The Journal of Foot & Ankle Surgery 50 (2011) 108–116

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Pigmented Villonodular Synovitis of the Ankle—Radiation Therapy as a Primary Treatment to Reduce Recurrence: A Case Report with 8-year Follow-up

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ARTICLE INFO

Level of Clinical Evidence: 4
Keywords:
ankle
foot
giant cell tumor
neoplasm
soft tissue mass
surgery
tendon sheath

ABSTRACT

Pigmented villonodular synovitis (PVNS) is a rare, benign, idiopathic proliferative disorder of the synovium that results in villous and or nodular formations that have been reported to manifest within joints, tendon sheaths, and bursae. The overall incidence includes 2% to 10% that occur within the foot and ankle joints. PVNS has a high rate of recurrence and up to a 45% recurrence rate has been reported despite surgical intervention. Although traditional treatment for PVNS includes synovectomy with arthroplasty of the affected joint, radiation therapy is now suggested as an adjunctive therapy that is believed to reduce recurrence of the disease. We present a case of PVNS where the patient was treated in 2 stages: surgical resection of the tumor with arthroplasty of the ankle joint followed by radiation therapy. A retrospective review of the chart, radiographs, and MRIs was conducted for a 36-year-old, African American female who had been treated and followed for 8 years. Pathologic examination of the tumor confirmed the diagnosis of PVNS. No evidence of recurrent PVNS was identified in the long-term postoperative MRI examination. The fact that ancillary imaging examinations failed to reveal evidence of recurrence and that the patient expresses a very high patient satisfaction supports the potential benefit of adjunctive radiation therapy for this condition.

Pigmented villonodular synovitis (PVNS), first termed by Jaffe et al in 1941 (1), is an uncommon proliferative disease usually affecting the synovium of the joints and or tendon sheaths resulting in effusions and bony erosion with 2% to 10% affecting the joints of the foot and ankle (2–8). Although recurrence is high, malignant transformation is considered rare (9, 10). In response to this high rate of recurrence, authors have explored the potential benefit of radiation therapy for this condition. To date, there are only 9 articles documenting the benefits of radiation therapy supporting the use of this technique in the current literature (5, 11–19). The success of radiation therapy based on these reports has modified the current trend in interventional therapy for PVNS. To illustrate the destructive nature of this unusual condition, the authors present a case of PVNS where the patient was treated in 2 stages: surgical resection of the tumor with arthroplasty of the ankle joint, followed by radiation therapy. A retrospective review of the chart, radiographs, and magnetic resonance images (MRIs) was conducted for a 36-year-old, African American female who had been treated and followed for 8 years.

Historical Review

PVNS is usually a monoarticular manifestation most commonly affecting the knee (19); however, bilateral hip involvement has been reported (20). In one study of 58 cases of PVNS, the knee was the most common location of occurrence and accounted for two thirds of those cases. In descending order of occurrence, the other locations included 16% in the hip and 7% in the ankle with only infrequent occurrence in the wrist, shoulder, or elbow (8). In this article, symptoms may have been present from weeks to years (2 weeks to 25 years in one literature review), defining this condition as a chronic entity. In an early description, 3 forms of this proliferative disease were defined: nodular, localized or diffuse, based on gross and histologic findings (21). More recently, Granowitz and Mankin (22) subdivided PVNS into 2 forms: isolated nodular lesions and those with diffuse joint involvement. Both of these types share the same histological findings, including the proliferation of mononuclear cells with fibrous stromal cells throughout with multinucleated giant cells and lipid-laden histiocytes also present (22–25). Myers et al (8) went so far as to discuss the PVNS entities as a spectrum of disease evolving from a diffuse to well-localized giant cell tumor of tendon sheath.

Financial Disclosure: None reported.
Conflict of Interest: None reported.
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doi:10.1053/j.jfas.2010.10.001

The etiology of PVNS has remained controversial and the current suspicion is that these lesions develop from chronic inflammation or trauma rather than being true neoplasms in and of themselves. Bone and joint changes likened to PVNS have been reported in patients with hemophilia and it is from these cases that the idea of hemarthrosis inciting this process has been discussed. Through animal studies, it has been ascertained that injection of blood into a joint will produce inflammatory changes likened to that of PVNS and so the notion that this may be trauma related is a reasonable one (24). To support this theory, there has been a case report specifically on the rapidly progressive destruction of the subtalar joint after incidental trauma (25). Alternate studies have looked at the relationship of the proliferating cell nuclear antigen (PCNA) to PVNS, as it is one of the cell cycle–related proteins directly involved in DNA synthesis that may be involved in this process (26–28). Further discussions of the potential etiology of PVNS have included a more simplistic culprit for this condition. For example, it has been proposed that chronic intra-articular inflammation may simply lead to synovial hyperplasia and neovascular development within the joint. This would lead to intra-articular capillary fragility and hemarthrosis with even repetitive cyclic activity in addition to overt trauma. This in and of itself would set the stage for hemosiderin dumping from hypervascular synovium and cellular uptake of iron and other blood components yielding the characteristic histologic findings of PVNS.

