CHAPTER **17**

COMPLICATIONS ASSOCIATED WITH SURGICAL TREATMENT OF PLANTAR FIBROMATOSIS

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INTRODUCTION

Plantar fibromatosis is defined as a rare benign fibroproliferative disorder involving the plantar aponeurosis (fascia). Although benign, the condition is locally aggressive. Treatment is indicated for pain, feeling of the mass in the foot, shoe-fit problems and functional gait abnormalities. Symptomatic lesions that require surgical intervention have been historically addressed by local excision, wide excision, or complete (subtotal) plantar fasciectomy.[1] There is a high recurrence rate after local surgical excision. Recurrence rates have ranged from 60-100% with simple excision.[2] Treatment of this condition can be problematic due to its propensity for complications and recurrence.[2-11] Several possible complications associated with surgical excision including recurrence, wound healing problems, scarring, and nerve injury create a challenge to the foot and ankle surgeon. Various attempts to lessen recurrence have included use of Marlex mesh,[5] free dermal fat grafts,[6] and split thickness skin grafting,[2] which unfortunately have not been universally successful. Most now agree that subtotal fasciectomy decreases the risk of recurrence in primary and recurrent lesions.[2,3,7-11] The ideal outcome would preserve anatomic structure, have minimal scarring and maintain a supple functional foot for weight bearing. This article will review the methods of treatment that decrease the potential complications associated with recurrence, nerve entrapment, and wound healing.

REVIEW

Plantar fibromatosis is defined as a benign process of fibrous proliferation that replaces the normal cellular architecture of the plantar fascia (Figure 1). It is also known as Ledderhose's disease.[8] It tends to have a benign clinical behavior with an insidious onset and a slowly progressive course. It can manifest as either multiple nodules or a solitary nodule (lesion). The lesions can occur at any age including childhood, although most reports describe the 4th to 6th decade of life as the most common time period. The lesions are more common in Caucasian male patients.[6,12]

Fibromatoses are divided into 2 subtypes depending on their location (whether they involve superficial or deep tissues). Deep fibromatosis (desmoid tumors) include intra-abdominal types, abdominal, and extra-abdominal types. The superficial lesions include palmar fibromatosis (Dupuytren contracture), plantar fibromatosis (Ledderhose's disease), penile fibromatosis (Peyronie's disease), and knuckle pads. Many times plantar fibromatosis coexists with other fibrous diseases such as Dupuytren's contracture and Peyronie's disease.[13] These lesions usually occur in regions of stress. The etiology of plantar fibromatosis is unknown. There is research documenting familial tendencies. Fetsch et al questioned 25 pre-adolescent and adolescent fibromatosis patients and identified that 11 had a family history of palmar or plantar fibromatosis.[12] A simple mutation usually described as primary trisomies of chromosomes 7 and 8 in superficial fibromatosis have been described. Recently a case of clonal reciprocal translocation identified in a case of plantar fibromatosis may represent a early neoplastic-relevant mutation.[13] Other associated causes described include trauma, neuropathy, gout, naturopathies, alcoholism, metabolic disorders, infection, genetic diseases, and autoimmune diseases.[14]

Ledderhose was the first to describe the histologic features of the disease in 1897.[8] Plantar fibromatoses are

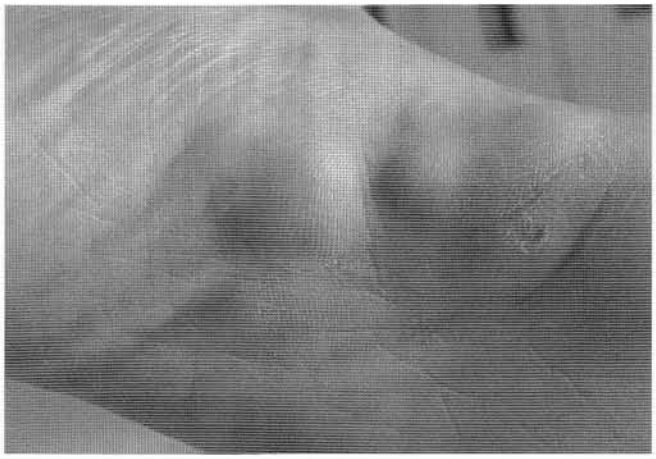

Figure 1. Clinical appearance of multiple, recurrent plantar fibromatoses affecting the medial abductor fascia and the distal medial extension of the plantar fascia.

