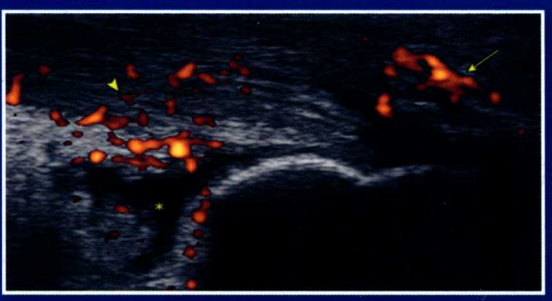
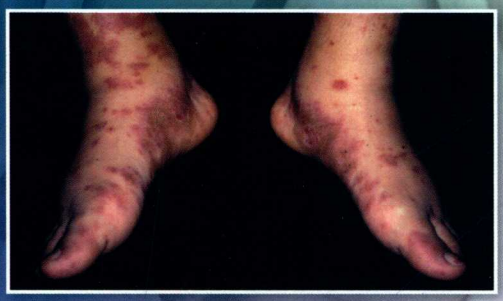
Systemic Disease Manifestations in the Foot, Ankle, and Lower Extremity





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Philadelphia • Baltimore • New York • London
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Acquisitions Editor: Brian Brown
Editorial Coordinator: Dave Murphy
Marketing Manager: Dan Dressler
Production Project Manager: Marian Bellus
Design Coordinator: Steve Druding
Manufacturing Coordinator: Beth Welsh
Prepress Vendor: S4Carlisle Publishing Services

9 8 7 6 5 4 3 2 1

Printed in China

Library of Congress Cataloging-in-Publication Data
ISBN-13: 978-1-4511-9264-3
ISBN-10: 1-4511-9264-9

Cataloging-in-Publication data available on request from the Publisher.

LWW.com

CCS0417

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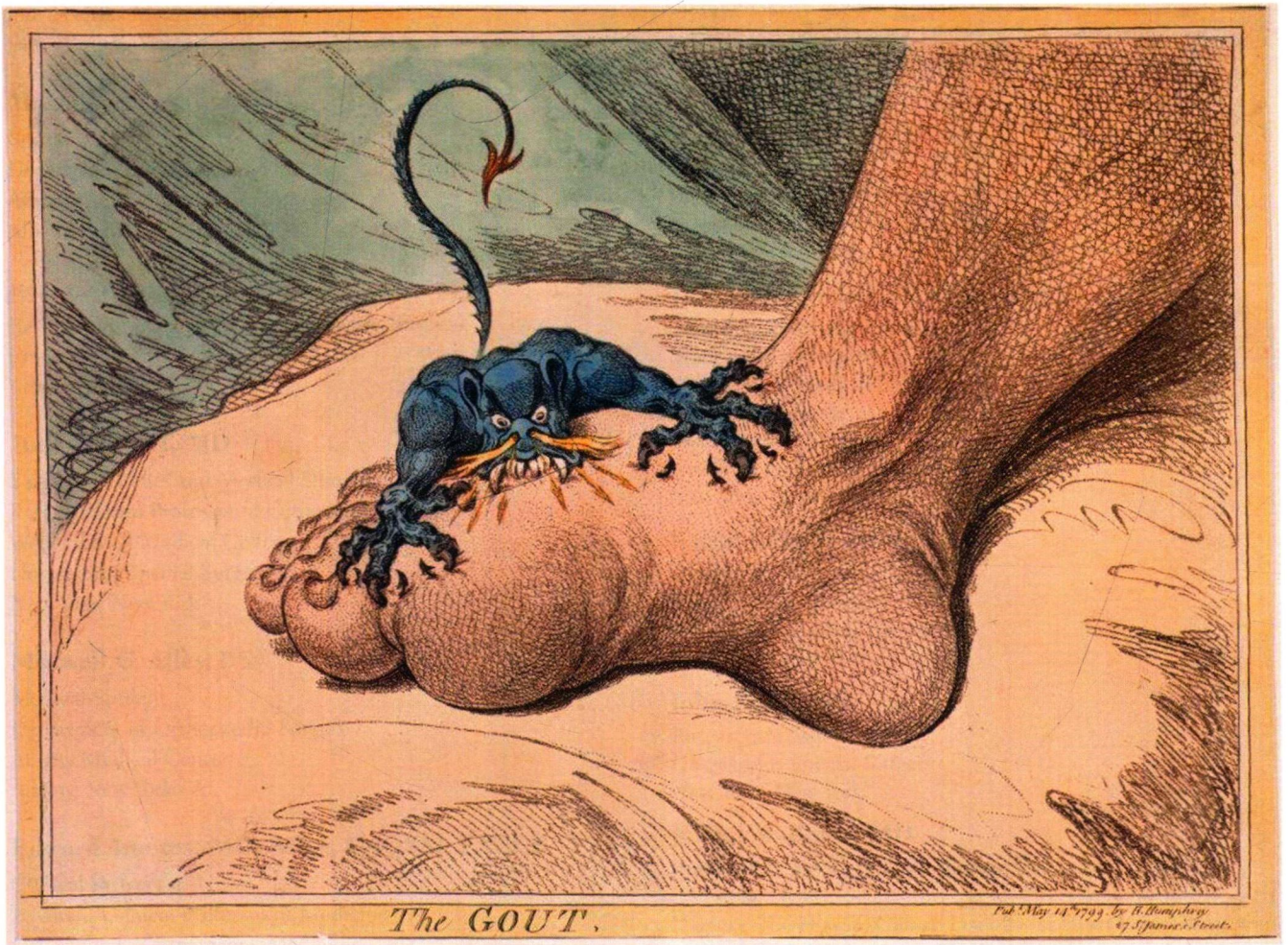

