CHAPTER **42**

EVALUATION AND TREATMENT OF SUSPICIOUS SOFT TISSUE TUMORS OF THE FOOT AND ANKLE

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Soft tissue tumors of the foot and ankle can present both a diagnostic and therapeutic challenge. Reports involving soft tissue tumors in the literature often are limited to case presentations of an unusual soft tissue mass. Although rare, malignant tumors presenting in the foot and ankle can be life-threatening. These tumors may be primary, (originating in the lower extremity), or secondary (metastatic from another site in the body to the foot or ankle).

Most malignant soft tissue tumors presenting in the foot and ankle are primary in nature, and soft tissue sarcomas represent the bulk of those soft tissue tumors without cutaneous manifestations. Frequently, the patient presenting with such a mass will be quite unaware of its malignant potential. Due to their rarity, it is not unusual for sarcomas of the foot and ankle to be misdiagnosed as a more commonly encountered mass. For example, a plantar sarcoma can be mistaken for a plantar fibroma, a dorsal synovial sarcoma mistaken for a ganglion, or an intermetatarsal space mass mistaken for a Morton's neuroma. Due to the numerous variations in the soft tissue sarcoma's clinical appearance and behavior, the physician treating the foot and ankle should demonstrate appropriate caution and possess an understanding of basic principles involved in the evaluation and management of suspicious soft tissue masses. With this knowledge, the physician can confidently approach the tumor with an appropriate plan of treatment. This article will outline a step-by-step approach to assess the potential soft tissue sarcoma. This approach can be similarly used for virtually all soft tissue tumors. The approach includes the following five steps: patient history; physical examination; accessory diagnostic studies; biopsy, when necessary; and a definitive treatment plan. An appreciation of this five-step approach will enable the physician to assume a vital role in the management of patients with soft tissue sarcomas.[1]

DISTRIBUTION/ETIOLOGY

Soft tissue sarcomas are relatively rare neoplasms. Benign soft tissue masses outnumber them by roughly a 100 to 1 ratio.[2] However, when present, sarcomas are often seen in the lower extremity and therefore the odds are that they will occasionally be encountered by the physician treating the foot and ankle. The etiologic factors are not well understood, but are believed to be related to the activation of viral oncogenes. Chemical exposure, radiation exposure, environmental factors, and trauma have all been implicated as possible factors initiating the viral induction of a tumor.[3,4]

The majority of soft tissue sarcomas are believed to originate from the mesenchymal soft tissues. Thus, like benign soft tissue masses, sarcomas with vascular, muscular, lipomatous, neural, fibrous, and synovial origins may be seen (Table 1). Synovial sarcoma is probably the most commonly encountered sarcoma in the foot and ankle.[5,6]

Table 1

PRIMARY SOFT TISSUE NEOPLASMS

TYPE	BENIGN	MALIGNANT
Vascular	Glomus Tumor Hemangioma	Angiosarcoma
Muscle	Leiomyoma	Leiomyosarcoma Rhabdomyosarcoma
Fat	Lipoma Angiolipoma	Myxoid liposarcoma Pleomorphic liposarcoma
Neural	Neurofibroma Neurilemoma	Neurosarcoma
Fibrous	Fibroma	Fibrosarcoma Fibrous histiocytoma
Synovial	Giant cell tumor of tendon sheath	Synovial sarcoma

STEP 1 – PATIENT HISTORY

The initial step taken by the clinician in the evaluation of a soft tissue sarcoma is to obtain a thorough history of the lesion. The standard NLDOCAT (nature, location, duration, onset, course, aggravating factors, and treatment) should always be determined.

The clinical presentation of soft tissue sarcomas can vary tremendously. The usual presentation is that of a nonspecific, solid mass in the subcutaneous or deeper tissues. The suspicious soft tissue mass is typically brought to the patient's attention by its physical size, rate of growth, degree of discomfort, or even complaints of paresthesias. The patient will often be asymptomatic, and may first seek medical attention when a recent change in the size of the mass is noticed, or when the size of the mass limits the choice of shoes. Soft tissue sarcomas are generally slow-growing tumors, and the rate of growth will only occasionally be helpful to the physician in assessing the aggressiveness of the lesion and its potential for malignancy. Occasionally, the patient will present with only the innocent complaint of "swelling" in the area of the foot or ankle. This type of complaint can be very misleading and the skilled examiner must be alert to the possibility of an underlying neoplasm.

Any discomfort or paresthesias that may be present are generally the result of exogenous pressure of the mass upon a peripheral nerve or nerves. The clinician can expect sensory abnormalities to predominate over motor abnormalities. The sensory abnormalities are typically well-localized over the distribution of the compressed nerve(s). Any pain that may be present is usually sharp or burning in nature and frequently increases with activity. The physician must exercise a thorough understanding of peripheral nerve anatomy and nerve compression in order to conduct and complete a proper clinical examination.

Environmental and occupational exposures, previous trauma, and personal health may provide the clinician with helpful clues. The patient's past environmental or occupational exposure to certain carcinogens or radiation may contribute to the development of these tumors. Additionally, certain medications have carcinogenic potential, and this should be elicited by the clinician in the patient history. Also, trauma may play a part in the formation of a soft tissue tumor. Finally, it should be remembered that certain diseases are associated with a greater potential for the formation of malignant soft tissue masses. Exploring these areas during the patient history interview may help in the discovery of a potential soft tissue sarcoma.[7]

STEP 2 – PHYSICAL EXAMINATION

The physical examination and documentation of the findings of the examination are a critical component of the thorough approach to the suspicious soft tissue mass. The physical examination begins with inspection of the tumor. Important diagnostic clues are often derived from the presence or absence of edema, the color of the lesion and the surrounding tissues, and the general turgor and texture of the overlying skin.

During the physical examination, the clinician should accurately palpate and measure the mass. The depth of the mass and its fixation to bone, tendon, or other surrounding structures should also be determined. This can be done with active and passive movement by the patient and by direct palpation by the examiner. Tumors found above the deep fascia will generally be mobile, while those located below the deep fascia will be fixed. Palpation by the examiner should also include evaluation of the texture and the density of the soft tissue mass. If the mass is subcutaneous, illumination through the skin with a penlight may help ascertain whether the mass is fluid-filled or solid. If the mass is fluid-filled, the light can often be seen to spread throughout the soft tissue lesion. Conversely, if the mass is solid, light will not disperse within the mass. All of the findings related to the potential tumor should be documented in the patient's chart.

The examiner should also perform a careful examination for any possible neurovascular involvement. The patient's pulses should be compared to the contralateral limb, and the proximity of the tumor to major vessels should be assessed. The limb should be evaluated for any lymphatic or venous obstruction as well. Palpation and percussion of the mass and surrounding nerves should be performed to assess any possible neurological involvement. In some cases, the lesion may actually be endogenous to the nerve, as in the case of a malignant schwannoma, rather than exogenous. The examiner should be aware that active or passive manipulation of the involved areas may

exacerbate symptomatology and make the neural pathology easier to demarcate. Occasionally, when there is sensory involvement, the patient can aid the examiner by pointing to areas of proximal or distal paresthesia and a specific nerve can literally be "mapped out" in the process.

