Classification and Treatment of Plantar Fibromatosis

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ABSTRACT

A retrospective study of 18 patients (23 feet) with plantar fibromatosis who required surgical excision between January, 1991, and June, 1998, was performed. Subtotal plantar fasciectomy was performed to remove the tumor with a wide disease-free margin. 16 patients (21 feet) were interviewed and 14 patients (19 feet) were examined with an average followup of 36 months. Two patients (2 feet) with less than 12 months followup were excluded. Both subjective and objective evaluations and pre- and postoperative x-rays were reviewed to assess the alignment of the bony arch.

There were nine males and nine females, age 49 years, average, at the time of diagnosis. Sixty-seven percent of patients had bilateral disease, and 28% had associated Dupuytren's contracture. There were 18 primary and five recurrent tumors.

An operative staging system, I to IV, for plantar fibromatosis is presented which incorporates the extent of plantar fascia involvement, the presence of skin adherence, and the depth of tumor extension. The stage of the tumor correlated well with postoperative wound healing, skin necrosis, and recurrence.

In fifteen of 21 feet, the patients were satisfied without reservations, and in three of 21 feet, they were satisfied with reservations. In 18/21 (86%) feet, the patient reported he/she would have surgery done again.

There were two recurrent tumors. One was reoperated and the patient was disease free twelve months postoperatively. The other recurrence was asymptomatic 40 months postoperatively and required no treatment.

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Peter G. Mangone, M.D. Blue Ridge Bone & Joint Clinic 129 McDowell Street Asheville, NC 28801 (828) 258-8800 (828) 258-0416 One patient required an excision of a postoperative cutaneous neuroma. Eleven of 21 feet (52%) experienced delayed healing and of which four required a split thickness skin graft. Ten of the eleven feet with delayed wound healing and all four cases requiring a skin graft had a stage III or IV tumor. Pre- and postoperative weightbearing radiographs revealed a slight decrease in the calcaneal pitch angle, navicular height, and medial cuneiform height indicating a decrease in the height of the medial longitudinal arch.

Keywords: plantar fibromatosis, plantar fasciectomy, fibromatosis other, arch height

INTRODUCTION

Plantar fibromatosis is a benign but often locally aggressive tumor of fibrous tissue.^{9,15} The tumor may be asymptomatic, but symptoms commonly include the feeling of a mass in the foot, difficulty in fitting shoes, and pain and tenderness while weightbearing. Initial treatment involves anti-inflammatory medication, modification of activities, occasionally injection of corticosteroid into the tumor, custom molded orthotics, and physical therapy. These modalities frequently do not halt the tumor progression, but they may decrease the patient's symptoms to a tolerable level. When nonoperative treatment is ineffective, surgical treatment is recommended to relieve pain, reduce deformity, and improve function. Surgical management is challenging because the tumor can involve the skin as well as the deep neurovascular structures.

There is a high incidence of recurrence after both local and wide excision.^{1,2,9,11,15,17,18} Subtotal plantar fasciectomy, however, has been reported to decrease the risk of recurrence in both primary and recurrent tumor cases.^{2,4,17,19} Because of the increased chance of recurrence, outcome results of previous studies have focused mainly on recurrence rates,^{2,4,11,16,18} and patient satisfaction has been examined in only one study.¹⁹ There is a need to determine the long term outcome of patients after subtotal plan-

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tar fasciectomy as well as to predict the postoperative problems associated with surgical treatment. The purpose of this study is to evaluate the subjective, objective, and radiographic findings of patients who underwent subtotal plantar fasciectomy for the surgical treatment of plantar fibromatosis by the same surgeon using the same technique. A staging classification system for plantar fibromatosis and recommendations for treatment of this condition are presented in order to assess the risk of postoperative complications and predict recurrence. The surgical technique presented is a standardized approach which we found to be the most effective in removing the tumor.

