Chevron Ankle Arthrodesis with Bone Grafting and Internal Fixation

A new technique for ankle arthrodesis was described in 1983 by Marcus et al. in the Journal of Bone and Joint Surgery. It is a chevron ankle arthrodesis with bone grafting and internal fixation. The operation has many features distinguishing it from previously described methods of ankle arthrodesis.

The advantages of the technique over other methods of arthrodesis include: bimalleolar approach to the ankle providing excellent exposure; minimal bone resection of the tibiotalar joint, thereby preserving height of the joint and length of the extremity; inherent mechanical stability at the osteotomy sites afforded by the Chevron cuts; several features designed to enhance rapid fusion, including the congruity and stability of the cuts made, onlay bone grafting and rigid internal compression fixation; a normal-looking ankle contour postoperatively, resulting in a superior cosmetic result.

The operation has been utilized at St. Anne's Hospitals and can be augmented for use in pantalar arthrodesis.

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Marcus *et al.* (1) described a new operation for ankle arthrodesis during 1983. The operation has several features distinguishing it from the more than 30 previously described techniques. Furthermore, the long-term results were very satisfactory, including solid and rapid fusion, relief of pain, and a normal appearance of the ankle contour postoperatively.

The authors have utilized this operation at St. Anne's Hospitals for ankle arthrodesis, and modified it for use in pantalar arthrodesis. It is a superior technique and is applicable even to ankles with severe fracture deformities and marked varus or valgus.

In this report on the Chevron technique, the authors present a case of pantalar arthrodesis utilizing the method described by Marcus *et al.* This case of traumatic arthritis of the ankle with marked fracture deformity was complicated by ankle valgus, a distorted and prominent lateral malleolus, tibiofibular synostosis, and a subtalar joint depression fracture of the calcaneus with obliteration of Böhler's angle. The Chevron technique used at the ankle contributed to an excellent result with pantalar arthrodesis.

The features of the Chevron ankle arthrodesis are: 1) a tibiotalar joint resection attained with minimal bone removal; 2) the promotion of inherent mechanical stability at the osteotomy site from the configuration of the opposed surfaces; 3) the preservation of height of the ankle and length of the extremity; 4) the erasure of joint surfaces without altering their natural curvature, as opposed to the flat surfaces of the Charnley-type resections (2); 5) an arthrodesis operation with four features designed to enhance fusion such as a) multiple surfaces of cancellous bone in contact, b) autogenous onlay bone grafting, c) cancellous bone chips packed into any gaps, d) rigid internal compression fixation; 6) a bimalleolar approach to the ankle; 7) the complete removal of the distal fibula; 8) the vertical resection of the medial tibial flare, including malleolus, and removal of the inner one-third before its replacement as an onlay graft, providing an important stimulus for osteogenesis; 9) the transfibular and distal tibial osteotomies that allow for complete exposure of the ankle, including the posterior medial and lateral recesses of the joint, and direct visualization of the surfaces to be cut and coapted; 10) a vertical calcaneotibial Steinmann pin (removed after 2 weeks for ankle arthrodesis alone), screws, and staples that provide rigid compression fixation across the fusion site; 11) a slim, normal-looking contour at the ankle—an excellent cosmetic result—in contrast to the bulky and edematous ankles resulting from other arthrodesis methods.

The detailed account of the procedure for chevron ankle arthrodesis is recorded by Marcus *et al.* (1) in the Journal of Bone and Joint Surgery. Important features of the technique are described here. The procedure is augmented for pantalar arthrodesis, whereby the triple

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Figure 1. Preoperative ankle radiograph demonstrating posttraumatic fracture deformity. *A*, Anteroposterior view noting ankle with valgus position, distorted lateral malleolus, and fusion of the fibula to the tibia; *B*, lateral projection noting deformities at ankle and subtalar joints with joint depression of the latter and obliteration of Böhler's angle.

arthrodesis is done first. The pantalar can be done in one operation or in two-staged operations with recovery time in between. In the review by Waugh *et al.* (3) of 116 pantalar fusions, a two-stage operation did not appear to provide any advantage over a one-stage procedure.