Case Report

A 36-year-old African American woman complained of insidious onset of burning right ankle pain and swelling, progressively worsening for 1.5 years. She denies history of specific injury or trauma. Her employment as a factory worker required weight bearing for 12 hours per day on the concrete flooring of the industrial line. With prolonged weight bearing, she felt “feverish sensation in the ankle joint” and she felt and often heard a “crunching” in her ankle. The sense of stiffness is accompanied by a tightness and shooting sensations into the foot. The frequency of these symptoms varied from 2 episodes per month to daily with every step and this changed depending on her activities. Over time, the pain became more constant in nature and recently she developed pain regardless of her weight-bearing status. She described a sense of increased pressure in the ankle while lying in bed at night, which interfered with her ability to sleep. Using the analog pain scale, the intensity of her pain was graded as ranging from a minimum of 1 of 10 to a maximum of 7 of 10. She tried using ice and compression wraps for her ankle but they did not relieve the pain. She had been seen by a foot and ankle specialist who had diagnosed arthritis and prescribed an MRI to clarify the diagnosis. The MRI was read as positive for rheumatoid arthritis and identified a rheumatoid nodule at the anterolateral aspect of the right ankle joint. Despite physical therapy and use of an ankle brace, her symptoms failed to remit. She presented to the author’s (M.S.J) office for evaluation and treatment recommendations for chronic ankle pain. Her part medical history was benign and she reported no family history of rheumatoid arthritis or unusual or severe osteoarthritis.

The clinical examination revealed that the patient had a mild genu valgum and the ankles were externally rotated equally. The medial arch was non weight bearing and the forefoot was full weight bearing without evidence of plantar lesions. There was a supple fullness over the anterolateral ankle and sinus tarsi. The relaxed calcaneal stance position was in varus bilaterally. Unilateral toe rise aggravated the right lateral ankle joint pain. The patient exhibited an antalgic gait favoring the right ankle. The manual examination of the foot and ankle revealed a full range of motion within the subtalar joint, tarsometatarsal joint, and ankle joint bilaterally. No crepitation was noted, neither palpable nor audible was elicited on an aggressive manipulation of the ankle. The Achilles tendon was tight bilaterally and restricted the ankle motion to neutral position regardless of the position of the knee. There was a supple, spongy soft tissue enlargement within the anterolateral ankle and rear foot. She had 2 distinct target areas of tenderness on deep palpation and manipulation of the ankle. The most significant area of tenderness was in the area of the anterior tibiofibular ligament and the area of less significance was within the posterior lateral ankle in the region of Kaeger’s triangle. Muscular weakness of the right peroneus brevus and tibialis posterior tendon was graded as 4/5. No similar weakness was noted in the contralateral limb. The neurovascular status was intact and the lower extremities were otherwise healthy appearing.

The lateral ankle radiographs were not overtly impressive and revealed only a scalloped morphology of the dorsal talar neck and a posterior hiatus sign within the posterior ankle joint (Fig. 1, A). The ankle mortise was narrowed; however, was in congruous alignment without evidence of an osteochondral defect (Fig. 1, B). The subtalar joints and midtarsal joints were in neutral alignment. There was no evidence of increased soft tissue density within the foot and ankle.

The MRI evaluation reported a prominent multinodular synovial-based mass predominately situated in the anterior aspect of the tibiotalar joint, filling the anterior recess (Fig. 2, A). This actually

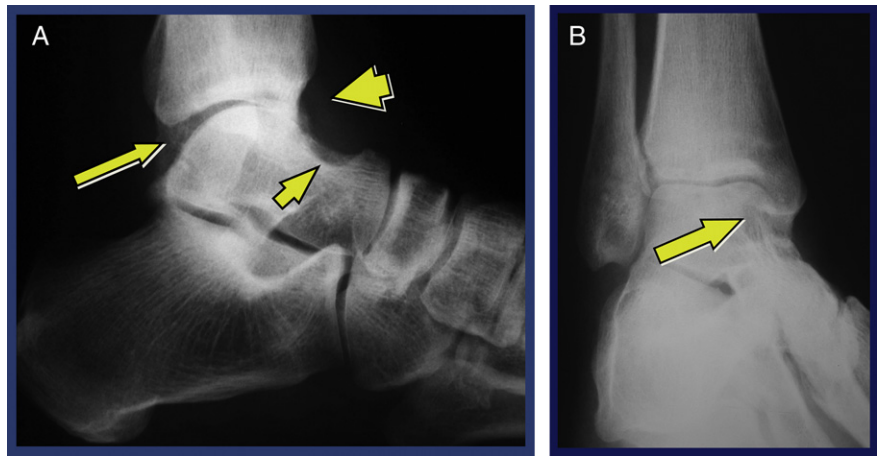

Fig. 1. (*A*) The lateral radiograph was overtly impressive and revealed only mild anterior joint space narrowing with a trace osteophytic lipping. Findings typical for chronic ankle pain. The only unusual characteristics noted in retrospect were a scalloped margin at the dorsal neck of the talus (small arrow head), an enlarged posterior hiatus (long arrow) and a spherical scalloped margin in the distal anterior tibial plafond (Large arrow head). (*B*) The ankle mortise was narrowed however was completely congruous in alignment without evidence of osteochondral defect. There was subtle evidence of a large circular lucency in the subchodral aspect of the medial talar shoulder indicated by the arrow.