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FOREWORD

Medicine has needed a cutting-edge, authoritative textbook on how systemic disease can manifest in the foot, ankle, and overall lower extremity. It is with great pleasure, and from the personal point of view of a satisfied consumer, that I write the foreword for this fascinating book.

Podiatric problems provide vital insights into the health care system as a window to systemic disease, covering all the body systems such as nerves, vascular, skin, endocrine, and musculoskeletal.

Foot and ankle pain will often bring a person into the health care system because of how it threatens their lifestyle. It happens quite often that a podiatric evaluation will point to other pathologies that can then be identified and treated by the appropriate specialist.

Therefore, while a patient may present with seemingly minor maladies, it is critical that the medical professional has the knowledge and insight to identify those lower extremity pathologies as markers for more systemic disease. From quality-of-life issues to a more serious examination of overall health, the Doctor of Podiatric Medicine (DPM) in conjunction with the Doctor of Medicine (MD) has the opportunity to open a portal to an integrated science–based health care approach that seeks to heal the whole body.

As Dr. Positano and I have discussed, there has been no significant research in Western medicine that "maps" out the foot and the many meridians that Eastern medicine has always recognized as critical to well-being. For the first time, there is an authoritative book, clearly, compellingly, and eloquently written, that provides a benchmark for the practicing medical professional.

It is rare that I recommend a medical textbook as both sage and illuminating. But I do so herein with no reservation.

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PREFACE

The foot, ankle, and lower extremity *is often referred to by those health care providers who specialize in these areas as a* mirror of systemic disease *because* many systemic diseases, including heart disease, diabetes, skin disease, and neurologic disease, first present in *this anatomic region* of the body. *Although all too frequently ignored*, examination of the lower extremity can reflect a person's general health, *both physical and psychological*, and the overall condition of the body's functional systems such as cardiovascular, neurologic, dermatologic, musculoskeletal, and endocrinologic. Yet, when patients visit their internists, they are usually instructed to "Take off everything but your shoes and socks." By not examining the foot and ankle, the physician can miss the early warning system of disease that the lower extremity can provide.

