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Platelets Rich Plasma Injections for Chronic Plantar Fasciitis

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Abstract

Background: Plantar The majority of cases of fasciitis resolve on their own. Although the majority of patients get a spontaneous resolution of their symptoms within a year of their inception, a small percentage endure a chronic course that significantly impacts their daily lives, quality of life, and health care costs. Plantar fasciitis is a condition whose cause and treatment are still a mystery. Plantar fasciitis, despite its inflammatory connotation, is really a degenerative disease caused by microtrauma that wears down the plantar fascia at its origin. A relatively new method for treating plantar fasciitis involves injecting PRP locally. TGF, VEFG, and PDGF are only a few of the growth factors, cytokines, and interleukins found in PRP. Plantar fasciitis is alleviated by the growth factors and anti-inflammatory cytokines found in PRP, which start the repair process at the site of degeneration of plantar fascia. The optimal site for a platelet-rich plasma injection is the most painful part of the afflicted heel. Objective: Aiming to assess the efficacy of platelet rich plasma (PRP) in chronic plantar fasciitis, this review article will center on the causes, risk factors, and current practices in the treatment of this condition. Final thoughts: A frequent repetitive strain injury (RSI) in the workplace or athletics is PF. When conservative treatments and steroid injections fail to alleviate persistent plantar fasciitis, a PRP injection may be considered. Both the amount of discomfort and the thickness of the planter fascia were significantly reduced. During the follow-up, no complications were recorded. When it comes to diagnosing plantar fasciitis, sonography is a great non-invasive option. Sonographic findings of PF include hypoechoic fascia and increased fascia thickness.

Keywords: Chronic Plantar Fasciitis, Platelet Rich Plasma, Risk Factors, and the Causes of the Condition.

1. Introduction

Plantar When adults experience pain in their feet or heels, plantar fasciitis is a common cause. In 30% of cases, it affects both sides. There is a younger peak among athletes, although the average age is 40–60. Because the disease affects the medial calcaneal tuberosity, where the plantar fascia originates, the discomfort is concentrated there. Many factors contribute to the aetiology, which is not well understood. Factors that increase the likelihood of this injury include being overweight, having flat feet, standing for extended periods of time, jogging, leaping, and wearing shoes that don't fit properly. Seronegative spondyloarthropathies and isolated plantar fasciitis are also possible [1].

A number of treatments have been documented, however there is insufficient and inconsistent data to support any one method of treatment. There is currently no established method for alleviating plantar fasciitis. The short-term benefits of the corticosteroid injections were good, but they came with a host of side effects, both local and systemic. Due to these challenges, alternative treatments for plantar fasciitis are being sought after [2].

Recent data suggests that injecting plantar fasciitis patients with autologous platelet rich plasma (PRP), which includes a variety of growth factors and cytokines, may activate local factors to speed up the healing process. When contrasted with injectable steroids, autologous PRP has no negative side effects. Research on platelet-rich plasma injections has been encouraging so far [3].

The purpose of this research was to assess the efficacy of platelet-rich plasma (PRP) in the treatment of chronic plantar fasciitis by concentrating on the causes, risk factors, and current practices of this condition.

2. Anatomy:

When it comes to treating disabilities, a knowledge of the foot's anatomy is crucial [4].

Follicle of the foot (PF):

The plantar fascia, also called the aponeurosis, is made up of elastin and collagen fibers, with the collagen fibers being mostly longitudinally oriented but also transversely. Its thick middle section covers the long and short digital flexors, while its medial and lateral sections lie over the hallux and fifth toe intrinsic muscles [5].

According to[6], the medial process of the calcaneal tuberosity is the point of origin for the abductor hallucis, flexor digitorum brevis, and abductor digiti-minimi muscles, and it is also the site of attachment for the plantar fascia (aponeurosis) at its prominent medial margin.

There are three bands that make up the planter fascia:

The plantar fascia's principal functional and anatomical section is located in the center, whereas the lateral and medial sections are mostly fascial layers. In terms of importance and frequency of illness, it is the most vulnerable of the three bundles. Both the middle section and its thickness are its stronger points. Attached to the medial process of the calcaneal tuberosity distal to the flexor digitorum brevis, it is thin posteriorly. It widens and thins out somewhat as it curves around the metatarsal heads. There are five bands that split just before these, with one band for each toe that goes into the metatarsophalangeal joints. According to [7], transverse fibers connect the five bands as they separate underneath the metatarsal shafts.

The abductor digiti minimi are covered by the lateral portion of the plantar aponeurosis, which is narrow at the distal end and thick at the proximal end. The fascia on the dorsum of the foot and the central

section of the aponeurosis form a continuous medial boundary [8].

The plantar aponeurosis is rather narrow where it covers the abductor hallucis on the medial side. The fascia dorsalispedis and the flexor retinaculum form a medial and proximal joint, whereas the middle section of the plantar aponeurosis forms a lateral joint [9].

Contrary to popular belief, a calcaneus spur does not develop as a result of traction but rather as a result of the intrinsic pull on the tubercle, which causes the anterior lip of the spur to collapse and calcification to form on top of the flexor muscle [10].

Collage necrosis, angiofibroblastic hyperplasia, chondroid metaplasia, and matrix calcification are common findings in surgical specimens taken from inflammatory fascia. According to Lakshmy (2018), these alterations are in line with a healing inflammatory reaction that occurs as a result of overuse.

Three distinct kinds of calcaneus spurs exist:

Big spurs that don't hurt because the spur's development angle doesn't create a stress point or the inflammatory alterations aren't bad enough to produce immediate pain. These spurs are often discovered by accident during radiographs.

The depression of the longitudinal arch changes the pitch of the calcaneus, leading to massive and painful spurs when weight is applied. This causes the spur to become a site of stress, which in turn causes myositis of the intrinsic muscles and the adventitious bursa to develop, leading to excruciating agony.

Indicative of a subacute inflammatory response, spurs with little bone growth and an uneven or jagged form sometimes coexist with a region of reduced density near the plantar fascia's origin [11].

