Managing Complications of Foot and Ankle Surgery

Hallux Valgus

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KEYWORDS

• Hallux valgus • Complications • Hallux varus • AVN • Malunion
• Recurrent hallux valgus

KEY POINTS

- A systemic literature review revealed a 2.1% need for revision due to complications after Hallux valgus surgery.
- The incidence of recurrence in juvenile patients is higher compared to adult patients.
- The incidence of acquired hallux varus is up to 13%.
- The more proximal the osteotomy is performed the higher is the risk of dorsiflexion malunion of the first metatarsal.

INTRODUCTION

Hallux valgus deformity is nowadays one of the most common and symptomatic disorders affecting the foot. Modern lifestyle is a very important factor in developing hallux valgus; this is demonstrated by Kato and Watanabe. Although reports on hallux valgus correction in Europe date back to the nineteenth century, Kato and Watanabe[1] from the Kyorin University in Tokyo reported in 1981 that before 1972 their department had not performed hallux valgus correction due to lack of symptomatic patients. In 1978, footprints of ancient Japanese from the Jomon period (6.000 BC–300 BC) were discovered without any evidence of hallux valgus. More than thousands of years the traditional Japanese footwear was a combination of the "geta" sandal and the "tabi" socks where the hallux is separated from the lesser toes. With the increasing number of western leather shoe manufacturers and the reduction of factories of the classic geta sandals the numbers of hallux valgus surgeries increased.

Early reports of surgical correction of hallux valgus deformity date back to the mid-nineteenth century. With the first reports of hallux valgus corrections first reports of complications were also presented. Already in 1986, Riedel described metatarsalgia as complication of the Hueter resection of the metatarsal head. The fact that Helal[2]

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counted in 1981 more than 150 different techniques to correct hallux valgus shows that numerous complications are linked to hallux valgus surgery.

The reported incidence of complications varies from 10% to 55%.[3] In most studies early complications such as delayed wound or bone healing and infections represent most of the documented complications.

Barg and colleagues[4] performed a systematic literature review on unfavorable outcomes following surgical treatment of hallux valgus deformity. A number of 229 studies published from 1968 to 2016 were included. Most patients received distal osteotomies (52.6%) followed by proximal osteotomies (10.1%) and shaft osteotomies (8.0%). The need for revision due to complications averaged 2.1%.

Lagaay and colleagues[5] performed a retrospective multicenter chart review to identify complications that necessitated revision surgery after the primary surgery. For 646 patients who received either a modified Chevron-Austin osteotomy (270 patients), modified Lapidus arthrodesis (342 patients), or closing base wedge osteotomy (34 patients) to correct hallux valgus deformity revision surgery for complications was calculated and compared. Complications included recurrent hallux valgus, iatrogenic hallux varus, painful retained hardware, nonunion, postoperative infection, and capital fragment dislocation. The rates of revision surgery after Lapidus arthrodesis, closing base wedge osteotomy, and Chevron-Austin osteotomy were similar with no statistical difference between them. The total rate for reoperation was 5.56% among patients who received Chevron-Austin osteotomy, 8.82% among those who had a closing base wedge osteotomy, and 8.19% for patients who received modified Lapidus arthrodesis.

In this article the authors covers recurrent hallux valgus deformity, iatrogenic hallux varus, malunion, and avascular necrosis (AVN).

RECURRENT HALLUX VALGUS DEFORMITY

Peabody in 1931 stated that with his technique the cosmetic result was perfect and there was no recurrence. But since then, the reported incidence of recurrence after hallux valgus surgery has been shown to be as high as 30%.[6] Austin and Leventen[7] reported a 10% recurrence rate among 300 Chevron osteotomies they reviewed.

Barg and colleagues[4] reported in their meta-analysis an incidence for recurrence of 9.3% (4.6%–15.5%) for proximal metatarsal osteotomies. The lowest recurrence rate was reported for first tarsometatarsal arthrodesis with 1.7% (0.1%–5.1%).

The major controversy arising from the topic of recurrent hallux valgus deformity is the question when a deformity should be classified as recurrence. It has now received acceptance that a hallux valgus angle of more than 20[8] and an intermetatarsal angle of more than 10° should be classified as hallux valgus recurrence.

It is generally accepted that the cause of a recurrent hallux valgus deformity is multifactorial.[8–10]9-11 One may distinguish between patient-related factors and surgical-related factors. Under the term “patient-related” factors, conditions such as skeletal immaturity, first tarsometatarsal hypermobility or arthritis, and increased distal metatarsal articular angle (DMAA) are categorized as anatomic factors. Noncompliance in the immediate postoperative phase or the excessive use of high-heel shoes may be summarized as social factors. Conditions such as general hyperlaxity, neuromuscular, or neurologic disorders are systemic factors. Surgical factors include procedure selection, technical issues including the method of fixation, and the surgeon’s intraoperative performance.[10]

Scranton and colleagues published in 1984[11] a series on 31 juvenile patients with 50 operated feet. Thirty-six percent had hypermobile feet and 32% a long first ray. The recurrence rate in these conditions was 56% and 50%, respectively.

