CHAPTER **14**

PREVENTION OF POSTOPERATIVE COMPLICATIONS FOLLOWING PLANTAR FASCIOTOMY

Donald Green, DPM
Shannon Connolly, MSIV
Ryan Tingle, DPM

INTRODUCTION

Plantar fasciitis is generally well treated with conservative measures. The use of nonsteroidal antiinflammatory medication, steroid/anesthetic injections, daily stretching and icing, physical therapy, heel cups, changes in shoe gear, strapings, orthoses, night splints, and even occasional cast immobilization regimens are effective in relieving symptoms in most patients.[1-12] Probably less than 5-10% of patients will require surgical intervention.[13-19]

Surgical treatment of plantar fasciitis, for those few patients that are not fully responsive to conservative treatment, is also very effective. Good results are routinely reported in the literature.[1,2,13-15,17,20-24] Although studies on these surgeries report relief of pain and high patient satisfaction rates, they also report a large number of postoperative complications. A significant number are temporary but a few are long term complications.

This article will present a review of the literature on postoperative complications associated with surgical correction of plantar fasciitis. Methods of prevention of these complications that were extrapolated from the literature and from personal experience of the senior author will also be discussed.

DISCUSSION

Fasciotomy complications fall into four broad categories. One category, usually creating temporary complications, includes problems that result from instability that is created with a fascial release. A second category includes complications that are specific to the fasciotomy procedures. The third category involves complications that could occur with any surgery. Finally, the ultimate complication is the failure of the procedure to resolve the problems.

Yu has done extensive study of the plantar fasciitis utilizing MRI. He indicates that in acute plantar fasciitis, there is marked thickening of the enthesis of the plantar fascia and surrounding high signal intensity on T2-weighted images within and around the fascia.(Figure 1) In more chronic plantar fasciitis this is also true but to a lesser degree.[25] Following release of the fascia, no edema was evident in the fascia or peri fascia structures of patients that were asymptomatic at two years postoperative. There was thickening at the fasciotomy site but reduction of thickness at the enthesis.[26,27]

INSTABILITY-DERIVED COMPLICATIONS

Instability-derived complications occur because the fascial release temporarily destroys one of the structures that supports the midfoot and allows greater movement of the tarsal joints. This can lead to medial arch fatigue and cramping, dorsal foot pain, and lesser tarsal strain. Additional overuse strain can fall on the forefoot leading to metatarsalgia or stress fractures.[2,5,13,15,17,20-23,28-37] (Figure 2) Fortunately these symptoms are usually temporary in nature and resolve in 1-12 (average three months).[2,4,13-15,21,28,30,32,34,38-40]

Figure 1. Perifascial edema is seen at the insertional area of the calcaneus in this patient with acute plantar fasciitis

Figure 2 (Left). An early stress fracture of the third metatarsal. (Right). Three weeks later showing callus of healing.

Figure 3. The plantar fascia has three parts. The medial band is thin and primarily covers the abductor hallucis muscle belly. The central band is the largest portion and primarily inserts into the medial calcaneal tuber. The lateral band primarily covers the abductor digiti minimi and inserts into the lateral calcaneal tuber.

Lateral arch instability can lead to cuboid syndrome or calcaneal cuboid strain, sinus tarsitis, and possibly sural neuritis. Pain in the lateral midfoot is one of the most common postoperative complications following plantar fasciotomy.[13,17,20,30,32-34] These symptoms are caused by the hypermobility of the lateral column. Under these conditions, the cuboid rotates in a plantar-lateral direction upon weightbearing.[30] This places strain on the calcaneocuboid joint capsule, the long and short plantar ligaments, and the peroneus longus tendon. Daly found biomechanical differences in the shear forces and progression of central peak pressure during gait in patients who had undergone fasciotomy compared to a control group.[28]

Two cases of painful os peroneum have been reported as postoperative complications of plantar fasciotomy.[30] The increased hypermobility of the medial column could explain the additional strain on the peroneus longus tendon leading to the symptoms. Also if the cuboid were deviating plantar-laterally in these patients, it could press against the os peroneum and inflame this accessory bone.

A case of a painful cuboid cyst has also been noted after fasciotomy.[30,33] The cuboid may have been deviating plantarly, accepting more ground reactive force. The increased pressure would have weakened subchondral bone and/or allowed synovium or other fluid to enter through a small defect in the cartilage, resulting in this cyst.

In a study of fasciotomies performed with a minimal incision technique, Benton-Weil reported that 1/57 patients developed peroneal tendonitis.[17] Barrett reported 3/652 patients that underwent endoscopic fasciotomy to have a peroneal tenosynovitis. These problems were also most likely due to aggravation of the peroneal tendon in the area where it contacts the cuboid.[23] Brekke and Green[13] and Barrett and Day[23] both found cases of sinus tarsi pain following fasciotomy. These complaints may have been due to the increased motion allowing repetitive micro trauma to inflame the subtalar joint.

Metatarsalgia and metatarsal stress fracture are other postoperative complications caused by altered biomechanics and instability.[22,29] in Stones' study of endoscopic plantar fasciotomy with release of only the medial half of the fascia it was found that the most common complaint postoperatively was pain in the ball of the foot.[20] Other presenting symptoms include burning and numbness.[30,32,33,36] The increased forefoot loading that occurs with fasciotomy is believed to be the cause of these symptoms.[26] Brekke and Green reported one patient who fractured her third metatarsal after fasciotomy while walking in a postoperative shoe.[13] (Figure 3) Sammarco[31] also reported a patient with a fracture of the metaphyseal area of the third metatarsal after endoscopic fasciotomy. In these cases, it is likely that hypermobility of the lateral column rendered it less effective at accepting

ground reactive forces. This would cause a transfer of pressure to the third metatarsal.

Dorsal midfoot pain is also a common complaint after fasciotomy that is believed to result from instability.[2,13,15,32,34,35] The inability of the calcaneocuboid joint to lock after fasciotomy can contribute to jamming and instability across the dorsal midfoot. Loss of the fascial support allows jamming of the tarsal bones and increased vertical forces.

Woeffler, in a study on instep plantar fasciotomy involving release of the central band of fascia, reported 1/30 patients to have dorsal pain after extended activity.[35] Brekke and Green found dorsal pain to occur with a minimal incision technique where only fibers attached to the medial tubercle were cut.[13] The activity-induced pain and the pain with resection of only the most medial fiber suggests that even minor increases in instability of the midfoot can be problematic. Of course, the more complete the release, the more instability would be expected.

