Osteomyelitis and Diabetes

Adhering to basic principles is key.

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Osteomyelitis, from the Greek root words osteon (bone), myelo (marrow) and itis (inflammation), is an infection that spreads to the bone causing bone marrow edema. Some studies may support that long-term antibiotic therapy alone is the preferred method of treatment, but more studies support that the condition is a surgical disease. The surgical removal of necrotic, infected bone followed by antibiotic therapy remains the more common practice.

While there could be more studies done to evaluate incidence, one study done by the Mayo Clinic reports a higher incidence of osteomyelitis associated with diabetes. In their study of 760 cases of diagnosed osteomyelitis, the most common site of diabetes-related osteomyelitis are as follows: 56% on toes, 29% metatarsal, and 8% tarsal bones, with 60% resulting in amputation for diabetes-related osteomyelitis. The second most common source of osteomyelitis according to their study are equal scores between hematogenous and traumatic causes with the traumatic (contiguous) osteomyelitis mimicking the incidence of the diabetic-related osteomyelitis: 20% on toes, 13% metatarsal, and 7% tarsal.[1] Another study reports that 15% of diabetic foot ulcers get the diagnosis of osteomyelitis.[2]

On initial presentation of a patient complaining of a painful, red, swollen, warm foot it might be difficult to draw the line between infection and normal post-op course, especially if the patient just had foot surgery. The Infectious Diseases Society of America (IDSA)and Integrative Wellness Group (IWG) on the diabetic foot both define foot infection as the presence of at least two of the following: local swelling or induration, local tenderness, local warmth, purulent drainage.[3]

Figure 1: Probe to bone test.

Figure 2: X-ray findings of osteomyelitis

If there is drainage, and you suspect infection, it is prudent to obtain a bacterial culture after proper cleaning of the wound. Place the patient on a broad spectrum empiric antibiotic since most cases of osteomyelitis are polymicrobial.

Blood work-up includes blood markers for inflammation such as ESR, CRP, procalcitonin, and CBC showing leukocytosis (a left shift in Leukocytes).[4] This should be taken initially and subsequently to monitor efficacy of antibiotic treatment.

A thorough history and physical should be performed to determine predisposing factors such as diabetes, neuropathy, peripheral vascular disease, history of trauma, surgery, or IV drug use.

In your wound evaluation, the result of the "probe to bone" test (Figure 1) has been a standard evaluation tool in determining the possibility of a bone infection present. This is performed by using a stainless steel probe to detect bone through the wound. Studies have varying results of its accurate predictive value, ranging from 57%[5] to 89%.[6]

An initial standard set of x-rays should be evaluated for any bony abnormalities. Initial x-rays will not diagnose early osteomyelitis as the hallmark features of osteomyelitis such as bone edema cannot be seen on x-rays. The features of osteomyelitis that might be seen on x-rays could include periosteal reaction secondary to periosteal elevation, bone lucency secondary to intra osseous swelling and soft tissue swelling (Figure 2). All these are non-specific to osteomyelitis with a differential diagnosis that might include previous surgery, stress fracture, bone tumors, and soft tissue infections.[7]

Recent studies have supported that standard x-rays have a .68 specificity and a .54 sensitivity for diagnosing osteomyelitis.[8] X-ray findings of osteomyelitis also lag two weeks to a month as compared to clinical

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findings of osteomyelitis.[9]

In spite of the aforementioned facts, however, it remains a safe practice that if there is an ulcer and your initial x-ray shows bony destruction, cortical erosion, periosteal reaction, mixed lucency, and sclerosis, one should initiate treatment of presumptive osteomyelitis.[9]

Serial x-rays every 2-4 weeks should be taken to monitor any bone changes. If the x-rays are normal but the wound is not healing and the "probe to bone" test is positive, consider ordering an MRI or a percutaneous bone biopsy.[10,11]

