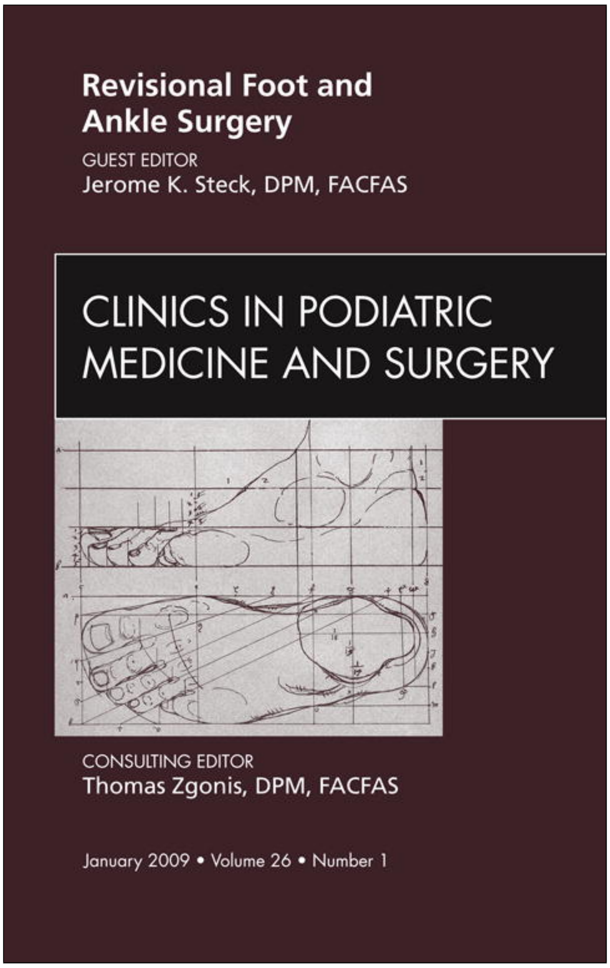
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The Use of Ilizarov Technique as a Definitive Percutaneous Reduction for Ankle Fractures in Patients Who Have Diabetes Mellitus and Peripheral Vascular Disease

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KEYWORDS

• Ilizarov external fixation • Diabetes mellitus • Ankle fracture
• Peripheral neuropathy • Peripheral vascular disease

More frequently, trauma surgeons in the United States use external fixation to stabilize lower extremity fractures temporarily until the soft tissue envelopes are prepared for surgery.[1,2] Open reduction internal fixation (ORIF) is then executed after the decrease in soft tissue swelling and when the skin lines are present in the nonvascularly compromised patient.[3] Standard treatment for a similar case would involve a period of non–weight bearing for approximately 6 to 8 weeks, followed by limited protected weight bearing and evidence of radiographic bone healing throughout the postoperative period. In a previous study reported from Sweden,[4] a great deal of emphasis was placed on early weight bearing after ORIF of ankle fractures for patients who did not have diabetes mellitus or dense peripheral neuropathy.

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Over the past 5 decades, the prevalence and severity of ankle fractures have increased in individuals.[5] Treatment of ankle fractures among diabetic patients tends to be fraught with increased complication rates, however, and poses unique challenges for the treating physician.[2] Peripheral vascular disease or peripheral neuropathy is presumed to be a contributing factor leading to higher complications in the treatment of ankle fractures.[6] As a result, infection, wound healing problems, nonunions, and loss of fixation tend to be the end result.[7] Low and Tran[8] performed a retrospective review of 10 diabetic patients treated surgically for ankle fractures and noted four wound infections, two of which resulted in transtibial amputation. Based on this study, they concluded that infection was considered a major problem in diabetic patients treated surgically for ankle fractures. There have also been several case-controlled studies reported on surgical treatment of ankle fractures in diabetic patients. Results have shown an overall complication rate of 43%, with the infection rate being 30%.[8–10]

