

The Damage and Treatment of Foot Pronation

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Abstract: Foot pronation is a motional pattern, defined as the inward rolling of the foot while walking or running, can trigger a variety of health problem in lower limb, including plantar fasciitis, Achilles tendinopathy, and knee pain. This disorder alters natural biomechanics by disturbing the line of force in lower-limb and putting unnecessary strain on both muscles and joints. Effective treatment options to the problem include physical therapy, custom orthotics, and specific strengthening exercises. Additionally, proper footwear can assist people who participate in sports alleviate the negative consequences of pronation by providing extra support and suitable cushioning to the foot structure. This study emphasizes the need of personalized approaches for the best possible rehabilitation and prevention by thoroughly examining the processes of foot pronation, the injuries resulting from it, and current evidence-based treatment options. It aims to helps optimize patient outcomes and overall life quality using scientific method and intervention tactics.

Keywords: Foot pronation, overpronation, under-pronation, treatment

1. Introduction

The pronation of the foot is an inherent part of human physiology, allowing for regular functioning of the foot at gait and during a run. It entails the inversion of the foot on the ground as it touches the floor to provide cushioning and spread the weight over the foot's bottom [1]. This movement also helps people maintain equilibrium and balance, which will help you when you must traverse through rough terrains without so much discomfort felt by your joints and muscles. While some degree of pronation occurs naturally during walking and running, excessive or insufficient pronation is problematic for biomechanics.

Overpronation occurs when the foot abducts and the lower part of the foot rolls inward; as a result, the arch flattens more than is required. This may stretch or over-stress the structures formed from Connective tissues, muscles, and ligaments in a domino effect. Over time, overpronation causes the skeletal frame to deform, and this may lead to a situation where the plantar fascia becomes stretched and develops an inflammation commonly known as plantar fasciitis. This condition affects more people who spend a lot of time on their feet doing other activities like – running or other sporting activities. Overpronation also causes Achilles tendinitis, which is a condition that results from stretching the Achilles tendon and manifests as stiffness and pain at the ankle [2].

The second type, under-pronation, also known as supination, poses a different problem. In this condition, the foot turns outward, and the shock-absorbing ability of the foot is compromised. This deficiency in shock absorption ultimately leads to a concentrated load on the outer edge of the foot.

It thus increases the person's vulnerability to stress fractures, especially in the metatarsal area [2]. Furthermore, under-pronation has higher effects on the kinetic chain, instability at the ankle, and iliotibial band syndrome, which results in pain in the lateral part of the knee.

The causes of abnormal pronation patterns may be various. Another factor is genetic inheritance, in which people are born with certain structural abnormalities like being flat-footed or having high-arched feet that can lead to over or under-pronation. Some other factors also worsen these diseases and conditions. Conditions like obesity cause increased pressure on the feet, meaning any issues concerning pronation will be magnified. These conditions are also caused by occupational factors, such as standing on hard surfaces for long hours, which, in a way, puts constant pressure on the feet [3].

Ensuring that foot pronation problems are corrected reduces the associated injuries and optimizes biomechanical output. Thus, the consequences of ignoring issues related to pronation are not limited to the feet because the musculoskeletal system is integrative and encompasses the knees, the hip joints, and even the lower spine [4]. Hence, it becomes necessary to focus on the early identification and treatment of these disorders to prevent developmental consequences. This paper aims to outline the whole range of foot pronation, its impact, and potential treatments. The focus will be made on conservative treatment like orthotics and physical therapy, whereas surgical treatment will be used in severe cases. Only through improved awareness of foot pronation and its implications can holistic solutions for prevention, treatment, and recovery be achieved.

2. Damage Caused by Foot Pronation

2.1. Common injuries and conditions

2.1.1. Plantar Fasciitis

Overpronation is major factor in plantar fasciitis since the inward rolling of the foot increases the stress on the plantar fascia. This ligament, located along the sole from the heel to the toes, helps maintain the foot arch and acts as a shock-absorbing pad during walking or running [5]. Long-standing overpronation may lead to micro-fissures in the plantar fascia, causing inflammation and heel pain. The pain is usually most severe when the person first wakes up and gets out of bed or after a long period of inactivity. Failure to treat plantar fasciitis can lead to a chronic condition that greatly affects the mobility and general well-being of the patient. Protective measures include adequate requisites, stretching orthotic devices, and appropriate shoes to offload the tension involving the plantar fascia and facilitate healing [6].

