

WHAT'S NEW IN SURGICAL OPTIONS FOR HALLUX RIGIDUS?

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Introduction

The term *hallux rigidus* is used to describe a condition characterized by pain and a reduction in the range of motion, especially dorsiflexion, at the first metatarsophalangeal joint¹⁻³. According to the etiology, hallux rigidus can be classified as primary (hallux limitus) or secondary (Table I)^{1,2,4-8}.

Functional Consequences

With normal locomotion, the amount of hallux dorsiflexion during propulsion must approximate 65° to 75°. With hallux rigidus, dorsiflexion of the first metatarsophalangeal joint is

restricted⁹. As a consequence, during the propulsive phase of gait, functional limitation and pain lead to an internal rotation of the forefoot, reducing push-off and creating transfer metatarsalgia (Fig. 1)^{9,10}.

Indications for Surgery

The indication for surgery is pain combined with degenerative changes of the first metatarsophalangeal joint. Because there is no correlation between reduction of dorsiflexion and radiographic findings in hallux rigidus, we believe that the most useful parameter for the choice of a specific surgical technique is the extent of arthritis of the metatarsophalangeal joint as

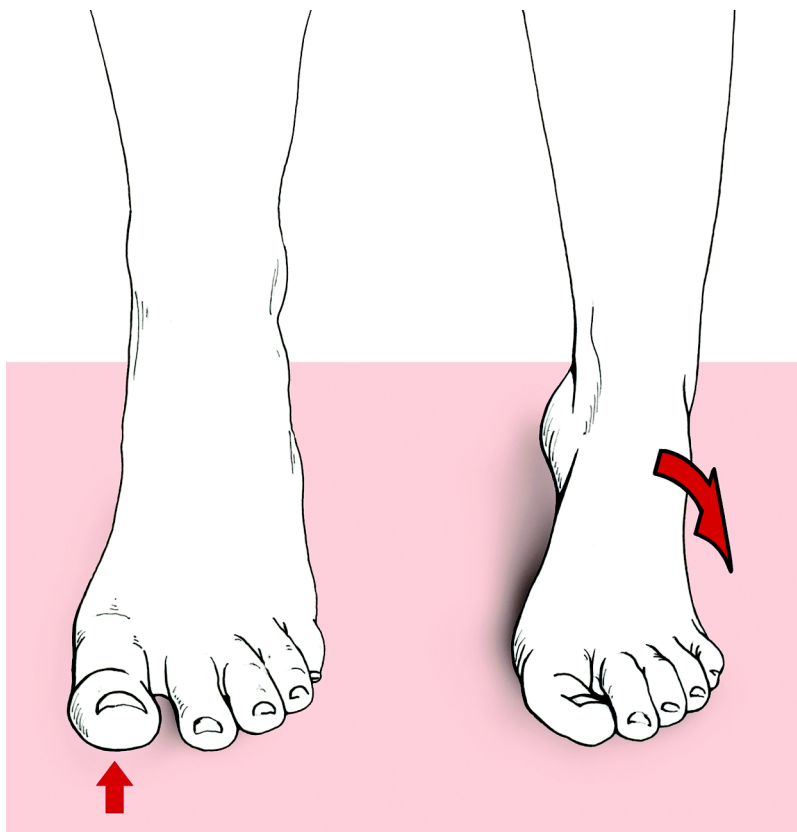


Fig. 1

During the propulsive phase of gait, the hallux is unable to dorsiflex adequately. As a consequence, the foot internally rotates, reducing push-off and causing transfer metatarsalgia of the lesser metatarsals.

TABLE I Etiology of Secondary Hallux Rigidus

Flexible flat foot—hypermobility of the first ray
Uncompensated varus deformity
Length pattern aberrations
Postoperative complications
Trauma and arthritis
Osteochondritis dissecans of the first metatarsal head
Osteochondral fractures
Paralytic deformities
Metabolic conditions
Inflammatory diseases
Clubfoot sequelae

seen radiographically with use of a classification system described by Coughlin and Shurnas¹¹ and modified by us (Table II) (Fig. 2).

Patient Factors

The surgical strategy has to be planned according to the arthritis classification and must include consideration of other patient factors (Table III). The goal of surgery is to relieve pain, improve function, reduce the progression of arthritis, and correct any associated deformity.

Aim of the Report

The purpose of this report is to present guidelines for the surgical treatment of hallux rigidus by presenting the results of the treatment of a consecutive series of 111 feet.

Materials and Methods

One hundred and eleven feet with hallux rigidus in eighty-six patients were treated consecutively between 1992 and