Sharkey et al found significantly increased peak pressure under the metatarsal heads with sectioning of the medial one-half of the plantar fascia, and an additional strain and bending of the second metatarsal with total release of the fascia.[24] Donahue studied the strains that cause metatarsal stress fractures and found that total release of the plantar fascia placed a significantly greater strain on the second metatarsal than did muscle fatigue. The mean peak strain on the second metatarsal in feet that had a release of the fascia was twice that of the mean peak strain caused by normal walking conditions.[11]

Cramping in the arch,[32] and intrinsic myositis,[33] may also present as postoperative complications of plantar fasciotomy. The intrinsic musculature may attempt to stabilize the midfoot and reproduce the arch. In doing so, the muscles become overworked and inflamed. Arch strain and pain has been frequently reported and may be due to increased demand on the portion of fascia that remains attached at its origin.[20,22,23,32]

Greater motion of the tarsal joints following plantar fasciotomy is evidenced by documented changes in arch height and tarsal joint rotation. The dependency of foot structure and arch height on the integrity of the plantar fascia has been extensively studied in both cadaver models and in clinical research.[3,21,28,35,42] The amount of decrease in arch height can vary from very minimal change to a radiographically and clinically significant observable flattening.

Thorardson sequentially sectioned the fascia in one-quarter increments from medial to lateral to determine if a greater sectioning would cause greater loss of arch height. A consistent decrease in arch height with each successive cut into the fascia was seen.[42] One cadaver study by Sharkey showed moderate decrease in the arch with partial sectioning, and a total collapse of the arch with total release.[24] These dramatic results are not usually seen clinically. Although a total loss of fascial support may produce more instability in the immediate postoperative period than a partial sectioning does, it would be very unusual for this procedure to cause total collapse as was suggested in this cadaver study.

Daly, using roentologic evaluation of longitudinal arch height in a study of 13 feet, demonstrated a significant 4 mm decrease with fasciotomy.[28] Although clinically no significant collapse was noted, the patients did exhibit a persistent abnormal gait to some extent. Brekke and Green showed an average of 4 degrees of reduction in the calcaneal inclination angle postoperatively in 44 patients.[13] Woelffer noted flattening of the arch in five of thirty patients who underwent a partial release of the fascia.[35] Several other studies on the various techniques of plantar fasciotomy have also demonstrated loss of arch height or exacerbation of flatfoot deformity.[14,30]

The partial instability seen after fasciotomy is translated into various kinds of foot pain when the tarsal bone movement puts abnormal strain on periarticular structures. The instability-derived complications are usually temporary. The process of healing from fasciotomy involves fibrosis and the arch regains some stability as this fibrotic remodeling occurs. As the instability subsides, so do most of the associated painful symptoms.

TREATMENT

Three major interventions can reduce the incidence of these instability-derived complications. Release of only the medial portion of the fascia rather than total release of the fascia, use of a well molded short leg walking cast for two weeks postoperatively, and the use of functional orthoses seem to help significantly decrease the symptoms of instability and allow their resolution at a faster rate.

The medial release seems to be adequate to resolve the symptoms while maintaining some stability to the lateral column. This is supported by the cadaver studies above as well as clinical experience.[14,21,28,41] Barrett and Stone in separate studies reported reduced complication rates when they switched procedures from total fasciotomy to a partial release only.[20,25,30,34] Most of the literature supports the theory that medial release produces less lateral and central midfoot symptoms than does a total release. A review of the recent literature on plantar fasciotomy shows a predominance of procedures where only the medial portion of the fascia is cut, and very few total releases. Surgeon preference for preserving the lateral band of fascia is evident.[1,6,14,15,20,22,25,28,30,34,42]

Barrett reported a great reduction in postoperative lateral midfoot pain by releasing only the medial two-thirds instead of doing a total release.[25] Stone and Davies, in a retrospective study of 40 patients that underwent a full fascial release, reported every patient to have at least 1 postoperative complication.[30] The authors modified their procedure to leave at least 50% of the lateral fascia intact. In a second study they found a noticeable decrease in the percentage of patients who complained of heel pain, lateral midfoot pain, arch strain, and fatigue and stiffness.[20] There was a significant increase in patient satisfaction as noted by the number of patients that would recommend the surgery to others as well as have the surgery again. Their modifications also included performing the release from a central position going medially, postoperatively putting patients in a weight bearing cast for 4-6 weeks, and using prophylactic antibiotics postoperatively. The authors felt that this reduction of symptoms with change in procedure was significantly enhanced by the use of the weight bearing cast postoperatively. Both of these changes seemed to reduce the strain in the arch that occurs with the total loss of the plantar fascia.

Zimmerman compared patients who were non-weightbearing with crutches, patients who were full-weightbearing after surgery, and patients who were put into a short leg walking cast for two weeks after surgery.[36] (Figure 4) He found that patients who used a weightbearing cast achieved 80% pain reduction and return to normal activity sooner than the other two groups. A weightbearing cast might allow the right amount of immobilization and weight bearing to achieve successful surgical healing and resolution of the fasciitis. Its routine use then, might also prevent postoperative pain. Consequently, the 4-6 weeks of postoperative weight bearing casting recommended by Stone[9] may actually be shortened to 2-4 weeks.

Figure 4. A well-molded walking cast is used for two or more weeks postoperatively.

The instability of the midfoot that causes altered biomechanics and postoperative pain, can be treated with orthotic use once the patient returns to shoe wear. The orthotics will ideally control motion at the midfoot and reduce the strain that is put on periarticular soft tissue structures when the tarsal bones shift excessively. Orthotic use has been been advocated by Perelman.[2] Brekke and Green recommended orthoses for the patients whose symptoms had not resolved due to requirements of prolonged weight bearing.[13] The orthotic should control motion, thereby reducing the pain associated with excessive motion of the tarsal joints. Use orthoses postoperatively once the patient returns to normal shoe gear to help neutralize the increase in peak pressures and peak strains in the forefoot noted by Sharkey and Donohue.[21,41] Of course, a functional orthosis will also help to neutralize the forces that originally caused the strain to the plantar fascia. These preventative methods all address the hypermobility etiology of this first category of complications.

COMPLICATIONS RELATED TO SPECIFIC TECHNIQUES

Complications that are more related to the specific techniques of the surgery make up the second category. This category includes some complications that could occur with any surgery but may be more significant or somewhat more common with the specific fasciotomy techniques. Some may be more common with one or another of the surgical approaches.

SURGICAL TECHNIQUES

Surgical techniques to treat plantar fasciitis have evolved and improved over the years since their first appearance in the literature in the early 1900s. Currently, surgical treatment is usually provided by one of four types of procedures: the endoscopic plantar fasciotomy, the minimal incision fasciotomy, the in-step fasciotomy, and the open procedure for plantar fasciotomy.