The foot is unique because it contains all the systems of the body, *including musculoskeletal, vascular, neurologic, dermatologic, and immune.*

A painful foot, heel, bunion, tendon, knee, hip, or lower back will bring a patient into the health care system, because the pain interferes with mobility. The ability to do everyday tasks, such as exercise, walking, shopping, playing sports, is often limited. Foot, ankle, and lower extremity *pathologic* conditions may not be life threatening *in most cases*, but they do restrict lifestyle *both directly and indirectly and also the physical and mental health.* This disruption in the quality of life will bring the patient into the health care system, which can result in early identification of many more serious medical problems and can lead to referral to the appropriate medical specialist. *Significant life-threatening pathologies including malignant neoplasms, cardiovascular disorders, immunosuppressive syndromes, and progressive neuromuscular disease may initially manifest with subtle lower extremity signs and symptoms.*

Health professionals with the MD, DPM, DO, DC, DPT, and PA titles, who specialize in musculoskeletal care, can often recognize systemic disease in its infancy or more advanced stages. Clinical medical studies could be derived from the thorough examination of the foot, ankle, and lower extremity in relation to systemic disease. Internal medicine and musculoskeletal disciplines potentially could meet, explore, and produce a new area of specialization.

For these reasons, practitioners of internal medicine, orthopedics, and podiatric medicine need to make the examination of the foot, ankle, and lower extremity an important and integral part of their physical examination. Residents, fellows, medical students, and musculoskeletal practitioners should be instructed in the thorough examination of the foot, ankle, and lower extremity. It is a powerful diagnostic tool that is too often ignored.

Rock G. Positano, DPM, MSc, MPH
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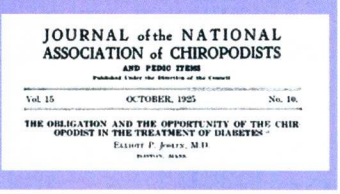
"When patient's consult you and uncover their feet, they little think that at the same time they lay bare their habits, their hearts, and their heads. The individual who cares for the cleanliness of his feet is careful also about the condition of the rest of his body; the individual who has good circulation in his feet, whose feet are neither cold nor blue and possess good muscular power, is likely to have a sound heart; and if the arteries in the feet are healthy there is a strong probability that those in the head are healthy too. When you treat the feet of a judge you are able to form an opinion of his efficiency on the bench, when you see the feet of a financier you can form an opinion of his ability in finance. Only to the physician and the priest will be patient willingly show more his soul."


JOURNAL of the NATIONAL ASSOCIATION of CHIROPODISTS
AND PEDIC ITEMS
Vol. 15 OCTOBER, 1925 No. 10.
THE OBLIGATION AND THE OPPORTUNITY OF THE CHIROPODIST IN THE TREATMENT OF DIABETES

Systemic Disease Manifestations *in the* Foot, Ankle, *and* Lower Extremity

CONTENTS

CHAPTER 1

Presentation of Systemic Disease When Imaging the Lower Extremity

HELENE PAVLOV • CAROLYN M. SOFKA • SATINDER S. REKHI JR. • JESSICA R. SPIVEY

The foot and ankle are constantly being stepped on and stressed by both normal and extraordinary forces. Feet are taken for granted, until they are hurt, limit ambulation, make wearing shoes difficult, cause gait disturbances, or some other malady forces the foot and/or ankle to take on a new level of importance. Most of the time, foot conditions are localized to a bunion, flat foot, or Achilles tendon injury that can be treated with orthotics, change of footwear, exercises, local injection, or a combination of these therapies and/or surgery. On other occasions, foot and/or ankle pain and abnormalities of the lower extremity may result from an underlying systemic condition. When reviewing imaging examinations, for example, radiographs (X-ray), magnetic resonance imaging (MRI), ultrasound, or computerized tomography (CT) examinations of the lower extremity, possible underlying systemic conditions must be considered. Familiarity with systemic conditions that can be identified on an imaging examination facilitates early diagnosis and intervention. These conditions fall into the classic categories of arthritis, infection, tumor, vascular, developmental, metabolic, and other. In this chapter, the imaging findings of various systemic conditions that can present with changes in the lower extremity are organized alphabetically.