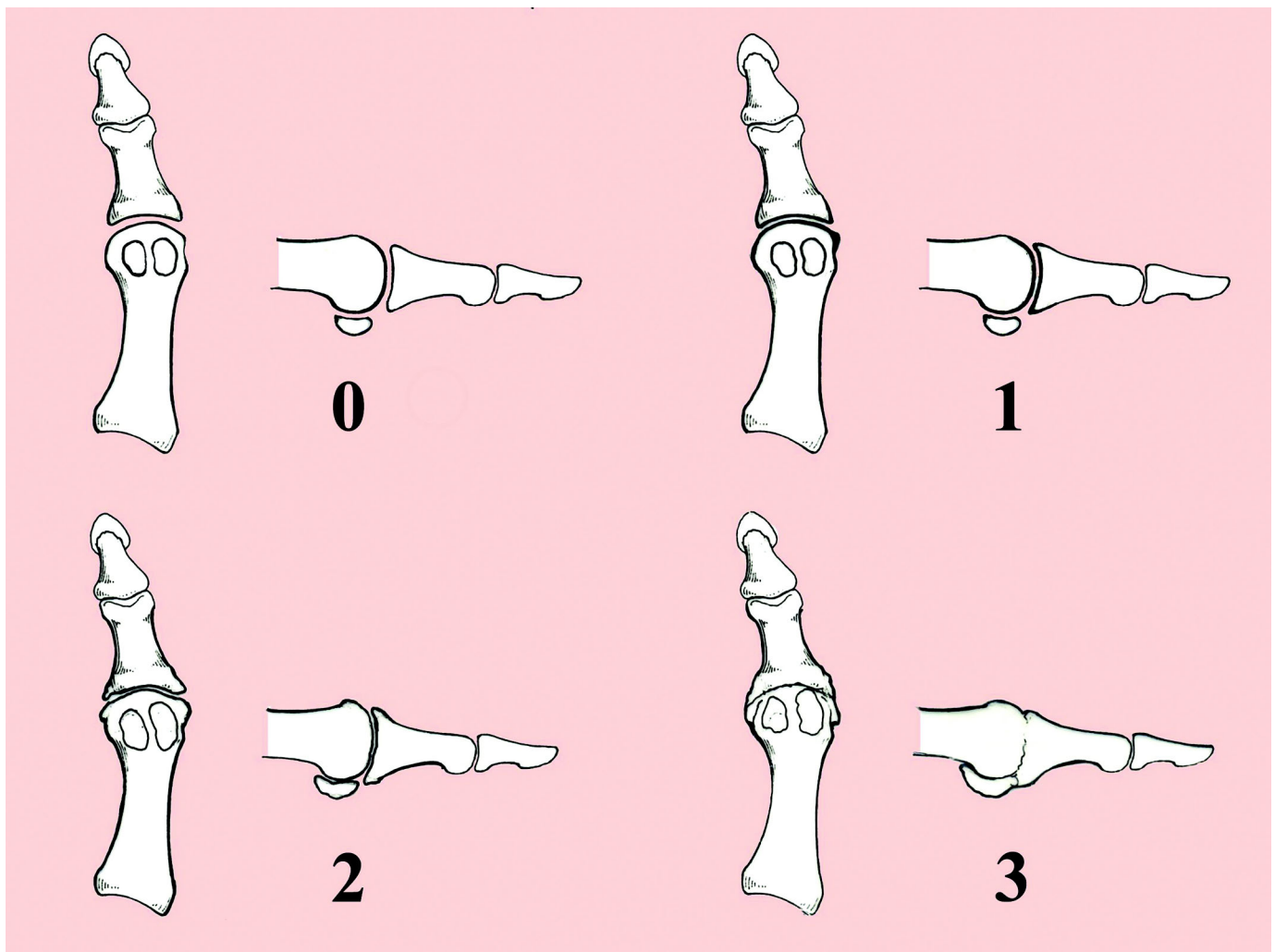


Fig. 2

Radiographic classification of hallux rigidus. (See Table II for a description of the grades.)

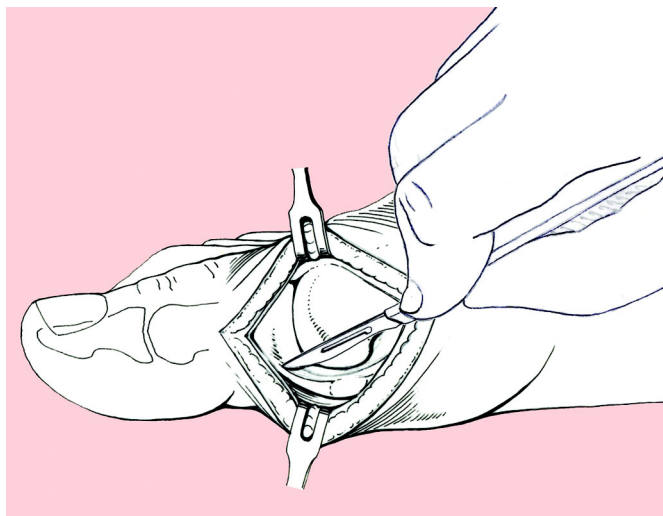


Fig. 3

Plantar release for grade-0 hallux rigidus. The plantar plate is completely detached from the plantar surface of the base of the proximal phalanx with use of a blade or a periosteal elevator.

2000. There were sixty-seven female and nineteen male patients, and they had a mean age of 53 ± 12 years. At admission, all patients were evaluated clinically with regard to pain, range of motion, and alignment. In all patients, the range of motion of the first metatarsophalangeal joint was measured with use of a goniometer and according to the method of Ronconi et al.¹², with the foot at 90° to the leg in a non-weight-bearing state, and the value was recorded. Beginning in 1995, the patients were asked to complete the American Orthopaedic Foot and Ankle Society questionnaire¹³. Anteroposterior and lateral weight-bearing radiographs were evaluated.

Surgical Technique

Surgical treatment was performed with the patient under general, spinal, or local block anesthesia. A tourniquet was applied, according to the anesthetic technique, at the thigh or ankle level. All patients were discharged the day of surgery if they were treated with local anesthesia or the day after surgery if they were treated with general anesthesia, and weight-bearing was permitted in a postoperative shoe. Antibiotic therapy was given for two days, and antithromboembolic therapy (low-molecular-weight heparin) was given until the time of suture removal.

Grade-0 Hallux Rigidus

In seven feet affected by hallux rigidus associated with grade-0 arthritis of the metatarsophalangeal joint, a plantar release alone was performed¹⁴. For these patients, the approach is medial, proceeding through the skin, subcutaneous tissue, and capsule directly to the bone. The capsule is released. A synovectomy is performed first, and then the plantar plate is completely detached from the plantar surface of the base of the proximal phalanx with use of a blade or a small periosteal elevator (Fig. 3). The sesamoid bones are released

from the metatarsal head. The great toe is then manipulated until 90° of dorsiflexion can be achieved. The capsule is then closed with 0-gauge reabsorbable sutures, avoiding excessive tension of the capsule. A compressive gauze dressing is applied for two weeks, and early active and passive motion is then begun.

Grade-1 Hallux Rigidus

In eighteen feet affected by hallux rigidus associated with grade-1 arthritis of the metatarsophalangeal joint, one of two decompressive osteotomies (both achieving shortening

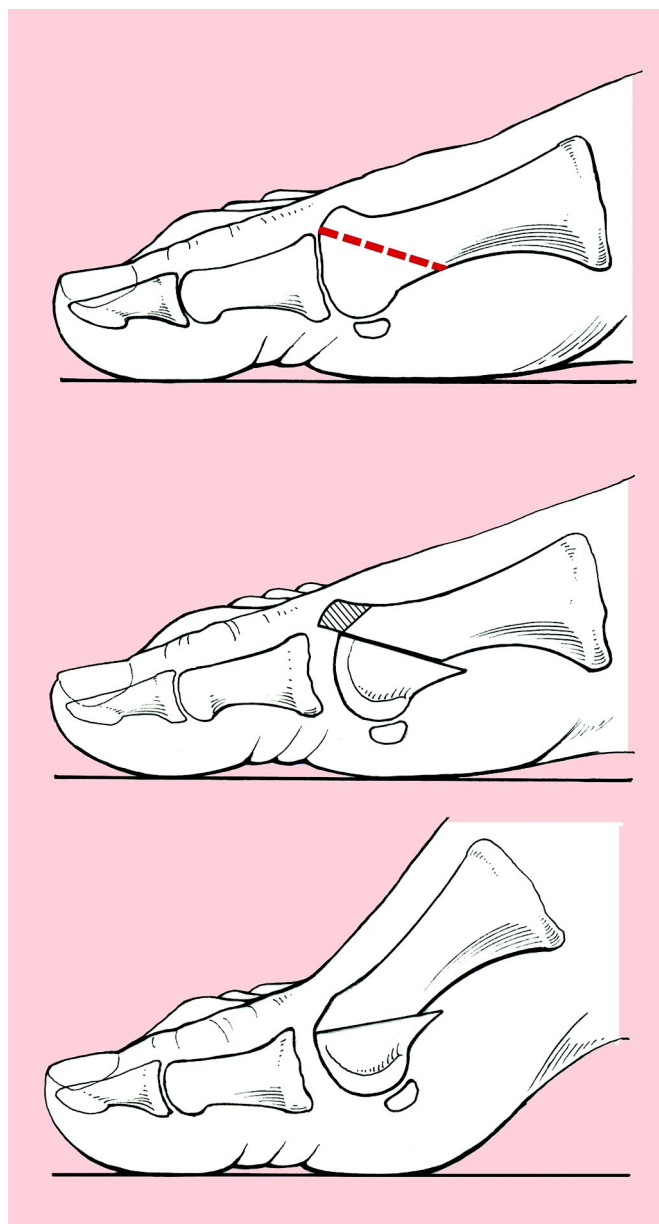


Fig. 4

Sliding osteotomy for grade-1 hallux rigidus. The osteotomy is performed in a distal-to-proximal direction. Proximal displacement of the head permits decompression of the joint.