In the example illustrated here, the pantalar was complicated by ankle and subtalar fracture deformities with marked ankle valgus, a distorted and broadened lateral malleolus, obliteration of Böhler's angle, and a fibula fused to the tibia (Fig. 1).

Procedure

The surgical approach is bimalleolar. Access to the subtalar joint in this case, was obstructed laterally by the distorted fibular malleolus. Resection of the distal fibula necessarily would precede entrance to the subtalar joint. Through serpentine medial and lateral incisions, the midtarsal joint is resected, aligned and fixated with broad bone staples. The medial and lateral foot incisions are extended proximally (Fig. 2).

The lateral incision is performed from inferior to the tip of the malleolus, proximally, along the posterolateral fibula, to a level 6 cm. above the malleolus. After subperiosteal dissection of the distal 4 cm. of the fibula, taking care to protect the peroneal tendons, sural nerve, and lesser saphenous vein, an oblique osteotomy is performed and the distal fibula is excised.

Access to the subtalar joint is gained posterolaterally. The joint is prepared for fusion, or in this case, for grafting, which contributes to joint fusion and preserved height of the calcaneus. Cartilage is denuded with curved osteotomes and a bone gouge, and the raw surfaces are dug up with the gouge.

Corticocancellous bone from the iliac crest, taken before the operation, or a slab of bone from the medial malleolus, can be packed into the joint.

Thomas (4) used a modified Grice extra-articular arthrodesis of the subtalar joint in adults for painful malunited fractures of the calcaneus and other affections. Through a sinus tarsi approach, he stabilized the subtalar joint with a full thickness iliac slab graft, in lieu of two tibial grafts. Gallie (5) also used two tibial grafts for subtalar fusion, but his approach is posterior, an approach that does not allow correction of varus or valgus position of the rearfoot.

Subtalar arthrodesis with the use of a table of corticocancellous bone from the iliac crest (method of Thomas) was performed in the present case with pantalar fusion. The cortical bone serves as a strut graft, and cancellous bone fills the remaining void. Compres-

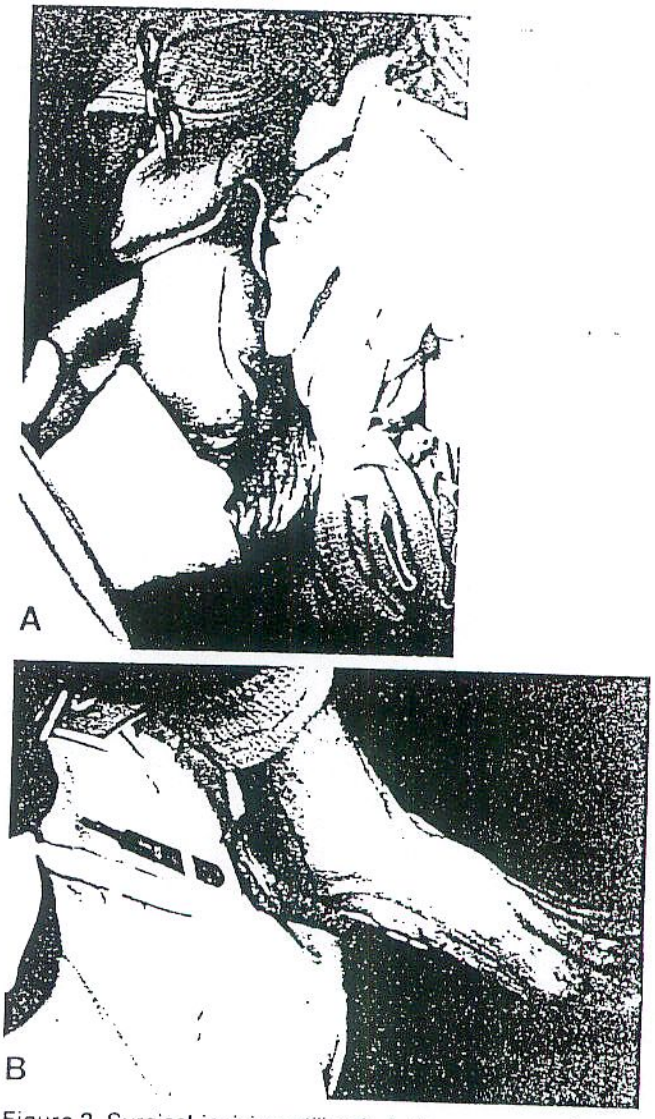

Figure 2. Surgical incision utilized: *A*, for exposure of lateral ankle after extension from the foot; *B*, medial incision.