2.1.2. Achilles Tendinitis

Thus, Achilles tendinitis is the inflammation of this band of tissue connecting the calf muscles to the heel bone or the Achilles tendon. This leads the foot to turn inwards, which would cause more force to be applied to the peripheral structures and alter the position and use of the lower limb. This increases the stress on the Achilles tendon and results in continuous micro-tearing and inflammation. In this scenario, people diagnosed with Achilles tendinitis experience discomfort, stiffness, and inflammation in the tendon of the calf muscle, which can be felt more after exercising. The pain may increase, especially with increased physical activity such as standing, walking, or even running. To reduce pain, inflammation, and stiffness, one is advised to rest the sore area, apply ice to the affected part, and perform some stretching. Other interventions could also be useful to enhance foot motion and reduce pressure on the tendon to advance healing [7].

2.1.3. Shin Splints

Shin splints are a term used to describe the pains along the inner edge of the shin bone, commonly known as the tibia, due to some form of inflammation in the muscles, tendons, or bone itself. This condition is often linked to overpronation, where the foot rolls inwards to an excessive level, putting pressure on the lower leg [8]. Overpronation changes the natural movement of the leg and puts more stress and strain on the lower part of the shinbone. Shin splints are common in those who engage in activities that cause strain, such as runners, dancers, and people joining the military. It is commonly associated with physical therapy, which may become more severe during motion and even subside and reappear after physical activity. Some recommended treatments for shin splints include complete rest from the exercises, icing of the injured area, and correct shoe wear and orthotics for foot alignment. Low-impact activities like stretching and strengthening exercises for the muscles at the lower leg also prove beneficial for the relief of symptoms and in preventing their reoccurrence [1].

2.1.4. Knee and Hip Pain

Pain in the knee and hip regions are some of the results of overpronation, which involves the foot rolling inwards, causing displacement of the lower limbs. This leads to the foot rolling inward, which interferes with the proper motion pattern of the knee and hip joints and creates additional stress and load [5]. In the long run, this may lead to conditions such as the patellofemoral pain syndrome, which is pain that occurs around the kneecap, and hip bursitis, which is inflammation of the fluid-filled sacs in the hip joint. Yes, overpronation also changes the walking pattern, and this puts more pressure on the knee and hip joints, thus increasing the chances of developing osteoarthritis as one arises. The general approach in dealing with knee and hip pains is arthritis treatment, which is done by correcting the foot alignment. To correct the deformities, orthotic devices, lower limb strengthening exercises, and physical therapy may be applicable to assist in proper alignment and reduce pain and delayed joint degradation [6].

2.2. Long-term effects

2.2.1. Impact on Posture

Incorrect foot pronation, especially overpronation, drastically influences an individual's posture. When the foot rolls inwards, it rolls too much, causing the arch to flatten and altering the position of other lower limb parts. Such malalignment goes to the knees, hips, and spine to create compensative postural changes. For example, overpronation causes the foot to roll inward after the heel strikes the ground, and this causes the knees to rotate inwards during movement. This misalignment adds pressure to the joints and muscles, which may cause knee problems or hip bursitis.

Posture alteration is not only limited to the lower body. The change in leg position influences the pelvis, which in turn may incline forward or backward to balance, thus bringing instability to the lumbar spine. This may lead to lower back pain, which is frequent among overpronators who suffer from the condition. Such changes in posture due to these compensatory mechanisms result in chronic pain and restricted movement and, therefore, adversely impact an individual's quality of life. Using foot orthotics, exercises, and physical therapy is the key to correcting foot pronation and regaining proper alignment so the posture is improved and fewer musculoskeletal problems arise [7].