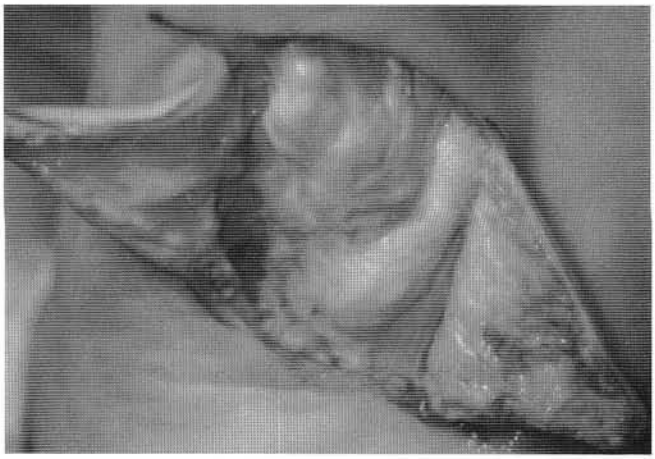

Figure 2A. Surgical appearance of plantar fibromatosis after surgical exposure.

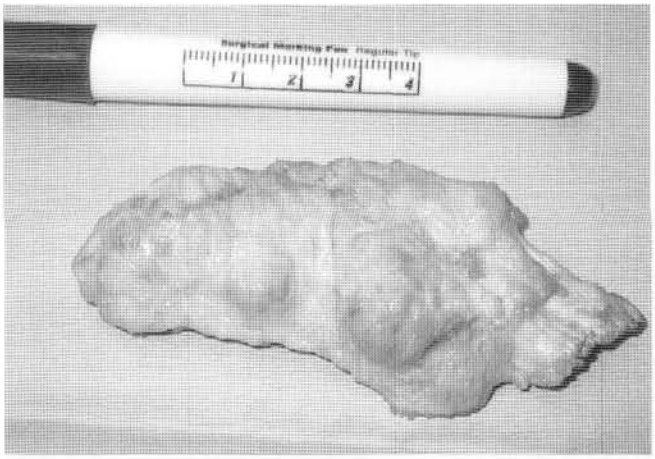

Figure 2B. Pathology specimen of an excised plantar fibromatosis.

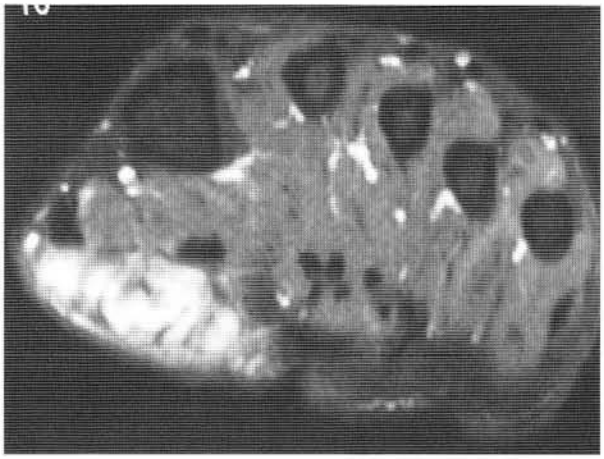

Figure 3A. Magnetic resonance imaging of recurrent plantar fibromatosis.