Although lymph node involvement is unusual with soft tissue tumors of the foot and ankle, the physical examination would not be complete without palpation of both popliteal and inguinal lymph nodes. These areas should be soft and not tender to palpation. If the lymph nodes are easily palpated yet found to be soft and easily movable, the examiner should be aware that possible reactive lymphadenitis may be present. Harder, fixed nodes suggest a possible metastatic sarcoma.[8]

STEP 3 – ACCESSORY DIAGNOSTIC STUDIES

After a complete history and physical examination has been performed on the patient, additional tests can be undertaken by the clinician to further assess the mass. Diagnostic tools such as radiographs, laboratory studies, and advanced imaging techniques can be employed if necessary.

Standard pedal radiographs are of limited value in evaluating the soft tissue tumor. However, radiographs are indicated to rule-out any osseous extension or involvement. The radiographs in such instances should always be taken with soft tissue attenuation. Standard radiographs with soft tissue attenuation and xeroradiographs can be expected to offer similar visualization of the soft tissue mass.[9] The margins of the mass may even be determined in some instances as a soft tissue opacity. The mass itself should be radiographically inspected for the presence of calcifications. These calcifications occur due to metatastic, metabolic, and dystrophic causes. Their identification in a soft tissue mass can be suggestive of malignancy.[10] If any osseous invasion is identified by the clinician, consultation with a radiologist is advisable.

Since plain radiography and xeroradiography offer poor specificity for the presence of a soft tissue neoplasm, more advanced imaging techniques are often necessary. Ultrasonography, computerized axial tomography (CT), and magnetic resonance imaging (MRI) have supplanted standard radiography and xeroradiography in the evaluation of soft tissue masses of the lower extremity. Simply stated, there are three questions that one must answer when evaluating an advanced imaging study of a suspected musculoskeletal tumor. First and fundamentally, "Is there a mass?" Second, "If a tumor is present, can the tumor be histologically characterized?" And third, "If a tumor is present, what is its extent?"

Ultrasonographic evaluation can be helpful in the localization and characterization of soft tissue masses. Use of ultrasonography in the lower extremities requires a skilled ultrasonographer and a radiologist knowledgeable in their interpretation. Ultrasonography's greatest strength is in discriminating whether a mass is solid, cystic, or both. Ultrasonography is generally unreliable in determining the histologic type of a soft tissue tumor, although certain characteristics distinguishing benign and malignant tumors are recognized (Table 2).[11] Soft tissue tumors derived from fibrous components or perineural fibrosis (e.g., a Morton's neuroma) are comparatively hypoechoic relative to surrounding normal tissues.[9] Further, angiomas and neurilemomas are usually hyperechoic.[12] These benign lesions usually demonstrate homogenous echoes and well-defined margins. Conversely, a malignant tumor typically demonstrates inhomogenous echoes, irregular margins, and invasion of surrounding structures.

Table 2

ULTRASONIC CHARACTERISTICS OF SOFT TISSUE TUMORS

BENIGN	MALIGNANT
Homogenous echoes	Inhomogenous echoes
Regular margins	Irregular margins
Displacement of muscle fibers	Muscle fiber rupture
Surrounding tendons or muscles	Infiltration of adjacent structures

Computerized axial tomography (CT) and magnetic resonance imaging (MRI) are the most helpful diagnostic tools. Both of these techniques allow cross-sectional visualization of the anatomic part being analyzed. Furthermore, they both allow some assessment of the boundaries and possible tissue composition of the soft tissue mass. This can be particularly helpful in planning biopsies or surgical

excision of the mass. It should be remembered that MRI is well-documented to be superior to CT in assessing soft tissue masses and their extent.

When CT scans are performed for the evaluation of soft tissue masses, coronal (or frontal) plane images with soft tissue windows will generally afford the most information. Besides the location and extent of the mass, some determination can be made about the density of the soft tissue mass. However, on CT images, muscles, tendons, nerves, and blood vessels all have similar gray scale values, and the contrast between them can be minimal (Fig. 1). CT scans are most useful when cross-sectional bone detail is needed or when calcifications are present.[13]

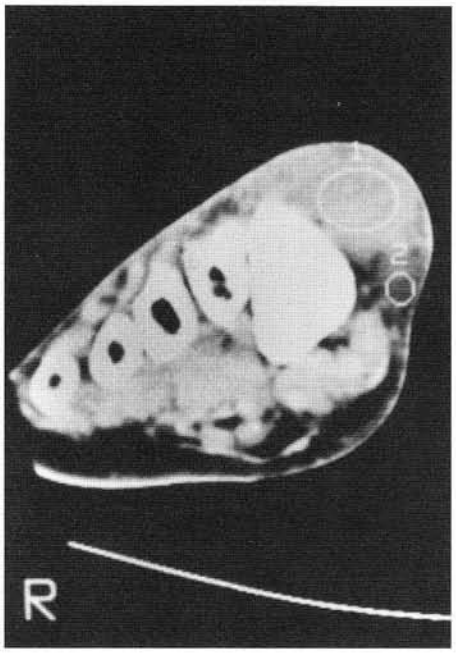

Figure 1. Frontal (coronal) CT image of soft tissue mass over the dorsomedial aspect of the foot. Note that the mass has the same gray scale density as muscle and nerve. The mass was a malignant fibrous histiocytoma.

Comparatively, the main advantage of MRI in the evaluation of soft tissue masses is the dramatic soft tissue contrast inherent in the technique. The appearance of soft tissue tumors on MRI varies with the pulse sequence selected. In most soft tissue tumors, there is an augmentation of water content in the pathologic tissue when compared to the surrounding normal tissues. Therefore, different pulse sequences allow MRI to be very sensitive to this increased water content in tumorous tissue (Figs. 2A-2B). Another advantage of MRI is the ability to obtain direct images in all three body planes. CT

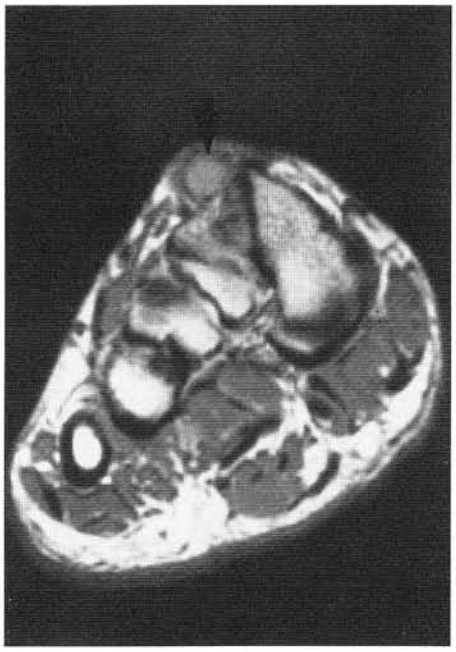

Figure 2A. MRI of a ganglion over the dorsum of the foot. T1- weighted MR image of the mass (arrow).