To Calcaneus:

One of the main bones that helps to sustain the body's weight is the calcaneus, which is also the biggest tarsal bone. The result is the posterior limb of the foot's longitudinal arches that is more vertical, shorter, and less flexible.

[12] state that the calcaneus plays a crucial role in walking by acting as a lever arm that is propelled by the soleus and gastrocnemius muscles. It also offers a stable base to support the body weight and keeps the posterior column of the foot at a proper length.

There are six different surfaces on the calcaneus: the front, back, lateral, superior, and plantar. Medial and lateral tubercles are extensions of the calcaneal tuberosity. A portion of the abductor digiti minimi originates from the tiny lateral tubercle. According to [13], the plantar fascia, flexor digitorum brevis, and abductor hallucis all join to the greater medial tubercle.

Just above the Achilles tendon's insertion, you'll find the following bursae.

The subtendinous calcaneal bursa, which is also known as the retrocalcaneal bursa, is a kind of sac that sits between the calcaneus and the Achilles tendon, just prior to it [14].

Located behind the Achilles tendon, between the skin and the back of the distal tendon, is the subcutaneous calcaneal bursa, which is also known as the Achilles bursa [15].

Disease mechanisms

A local inflammatory reaction to stress is the pathophysiology of overuse injuries. When it comes to tiny tissue, the rate of breakdown outpaces the rate at which it can recover. Tendonitis, tendon ruptures, ligament failure, inflammation, and degeneration of the affected tissues are the outcomes [16].

The collagen deterioration was caused by overuse and frequent micro-trauma. Persistent micro-trauma prevented healing, which likely explains the presence of the chronic lesions. The pathological examination revealed a variety of diseases, including inflammation (fasciitis or rupture), dysplasia (chondroid or osteoid), fibromatosis, microcalcifications, and a mix of the two [17].

In reaction, mononuclear cells proliferate in the affected area.

If acute inflammation persists after treatment, macrophages adapt to a new function by allowing a flood of fibroblasts to infiltrate the affected region and ramp up collagen production. An increase in collagen synthesis is associated with a reduction in plantar fascia extensibility [18].

Ligamentous structures inflame and destroy their connection to the calcaneus. The process by which ligaments join to bones involves a series of changes to their composition. Initially, the collagen fibers get denser, then they connect with cartilaginous cells, and lastly, they calcify and adhere to the surface of the bone by a cement line. An 'enthesis' is the name given to the connecting structure. According to (7), entheses are metabolically active locations where inflammatory cells may infiltrate.

Occurring along the path of many tiny capillaries that traverse the enthesis, inflammatory alterations at attachment sites are puzzling in origin. An inflammatory lesion focused on ligamentous attachments is what the medical community has coined the name "enthesopathy" to describe this dramatic disorder. A little fissure or erosion develops in the cortical bone as a consequence. An accumulation of inflammatory cells has penetrated the connective tissue around the link. Tissue injury at the attachment site triggers the reaction, which seems to be generic. The enthesis undergoes inflammatory erosive changes, although healing is finally accomplished by the laying down of new bone. According to [19], a spur of bone on the calcaneus may develop in instances of persistent localized heel pain since the inflammatory process seems to be ongoing and the process of bone laying down takes time.

Chronic plantar soft tissue strain causes a variety of pathological alterations, such as thickening and edema from low-grade periostitis, proliferation of fibroblasts, and infiltration of inflammatory cells. According to [20], the abductor digiti quinti muscle and the mixed nerve to the medial calcaneal nerve are two nearby tissues that may be indirectly affected by this inflammatory process.

Caused by Repetitive Stress Injuries, PF is a prevalent injury in the workplace and in sports. It is a degenerative, non-inflammatory disease that is common in clinical practice and is linked to overuse. According to [21], its pathophysiology resembles tendinosis and tendinopathy.

Collagen deterioration due to repeated microtears that the body is unable to heal is the typical culprit behind the discomfort. Reduced and impaired repair and re-modeling of the extracellular matrix necessary for healing occurs due to decreased nutritional supply through the injured tendon from non-functional capillaries. A rise was seen in vascularity, vascular cells, fibroblastic growth factor (FGF), and vascular endothelial growth factor (VEGF) [22].

Possible causes of PF:

Problems with the structure

Achilles tendonitis: When the talocrural joint doesn't fully extend its range of motion (which is normally 20 degrees), the subtalar joint (STJ) and midfoot may roll inward to compensate, which puts more pressure on the plantar fascia and other foot structures that are trying to re-supinate the STJ before you lift your heel [23].

In a case of forefoot varus, the front foot is turned inside out in comparison to the back foot. According to [24], the STJ may prolong pronation until late stance so that the forefoot may make contact with the ground.

The hindfoot varus, sometimes called the rearfoot varus, is an inverted heel-toe alignment.

Vallus pesplanus: A flat foot that tends to pronate too much and too quickly. The STJ quickly and excessively pronates upon landing and during midstance, putting more strain on the foot's ligaments, muscles, and plantar fascia, which are trying to slow down and control pronation [25].

The fish pescavus According to[26], a person may be more likely to get plantar fasciitis (PF) if their STJ does not fully pronate from the loading response to early midstance, which might prevent the pescavus foot from adequately absorbing ground reactive stresses.

Incorrect usage (training mistakes)

Overtraining the lower extremity's supporting systems may lead to injury if one does not gradually increase the intensity, length, and frequency of training runs and does not include hills on training routes soon enough [27].

Obesity, deterioration with age, certain jobs, and Difference in Limb-Length

The plantar fascia may also be injured by jobs that demand prolonged standing or walking on hard floors. Athletes, nurses, mail couriers, and warehouse workers often deal with this problem. The rapid rise in body weight during pregnancy may put extra strain on the ligaments of the foot, leading to PF. [27] The incidence and severity of PF are both increased when there is a difference in the length of the affected limbs [28].

Traumatic

Injury to the plantar fascia caused by trauma occurs far less often than PF. The lesion's position is a key differentiator; it usually affects the plantar fascia around 2 to 3 centimeters from the insertion. Acute and subacute injuries are categorized by [29].