Materials & Methods

The records of 18 (23 feet) patients with plantar fibromatosis who underwent subtotal plantar fasciectomy between January, 1991, and July, 1998, were reviewed. All patients who underwent surgery either failed nonoperative treatment or requested excision of the tumor after discussion of the risks and benefits of operative versus nonoperative treatment. Indications for surgery included symptoms of a painful plantar mass of the foot, an enlarging mass, difficulty in fitting footwear, and altered activity level. The rapid growth of the mass was not a contraindication for surgery. MRI was not obtained unless the tumor presented with unusually rapid growth, excessive pain, or extension distal to the level of the metatarsophalangeal joints. Clinical data included age at diagnosis, sex, presence of Dupuytren's contracture, bilateral versus unilateral disease, family

Table 1 TUMOR STAGING SYSTEM FOR PLANTAR FIBROMATOSIS		
Tumo	or Grade Description	
Τ	Focal disease isolated to a small area on the medial and/or central aspect of the fascia No adherence to the skin No deep extension to the flexor sheath	
11	Multifocal disease, with or without proximal or distal extension No adherence to the skin No deep extension to the flexor sheath	
III	Multifocal disease, with or without proximal or distal extension Either adherence to the skin or deep extension to the flexor sheath	
IV	Multifocal disease, with or without proximal or distal extension Adherence to the skin and deep extension to the flexor sheath	

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history, and previous tumor excision. Surgical records were reviewed with respect to technique, focal versus multifocal disease, involvement of the skin, involvement of the deep neurovascular structures, and method of closure. Postoperative data was obtained from the record regarding recurrence, wound healing time, requirement for additional surgical procedures, and postoperative complications. At the time of review, 14 patients were personally interviewed and underwent clinical examination including weightbearing lateral foot x-rays. Two patients were unable to return for evaluation. One patient was interviewed by telephone and information was correlated with data from the patient's record. A second patient could not be contacted but had 12 months postoperative followup documentation in the record.

Review of operative records was performed and a tumor staging system was developed based on focal versus multifocal disease, skin adherence, and extent of deep extension. The postoperative course and outcome were compared to the tumor stage in order to predict delayed healing, recurrence, and outcome. The staging system is outlined in Table 1. (Figures 1, 2 and 3)

Preoperative evaluation was performed on 12 patients (16 feet) using the University of Maryland Foot score* and four patients (five feet) using the AOFAS midfoot score.** The scoring system used for each patient depended on the date of the patient's initial evaluation. Patients presenting earlier, before June, 1997, were assessed using the Maryland Foot score, and patients presenting later were assessed with the AOFAS midfoot score. This change occurred after the AOFAS Clinical Rating Scale became a commonly accepted method of outcome measurement. Rather than extrapolate data retrospectively from one rating scale to another, the system used for each patient's preoperative evaluation was adopted to assess his/her postoperative outcome. This was done in order to improve accuracy when comparing preoperative and postoperative scores. Patients were also asked two additional questions to evaluate their subjective satisfaction with the procedure: (1) was the patient completely satisfied, satisfied with reservations, or dissatisfied with the procedure; (2) would the patient have the procedure performed again. Measurements on the lateral weightbearing xrays pre- and postoperatively included the talo-first metatarsal angle, calcaneal pitch, navicular height, cuboid height, and medial cuneiform height to determine any change in the longitudinal arch of the foot. (Figure 4) The data was tested for statistical significance with the two-tailed paired Student's t-test and repeated measures ANOVA with p = 0.05.



Fig. 1. Intraoperative photo of stage I plantar fibromatosis.

Surgical technique

A longitudinal incision was made along the nonweightbearing portion of the plantar arch, and the tumor was identified. Under loupe magnification, the surrounding plantar fascia was dissected from the dermis by both blunt and sharp dissection to identify the medial, lateral, distal, and proximal disease-free borders of the plantar fascia. Care was taken, whenever possible, to create a full thickness flap of skin including as much subcutaneous tissue as possible. The fascia was divided near its proximal origin, at least 1.5 cm proximal to the tumor. It was then dissected free from the underlying origin of the flexor digitorum brevis muscle from proximal to distal taking care to protect the adjacent nerves and vessels. When free of most of its deep attachments, the fascia was divided as far distal as possible, at least 1.5 cm beyond the most distal part of the tumor. Where required, excision of the fascial septae which extend between the flexor tendons was performed. In other cases, the tumor was adherent to the skin necessitating the removal of subcutaneous tissue and cre-

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Fig. 2. Intraoperative photo of stage III plantar fibromatosis.