Endoscopic plantar fasciotomy involves the use of either general anesthesia with a thigh tourniquet or intravenous sedation and local anesthesia with an ankle tourniquet. A 0.5 cm incision is made 1-1.5 cm distal to the fascial insertion on the medial calcaneal tubercle. Preoperative radiographs are sometimes used to help the surgeon find and accurately mark this location on the skin. The incision can be made either in line with the calcaneal inclination angle or vertically. Blunt dissection through the subcutaneous tissues to the medial margin of the plantar fascia is then performed. An endoscopic trocar and cannula are inserted into this incision and advanced laterally. A 0.5 cm incision is made on the lateral heel over the area where the cannula contacts the lateral cutaneous tissue. The cannula is then advanced through this incision. The trocar is removed and an endoscopic camera is inserted medially. The fascia is visualized dorsally through the slot in the cannula. A blade is inserted laterally, and used to sever the fascia. The wound is irrigated with saline and closed primarily.[13,15,20,22,23,30,34]

The minimal incision procedure may be performed under local anesthesia (usually with epinephrine) with or without intravenous sedation. A 5 to 10 mm incision is made plantarly over the distal aspect of the medial calcaneal tubercle. The incision is often transverse but may be vertical. Blunt dissection through the subcutaneous fat and fascia is performed with a hemostat. For orientation, the medial and lateral margins of the central band of the plantar fascia are palpated with the hemostat to identify the insertion at the medial calcaneal tubercle. The medial digits are held in dorsiflexion, and a #64 or #67 blade is used to sever the medial fibers of the fascia. The wound is closed primarily with one or two sutures.[13,21]

The in-step plantar fasciotomy may be performed under local anesthesia with or without intravenous sedation. A transverse incision is made in the plantar medial arch approximately 2.0 cm in length. This is usually located approximately 1.5 cm anterior to the calcaneal fat pad (This can vary depending on the surgeon). This area is relatively superficial and with minimal blunt dissection the central band of the fascia can be easily isolated. The plantar fascia is incised sectioning the tight medial aspect of the fascia. Some surgeons will resect a small portion of the fascia. Palpation will reveal successful release of the medial fibers. Closure of the skin is done superficially including the skin and subcutaneous layer as a unit.[2,32,35,43]

The open procedures are usually performed under intravenous sedation with local anesthesia but sometimes are done under general anesthesia with tourniquet control for hemostasis. A variety of incisions are used. A 3cm oblique incision over the medial heel, a 1.5 to 2.0 cm transverse incision over the plantar medial arch that is 1.5 cm anterior to the fat pad of the heel, a 1.5 X 0.5 cm transverse L incision over the posterior aspect of the medial longitudinal arch, and a 4 to 8 cm incision on the medial heel and arch are the more common approaches. Blunt dissection through the subcutaneous fat to the plantar fascia is then performed. The fascia is visualized and severed. The wound is irrigated and closed in layers.[4,13,38]

All of these procedures are effective. A study by Brekke and Green comparing three of the four approaches showed that the open procedure produced the highest patient satisfaction rates, the minimal incision procedure produced the greatest reduction of pain, and the endoscopic procedure produced a quicker return to preoperative activities.[13] Tomczak compared endoscopic and open procedures and found that the endoscopic fasciotomy returned patient to work an average of 55 days sooner than the open fasciotomy.[4] The in-step plantar fasciotomies have also proven effective.[2,32,35,43]

TECHNIQUE COMPLICATIONS

Three main areas of complications are related to the techniques of the surgery. Painful scarring can be associated with the in-step or the open techniques. Neuritis can be associated with the open or the endoscopic techniques. Acute fractures of the calcaneus can be associated with resecting the horizontal heel spur that is most commonly done in the open technique.

Painful scarring at the incision sites is a potential problem with any surgery. Although not a major complication following fasciotomy, scarring does occasionally become a postoperative problem.[2,13,35] Incision placement for optimal visualization versus incision placement for minimal scarring, have been discussed in relation to plantar fasciotomy. An incision placed in the instep is often a preferred approach to fasciotomy because it provides better access to the fascia, which is easily palpated and identified at this level.[32,44] Brown has advocated a transverse plantar incision because it parallels branches of the medial calcaneal nerve. He reported good results with this approach, with no heel pad symptoms or numbness after surgery.

However, because of the predominance of fibrous tissue and scarcity of subcutaneous fat at the medial instep, this incision is more likely to cause fibrosis and adhesions than a more proximal incision into part of the fat pad. In a study by Woefler where a transverse plantar incision was made 1.5cm distal to the anterior fat pad, 3/30 patients reported painful scars.[35] Perelman used an L incision over the posterior medial aspect of the longitudinal arch and documented 6/41patients with a painful, palpable area of tissue at this site.[2] Fishco reported that the largest complication (9.6%) in his review of 94 instep fasciotomies was a painful scar. The farther distally that the scar was placed in the arch, the higher incidence of pain was reported.[32] This was confirmed by Boberg et al in his study of instep plantar fasciotomies.[43] However many reports of plantar fasciotomy through a plantar approach have reported no incidence of painful scars.[43]

Even with the endoscopic plantar fasciotomies, portal scars can be painful. O'Malley et al reported 2/16 patients and 3/16 feet in their study had painful scars that were only locally symptomatic and did not radiate or have a Tinel's sign.[15] Medial heel incisions present the greatest risk of damage to sensory branches of the posterior tibial nerve that can lead to a painful scar.

Attempts to minimize prominent scarring can be made by placing the incision along the relaxed skin tension lines. Incisions that parallel these creases in the skin are under the least possible tension and will produce a finer scar. Haphazard collagen bundling is lessened, avoiding a soft tissue prominence that could send fibrous attachments to sensory nerves, or could become irritated with shoe wear. Painful scars can be treated with steroid impregnated occlusive dressings, steroid injections, hyaluronidase injections, and ultrasound to break up adhesions, Silicon sheathing over the wound has also proved effective in lessening hypertrophic scars. However the patients should be reassured that this is a complication that has usually been shown to resolve with time.[35] Woelffer documented that 11/41 patients who underwent an open procedure complained of painful scars at an average of 11.3 months of follow up.[35] From this same patient population, at five years follow up, only 3/30 patients still complained of a painful scar. Although attrition may account for fewer symptomatic patients at the 5-year follow up, the results suggest that scarring symptoms can heal over long periods of time. This was supported by the studies of O'Malley et al and Kinley et al.[5,15]

Neuritis is another postoperative complication of plantar fasciotomy.[5,13,15,20,30,32] This complication can present with pain, burning, and/or numbness. In open procedures with the long medial incision, the calcaneal sensory nerve branches can be entraped or sectioned. Kinley reported 3/66 patients with neuritis after endoscopic plantar fasciotomy.[5] One case was a sural neuritis and the other two cases involved injury to the medial plantar nerve. Damage to these nerves could have occurred from the endoscopic instruments in the lateral and medial portals, respectively.