For instance, when a patient leaps from a great height, the patient may get acute injuries due to a powerful axial compression force. Uneven landing surfaces put extra strain on the plantar fascia, especially when the heel hits the ground after the forefoot does. A common occurrence is a fall from a little height, such as when the front foot hits the curb with more dorsiflexion. A sharp pain and a cracking sound are common complaints from the sufferer. Injured areas could show signs of bruising [30].

Persistent but undiagnosed plantar disease might lead to less severe foot injuries. Chronic abuse is the underlying cause of both PF and these conditions, making it more difficult to distinguish between their histories. Patients with PF who suffer a traumatic partial tear have several characteristics with those with real PF [31].

Evaluation for PF

Just like with any medical issue, it's crucial to take a thorough history of the patient's heel pain. Ask them when the pain first started, where it hurts, whether it spreads, what causes it, and what alleviates it. A thorough investigation of the possible impact of shoe style and heel height on the aforementioned set of symptoms has to be undertaken [32].

The past

It often manifests as a solitary symptom in middle-aged, overweight individuals who continue to be physically active via walking and standing-based tasks.

When a patient presents with heel pain, a doctor will likely diagnose it in the area of the plantar medial heel. Direct pressure, commonly known as palpation, may cause pain. When the knee is straight, there is usually a corresponding equinus contracture, which is characterized by calf stiffness. Dorsiflexing the toes, which stretches the plantar fascia, may potentially make symptoms worse. Plantar fasciitis is more likely to occur in those who have flat feet. [33] Nevertheless, this problem may occur in any kind of foot.

How it begins and how long it lasts; it's often subtle but may be abrupt, like a terrible incident. It may cause varying degrees of impairment. [34] found that while some patients report a little discomfort, others say the pain is so severe that it makes them stay home from work.

Diagnosis relies heavily on pain location. To obtain a good feel for where a patient's foot discomfort is coming from, it's helpful to have them trace the area with their finger. While some patients may initially have migratory or scattered heel pain, with time, the pain often centers in the medial calcaneal tuberosity. figure 2. When dealing with bilateral symptoms, it's crucial to determine whether both feet are equally affected or if one foot is much worse [35].

Fig. (1) The left above mark indicates the typical point of maximal tenderness in plantar fasciitis. The left below mark indicates the location of tenderness in heel pain caused by thinning of the heel fat pad. The right mark shows typical location of morning pain.[39]

The usual site of peak discomfort in plantar fasciitis is shown above the left mark in Figure 2. The sensitive spot in the heel, produced by the fat pad thinning, is marked on the left below. The usual site of morning discomfort is shown by the right mark [36]**.**

Swelling: While some patients may come in complaining of a lump on the foot, such as a ganglion or plantar fibromatosis, it is important to suspect a tumor if the swelling is continuing to grow and is located in an odd place or if its etiology is unclear [37]

If the patient is really unable to work due to a foot condition, it is considered a substantial disability; a thorough occupational history should be obtained, including the patient's hobbies and sports, in order to assess functional impairment [38].

Pain, weakness, or both might limit the amount of distance that can be walked. It could be challenging for patients to articulate their maximum allowable walking distance. According to [39], patients could find it more manageable to express their walking distance in terms of time, such as 5 or 10 minutes, before they need to take a break.

Shoes: Shoes may reveal a lot about the level of discomfort you're experiencing, which might help pinpoint the source of your foot pain. A good pair of shoes will include a heel cup and arch support. The absence of enough cushioning in worn or poorly fitted shoes might worsen PF. Patients may have foot pain when first putting on their brand-new shoes [35].

Injury history and surgical procedures: This should not be disregarded as a potential etiological element. The injury could not have been caused by a single, abrupt event, but rather by the cumulative effects of activities like dancing, jogging, or other sports, or by the demands of the job itself. When symptoms persist after a prior operation, it is important to understand the specifics of those symptoms, whether they improved right away or whether they changed over time [40].

Current state of health: The foot may be an indicator of several systemic disorders. The origin of foot pain might be due to a vascular problem or back discomfort. A neoplasm may be present if there is a significant decrease in hunger, weight, or nighttime discomfort [34].

Medical evaluation

Examine This: Whether you're sitting, standing, or walking, you should check your foot. Examination of the patient's gait reveals that they are in pain if they have an antalgic gait, which is characterized by a shorter stance phase. A more thorough examination for indications of pressure or keratoses will be necessary in the future in the event of an abnormal pattern of shoe use or any abnormal loading pattern of the foot [41].

Sense (Feeling): Pain in the medial tuberosity of the calcaneus is worse as the foot and toes bend inward. Additionally, there is a lack of ankle dorsiflexion because of a stiff Achilles tendon [42].

The medial tubercle of the calcaneus and the base of the great toe constitute the area where this fascia is thickest. In this space, you may feel the tight fascia as your toes passively extend. When a patient has PF, they may feel pain along the taut fascia.

Any area of the foot that is swollen should be noticeable. Within the plantar fascia, you may feel the nodules that are associated with plantar fibromatosis. It is also possible to feel cysts and edema in the synovium. Plantar fascial nodules are common and could be a sign of osseous spurring [43].

To rule out tarsal tunnel syndrome, a neurological examination should be conducted. This includes percussion across the tarsal tunnel, also known as Tinel's sign at the posterior tibial nerve. Nonspecific Tinel's symptoms may coexist with proximal lesions, and S1 radiculopathy often involves sensory involvement of the sole. In order to detect degenerative disk disease, it is necessary to thoroughly examine the leg's motor and sensory systems farther proximally. [48] A straight leg lift test should be conducted to rule out sciatica if the patient reports either proximal or distal radiation of pain. [47] To assess the health of the sensory nerve in the foot, a combination of gentle touch and pin prick is used. According to [44], if there is any discomfort or weakening in the muscles' active motor power, it is important to assess this.

Medical Evaluations:

Injuries to the plantar fascia may occur during maneuvers such as toe-walking, standing on tiptoes, or passive dorsiflexion of the toes (Windlass test). According to [45], the sensitivity of the windlass test may be enhanced by having patients bear weight throughout the test.