and plantar displacement of the metatarsal head) was performed^{15,16}. Ten feet without any deformity of the hallux and with grade-1 hallux rigidus received a sliding decompressive oblique osteotomy¹⁵ (Fig. 4). Through a dorsal approach to the metatarsophalangeal joint, after retracting the extensor hallucis longus medially, the dorsal aspect of the capsule is incised. By forcing the hallux into extreme plantar flexion, the metatarsal head is exposed. After performing a plantar release and removing any osteophytes, the osteotomy is performed in a distal-to-proximal direction beginning from approximately 3

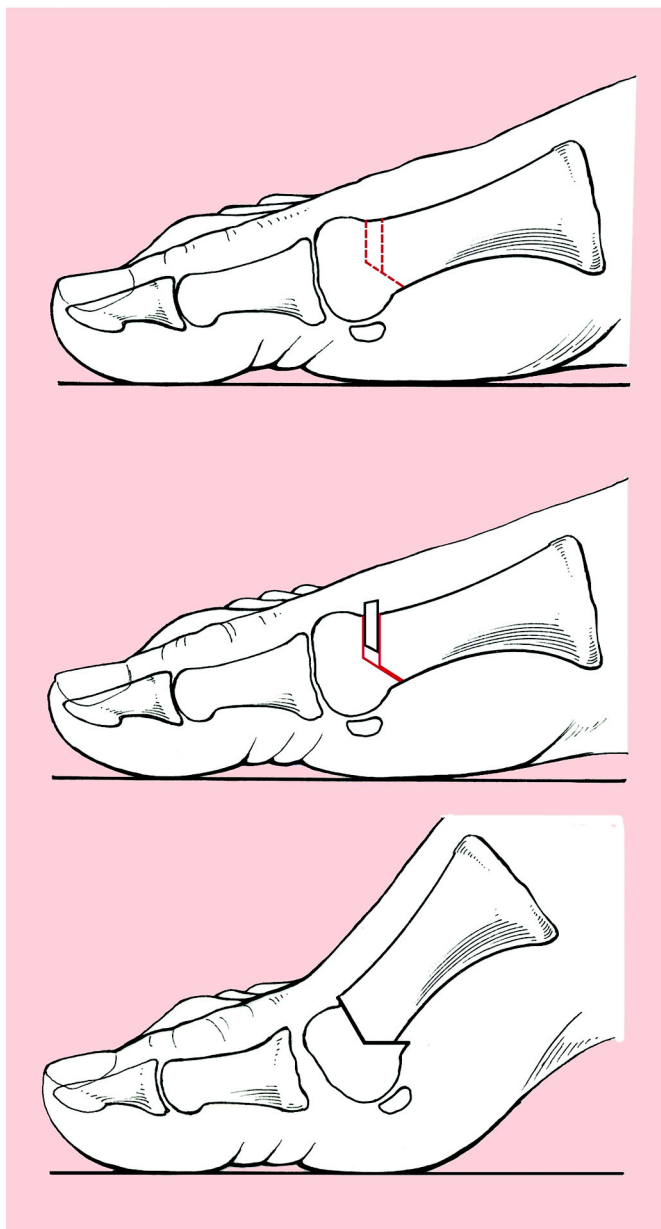


Fig. 5
Modified chevron osteotomy for grade-1 hallux rigidus. Two chevron-shaped bone cuts are performed, and a 3-mm slice of bone dorsally is removed to achieve plantar and proximal displacement of the head fragment.

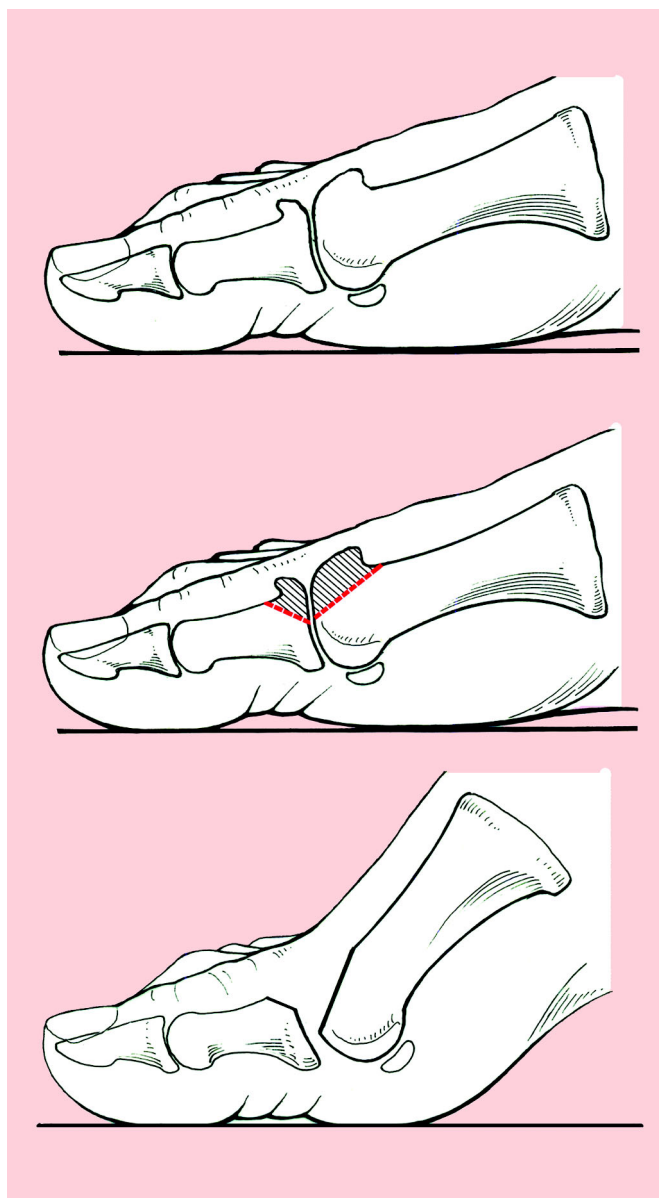


Fig. 6
Cheilectomy for grade-2 hallux rigidus. A dorsal resection of 25% to 30% of the metatarsal head is performed.

mm inside the articular surface. The head fragment is displaced proximally by 3 to 5 mm, and the consequent plantar displacement is approximately 1 to 2 mm. The head is fixed temporarily with use of a 1.6-mm Kirschner wire. Definitive fixation is then obtained with a 2.7-mm hydroxyapatite-coated cancellous bone screw. The dorsal spike of the proximal fragment is resected tangentially.