Nerve damage can also present in the form of numbness. Numbness of the hallux, the endoscopic portals, the distal arch, and the lateral side of the foot may have occurred from injury to the medial plantar, medial calcaneal, lateral plantar, or sural nerves.[13,30,32] (Figure 5)

Prevention of complications that involve nerve injury, including neuritis, numbness, and painful scarring can be attempted with preoperative planning and minimal tissue handling intraoperatively. Placing incisions parallel to nerves

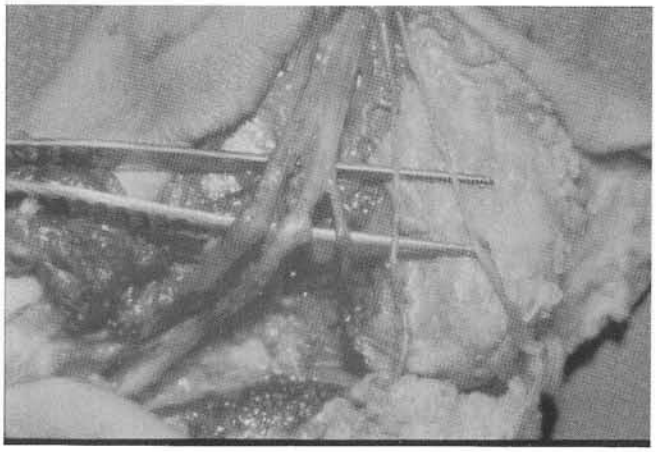

Figure 5. The nerve structure at the medial rearfoot show the medial and lateral plantar nerves with the first plantar nerve (Baxter's Nerve) coming off the lateral plantar nerve. There are several sensory calcaneal nerves seen on the medial side of the calcaneus.

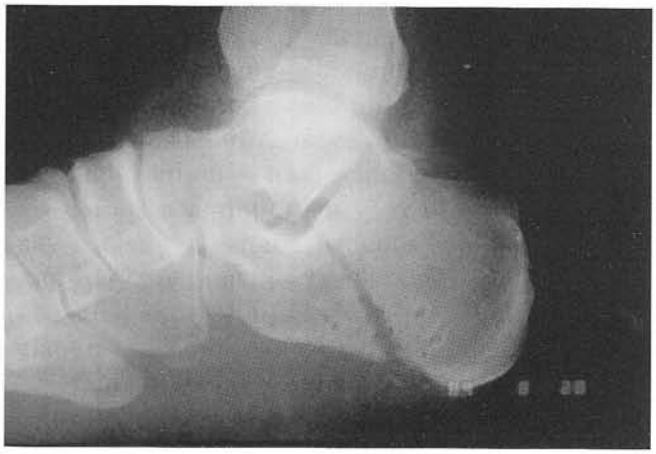

Figure 6. A stress riser can occur with aggressive spur removal with an osteotome or with transcortical drilling. With weight bearing this can lead to an acute fracture.

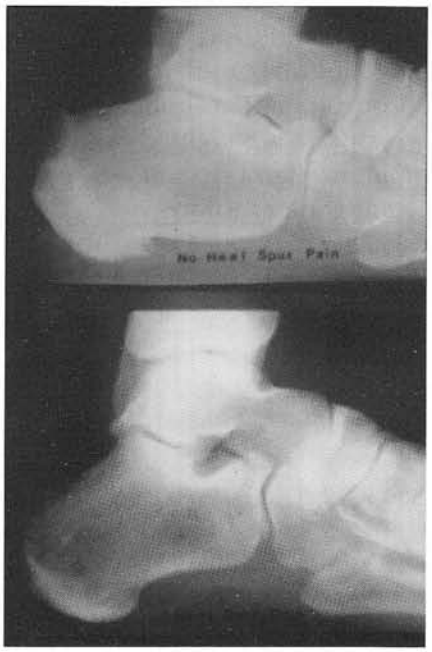

Figure 7 (Top). This patient with a large spur is asymptomatic. (Bottom). This patient has the plantar fasciitis symptoms but has not developed a plantar spur.

in the area will reduce accidental sectioning of these nerves and avoid a postoperative neuritic site. Minimal tissue handling will reduce iatrogenic nerve injury and reactive fibrosis that could produce painful adhesions. Numbness at endoscopic portals often resolves within a few weeks. Numbness in other areas is also usually a temporary phenomenon, suggesting a bruising of the nerves involved rather than a complete severance

Another complication that originates from intraoperative trauma is acute calcaneal fracture. The aggressive nature of heel spur resection with a mallet and osteotome can produce stress risers in the calcaneus. These can develop into a fracture as the patient bears weight postoperatively.(Figure 6) There is some controversy in the literature as to the role that the calcaneal spur plays in the symptomatology of plantar fascitis. Many authors feel that the spur should not be removed in most instances.

Sammarco felt that the heel spur was not the cause of the symptoms in plantar fasciitis.[14] He felt that entrapment of the first branch of the lateral plantar nerve played a much larger role in the symptoms. Lapidus, in his study involving 323 patients concluded that the spur was related to the

aging process and was not a factor in developing pain in the heel.[9]

Barrett found that 21% of 200 cadaver feet had heel spur.[33] Because this percentage is much greater than the percentage of the general population with heel spur/plantar fasciitis, it can be inferred that the heel spurs themselves are not painful. Rubin noted 125/461 of his patients had heel spurs (21 %). Only 10% 0f these patients had symptoms.[45] Shama demonstrated 132/1000 patients had calcaneal spurs. Only 39% of these patients with a spur had painful symptoms.[46] Tanz in his study of 100 radiograghs found that 16% of the patients had painless spurs.[47]

Many times in our practices when taking x-rays for other reasons, an asymptomatic large heel spur can be reported. Sometimes, a foot with clinical plantar fasciitis, has not yet developed the plantar spur.(Figure 7) O'Malley reported that 12/19 patients with painful plantar fasciitis had no spur present.[15] He did not resect the spurs that were present and he found no corrolation to the heel spurs presence or absence with the results. In fact many studies have demonstrated good results without resecting the spur.[2,5,13-15,17,20-23,30,32,34,35]

A few studies were undertaken to resect the spurs without doing a plantar fasciotomy. It must have been difficult to remove the spur without cutting some of the fascia to get exposure to the spur. Steindler Duvries reported only 7/16 patients had good results with this technique.[48] Anderson reported 11/72 patients had either fair or poor results with this technique.[1] He also reported that in his literature search that he found five studies (Ali, McBryde, Snider, Tanz, and Ward and Clippinger) that when combined reported that 61/63 patients had good results with fasciotomy only. On the other hand Schepsis,[6] Foreman and Green,[70] and McCarthy and Gorecki,[49] demonstrated in their studies that the spur is located not in the plantar fascia but superior to it in the insertional area of the flexor digitorum brevis muscle.