FIBROUS DYSPLASIA

Fibrous dysplasia is a sporadic bone disease in which benign fibro-osseous lesions develop during skeletal formation.[1] Occasionally, fibrous dysplasia can arise as a component of McCune–Albright syndrome or Mazabraud syndrome.[2] Lesions can occur anywhere on the skeleton, with the craniofacial bones, ribs, and long bones most commonly involved.[1] In the lower extremity, the femur and tibia are most often affected.[1] Fibrous dysplasia occurs in both monostotic and polyostotic forms, with the former accounting for approximately 80% of all cases.[2] Often asymptomatic, fibrous dysplasia is diagnosed incidentally on radiographs obtained for unrelated reasons.[1] In such cases, no treatment is needed.[1] The polyostotic form is more likely to produce symptoms including pain, limp, and deformity, and large lesions are prone to pathologic fracture.[1] Rarely, fibrous dysplasia is complicated by malignant degeneration, particularly in previously irradiated areas.[1]

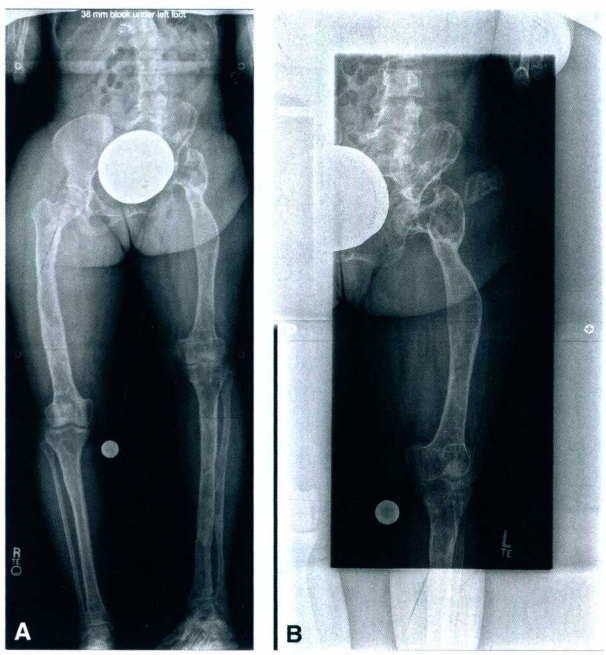


FIGURE 1-1. Radiographic pattern of fibrous dysplasia. Frontal X-ray of the lower extremities **(A)** and left femur **(B)** demonstrates expansile lesions with characteristic ground glass matrix, thin cortices, and bowing deformities. Not atypically, polyostotic fibrous dysplasia affects one side more than the other.

Fibrous dysplasia demonstrates a characteristic radiographic appearance of intramedullary, well-defined, and expansile lesions with a radiolucent "ground glass" matrix.[1,2] Shepherd's crook deformity of the proximal femur is a lateral bowing deformity and coxa vara.[2] Saber shin deformity is an anterior bowing deformity of the tibia commonly associated with fibrous dysplasia (**Fig. 1-1**).

GOUT

Gout, an inflammatory arthritis, is a crystal arthropathy characterized by hyperuricemia and subsequent deposition of monosodium urate (MSU) crystals in joints and soft tissues.[3] Gout is a common and potentially debilitating condition, disproportionately affecting men.[3] Affected individuals experience recurrent acute inflammatory flares as well as chronic

destructive changes secondary to MSU crystal deposition. Gout can involve any joint but most frequently affects the feet, demonstrating a predilection for the 1st metatarsophalangeal (MTP) joint.[4] Gout can be associated with metabolic syndromes, myocardial infarction, and diabetes mellitus.