Surgical-related factors are certainly the reason for most of the hallux valgus recurrences. Inadequate procedure selection is a critical issue. One procedure does not correct adequately all forms of hallux valgus deformities. Roger Mann in his textbooks has tried to set up an algorithm to address the various stages of hallux valgus deformity {Mann}. Axel Wanivenhaus and colleagues[12] published the outcome of the consensus meeting of the Austrian Foot and Ankle Society on decision-making in hallux valgus surgery. In order to avoid recurrence and complications, the distal metatarsal osteotomies (Chevron and Kramer type) are reserved for mild and moderate deformities; diaphyseal (SCARF) and proximal osteotomies (crescentic, Ludloff, proximal Chevron) for severe; and the Lapidus arthrodesis for the arthritic first tarsometatarsal joint, the hypermobile first tarsometatarsal joint, and the really severe deformities with an intermetatarsal angle exceeding 20 degrees.

If the intermetatarsal has been sufficiently corrected and only the increased hallux valgus angle is bothering the patient, an Akin osteotomy is an option. In many cases also a reefing or plication of the medial capsule needs to be included. Specially in elderly patients who are suffering from the pressure of the hallux on the second toe a minimal invasive surgical Akin is a good option.

For mild recurrence with eventually increased DMAA, a distal Chevron-like osteotomy is recommended. By using a modified dorsal cut with a medial wedge resection, the eventually increased DMAA may also be corrected (**Fig. 1**).

The SCARF osteotomy is an immensely powerful technique to correct recurrence. Bock and colleagues[13] presented in 2010 a series of 35 patients with 39 feet where they choose to use the SCARF osteotomy for recurrent hallux valgus deformity. The previous failed techniques included 16 (14 patients) Keller resection arthroplasties,

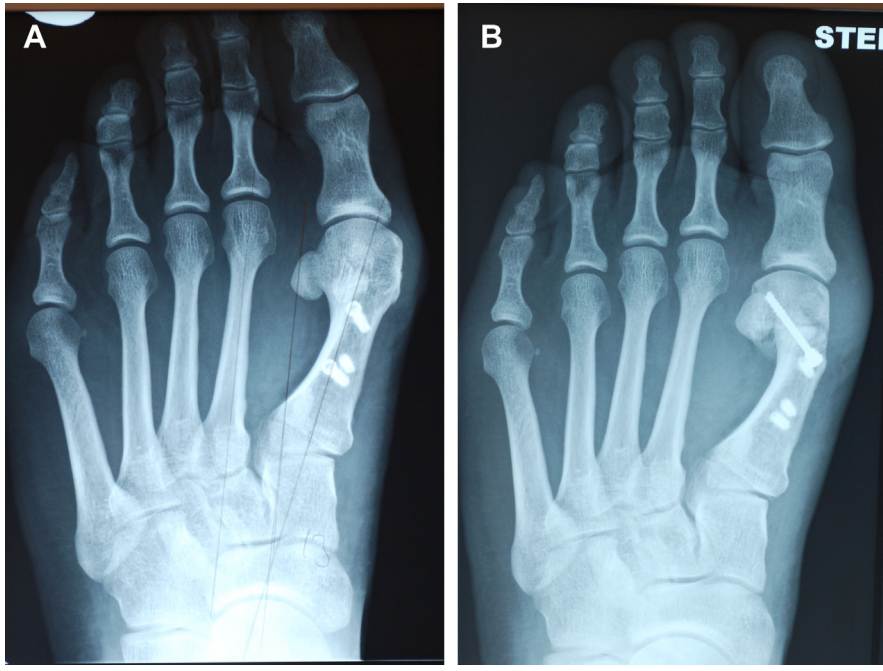

Fig. 1. A 31-year-old female patient with hallux valgus recurrence following SCARF osteotomy. (*A*) Preoperative anteroposterior (AP) radiograph. (*B*) AP radiograph at follow-up following revision Chevron osteotomy.