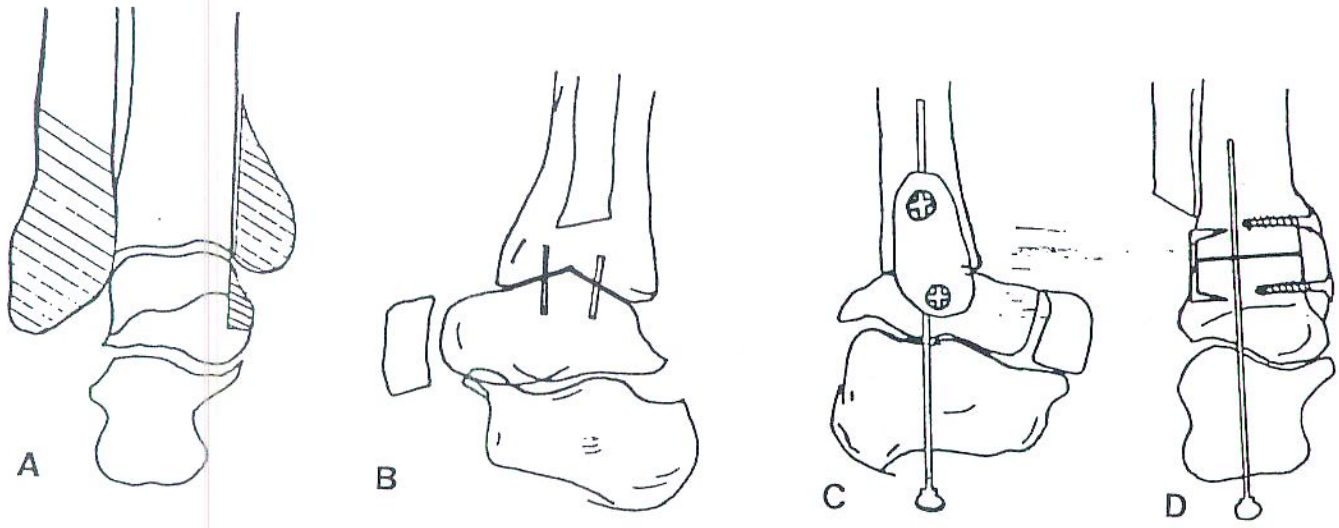

Figure 3. Illustrations depicting osseous technique and fixation in the Chevron ankle arthrodesis. *A*, medial and lateral resections; *B*, resected fibula, Chevron osteotomies, and bone staples; *C*, completed osteotomies, onlay graft, and fixation in place (axial Steinmann pin used if pantalar arthrodesis is performed); *D*, completed operation.

sion fixation is attained by driving a Steinmann pin axially through the calcaneus into the talus.

The medial incision is also extended proximally, under the malleolar tip, posterior and proximal along the medial tibia for 10 cm. The medial tibial flare is dissected subperiosteally, being careful to protect the neurovascular bundle. The entire tibial flare, including the malleolus, is removed by a vertical cut with a sagittal saw. The medial talar wall is denuded of cartilage. The tibial slab is set aside for use later as an onlay graft. With sharp dissection, the remaining capsule and ligaments are divided. The foot can then be taken out from under the leg, medially and laterally, for work on the tibial and talar osteotomies (Fig. 3).

The tibial Chevron resection is completed first. The ankle is reduced and the foot brought into the desired amount of plantarflexion. (Marcus *et al.* (1) recommended an equinus position between neutral and 5 degrees of plantarflexion.) The apex and angles of the Chevron cuts on the talar dome are marked with an osteotome to correspond with those on the tibia. The articular surface of the talus, as the foot is held in proper position, is resected with matching cuts, so the four resected surfaces fit congruously. The Steinmann pin is then advanced across the Chevron site, proximally along the tibia for several centimeters. Maintenance of ankle position is then insured. One, or preferably two, staples are driven across the fusion laterally into the tibia and talus through predrilled holes angled or spaced to provide compression as the staples are secured (Fig. 4).