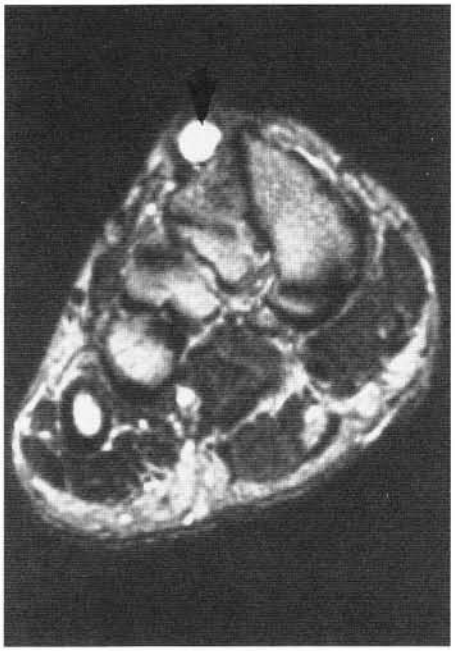

Figure 2B. T2-weighted MR image of the mass. Note the increased signal intensity and uniform homogeneity of the mass (arrow). This MRI appearance is consistent with a fluid-filled mass such as a ganglion.

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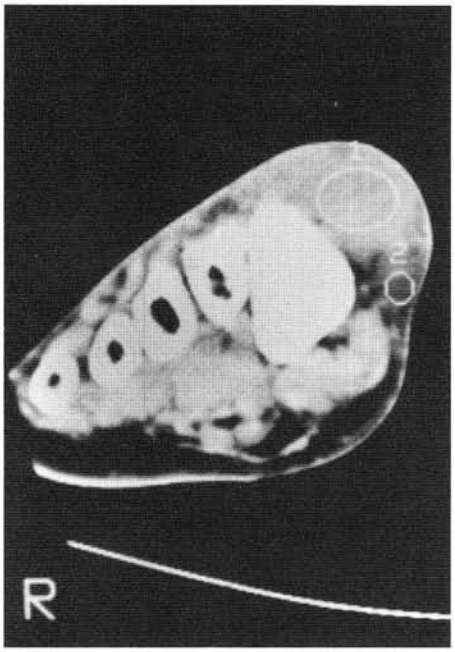

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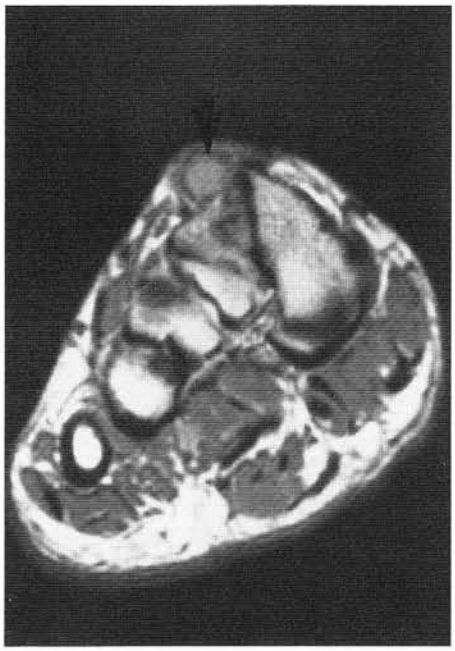

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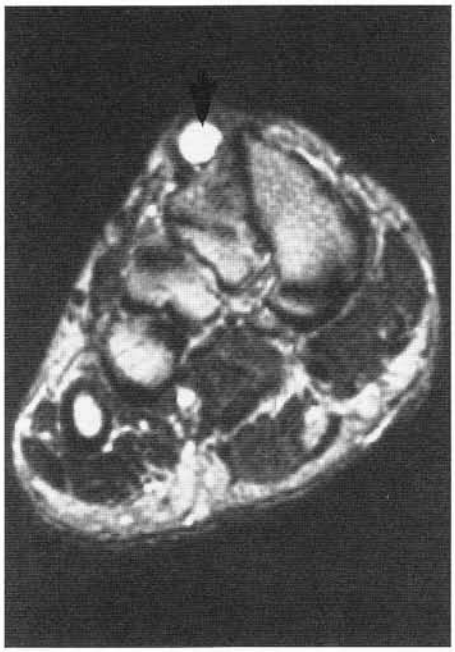

Figure 2B. T2-weighted MR image of the mass. Note the increased signal intensity and uniform homogeneity of the mass (arrow). This MRI appearance is consistent with a fluid-filled mass such as a ganglion.

skilled in imaging the lower extremity, can obtain direct CT sagittal plane images of the foot and ankle. However, due to the ease of obtaining the images and greater acceptance, the sagittal (or longitudinal) plane images obtained with MRI are generally superior to those obtained with CT.

Likewise, the staging and characterization of soft tissue tumors is also superior with MRI. Benign soft tissue masses tend to have well-defined margins and a relatively homogenous internal structure when visualized on either MRI or CT (Figs. 3A-3D). Contrasting, malignant soft tissue masses tend to have irregular, poorly-defined margins and inhomogenous internal structure (Figs. 4A-4D). Some tumors can be histologically identified by magnetic resonance images or CT scans, but neither MRI nor CT can routinely differentiate benign tumors from malignant tumors. In this sense, MRI can be considered to be very sensitive for a soft tissue neoplasm but relatively nonspecific.

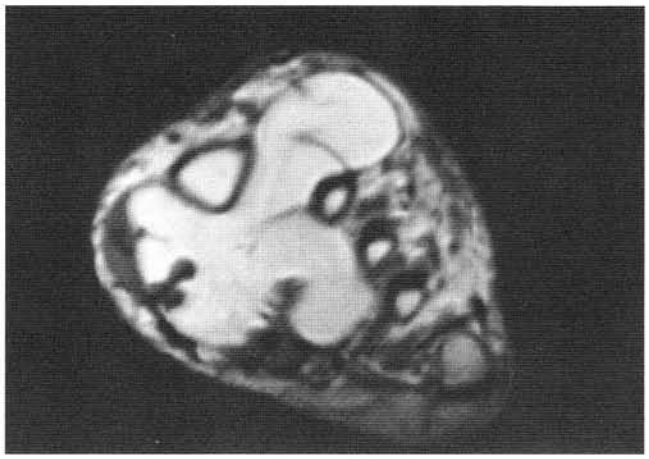

Figure 3A. Frontal (coronal) T1-weighted images of a pedal soft tissue mass. Note that the mass is homogenous, fairly well demarcated, and does not appear to invade bone.

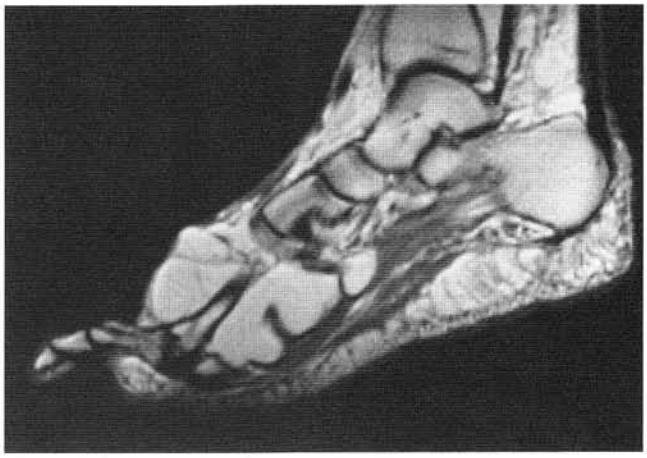

Figure 3B. Sagittal (longitudinal) T1-weighted images of a pedal soft tissue mass.