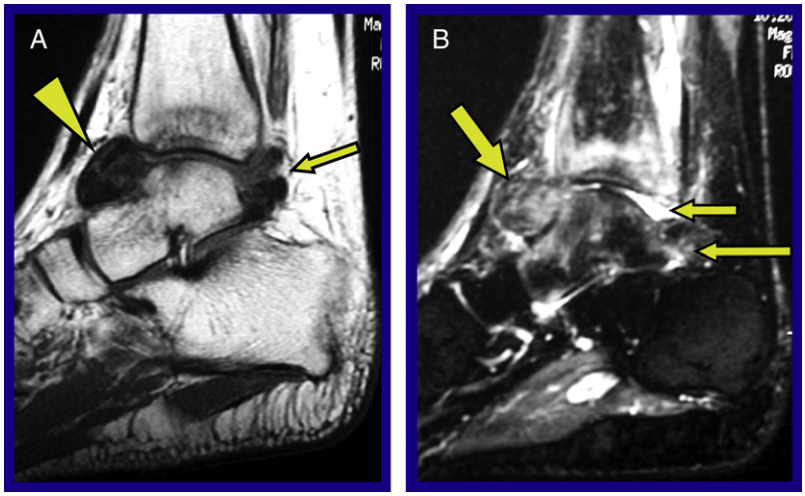

Fig. 2. (*A*) MRI T-1 imaging sagittal section reveals a prominent multi nodular synovial–based mass predominantly situated in the anterior ankle (arrow head). There is a bifid nodule within the posterior ankle capsule that emits a nonhomogeneous signal intensity and is best appreciated in the T-1 imaging sequence (small arrow). (*B*) MRI Split Tau Inversion Recovery (STIR) sequence sagittal section reveals the mass within the anterior ankle juxtaposed to the dorsum of the talar neck. The inflammatory process appears most intense within the distal tibia with intra medullary edema less intense throughout the talus. The morphology and the location of the anterior ankle mass are commensurate with scalloping of the dorsal talar neck appreciated on plain radiographs (fat arrow). The fluid within the posterior hiatus (small arrow) and the mixed signal intensity within the bifid nodule in the usual location of the os Trigonum (long arrow) are evident within this STIR sequence image.

extended into the region of the syndesmosis. There was associated bony erosion at the lateral aspect of the tibiotalar articulation as depicted on coronal T1-weighted spin-echo imaging. Sagittal fat suppressed and short Tau inversion recovery (STIR) imaging depicted reactive marrow edema in both the distal tibia and in the talar dome and body (Fig. 2, B). The subtalar joint was spared. There was no scarring or synovitis in the sinus tarsi. The synovial process extended in the posterior recess of the tibiotalar joint but to a lesser degree than the anterior disease. Axial images depicted fullness in the lateral gutter. With respect to signal characteristics, the synovial process was strikingly low in signal intensity on T1-weighted images and remained low in signal intensity on the fat-suppressed proton density images. No true T2-weighted images were performed. There was only a small joint effusion.

Basic serologic testing was performed and a rheumatology consult was conducted before scheduling the surgical intervention. This preoperative blood work included a leukocyte count of 7.1, platelet count of 294, C-reactive protein quantitative of 1.8 (range 0.0–4.9), rheumatoid factor of 7.5 (range 0.0–13.9), antinuclear antigen was negative, and erythrocyte sedimentation rate of 7.0 (range 0–20).

Surgical Technique

A linear incision was made along the anterior lateral ankle joint just medial to the fibula exposing the subcutaneous structures of the anterior ankle joint. Bleeding vessels were bovied, cauterized, or ligated as needed. After retraction of the extensor tendons, sparse areas of hemosiderin deposition were noted within the deep fascia (Fig. 3, A). Deep to the extensor tendons, a large, firm, chocolate-colored mass was found overlying the dorsum of the talar neck and anterolateral ankle joint (Fig. 3, B). The mass was excised en toto and did not have an independent blood supply. The greatest dimensions of the lesion measured 5.0 × 3.0 × 1.7 cm (Fig. 3, C), which was sent for histological examination. Deep wound swabs were sent for microbiology and there was no report of bacterial growth from the wound.

Postoperatively, the patient was immobilized in a Jones compression short-leg splint for 2 weeks while non weight bearing, followed by partial weight bearing for 2 weeks in a fracture boot.

The pathology report diagnosed the mass as a pigmented villonodular synovitis (PVNS). A mixture of villous and nodular proliferation was described with both mononuclear and multinuclear cells with hemosiderin deposition throughout (Fig. 4, A and B).

The patient was then treated with a series of radiation treatments of 34 Gy in 15 doses over a 3-week period. The course was unremarkable with the exception of a slight hyperpigmentation of the skin of the ankle in the area of the delivered radiation that healed with local care (Fig. 5, A and B). The patient discontinued follow-up after 14 months postoperative and failed to pursue the use of an ankle foot orthosis (AFO). She related that she preferred to go barefoot because she was typically just at home with the children. The most recent clinical and radiographic examinations were performed at 7 years postoperative because of a complaint of discomfort in the ankle (Fig. 6, A–C). The patient was now interested in the conservative option, ie, an ankle foot orthosis; a leather lace-up device was tolerated well. The patient was able to walk, perform toe-rise maneuvers and stoop; however, was experiencing recurrence of discomfort in the ankle joint. Her rear foot position remained unchanged from the varus condition noted in the preoperative setting. The AFO, an Arizona brace, reduced her pain significantly for the preceding 9 months. An updated MRI identified increased joint space narrowing and degenerative change within the ankle mortise; however, failed to reveal evidence of overt recurrence of tumor or nodular excrescences at 7 years postoperative (Fig. 6). At the writing of this article, the patient is 8 years postoperative and continues to participate in her usual daily activities.

Epidemiology

The epidemiology of PVNS discussed in the literature stimulates more questions than it answers and to date there is no consensus regarding the exact cause of this disease. One of the largest studies geared at providing information to determine the pathogenesis of this condition reviewed 166 cases. In this study, most PVNS cases affected males nearly 2:1 over females in a reported incidence of 1.8 cases per million annually (8). This suggests that the entity is rare in its occurrence. Looking at social influences, such as household crowding, occupation, marital status, or median family income, there were no significant concentrations to report in this large study.

