Minimally Invasive Hallux Valgus Correction, Perspective 1

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Historical Perspective

The main goal of surgical correction of hallux valgus is the morphologic and functional rebalance of the first ray, correcting all other characteristics of the deformity [1]. Historically, distal metatarsal osteotomies have been indicated in cases of mild or moderate deformity with an intermetatarsal angle as large as 15°. Using certain osteotomies, it is possible to correct intermetatarsal angles as large as 20°. Distal osteotomies may also be used to correct deformities characterized by deviation of the distal metatarsal articular angle (DMAA) or to address concomitant stiffness [2]. Since the first operation published by Reverdin [3] in 1881, many authors have reported their experiences using different operations, each of them characterized by different indications, approaches, designs, and fixations [4–12]. Several comparative studies have been reported comparing radiographic and clinical results among many different techniques, and a review of the literature reveals the satisfaction with all operations to be in the upper 80 % level or higher [2, 13]. In 1983, New (personal communication) reported a percutaneous technique for hallux valgus correction. This technique was then reported by Bosh et al. [14], who performed a Hohmann-type [4] osteotomy fixed by only one K-wire, as described by Lamprecht and Kramer [15] in 1982, and, more recently, Magnan et al. [16] reported a description of his experience. These percutaneous operations reduce the surgical trauma because they are performed

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without large incisions and soft tissue procedures. They require, on the other hand, the use of particular instrumentation, such as Lindemann's osteotrite, manipulators, or dislocators. Furthermore, with these percutaneous techniques, the correction is performed blindly, and the intraoperative use of fluoroscopy is needed. The minimally invasive bunion correction used by us is not a new technique [17, 18] because it uses an osteotomy and a stabilization method already reported by other authors, making the surgical technique usable in accordance with current concepts in hallux valgus surgery.

Our technique, in fact, consists of a linear distal osteotomy at the metatarsal neck level, as described by Hohmann [4], Wilson [6], and Magerl [9], which is performed through a small medial incision and is stabilized using only one K-wire, as reported by Lamprecht and Kramer [15] and Bosh et al. [14]. The characteristics of this technique can be summarized with the abbreviation SERI (simple, effective, rapid, inexpensive). This technique is simple and can be easily repeated, without removal of the eminence and without lateral release. It is minimally invasive and is performed under direct vision and without radiations. The technique is effective because, using different inclinations of the bone cut and different displacements of the head (lateral, dorsal, plantar, medial tilt, or rotation), it is possible to correct the pathoanatomy of each deformity. The surgical time spent is approximately 5 min. This can be reached after an adequate learning curve and permits obtaining a surgical time saving of 12 min compared with the most commonly used techniques (i.e., scarf). Finally, the technique is inexpensive because no particular instrumentation is needed, the hardware is only one K-wire for stabilization, a short surgical time is spent, and fewer complications are reported.

Indications and Contraindications

The SERI technique is indicated to correct mild to moderate reducible deformity when the hallux valgus angle is as large as 40° and the intermetatarsal angle is as large as 20°. The operation is indicated if the metatarsophalangeal joint is either incongruent or congruent, or with modification of the DMAA, and if mild degenerative arthritis is present. The technique is indicated even in cases of recurrent deformity. Specific contraindications of the SERI technique are patients older than 75 years, severe deformity with the intermetatarsal angle larger than 20°, severe degenerative arthritis or stiffness of the metatarsophalangeal joint, and severe instability of the cuneometatarsal or metatarsophalangeal joint.

Preoperative Planning

The preoperative plan includes acquiring a complete history of the patient and a physical and radiographic examination. The patient's complaints of pain, limitations in the use of footwear, and cosmetic concerns should be considered. Moreover, the severity of the prominent medial eminence and the hallux valgus deformity, as well as the great toe mobility at the metatarsophalangeal joint and the reducibility of the deformity, should be evaluated. The latter is tested by pushing laterally the metatarsal head with one hand and simultaneously pushing the great toe medially with the other hand. Stability of the metatarsophalangeal and cuneometatarsal joints must be assessed. Combined rotational deformity of the great toe or callosities under the first or second and third metatarsal heads must be considered, as well as any associated deformities of the lesser toes.

A standard radiographic examination, including anteroposterior and lateral weight-bearing views of the forefoot, allows the assessment of the arthritis and congruency of the joint and measurement of the hallux valgus angle, intermetatarsal angle, DMAA, and metatarsal and the digital formula. Therefore, planning of the operation is performed in terms of the obliquity of the bone cut, the extent of the medial-lateral or dorsal-plantar dislocation of the metatarsal head, and the correction of the DMAA.