When the plantar fascia is under too much stress, it irritates the tissues around its origin at the medial calcaneal tubercle. A positive test will replicate discomfort in the medial calcaneal tubercle, and it involves standing while forcefully extending the great-toes. Regardless, this test has just a 31.8% sensitivity rate, despite researchers reporting a 100% specificity rate [46].

Standardized test:

In order to rule out referred pain, the ankle and subtalar joints are passively and actively evaluated for mobility and range of motion. The number 49.Potentially in need of treatment include the hips, knees, spine, upper limbs, and central nervous system. Diseases that affect the whole body, like diabetes or RA, might show symptoms in other parts of the body [47].

Research and Experimentation: Although routine urine or blood testing has not been shown to improve outcomes for people suspected of having PF, it may aid in either confirming or ruling out the diagnosis. Determine the uric acid level in cases when gouty arthritis is being considered. If inflammatory diseases like rheumatoid arthritis or ankylosing spondylitis are being considered as diagnosis, confirmation testing including serology might be useful. The use of these tests is limited, however, since human leukocyte antigen (HLA)-B27 is only 65% sensitive in detecting ankylosing spondylitis and rheumatoid factor specificity is only around 50%. [48] found that although an increased white blood cell count, erythrocyte sedimentation rate, and C-reactive protein might suggest infection, no set of serologic tests could definitively rule out the potential of infection.

Radiography: Clinical criteria are used to diagnose PF. In most cases, imaging scans are only ordered after conservative treatment has failed or when the patient presents in an unusual way. When assessing the osseous structures, radiographs are helpful. in the 53rd The calcaneus and foot's bone architecture may be better seen using axial, lateral, and antroposterior radiographs. Even while sub-calcaneal heel spurs are visible, it doesn't mean they're the source of your discomfort (fig. 3). Up to 15% of asymptomatic people have them, while only 50% of patients with sub-calcaneal heel pain syndrome have them detected. According to [49], patients could notice a bigger spur on the unaffected foot on the other side.

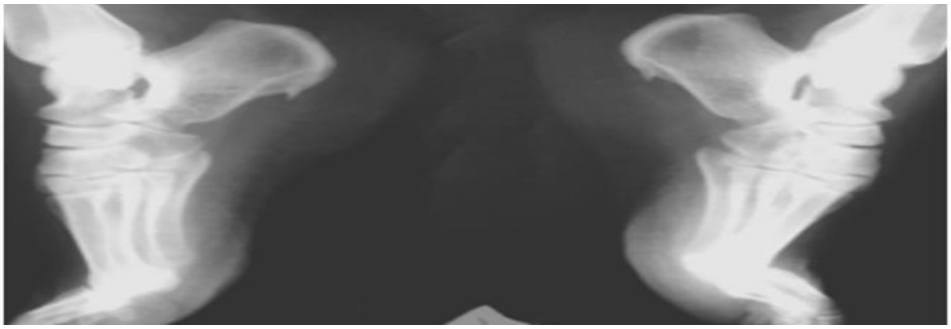

Fig. (2) Lateral radiograph of the calcaneus showing calcaneal spur in both side [49].

The calcaneus is the most frequent foot and ankle bone to sustain a stress fracture, however any bone may be affected. Stress fractures are often suspected clinically since they are not always visible on radiographs. Trabecular sclerosis, periostitis, Possible modest radiographic changes include changes in cortical thickness and anomalies within the cortical layer [50].

Ultrasound Assessment:

When it comes to diagnosing plantar fasciitis, sonography is a great noninvasive option. According to [51], when the ultrasound beam is angled at 90 degrees, the typical plantar fascia appears hyperechoic and almost isoechoic with the neighboring fat of the heel pad.

But in the sagittal plane, the fascia stands out due to its striated look, which is caused by the fibers' longitudinal orientation. Hypoechoic artifacts of normal fascia can be a potential hazard if the ultrasound beam is not perpendicular to the tissue [52].

The recurrent process of micro-tears, fiber degradation, or edema may be associated with hypoechoic fasciitis, which is similar to tendinitis. [56] In comparison to both asymptomatic and control group patients, those with PF had noticeably thicker plantar fascia in their heels. Sonographic findings of PF include hypoechoic fascia and increased fascia thickness [53].

When it comes to diagnosing degenerative illnesses and necrotic tissue, magnetic resonance imaging (MRI) may be your best bet. The typical fascia of the foot; MRI makes it possible to see the plantar fascia clearly. The typical plantar fascia appears as a narrow, linear region with a weak signal throughout all pulse sequences. An elevated signal on T2 sequences in the fascia and surrounding soft tissues may be indicative of PF. The calcaneus's neighboring bone marrow often experiences an uptick in signal strength [54]

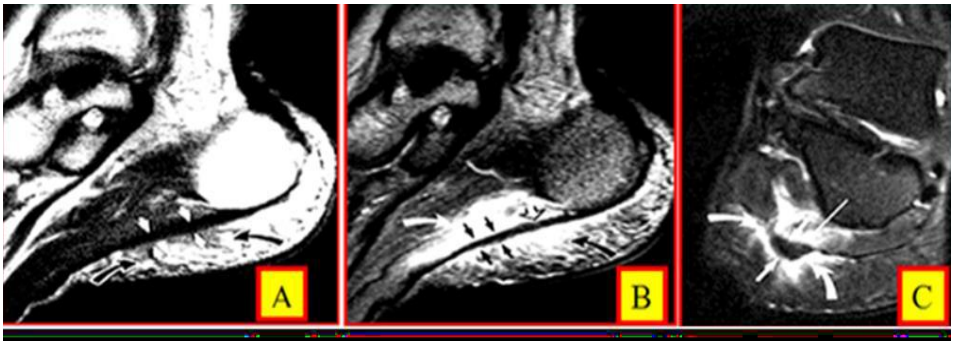

Fig. (3) Acute PF in a 37-year-old woman with heel pain exacerbated while walking. (A) Sagittal T1-weighted. MRI shows thickened plantar fascia (straight arrows) and extensive low signal intensity in the adjacent heel fat pad (curved arrows) consistent with edema. (B) Sagittal T2-weighted MRI reveals thickened plantar fascia (black straight arrows) with intrasubstance abnormal increased signal intensity (open arrow) and widespread abnormal high signal intensity (edema) infiltrating perifascial soft tissues (curved arrows). (C) Coronal MRI shows irregular thickened plantar fascia (short straight arrows) with intrasubstance foci of abnormal high signal intensity (long straight arrow). Extensive perifascial increased signal intensity (curved arrows) corresponds to soft-tissue edema. [54]