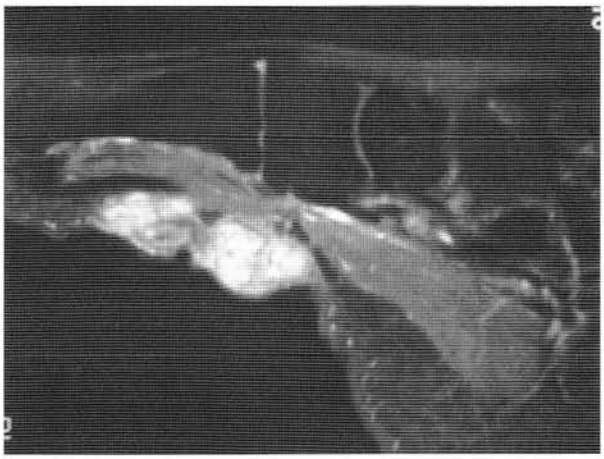

Figure 3B. Magnetic resonance imaging of recurrent plantar fibromatosis.

usually irregular, rubbery to firm, off-white fibrous tissue masses[15] (Figure 2). Microscopically, plantar fibromatoses have been shown to be very similar to palmar fibromatoses. Fibromatosis have been classified into 3 phases: proliferative, active (evaluative), and maturation (residual).[16] In the first phase fibroblasts proliferate in an intracellular substance, resulting in the formation of the nodule. In the active phase the nodule further develops. The cells in this phase have the characteristics of fibroblasts and of smooth muscle (myofibroblasts). Finally in the third phase, there is a prevalence of collagen fibers in an abundant matrix with scattered fibroblasts and inflammatory cells.[13,15]

Microscopic evaluation usually shows uniform, spindle shaped multinodular fibroblast cells in an interwoven pattern with perivascular inflammatory cells, which are peripherally arranged including lymphocytes, neutrophils and multinucleated giant cells. Cellular atypical is usually mild.[12] These lesions all have an infiltrative growth pattern and involve dense regular connective tissue. Within this tissue there is also a proliferation of spindled myofibroblasts with a tendency to form intersecting fascicles. The evidence of a cytoskeleton and an extra cellular filamentous system supports the ability for the myofibroblasts to generate and exert the intracellular forces that contribute to the contraction of the aponeurosis. Flexion contracture of the toes associated with plantar fibromatosis has been described although this is usually more common in the hands (Dupuytren's contracture) than the feet.[17,18] Plantar fibromatosis can usually be easily recognized by those who specialize in the lower extremity although with any soft tissue mass it is critical to exclude a potential malignancy with appropriate diagnostic modalities including radiographs, ultrasound, and magnetic resonance imaging (MRI). Radiographs rarely will reveal any abnormality other than some soft tissue fullness, edema and increased density. The sonographic appearance of the plantar fascia in plantar

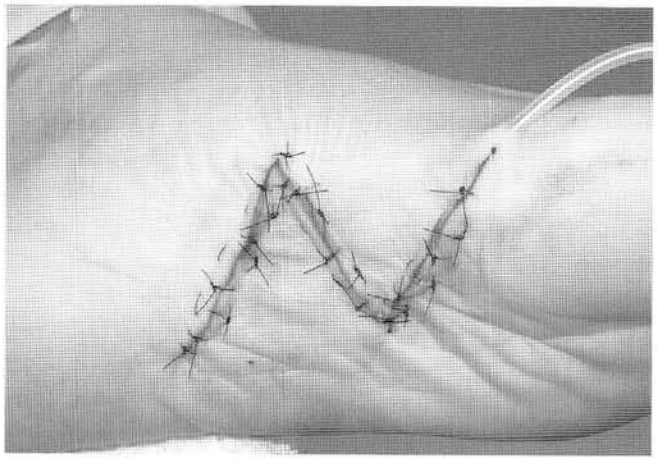

Figure 4. Z-flap skin incision.