The slab of tibial flare has been trimmed of its inner third and is replaced to bridge the fusion medially. It extends distally, flush with the superior two-thirds of the medial talar wall, and is secured by screws into the tibia and talus. The screw heads are countersunk. Many arthrodesis techniques recommend fibular onlay grafting, but this has the disadvantage of being mostly cortical bone.

Apposition of all the approximated surfaces is inspected, and any gaps are packed with cancellous bone chips from the iliac graft or the remaining medial tibia. The Steinmann pin is cut to protrude ¾ inch from the plantar heel. The wounds are closed in layers over closed-suction drains. (Skin staples can provide expedient skin coaptation.) An above the knee plaster cast is applied on the operating table and then bivalved.

Postoperatively, the limb is elevated in a Thomas splint, or other suspension-frame apparatus for 48 hours. The plaster and drains are removed, and the extremity is redressed, padded, and casted for 2 weeks. Skin staples or sutures are removed and the axial pin extracted in cases of ankle arthrodesis alone (in pantalar arthrodesis, the pin remains for 8 weeks), and another above-the-knee cast is applied (Fig. 5). The patient is kept non-weightbearing for 10 weeks. Partial weightbearing in a walking cast is permitted for an additional 4 to 6 weeks. Solid fusion is expected in 12 to 16 weeks (Figs. 6, 7).

Discussion

The amount of acceptable plantarflexion of the foot on the ankle in arthrodesis has been controversial in the literature. The authors agree with Marcus *et al.* (1) that neutral to 5 degrees of plantarflexion is the appro-

priate amount in a nonparalytic limb. Westin, in commentary on the report by Waugh *et al.* (3), proposed 5 to 10 degrees in all patients. Waugh *et al.* had proposed 10 degrees of plantarflexion in males and 15 degrees in females in the absence of flail knee. Plantarflexion was increased in patients with flail extremities to stabilize the knee by the resultant genu recurvatum. Waugh reported that most patients whose ankles were fused in 10 degrees or less of plantarflexion were happier than those in more equinus. He stated that increasing plantarflexion resulted in greater pressure being distributed to the metatarsal heads as is manifested by formation of callosities. Fusion in equinus to compensate for a shortened extremity did not prove to be a good choice. Patients were more willing to accept a shortened extremity and a full sole build-up for their shoe than unequal heel heights (3).

The surgeon's proposed angle of equinus is often quite different from the angle as measured on the postoperative roentgenograms. Intraoperative x-rays would eliminate these discrepencies according to the report of Lance (6).

Advantages of this ankle arthrodesis technique over those previously reported include: 1) bimalleolar ap-