A 37-year-old lady with acute plantar fasciitis (PF) who had worsening heel discomfort while walking (Figure 4). A sagittal T1-weighted image. MRI scans reveal thicker plantar fascia (straight arrows) and widespread low signal intensity in the fat pad next to the heel (curved arrows), which is indicative of edema. In (B), sagittal T2-weighted MRI shows thicker plantar fascia with intrasubstance abnormal increased signal intensity and perifascial soft tissues infiltrating with widespread abnormal high signal intensity, as shown by curved arrows and a thickened substance (black straight

If a patient is recalcitrant to treatment or if a diagnosis is unclear, an electrodiagnostic test measuring nerve conduction velocity may be necessary. To establish that tarsal tunnel syndrome, sciatica, peripheral neuropathy, or entrapment of the first branch of lateral plantar nerve are not contributing factors, it is essential to conduct a comprehensive electromyographic (EMG) and nerve conduction study (NCS) of the sensory and motor nerves to the foot, comparing it to the other foot [55].

Imaging of the bones:

By showing radionuclide uptake at the base of the calcaneus, bone scans might potentially indicate PF as a diagnosis. Other than calcaneal uptake, stress fractures, osteomyelitis, and Achilles bursitis are other explanations for the results of this test.[63] Bone scans may show that individuals with PF have greater uptake near the fascia's origin and that patients with calcaneal stress fracture have increased uptake along the whole calcaneus, however these findings are seldom used to establish the diagnosis **[56].**

Medical Care

Treatment Options Other Than Surgery (Conservative Measures)

For the symptoms of plantar fasciitis, there is a broad range of treatment options, including non-steroidal anti-inflammatory drugs, orthotics and shoe arrows, open arrows). (C) Coronal MRI reveals thicker plantar fascia in an irregular pattern, with short straight arrows indicating thickening, and long straight arrows indicating intrasubstance spots of abnormally high signal intensity. Edema of soft tissues is indicated by a considerable increase in signal intensity along the borders of the image (curved arrows) [54].

MRI assessed for heel spur existence and severity, plantar fascia thickness and signal intensity, soft-tissue and calcaneal bone marrow edema, and other conditions.

inserts, physical therapy, a night splint, extracorporeal shock wave therapy, injections, and alternative medicine.

medicines that do not include NSAIDs

When used as directed, nonsteroidal anti-inflammatory drugs (NSAIDs) may alleviate inflammatory pain, particularly during the first phases of therapy.[57] state that if a patient's discomfort does not improve after two months, they should return for a follow-up examination.

Shoe inserts and orthotic devices: Other names for them include insoles, cushions, arch supports, pads, and inserts. Nowadays, there are a number of in-shoe devices that are collectively known as orthoses, and their functions range from providing support and increased shock absorption to altering the foot's natural posture [58].

Several manufacturers provide premade orthoses in different materials to treat common foot ailments. These orthoses are generic and available for purchase. Custom orthoses may be built to target a particular portion of the foot (heel cushions, arch support, etc.) or the whole foot (complete insole, etc.) to alleviate pressure and stress. Heel cushions, arch supports, and detachable complete orthoses are the three main categories. Nowadays, a lot of sports shoes include insoles [59].

Treatments for plantar fasciitis have varied and included various forms of physical therapy. In the first phases of treating plantar fasciitis, it is common practice to use ice in the form of a massage, a bath, or an ice pack. After filling a small paper or foam cup with water, the patient may apply ice massage to their sore heel. They should rub the ice in a circular motion with mild pressure for five to ten minutes, no more than thirty minutes, three or four times a day. The inflammation process of the injury may be alleviated and the swelling controlled with the use of ice. According to[60], icing is often done after a workout, stretching, strengthening, or a long day on the job.

Night splint: The majority of people sleep with their feet in a naturally flexed posture, which shortens the plantar fascia. While you sleep, a night dorsiflexion splint may stretch your calves and plantar fascia without you even realizing it. According to [61], keeping the plantar fascia stretched as you sleep should help minimize morning start-up discomfort and promote healing by reducing strain with the first step in the morning.

Intraoperative Shock Wave Treatment: (ISWT)

An successful therapy for insertion tendinopathies, ESWT first appeared in the early 1990s. For those cases of persistent plantar fasciopathy that have not improved with more conservative methods, it has been highly recommended. A number of hypotheses have been advanced to explain the activity of shock waves; they include a hyperstimulation mechanism that disables the gate-control system, direct suppression of nociceptors, neovascularization, and direct stimulation of healing. According to [61], ESWT is a beneficial noninvasive therapy that might be a wise and cost-effective short-term alternative to surgical methods for treating recalcitrant plantar fasciopathy.

Puncture Treatment for Plantar Fasciitis

Conservative therapy is the gold standard for PF, but it doesn't work for about 10% of patients, and there's not much proof that local corticosteroid treatment reduces pain for more than a few days [62].

An effective and popular treatment is the palpation-guided injection of corticosteroid formulations into PF. But it doesn't always work, and sometimes you have to inject yourself more than once. Reasons for this might include obesity and injection errors [63].

About six weeks after the start of therapy, the patient should have a reevaluation. It is possible to think about injecting steroids if other treatment methods fail. Avoiding atrophy of these tissues requires caution in preventing the steroid from penetrating the plantar fat pad [64].

Although injecting a corticosteroid at the site of most palpable soreness is an effective therapy, some individuals may need more than one injection. According to [65], the rate of response to repeated injection is unknown.

Procedure for Surgery

Recalcitrant plantar fasciitis has been treated with a variety of surgical methods, such as endoscopic plantar fasciotomy, calcaneal osteotomy or decompression, heel spur removal, and plantar fasciotomy (open or percutaneous) [65].