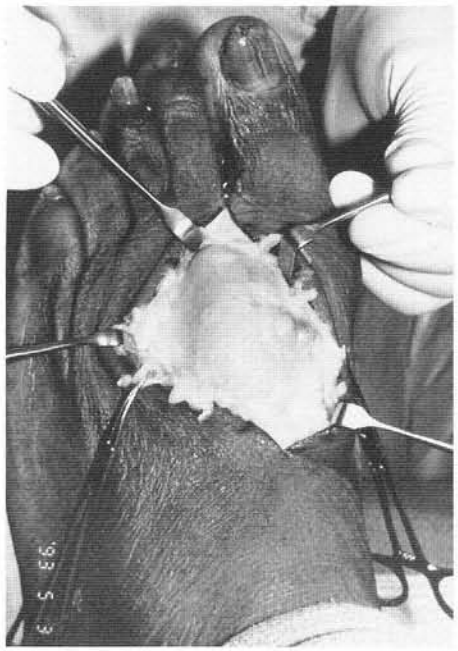

Figure 3C. Excisional biopsy was performed.

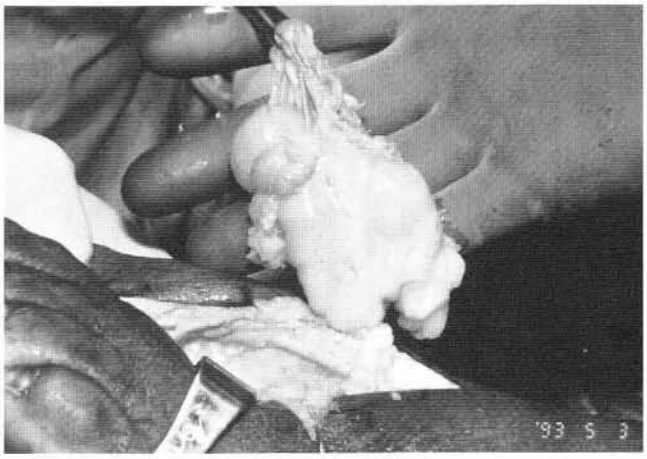

Figure 3D. Excisional biopsy confirmed the mass to be a benign fibrolipoma.

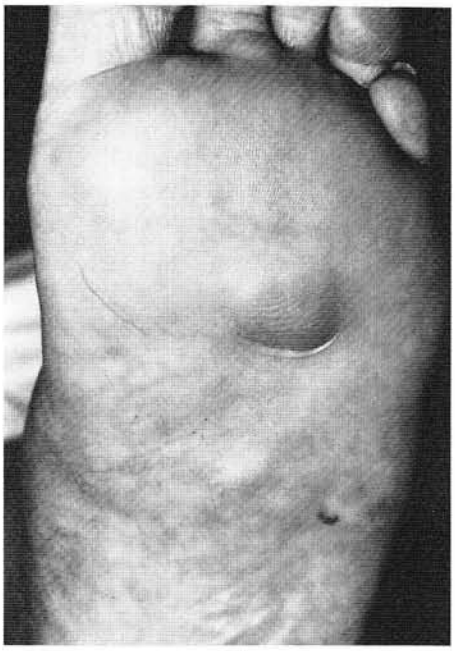

Figure 4A. Clinical appearance of a tumor on the plantar aspect of the foot. The mass was non-painful, and slowly enlarging.

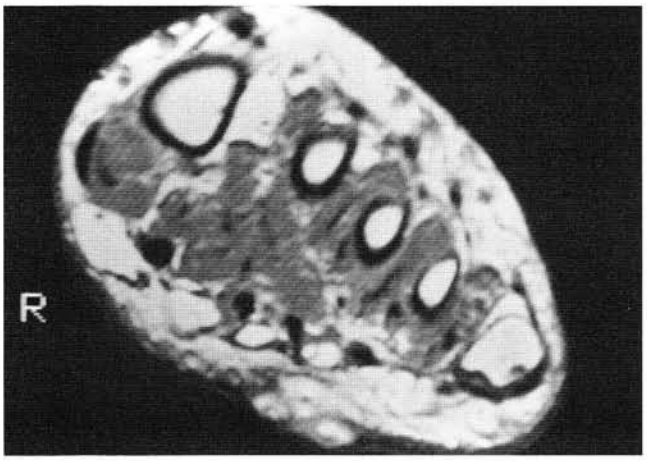

Figure 4C. T2-weighted MR image of the mass. Minimal increase in intensity is noted, and the mass remains poorly-defined and inhomogenous.

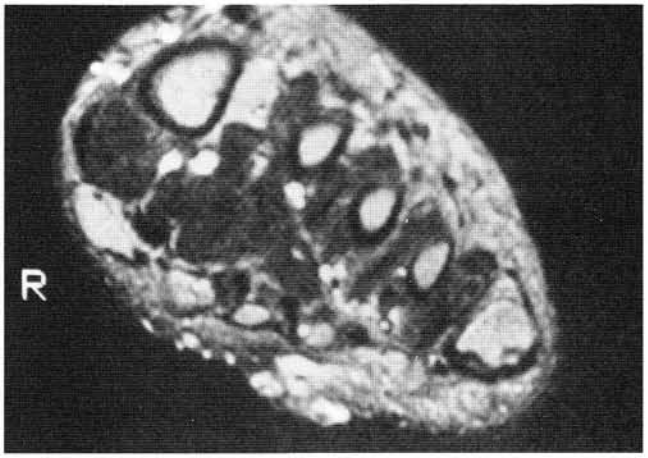

Figure 4B. T1-weighted MR image of the mass. Note the mass is poorly-defined, and inhomogenous.

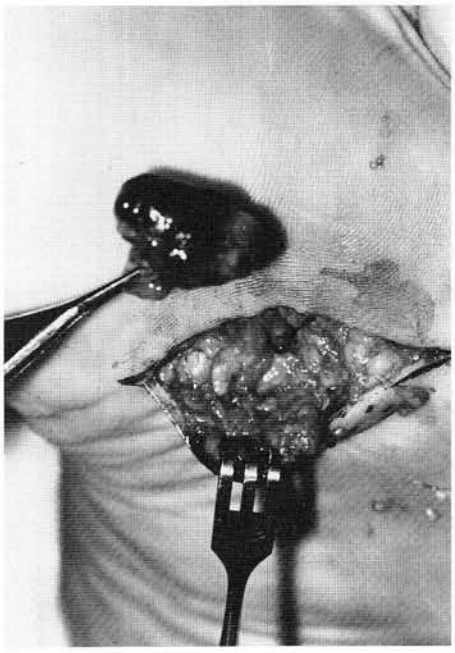

Figure 4D. Excisional biopsy of the mass, which was confirmed to be a malignant papillary syringocystadenoma.