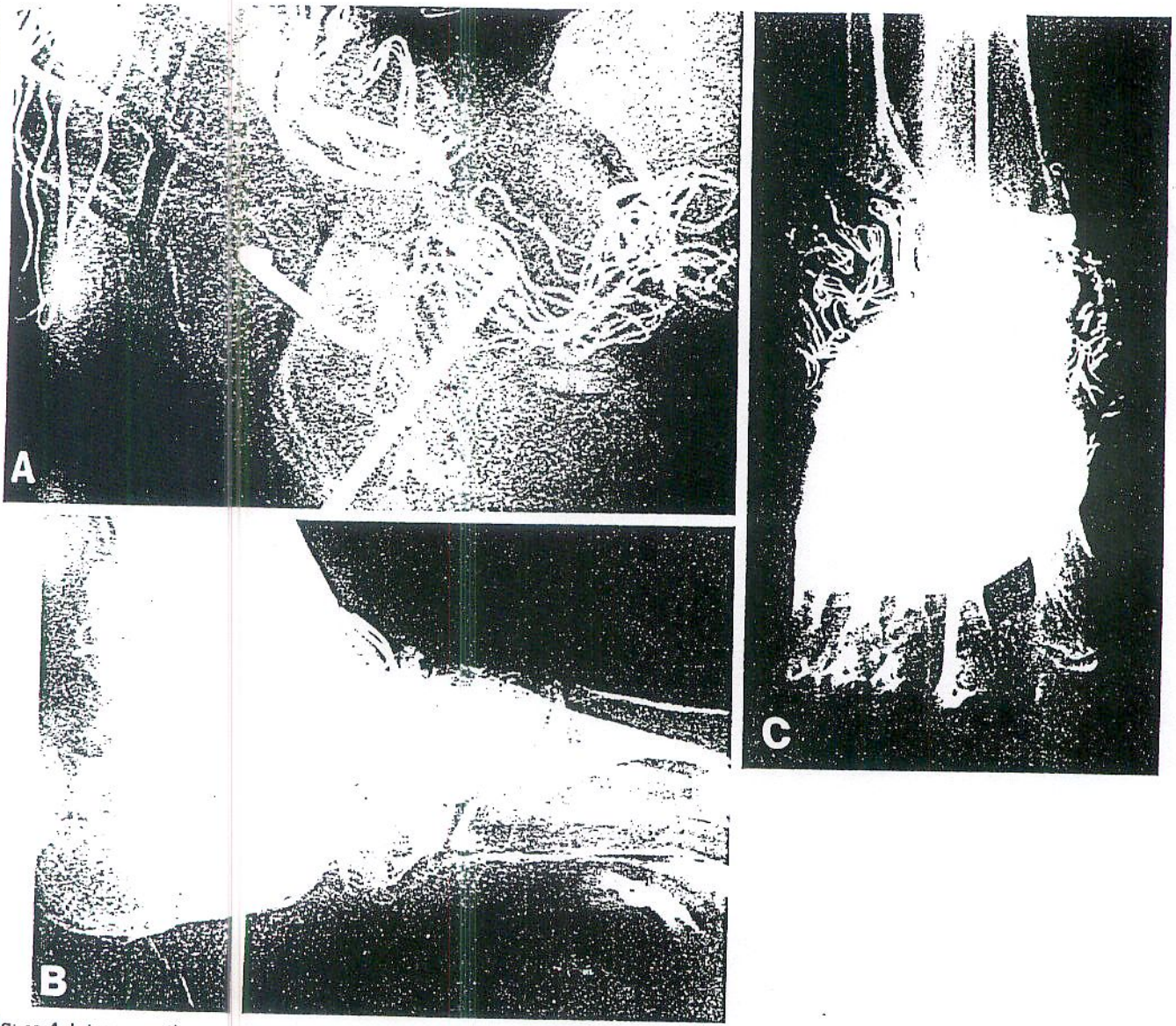

Figure 4. Intraoperative x-rays with bone grafting and internal fixation. *A*, lateral view of triple arthrodesis (wire mesh-marked spaces); *B*, lateral view of subsequent Chevron procedure followed by advancement of axial compression pin and internal fixation with bone staple and bone screws; *C*, anteroposterior visualization of completed operation. (Note ankle joint is obliterated and medial onlay graft eliminates lateral ankle space.)