2.2.2. Development of Arthritis

Pronation can be considered a pathological gait pattern where the ground force is not distributed evenly, and such a habit can lead to arthritis, assuming one has been overpronating for a long time,

especially affecting the knee and hips. Overpronation is the excessive internal rotation of the foot, which changes the position of the lower limbs and shifts the pressure to the inner part of the knee joints. This misalignment puts pressure and stress on the articular cartilage, a smooth tissue between the bones that acts as a shock absorber. Such gradual wearing off of the cartilage leads to osteoarthritis, which causes joint pain, stiffness, and reduced mobility [9].

Furthermore, underpronation can also cause arthritis as the pressure increases on the outer margin of the joint. Failure to provide support and encourage shock absorption during weight-bearing movements increases the pressure on hip joints and leads to the deterioration of cartilage over time. During arthritis development, inflammation and repeated exertion of stress on the joint contribute to the arthritis' worsening. In this case, efforts to rectify abnormal pronation should be made as early as possible to avoid or delay arthritis. This may entail the application of orthoses, proper footwear, and performing exercises to improve the position and function of the joint and, therefore, decrease the stress it undergoes [6].

3. Treatment Options for Foot Pronation

3.1. Conservative treatments

3.1.1. Footwear recommendations

Therefore, the proper selection of shoes can contribute to solving the problem associated with foot pronation. Shoes also ensure that the foot remains correctly positioned to correct irregular pronation or that the feet do not pronate incorrectly. Therefore, the overpronators should wear motion-control shoes because they offer additional support at the foot arch and prevent it from rolling further [10]. They generally have a firmer midsole and contain a medial post or shank to stabilize the foot. Meanwhile, for underpronators or supinators, the ideal type of shoes should fall under either the neutral or cushion categories. These shoes seek to assist the pronation and provide support and cushioning to the outsole since it is affected by underpronation. It is crucial to evaluate the shoes' state and change them when needed because the supportability of the footwear depends on its condition. Similarly, seeking the opinion of a podiatrist will guide the identification of the appropriate arch support depending on the degree of pronation one has [6].

3.1.2. Orthotics and Arch Supports

Orthotics and arch support help treat foot pronation since they apply personalized support required to restore the structural balance of the foot. The arch is stabilized for overpronation, and the foot does not roll inward, thus minimizing pressure on the plantar fascia and other structures. These are specific orthotics that are designed to match the foot structure of the user and offer the maximum support. Orthotics are particularly advised to use under pronators since they add padding to the sole while assisting the foot in adapting to flat ground running [11]. These arch supports can be purchased over the counter but custom orthotics may be more beneficial because they address the users' biomechanical needs. Wearing orthotics daily also helps reduce soreness and prevent the onset of other disorders such as plantar fasciitis and shin splints. Therefore, it is recommended to involve a podiatrist or an orthopedic specialist to get a prescription for the orthotics [7].

3.1.3. Stretching and Strengthening Exercises

Exercises scheduled as stretching and strengthening can be helpful in the prevention and treatment of foot problems caused by pronation. Some of the activities commonly known to help in flexibility include calf stretch, which assists in lowering stiffness in the foot and toes, and toe stretch activity,

which assists in increasing flexibility. The particular exercises involve toe curls, foot arch raises, and heel lifts aimed to strengthen the muscles that aid in supporting the arch of the foot, thus increasing the stability of the feet [11]. These exercises assist in minimizing current foot pain and prevent an individual from experiencing other related complications arising out of improper biomechanics of the foot. Besides, one should remember that practice makes perfect, and it is crucial to adhere to the recommendations of the physical therapist to obtain the most effective results [6].

3.2. Physical therapy

3.2.1. Techniques and Modalities

Foot pronation physical therapy includes specific procedures and methods used with the intent to address cases of pronation and assist in treatment. Joint mobilizations and soft tissue massage during the manual therapy process also contribute to the relaxation of tension in the muscles of the foot and lower leg in order to facilitate better positioning. Flexibility workouts are preferred to help the Achilles tendon, calf muscles, and plantar fascia stretch. Methods like ultrasound therapy and electrical stimulation are commonly applied to decrease inflammation as well as pain. Ultrasound therapy is effective in heating and promoting the healing of soft tissues, while electrical stimulation aids in managing pains and strengthening weak muscles. Gait retraining is also another important approach that has to do with addressing flawed biomechanics attributed to pronation complications. Both these procedures assist in the restoration of normal mechanics of the foot, thus minimizing further injuries and enhancing function. Individualized physical therapy guarantees that such techniques are used appropriately to meet the specific requirements of the patients [7].