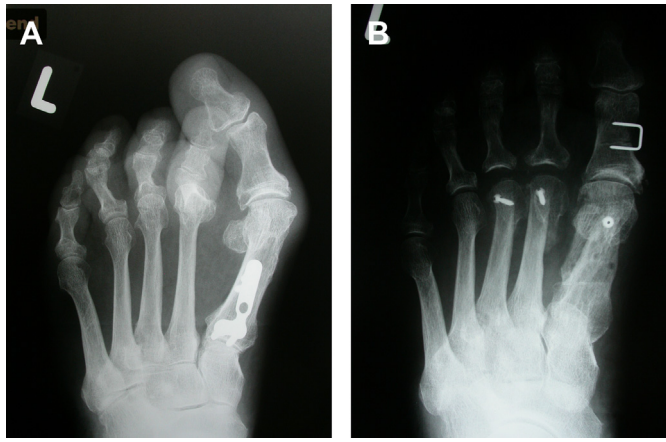

Fig. 2. A 64-year-old woman with hallux valgus recurrence and transfer metatarsalgia following proximal metatarsal osteotomy. (*A*) Preoperative AP radiograph. (*B*) AP radiograph at follow-up after SCARF osteotomy, Akin osteotomy, Weil osteotomy of the second and third metatarsals, and PIP arthrodesis of the second and third toe. PIP, proximal interphalangeal.

15 (13 patients) simple bunionectomies, 6 distal metatarsal osteotomies (Chevron and Kamer), and 2 SCARF osteotomies. On all clinical and radiological parameters beside metatarsophalangeal (MTP) joint motion and interphalangeal joint motion, they achieved statistically significant improvement (Fig. 2). Contraindications to use the SCARF osteotomy were prior MTP arthrodesis, hallux rigidus, range of motion less than 40°, cock-up deformity or unstable first toe after Keller arthroplasty, unstable first tarsometatarsal joint, peripheral neuropathy, vascular disease, and Charcot arthropathy.

Severe recurrent hallux valgus, in most cases associated with instability of the first tarsometatarsal joint, are the perfect indications for the Lapidus arthrodesis. The advantage of the Lapidus arthrodesis is that with the long lever arm of the proximally corrected first metatarsal, large intermetatarsal angles can be corrected. In addition, the fusion eliminates any rotation or translation of the first ray.[14] A potential downside for the Lapidus for correction of recurrent hallux valgus is the fact that healing is longer than after most other metatarsal osteotomies. Another downside is the fact that the Lapidus leads to additional shortening of the first metatarsal, which includes the risk for transfer metatarsalgia. Coetzee and colleagues believe that a shortening of less than 0.5 cm may be neglected. For shortening between 0.5 and 1 cm, plantarflexion of the first metatarsal can compensate for the shortening. With more than 1 cm shortening, a Weil shortening osteotomy of the lesser metatarsals may be taken into consideration[14] (Fig. 3).

Another surgical option for severe recurrent hallux valgus deformity is the first MTP fusion. The indication is either for the combination of hallux valgus with rigidus (ie, arthritis) or malposition of the metatarsal head.

The bunionectomy, according to Silver, specially performed in a percutaneous technique with a burr[15] (new procedure) often causes severe recurrent hallux valgus deformity. The aggressive resection of the medial metatarsal head leads to medial capsule instability and also an incongruent joint. The difficulty in these cases is to realign the joint and to find sufficient bone contact without resecting parts of the metatarsal head (Fig. 4).

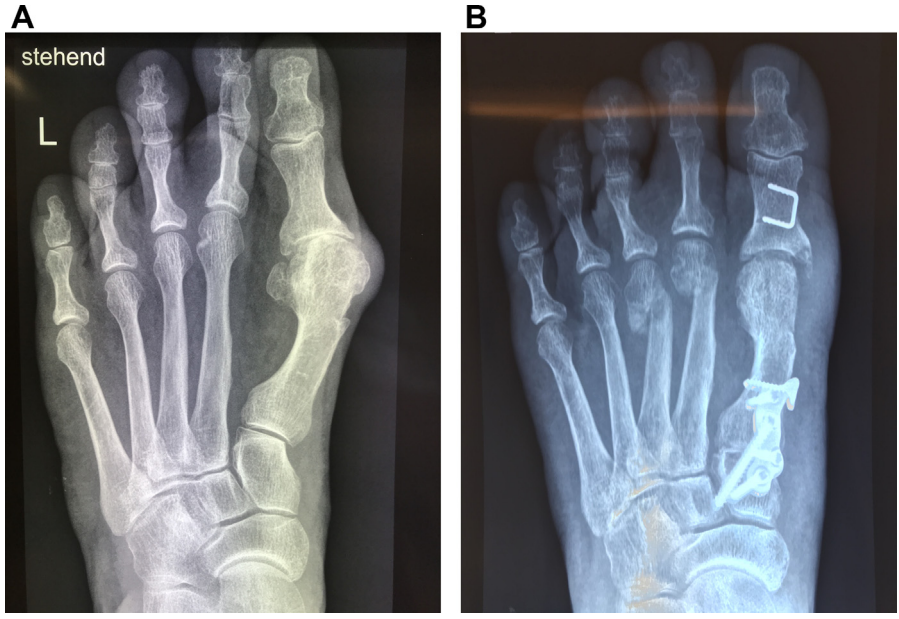

Fig. 3. A 62-year-old woman with hallux valgus recurrence and transfer metatarsalgia following Kramer osteotomy (original version of the SERI or Bösch). (*A*) Preoperative AP radiograph. (*B*) AP radiograph at follow-up following revision with Lapidus arthrodesis, Akin osteotomy, and minimally invasive DMMO 2 to 3. DMMO, distal metatarsal minimally invasive osteotomy.