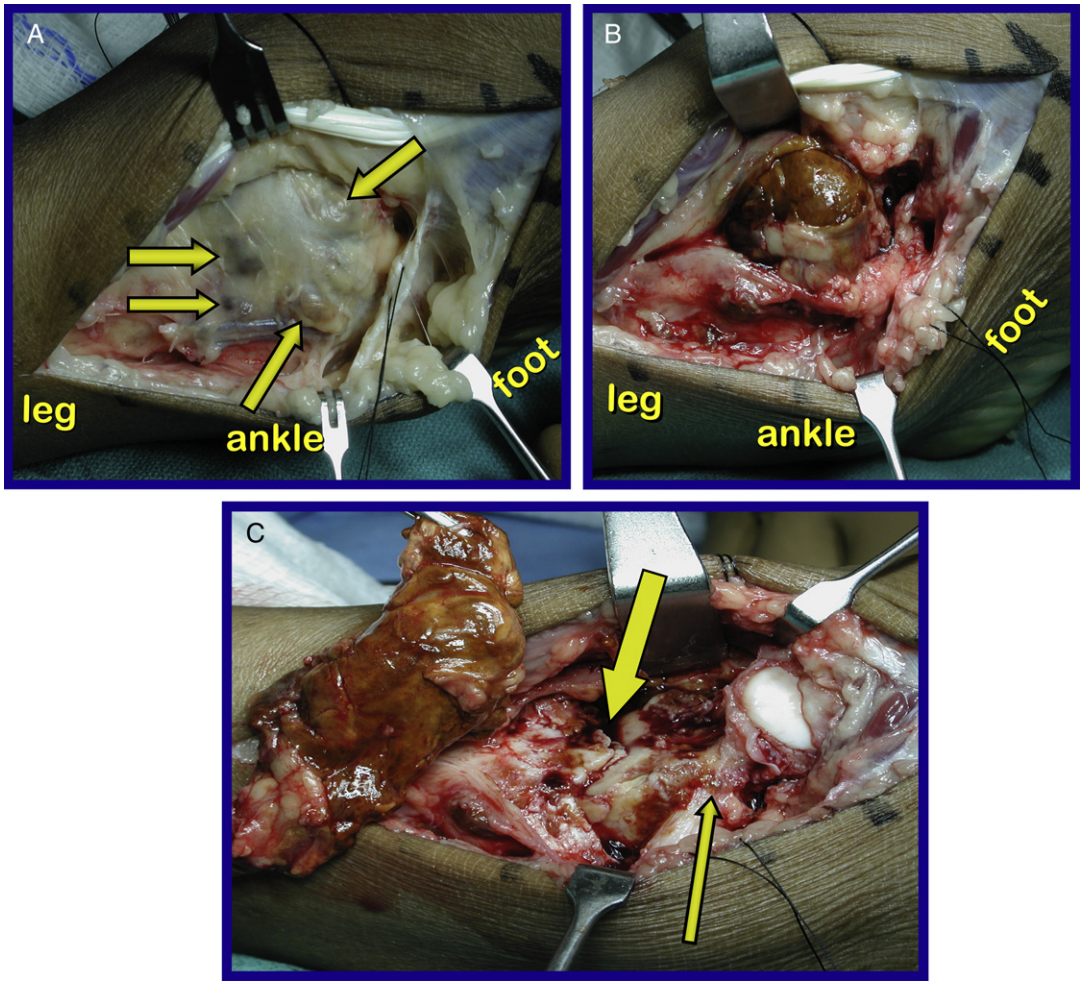

Fig. 3. (*A*) Nodular hemosiderin deposits are noted within the deep fascia. The foot is to the Right, the toes are pointing upward and the ankle is on the Left. The Senn retractor is at the anterior ankle joint. Nodules within the deep fascia of the ankle are indicated by the 3 arrows. There was a large vein tied off along the posterior border of the region. This was a normally occurring vessel unrelated to the soft tissue mass below it. (*B*) Deep to the extensor tendons, a large, firm, chocolate-colored mass measuring 5.0 cm × 3.0 cm × 1.7 cm was found overlying the dorsum of the talar neck. (*C*) The mass was excised en toto revealing the destruction of the underlying surfaces of the ankle mortise. The excised mass with its large nodular component located nearest the retractor spans 5.0 cm in length with a color and texture grossly reminiscent of hepatic tissue. The underlying degenerative condition of the anterior margin of the tibial plafond with its large triangular shaped osteophyte is best appreciated here (large arrow). The deep scalloping of the talar neck is well defined here (skinny arrow).

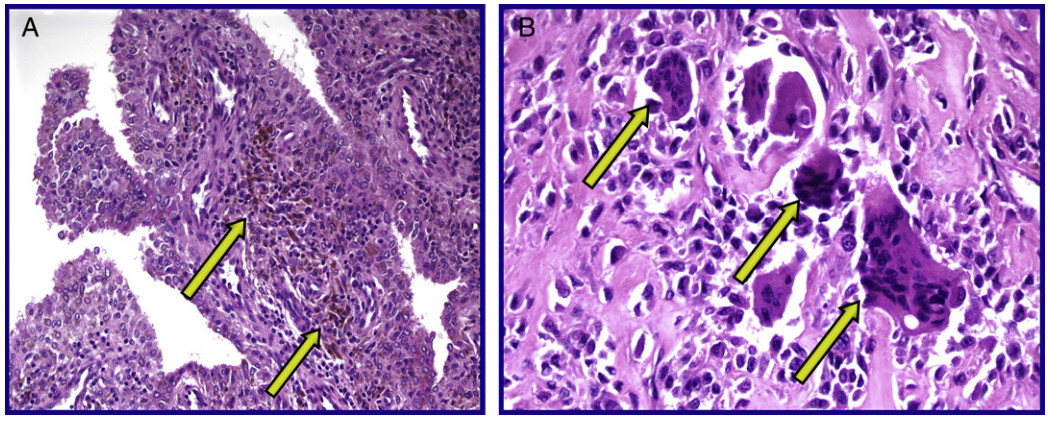

Fig. 4. (*A*) Low power; 10× Hematoxylin & Eosin (H&E) stain preparation. This H&E stain reveals hemosiderin deposits (indicated by arrows) throughout the fingerlike projections of villous formations seen under low power characteristic of PVNS. (*B*) Under high power multi nucleated giant cell formations are evident. Because this cell type is present in the spectrum of PVNS conditions it has been described as a giant cell tumor of tendon sheath.