Thus, MRI has emerged as the modality of choice for the assessment of soft tissue tumors of the musculoskeletal system. Berquist et al.[14] evaluated the MRI interpretations of 3 radiologists and found that they accurately identified soft tissue tumors as being malignant 90% of the time with a negative prediction value of 94%. Generally, CT, like plain radiography, is considered superior to MRI in the assessment of bone involvement and calcifications.

The examiner may also find nuclear medicine studies to prove beneficial where there is contiguous bone involvement and extension from soft tissue sarcomas. These conditions can be readily detected utilizing three-phase Technetium-99 bone scans. However, bone scans are of minimal use in the identification of distant metastases, and therefore, their value is limited to confirmation of any bone involvement, or lack thereof, as compared with other imaging techniques. In much the same way, gallium-67 scans are of little value in assessing the soft tissue sarcoma. Distant metastases are detectable in some histological types of sarcoma, such as malignant schwannoma and rhabdomyosarcoma, but are frequently associated with false-negatives in most types of sarcoma.[15,16]

In some instances, other tests may be desirable. For example, if the mass is pulsatile or near a major vessel, angiograms or an MRI study with vascular contrast media may be ordered prior to biopsy or surgical excision.[9] This will enable the surgeon to properly plan a treatment.

When a potential sarcoma is identified, chest radiographs should also be performed and examined for possible metatastic spread. This is advisable since the first site of sarcoma metastasis is usually pulmonary, and about 15% of patients presenting with a primary soft tissue sarcoma will have pulmonary metastases. Currently, about two-thirds of these metastases are detectable on conventional chest radiographs, and the remainder can be visualized on chest tomography or a chest CT scan.[17,18]

Finally, laboratory studies are usually of little value in evaluating the presence of a possible soft tissue sarcoma. Lab studies evidencing alterations of the complete blood count, and blood chemistry profile, may be noted once there is already significant systemic involvement and metastasis.

STEP 4 – BIOPSY

As soon as a suspicious soft tissue mass is identified, the patient should be counseled and educated as to the potential tumor and the need for biopsy. The word "tumor" often engenders great fear in the patient, and emphasis must be placed upon the realistic small potential for malignancy. However, the physician should emphasize the advantage of early diagnosis, inasmuch as early identification and treatment of tumors increase the chance for successful management and may preserve limb and life. At a consensus conference on musculoskeletal sarcomas, a biopsy was considered essential for an exact diagnosis before the development of a definitive treatment plan.[19] Biopsy requires strict adherence to certain principles to prevent compromise of the definitive treatment plan and ultimate patient outcome.

There are four types of biopsy procedures that may be employed to establish the diagnosis of soft tissue sarcomas. They are fine needle aspiration, trocar needle biopsy, excisional biopsy, and incisional biopsy. These biopsy procedures are essential to make the histological diagnosis and establish the appropriate treatment plan. Whenever a biopsy is taken, a portion should be sent for histologic evaluation, and whenever possible, another portion should be sent for bacterial and fungal cultures. As a general rule of thumb, one should remember the quip "to biopsy your cultures and culture your biopsies," as suspected infections often turn out to be tumors and vice-versa.

Fine needle aspiration, a closed biopsy technique, has been shown to be useful in the diagnosis of many carcinomas, but generally should not be used for the definitive diagnosis of soft tissue tumors. Aspiration may demonstrate certain cytological characteristics, but exact histological classification and the degree of differentiation are virtually impossible to determine from fine needle aspiration samples. When a suspicious soft tissue mass is encountered, the clinician should temper the desire to perform fine needle aspiration, as the needle may actually "track" the potentially malignant tumor to other areas in the vicinity of the aspiration attempt. Many reports exist that highlight the disastrous, inadvertent spreading of a malignant tumor by the unsuspecting clinician who thought he was simply "aspirating a ganglion."

The second biopsy technique, also a type of closed biopsy, is trocar needle biopsy. Various sizes of needles can also be used to perform needle biopsies, where a solid core of tissue is obtained with the needle (Fig. 5). This technique is advantageous over fine needle aspiration, as it provides a tissue diagnosis and not just a cytological diagnosis. By obtaining several tissue cores, a histologic assessment of the tumor can be made by the pathologist. Proponents of trocar needle biopsy state that it is less traumatic, can be performed under local anesthesia in the out-patient or office setting, and is less likely to compromise definitive surgery because

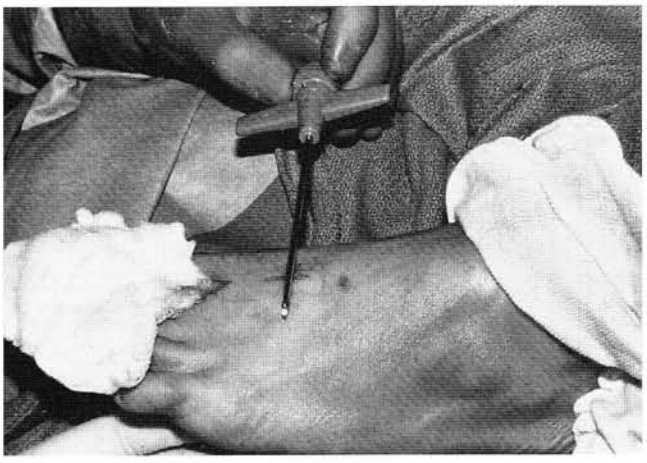

Figure 5. Example of a trocar needle biopsy.

of a smaller hematoma. The main disadvantage of trocar needle biopsy is the risk of sampling error, because of insufficient sample size or inadvertently obtaining a non-representative tissue sample. Sampling error can be as high as 20% even when performed by an experienced clinician.[20]

Open biopsy is the more time-honored method of biopsy, and can be either excisional or incisional. Excisional biopsy involves removal of the entire mass, while incisional biopsy involves removal of a small, but adequate, specimen from the tumor. Since open biopsy involves creating a surgical incision, it must be performed with forethought and meticulous technique to avoid microextension and transplantation of tumorous cells. All surgical incisions should be placed in line with underlying structures like muscle, tendon, and bone. Therefore, in the lower extremity, most open biopsy incisions should be longitudinal. Should the definitive treatment plan require further surgery, the orientation of the biopsy incision in this manner allows en bloc excision of the incision site, along with extension of the incision as necessary to expose major muscle compartments and neurovascular structures.

Generally, excisional biopsy should not be performed when a soft tissue tumor is suspected of being malignant. This is because the excisional biopsy will compromise the tissue planes and surrounding structures, making subsequent definitive procedures more difficult. Since most soft tissue sarcomas present with a pseudocapsule, simple excision of the mass will certainly leave some microscopic tumor behind. This is not to say that the technique should not be utilized. Smaller tumors, less than 2 centimeters in size, and more superficial tumors may be amenable to excisional biopsy in certain instances.