Medical vs Surgical Management

Several studies have offered criteria selection for choosing medical versus surgical management of bone infection. One algorithm reported in the proper medical management of osteomyelitis states that if there is no wound, and there is cellulitis, treat conservatively instead of surgically.[12]

IDSA guidelines strongly recommend a trial of non-surgical management if there is no persisting sepsis after 48-72 hrs. of treatment, if the patient can receive and tolerate appropriate antibiotic therapy, if the degree of bony destruction has not caused irretrievable compromise to the mechanics of the foot (bearing in mind potential for bony reconstitution), if the patient prefers to avoid surgery, and if patient's comorbidities confer high risk to surgery, if no contraindications to prolonged antibiotic therapy (e.g., high risk for C. difficile infection), and if surgery is not otherwise required to deal with adjacent soft tissue infection or necrosis.[3]

Foot surgery is indicated in dealing with osteomyelitis when the following conditions are met: When the bone is protruding through the ulcer, when there is extensive bone destruction seen on x-ray or progressive bone damage on sequential x-ray while undergoing antibiotic treatment, when the soft tissue envelope is destroyed, and when there is gangrene or spreading soft tissue infection.[13,14] Other conditions that war-

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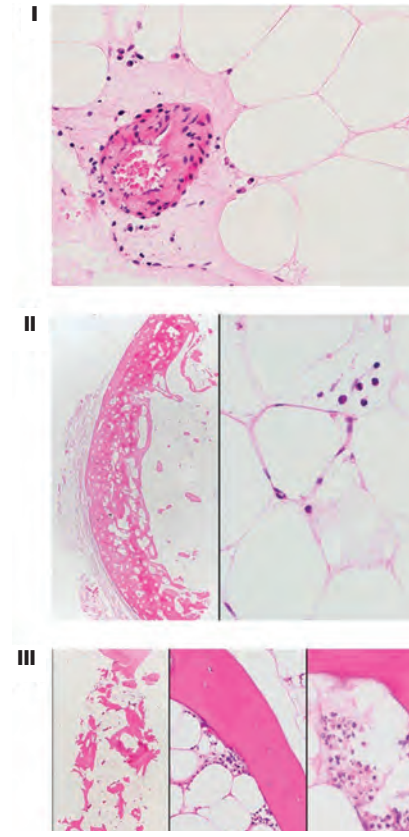

Figure 3:
I Bone Biopsy—no osteomyelitis, absence of neutrophils
II Bone Biopsy—Probable osteomyelitis less than or equal to 5 neutrophils per HPF
III Bone Biopsy—Definite osteomyelitis more than 5 neutrophils per HPF

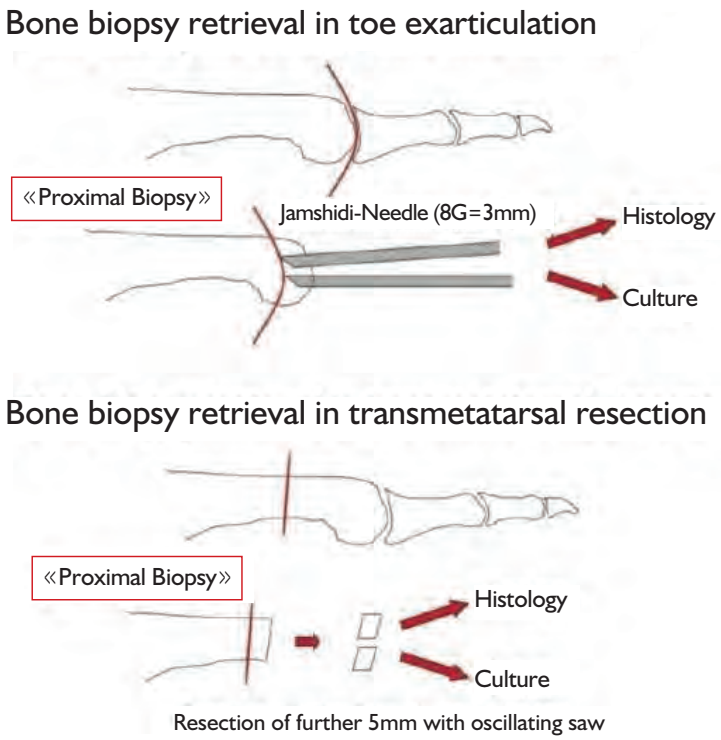

Figure 4: Top—Bone biopsy retrieval in toe exarticulation. Bottom—Bone biopsy retrieval in transmetatarsal resection.