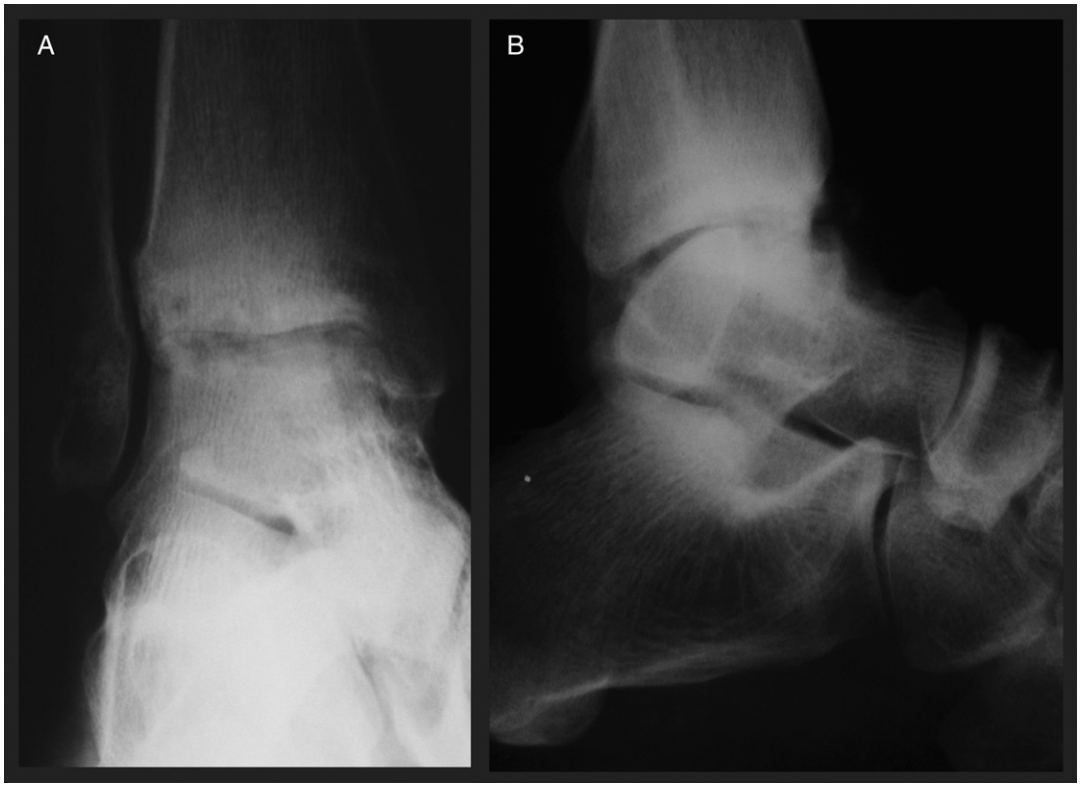

Fig. 5. Mortise and Lateral Ankle Radiographs. At 1.5 years after tumor resection and radiation therapy the position of the ankle mortise was well maintained despite end stage joint space narrowing noted in both the mortise *(A)* and lateral view (5). The progressive degenerative changes noted within the ankle are undeniable and reflect the insidious nature of the disease process.

It has been repeatedly stated that PVNS occurs more often in the age range of 20 to 50 year; however, numerous incidents of occurrence within the pediatric population have been well documented in the past 3 decades (29–63). In reviewing the current English literature, specifically articles including the terms pediatrics, adolescents, children, and teenagers, the authors have been able to retrieve 34 articles reporting the occurrence of PVNS in the pediatric, adolescent ,and teenage populations. Based on a meta-analysis of these reports, which included 49 patients between 1968 and 2007, the age range was found to be between 11 months and 17 years.

In the lower extremity, the presentation ranges from a painless swollen mass to diffuse pain in the extremity with only subtle edema within the foot and ankle joints. In cases of well-localized disease, a "catching or locking" of the joint or tendon may be related. The history may or may not include an episode of trauma. The clinical presentation may be a subtle swollen enlargement of a periarticular region, while a frank tumorlike mass may be found impinging on joint structures (3, 5, 6, 16, 18, 29, 30, 39, 42, 51, 61, 64–77).

The clinical complaint is typically painful joint swelling; however, painless periarticular edema has been reported. The knee is decidedly the most commonly affected joint and the weight-bearing joints of the lower extremity seem to be affected more than that of the upper appendicular skeleton. Dysfunction or limitation of motion is a portion of the complaint in most cases. Often symptoms have been present for numerous months and most articles describe a protracted time to definitive diagnosis. This suggests a chronic and insidious process rather than an acute onset of pathology. The duration of pain has been cross-correlated with the variety of PVNS, ie, constant pain is most closely associated with diffuse disease, whereas a well-localized entity may prove to be intermittently painful with pain-free periods, which may explain a protracted course before presentation noted in many instances. In localized disease, the nodular mass may have a stalk that emanates from the joint or tendon resulting in locking or catching, prompting an intermittent pain syndrome. The history may include an episode of trauma that may be remote (months to years) from the time of presentation. Contrary to other descriptions of the onset, Myers et al (8) recorded a history of acute trauma in a substantial number of cases; 88% (7 of 8 cases) of localized PVNS as compared with 38% of patients with diffuse PVNS. In that study, trauma was described as acute as a result of a fall or direct blunt trauma to the area. When synovial fluid aspirates are able to be obtained, a variable number of leukocytes and red blood cells can be expected. Systemic disease beyond arthritic conditions has not been associated with this condition. As such, there has not been any one serologic study that has proven helpful in diagnosing the condition and in fact routine serology has often been reported as negative when not complicated by the presence of rheumatoid arthritis. In the study by Myers et al (8), there was a slight yet significant increase in the number of polymorphonucleated leukocytes when compared with patients with giant cell tumor.