The Keller-Brandes is another technique leading to severe recurrent hallux valgus deformity. Specially in the presence of a significant metatarsus primus varus deformity or in the young and active patient excision arthroplasty, it is associated with a high rate of recurrence.[16] The salvage of a failed Keller procedure may be present as a formidable technical challenge for the surgeon. As Coughlin[17] has stated, "failure of the procedure leaves only limited options for salvage, which depend largely on the extent of the excisional arthroplasty that was done."

The fixation of the first MTP fusion for recurrent hallux valgus is often challenging. Although in most cases a dorsal plate with oblique compression screw is advocated, in cases after minimally invasive resection or Keller arthroplasty, the base of the proximal phalanx is too short for this. In these cases, the use of 2- to 3-threaded K-wires 1.8 to 2 mm in thickness has proved its efficiency in the author's experience.

Garcia-Ortez and colleagues[18] compared 29 primary first MTP fusions with 34 first MTP fusions for recurrent hallux valgus deformity. They found no difference in fusion rates between patients treated with a plate and compression lag screw and those treated with crossed screws. The union rate was comparable with those in other studies.

Machacek and colleagues[16] reviewed first MTP fusion versus repeat resection arthroplasty for failed Keller-Brandes. The results after first MTP fusion were excellent and good in 23 out of 29 patients. After the repeat resection arthroplasty 11 out of 18 patients were dissatisfied. As already stated by McKeever, it is the position and the successful fusion that is important and not the method by which it was produced.[16] Coughlin[17] reviewed 16 first MTP fusions in 11 patients for failed Keller-Brandes

Fig. 4. A 45-year-old female with hallux valgus recurrence following minimal invasive (MIS) bunionectomy is shown. (*A*) Preoperative AP radiograph. (*B*) Preoperative clinical picture. (*C*) AP radiograph at follow up of 22 years after MTP fusion. (*D*) The same patient on a clinical picture 22 years following revision surgery.

procedures. The fusions were stabilized with threaded K-wires. All patients were rated excellent and good.

HALLUX VARUS

Acquired hallux varus following hallux valgus correction has a reported incidence of 2% to nearly 13%.[19] Hallux varus occurs because of soft tissue or bone imbalance that allows the normal musculotendinous forces of the MTP joint to exert a varus deforming force. Causes of hallux varus after hallux valgus surgery include removal of the fibular sesamoid, excessive medial capsular reefing, removal of an excessive amount of the medial eminence, overcorrection of the 1M angle, excessive plantar lateral release, and excessive postoperative bandaging. Patients with hallux varus most commonly complain of cosmetic deformity, difficulty with shoe wear, and pain.

Hallux varus deformities can be classified in flexible and rigid deformities. In addition, it is important to evaluate the status of the interphalangeal joint whether it is contracted or not and to assess for rotational deformity, arthritis, and bony deformity. Trnka and colleagues[20] reviewed 19 feet in 16 patients. Only a higher degree of hallux varus deformity (16°–24°) was clinically troublesome; a small hallux varus angle on radiographs did not have any clinical relevance.

If the deformity is recognized early after the surgery, tight correctional tapings into valgus position may be successful if the cause is soft tissue related. Malposition of the metatarsal head should be immediately addressed. According to Skalley and colleagues[21] nonsurgical treatment was successful in only 12 (22%) of 54 patients in such situations.

For surgical treatment of hallux varus deformity guidelines are helpful. Bevernage and Leemrijse[22] tried to establish such an algorithm.

For mild deformities the first step is to release the medial capsule, which can be done in a V-Y fashion. If with the release of the medial capsule the varus position is corrected under a push up test of the forefoot, further techniques are not necessary. The next soft tissue procedure is the stabilization of the lateral capsule. One can distinguish between dynamic tendon transfers and static tendon tenodeses, each aiming to substitute for the incompetent lateral collateral ligament (Fig. 5).