ation of a full thickness skin flap in order to adequately excise the tumor. The subcutaneous tissue was closed with interrupted absorbable suture (3-0 Vicryl, Ethicon, Johnson & Johnson, Princeton, New Jersey), and the skin was closed with interrupted nonabsorbable monofilament suture (4-0 Ethilon, Ethicon, Johnson & Johnson, Princeton, New Jersey). A penrose drain was used only if unusually deep tissue dissection was required or significant

	Average Change	Statistical	
Talo-1st metatarsal angle	-1.8 degrees	p=0.16	
Calcaneal pitch	-1.5 degrees	p=0.002*	
Navicular height	2.8 mm	p=0.01*	
Cuboid height	1.0 mm	p=0.055	
Medial cuneiform height	2.4 mm	p=0.03*	



Fig. 3. Intraoperative photo of stage IV plantar fibromatosis.

bleeding was encountered. A compression dressing was applied and weightbearing restricted to toetouching with crutches until the wound was healed. Patients with bilateral tumor excision underwent surgery on each foot at different times. All patients received intravenous antibiotics preoperatively, and a tourniquet was used in all cases to control bleeding and improve visualization.

Results

Eighteen patients (23 feet) who underwent subtotal plantar fasciectomy had a clinical and pathologic diagnosis of plantar fibromatosis. There were nine males and nine females. Average age at the time of diagnosis was 49 years (range 11 - 67 years) (M = 45 years and F = 52 years). Twelve of eighteen patients (67%) had bilateral tumors (M = 5 and F = 7) and 5/18 patients (28%) also had Dupuytren's contracture present (M = 2 and F = 3). Only five of the 12 patients with bilateral disease had the surgery performed on both feet (M = 1 and F = 4). The remaining seven of the twelve failed to meet the surgical

indications for the contralateral foot. There were 18 primary and five recurrent tumors in this series. One patient had a positive family history for plantar fibromatosis, and one patient had diabetes mellitus.

There were two patients (two feet) with less than 12 months of postoperative followup. These patients were lost to followup and deleted from the study. Neither patient had a documented recurrence at the time of the last postoperative office visit, one month and three months respectively. The sixteen patients (21 feet) included in this study had an average followup of 36 months (range 12 - 91 months). With respect to the classification of the tumor, there were two feet with stage I disease, five feet with stage II disease, and eight feet with stage IV disease.

The average time for wound healing was eight weeks (range 2 - 14 weeks). Eleven of 21 feet (52%) had delayed healing (greater than four weeks), and four of those feet required a split thickness skin graft. Ten of the eleven feet with delayed wound healing had either a stage III (three feet) or IV (seven feet) tumor. (Figure 5a and 5b) The other patient had a stage II tumor. One additional patient required a subsequent surgery to excise a cutaneous neuroma. Postoperatively, eight patients (10/21 feet) required either an orthotic device or preferred comfortable shoewear. In six of these eight cases, the patients were satisfied without reservation with the treatment. There was one postoperative medical complication, a pulmonary embolus. This was treated successfully, and the patient was completely satisfied with the surgery.

There were two recurrent tumors in our study. One occurred in an 11 year old male with a stage IV tumor and a pathologic diagnosis of juvenile aponeurotic



Fig. 4. Lateral weightbearing foot x-ray illustrating the measurements to assess the bony arch. A, calcaneal pitch; B, cuboid height; C, navicular height; D, medial cuneiform height; and E, talo-1st metatarsal angle.

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fibroma. Although a distinct tumor,¹³ it is considered the pediatric equivalent to adult plantar fibromatosis.^{10,14} The recurrence occurred 12 months postoperatively. He underwent reoperation at that time, and at 12 months followup had no recurrence. The other recurrence occurred in a 58 year old female with extensive stage III bilateral involvement who had surgery performed on both feet. The left side has remained disease free, but the right foot developed a 1 x 2 centimeter mass six months postoperatively on the medial nonweightbearing portion of the sole. Forty months after surgery, the mass has not changed in size. Her foot is asymptomatic and does not require further treatment.

Fourteen patients (19 feet) returned for clinical and radiographic evaluation. Two patients (two feet) were unable to return. One of these patients was interviewed by telephone. The other patient could not be contacted and his record only was used in the study.