The preferred open biopsy technique in most instances is incisional biopsy. The incisional biopsy is usually the procedure of choice for assessing soft tissue tumors larger than 2 centimeters in size, or deeper soft tissue masses. The biopsy can be performed by placing an incision over the mid-portion of the mass and carrying it deep to the tumor. The incision should be longitudinal, and no longer than is necessary to obtain an adequate amount of tissue. Further, sharp dissection should be used with no undermining of adjacent soft tissue planes. In this way, contamination of adjacent tissue planes is minimized. Most importantly, the tumor is directly visualized. Again, a specimen or small wedge of tissue is obtained by the surgeon for tissue examination and histologic diagnosis. Good hemostasis is then accomplished, and the surgical wound is closed in layers (Figs. 6A-6F). If a surgical drain is necessary, it should be brought out either through the incision itself or through the skin, close to the end of the incision. It should be remembered that the drainage tube tract is potentially contaminated, and may have to be excised if future treatment demands wide local excision of the tumor site.

When performing a biopsy of a suspicious soft tissue mass in the lower extremity, care must be paid to avoid unnecessary maneuvers which might increase the potential for tumor spread or invasion. Ideally, the biopsy is performed under general or spinal anesthesia to avoid the need for local

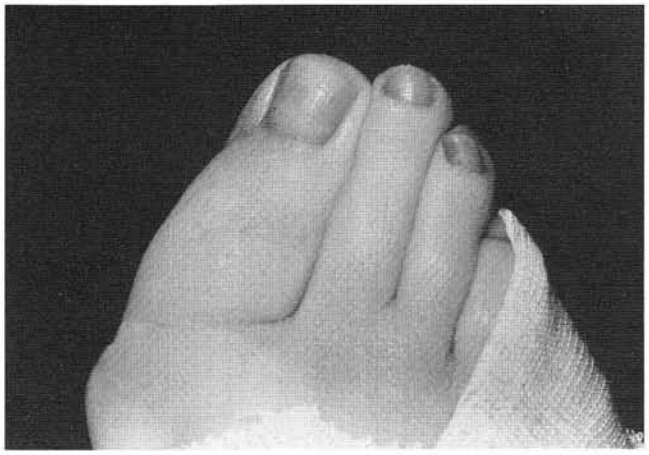

Figure 6A. Clinical appearance of a soft tissue mass encompassing the entire dorsum of the hallux.

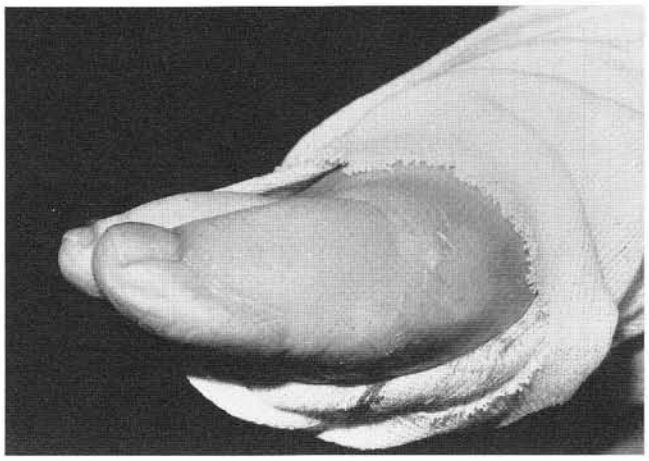

Figure 6B. Clinical appearance

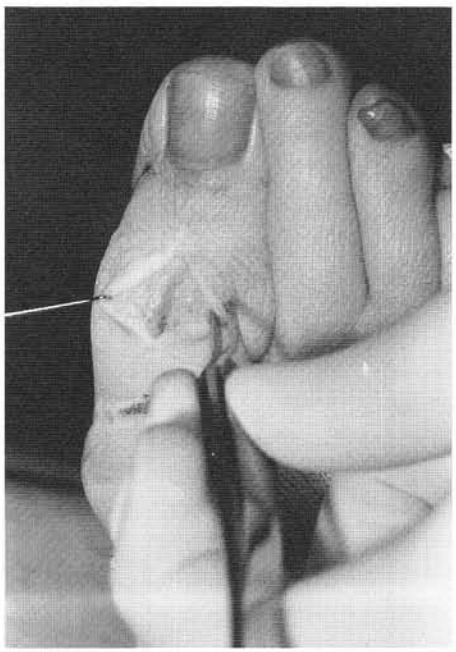

Figure 6C. Incisional biopsy of a mass centered over the middle of the mass. Note a skin marker was used to define the margins of the mass as closely as possible.

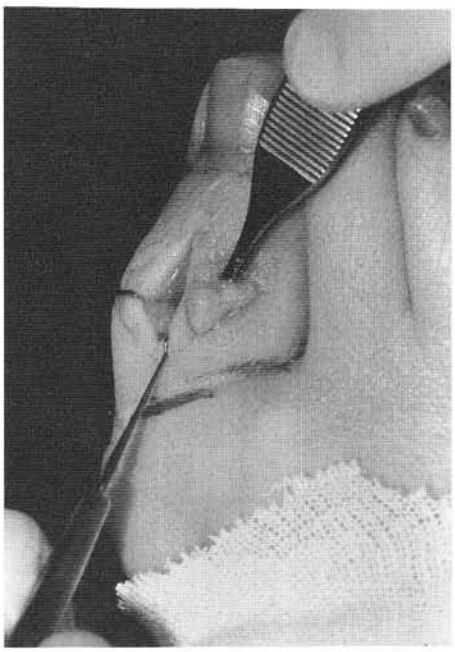

Figure 6D. A small wedge of tissue is removed for pathologic examination. Note that the mass has the intraoperative appearance of a lipoma.

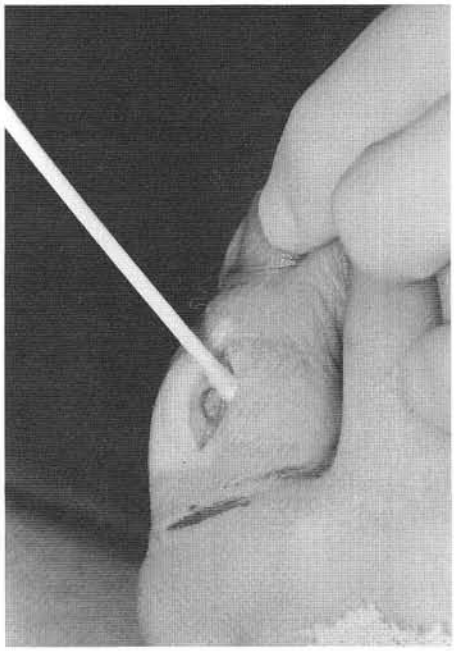

Figure 6E. Bacterial and fungal cultures are obtained to rule-out an infectious process.