As with any other techniques, during bunion correction, the main concern is the ability to

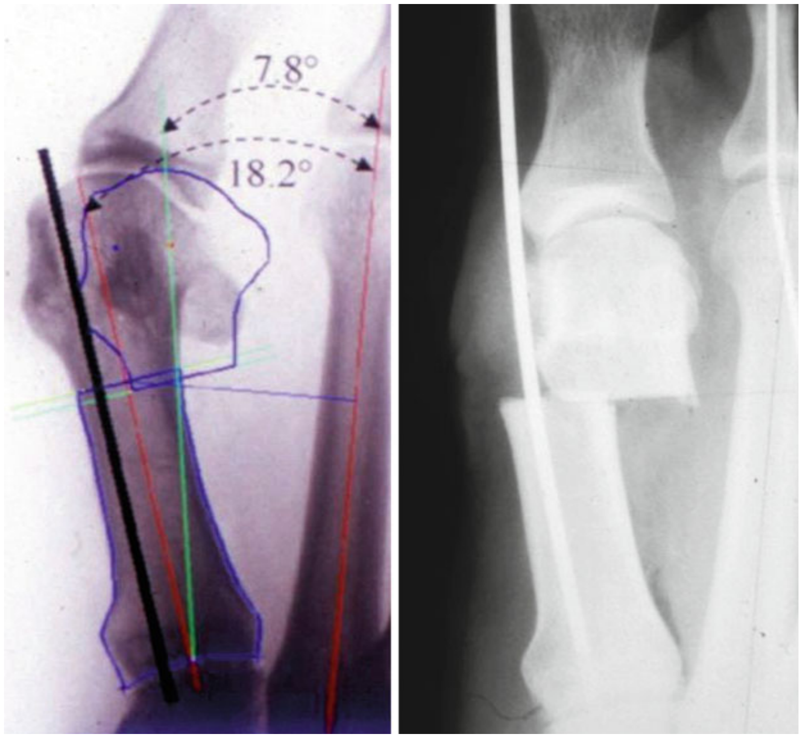

Fig. 1 The computerized planning of the osteotomy and the correction obtained on the postoperative X-rays

perform precisely and surgically what has been planned preoperatively. To facilitate this, we developed a software that, beginning with a scanned, standard weight-bearing anteroposterior view, is able to simulate the correction needed, considering any anatomic variables of each patient. The software is able to state the precise amount of the bone cut inclination and the dislocation of the metatarsal head (Fig. 1).

Technique

Before surgery, the patient's foot or feet are scrubbed using disinfectant soap. The operation is usually performed using local or block anesthesia and 7.5 mg ropivacaine hydrochlorate monohydrate. An Esmarch bandage is used at the ankle level. The patient is placed in the supine position. The foot is kept extrarotated, and the lateral edge is placed on the operating table. Normally, with this technique, soft tissue release is not needed because attenuation is achieved with the lateral offset of the metatarsal head itself. If a slight stiffness of the metatarsophalangeal joint is present, manual stretching of the adductor hallucis is performed, forcing the big toe into a varus position.

A 1-cm medial incision is made just proximal to the medial eminence through the skin, subcutaneous tissue, and down to the bone (Fig. 2a). The soft tissues are separated dorsally and plantarly, and they are divaricated using two retractors that are 5 mm in width (Fig. 2b). The medial wall of the metatarsal neck is now evident, and a complete osteotomy is performed using a standard pneumatic saw with a 9.5 × 25 × 0.4-mm blade (Hall Surgical Linvatec Corporation, Largo, FL, USA; Fig. 2c). With a small osteotome, the head is mobilized. A 2-mm K-wire is inserted, using a normal drill passing through the incision, into the soft tissue adjacent to the bone in a proximal to distal direction along the longitudinal axis of the great toe (Fig. 2d). The K-wire exits at the medial area of the tip of the toe close to the nail, is retaken by the drill (Fig. 2e), and is retracted up to the proximal end, reaching the osteotomy line (Fig. 2f). Using a small, grooved lever (Fig. 3a)

