment can effectively improve the knee joint dynamics of patients with patellofemoral syndrome. [7]

#### 2. Principles of orthopedic insoles for treating patellofemoral syndrome

Orthopedic insole by Dr. Merton [8] An auxiliary orthopedic tool for the purpose of restoring the abnormal force line structure of the lower limbs of the human body based on the anatomy of the foot and ankle. Orthopedic insoles, as a simple lower limb orthopedic device, are often used to treat foot pain and correct patients Deformity of the foot and placing the foot and ankle joints in a more stable position to improve balance.

The combined treatment of lower limb orthosis can not only improve the foot problems caused by pfps, redistribute the pressure of the soles of the feet, but also relieve knee pain, correct knee valgus, and put the human body in the correct state of biological force line to achieve treatment. The purpose of pfps.

## II. TRADITIONAL LOWER LIMB ORTHOSIS TYPES FOR PATELLOFEMORAL SYNDROME

### A. Knee orthosis

#### 1. Chuck knee orthosis

The chuck knee orthosis is mainly composed of pads, belt pads, knee pads, buckle straps, lock pins, angle adjustment disks, stainless steel pipe racks, aluminum frames or aluminum oxide plates, plastic extension limit blocks, and flexion limit blocks. It consists of pads, belt pads, knee pads, buckle straps, lock pins, and angle adjustment discs that directly contact the human skin, and the other components do not directly contact the human body. It can limit the knee joint angle. According to the needs of clinical treatment, you can choose a fixed angle or lock in any range of motion between  $0^{\circ}$  - $180^{\circ}$  to help the patient's knee joint function gradually recover. It is suitable for early intervention of pfps treatment, but it is cumbersome and difficult to wear. Disadvantages such as comfort.

#### 2. Hinged knee orthosis

Hinged knee orthosis is mainly composed of thigh support, straps, upper and lower struts, fixed frame, rotating hinge, etc. Its working principle is to install a parallel device outside the human knee joint, during the knee straightening process, the thigh of the orthosis. The support exerts a lifting force on the thigh, the orthosis shares the pressure of the femur on the tibia, and reduces the pressure on the knee joint<sup>[9]</sup>. The straps and hinges can control the valgus knee, improve the position of the sacrum, and make the pressure distribution uniform. At the same time, the straps provide most of the load-free effect, which is suitable for the early treatment of pfps. But it cannot control the sacrum. Reduce the possibility of further damage.

#### 3. Traditional knee pads

Knee pad is an item used to protect people's knees. It has the functions of sports protection, cold protection and joint maintenance. It is divided into sports knee pads and health knee pads. It is suitable for athletes, middle-aged and elderly people, and patients with knee diseases. The knee pads for traditional treatment of pfps can control the sacrum and reduce the possibility of further damage. Protect the knee joints during exercise, prevent extra load, and are suitable for the later treatment of pfps. The knee pads in the prior art are mainly aimed at improving the materials used, elasticity, appearance, etc. , Lack of targeted protection design for pfps, and use flexibility is not high.

### B. Traditional orthopedic insoles

Orthopedic insoles can change the ground to adapt to the wearer's personal foot shape. People who suffer from lower limb biomechanical abnormalities or foot mechanical problems caused by these abnormalities need to wear corrections. Traditional orthopedic insoles are made with plaster model insoles. It is necessary to use gypsum bandage on the patient's foot to take the negative type, gypsum positive shape, and use

plastic plates for high-temperature molding or metal. However, it takes a long time to make it, and it is difficult to get the shape and shape, which cannot be adapted to the actual situation of the foot.

## III. DESIGN PRINCIPLES OF NEW LOWER LIMB ORTHOSIS

The following mainly introduces two new types of lower limb orthosis for treating patellofemoral syndrome, including new knee orthosis and personalized orthopedic insoles.

### A. New knee orthosis

The new knee orthosis is a knee braid made of moisture-absorbing and sweat-wicking fibers, which directly transfers the load from the upper part of the knee joint to the lower part of the knee joint to realize a new method of freeing the knee joint. The knee pad body is provided with the shape of a human knee. Adapted concave cavity housing, with silicone cushions in the concave cavity, to improve the patient's wearing comfort; Limiting the torque of the knee's coronal valgus can effectively delay the condition and reduce joint load, so there are two rigid hinges on both sides of the knee pads. The brace can not only prevent the occurrence of knee valgus or limit its further deterioration, but also adjust the angle of the knee joint and improve the stability of the knee joint; elastic straps are stitched on both sides of the bottom of the knee pads, and the cross-shaped bonding is used to make it more stable. Good strengthening support; the main body of the knee pads uses soft materials that absorb moisture and sweat, reducing frictional contact between the skin and various materials, and avoiding skin pressure sores, redness, and ulcers.

The new knee orthosis has the advantages of light and breathable, high comfort, good protection and strong stability. It fixes the patella to the femoral block, prevents abnormal movement of the patella, can better improve knee pain, and greatly improves the patient. Wear compliance.