Radiographs of involved joints may reveal marginal "punched out" erosions, sclerotic margins, and overhanging edges, with relative preservation of the joint space; however, X-ray changes typically occur late in the course of the disease.[3,4] Radiographs may also demonstrate macroscopic depositions of MSU crystals, or tophi, which are a hallmark feature of chronic gout.[4] Tophi may be periarticular or intra-articular; CT is particularly useful in detecting intra-articular depositions.[4] Tophi display intermediate or low signal on T1-weighted MRI sequences, with variable appearance on T2-weighted sequences.[3] Postcontrast sequences generally demonstrate enhancement, and there is often associated synovial thickening and adjacent marrow edema.[3,4] MRI can also reveal erosions before they become visible on radiographs (**Fig. 1-2**).[4]

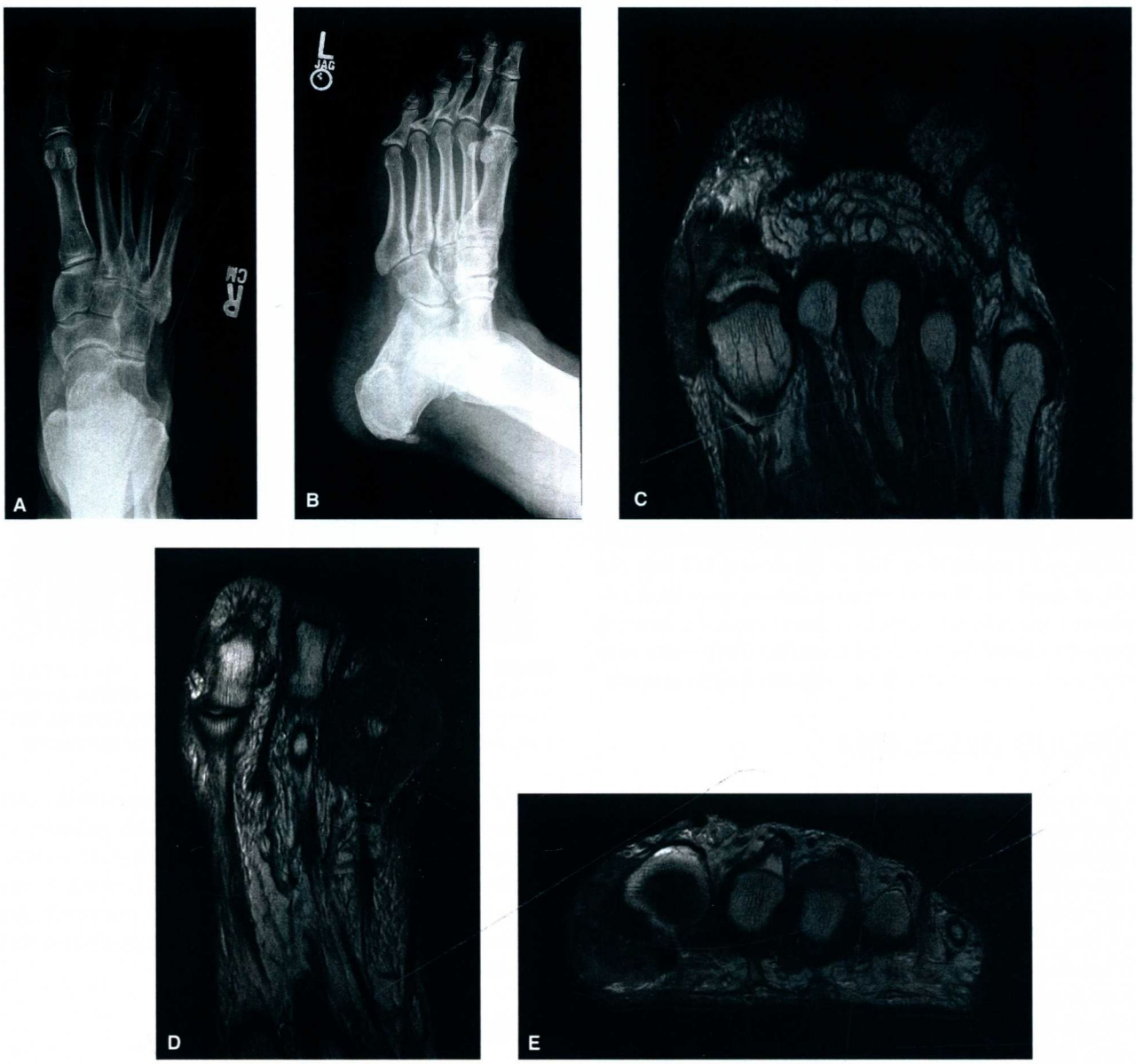


FIGURE 1-2. Radiographic and MR patterns of gout. A and **B:** Frontal and oblique radiographs of the foot in different patients with gout. **A:** Frontal X-ray of the foot demonstrates medial soft tissue prominence of gouty tophus adjacent to the metatarsal head of the great toe without underlying bone or joint abnormalities. **B:** Oblique X-ray view demonstrates classic "overhanging edge" of gout at the medial and lateral aspects of the metatarsal head of the great toe. **C to E:** MR demonstration of gout. **C:** Coronal fast spin echo MR image of the 1st MTP joint demonstrates the heterogeneously hyperintense soft tissue mass of gouty tophus medial to the 1st MTP joint. **D:** Coronal fast spin echo proton density-weighted image demonstrates a heterogeneous expansile hyperintense mass of gouty typhus circumferentially about the 3rd PIP joint. **E:** Axial fast spin echo proton density-weighted image through the forefoot demonstrates focal heterogeneously hyperintense soft tissue tophus within the plantar margins of both the 1st and 3rd MTP joints. The soft tissue tophus about the 3rd MTP joint extends dorsally.

HYPERTROPHIC PULMONARY OSTEOARTHROPATHY

Hypertrophic pulmonary osteoarthropathy (HPO) or Pierre Marie–Bamberger syndrome is a syndrome of unknown etiology characterized by the triad of periosteal bone deposition, clubbing of the digits, and arthralgia, which occurs in association with pulmonary pathology.[5,6] HPO can develop in many chronic pulmonary conditions, but in the majority of cases is associated with primary lung malignancies.