Diagnosis

The definitive diagnosis of PVNS is determined by tissue biopsy for histologic evaluation; however, magnetic resonance imaging can readily identify such lesions and differentiate them from other forms of chronic degenerative change. From a histologic standpoint, there are a few predictable cell types that present themselves in the face of this disease. Most notably, round cells, giant cells, capillaries, and clefts have been reported from biopsy specimens (8). Tissue staging most predictably includes granulation tissue composed of early stromal cells (78, 79).

There are distinct MRI findings noted in conjunction with PVNS and these are considered hallmark for the diagnosis. The ferromagnetic hemosiderin depositions noted throughout PVNS synovitis or

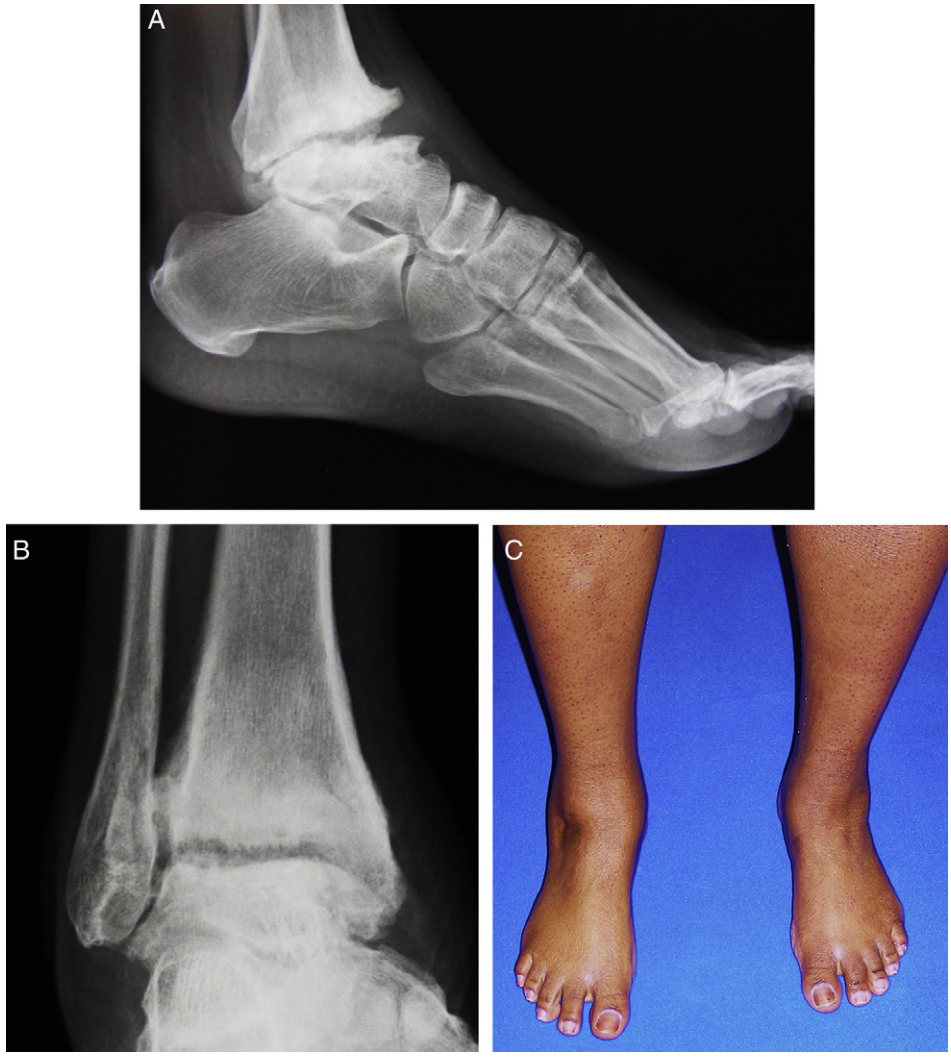

Fig. 6. (*A*) At 7-years postoperative, the patient has a functional pseudoarthrosis that is able to be managed with an ankle foot orthosis. (*B*) Mortise ankle view reveals a shaggy periostitis across the entire distal tibial plafond with flat and widened talar dome. Despite the progressive change in morphology the tibiotalar joint remains congruous in alignment. (*C*) The patient is able to walk, perform toe rise maneuvers and stoop; however she has recently been experiencing recurrence of discomfort in the ankle with prolonged standing and walking.

nodules produce an intensity pattern that is pathoneumonic (23, 35, 66–69, 80, 81).

On T2 imaging, heterogeneous signal intensity is noted throughout nodular formations; a high signal intensity with linear patterns of low signal intensity is characteristic of this lesion. The T1 image will demonstrate low to medium signal intensity from that same tissue. These characteristics differentiate PVNS from normal joint fluid or soft tissue edema. Chondral defects from this disease will emit a low signal intensity on T1 imaging, consistent with a chronic degenerative disease (20, 31, 60–66). Although ultrasound has been used to evaluate lesions within the lower extremity, it is not considered the standard in imaging for PVNS (71).

Treatment

The traditional treatment suggested for pigmented villonodular synovitis has been synovectomy with arthroplasty of the affected bone and joints (71–75, 77, 82, 83).