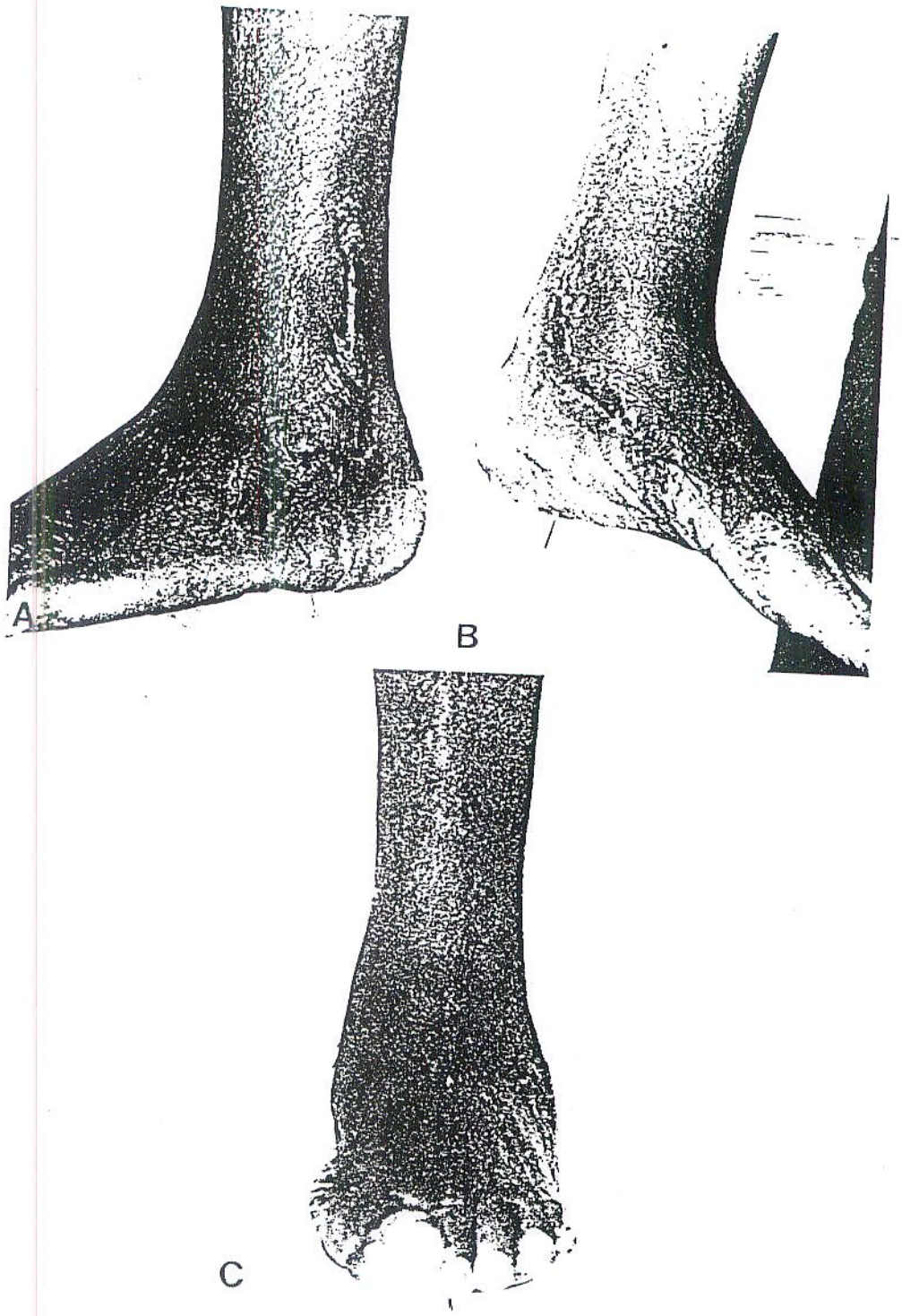

Figure 5. Six weeks postoperative. Clinical appearance demonstrates minimal edema and a slim, normal ankle contour. *A*, lateral, *B*, medial, and *C*, frontal views.

proach to the ankle joint for excellent exposure to the entire ankle, including the most posterior medial and lateral recesses of the joint; 2) subsequent ease of soft tissue retraction facilitating operation and avoiding traumatic heavy retraction of soft tissue; 3) minimal bone resection, thus preserving height of the ankle and length of the extremity; 4) inherent mechanical stability at the osteotomy site from the Chevron cuts; 5) features designed to enhance rapid, thorough, and solid fusion, including the congruity and stability of opposed sur-