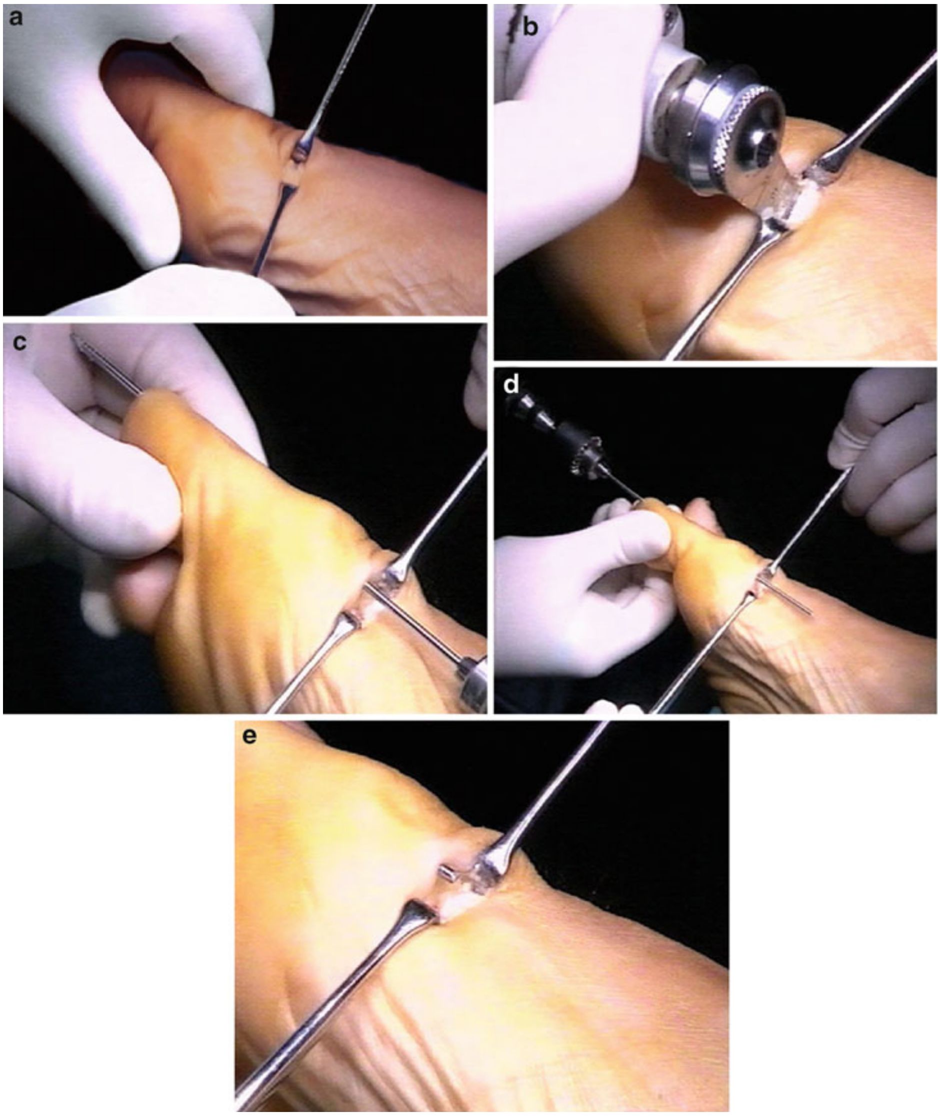

Fig. 2 Surgical technique: the skin incision is approximately 1 cm in length. The soft tissues are separated and divaricated by two retractors 5 mm in width (**a**). The metatarsal osteotomy performed by a standard saw (**b**). The insertion of a 2-mm K-wire in the soft tissue of the great toe along the long axis in a proximal-distal direction (**c**). The K-wire is retracted (**d**) up to the proximal end reaching the osteotomy line (**e**)

to prize the osteotomy, the correction is obtained by moving the metatarsal head depending on the pathoanatomy of the deformity (Fig. 3b, c). Stabilization of the correction is obtained by inserting the K-wire into the diaphyseal channel in a distal to proximal direction until its proximal end reaches the metatarsal base (Fig. 3d). A slight varus position (approximately 10°) of the toe is necessary and is obtained by forcing the toe after K-wire stabilization. If the proximal stump of the osteotomy is prominent medially, a small wedge of bone is removed. The skin is sutured with one 3–0 reabsorbable stitch (Fig. 3e). The distal extremity of the K-wire is curved and cut out of the tip of the toe (Fig. 4). This technique can be performed bilaterally or combined with the