Eight feet with deformity of the great toe (seven with valgus alignment and one with varus) and grade-1 hallux rigidus underwent a modified chevron decompressive osteotomy¹⁶ (Fig. 5). With use of a medial approach, the medial eminence of the head is removed. After performing a plantar release, a chevron-shaped osteotomy is made. A 3-mm slice of

TABLE II Classification of Arthritis of the Metatarsophalangeal Joint Associated with Hallux Rigidus

Grade 0	Normal or minimal joint-space narrowing without osteophytes.
Grade 1	Dorsal osteophyte is the main finding, with minimal joint-space narrowing, minimal periarticular sclerosis, and minimal flattening of the metatarsal head with a lateral spur.
Grade 2	Dorsal, lateral, and possibly medial osteophytes with a flattened appearance of metatarsal head, no more than one-quarter of the dorsal joint space involved on the lateral radiograph, and mild-to-moderate joint-space narrowing and sclerosis; the sesamoids are not usually involved.
Grade 3	Same as grade 2 but with substantial narrowing, possible periarticular cystic changes, more than one-quarter of the dorsal joint space involved on the lateral radiograph, and the sesamoids are enlarged and/or cystic and/or irregular.

bone is dorsally cut and removed to achieve plantar and proximal displacement of the head combined with lateral or medial displacement as needed to correct the deformity. Fixation is achieved with a 1.8-mm percutaneous Kirschner wire. In the case of a valgus deformity, any medially protruding portion of the proximal fragment is also resected tangentially. A compressive gauze dressing is applied for four weeks. The Kirschner wire is then removed, and active and passive range-of-motion exercises are begun.

Grade-2 Hallux Rigidus

Thirty-three feet with hallux rigidus associated with grade-2 arthritis of the metatarsophalangeal joint were treated with a cheilectomy¹⁷⁻²⁰. A medial or dorsal approach is used. After plantar release, all osteophytic prominences surrounding the metatarsal head and the base of the proximal phalanx are excised. Next, resection of 25% to 30% of the dorsal aspect of the metatarsal head is performed according to the technique of Mann and Clanton¹⁸ (Fig. 6). A compressive gauze dressing

TABLE III Important Patient Factors for Consideration in the Surgical Strategy

Age
Gender
Etiology
Degree of functional impairment
Level of patient activity
Forefoot morphology (metatarsal and digital length)
Presence of transfer metatarsalgia
Combined deformity of the big toe
Presence of arthritis of the metatarsal-cuneiform or interphalangeal joints
Expectations of the patient
Appearance

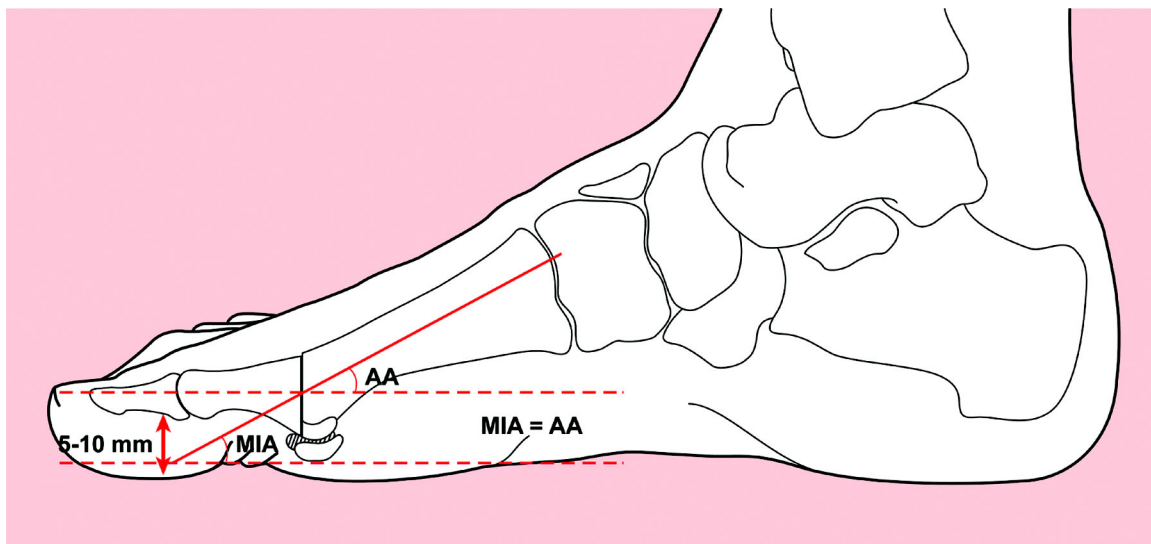


Fig. 7

Arthrodesis for grade-3 hallux rigidus. In the sagittal plane, the proper position of the arthrodesis is with the toe parallel to the ground. MIA = metatarsal inclination angle, and AA = arthrodesis angle.

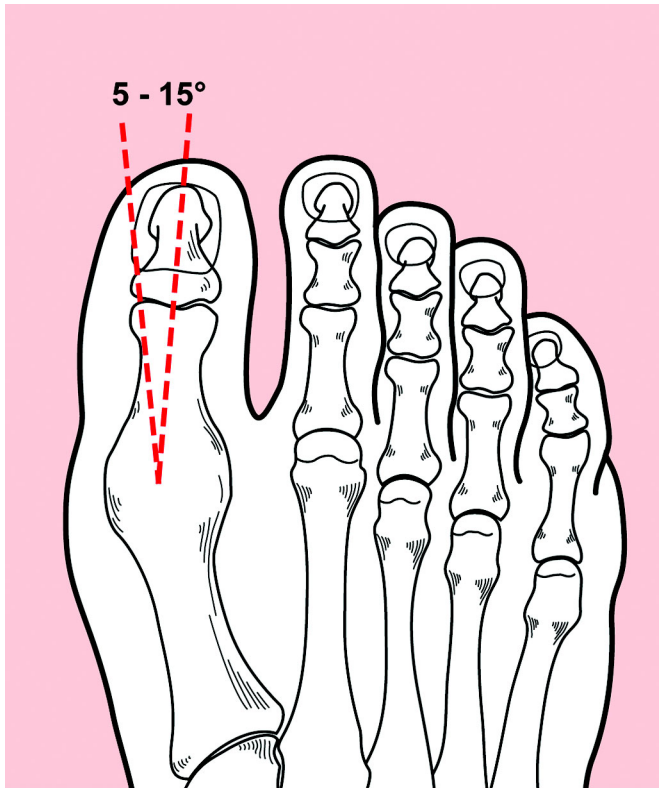


Fig. 8
Arthrodesis. In the horizontal plane, the arthrodesis angle must be 5° to 15° of valgus deviation, and, in the frontal plane, the rotation must be neutral.

is applied for two weeks, and early active and passive motion exercises are advised.