McCormack and Leith[11] performed a review of 26 diabetic patients with displaced malleolar fractures and a cohort group. They noted an overall complication rate of 42% in the diabetic patients compared with no complications in the cohort group. Six of the 19 patients treated surgically developed a deep infection, and 2 patients eventually required an amputation at an unspecified level. The major complication noted in the nonoperative group revealed loss of reduction and malunion. Blotter and colleagues[9] performed a retrospective review of 21 patients who had diabetes and 46 randomly selected patients who did not have diabetes and were treated surgically for ankle fracture and reported a 43% complication rate in the diabetic patients compared with 16% in the nondiabetic group. The complications in this review were noted to be more severe in patients who had diabetes mellitus, including deep infections, and, thereafter, some of the patients required a below-the-knee amputation. In 2000, Flynn and colleagues[12] retrospectively reviewed 25 patients who had diabetes and 73 patients who did not have diabetes and were treated surgically or nonsurgically for closed ankle fracture. This study revealed that diabetic patients were likely to have infection develop 32% of the time compared with 8% of the time in patients who did not have diabetes. They concluded that diabetic patients who were noted to have signs of peripheral vascular disease, neuropathy, severe swelling, or ecchymosis were poor surgical candidates and most prone to infection and complications with their surgery.

Although the aforementioned studies discuss diabetic and nondiabetic patients, they all emphasize that these injuries can have disastrous results, with infection rates ranging from 17% to 50% and amputation rates of 4% to 17%.[7] Peripheral vascular disease, peripheral neuropathy, poor bone quality, poor immune function, and diminished healing potential, coupled with poor compliance, are noted prognostic factors for poor results.[7]

In this article, the authors demonstrate an alternative technique that may be useful in the surgeon's toolbox when dealing with the immunocompromised diabetic patient (peripheral vascular disease or peripheral neuropathy) and the presence of an unstable ankle fracture. The authors recommend that percutaneous reduction with an Ilizarov type circular external fixator can generate a construct that maintains anatomic alignment and simultaneous compression across the fracture site(s) and may allow early and full weight bearing if needed during the postoperative period.