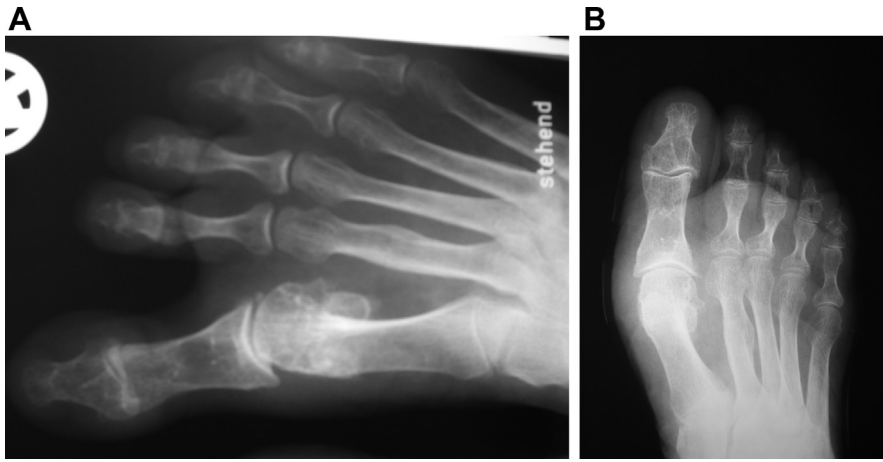

Fig. 5. A 61-year-old woman with flexible hallux varus following Austin osteotomy. (*A*) Preoperative AP radiograph. (*B*) AP radiograph at follow-up after medial soft tissue release and lateral capsule plication.

For the dynamic transfers the abductor hallucis tendon, the extensor hallucis brevis, and the extensor hallucis longus may be used. Tendon transfers have the potential for dynamic correction of the deformity.

The abductor hallucis tendon transfer was described by Hawkins.[23] The tendon is released from the base of the proximal phalanx, routed deep to the intermetatarsal ligament, and anchored to the lateral side of the base of the proximal phalanx.

When the extensor hallucis longus is used, it can be used as a total or split transfer. The tendon detached from the distal insertion and is redirected beneath the first intermetatarsal ligament and attached to the plantar-lateral aspect of the proximal phalanx.[24]

A tenodesis provides static correction. In this case, either the extensor hallucis brevis or the abductor hallucis tendon is used. For the abductor hallucis transfer, one-third of the tendon width is harvested, detached proximally, and completely released from the tibial sesamoid. The tendon is passed through 2 bone tunnels, from medial to lateral through the proximal phalanx, and then from lateral to medial through the first metatarsal. An alternative is the extensor hallucis brevis tendon. It is transected at the musculotendinous junction, then mobilized to its distal insertion, passed plantar to the intermetatarsal ligament, and reattached through a bone tunnel from lateral to medial on the first metatarsal.

Plovanich and colleagues[25] conducted a review assessing the sustainability of soft tissue release with tendon transfer, including 8 studies that revealed a 16.6% (11/68) incidence of complications and a 4.4% (3/68) recurrence (see **Fig. 5**).

A small suture button device is an alternative to use tendon grafts to stabilize the lateral capsule.[26] Bone tunnels are created in the proximal phalanx and first metatarsal, and the device is passed through each tunnel starting proximally until the leading oblong button is resting in line with the proximal phalanx. With the toe held in a reduced position, pull is applied on the suture attached to the round button on the medial side of the first metatarsal.

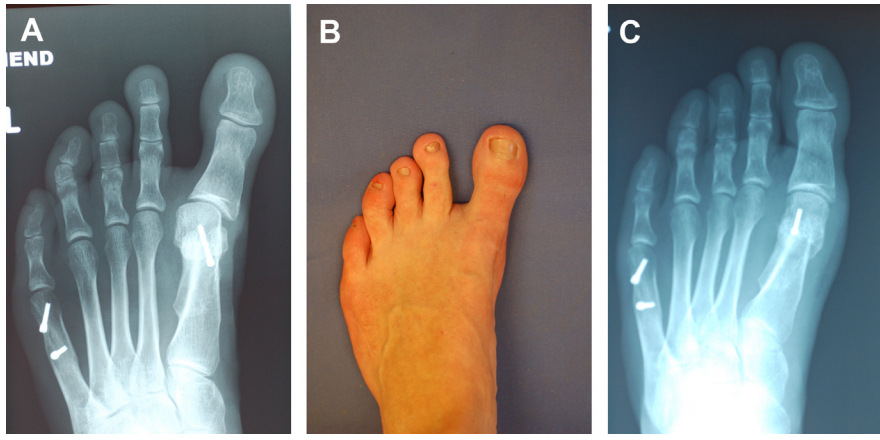

Fig. 6. A 46-year-old female with flexible hallux varus deformity and transfer metatarsalgia following SCARF osteotomy is demonstrated. (*A*) Preoperative AP radiograph. (*B*) Preoperative lateral radiograph. (*C*) AP radiograph at follow up after Contra-Chevron osteotomy (performance of Chevron with medialization of the capital fragment), MIS Contra-Akin osteotomy and MIS DMMO of the second and third metatarsal.