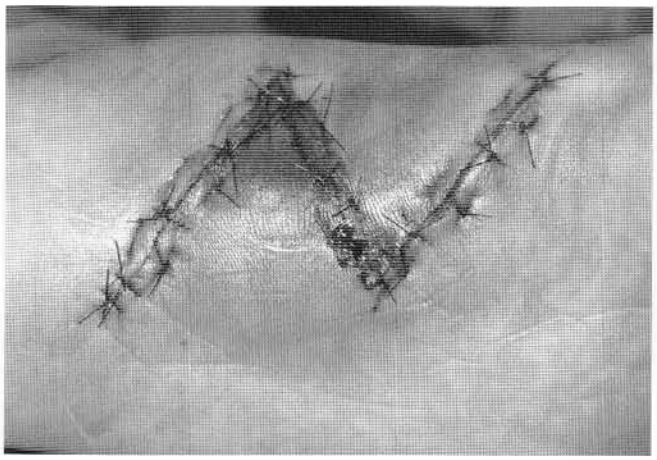

Figure 5. Wound healing problems can occur with necrosis and dehiscence especially in revisional cases with extensive involvement to skin and deep structures.

fibromatosis is most commonly described as hypoechoic, well defined, without acoustic enhancement or intrinsic vascularity.[19] More commonly MRIs are utilized to confirm the clinical diagnosis. MRI characteristics in plantar fibromatosis show a relatively low signal intensity on both T1 and T2 images compared with sarcomas that tend to have moderate increase signal in T1 and increased T2 signal (Figure 3).[20,21]

TREATMENT/RESULTS

The decision to treat these lesions depends on the size and location of the lesion and patient symptomatology. Once surgical intervention is planned, it is critical to consider the plantar neurovascular anatomy to decrease the potential complications associated with plantar fasciectomy. As a general rule the deep arterial flow into the foot follows a proximal to distal orientation into the distal extensions of the medial and lateral plantar arteries. The blood flow through the plantar skin within the subdermal plexus follows a different orientation. The vessels reach the skin through a perforating system from the larger lateral plantar artery and the smaller medial plantar artery deep in the central compartment of the foot. The perforating vessels move from deep to superficial on either side of the central band of the plantar fascia through the medial and lateral plantar sulci. Once the blood moves through the perforating arteries to the skin, the blood flow then changes to a more transverse orientation toward the central aspect of the arch. Venous flow is exactly opposite, heading from central to medial and lateral.

Skin viability is critical to the successful wound healing in any plantar arch incision. Successful incision placement will consider both the superficial and deep arterial flow. Incision placement that considers the skin arterial flow is critical to avoid complications associated with plantar fasciectomy. Longitudinal parallel incisions must be avoided. Large flaps that may cross blood flow from the opposite direction may lead to apical necrosis.[22-24]

Subtotal plantar fasciectomy requires precise anatomic dissection. It is critical to maintain viable skin margins with enough exposure to ensure adequate visualization of the entire extent of the plantar fascia including an adequate excision margin as well as identification and avoidance of the neurovascular structures. Therefore, skin incision placement is an important consideration. If possible, the incision should be centrally located in the arch providing access for the transverse flow of blood toward the center of the foot but still allowing for adequate visualization of the underlying mass.

Historically, Curtin proposed an incision that curved from the plantar medial first metatarsal in a lazy S fashion in a medial to lateral direction to the lateral weight bearing surface then ending back medially just distal to the calcaneal tuberosity.[2] This approach crosses the midline and places a large portion of the incision directly over the superficial branch of the medial plantar nerve increases the potential for postoperative neuroma. Another incisional approach utilizes a longitudinal incision, which provides less disruption to the blood supply but is perpendicular to relaxed skin tension lines. Others have tried to follow relaxed skin tension lines more by modifying surgical approaches with transverse, lazy S or Z-flaps (Figure 4). Maintaining a wide base with an adequate apical angle is critical with the use of skin flaps. Gentle handling of the apex of the skin flaps is critical. The author will utilize suture to retract the skin flaps to avoid apical necrosis. The author prefers the Z-flap to provide adequate exposure while maintaining transverse blood flow into the flaps. All incisions have a risk of wound healing complications.