When discomfort is localized to the area where the core plantar fascia band originates, a procedure called an isolated plantar fasciotomy may be explored. Oblique incisions are created in the medial plantar aspect of the back foot. Half of the medial fascia is freed after the blunt exposure of the plantar fascia. According to biomechanical research, releasing the fascia in its entirety can cause the medial and lateral columns of the foot to collapse, which is not something you want to happen. [42] A proximal medial longitudinal arch incision is used for the release of the plantar fascia. The treatment shortens the healing period by releasing the central chord of the plantar fascia while leaving the lateral 35% to 50% intact [66].

The calcaneal spur's base is being bored:

In situations of persistent plantar heel discomfort, decompression of the calcaneus by several drill holes has also been shown to be effective. Drilling holes that are too close together across the calcaneus weakens its structure (fig. 5). When the foot bears weight, the tendon Achillis and plantar fascia pull on it, causing the calcaneus to collapse [67].

Scanned image 5: A When drilling the calcaneus, the stress is at its highest at sites A and B. A and B both experience a reduction in tension, and the calcaneus's body involutes within itself at point B. The study conducted by Gültekin et al. in 2021Through calcaneal osteotomy, the exposed lateral wall was exposed and an osteotomy was performed using an oscillating saw, starting 1 cm anterior to the calcaneal attachment of the plantar fascia and continuing 1 cm anterior to the calcaneal attachment of the Achilles tendon. The surrounding tissue was protected throughout the procedure [68].

The proximal piece was subjected to around 5 mm of plantar displacement after the osteotomy, which included attaching the plantar fascia. In order to fix misalignment, patients whose feet were already pronated before surgery had the proximal fragment displaced around 5 mm medially at the same time [69].

Per [70], two 4.5 mm cannulated cancellous screws were introduced from the infero-medial and lateral aspects of the calcaneal tuberosity to the distal fragment during the post-osteotomy fixation procedure, which was carried out under the guidance of an image intensifier.

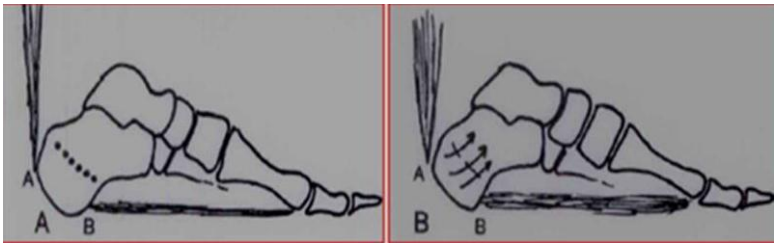

Fig. (4) A, Maximum tension at points A and B with drilling of the calcaneus. B, there is involusion of the body of the calcaneus upon itself and a decrease in tension at points A and B. [75]

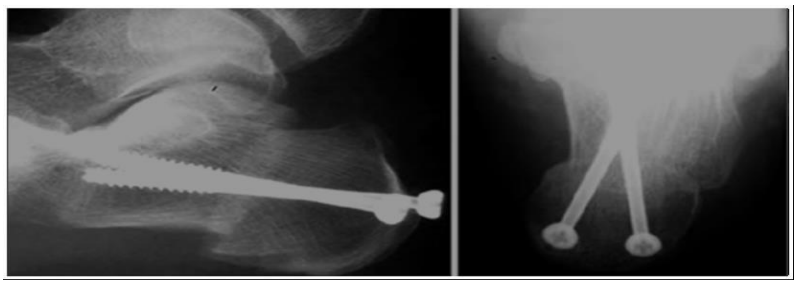

Fig. (5) Post-calcaneal osteotomy radiographs. A lateral examination reveals that the proximal fragment has shifted about 5 mm to the plantar side. B. In the case of a pronated foot patient, the axial image reveals an extra 5 mm medial displacement of the proximal fragment [71].

The One drawback of the treatment is the increased invasiveness compared to plantar fascia release. Additionally, the time it takes to complete bone fusion means that weight bearing cannot be resumed for a longer period. Nevertheless, problems like sural nerve damage may be avoided by exposing the calcaneus below the skin's surface, and all patients should be able to achieve bone fusion within six weeks [72].

The idea is to ensure that the plantar fascia remains intact while reducing strain on it near the calcaneal connection. Relaxation of the plantar fascia, which might lead to a reduction in longitudinal arch height, was the only risk associated with this operation [73].

Debris excision:

According to a study of fifty individuals who had a medial incision made over the heel to remove a spur, the spur is thought to be the cause of PF symptoms. All fifty patients reported a reduction in their symptoms. At the 6-month follow-up, 89 patients who had a combination of heel spur excision, fascial release, and partial fasciotomy indicated that their heel discomfort had completely subsided. Although spur removal does not totally eradicate pain, it does alleviate mechanical stress by requiring the fascia to be completely divided in order to get sufficient exposure [66].

When treating plantar heel discomfort, surgeons seldom remove the spur from the heel. In very unusual cases, an osteophyte could be so big that it presses on the first branch of the lateral plantar nerve, or it might be pointing in a plantar direction that it has to be removed. To remove the spur, one must carefully dissect the origin of the flexor digitorum brevis muscle while taking great care not to damage any nearby nerves or arteries. Heel spur excision is associated with increased postoperative edema, discomfort, and ecchymosis, which in turn lengthens the healing period [74].

Plantar fascia relaxation with endoscopy:

Although technically challenging, endoscopic plantar fascia release has been shown to reduce soft tissue stress and postoperative discomfort. It was impossible to manage the precise proportion of resection, even if partial release was achievable. Because it is not possible to relax the deep fascia of the abductor hallucis muscle during the treatment, it is not recommended for patients who are experiencing symptoms of compression neuropathy. Nonetheless, almost all patients (97%) said that the procedure helped alleviate heel discomfort [75].

A growing number of people are opting to have endoscopic plantar fascia released. When executed properly, this method allows patients suffering from isolated plantar fasciitis to return to function more quickly after surgery with reduced postoperative morbidity. On the other hand, the lateral plantar nerve is vulnerable to damage and the surgeon may have limited vision during this technically demanding operation. According to [72], individuals who may be experiencing compression of the lateral plantar nerve branch should not have an endoscopic release.