The average preoperative Maryland Foot score was 65/100 (range 50 - 93) (N = 16 feet). Postoperatively, the average Maryland Foot score was 86/100 (range 63 - 98) (N = 14 feet) The average preoperative AOFAS midfoot score was 70/100 (range 61 - 77) (N = 5 feet). and postoperatively the AOFAS midfoot score was 77/100 (range 64 - 88) (N = 5 feet). Preand postoperative weightbearing lateral x-rays were available for 14 patients (18 feet). The average change between the pre- and postoperative x-ray measurements are summarized in Table 2.

Patients reported that in eighteen of 21 feet (86%) they would have the procedure done again under similar circumstances. In 15/21 (71%) cases, the patients were satisfied without reservation and 3/21 (14%) cases were satisfied with reservations. Three patients (three feet) (14%) were dissatisfied. Two of the three dissatisfied patients had stage IV disease. One patient reported nonlocalized plantar numbress without pain. This patient had a preoperative tarsal tunnel syndrome documented by EMG/NC studies and complained of similar symptoms preoperatively also. He refused treatment of his tarsal tunnel syndrome. The other patient reported clawing of the toes and cramping in the thigh. In this patient, clinical exam revealed lesser toe clawing similar to the contralateral and nonoperated side. The third patient reported pain greater than before the surgery. No abnormalities were found on her clinical examination. Her neurologic exam, foot contour, and mechanical function were within normal limits.

Discussion

A recent report indicates that the major cell respon-

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sible for plantar fibromatosis is the myofibroblast similar to that found in Dupuytren's contracture.⁸ Although benign, the condition is locally aggressive and has a high recurrence rate when treated with local excision.^{1,2,9,11,15,17,18} Subtotal plantar fasciectomy appears to decrease the risk of recurrence in both primary and recurrent tumors.^{2,4,17,19} Our experience confirms the efficacy of this treatment regimen. Our recurrence rate of 9.5% with subtotal plantar fasciectomy was similar to other reports utilizing a similar approach as the treatment.^{2,4,11,19}

Sixty-seven percent of patients had bilateral tumors, a slightly higher incidence than previous studies.^{1,4,15,16,18,19} Twenty-eight percent had associated Dupuytren's disease. This incidence did not differ significantly from previous reports.^{1,4,15,16,18,19} Our population, with an average age of 49 years was older compared to other series that report patients in the fourth decade or younger.^{1,2,9,16} Some reports indicate a male predominence,^{1,9} but our patients were equally divided by sex. Contrary to other published data,² we found no relationship in our patients between family history, bilateral disease, or rate of tumor growth and recurrence. Previous studies have focused on recurrence rates and demographics,^{2,4,11,16,17,18} but information concerning the long term results of this surgery including decrease in arch height is unclear.

Subtotal plantar fasciectomy requires meticulous dissection to define the extent of the involved plantar fascia, excise the tumor with an adequate margin of disease-free tissue, and avoid injury to the neurovascular structures. Aluisio et. al. reported two cases of lateral plantar nerve laceration and one case of medial plantar nerve entrapment after skin grafting.² Wapner et. al. described two cases of a postoperative medial plantar neuroma in twelve patients.¹⁹ One of our 21 cases had a plantar cutaneous neuroma. We recommend the use of loupe magnification since it allows clear visualization of the neurovascular structures. This may have contributed to a lower rate of postoperative neuroma in our series.

Injection studies show a clear line of demarcation between the skin supplied by the medial and lateral plantar arteries.³ Dissection beneath the skin, even while preserving the subcutaneous tissue, puts the skin at risk for necrosis. The recommended incision is made between these two zones of vascularity on the nonweightbearing portion of the arch and limits devascularization of the plantar skin.^{5,6} Extensive dissection is often necessary in a stage III and stage IV tumor to completely excise it with a sufficient margin of normal tissue in order to prevent recurrence. This disrupts the tenuous blood supply coming from

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the deep aspect of the foot through the plantar fascia to the subcutaneous tissue and skin. Although we used a linear incision, other authors have recommended a curvilinear incision to decrease tension on the skin flap.¹⁹ This may help decrease wound complications, but we believe the major factor involved in skin necrosis is the tenuous blood supply to the plantar foot combined with tumor extension into the deep layers of the skin. This corresponds with our finding that stage III and IV tumors were much more likely to develop skin necrosis than less invasive tumors depsite the use of a linear incision in all cases.