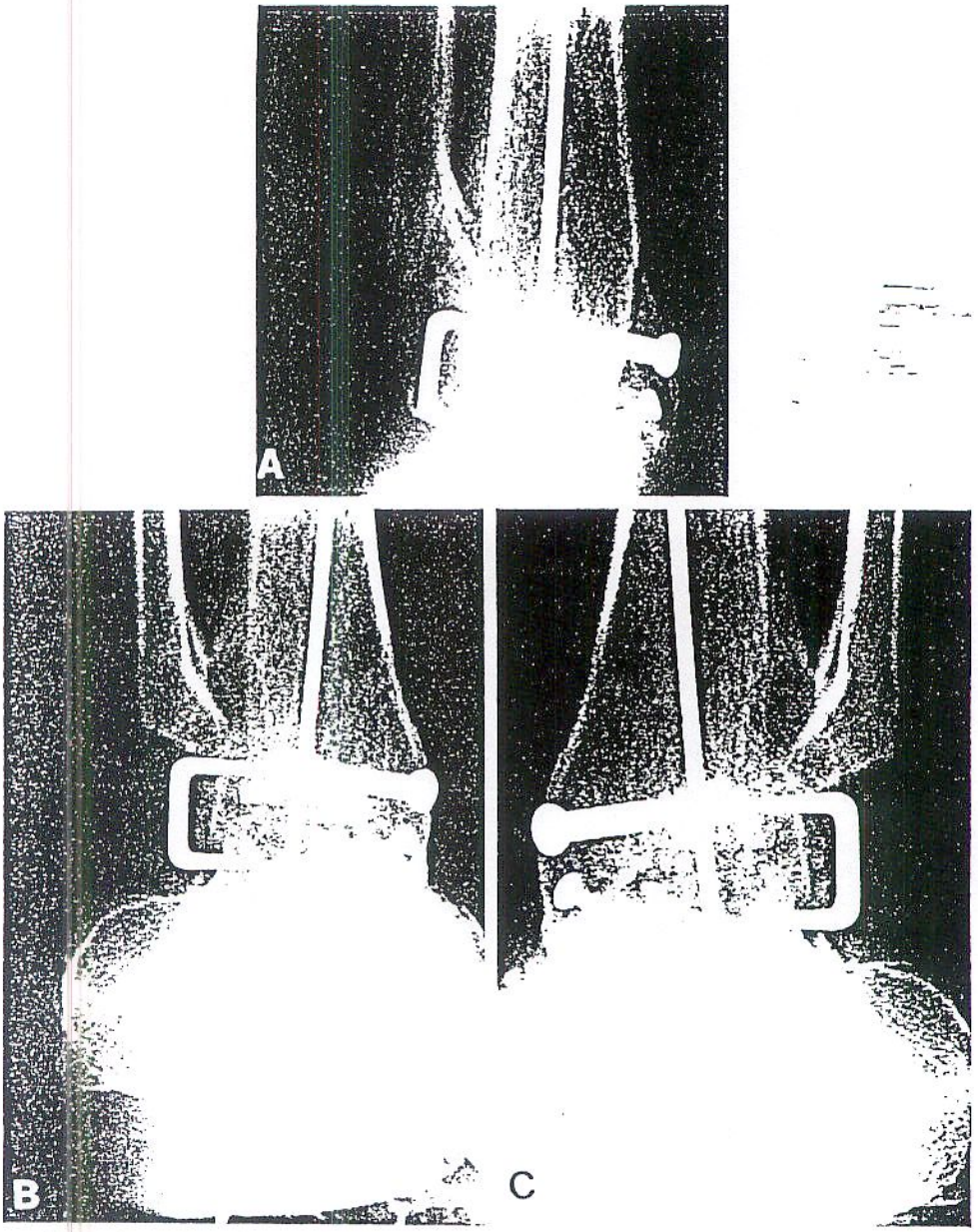

Figure 6. X-rays at 10 weeks postoperative demonstrate consolidation at the ankle with subtalar fusion progressing. *A*, anteroposterior; *B*, lateral; *C*, oblique.

faces, onlay bone grafting, and an axial pin, screws, and staples to secure rigid internal compression fixation; 6) a slim, normal-looking ankle contour—an excellent cosmetic result.

Stewart *et al.* (7) stated: "we are positive that the narrowing of the malleoli produces a much better result". Stewart also reported peroneal irritation in four of their patients, a complication apparently not reported previously in the literature. They felt that perhaps narrowing of the malleoli removed some of the lateral support to the peroneal tendons. Irregardless, the complication should pose less of a problem in pantalar arthrodesis than in ankle arthrodesis alone, because the additional midtarsal joint fusion reduces further foot movements resulting from peroneal muscle activity.