Grade-3 Hallux Rigidus

In fifty-three feet affected by hallux rigidus associated with grade-3 arthritis of the metatarsophalangeal joint, an arthrodesis or resection arthroplasty with a bioreabsorbable poly (DL-lactic acid) spacer was performed^{6,21-23}.

In thirty-one feet with grade-3 hallux rigidus in young patients with high functional demands or in patients with severe deformity, regardless of age, an arthrodesis of the first metatarsophalangeal joint was performed^{6,21,22}. The approach is medial, proceeding through the skin, subcutaneous tissue, and capsule directly to the bone. After release of the metatarsal head and the base of the proximal phalanx, all osteophytes are removed. A resection of the joint through two parallel cuts is then performed. The toe must be placed in the proper position. In the sagittal plane, the arthrodesis angle must be equal to the metatarsal inclination angle with the toe parallel to the ground (Fig. 7)²⁴. In the horizontal plane, the arthrodesis angle should be 5° to 15° of valgus deviation, and, in the frontal plane, the rotation of the toe must be neutral (Fig. 8)²⁴.

Screw fixation in the correct alignment is obtained with use of a 1.8-mm percutaneous Kirschner wire in order

to control the rotation and a 3.5-mm hydroxyapatite-coated lag screw to create compression across the arthrodesis. A compressive gauze dressing is applied for one month, and the Kirschner wire is then removed. The day after removal of the wire, full weight-bearing and physical therapy (range-of-motion exercises of the interphalangeal joint and hydrotherapy) is advised.

In three feet in young patients with severe shortening of the toe, a lengthening arthrodesis was performed with use of

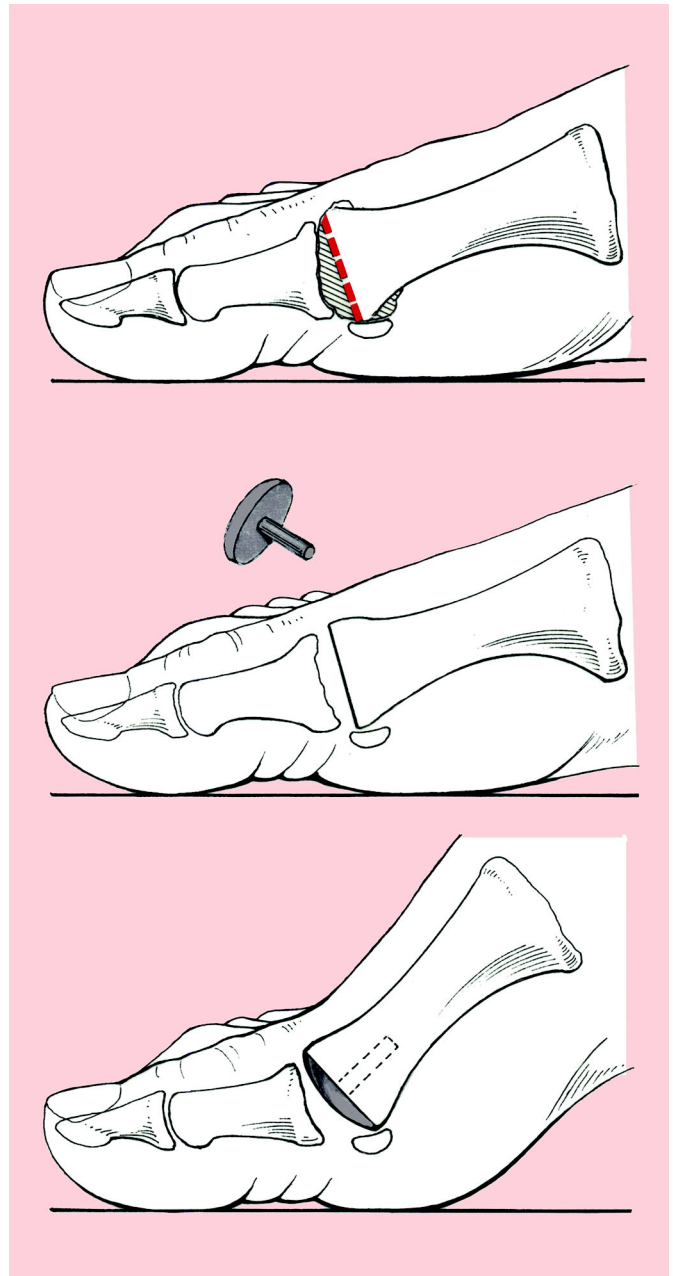


Fig. 9
Arthroplasty with use of a poly(DL-lactic acid) spacer. The implant is inserted after minimal resection of the metatarsal head and reaming of the medullary canal.

an autologous bone graft harvested from the iliac crest or from the proximal aspect of the ipsilateral tibia. Fixation in these feet was achieved with two 1.8-mm Kirschner wires.

In twenty-two feet with grade-3 hallux rigidus (eighteen feet in elderly patients or in patients with low functional demands, three feet in young patients who refused arthrodesis, and one foot in a professional soccer player), an arthroplasty with a bioreabsorbable poly(DL-lactic acid) spacer was performed²³ (Fig. 9).

Through a medial approach, after release of the base of

the proximal phalanx and of the metatarsal head and removal of all osteophytes, a minimal resection of the head is carried out. Then the medullary canal is prepared to accommodate the stem of the spacer, which is cannulated to enable the passage of a 1.4-mm Kirschner wire. The spacer is positioned in the joint and is then stabilized by running the Kirschner wire from the end of the toe through the spacer and along the entire first ray. A compressive gauze dressing is applied for two weeks. The Kirschner wire and sutures are then removed, and physical therapy is begun.

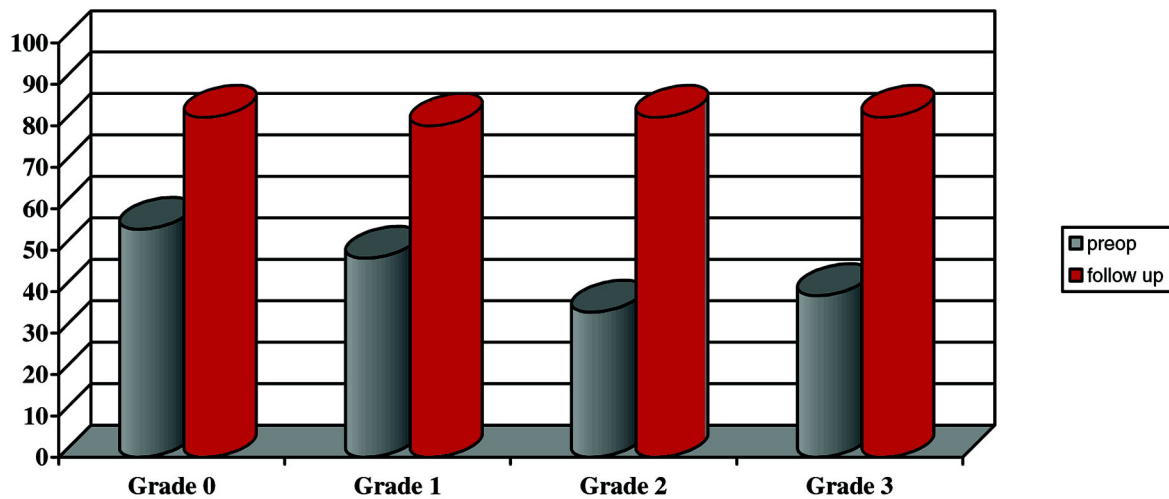


Fig. 10

Scores on the American Orthopaedic Foot and Ankle Society scale obtained preoperatively and at the time of follow-up.