### B. Personalized orthopedic insoles

The rise of 3d printing technology brings rapid development in the field of medical aids to the treatment of patellofemoral syndrome. 3d printed orthopedic insoles acquire the shape of the foot through a three-dimensional scanner, and import the scanned model data into automated reverse processing software. Perform optimization<sup>[10]</sup>. The optimized 3D model is then imported into the 3D design software for personalized design, and the appropriate 3D printing materials and 3D printing are selected after processing through finite element strength, orthopaedic insole and foot fit analysis. The method is processed and manufactured. The personalized orthopedic insole is composed of a 3D printed base layer, a shock-absorbing antibacterial layer, a moisture-wicking layer, a arch pad, and a height-inclined block. The arch pad can raise the patient's arch and improve the patient's foot. The problem of bow collapse; the inner height of the oblique block is higher than the outer height, which corrects the problem of foot eversion; the insole is reinforced with the heel cup, which fully supports the sole of the foot, more closely fits the foot, and is more comfortable to walk, which solves the problem. The problem of ankle instability. Patients can replace the arch pad and the height-inclined block according to the recovery situation, without the need to replace the insole body, which saves time and costs, and solves the complex manufacturing

process of traditional orthopedic insoles, which can not meet the foot Adaptation to the actual situation and other issues.

The orthopedic insole produced by 3d printing technology has the advantages of light and breathable, anatomical structure, comfortable and beautiful, etc., and its surface accuracy is high, which greatly improves the compliance of patients.

#### IV. CLINICAL APPLICATION AND PRECAUTIONS OF LOWER LIMB ORTHOSIS COMBINED WITH PATELLOFEMORAL SYNDROME

##### A. Timing of orthopedic intervention

The role of the knee orthosis is to fix the position of the sacrum, enhance the stability of the knee joint, and reduce pain; the role of the orthopedic insole is to improve the foot problems caused by pfps. The combined use of the lower limb orthosis can improve the lower limb biological force line and achieve more Good therapeutic effect.

The patients selected in this review are athletes with pfps from Shanghai Greenland Shenhua Club, who have not undergone surgery and directly adopted a lower limb orthosis combined treatment. The lower limb orthosis should be treated as soon as possible, and the earlier the knee orthosis is, the better. The treatment is to control the valgus knee and improve the position of the metatarsal bone; the early intervention of the orthopedic insole is to prevent the problems of flat feet and foot valgus from aggravating. Therefore, early orthopedic treatment should be performed to obtain better results.

##### B. Pain assessment

The pain is often assessed using the Visual Analog Scale (VAS), McGill pain questionnaire (MPQ), and verbal rating scale (VDS). The most commonly used methods are Bond and Pilowsky. Visual Analog Scale (VAS) developed in 1966 [11]. This scale is a 10 cm long line segment that represents the continuity of pain, and the two ends of the line represent the limit of sensation: painless or maximum pain. Subjects indicate their own level of pain based on their feelings. If there is a change of more than 2 cm on the VAS scale after the test, it reflects that the patient's symptoms have really improved. The VAS test method is relatively simple and sensitive, and can be completed by most patients without effort, and has been widely used Assessment of pain in patients with PFPS.

##### C. Functional evaluation

Kujala Patellofemoral Score (KPS), Lysholm knee joint rating scale, JOA knee joint function assessment scale (JOA), etc. The assessment content includes 8 indicators such as pain, instability, lock, swelling, up and down stairs, squat, limp, and support. The normal score is 100 points. The smaller the score, the more severe the dysfunction.

##### D. Indications to discontinue orthosis

There are three indications for discontinuing orthopedic treatment: (1) arch collapse, foot valgus, ankle instability, etc. have improved and the knee angle returned to normal; (2) pain has not improved significantly after wearing for a long time; (3) Major problems occurred during the experiment and could not be completed. Many severe pfps patients may still need surgery, but orthopedic treatment is less invasive to the patient

and is an important method to supplement or replace surgical treatment. Successful treatment depends on Choose the right orthosis and the right treatment.

#### SUMMARY AND OUTLOOK

Pfeps is one of the common knee joint diseases in clinical practice, which mainly occurs in young athletes. The pathogenesis is still unclear. Most scholars believe that it is related to abnormal patella running trajectory. Patients with pfps generally have knee valgus, foot valgus, and arch collapse. , Ankle instability, etc. People have proposed a variety of treatments for the complexity of pfps, but clinicians have not yet reached a consensus on the best treatment. With the advancement of science and technology, interventions in rehabilitation engineering have gradually emerged. It is also effective for the treatment of pfps, however, no research has been conducted from the perspective of the combination of knee orthosis and orthopedic insoles. Therefore, this study combines the analysis of the lower limb biological force lines to design new knee orthotic and orthopedic insoles, both considering The fixation and protection to the sacrum position can correct the misalignment and alignment of the feet, and the lower limb orthosis is worn in combination to achieve the purpose of treating pfps.

Future lower limb orthosis can be improved in terms of materials and structure to create orthoses with greater comfort, higher stability, and more in line with human body structure; at the same time, gait analysis for large sample sizes of pfps patients is still blank. It is believed that research in this area will lay a better foundation for the early diagnosis of pfps, biomechanical analysis, and evaluation of the effect after treatment.

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