Although the use of arthroscopic resection of pathologic synovium has been described for pathology within the knee (1, 13, 20), this method is obviously restricted to intra-articular manifestations, yet the disease often presents as a periarticular manifestation.

Regardless of the type of surgical procedure performed, the recurrence rate of PVNS is high, ranging from 18% to 45%. Because of the risk of recurrent disease despite intervention, alternate methods of therapy have been explored and are reported with varying success (68, 69, 71, 76, 77, 82, 84, 85).

In recent years, the use of radiation therapy as an adjunctive procedure has been suggested. In the current literature there are 4 retrospective studies specifically for lower extremity PVNS that describe radiation therapy as a useful supplement to surgical intervention (5, 16–18).

Similar techniques have been described for use in regions other than the lower extremity with comparable success (11, 12–15, 17, 19, 86, 87).

Segler (18) suggested that there is potential benefit in using this technique before surgical intervention. It is suspected that having irradiation therapy before surgical excision will provide an idea of tumor responsiveness to radiation therapy, may reduce size of the tumor, and may preserve the function of the organ.

Given the high rate of recurrence of PVNS, the authors have explored the potential benefit of radiation therapy for this condition.

Specifically the effect of focused external beam radiation therapy, which has been trialed and reported in the current literature (5, 12–19).

We present a case of PVNS where the patient was treated in 2 stages: surgical resection of the tumor with arthroplasty of the ankle joint followed by radiation therapy. A retrospective review of the chart, radiographs, and MRIs was conducted for a 36-year-old African American female who had been treated and followed for more than 7 years at the writing of this article. The patient underwent surgical resection of the PVNS tumor and ankle arthroplasty followed by a series of radiation treatments of 34 Gy in 15 doses over 3-weeks. Pathologic examination of the tumor confirmed the diagnosis of PVNS. No evidence of recurrent PVNS was identified on postoperative MRI at more than 7 years after surgery. The fact that radiographs and MRI examinations failed to reveal evidence of recurrence and a very high patient satisfaction (ie, would have the procedure done again) supports the potential benefit of adjunctive radiation therapy for this condition.

Discussion

The authors believe their case is unique not only in that they have used radiation therapy as an adjunctive therapy for PVNS but that they have provided meaningful follow-up of that case to support this method of therapy. Although there has been another published account of nodular PVNS invasion of the ankle joint, this article reports strictly surgical excision without the benefit of adjunctive therapy and fails to provide any postoperative information in contrast to the present case report (64).

Because PVNS has a high rate of recurrence, up to 45% despite surgical intervention, it is important to be able to identify and diagnose this condition early to reduce bone and joint destruction from the disease. Given that the symptoms of PVNS can be vague, the differential diagnosis may include a variety of conditions, such as rheumatoid arthritis, fibroxanthoma, hematoma, pigmented villonodular synovitis, synovial hemangiomas, and synoviosarcoma. Ordering an MRI early in this disease will identify the hallmark characteristics of PVNS and will provide the definitive diagnosis required for prompt treatment. This is, in the authors' opinion, the best way to forestall if not halt the progression of this destructive disease. Although malignant transformation can occur, it is considered rare (9, 10). Lymphadenopathy from this proliferative disorder has been likened to that seen in malignant melanoma, further underlining the importance of determining a definitive diagnosis for this disease (58, 88).

Although it is understood that the gold standard for the diagnosis of PVNS is biopsy, to date the method of treatment for this condition remains variable and ranges from wide excision to arthroplasty of the affected joint structures. Most recently, however, the literature has included radiation therapy as an adjunctive method of treatment geared at reducing the risk of recurrence.

O'Sullivan et al (17) reviewed 14 patients with PVNS of the foot, ankle, knee, wrist, and finger who received radiotherapy after surgical intervention. Patients were treated with 35 to 50 Gy in 14 to 25 fractions. Ultimately, 12 patients became asymptomatic, 1 patient remained symptomatic, and 1 patient was lost to follow-up. Long-term follow-up extended to 69 months after radiation therapy. With the enthusiasm for radiation therapy mounting in the literature, Katz et al (14) conducted a retrospective study evaluating the efficacy of performing surgical synovectomy followed by radiosynovectomy to reduce the risk of recurrence. Eleven patients with confirmed PVNS had undergone intra-articular radiation therapy within 6 months after surgical synovectomy. Yittrium-90 citrate or Re-186 sulside were the agents selected for radiation therapy and results were based on a clinical grading scale at 1 year after treatment. The rating scale included the degree of hydrops, rubor, motility, and degree of pain and from this, it was concluded that combination therapy is highly efficacious in treating PVNS.

In a prospective study to assess the effectiveness of prophylactic radiotherapy in postoperative PVNS excision, Kotwal et al (15) reviewed 48 patients treated for PVNS. Fourteen of the 48 patients had undergone local irradiation at 20 Gy in divided doses of 2 Gy per surface daily at 200 kV. These 14 patients were selected because of either incomplete excision or abnormal mitotic figures noted within the tissues. No recurrence was noted in the irradiation group. Two patients from the nonirradiation group had recurrence. No adverse side effects of radiation therapy were reported.

Shabat et al (19) reviewed 10 patients after synovectomy of the ankle, knee, or hip followed with adjuvant treatment of intra-articular injection of yttrium 90. These patients were followed approximately 6 years. Patients were given 1 dose of 15 to 25 mCi 90 yttrium. As a result, 9 patients became asymptomatic and 1 patient remained symptomatic but without any progression of bony damage 6 years beyond treatment.