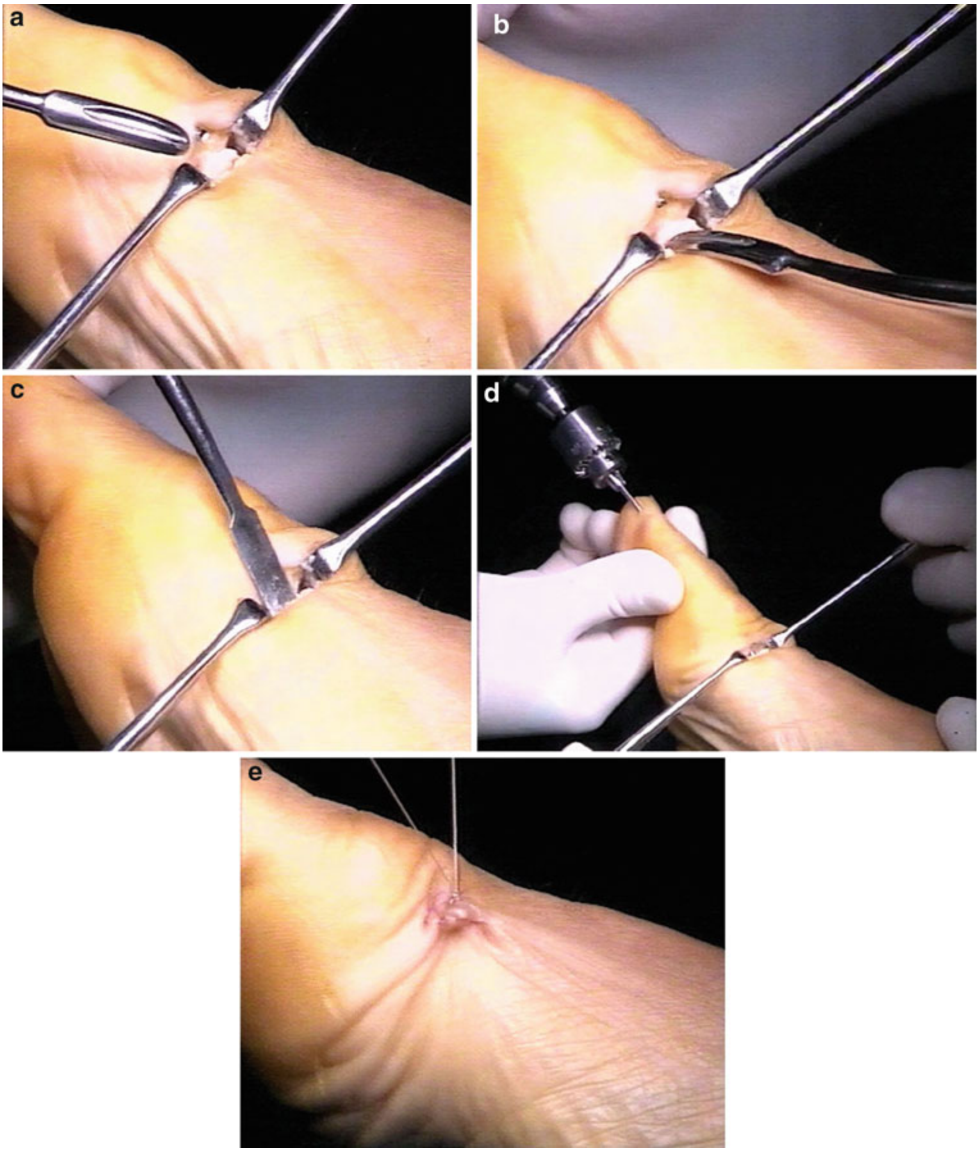

Fig. 3 Surgical technique: the grooved small lever (**a**). The correction of the deformity prizing the osteotomy and moving the metatarsal head as necessary (**b**, **c**). The osteotomy is stabilized by inserting the K-wire into the diaphyseal channel in a distal-proximal direction (**d**). The skin is sutured using only one 3–0 reabsorbable stitch (**e**)

correction of any other associated deformities of the forefoot or hindfoot during the same surgical session. The key points of the technique are the inclinations of the osteotomy in the medial-lateral and dorsal-plantar directions, the displacement of the head in the medial-lateral and dorsal-plantar directions, and the rotation of the metatarsal head and its medial tilt according to the correction of the DMAA. The inclination of the osteotomy in the medial-lateral direction is perpendicular to the foot axis (i.e., to the long axis of the second metatarsal bone) if the length of the first metatarsal bone must be maintained (Fig. 5a). The osteotomy is inclined in a distal to proximal direction up to 25° if