SURGICAL TECHNIQUE

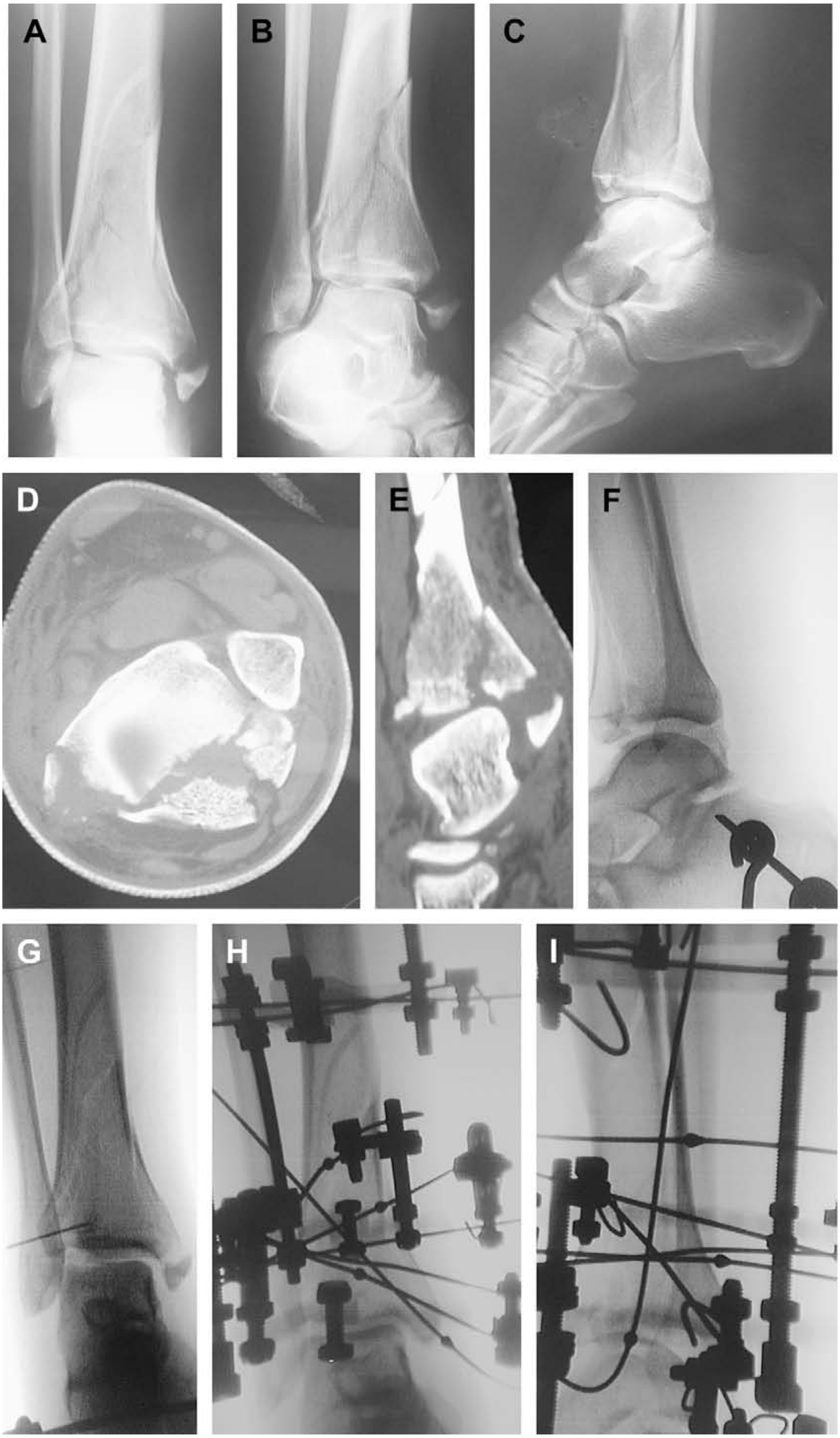
The initial clinical presentation is a valuable predictor of what additional surgical steps might be required. Radiographic examination, along with a CT scan, should be obtained to confirm a diagnosis and determine the severity of pathologic findings (**Fig. 1**).

After obtaining a thorough and complete past medical history, a physical examination is performed. In the physical examination, close attention is noted to the vascular and neurologic status in addition to the integrity of the skin. The presence of peripheral vascular disease can be demonstrated by decreased or absent pedal pulses, presence of skin necrosis, and atrophic skin. These changes should be closely evaluated and further documented by Doppler testing or noninvasive studies. It is for those diabetic patients who present with signs of peripheral vascular disease that this proposed technique is indicated. The overall operative treatment goals in this patient population are to maintain an articular surface, along with the axial alignment and length of the tibia and fibula, and to prevent any further risks for soft tissue complications.

After the initiation of anesthesia, the patient is placed on a fracture table. The entire lower extremity is prepared above the knee. Attention is directed to the posterior/inferior calcaneus, where a transfixion pin is placed medially to laterally through the body of the calcaneus, ensuring avoidance of injury to the neurovascular structures. Subsequent to the placement of the transfixion pin, a Bohler's clamp is attached to the pin and weights are applied for traction to obtain ligamentotaxis. Once ligamentotaxis is accomplished and the fracture is out to length, fluoroscopy is introduced to the surgical site. Based on the fracture type, olive wires are used for reduction and anatomic alignment under fluoroscopy. For example, if there is a trimalleolar fracture, the medial malleolus is reduced and percutaneously fixated, with olive wires being perpendicular to the fracture line. Next, attention is directed toward the fibular fracture. An olive wire is percutaneously placed perpendicular to the fracture line in an anterior-to-posterior direction. Then, another olive wire is placed perpendicular to the posterior-to-anterior direction. If a large posterior malleolus fracture is identified, another olive wire is percutaneously inserted in a posterior-to-anterior direction and perpendicular to the fracture line. If a pilon fracture is present, the same approach is considered, with the addition of adding olive wires perpendicular to the more proximal fracture fragments (**Fig. 2**).