Furthermore, when conservative treatment of plantar fasciitis is successful 90-95% of the time, the heel spur does not go away. Lapidus and others concluded that heel spurs are a normal part of the aging process and are not painful.[9] The heel spur generally does not need to be removed since it generally does not contribute to fascial pain.[21,50,51]

NEW AND UNPROVEN TECHNIQUES

Extracorporeal shock wave therapy is a new treatment of plantar fasciitis. Literature documenting its efficacy and safety is scarce. The device is composed of a spark plug that is housed in a water-filled plastic dome. Electrical charges are sent down the electrode, causing a shockwave. This is applied to the heel to create local injury in the area of plantar fascia insertion. Unlike the previously discussed procedures, sectioning of the fascia is not involved. The local injury encourages vascular ingrowth. This increased vascularity brings with it a greater capacity for healing and fibrosis. Contraindications to this procedure include anticoagulated patients, patients with a bleeding disorder, children, pregnant women, and patients with osteoporosis. Side effects include erythema, bruising, numbness, tingling, and a tear in the fascia.[52,53]

Another new treatment is laser resection of the heel spur. This method uses infrared radiation to resect the spur. Advantages of this procedure are reported as an earlier return to work, coagulation, and disintegration of tissue.[54]

GENERAL SURGICAL COMPLICATIONS

Other postoperative complications such as infection or wound dehissence, deep vein thrombosis, or phlebitis can occur with any surgery.[14] Current studies on the surgical treatment of plantar fasciitis report infrequent occurrences of infection. These infections usually are superficial and respond quickly to antibiotics. Consequently, this has not been a major concern.[20,30,32,34] Deep infection is always a concern. These can be very significant and hard to eradicate.[30] These may require multiple debridements, drains and even antibiotic beads (Figure 8). Fortunately, in the absence of deep hematomas, this is a rare occurrence. Some surgeons attempt to reduce the possibility of infection with the routine use of prophylactic antibiotics and drains. Good surgical techniques and avoiding power equipment that may burn bone deep in the wound seems to be as effective as prophylactic antibiotics without increasing the risk of creating an environment for super infection. Drains are an excellent idea if a possibility of significant hematoma exists.

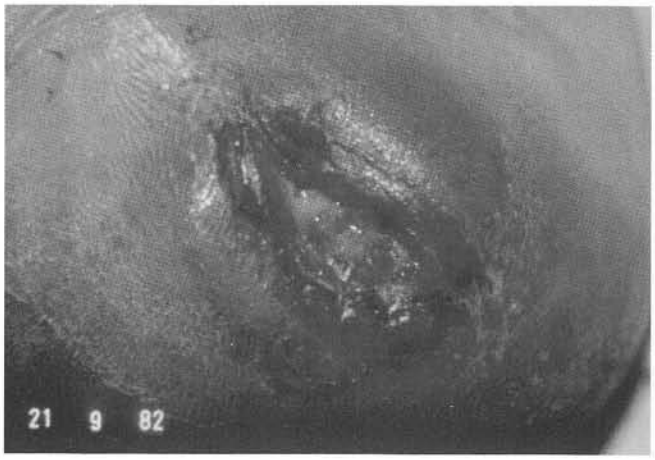

Figure 8A. Deep infection following open fasciotomy, medial aspect of the right heel.

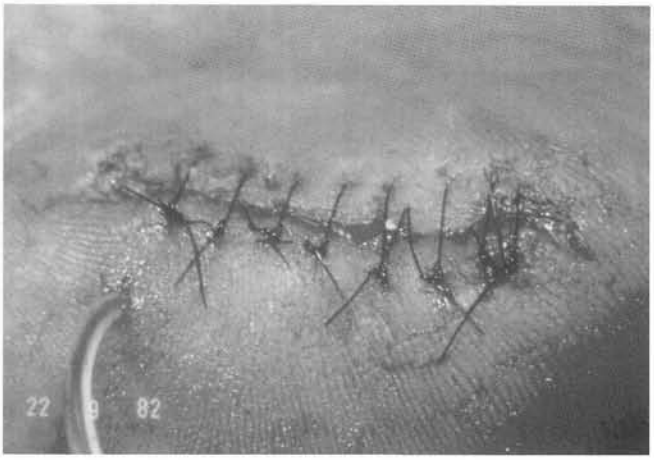

Figure 8B. Following multiple debridements and primary closure over a drain.

Sammarco reported 2 cases of post operative infection in his study. He also reported one case of deep vein thrombosis and one case of thrombophlebits.[14] Two separate cases of pseudoaneurysm as a postoperative complication of fasciotomy have been documented.[55,56] One case involved an open technique where injury to the posterior tibial vessels caused an arteriovenous fistula. The other case involved endoscopic plantar fasciotomy. This aneurysm was covered by a fibrous capsule, which indicates that the aneurysm was traumatically induced.

CHRONIC RECALCITRANT HEEL PAIN POST FASCIOTOMY

Chronic recalcitrant heel pain after fasciotomy is an infrequent but significant problem.[22,34] One retrospective study of patients who had undergone endoscopic plantar fasciotomy by Stone and McClure found 2/25 patients (8%), to have continued heel pain.[20] Barrett and Day in another retrospective study of endoscopic plantar fasciotomy found residual heel pain in 19/652 patients.[23] The protocol for both of these endoscopic studies involved sectioning only the medial band of the fascia. Perlman documented two cases of residual heel pain in association with an open fasciotomy.[2] Most studies have a small percentage of recalcitrant heel pain patients.[2,4,5,13,15,17,20,22,23,30,33,34,39] Residual chronic plantar fasciitis must be ruled in or out.

Yu studied postoperative fasciotomy patients with MRI. Some of these patients were asymptomatic and others had recalcitrant heel pain. Those that had radiograghic findings consistent with residual plantar fasciitis had clinical symptoms that corresponded to chronic fasciitis as well. (Figure 1) However, there were a significant number of patients that did not have MRI findings consistent with plantar fasciitis.[25,26]

Other possible causes of continued heel pain after fasciotomy include systemic disease, entrapment of the first branch of the lateral plantar nerve, prominent plantar protrusion, and acute complete plantar fascial rupture.[14,16,26,31,57-61] MRI may prove helpful in these difficult cases when it is hard to clinically determine the etiology.

Systemic Disease

Systyemic diseases that can cause heel pain include systemic lupus erythematosis (SLE), rheumatoid arthritis (RA), anklosing spondoylotis, reiters disease, gout, pseudogout, psoriatric arthritis, gonorrhea, inflammatory bowel disease, and a hidden focus of infection.[4,60,61] Lundeen reported that one of his two patients that had no relief from plantar fasciotomy later was diagnosed with rheumatoid arthritis.[22]

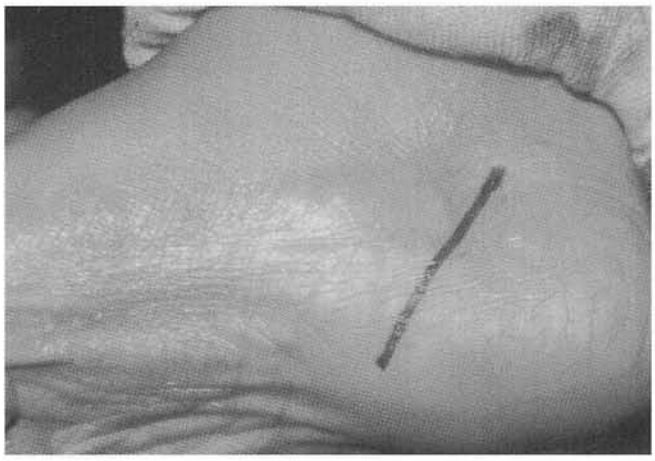

Figure 9A. The incision for the release of the fascia over Baxter's nerve runs from posterior superior to inferior distal over the route of the nerve.

Figure 9B. The abductor hallusis is reflecteded plantarly and deep fascia underneath it is incised over the first branch of the lateral plantar nerve.