Problems with ankle arthrodesis, particularly nonunions and continued pain postoperatively, have been a source of controversy throughout the historical accounts of the operations. Studies of ankle arthrodeses have addressed those complications. Results of the review by Lance *et al.* (6) (190 consecutive arthrodeses of the ankle) should instill a healthy respect for ankle arthrodesis. It proves to be a procedure of many tech-

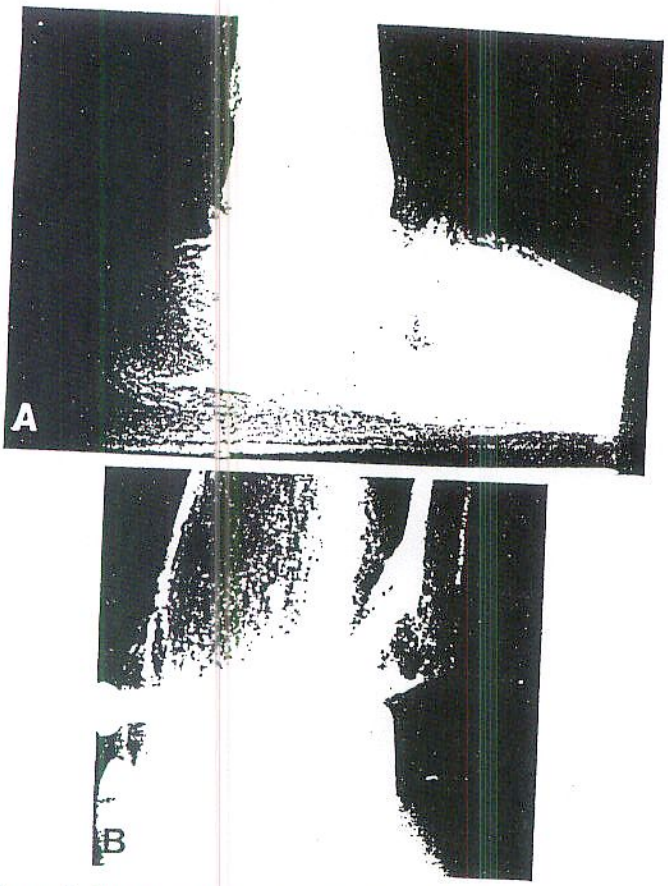

Figure 7. Fourteen weeks postoperative. *A*, lateral view, in particular, demonstates fusion; *B*, anteroposterior.

nical pitfalls, often requires a prolonged time for bony consolidation, and is associated with a high rate of nonunion. Poor results and failures occur, even in those cases in which bony union is achieved. Because arthritis of the ankles is often accompanied by arthritis of the subtalar and midtarsal joints, successful ankle fusion can still leave a patient with a painful foot (8).

Summary

A new technique for ankle arthrodesis was reported by Marcus *et al.* in 1983. The operation has several features that distinguish it from previously reported techniques. The advantages of this surgery are discussed. The procedure can be augmented for utilization in pantalar arthrodesis. It has been used at St. Anne's Hospitals, and is considered to be a superior technique in several aspects, compared with operations previously described. The technique represents a very sophisticated approach to ankle arthrodesis. After careful evaluation of the many previously reported operations and their shortcomings, this procedure applies important principles critical to the success in ankle arthrodesis.

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Comment: Arthrodesing procedures have been a part of the surgeon's armamentarium for many years, and in many cases they offer resolution of symptoms and return to an acceptable level of activity. The advent of joint replacement surgery has made many of these procedures obsolete because of the high level of success and a more normal joint function.

Unfortunately, joint replacement surgery of the ankle has not met with a high level of success because of the complex motion needed for a normal functioning ankle joint. Arthrodesis of the ankle has been very successful in relieving patients' symptoms and allowing them to resume a relatively normal activity level.

Many authors have described different approaches and techniques for performing this procedure. The Chevron ankle arthrodesis provides a high degree of stability and bone-to-bone contact necessary for uneventful healing. The authors present in a very detailed manner the advantages of the procedure and of internal fixation.

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