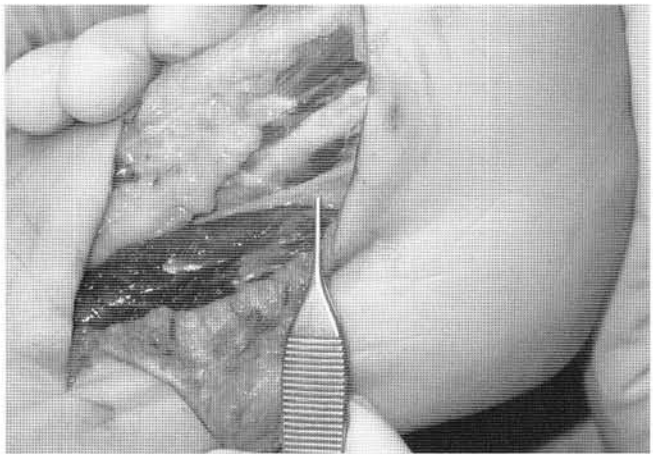

Figure 6. Anatomic appearance after excision of plantar fibromatosis. Note the abductor hallucis, flexor hallucis longus, medial plantar nerve and the flexor digitorum brevis.

Necrosis and dehiscence are problems that can occur. Many times recurrent lesions with multiple nodules and epidermal adhesions are prone to these problems (Figure 5).

Avoiding postoperative nerve entrapment and associated chronic pain is probably the most important surgical consideration. The medial plantar neurovascular bundle tends to run between the flexor digitorum brevis and abductor hallucis muscle belly (Figure 6). Often the fibromatosis may impinge on this neurovascular bundle.[25] Dissection of plantar fibromatoses requires anatomic precision from the underlying muscle/tendon, surrounding fat, neurovascular tissue and overlying skin are essential. The fibromatosis should be removed without injury to the surrounding tissue, excising only the fascia and associated fibrosis tissue. Entrapment of the plantar nerves with postoperative cutaneous neuroma formation is not uncommon due to the close proximity of the fibromatosis to the neurovascular structures.[2,9,11] Wapner et al described 2 severe cases of intractable pain out of a series of 12 patients after revisional cases due to neuroma formation that have contemplated amputation.[2] Sammarco had 1 case of 21 who developed a plantar cutaneous neuroma.[11] Aluisio et al reported 2 cases of lateral plantar nerve laceration and 1 case of medial plantar nerve entrapment.[9]

One must avoid adhesion of the musculotendinous structures including the flexor hallucis longus tendon and avoid direct scarring of the epithelial layer to deeper structures. Sammarco et al described a staging system (I–IV), which depends on the extent of plantar fascia involvement, the presence of skin adherence, and the depth of the tumor. Stage I was described as focal disease isolated to a small area on either the medial or central band of the plantar fascia with no adherence to the skin or deep extension to the flexor sheath. Stage II is also free from skin and deep flexor sheath extension although it is described as multifocal. Stage III lesions are also multifocal but exhibit either deep extension to the flexor sheath or adherence to skin. Finally, Stage IV lesions are multifocal, have extension to the flexor sheath and also are adhered to the skin. The stage of the tumor has been shown to correlate well with postoperative wound healing, skin necrosis and recurrence. In 11 of the 21 feet (52%) presented by Sammarco wound healing took longer than 4 weeks and 4 of them required split thickness skin grafting. Ten of the eleven patients with wound complications had either a Stage III or Stage IV lesion.[11]