[5] Rarely, patients with extrathoracic diseases such as inflammatory bowel disease can develop HPO.[5] Patients typically present with pain, tenderness, and swelling. Radiographs demonstrate generalized periosteal reaction along the diaphyses and metaphyses of long bones sparing the epiphyses.[6] MRI can be helpful in demonstrating adjacent soft tissue swelling and muscular edema (**Fig. 1-3**).[6]

INFARCT AND OSTEONECROSIS

Osteonecrosis and bone infarct define bone death. Osteonecrosis is typically used to describe ischemic bone death in a subchondral location, and bone infarct is used when the lesion is not in a subchondral location. Systemic causes of bone death are corticosteroids, sickle cell anemia, collagen vascular disease, alcoholism, and idiopathic.[7] The most common cause of osteonecrosis in a subchondral location is trauma that presents as mixed lytic and sclerotic areas on radiographs and that can progress to microfractures in articular collapse if left untreated.[8]

Infarcts in the lower extremity occur primarily in the medullary cavity of the long bones.[8] On radiographs, infarcts present as an elongated serpiginous rim of sclerosis with a central lucency. MRI is the most sensitive test for suspected bone infarct and demonstrates characteristic findings.[7] The lesions contain a center of devitalized marrow surrounded by a rim of granulation tissue and sclerosis, which gives these lesions a central high signal from adipose marrow with a surrounding ring of hyperintense inner granulation tissue and hypointense outer ring of sclerosis and is classically referred to as the "double-line" sign (**Fig. 1-4**).

MAFFUCCI SYNDROME

Maffucci syndrome is a nonhereditary and rare dyschondroplasia of unknown origin characterized by multiple enchondromas combined with soft tissue venous malformations.[9] Enchondromas are benign cartilaginous lesions within the metadiaphysis of tubular bones that typically present as osteolytic expansile lesions with central stippled calcifications characteristic of a chondroid matrix (**Fig. 1-5**).[10]

MELORHEOSTOSIS

Melorheostosis is an uncommon sclerosing bone dysplasia of unknown etiology.[11,12] Patients are usually asymptomatic but can present with limb stiffness or pain.[11] The typical appearance on radiographs is of flowing hyperostosis along the outer cortical surface of the long bones of the lower extremity, which usually has an undulating appearance, referred to as "dripping candle wax sign" (**Fig. 1-6**).[11]