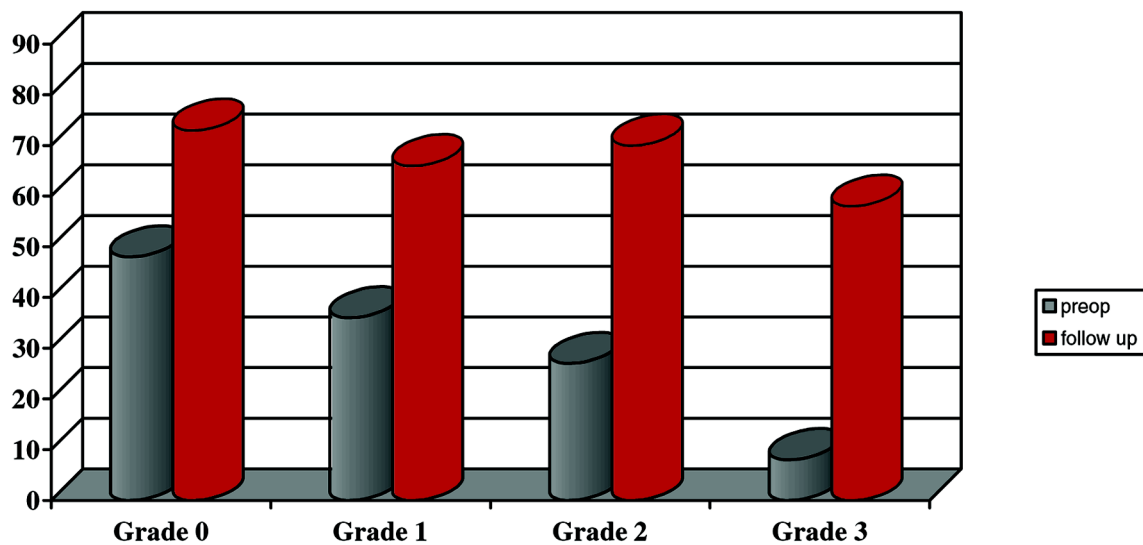


Fig. 11

The mean range of motion of the first metatarsophalangeal joint, measured preoperatively and at the time of follow-up, in patients who did not undergo arthrodesis of the first metatarsophalangeal joint.

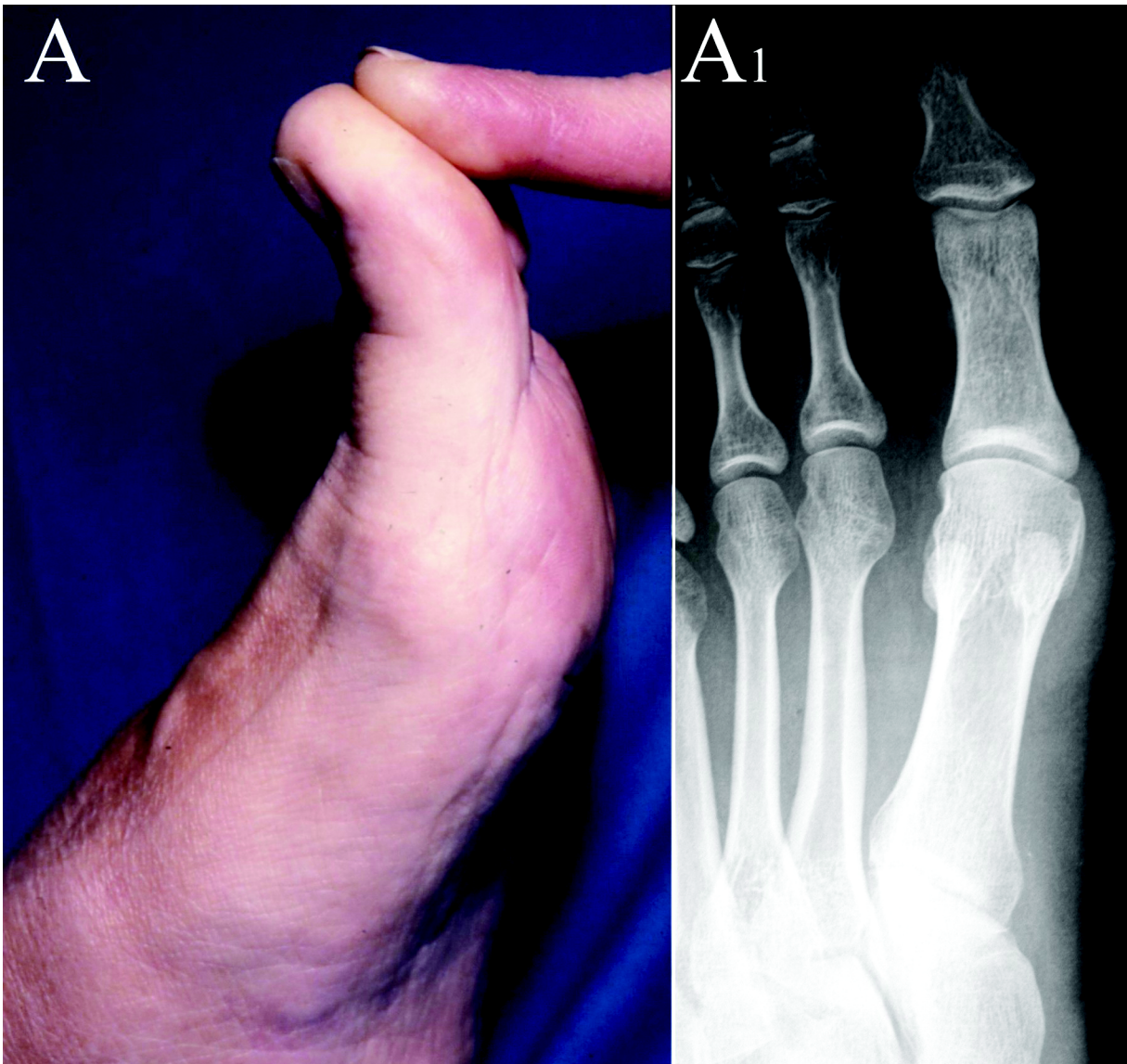


Fig. 12-A

Figs. 12-A and 12-B The foot of a twenty-eight-year-old man with grade-0 hallux rigidus. Clinical and radiographic appearance before surgery (A and A₁).