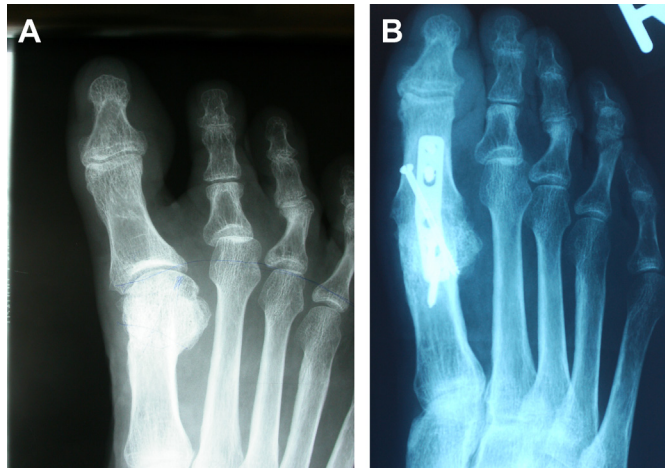

Fig. 7. A 69-year-old woman with rigid hallux varus deformity following Chevron osteotomy. (*A*) Preoperative AP radiograph. (*B*) Revision with MTP fusion.

If the hallux varus deformity is caused by either overcorrection of the metatarsal with a zero or negative intermetatarsal angle or too aggressive translation of the distal osteotomy or malunion of the distal metatarsal osteotomy, bony correction is needed.

The reverse Chevron has been described by Bilotti,[27] Choi,[28] and Lee.[29] Choi and colleagues[28] reviewed 19 patients with iatrogenic hallux varus treated with a reverse distal Chevron osteotomy. Of the 19 patients, 11 (58%) were very satisfied, 7 (37%) were satisfied, and 1 (5%) was very dissatisfied. There was a significant improvement of the American Orthopaedic Foot and Ankle Society score and the mean Hallux valgus angle (HVA) improved significantly from −11.6° (−26° to −5°) preoperatively to 4.7° (−2° to 10°, $P < .01$) at last follow-up (**Fig. 6**).

Kannegieter[30] reviewed their method of a combination of rotational SCARF and a reverse Akin osteotomy for hallux varus correction. They described a stepwise approach of soft tissue release and ultimately bony procedures. The 5 cases reviewed at an average follow-up of 38 months indicated an improved hallux valgus angle from 10° to 11° and an improved intermetatarsal angle from 5° to 9°, and 100% of subjects felt better off as a result of their revision surgery.

Rigid varus deformities can only be salvaged by first MTP fusion. Occasionally a lateral closing wedge osteotomy (Contra-Akin) is helpful. From personal experience, a first MTP fusion needs rigid internal fixation. The bone stock of the metatarsal head is often poor and simple, so crossed screw fixation will fail. In these cases, a combination of dorsal plate and oblique compression screw gives better stabilization (**Fig. 7**).

MALUNION

Osteotomies for hallux valgus correction and Lapidus procedures can end up in an iatrogenic dorsiflexion or plantarflexion of the first metatarsal. In particular, after distal metatarsal osteotomies, a varus or valgus tilt of the metatarsal head may occur. Any metatarsal osteotomy is accompanied with some degree of shortening, but excessive shortening of the first metatarsal can present substantial challenges and will result in transfer metatarsalgia.

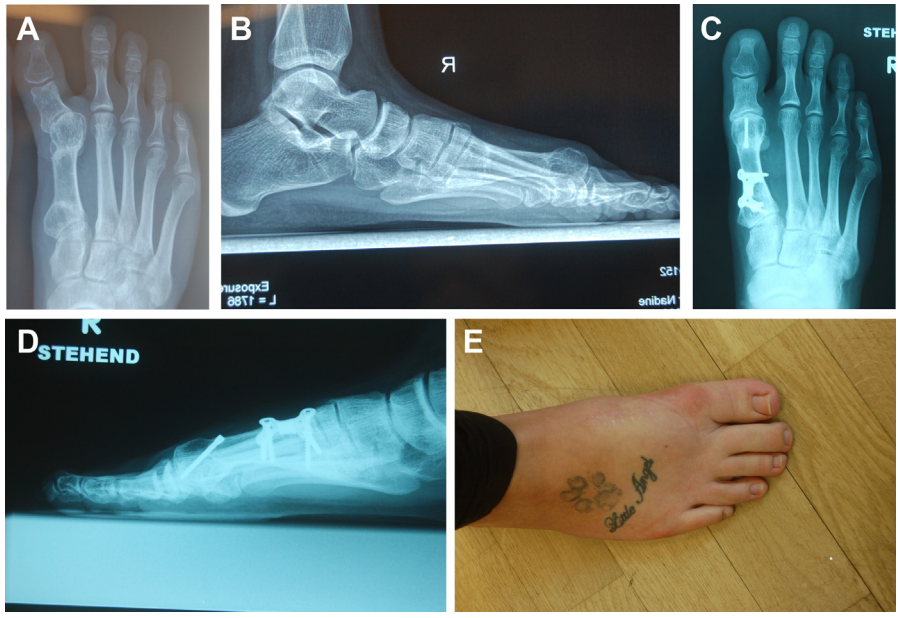

Fig. 8. A 21-year-old female with dorsiflexion malunion and hallux varus following MIS double osteotomy is shown. (*A*) Preoperative AP radiograph. (*B*) Preoperative lateral radiograph. (*C*) AP radiograph shown at follow up after revision with Contra-Chevron osteotomy (performance of Chevron with medialization of the capital fragment) and plantarflexion osteotomy[SE1] [SE2] [HJT3] (*D*) Lateral radiograph at follow up. (*E*) Clinical picture of the same patient at follow up.