After the fracture reductions and good anatomic alignment with the olive wires, multiple fine wires are used to build a multiplane circular external fixator to construct a secure external fixator block. This multiplane circular construct is built with a fine-wire technique and provides stability for the entire lower extremity. Once the circular ring fixator is mounted, tensioned, and stabilized, the opposed ends of the olive wires opposite the fractures are secured off the stable external fixator block. Next, each of the olive wires (opposite side of the olive) is tensioned to 90 to 110 kg (based on the bone quality) for compression across the fracture lines. The olive wire(s) is then secured to the stable external fixator block. The olive wires that are tensioned off the stable block allow for compression across the fracture line through the olive wires.

The estimated time for bony consolidation is approximately double the time normally estimated for a patient who does not have diabetes mellitus. Prolonged stabilization is essential to prevent neuropathic fractures from progressing into a Charcot deformity. A patient who has diabetic neuropathy and the presence of peripheral vascular disease generally has consolidation at 12 to 16 weeks. After frame removal, the patient then progresses to a walking-assisted device for approximately 4 to 6 weeks and further bracing for up to 12 months. Frequent postoperative visits, along with patient education and close monitoring, are essential to the patient's overall successful outcome.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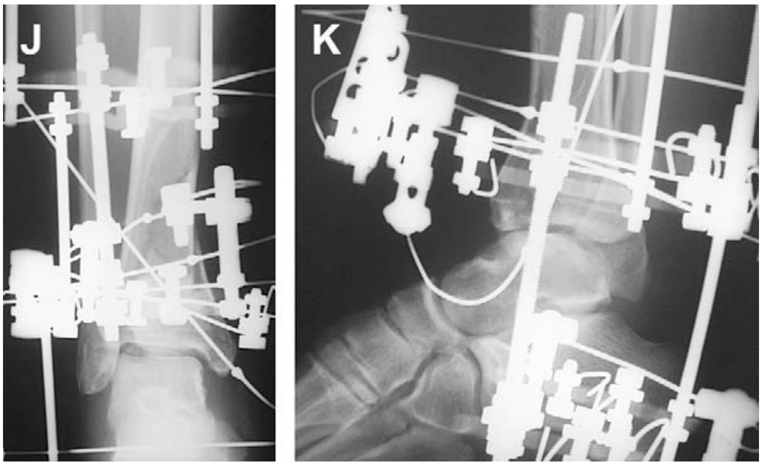

Fig. 1. (*continued*)

DISCUSSION

The use of external fixation has gained a popular role in staged protocols as a primary tool for reduction and preliminary fixation until soft tissue consolidation makes internal fixation feasible.[13] Limited literature is currently available to demonstrate the use of external fixation for acute ankle fracture repair in the vascularly compromised patient with an emphasis on early weight bearing and permanent fixation and on reducing the chance of a second operation to implant internal hardware.

Sound principles and techniques of external fixation are necessary to minimize postoperative complications in diabetic patients who have vascular disease and ankle fractures. Timing of surgery, soft tissue monitoring, proper surgical techniques, and an understanding of the bone healing process in a patient who has dense peripheral diabetic neuropathy are paramount to the patient's long term successful outcome.

Finally, the authors want to emphasize that this particular technique may be applied in a selective group of patients, including but not limited to diabetic patients with the presence of an unstable ankle fracture and peripheral vascular disease.

Fig. 1. Preoperative anterior-posterior (*A*), medial oblique (*B*), and lateral (*C*) radiographic views show an intra-articular distal tibial fracture in a vascularly compromised diabetic patient. (*D*, *E*) CT scan was ordered at the initial presentation, showing the extent and severity of the fracture. Intraoperative views demonstrate the Bohler's clamp in the calcaneus (*F*) with weight distraction off a fracture table aligning and reducing the fractures by means of ligamentotaxis (*G*). In *G*, note the placement of the small needles as landmarks for the fracture location. Immediate anterior-posterior (*H*) and lateral (*I*) postoperative films show fracture repair by means of the use of multiple percutaneous tensioned olive wires attached to a multiplane circular external fixator. Postoperative anterior-posterior (*J*) and lateral (*K*) views at 5 weeks. The fixator was removed at 12 weeks.