Baxter's Nerve

Entrapment of the first branch of the lateral plantar nerve, commonly referred to as Baxter's nerve, can occur in two places. It could get pinched as it exits the deep intermuscular fascia just lateral to the abductor hallucis muscle and makes a 90 degree lateral turn, or as it runs between the plantar fascia and calcaneus. Entrapment of this nerve can be differentiated from plantar fascial pain. The nerve pain occurs with medial compression. This pain radiates laterally in the direction of the nerve. No induration of the plantar surface is felt. No reduction of symptoms occurs with conservative treatment for plantar fasciitis. Because this nerve is motor/sensory and supplies the abductor digiti minimi, paralysis of this muscle may also be seen. Treatment for this condition usually requires surgical release of the facia overlying the nerve.[16,47,59,62,63] (Figure 9) Sammarco as a routine part of his surgery for plantar fasciiitis, released the fascia over Baxters nerve as well as releasing the plantar fascia.[14]

Prominent Plantar Protrusion

Malay has described the prominent plantar protrusion (PPP) as an osseous protrusion on the calcaneus, seen on lateral x-ray.(Figure 10A) This also may have a cartilagenous component which would not be appreciable radiographically.[57,58] Malay reported that in a study of 419 patients, 6.2% had a prominent plantar protrusion. Eleven of these patients did not respond well to conservative treatment consisting of heel padding. All eleven of these patients required surgical removal of this protrusion. The procedure involves a plantar longitudinal incision, resection of the spur, remodeling of the plantar surface of the calcaneus, followed by 3 weeks of non-weight-bearing.[58] (Figure 10B)

TREATMENT OF CHRONIC POSTOPERATIVE RECALCITRANT PLANTAR FASCIITIS

Transcortical drilling for vascular engorgement was described by Hassab and El-Shariff in the 1970s.[64] It has not passed the test of time and may only be setting up stress risers that may lead to acute calcaneal fractures.(Figure 11)

Internal fixation for stress fractures was tried in the past. Because of the MRI findings of fluid in the fascial insertional area in the calcaneus and the clinical tenderness of the heel, some clinicians felt that the calcaneus had a stress fracture. Internal fixation across the calcaneal tuber was tried as a means to relieve the pain. However, this technique has not passed the test of time.[65](Figure 12)

Weight loss has also been cited as an important part of treatment of plantar fasciitis. This is true

Figure 10A. The Prominent Plantar Protrusion (PPP) is an unusual prominence of the plantar surface of the calcaneus that can lead to weight bearing pain.

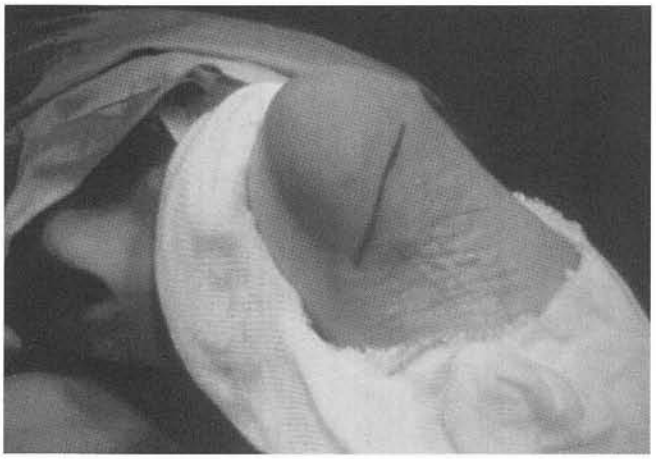

Figure 10B. A typical incision for resection of the PPP

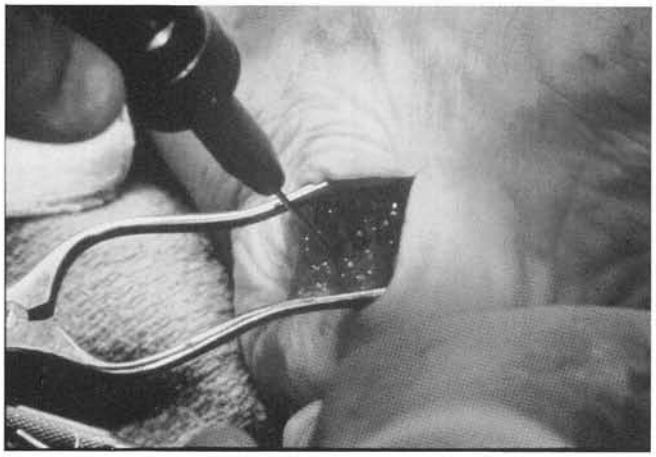

Figure 11. Transcortical drilling (creating holes in the cortex) of the medial calcaneus.

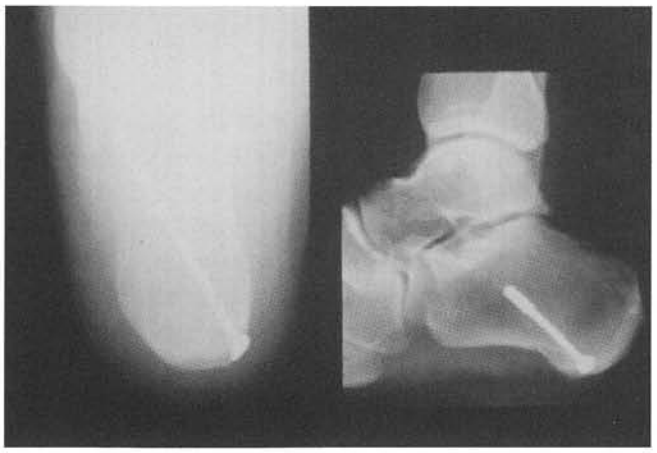

Figure 12. 4.0 Cancellous screw was placed across the "stress fracture."

not only in the post surgical patients but is also true in the conservatively treated patients. It is well known that the largest population with plantar fasciitis is the heavy, active, older than forty female group.[9,10,12,13,16,47,63] Quinn demonstrated an average of 26-29 pound increase in weight of both men and women who were treated less successfully by conservative care than those more successfully treated.[66] (Figure 13A) Weight loss could improve postsurgical results by reducing the strain on the joints of the midfoot. It is likely that a reduction in body weight would also reduce the movement of the tarsal joints, which is responsible for much of the biomechanically induced symptoms. Weight loss and reduction of the amount of time spent doing weight-bearing activities can lessen symptoms.(Figure 13B)

Ultimately a life style and possibly a job change may be necessary to eliminate or control the symptoms. Prolonged standing and exercise may need to be significantly curtailed. Twelve-hour working days may need to be dropped to 8-hour days. Rest periods off your feet may be necessary throughout the day. Standing jobs may need to be changed to more sedentary jobs.

CONCLUSIONS

An overview of postoperative complications associated with plantar fasciotomy is presented. These complications can be grouped into four categories: those that are instability-derived; those that are associated with the specific surgical techniques; those that can occur in any surgical procedure; and those that fail to relieve the symptoms.