The most-recognized complication is the likelihood of recurrence. Several authors have described decreased recurrence rates with subtotal plantar fasciectomy in revisional and in primary cases of plantar fibromatosis.[2,3,7-9,11] Durr et al proposed a decreased chance of recurrence with aggressive initial surgical resection. Despite their findings they still had a high rate of recurrence. In 11 patients, 24 procedures were performed and there were 16 recurrences. Two primary fasciectomies did not recur. Three of 6 revisional procedures that had complete fasciectomies recurred. This was compared with recurrences in 7 of 9 wide excisions and 6 of 7 local excisions.[8]

Similarly, Aluisio et al identified an increased chance of recurrence with multiple nodules, bilateral lesions and a positive family history. Seventeen patients in their study had primary surgery, 4 of 10 local excisions, 1 of 3 wide excisions and 2 of 4 subtotal fasciectomies developed recurrence. Twenty-one patients had revisional surgery. In the treatment of recurrent lesions subtotal fasciotomy was superior to local or wide excision. Three of 4 had recurrence with local or wide excision. Only 4 of 17 patients had recurrence with subtotal fasciotomy. All patients with recurrences developed the problem within 14 months postoperative.[9] Utilizing subtotal fasciectomy, Sammarco et al had only 2 recurrences in 23 cases with an 86% satisfaction rate.[11] Wapner et al had only 1 recurrence in 12 cases.[2] DeBree et al had a 90% recurrence rate in primary excisions followed by a 50% recurrence in subsequent surgies.[14]

In order to decrease recurrence, adjuvant radiotherapy has been attempted. Postoperative radiotherapy decreases the recurrence rate although it has led to serious side effects. Therefore, its use has been significantly limited.[14] Other attempts to lessen recurrence have included use of Marlex mesh[5] and free dermal fat grafts[6] although these modalities have not been implemented routinely.

Biomechanical effects also are an important considerations for long-term positive outcomes. Under tension, the plantar fascia functions to support the longitudinal arch, supinate the rearfoot, and stabilize the digits to the ground. Pontious et al described hammertoes as a postoperative complication associated with plantar fasciectomy.[26] Sammarco et al also showed that plantar fasciectomy lead to a slight decrease in calcaneal inclination, navicular height, and medial cuneiform height demonstrating the loss of medial longitudinal arch height secondary to settling phenomenon.[11] In order to dissipate these potential problems after plantar fasciectomy the author recommends postoperative use of custom molded orthoses to decrease the subsequent strain in the arch after plantar fasciectomy.

CONCLUSION

Plantar fibromatosis is a rare, benign, locally-aggressive fibroproliferative disorder involving the plantar fascia. Symptomatic lesions that require surgical intervention need to be addressed with complete (subtotal) plantar fasciectomy with particular attention to incision placement, exposure/visualization, and anatomic dissection to avoid potential complications that can occur frequently.