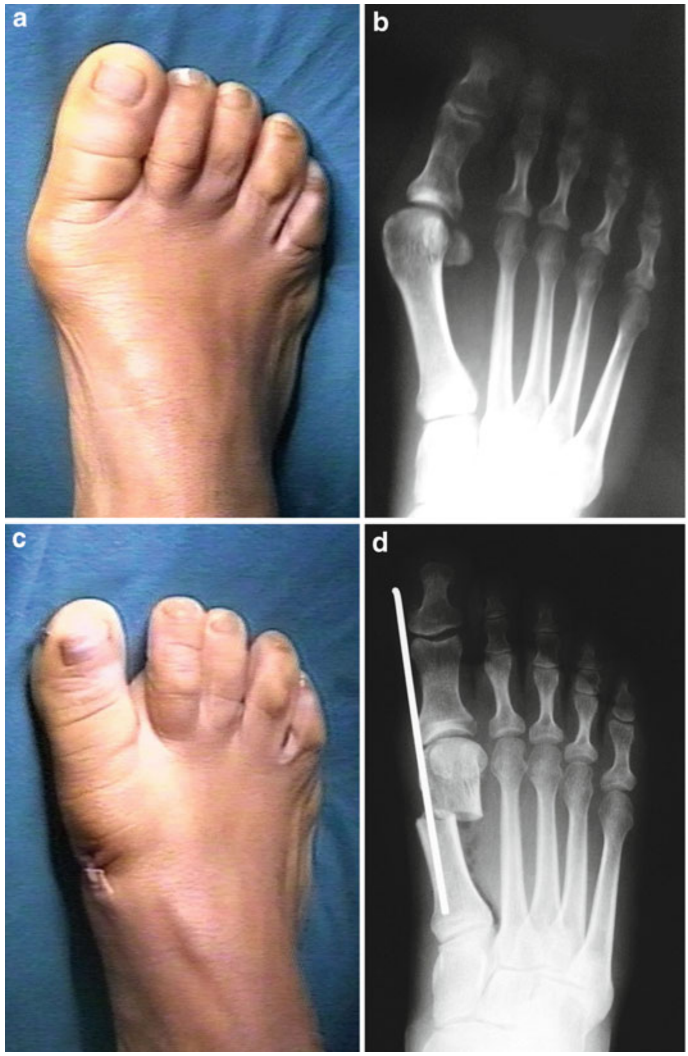

Fig. 4 Illustrative case preoperative (**a**, **b**) and postoperative (**c**, **d**)

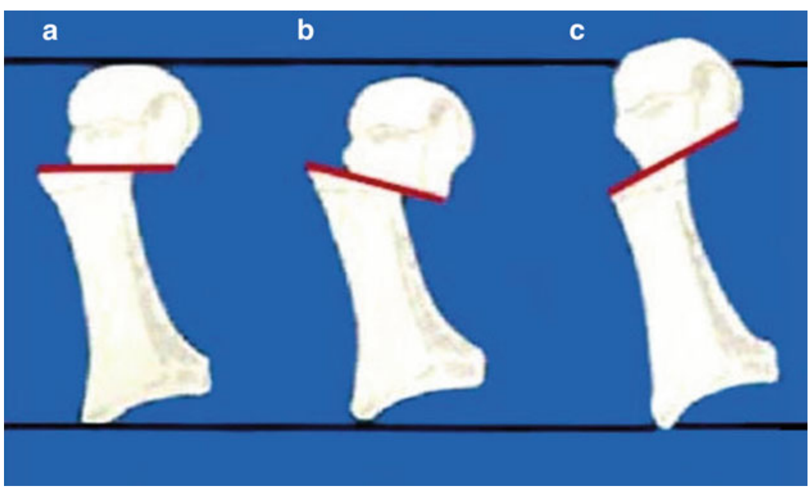

Fig. 5 Outline showing the different inclination of the bone cut and dislocation of the metatarsal head allowed by this technique in a mediolateral direction, perpendicular to the long axis of the second metatarsal bone (foot longitudinal axis) (**a**), proximally inclined (**b**), and distally inclined (**c**)