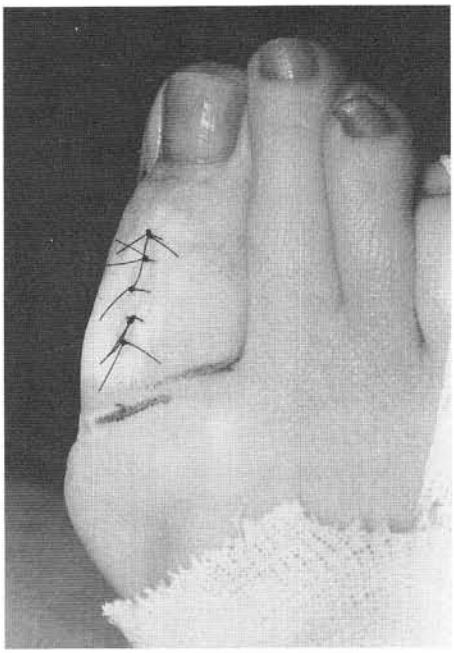

Figure 6F. The wound is closed with simple interrupted sutures, placed as close to the wound edges as possible. Pathology confirmed the mass to be a lipoma.

infiltration of an anesthetic agent during the biopsy procedure. If, however, local anesthesia is to be utilized, the block should be proximal enough to ensure that the needle used for anesthetic infiltration will not serve as a potential source for further microscopic dissemination of the tumor.

Further, debate continues over whether a tourniquet should or should not be used during biopsy. No scientific evidence exists to show tumor embolization increases after tourniquet release. Use of a tourniquet does allow better visualization during biopsy. If a tourniquet is used, the limb should

not be exsanguinated with an Esmarch or other compressive bandage, as this might traumatize the tumor and force tumor cells into the bloodstream. Simple elevation of the lower extremity followed by tourniquet inflation is adequate to prevent venous engorgement and bleeding, and will prevent any inadvertent tumor disruption. Generally, it is preferable to deflate the tourniquet prior to wound closure to obtain optimal hemostasis.[20]

If available, with any of the biopsy techniques, a prearranged preoperative and/or intraoperative consultation with a pathologist may be obtained. The pathologist should have information that includes biographical details, nature of the patient's complaint, familial history, description of the tumor area, and site of the sample's origin. Often, the pathologist will suggest specific fixatives for specimen transportation. A specimen must be of reasonable size, undamaged by instruments, representative of the disease process, and well-fixed to preserve the cellular structure of the tumor as closely as possible to the living state. Additionally, the pathologist may suggest a frozen section. At the time of surgery, a fresh, unfixed sample of the tumor is sent from the operating room to the pathology laboratory for rapid processing and examination. The frozen section report can be obtained within 10 to 15 minutes, and helps to confirm that an appropriate and representative specimen has been obtained. A preliminary diagnosis can also often be made by frozen section, but since freezing can damage cellular integrity, a treatment plan should not be made based solely upon the frozen section report. The physician should await final histological sections and diagnosis before any treatment plan is finalized.

Finally, if sutures are utilized for wound closure, they should be placed as close to the wound as possible. Small simple interrupted sutures are preferred to widely-placed mattress sutures.

5 – DEFINITIVE TREATMENT PLAN

Once a definitive diagnosis has been obtained by biopsy, the patient should be counselled on the findings. Since the suspicious soft tissue mass has the potential to be malignant, the final pathology consultation with the patient should be done in the physician's office and not over the telephone. Promises to call the patient with pathology results can lead to awkward situations if the tumor turns out to be malignant. Once the patient has been told of the findings, a definitive treatment plan may be discussed.

The definitive treatment plan will depend on certain prognostic criteria, including the following five elements: (1) the site of the tumor, (2) the tumor size, (3) the degree of differentiation, (4) the histological type, and (5) the age of the patient. Cooperative consultation with a pathologist, oncologist, and other specialists will certainly become necessary at this point if they have not been consulted earlier. The goal of the definitive treatment plan should be eradication of local disease, control of metastases, and retention of limb function.[21]

The site of the tumor is generally considered to be an important factor affecting the clinical course and prognosis. The distal extremity can be treated much more easily than proximal areas, and is associated with a better prognosis in most cases. Similarly, tumors superficial to the deep fascia have a better prognosis than tumors deep to the deep fascia.

Tumor size is also important. Sarcomas smaller than 5 centimeters have a far superior prognosis compared with those larger than 5 centimeters. Larger tumors are more difficult to adequately resect, and usually have greater involvement of the surrounding structures.[22]

The most important prognostic variable is probably the degree of differentiation of the sarcoma. Patients with well-differentiated tumors do relatively well, while those with poorly-differentiated tumors do considerably worse.[23]

Histologic evaluation is also a prognostic factor. For years, clinicians and pathologists based their treatment on histologic classification alone. However, differentiation is recognized as being much more important today. A well-differentiated fibrosarcoma will have virtually the same prognosis as a well-differentiated tumor regardless of histological type.

Likewise, age correlates variably with the prognosis. Children with some sarcomas do better than adults, but most sarcomas do similarly in any age group.

These factors have led to the development of a tumor staging system for sarcomas by the American Joint Committee for Cancer Staging and End Results Reporting. The system, known as the TNMG system, can give survival rates based upon four variables:

T – which stands for primary *tumor* size and *tissue* involvement,
N – which stands for regional lymph *node* involvement,
M – which stands for the presence of distal *metastases*, and
G – which stands for tumor histological *grade.*

Generally, higher staging suggests larger tumor, more tissue involvement, more lymph node involvement, more metastases, and higher histologic grade of the tumor. Based upon the tumor's stage, appropriate definitive treatment can be planned. Treatment plans calling for surgical resection, amputation, radiation therapy, and chemotherapy all can be utilized alone or in combination.

The primary mode of treatment for soft tissue sarcomas remains surgical excision. There are four basic methods by which surgical treatment can be performed. Intralesional surgery involves the removal of the tumor from within the reactive pseudocapsule. Marginal excision involves removal of the tumor by dissection outside but in contact with the reactive pseudocapsule. Wide excision involves en bloc excision of the tumor and biopsy of the incision/tract along with a cuff of surrounding normal tissue. Radical excision removes the entire anatomic compartment(s) containing the tumor and the biopsy incision/tract. The choice of surgical procedure is determined by the stage of the tumor, the anatomic site, and the anticipated disability.[24,25] In most cases, a minimum of wide excision with adjuvant therapy is necessary to achieve a favorable chance of local tumor control and to prevent recurrence. Intralesional and marginal resections are not adequate for most soft tissue sarcomas (Table 3).

Table 3

SURGICAL RESECTION OF SOFT TISSUE TUMORS

TYPE	PLANE OF DISSECTION	RESULT
Intralesional	Piecemeal debulking or curettage	Leaves macroscopic disease
Marginal	Shell-out en bloc through pseudocapsule or reactive zone	May leave satellite or skip lesions
Wide	Intracompartmental en bloc with cuff of normal tissue	May leave skip lesions
Radical	Extracompartmental en block (i.e., entire compartment)	No residual

Local adjuvants which may be used to prevent local tumor recurrence include radiation therapy and chemotherapy. There are many different chemotherapeutic regimens used to treat soft tissue sarcomas, but very few randomized, stratified studies based on tumor grade and histology have been performed.[26] The role of chemotherapy in the treatment of soft tissue sarcomas is still debatable, and future controlled studies are needed.

The role of adjuvant radiation therapy is less controversial. Studies by Eilber et al.[27] and Suit et al.[28] have shown that preoperative radiation therapy appears to improve the local control obtained when resection for large sarcomas is performed. This radiation may cause a firm rind to form around the tumor making surgical resection easier. Additionally, radiation used as a postoperative adjuvant has been clearly shown to be effective in controlling microscopic foci of residual disease not resected by surgery.[21,29-30]

As was stated earlier, regional lymph node involvement is infrequent. Therefore, lymph node dissection is generally not indicated. However, if the lymph nodes are hard and fixed, or if there is evidence of distal clinical lymphadenopathy, then the lymph nodes may be resected.