Intraoperative tumor staging based on our classification (Table 1) may help predict patients who will experience delayed wound healing. Seven of eight feet with stage IV disease had wound edge necrosis, and four of these required skin grafting. This represents a 50% rate of significant skin necrosis in patients with stage IV lesions. Likewise, three of six feet with stage III disease had skin necrosis, none requiring a skin graft. This indicates that patients with stage III and IV tumors have increased risk for



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delayed wound healing. Wapner et. al. described excision of the skin and delayed closure using either local flaps or split thickness skin graft when the tumor extended into the dermis.¹⁹ Although the rate of wound necrosis in our study is high, our results indicate all of the feet with stage III disease and 50% of the feet with stage IV disease healed without additional surgery. If the protocol outlined by Wapner et. al. had been followed, many of these patients would have required further surgery. We, therefore, do not recommend skin grafting during the initial procedure or within the first few weeks postoperatively since many of these patients will heal with local wound care alone.

Patient satisfaction as an outcome measure after surgery for plantar fibromatosis has been published only once in the past using several variables including walking tolerance, postoperative pain, return to employment, recurrence and subjective satisfaction. Using these guidelines, a 75% satisfaction rate was reported.¹⁹ In our study, the average postoperative Maryland Foot score rose 21 points, and the average



Fig. 5a & 5b. a, Preoperative photo of stage IV plantar fibromatosis. b, Postoperative photo of the same patient after subtotoal plantar fasciectomy and delayed split thickness slin graft. Although a large incision and extensive soft tissue dissection was required, the patient required only a small skin graft performed one month after the original procedure.

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postoperative AOFAS score rose seven points compared to preoperative totals. This data combined with a patient satisfaction rate of 86% indicates most patients function well after this surgery. Our findings, which are similar to a previous study¹⁹ seem to confirm that successful resection of this tumor results in an overall improvement in the patient's pain, deformity, and daily function.

Previous studies have focused on recurrence rates,^{2,4,11,16,17,18} but information concerning the effects of this surgery on arch height is unclear. The plantar fascia is responsible for 25% of passive arch stability.12 Complete fasciotomy for plantar fasciitis has been reported to decrease arch height on x-ray.7 A slight decrease in the height of the bony arch was found in our study. Comparison of the pre- and postoperative x-rays revealed that the decrease in the height occurred in the medial longitudinal arch. This does not appear to occur at the talonavicular joint alone since the talo-1st metatarsal angle remains statistically unchanged. Instead, we found that subsidence of the medial longitudinal arch occurs over the entire medial arch resulting in decreased calcaneal pitch, loss of medial cuneiform height, and loss of navicular height. Though not statistically significant, the decrease of cuboid height laterally revealed a trend of lateral column height loss as well. It is possible that following subtotal fasciectomy the entire midfoot may subside rather than just the medial side. There was one patient in our study who was dissatisfied without other cause, but we could not implicate the arch sag as a factor in that case.

Our results indicate that subtotal plantar fasciectomy is effective in the treatment of symptomatic primary and recurrent plantar fibromatosis. Patients with stage I or II disease have few postoperative problems. Patients with stage III or IV disease often have delayed wound healing, but most heal without further surgery. Radiographic analysis indicates a slight decrease in the height of the bony arch after surgery, but symptoms, if present, are minimal. Based on our results, we conclude that:

- 1.Subtotal excision of the plantar fascia should be performed with as wide margins around the tumor as possible (preferably 1.5 cm of normal tissue) through a plantar incision on the nonweightbearing arch.
- 2.Loupe magnification should be used during surgery to improve visualization of the neurovascular structures.
- 3. Tumor staging should be done both pre- and intraoperatively, I to IV, to help predict patients with

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increased risk of skin necrosis and recurrence.

- 4. The surgeon should counsel patients, especially those with stage III and IV tumors, about the risk of recurrence, skin necrosis, and the possibility of split thickness skin grafting.
- 5. If skin necrosis occurs, the surgeon should allow several weeks for healing with local wound care prior to proceeding with additional surgery such as skin grafting.

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