New approaches to therapy

The use of autologous platelet concentrate injections, also known as platelet rich plasma (PRP), has become increasingly popular in the field of orthopedic sports medicine as a therapeutic treatment for injuries to bones, muscles, tendons, and cartilage [76].

Platelets are tiny, non-nucleated particles found in the blood's peripheral circulation. Their main function is to stop bleeding. Proteins, cytokines, and other bioactive components found in platelets start and control fundamental processes in wound healing (Table 1). The typical range for platelet counts in blood is 150,000 to 350,000/mcL. The blood's fluid component, plasma, includes ions, proteins, and clotting factors. Improved wound healing has been linked to platelet-rich plasma, which is defined as plasma with a platelet concentration of 1,000,000 platelets/mcL in 5 mL of plasma. According to Theodorou et al. (2000), the concentration of growth factors is three to five times higher in platelet-rich plasma.

Table (1) The Role of Platelet-Growth Factors.

	Target cell/ tissue	Function
PD-EGF	Blood vessel cells, outer skin cells Fibroblasts, and many other cell types	Cell growth, recruitment Differentiation, skin closure Cytokine secretion
PDGF A + B	Fibroblasts, smooth muscle cells, chondrocytes, osteoblasts, mesenchymal stem cells	Potent cell growth, recruitment Blood vessel growth, granulation Growth factor secretion; matrix formation with BMPs(collagen and bone)
TGF-B1	Blood vessel tissue, outer skin cells Fibroblasts, monocytes TGF gene family includes the BMPs Osteoblasts—highest levels of TGF-Br	Blood vessel (±), collagen synthesis Growth inhibition, apoptosis (cell death) Differentiation, activation
IGF-I, II	Bone, blood vessel, skin, other tissues Fibroblasts	Cell growth, differentiation, recruitment Collagen synthesis with PDGF
VEGF, ECGF	Blood vessel cells	Cell growth, migration, new blood vessel growth Anti-apoptosis (anti–cell death)
bFGF	Blood vessels, smooth muscle, skin Fibroblasts, other cell types	Cell growth Cell migration, [82] blood vessel growth

APD-EGF, platelet-derived epidermal growth factor; PDGF; BMP; TGF; IGF; VEFG; ECGF; bFGF; these are acronyms for platelet-derived epidermal growth factor, platelet-derived epidermal growth factor, basic fibroblast growth factor, and insulin-like growth factor.

Autologous blood products are becoming more and more common in the US and Europe as a means to aid in healing for a range of purposes.There has been recent progress in our understanding of some growth factors and their critical function in wound healing. Based on this information, there is a lot of excitement about using concentrated platelets, which produce an excessive amount of these growth factors, to encourage healing in wounds that aren't getting better on their own. Autologous platelet-rich plasma (PRP) has a well-documented and 20-year history of safe usage in several medical specialties, such as wound healing, neurosurgery, ophthalmology, dentistry, orthopedics, sports medicine, ENT, ophthalmology, and urology [76].

The importance of growth factors in wound healing and tissue regeneration is well-established. When it comes to platelet-rich plasma (PRP), some writers have shown better results in terms of bone growth and tissue repair than others [77].

Concentrated platelets from autologous blood plasma obtained by centrifugal filtering are known as platelet-rich plasma (PRP). It contains high concentrations of growth factors such as transforming growth factor beta (TGF-), platelet-derived growth factor (PDGF), epidermal growth factor (EGF), and vascular endothelial growth factor (VEGF) [78].

Platelet alpha granules are storage units that hold dormant growth factors that are packed. Epithelial growth factor (EGF), platelet-derived growth factor (PDGF), transforming growth factor beta (TGFbeta), and vascular endothelial growth factor (VEFG) are the primary growth factors found in these granules. Osseointegration and osseoconduction are both aided by vitronectin, a cell adhesion protein found in the granules [79].

When inflammation is present, TGFbeta regulates cell migration and proliferation, stimulates cell replication, and affects interactions between fibronectin and other proteins. According to [80], the production of VEFG peaks only after the inflammatory phase, and it is a powerful activator of angiogenesis.

"Orthobiologics" refers to a potentially groundbreaking new field of medicine that might soon see the use of autologous growth factors in PRP. For knee osteoarthritis discomfort, first-generation injectables such visco-supplementation have been effective. These injections are an attempt to alter the joint's biochemical environment that is not based on biology. With PRP, a new generation of injectables is at your fingertips. This method allows for the introduction of a strong mix of growth factors at a high concentration, which may boost healing. According to [81], chondrogenesis in cartilage healing has been associated with TGF-b, which is found in PRP.

Recent findings from the 2007 International Cartilage Repair Society Meeting in Warsaw suggest that platelet-rich plasma (PRP) might improve the clinical outcomes of degenerative knee cartilage by increasing the proliferation of chondrocyte cells [82].

When utilized for chronic tendon healing, platelet-rich plasma (PRP) injections into the injured area have the effect of resuming the healing process. Bone augmentation, ligamentous injuries, cartilage injuries, muscle injuries, and wounds have all shown encouraging outcomes when treated with PRP. When conservative therapy fails to alleviate a chronic injury, PRP may re-ignite the inflammatory process, thereby transforming the injury into a new acute one. An additional benefit of PRP for long-term conditions is the potential enhancement of the healing process by the incorporation of autologous platelet concentrations [83].

Risk prevention

Since PRP is made from autologous blood, there is no need to worry about immunogenic responses or disease transmission. The promotion of hyperplasia, carcinogenesis, or tumor formation by PRP has not been shown in any research. According to [84], growth factors stimulate regular gene expression by acting on cell membranes instead of the cell nucleus.

Thrombocytopenia, ongoing infections, tumors, or a platelet count below 105/uL are all considered relative contraindications. It is not recommended to use this

product while pregnant or while nursing. [85] recommends against using these chemicals in local anesthetics for patients who are allergic to Bupivacaine (Marcaine).