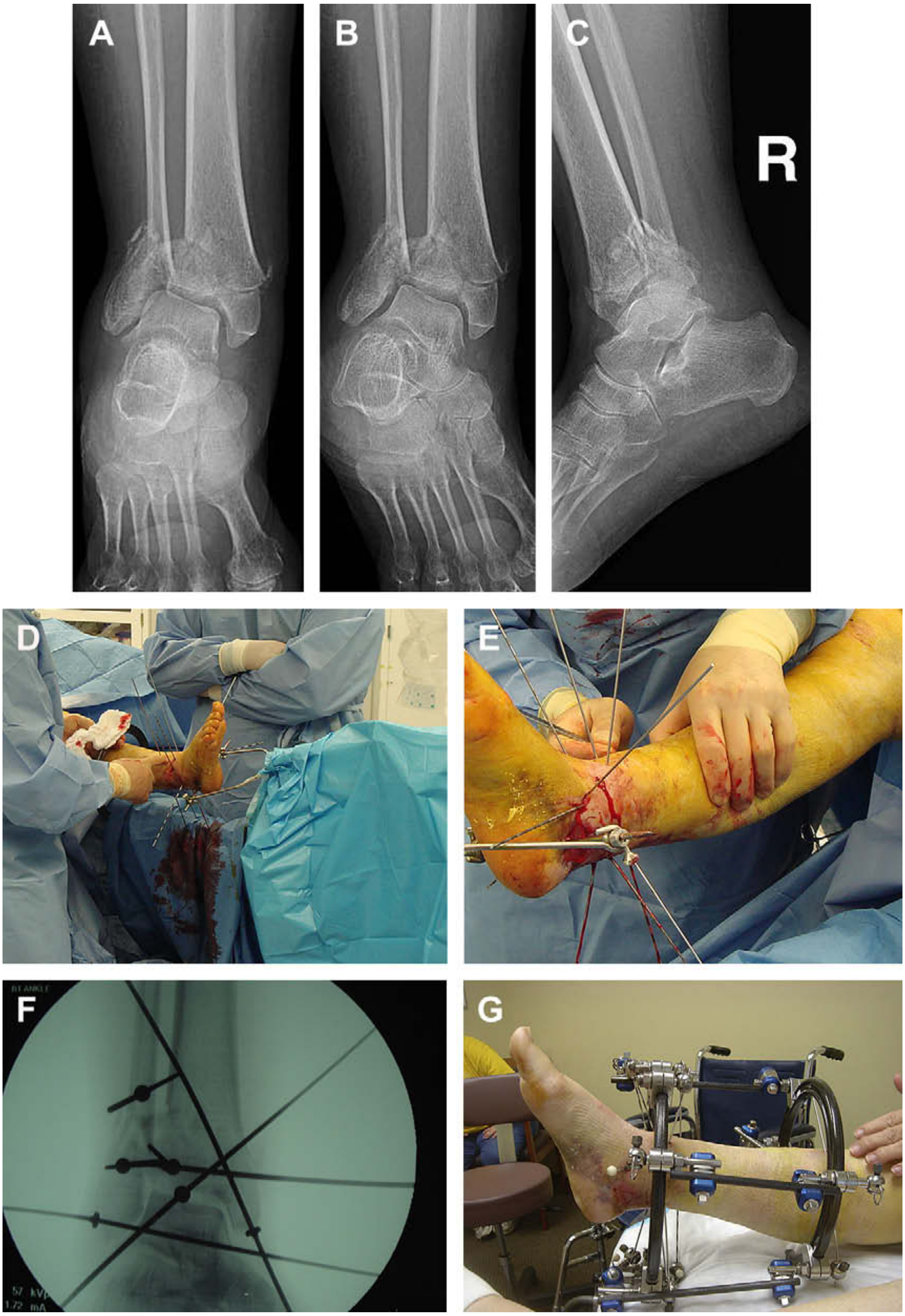

Fig. 2. Preoperative anterior-posterior (*A*), medial oblique (*B*), and lateral (*C*) radiographic views show an intra-articular trimalleolar ankle fracture in a vascularly compromised diabetic patient. (*D*) Intraoperative views demonstrate the Bohler's clamp in the calcaneus with weight distraction off a fracture table aligning and reducing the fractures by means of ligamentotaxis. (*E*) Reduction olive wires are