The most common failures following sarcoma treatment are local recurrence and distant metastasis. The clinical presentation of local recurrence is almost always the appearance of one or more nodules at the previous site of operative resection. If not previously performed, radical resection or amputation are usually performed if local recurrence of the soft tissue sarcoma occurs.

SUMMARY

Although relatively rare, soft tissue sarcomas are more prevalent in the extremities. The physician treating the lower extremities should be alert to the possibility that a soft tissue mass may indeed be a soft tissue sarcoma. Stepwise assessment and evaluation will ensure proper diagnosis and treatment. In this fashion, a logical approach and treatment program can be formulated avoiding unnecessary surgery, amputation, and mortality.

REFERENCES

1. Downey MS: Soft tissue sarcomas. In McGlamry ED (ed): *Reconstructive Surgery of the Foot and Leg Update '88*. Tucker, Georgia, Podiatry Institute Publishing Company, 1988, pp 112-116.
2. Potter GK, Ward KA: Tumors. In McGlamry ED, Banks AS, Downey MS (eds): *Comprehensive Textbook of Foot Surgery, 2nd ed*. Baltimore, Williams & Wilkins, 1992, pp 1136-1190.
3. Arlen M, Marcove RC: *Surgical Management of Soft Tissue Sarcomas*. Philadelphia, WB Saunders, 1987, pp 1-23.
4. Raaf JH: *Soft Tissue Sarcomas: Diagnosis and Treatment*. St. Louis, Mosby, 1993, pp 1-11.
5. Johnston MR: Epidemiology of soft-tissue and bone tumors of the foot. *Clin Pod Med Surg* 10:581-607, 1993.
6. Kirby EJ, Shereff MJ, Lewis MM: Soft-tissue tumors and tumor-like lesions of the foot: an analysis of eighty-three cases. *J Bone Joint Surg* 71A:621-626, 1989.
7. Potter GK: Evaluation of a patient for pedal neoplasia: basic principles and procedures. *Clin Pod Med Surg* 10:609-616, 1993.
8. Lawrence Jr W, Neifeld JP, Terz JJ: *Manual of Soft-Tissue Tumor Surgery*. New York, Springer-Verlag, 1983, pp 3-40.
9. Levey DS, Park YH, Sartoris DJ, Resnick D: Imaging methods for assessment of pedal soft-tissue neoplasms. *Clin Pod Med Surg* 10:617-632, 1993.
10. Black AS, Kanat IO: A review of soft tissue calcifications. *J Foot Surg* 24:243-250, 1985.
11. Vincent LM: Ultrasound of soft tissue abnormalities of the extremities. *Radiol Clin North Am* 26:131-144, 1988.
12. Fornage BD, Rifkin MD: Ultrasound examination of the hand and foot. *Radiol Clin North Am* 26:109-129, 1988.
13. Petasnick JP, Turner DA, Charters JR, Gitelis S, Zacharias CE: Soft-tissue masses of the locomotor system: comparison of MR imaging and CT. *Radiology* 160:125-133, 1986.
14. Berquist TH, Ehman RL, King BF, Hodgman CG, Ilstrup DM: Value of MR imaging in differentiating benign from malignant soft-tissue masses: study of 95 lesions. *Am J Roentgenol* 155:1251-1255, 1990.
15. Bitran JD, Bekerman C, Golomb HM, Simon MA: Scintigraphic evaluation of sarcomata in children and adults by Ga-67 citrate. *Cancer* 42:1760-1765, 1978.
16. Enneking WF, Chew FS, Springfield DS, Hudson TM, Spanier SS: The role of radionuclide bone-scanning in determining the resectability of soft-tissue sarcomas. *J Bone Joint Surg* 63A:249-257, 1981.
17. Chang AE, Schaner EG, Conkle DM, Flye MW, Doppman JL, Rosenberg SA: Evaluation of computed tomography in the detection of pulmonary metastases: a prospective study. *Cancer* 43:913-916, 1979.
18. Sindelar WF, Bagley DH, Felix EL, Doppman JL, Ketcham AS: Lung tomography in cancer patients: full-lung tomograms in screening for pulmonary metastases. *JAMA* 240:2060-2063, 1978.
19. National Institutes of Health Consensus Development Panel on Limb-Sparing Treatment of Adult Soft Tissue Sarcomas and Osteosarcomas: Introduction and Conclusions. *Cancer Treat Symp* 3:1-5, 1985.
20. Shives TC: Biopsy of soft-tissue tumors. *Clin Orthop* 289:32- 35, 1993.
21. Rosenthal HG, Terek RM, Lane JM: Management of extremity soft-tissue sarcomas. *Clin Orthop* 289:66-72, 1993.
22. Shiu MH, Castro EB, Hajdu SI, Fortner JG: Surgical treatment of 297 soft tissue sarcomas of the lower extremity. *Ann Surg* 182:597-602, 1975.
23. Collin C, Godbold J, Hajdu S, Brennan M: Localized extremity soft tissue sarcoma: an analysis of factors affecting survival. *J Clin Oncol* 5:601-612, 1987.
24. Harrelson JM: Tumors of the foot. In Jahss MH (ed): *Disorders of the Foot & Ankle: Medical and Surgical Management, 2nd ed*. Philadelphia, WB Saunders, 1991, pp 1654-1677.
25. Jaffe KA, Jones FK: Foot tumors. In Gould JS (ed): *Operative Foot Surgery*. Philadelphia, WB Saunders, 1994, pp 240- 262.
26. Elias AD, Antman KH: Adjuvant chemotherapy for soft-tissue sarcoma: a critical appraisal. *Semin Surg Oncol* 4:59-65, 1988.
27. Eilber FR, Morton DL, Eckardt J, Grant T, Weisenburger T: Limb salvage for skeletal and soft tissue sarcomas: multidisciplinary preoperative therapy. *Cancer* 53:2579-2584, 1984.
28. Suit HD, Proppe KH, Mankin HJ, Woods WC: Preoperative radiation therapy for sarcoma of soft tissue. *Cancer* 47: 2269-2274, 1981.
29. Brennan MF, Casper ES, Harrison LB, Shiu MH, Gaynor J, Hajdu SI: The role of multimodality therapy in soft-tissue sarcoma. *Ann Surg* 214:328-338, 1991.
30. Suit HD, Russell WO, Martin RG: Management of patients with sarcoma of soft tissue in an extremity. *Cancer* 31:1247-1255, 1973.

ADDITIONAL REFERENCES

O'Keefe RG: Surgical management of soft tissue tumors. In Oloff LM (ed): *Musculoskeletal Disorders of the Lower Extremities*. Philadelphia, WB Saunders, 1994, pp 626-638.

Page JC: Soft tissue tumors: diagnosis and treatment. In Butterworth R, Dockery GL (eds): *A Colour Atlas and Text of Forefoot Surgery*. London, Wolfe, 1992, pp 183-193.