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rant surgery include persistent sepsis, the patient cannot tolerate long-term antibiotic usage, and the systemic contraindication or ineffectiveness of long-term antibiotic usage.[3]

Imaging and Biopsies

Prior to performing surgery or continuing with long-term antibiotic therapy, MRI is the preferred choice for imaging modality for osteomyelitis with a 90% sensitivity and 83% specificity.[15] If surgery has already been decided, the MRI is used for pre-operative planning to potentially limit the extent of bone resection.[16]

The characteristic imaging result for osteomyelitis on non-contrast MRI changes include decreased intensity on T1 weighted images and increased intensity in T2 weighted and post-contrast images.[17] An experienced musculoskeletal radiologist is invaluable to differentiate osteomyelitis from Charcot arthropathy as well as post-surgical changes from a recent surgery.[18]

When there is documented failure of antibiotic therapy or when faced with uncertainty, it is prudent to obtain a punch biopsy for both histopathology and culture evaluation. In spite of the fact that most studies show that bone biopsy is the most definitive diagnostic tool for the proper diagnosis of osteomyelitis, there can be possible sampling errors that could result in a false positive or false negative result. Obtaining good samples could be done through an open approach or through a percutaneous approach, with the specimen

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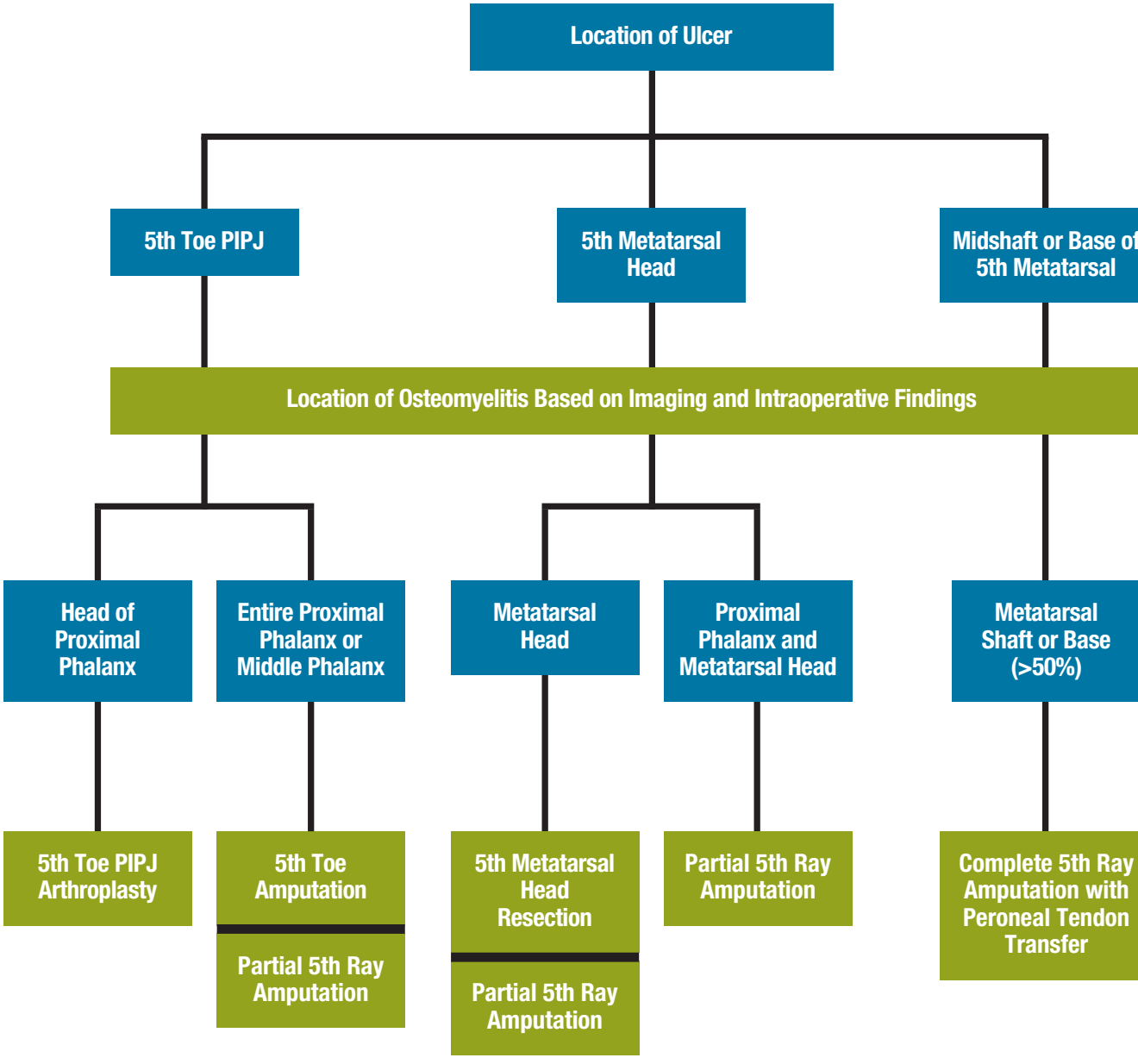