shown in place across the fracture fragments. (*F*) Intraoperative view shows anatomic reduction and ankle joint preservation with the use of multiple percutaneous tensioned olive wires. (*G*) Clinical picture at 3 weeks after surgery. The fixator was removed at 12 weeks. (*H–J*) Clinical views of dorsiflexion and plantarflexion at 6 months.

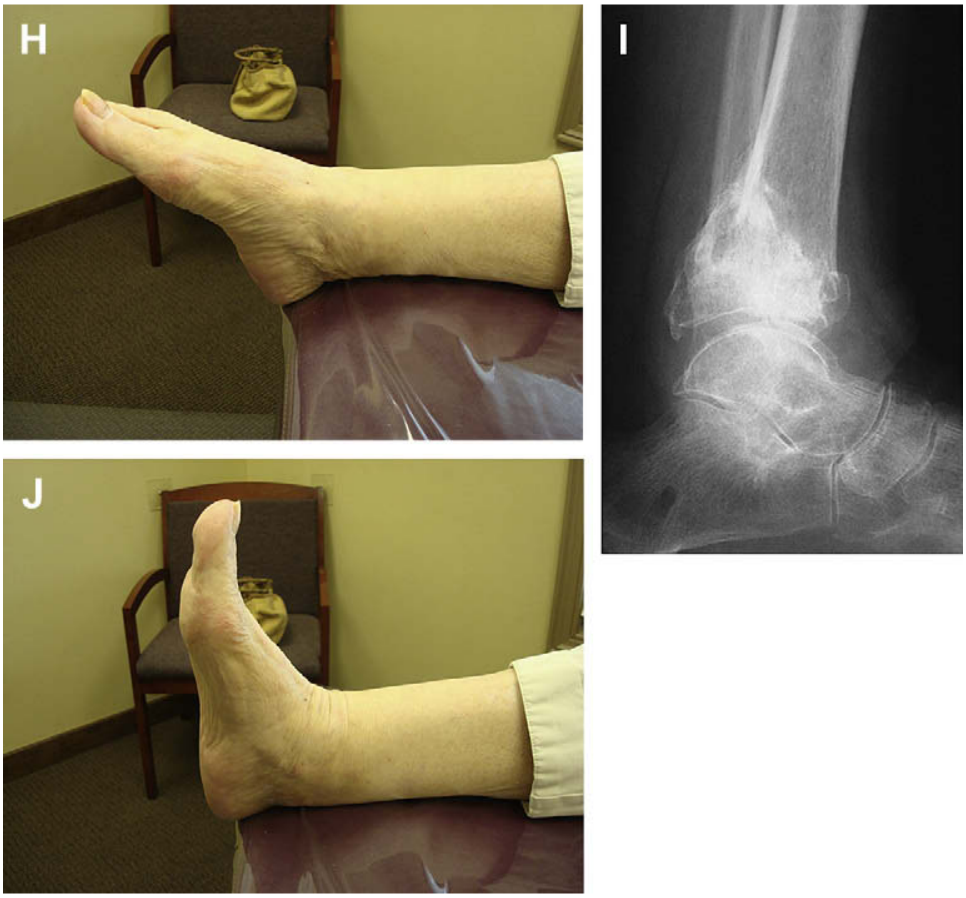

Fig. 2. (*continued*)

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