Chin et al (13) performed a retrospective study of 40 patients with confirmed PVNS where all patients had undergone either arthroscopic or open surgical procedure and experienced frank recurrence of the disease. Patients were then placed in 3 groups: group 1, 5 patients received surgery alone; group 2, 30 patients received surgery and intra-articular radiation synovectomy with the use of dysprosium 165; and group 3, 5 patients received surgery and external beam radiation of 35 Gy in a single fraction over a 15-day period. The average follow-up time was about 5 years. There were no substantial long-term complications from the external beam or intra-articular radiation therapy. Reported side effects included superficial wound infections, which were healed with local wound care and antibiotics. Eighteen percent (7 patients) of patients had recurrence after operative treatment and radiation therapy. Of these 7 patients, 5 were from group 2 and two were from group 3. They concluded that adjuvant intra-articular radiation therapy may be beneficial for eradication of small foci or residual disease, but complete resection of all PVNS tissue appears to be the key to preventing recurrence.

Brien et al's (5) retrospective study of PVNS in the foot and ankle included 11 patients who all underwent open excisional biopsy of the lesion. Six of the 11 patients had recurrence with a second surgical excision. Four of these 6 patients received postoperative radiation therapy with dosage of 3600 to 4000 cGy in 20 to 25 fractions. No recurrence of the disease was reported when radiation was used as an adjunctive therapy.

Lee et al (16) reviewed 7 patients with confirmed PVNS of the foot and ankle who underwent radiotherapy after synovectomy. The review followed these patients up to about 24 months status post radiation. Patients were treated with 35 Gy in 20 fractions for about 4 weeks. Ultimately, they found 6 patients asymptomatic and just 1 patient who remained symptomatic.

Berger et al (12) reviewed 7 patients who underwent surgical intervention and were then treated with radiotherapy. The review followed patients to about 29 months after radiotherapy. Patients were treated with 30 to 50 Gy in 1.8 to 2.0 fractions. The result found 6 patients asymptomatic and 1 patient remained symptomatic with restriction of joint movement.

Although it seems intuitive that there would be utility for radiation therapy as a preemptive strike against the disease before surgical intervention, there has been no clinical research to support this method. The notion that presurgical intervention may reduce the tumor size and therefore forestall if not halt the interruption of joint function has been discussed but not validated. When the disease strikes in particularly vulnerable regions, where en block resection may have a questionable risk:benefit ratio, the use of radiation therapy to reduce the bulk of the disease may be fruitful (18).

In preparing this article and reviewing the current English literature, the authors were able to identify 34 articles reporting the occurrence of PVNS in the pediatric and adolescent populations, although the condition has historically been reported as affecting primarily an adult population. Based on a meta-analysis of these articles, which included 47 patients between 1968 and 2007, the age range was found to be between 8 months and 17 years. Because historically the age range has been cited as 20 to 50 years, including the literature from the past 30 years would change this to a range of 8 months to 50 years. Considering the extensive number of cases reported in the literature to date questions whether this condition is truly rare or perhaps just unusual and underreported. The fact that the earlier literature includes fewer cases than the past 3 decades may be because the condition has previously been underreported or even misdiagnosed as other arthritic conditions in the past. If this unusual condition is truly associated with trauma (repetitive wear and tear or overt trauma) and chronic inflammation (89), then the incidence of the condition would be related to activity and injury rather than physiology or genetics (61). The chronic inflammation theory could explain why there are at least 24 reports of this disease occurring in the foot and ankle, as these are load-bearing joints subjected to cyclic loading and chronic wear and tear (3, 5, 6, 16, 18, 29, 30, 39, 42, 51, 61, 64–74, 76, 77, 90).

The duration of pain has been cross-correlated with the variety of PVNS, ie, constant pain is most closely associated with diffuse disease, whereas a well-localized entity may prove to be intermittently painful with pain-free periods, which may explain a protracted course before presentation noted in many patients. In localized disease, the nodular mass may have a stalk that emanates from the joint or tendon resulting in locking or catching, prompting an intermittent pain syndrome as is the case for dysfunction in our patient.

The fact that our patient was very active and worked vigorously on an industrial line would seem to place her in a category suspicious for the chronic inflammatory etiology, not unlike the patient populations reported by Saxena and Perez (72) where 10 cases had manifested in the ankles of athletic patients over a 10-year period. Because our patient with well-localized disease did not exhibit an elevation in acute phase reactants, such as platelets or C-reactive protein, seems to support the theory that this condition may be attributable to chronic inflammation and degenerative change associated with repetitive wear and tear or trauma. In Myers et al's study (8), there was a slight yet significant increase in the number of polymorphonucleated leukocytes when compared with patients with giant cell tumor. This suggests that the C-reactive protein is more likely to be elevated in diffuse disease as it represents an infiltrative, degenerative, and inflammatory condition in contrast to that of the well-localized disease associated with nodular PVNS. It seems intuitive that any condition resulting in tissue necrosis would prompt the elevation of acute phase reactants such as CRP. Although rheumatoid arthritis has been noted as a comorbidity in some case, it has not been reported as the inciting pathology. We consider this condition to be unusual and question whether it is truly a rare condition or if it has simply been underreported because of confusion with other destructive arthritic conditions, such as rheumatoid arthritis and nodule formations. In our patient, rheumatoid arthritis was the presumed culprit for pain, dysfunction, and the presence of periarticular nodule formation before presentation. With the benefit of excisional biopsy of the mass and affected synovium, ankle arthroplasty, and subsequent radiation therapy, the patient has been able to continue activities of daily living well. Unfortunately, we will never know how exactly how well the patient could have recovered both clinically or radiographically because she had been noncompliant with the prescribed ankle foot orthosis for 6 of her 8 years of follow-up (91).

Acknowledgments

The authors thank the Pathology Department of Saint Charles Hospital, Oregon, Ohio, and the Medical Library staff at St. Vincent Hospital, Toledo, Ohio, for their tireless efforts on this project.

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