Warning patients that their symptoms may temporarily increase after injection is a good idea [86]. This is because the injection triggers the body's natural reaction to inflammatory mediators.

Prepare for PRP

Different blood separation devices need different amounts of time to prepare, but they all work toward the same end. With the Biomet Biologics GPS III system, you can do it easily. Using aseptic approach, 30–60 ml of venous blood is collected from the antecubital vein. If you want to be careful with the resting platelets and not irritate or damage them, use a butterfly needle that is 18 or 19 g in weight. After that, the blood is spun at 3,200 rpm for 15 minutes in a centrifuge that has been authorized by the FDA. This is followed by the separation of the blood into RBC, PRP, and platelet deficient plasma (PPP). The next step is to remove the PPP from the device via a designated port and then dispose of it. The platelets are resuspended by shaking the device for 30 seconds while the PRP is in a vacuumed area. It is then necessary to remove the PRP. Three to six cc of platelet-rich plasma (PRP) is available, depending on the first blood sample [87].

Intramuscular injection technique

The clinical exam and imaging study data, including MRI and radiography, are considered for marking the damage area. To improve the localization of the PRP injection, dynamic musculoskeletal ultrasonography with a transducer of 6-13 Hz is advised. The patient is administered a platelet-rich plasma (PRP) injection into the injured region under sterile circumstances. This injection may or may not include 1 cc of 1% lidocaine and 1 cc of 0.25 Marcaine [88].

To maximize the benefit in a joint region, it is possible to add calcium chloride and thrombin to create a gel matrix that the PRP can cling to. A more extensive delivery zone may be achieved by expanding the peppering approach in a clockwise direction [89].

After that, the patient is watched while lying flat on their back for around fifteen to twenty minutes before they are sent home. The pain these injections cause is usually mild to severe and may last for up to a week. In addition to elevating the leg and modifying activities as tolerated, they are directed to freeze the injection site if pain management is necessary. The ideal painkiller is acetaminophen, or Vicodin for severe pain; nevertheless, NSAIDs should not be used in the first several hours after an injection [90].

Regenerative medicine for plantar fasciitis:

To ascertain if this procedure was effective in treating plantar fasciitis (fasciosis), they used a number of data collection strategies.

Each visit's ultrasound measurements of the medial, central, and lateral bands taken before and after the APC+ injection. Some patients may need more than one therapy. To get the maximal reduction in pain, some individuals may need to have two or even three PRP injections. The signal intensity and thickness of the fascial bands undergo substantial changes after injection. The bands of the plantar fascia close to the calcaneus point seemed thicker and hypoechoic than the unaffected side before injection. The photos taken before injection show this clearly in the hard copy[91].

According to [91], there is a notable shift in thickness and signal intensity seen in post-injection assessments taken at one week, four weeks, two months, and three months.

Plantar fasciitis stem cells: The phrase "stem cells" refers to the sort of precursor cells that have the potential to differentiate into various forms of tissue. The term "totipotent stem cells" refers to a special kind of cell that has the potential to differentiate into every kind of cell in the body, including the zygote, which is the precursor to every cell type. Although pluripotent stem cells may differentiate into almost any kind of tissue, they cannot give birth to a fully functional being. Example: human embryonic stem cells at all three stages of development. Since multipotent stem cells have undergone greater differentiation, their potential lineages are less malleable and more fixed, limiting the number of tissues from which they may derive. As an example, research has shown that mesenchymal stem cells may differentiate into a variety of connective tissues, including bone, muscle, cartilage, fat, and more [92].

Following a principle similar to that of organ transplantation, stem cell therapy seeks to use adult and embryonic stem cells to substitute other cells that have been destroyed or wounded due to illness. Based on the particular cells that need replacement, these newly produced stem cells may be programmed to assume the role of those cells. Cell transplantation has the potential to treat cartilage-related disorders like osteoarthritis by mending the affected area. It is possible for bone cells to be produced from stem cells to replace bone that has been lost due to injury or surgery [93].

These are the adult stem cells that may be found in fat, bone marrow, and blood. Because adult stem cells are used in bone marrow transplants, which are widespread, the treatment is not controversial. Various degenerative illnesses may be treated with adult stem cell therapies, and some hereditary disorders can be treated with stem cell treatments derived from the umbilical cord blood [94].

In situations of severe plantar fasciitis, stem cell treatment is a short operation using local anesthetic and a straightforward bone aspiration to remove blood products from the heel or shin bone. No stitches or even a single basic stitch will close the area. The damaged region is injected with concentrated stem cells obtained via centrifugation. The next step is to put the foot in a protective boot or shoe and let the stem cells do their job. Because the patient's own blood products are not rejected and complications are rare, the procedure is risk-free and takes 2–6 weeks to take effect. picture 7 [95].

Fig. (6) A. Stem cell centrifugation, B. Stem cell extraction before injection, and C. Stem cell injection into the injured region using ultrasound guidance [96].

Stem benefits of stem cell treatment include the fact that it can be derived from the patient's own cells, which eliminates the risk of immune system rejection, Has less ethical concerns, is already fairly specialized (induction could be easier), and can be taken [97].

The problem is that adult stem cells are hard to come by in big enough numbers, they don't survive in culture for nearly as long as embryonic stem cells do, and they can only develop into cells that are similar to their original tissue, despite the fact that they may be pliable [98].

Treatment of plantar fasciopathy with hyaluronic acid injections: A conservative alternative for treating plantar fasciopathy is the injection of high-molecular-weight HA, which is both efficacious and safe. Patients with plantar fasciopathy reported less discomfort and an increase in their ability to do everyday activities after receiving this therapy [99].

3. Conclusions

PF does a lot of work and is a typical repetitive strain injury in sports and the workplace. After conservative therapy and steroid injection have failed, patients with persistent planter fasciitis are suggested to get PRP injections. Both the thickness of the planter fascia and the level of discomfort were significantly reduced. The follow-up did not reveal any complications. One helpful non-invasive method for diagnosing plantar fasciitis is sonography. On sonography, PF is identified by thickened fascia and hypoechoic fascia.

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