Figure 5: Boffeli's Flow Diagram—Approach to 5th ray Osteomyelitis

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obtained away from the wound site.

Acute osteomyelitis is present if the biopsy shows the presence of inflammatory cells and/or osteonecrosis (Figure 3). Chronic osteomyelitis would show bone marrow fibrosis with devitalized or remodeled bone with or without lymphocytes or plasma cells.[19,20]

Histopathology samples would demonstrate post-surgical changes including trabecular disruption with bone necrosis and fibrinopurulent cellular response, similar to osteomyelitis. The difference is that the post-surgical changes would be localized to the area adjacent to where the bone had been previously manipulated.[22]

Bone biopsies are indicated if there is a diagnostic uncertainty, and there is inadequate culture data or failure of empiric antibiotic therapy.[11,23] It is recommended to take a biopsy on the area of clean bone after disarticulating or removing the infected bone(Figure 4). Take a punch biopsy in several areas extending up to 1 cm proximal to the area in question to obtain a specimen from clear margins.[24]

The goal of surgical debridement is to remove necrotic and infected bone until healthy bleeding bone is obtained. If using a tourniquet, this should be released in order to demonstrate the "paprika sign".[25] Bone is adequately resected once scattered pinpoint bleeding of the bone and marrow is demonstrated.

There have been many studies and literature written about surgically planning our incisions prior to performing bone debridement. One of the more important factors to consider in surgical planning is the consequence in foot biomechanics, structural deformity, the sequelae and the possible need for further resection and amputation. Since the most affected sites for osteomyelitis are the digits and metatarsal areas, bone debridement versus amputation, when warranted, is the preferred choice of surgical management.

The occurrence of osteomyelitis on the 5th digit and metatarsal could

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Figure 6: Fifth toe amputation. (A, B) Osteomyelitis involving the middle and proximal phalanges is typically treated with complete fifth toe or partial fifth ray amputation. (C, D) A standard tennis racket incision with dorsal and plantar flaps (E, F) The lateral head of the fifth metatarsal was remodeled which provided clean margin biopsy and reduced lateral prominence. (G) Primary wound closure with simple sutures allowed prompt healing with resolution of infection 5 days later. Confirmation of a clean bone margin allowed a short course of oral antibiotics.