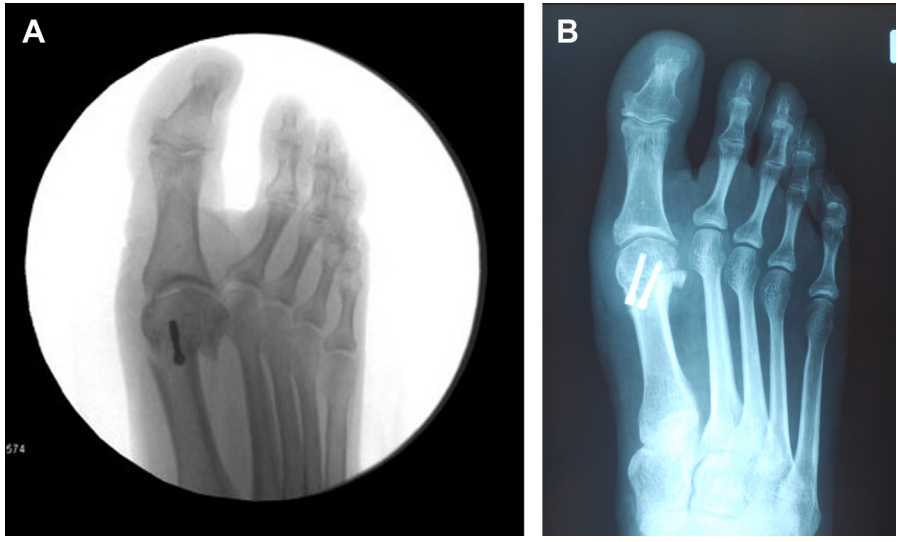

Fig. 9. A 50-year-old woman with valgus malunion of the metatarsal head 2 months after an Austin osteotomy. (*A*) Preoperative AP radiograph. (*B*) AP radiograph at follow-up following reosteotomy and rotation of the distal fragment.

Mild plantarflexion of the first metatarsal is desired to compensate the osteotomy-related shortening of the first metatarsal. On the other hand, increased plantarflexion results in sesamoid pain and capsular inflammation about the first MTP joint. Orthotics with a transverse metatarsal ped or a cut out under the first metatarsal head can be helpful. In more severe cases a dorsal closing wedge osteotomy of the first metatarsal represents a viable solution.

More common is an elevated first ray. Dorsiflexion leads to transfer metatarsalgia and even arthritis of the metatarsocuneiform joints. Proximal metatarsal osteotomies have generally a higher risk of dorsal malunions. Rates of up to 28% have been