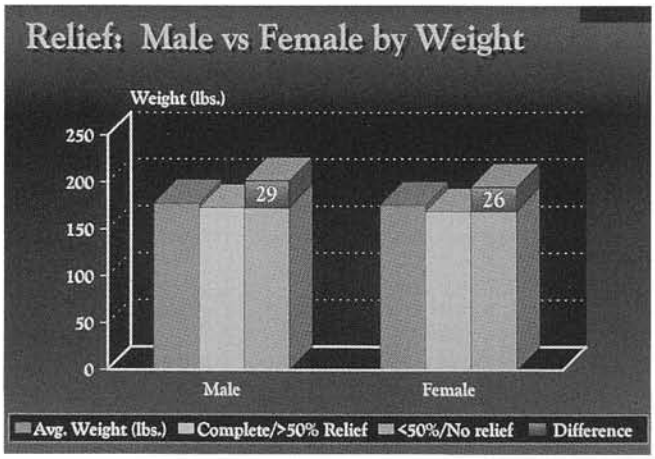

Figure 13A. Men and women that were improved by more than 50% averaged 29 lbs and 26lbs less respectively than those that did not improve that much in Quinn's study.

Figure 13B. Weight reduction of more than 25lbs can help to control the symptoms of plantar fasciitis.

An emphasis is placed on the instability-derived complications as their etiology can be addressed directly. Only partial medial release of the central band of the plantar fascia is recommended. Utilization of a well molded walking cast for two weeks or more postoperatively followed by a functional orthosis is also recommended.

For specific techniques, it is suggested that incisions in the medial arch be small and no more distal than 1.5–2.0 cm from the calcaneal fat pad. Furthermore care should be taken to avoid trauma to the nerves in the area during surgery. It is not recommended to remove the calcaneal spur except in very special circumstances.

In general, good surgical technique is advised due to the deep nature of the wound. This should avoid the need for prophylatic antibiotics in the normal healthy individual. Drains may be necessary if the potential for significant hematoma is expected. Power instruments that might burn bone should be avoided. Thus, a great potential for reducing the incidence of these complications exist.

Finally, a good differential diagnosis needs to be established preoperatively and reestablished post operatively in the recalcitrant heel pain patients. Transcortical drilling and internal fixation for a stress fracture should be avoided as these have not proven to be effective in resolving symptoms.

Significant loss of weight (> 25 lbs.) and life style and job changes to decrease weight bearing activities may ultimately be necessary to decrease the strain on the foot structures in those chronic recalcitrant plantar fasciitis patients.

REFERENCES

1. Anderson RB,Foster MD. Operative treatment of calcaneal pain. *Foot Ankle* 1989;9:317-23.
2. Perelman GK, Figura MA, et al. The medial instep plantar fasciotomy. *J Foot Ankle Surgery* 1995;34:447-57.
3. Kitaoka Hb, Luo ZP, et al. Mechanical behavior of the foot and ankle after plantar fascia release in the unstable foot. *Foot Ankle Int* 1998;18:8-15.
4. Tomczak RL, Haverstock BD. A retrospective comparison of endoscopic plantar fasciotomy to open plantar fasciotomy with heel spur resection for chronic plantar fasciitis/heel spur syndrome. *J Foot Ankle Surg* 1995;34:305-11.
5. Kinley S, Frascone S, et al. Endoscopic plantar fasciotomy versus traditional heel surgery: a prospective study. *JFAS* 1993;32:595-603.
6. SchepsisAH,LeachRE,CorzycaJ: Plantar fasciitis etiology, treatment, surgical results, and review of the literature, *Clin. Ortho.* 266: 185-196, 1991
7. PowellM,PostW,KeenerJ,Wearden S. Effective treatment of chronic plantar fasciitis with dorsiflexion night splints: a crossover, prospective, randomized trial: *Foot Ankle Int.* 19: 10-18, 1998
8. Tisdale C, Harper M.Chronic heel pain: treatment with a short leg cast, *Foot and Ankle Int.* 1996;17:41-2.
9. Lapidus PW,Guidotti FP. Painful heels: report of 323 patients with 364 painful heels. *Clin Orthop* 1987;39:178-69.
10. Lapidus PW,GuidottiFP. Painful heel: report of 323 patients with 364 painful heels, *Clin Ortho* 1987;39:178-89.
11. Scherer P,et al. Heel spur syndrome: pathomechanics and non surgical treatment, *JAPMA* 1991;81:68-72.
12. Karr SD. Subcalcaneal Heel Pain. *Ortho Clin.North* Amer.25:161-175,1994
13. O'Brien D,Martin WJ. A retrospective analysis of heel pain. *JAPMA:* 1983;75:416-8.
14. Brekke MK, Green DG. Retrospective analysis of minimal-incision, endoscopic, and open procedures for heel sppur syndrome.