REFERENCES

1. Mahan KT. Plantar fibromatosis: surgical considerations. In McGlamry ED, editor. Reconstructive Surgery of the Foot and Leg, Update '86. Tucker, GA: Podiatry Institute. p. 161-4.
2. Wapner KL, Ververelli PA, Moore JH, Hecht PJ, Becker CE, Lackman RD. Plantar fibromatosis: a review of primary and recurrent surgical treatment. *Foot Ankle Int* 1995;16:548-51.
3. Landers PA, Yu GV, White JM, Farrer AK. Recurrent plantar fibromatosis. *J Foot Ankle Surg* 1993; 32:85-93.
4. Curtin JW. Surgical therapy for dupuytren's disease of the foot: proper placement and design of skin incision. *Plast Reconstr Surg* 1962;30:568-76.
5. Oster JA, Miller AE. Resection of plantar fibromatosis with interposition of Marlex mesh. *J Foot Surg* 1986;25:217-25..
6. Lauf E, Freedman BM, Steinberg JS. Autogenous free dermal fat grafts in the surgical approach to plantar fibromatosis. *J Foot Ankle Surg* 1998;37:227-34.
7. Zgonis T, Jolly GP, Polyzois V, Kanuck DM, Stamatis ED. Plantar fibromatosis. *Clin Pod Med Surg* 2005;22:11-5.
8. Durr HR, Krodel A, Trouillier H, Lienemann A, Refior HJ. Fibromatosis of the plantar fascia: diagnosis and indications for surgical treatment. *Foot Ankle Int* 1999;20: 13-7.
9. Aluisio FV, Mair SD, Hall RL. Plantar fibromatosis: treatment of primary and recurrent lesions and factors associated with recurrence. *Foot Ankle Int* 1996;17:672-8.
10. Wiseman GG. Multiple recurring plantar fibromatosis and its surgical excision. *J Foot Surg* 1983;22:121-5.
11. Sammarco GJ, Mangone PG Classification and treatment of plantar fibromatosis. *Foot Ankle Int* 2000;21:563-9.
12. Fetsch JF, Laskin WB, Miettinen M. Palmar-plantar fibromatosis in children and preadolescents: a clinic pathologic study of 56 cases with newly recognized demographics and extended follow up information. *Am J Surg Pathol* 2005;29:1095-105.
13. Sawyer JR, Sammartino G, Gokden N, Nicholas RW. A clonal reciprocal t(2;7)(p13;p13) in plantar fibromatosis. *Cancer Genet Cytogenet* 2005;158:67-9.
14. DeBree E, Zoetmulder FA, Kus RB, Peterse HL, van Coevorden F. Incidence and treatment of recurrent plantar fibromatosis by surgery and postoperative radiotherapy. *Am J Surg* 2004;187:33-8.
15. DePalma L, Santucci A, Gigante A, DiGiulio A, Carloni S. Plantar fibromatosis: an immunohistochemical and ultra structural study. *Foot Ankle Int* 1999;20:253-7.
16. Ushijima M, Tsuneyoshi M, Enjoji M. Dupuytren type fibromatosis: a clinic pathological study of 62 cases. *Acta Pathol Jpn* 1984;34:991-1001.
17. Donato RR, Morrison WA. Dupuytren's disease in the feet causing flexion contractures in the toes. *J Hand Surg* (Br) 1996;21:364-6.
18. Classen DA, Hurst LN. Plantar fibromatosis and bilateral flexion contractures: a review of the literature. *Ann Plast Surg* 1992;28:475-8.
19. Griffith JF, Wong TY, Wong SM, Wong MW, Metreweli C. Sonography of plantar fibromatosis. *Am J Roentgenol* 2002;179:1167-72.
20. Morrison WB, Schweitzer ME, Wapner KL, Lackman RD. Plantar fibromatosis : a benign aggressive neoplasm with a characteristic appearance on MR images. *Radiology* 1994;193:841-5.
21. Pasternack WA, Davison GA. Plantar fibromatosis: staging by magnetic resonance imaging. *J Foot Ankle Surg* 1993;32:390-6.
22. Stapp MD. Plantar skin incisions: an overview. In Vickers NS, editor. Reconstructive Surgery of the Foot and Leg, Update '96. Tucker (GA): Podiatry Institute; 1996. p. 108-12.
23. Smith TF. The plantar skin and soft tissues: private surgical anatomy review. Update 2005: The Proceedings of the Annual Meeting of the Podiatry Institute. Tucker (GA): Podiatry Institute. p. 68-75.
24. Attinger C, Cooper P, Blume P. Vascular anatomy of the foot and ankle. *Oper Tech Plast Reconstr Surg* 1997;4:183-98, 1997.
25. Boc SF, Kushner S. Plantar fibromatosis causing entrapment syndrome of the medial plantar nerve. *J Am Podiatry Med Assoc* 1994;84:420-2.
26. Pontious J, Flanigan KP, Hillstrom HJ. Role of the plantar fascia in digital stabilization. A case report. *J Am Podiatry Med Assoc* 1996;86:43-7.