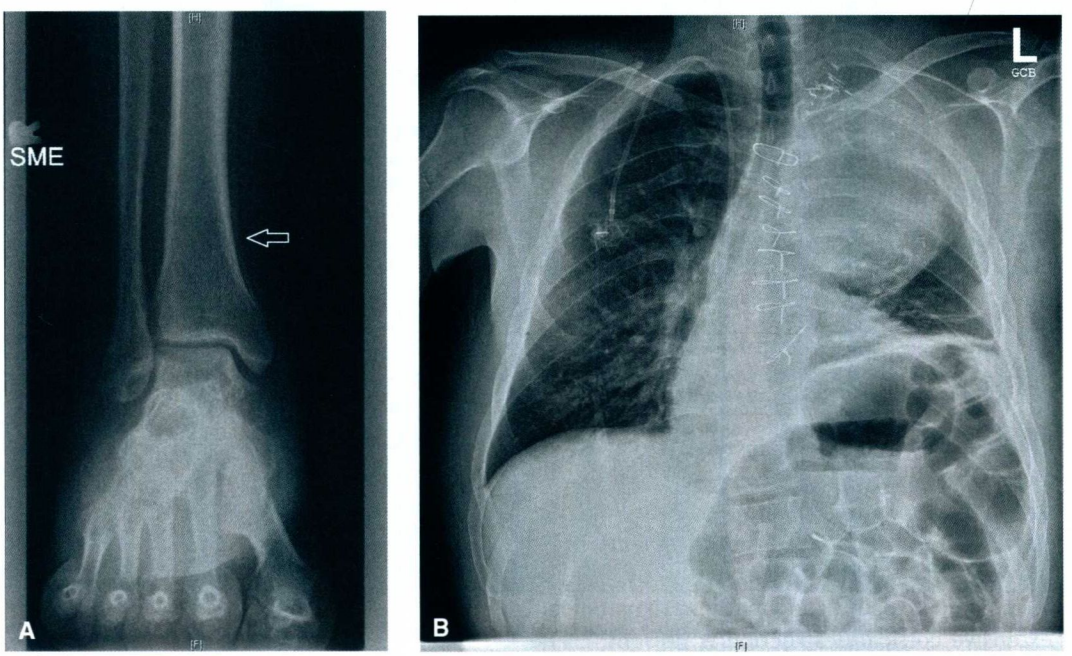


FIGURE 1-3. Radiographic presentation of HPO. A: X-ray of the right ankle demonstrates thick periosteal reaction at the distal aspect of the long bone, sparing the epiphysis (*arrow*) without underlying bone pathology. Posteroanterior (PA) radiograph of the chest **(B)** in the same patient demonstrates a large, left upper lobe lesion.