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Figure 7: Fifth metatarsal head resection. (A–C) Fifth metatarsal head resection rather than partial ray amputation. (D, E) Elliptical excision of the ulcer with proximal runout allowed exposure for metatarsal head resection. (F) Resection of the metatarsal head not only removed the bony prominence, but allowed for bone biopsy and (G) primary wound closure.

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be from neuropathy, arterial disease, abnormal pressure from shoes causing repetitive trauma, and previous surgery among other things. When the diagnosis is made early, we can limit the amount of bone that needs to be resected based on the location of the ulcer, the extent of the bone infection, and the circulation status of the patient, thereby providing stability to the forefoot.

Boffeli's Flow Diagram

Boffeli's flow diagram[20] (Figure 5) suggests resection of the head of the proximal phalanx if the infection is limited to this area, a fifth toe amputation if the entire phalanx (proximal or middle) is affected or a partial fifth ray resection (taking out less than 50% of the 5th metatarsal) (Figure 6). Armstrong[26] proved that a fifth metatarsal head resection alone can properly address the osteomyelitis of the 5th metatarsal head (Figure 7). Other surgeons elect to perform a partial fifth ray amputation (Figure 8). Lastly, a complete 5th ray amputation with a peroneal tendon transfer is recommended only when more than 50% of the metatarsal shaft is infected or if the base of the 5th metatarsal is involved.

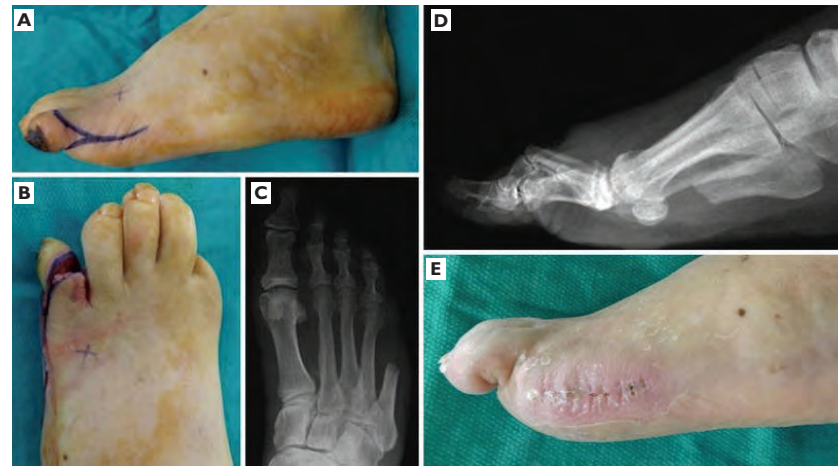

Figure 8: Traditional partial fifth ray amputation technique with demonstration of tennis racket incision. (A) Note that the proximal extension was midline along the lateral aspect of the foot which created matching dorsal and plantar flaps. (B) A dorsal flap of tissue from the fifth toe was preserved to allow tension free closure. (C, D) Post-operative x-rays showing the desired angle and location of metatarsal resection just proximal to the metaphyseal flare. Bone resection was performed with a saw with the intent to avoid plantar and lateral prominence. (E) Healing at 3 weeks post-operatively.

The surgical procedure of bony debridement and amputation is easier to perform than the management and decision-making of all the medical issues prior to getting to that stage.

Conclusion

The management of the diabetic foot with a chronic non-healing wound is much more than the scope of this article, but the basic precepts of proper patient evaluation, history, and work-up always remain the same. The surgical procedure of bony debridement and amputation is easier to perform than the management and decision-making of all the medical issues prior to getting to that stage. Remembering the foundations as outlined in this article will hopefully help in the management of your diabetic patient. **PM**

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