Postoperative Evaluation

Outcomes were assessed with use of the American Orthopaedic Foot and Ankle Society foot score¹³, range-of-motion measurements, and findings on anteroposterior and lateral radiographs. Preoperative and postoperative data (mean duration of follow-up, four years; range, three to eight years) were compared with the Student t test and the chi-square test ($p < 0.001$).

Results

Clinical Results

The mean score (and standard deviation) on the American Orthopaedic Foot and Ankle Society scale was 42 ± 14 points preoperatively and 81 ± 9 points at the time

of follow-up ($p < 0.05$) (Fig. 10). The mean range of motion of the metatarsophalangeal joint was $27^\circ \pm 17^\circ$ preoperatively and $75^\circ \pm 8^\circ$ at the time of follow-up for all patients who had not had a metatarsophalangeal arthrodesis ($p < 0.001$) (Fig. 11). No intraoperative complications were observed. One foot with a bioreabsorbable poly(DL-lactic acid) implant had a localized infection at the metatarsophalangeal joint with sinus formation. The implant did not require revision, but the infection resulted in ankylosis in an acceptable position. Five feet had inflammation around the Kirschner wire, which resolved spontaneously after the wire was removed. Four patients experienced deep venous thrombosis, and in one of them it was complicated by a pulmonary embolism. Ten patients required a second

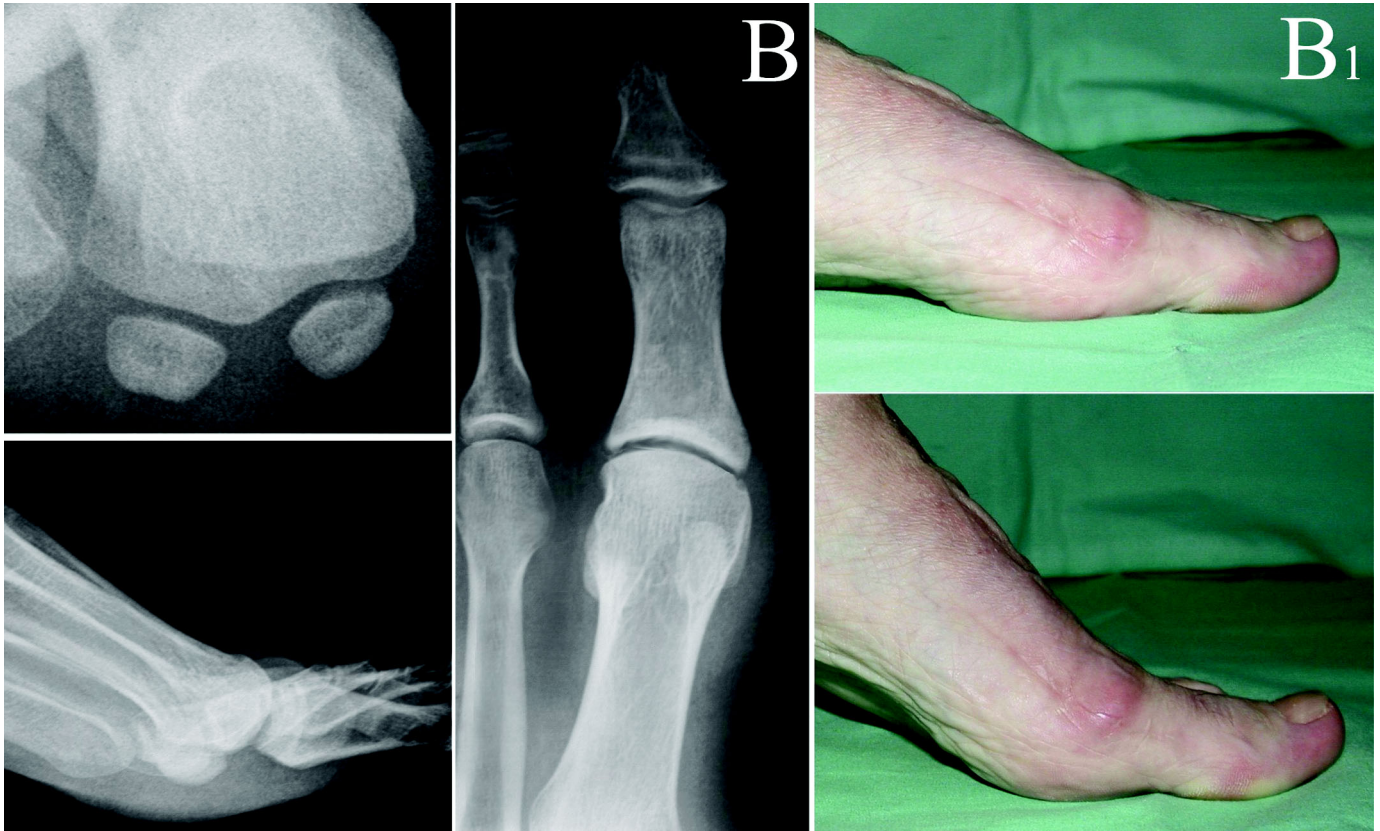


Fig. 12-B

An excellent radiographic (B) and clinical (B₁) result was maintained at four years after a plantar release.



Fig. 13

The foot of a forty-five-year-old woman with grade-1 posttraumatic hallux rigidus associated with a valgus deformity (A). A modified chevron osteotomy to correct the deformity of the first metatarsophalangeal joint was performed (B). She had an excellent clinical result five years postoperatively without progression of the arthritis (C).

TABLE IV Reoperations

Grade of Arthritis	Reoperations (no. of feet)
0 (n = 7)	1
1 (n = 18)	3
2 (n = 33)	3
3 (n = 22)	3

operation on the involved foot (Table IV).

Radiographic Results

Three of the seven feet with grade-0 arthritis of the metatarsophalangeal joint demonstrated a worsening of the arthritis at the time of the final follow-up. In the eighteen feet affected by grade-1 arthritis, all of the osteotomies healed well. Necrosis of the metatarsal head was not seen. In eight of the eighteen feet, the arthritis became more severe. In twelve feet with grade-2 arthritic changes, a worsening of the arthritis was observed. In the thirty-one feet with grade-3 arthritis that were treated with arthrodesis, two demonstrated a delayed union and one had a nonunion. In two of the twenty-two feet with grade-3 arthritis that were treated with a poly(DL-lactic acid) implant, bone reabsorp-

tion at the metatarsophalangeal joint was observed.

Discussion

This stepwise approach to the surgical treatment of hallux rigidus enabled us to achieve satisfactory results while maintaining the mobility of the first metatarsophalangeal joint and achieving considerable pain relief in most of the eighty-six patients at a mean duration of follow-up of four years.

Plantar release as an isolated procedure appears to be an adequate technique to treat hallux rigidus associated with grade-0 arthritis of the metatarsophalangeal joint; in fact, at four years postoperatively, the clinical results remained satisfactory even though two patients required an arthrodesis of the first metatarsophalangeal joint because of rapid and severe progression of the arthritis (Figs. 12-A and 12-B).