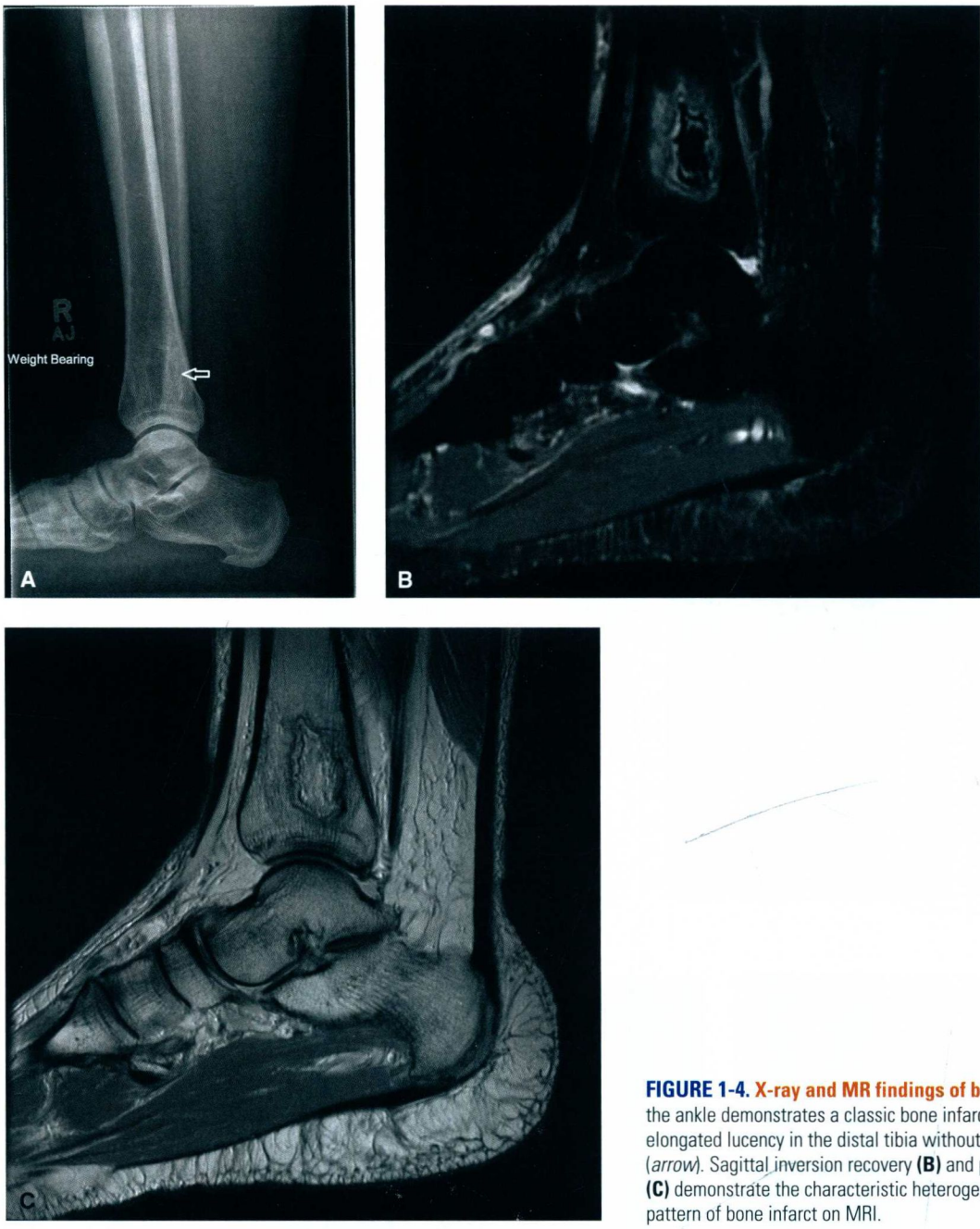


FIGURE 1-4. X-ray and MR findings of bone infarct. A: Lateral X-ray of the ankle demonstrates a classic bone infarct with an irregular serpiginous elongated lucency in the distal tibia without periosteal or endosteal reaction (*arrow*). Sagittal inversion recovery **(B)** and proton density-weighted images **(C)** demonstrate the characteristic heterogeneously hyperintense serpiginous pattern of bone infarct on MRI.

METASTATIC DISEASE

Bone is a common site of metastatic involvement in malignancy.[13] Many primary malignancies can metastasize to the skeleton; however, breast, prostate, and lung carcinoma are most frequently associated with osseous involvement.[13] Less frequently, kidney and thyroid cancers metastasize to the bone. Metastatic lesions can be painful and may lead to pathologic fracture if extensive cortical destruction is present.[14] The axial skeleton and proximal long bones are disproportionately affected in metastatic disease, in part because of the higher relative content of vascularized red marrow.[14]

The radiographic appearance of osseous metastases depends on the primary malignancy and the bone response elicited by the metastatic deposit.[13] Breast and lung carcinoma typically produce mixed lytic and blastic lesions.[13] Lytic lesions are characterized by excessive bone resorption and are often seen with thyroid and renal carcinoma, whereas blastic (sclerotic) lesions, characterized by excessive bone formation, are often seen with prostate carcinoma.[13] Radiographic features associated with osseous metastases include poorly defined margins, endosteal scalloping, cortical destruction, and periosteal reaction. An extraosseous soft tissue component may occasionally be associated (**Fig. 1-7**).[14]