3.2.2. Role of a Physical Therapist

A physical therapist must work closely with foot pronation patients by establishing an individualized treatment plan. They start with evaluating the patient's gait, foot positioning, and general biomechanics to determine how severe the pronation is. Therefore, during the evaluation, therapists prescribe specific exercises that will help tone the muscles that support the upper part of the arch and increase the flexibility of the foot and the lower leg. Also, physical therapists ensure that the patient understands the appropriate footwear when walking or exercising and the need to adopt orthotic devices for foot alignment. They may apply joint mobilization or other supplementary methods, such as ultrasound or electrical stimulation, to manage the pain and inflammation. It implies that monitoring and revisiting the treatment program helps fulfill the goals of treatment and prevent the possibility of further injuries. A recommended plan from the physical therapist is requisite in establishing sustainable alterations to foot biomechanics and overall function [1].

3.3. Surgical options

3.3.1. Types of surgical procedures available

In cases where conservative measures cannot help severe foot pronation, surgery can help fix the foot's structure and return it to its correct position. Various operations can be performed based on the particular deformity and the degree of pronation [12].

Osteotomy: This is a surgical technique in which bones in the foot are removed and rearranged to reconstruct the arch and other foot parts flattened by overpronation. It is commonly done on the heel bone or the first metatarsal to improve the weight distribution on the foot.

Tendon Transfer: A tendon transfer operation involves transferring tendons from one area of the foot to another to address alignment issues [12]. This procedure is usually applied to correct the weak arch, especially with flat foot deformity accompanied by overpronation.

Arthrodesis (Joint Fusion): Severe arthritis or the collapse of early supporting structures may necessitate fusing the joints to secure the foot [12]. This includes joining two or more bones in the foot or ankle to reduce motion in the involved joints for permanent pain-free foot function. Proper exercises, physiotherapy, and thorough follow-up after the surgery are key to restoring the foot's full strength, flexibility, and function over time [6].

4. Preventative Measures

It becomes necessary to educate individuals on the need to wear the right footwear to avoid foot pronation problems [13]. Shoes must cover and protect the foot, with specific reference to support for the arches, shock absorption, and stability during walking. Replacing worn-out shoes often prevents abnormal pronation since the shoes continue to provide the required support once they are worn out.

Consultation with health practitioners on foot checkups can identify signs of improper foot structure when walking. With proper intervention, recommended orthotics or footwear adjustments may be employed to arrest the further development of medical pronation-related ailments. These assessments assist in efficient foot comfort, diminishing the risk of long-lasting pain or harm [13].

5. Conclusion

Foot pronation is a natural process that happens when the foot is in motion, mainly during walking or running, when the arch of the foot turns from the outer side to the inner side. Excessive pronation and supination result in various injuries, such as plantar fasciitis, Achilles tendinitis, shin splints, and knee or hip pain. These conditions arise from incorrect placement of the lower limbs, with other pressures that might lead to long-term complications such as body posture abnormalities and arthritis if not treated.

It is therefore important to emphasize preventive measures and ensure that individuals suffering from foot pronation seek early treatment. Proper footwear accompanied by orthotics and exercises should also be employed to modify the foot kinematics so that it does not cause further complications. These efforts are supported by physical therapy as it offers unique techniques for enhancing the tonicity and structural alignment of the foot and lower limbs. In some instances, surgery intended to address the deformity and enable the foot to move more naturally is called for.

Therefore, raising awareness of foot pronation and other problems is necessary, and this can be avoided, if necessary, measures are taken. This will also reduce the formation of such problems through foot check-ups and teaching the necessary steps to be taken while choosing shoes. Thus, the advocacy for early diagnosis and management prevents a replay of this nightmare where people are stuck with pain and limited mobility as a way of life. In conclusion, it is possible to note that education, preventive activities, and the correct intervention can help achieve a better quality of life for foot pronation individuals.

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