Osteotomies of the distal aspect of the first metatarsal can produce an adequate decompression of the joint with relief of pain in patients with grade-1 arthritis (Figs. 13, 14-A, and 14-B), and cheilectomy provides optimal clinical results in hallux rigidus associated with grade-2 arthritis.

In some patients in all groups, progression of the arthritis was observed. We believe that this occurred as a result of incorrect grading of the arthritis leading to an inadequate surgical approach or to insufficient removal of bone.

When arthrodesis was indicated and the patient ac-



Fig. 14-A

A fifty-four-year-old woman with grade-1 hallux rigidus without deformity (A). A sliding osteotomy was performed and was stabilized with a 2.7-mm hydroxyapatite-coated screw. Dorsiflexion was considerable at three years postoperatively (B).

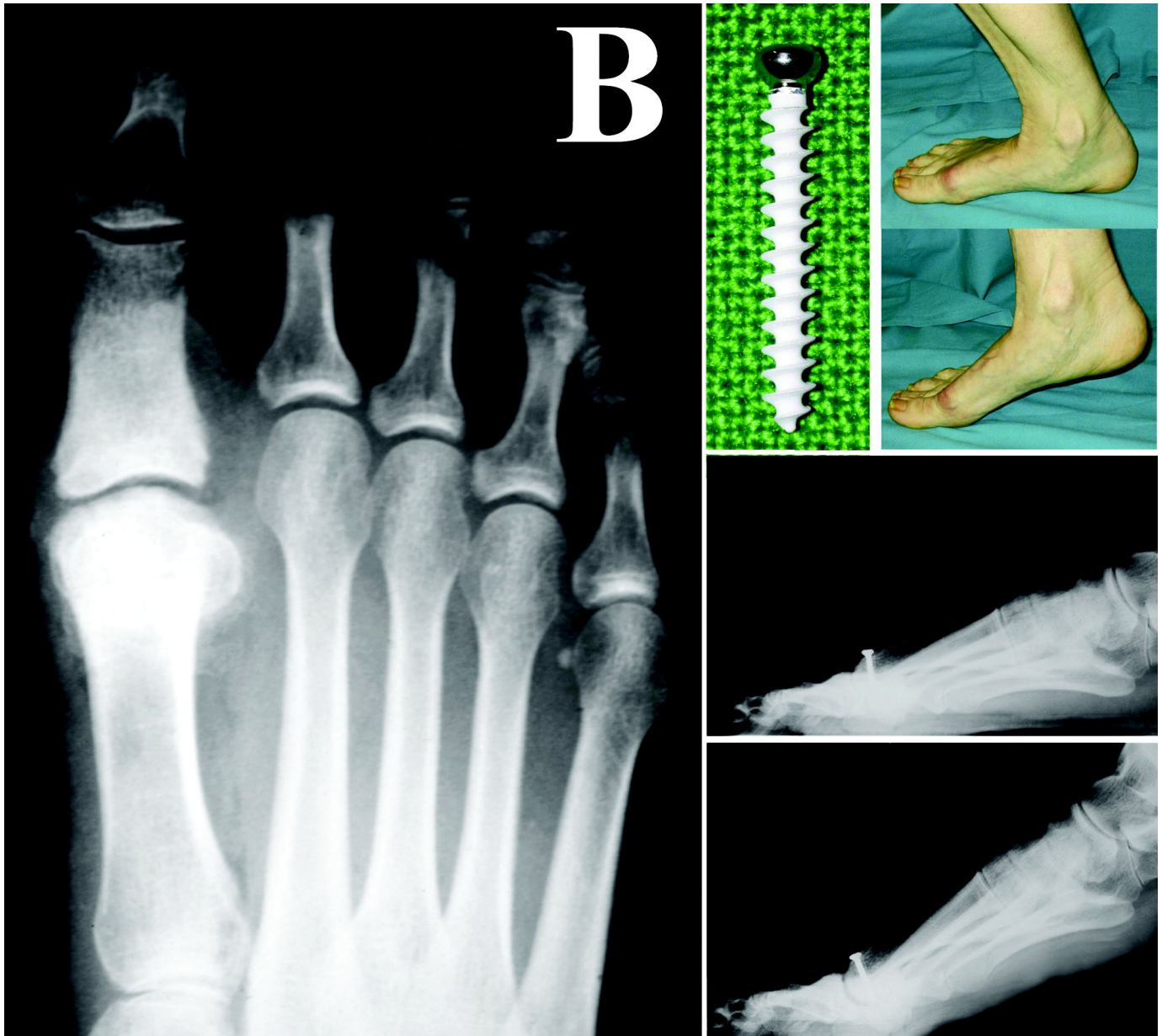


Fig. 14-B

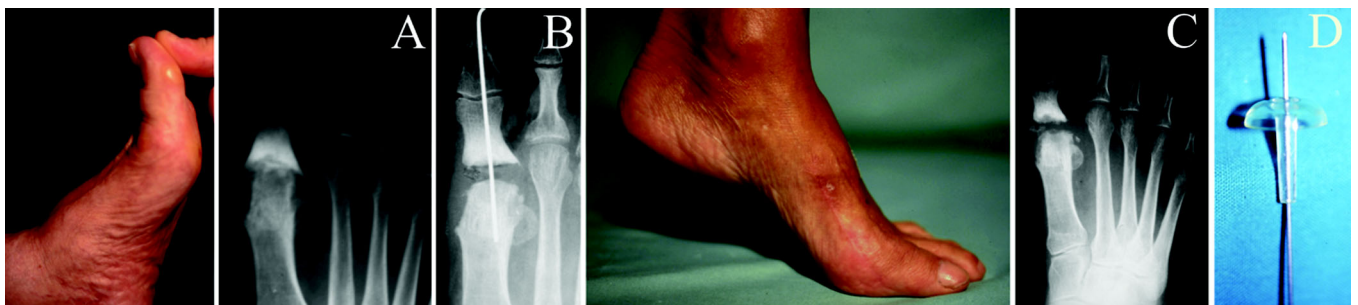


Fig. 15

A fifty-two-year-old woman with grade-3 hallux rigidus following a failed Keller procedure. The patient refused arthrodesis. The clinical and radiographic appearance before surgery (A) and radiographs made immediately postoperatively are shown (B). An excellent clinical and radiographic outcome was achieved at four years (C) after treatment with a resection arthroplasty with the bioresorbable poly(DL-lactic acid) spacer (D).

cepted the treatment, satisfactory results were achieved. An alternative for elderly patients, or when arthrodesis is not accepted by the patient, may be the reabsorbable implant. The spacer resorbs slowly over six months, facilitating the formation of a fibrous union that can maintain the stability and length of the toe (Fig. 15)²³.

In conclusion, hallux rigidus is a complex disorder characterized by several clinical and pathological findings. For this reason, to achieve optimal results, surgical treatment should be individualized with use of different surgical techniques depending upon the degree of arthritis and other clinical considerations.

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