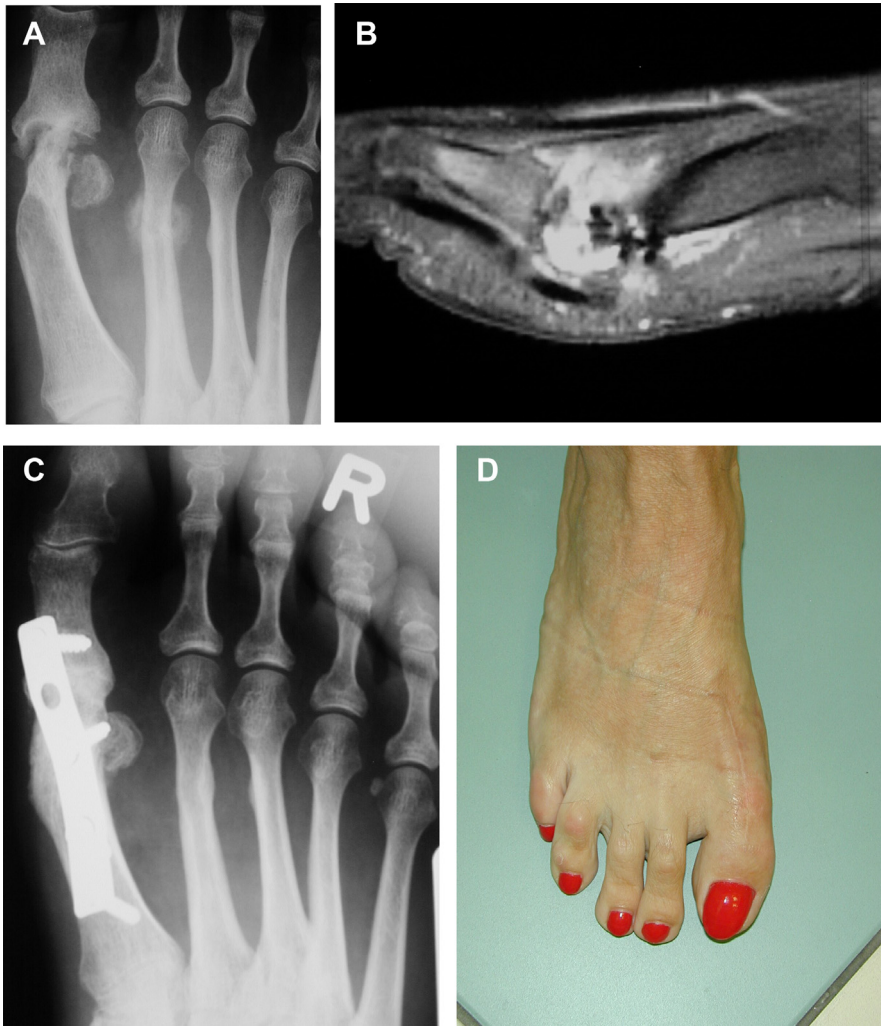

Fig. 10. A 47-year-old woman with avascular necrosis following a Chevron osteotomy. (*A*) Preoperative AP radiograph. (*B*) Preoperative MRI. (*C*) AP radiograph at follow-up following revision with interpositional iliac crest bone block fusion. (*D*) The same patient on a clinical picture 1 year after revision surgery.

described.[31] In these cases a dorsal opening wedge osteotomy with a bone graft is the method of choice (Fig. 8).

Varus or valgus tilt of the metatarsal head after a distal metatarsal osteotomy will result in joint incongruency, pain, and loss of range plantar flexion motion. In these cases, a distal correctional osteotomy is needed. Usually, preoperative planning is mandatory to assess the level and the amount of the correctional osteotomy. Either a dorsal to plantar crescentic or a Chevron type osteotomy with correctional wedges can be implemented (Fig. 9).

The incidence of shortening following hallux valgus surgery is for most techniques unknown. Trnka[32] published a series of proximal metatarsal closing wedge osteotomies with an average shortening of 5 mm. Shortening of the first metatarsal leads to other complications such as dorsiflexion malunion of the first metatarsal. The length difference can be corrected either by lesser metatarsal shortening (Weil osteotomy for example) or by lengthening of the first metatarsal. Goldberg and Singh[33] suggested a step-cut SCARF type lengthening osteotomy. By distracting the osteotomy, lengthening of 1 cm can be achieved; this has been presented with follow-up of 16 patients by Singh.[34] Patients with 10 mm lengthening achieve relief of symptoms, whereas patients with 8 mm achieved relief only in 50%.

AVASCULAR NECROSIS OF THE METATARSAL HEAD

Early reports of distal metatarsal osteotomies expressed concern about increased AVN if a lateral release is performed in combination with a distal metatarsal osteotomy. Jahss, Mann, and Meier suggested that AVN frequently accompanies lateral soft tissue release, with an incidence of up to 40%.[35–37]

Analysis of Meier and Kenzora's paper revealed a small percentage in follow-up of a small group of patients. Wallace[38] investigated the incidence of AVN of the metatarsal head among 13,952 osteotomies. The overall incidence was 0.11% and after a Chevron/Austin osteotomy 0.164%.

Partial avascular necrosis is often asymptomatic but will result in subsequent arthrosis. Painful and large avascular areas require surgical interventions. Here the bone block interposition arthrodesis is the procedure of choice[39] (Fig. 10).

SUMMARY

Surgical corrections of hallux valgus deformity are among the most common orthopedic procedures performed. Despite the general high success, complications can occur. The treatment of complications start before the first incision has been performed by thorough preoperative planning and the choice of the right procedure. Once the complication is evident, whether it is recurrent deformity, hallux varus, malunion, or avascular necrosis, thorough planning is once again necessary to address a patient's individual need.

CLINICS CARE POINTS

- Selection of the appropriate technique is the first step to avoid complications after hallux valgus surgery.
- One technique cannot adequately correct all forms of hallux valgus deformities.
- The Lapidus arthrodesis and the MTP-I fusion are the ultimate techniques to correct recurrent hallux valgus deformities.

- A flexible acquired hallux varus deformity with less than 15° may be corrected salvaging technique like a reverse Chevron combined with soft tissue techniques.
- For rigid or more severe (>15°) acquired hallux varus deformities the MTP-I fusion is the technique of choice.
- In case of malunion of the first metatarsal the first goal should be to correct the deformity itself and not to perform adjustments on the lesser metatarsals.

DISCLOSURE

There is no relationship with a commercial company that has a direct financial interest in subject matter or materials discussed in article or with a company making a competing product.

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