J Am Podiatry Med Assoc 1998;88:64-72.
15. Sammarco GJ. Surgical Treatment of Recalcitrant Plantar Fasciitis. *Foot Ankle Int.* 1996;17:520-6.
16. O'Malley MJ, Page A, et. al. Endoscopic plantar fasciotomy for chronic heel pain. *Foot Ankle Int* 2000;21:505-10.
17. BaxterDE,ThigpenSV. Heel pain:operative results. *Foot and Ankle,* 5:16-25,1984
18. Benton-Weil W, Borrelle AH, et. al. Percutaneous plantar fasciotomy: a minimally invasive procedure for recalcitrant plantar fasciitis. *J Foot Ankle Surg* 1998;37:269-72.
19. Gill LH, Kiebzak GA. Outcome of non surgical treatment for plantar fasciitis. *Foot and Ankle Int* 1996;17:527-32.
20. Wolgin M, Cook C, Graham C, Mauldin D. Conservative treatment of plantar heel pain: long term follow up. *Foot Ankle Int.* 15:97-102, 1994
21. Stone PA, McClure LP. Retrospective review of endoscopic plantar fasciotomy-1994through 1997. *J Am Podiatry Med Assoc* 1999;89:89-93.
22. White DL. Plantar fascial release. *J Am Podiatry Med Assoc* 1994;84:607-13.
23. Lundeen OL, Aziz S, et. al. Endoscopic plantar fasciotomy: a retrospective analysis of results in 53 patients. *J Foot Ankle Surg* 2000;39:208-17.
24. Barrett SL, Day AV, et.al. Endoscopic plantar fasciotomy: a multisurgeon prospective analysis of 652 cases. *J Foot Ankle Surg* 1995;34:400-6.
25. Sharkey NA, Ferris L, et al. Biomechanical consequences of plantar fascial release or rupture during gait: part i ñ disruptions in longitudinal arch conformation. *Foot Ankle Int* 1998;19:812-20.
26. Yu JS, Smith G et al. The Plantar Fasciotomy:MR Imaging Findings in Asymptomatic Volunteers, *Skeletal Radiol.* 28: 447-452, 1999
27. Yu JS, Spigos D, et al. Foot pain after a plantar fasciotomy: an mr analysis to determine potential causes. *J of Computer Assissted Tomography. Vol 23* #5:707-712.,1999
28. Yu JS, Pathologic and post operative conditions of the plantar fascia: Review of MR imaging appearances, *Skeletal Radiol,*29: 491-501, 2000
29. Daly PJ, Kitaoka HB, et al. Plantar Fasciotomy for Intractable Plantar Fasciitis: Clinical Results and Biomechanical Evaluation. *Foot Ankle Int* 1992:13:188-95.
30. Graves RH, Giacopelli J, et. al. Fluoroscopy-assisted plantar fasciotomy and calcaneal exostectomy: a retrospective study and comparison of surgical techniques. *J Foot Ankle Surg* 1994;33:475-81.
31. Stone PA, Davies JL. Retrospective review of endoscopic plantar fasciotomy-1992 through 1994. *J Am Podiatry Med Assoc* 1996;86:414-20.
32. Sammarco GJ, Idusuyi OB. Stress fracture of the base of the third metatarsal after an endoscopic plantar fasciotomy: a case report. *Foot Ankle Int* 1998;19:157-9.
33. Fishco WD, Goecker RM, et. al. The instep plantar fasciotomy for chronic plantar fasciitis. J Am Podiatry Med Assoc 2000;90:66-9.
34. Barrett SL, Day AV. Endoscopic heel anatomy: an analysis of 200 fresh frozen specimens. *JFAS* 1995;34:51-6.
35. Barrett SL, Day AV. Endoscopic plantar fasciotomy: two portal endoscopic surgical techniquesóclinical results of 65 procedures. *J Foot Ankle Surg* 1993; 32:248-56
36. Woelffer KE, Figura MA, et al. Five year follow-up results of instep plantar fasciotomy for chronic heel pain. *J Foot Ankle Surg* 2000;39:218-23.
37. Zimmerman BJ, Cardinal MD, et al. Comparison of the three types of postoperative management for endoscopic plantar fasciotomy. *J Am Podiatry Med Assoc* 2000;90:247-51.
38. Sharkey, NA, Donahue SW, et. al. biomechanical consequences of plantar fascial release or rupture during gait part ii: alterations in forefoot loading. *Foot Ankle Int* 1999;20:86-96.
39. LeachWG,SeaveyMS,SalterDR. Results of Surgery in Athletes with Plantar Fasciitis: *Foot Ankle,* 7: 156-161, 1986
40. WardWG,ClippingerFW. Proximal Medial Longitudinal Arch Incision for Plantar Fascial Release, *Foot Ankle,* 8: 152-155, 1987
41. Ward WG, Clippinger FW. Proximal medial longitudinalarch incision for plantar fascial release. *Foot Ankle* 8:152-155, 1987.
42. GormleyJ,KuwadaGT. Retrospective Analysis of Calcaneal Spur Removal and Complerte Fascial Release for the Treatment of Chronic Heel Pain. *J Foot Surg 31:* 166-169, 1992
43. Donahue SW, Sharkey NA, Strains in the metatarsals during the stance phase of gait: implications for stress fractures. *J Bone Joint Surg Am* 1999;81:1236-144.
44. Thorardson DB, Kumar PJ et al. Effect of partial versus complete plantar fasciotomy on the windlass mechanism. *Foot Ankle Int* 1997;18:16-20.
45. Boberg, J. In-step fasciotomy.
46. Brown JN, Roberts JS et. al. Plantar fascia release through a transverse plantar incision. *Foot and Ankle Int.* 1999. Jun;20(6):364-7.
47. RubinG,WhittenM: Plantar Calcaneal Spurs, *Am J Ortho.* 5: 38, 1963
48. ShamaSS,KominskySJ,LemontH: Prevalence of NonpainfulHeel Spurs and Its Relation to Postural Foot Position, *JAPMA,* 73: 122-123, 1983
49. TanzSS: Heel Pain, *Clin. Orthop. Rel.Res.* 28: 169-177. 1963
50. SteindlerA,SmithAK: Spurs of the Os Calcis, Surg. Gynecol obs, 66: 663-665, 1938
51. McCarthyDJ,GoreckiGE: The AnatomicBasis of Inferior calcaneal Lesion: Cryomicroanatomy Study, *JAPA,* 69: 527, 1979
52. BlakeRL,DentonJA,FergusonHB et al: Tl-61 vs Rohadur in Heel Spur Syndrome, *JAPMA* 81: 439, 1991
53. MitchellIR,MeyerC,KruegerWA: A Deep Fascia of the Foot, *JAPMA,* 81: 376, 1991
54. Ogden JA et. Al. Shock wave therapy for chronic proximal plantar fasciitis. *Clin Orthop.* 2001. Jun:(387):47-59
55. Maier M et. Al. Extracorporeal shock wave applicationfor chronic plantar fasciitis associated with heel spurs:predictionof outcome by MRI imaging. *J Rheumatol.* 2000. Oct;27910):2455-62
56. Bouchard JL. Retrospective study on the use of the nd:yag contact laser in surgical correction of plantar heel spur syndrome.
57. Nierenberg G, Hoffman A, et. al. Pseudoaneurysm with an arteriovenous fistula of the tibial vessels after plantar fasciotomy: a case report. *Foot Ankle Int* 1997;18:524-5.
58. Gentile AT, Zizzo CJ, et. al. Traumatic pseudoaneurysm of the lateral plantar artery after endoscopic plantar fasciotomy. *Foot Ankle Int* 1997;18:821-2.
59. Malay SD. Plantar fasciitis and heel spur syndrome: a retrospective analysis. *Reconstructive Surgery of the Foot and Leg: Update '96.* VickersNS et al. eds Tucker,Ga: Podiatry Institute Publishing: 1996:39-43.
60. Malay SD. Plantar fasciitis and calcaneal spur syndrome aggravated by prominent plantar protrusion.
61. Banks, AS. Entrapment of the first branch of the lateral plantar nerve another source of chronic heel pain.
60. GersterJC: Plantar fasciitis and achilles tendonitis among 150 cases of seronegative spondyloarthritis. *Rheumatol Rehabil* 1980;19:218-22.
62. FuryJG. Plantar fasciitis: the painful heel syndrome. *J Bone Joint Surg* 1975;57:672-3.
63. KenzoraJE, The painful heel syndrome: an entrapment neuropathy. *Bull Hosp Jt Dis Orthop Inst* 1987;47:178-89.
64. FormanWM, Green MA. The roll of intrinsic musculature in the formation of inferior calcaneal exostosis, *Clin Podiatr Med Surg* 1990;7:217-30.
65. Hassab HK, and El-Sharif AS: Drilling os calcis in painful heel with calcaneal spur, *Acta Orthop.Scand.* 45:152-157, 1974
66. SmithS: Fatigue perturbation of the calcaneus, foot and leg function, Vol 1, Langer Biomechanics Group.
67. Quinn M,Green DR. Conservative treatment of mechanically induced heel pain unpublished.
68. Snider MP,Clancy WF, McBeath A. plantar fascial release for chronic plantar fasciitis in runners. *Am J Sports Med* 1983;11:215.