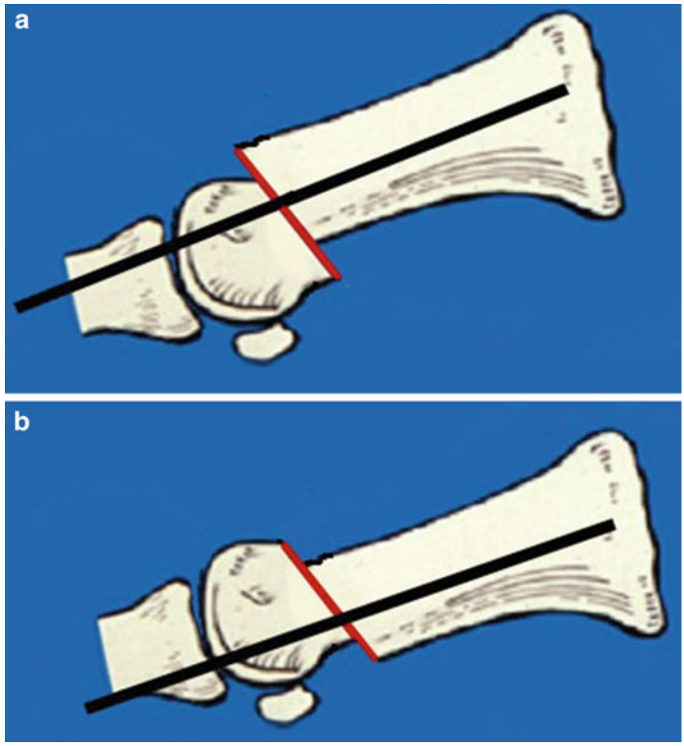

Fig. 6 Outline showing the inclination of the osteotomy in a dorsal-plantar direction (15° in distal-proximal way) and the plantar (**a**) or dorsal (**b**) dislocation of the metatarsal head. The different position of the K-wire related to the metatarsal head and toe is evident

shortening of the metatarsal bone or decompression of the metatarsophalangeal joint is necessary in case of mild arthritis (Fig. 5b). More rarely, if a lengthening of the first metatarsal bone is necessary (i.e., if the first metatarsal bone is shorter than the second or if laxity of the metatarsophalangeal joint is present), the osteotomy is inclined in a proximal to distal direction as much as 15° (Fig. 5c). In a dorsal-plantar direction, the osteotomy is normally inclined approximately 15° in a distal to proximal direction to control the dorsal dislocation of the metatarsal head under weight bearing (Fig. 6). The adjustment of the medial-lateral dislocation of the metatarsal head is performed by introducing the K-wire more or less superficially with regard to the medial eminence. The adjustment of the plantar dislocation of the metatarsal head, and more rarely of the dorsal dislocation, is obtained by introducing the K-wire in the upper (Fig. 6a) or more rarely in the lower (Fig. 6b) site, with regard to the long axis of the metatarsal head (Fig. 7). If shortening of the metatarsal bone is needed, normally, it is necessary to dislocate the metatarsal head in the plantar direction by several millimeters according to the extent of the shortening performed.

If pronation of the first metatarsal bone is present, the correction is obtained with a derotation of the big toe up to the neutral position (Fig. 8). To correct the DMAA, the K-wire is introduced into the soft tissue obliquely in a medial to lateral direction by as many degrees as necessary to obtain the correction (Fig. 9).

Results

Results regarding our first consecutive 54 ft in 37 patients (17 bilateral; 34 female patients, 3 male patients; mean age, 48 years; range, 10–70 years) are reported with a mean follow-up of 36 months (range, 22–52 months). The clinical evaluation was carried out postoperatively using the American Orthopaedic Foot and Ankle Society score. The radiographic evaluation preoperatively and postoperatively was carried out considering the hallux valgus angle, intermetatarsal angle, and DMAA measurements.

Fig. 7 Illustrative case: hallux valgus deformity combined with first metatarsal overloading (**a**, **b**). Postoperative X-ray in which the combined dorsal and lateral dislocation of the metatarsal head is evident (**c**, **d**)

All patients except four (7.4 %) declared their satisfaction with the result. Postoperatively, the mean score obtained was 81 points: 35 ft (64.8 %) were considered excellent, 10 (18.5 %) were good, 5 (9.2 %) were fair, and 4 (7.4 %) were considered poor. All of the osteotomies healed well, with callus evidence after an average of 3 months. All of the metatarsal bones remodeled themselves over time (Fig. 10), even in cases with marked offset at the osteotomy (few millimeters of bony contact). In our experience, the healing of the osteotomy and remodeling capability of the metatarsal bone are not related to the offset at the osteotomy, but it is preferable to obtain a bony contact not less than one third of the metatarsal section.

Complications

No severe complications, such as avascular necrosis of the metatarsal head or nonunion of the osteotomy, have been reported. In 5 ft (9.2 %), the radiographic healing of the osteotomy

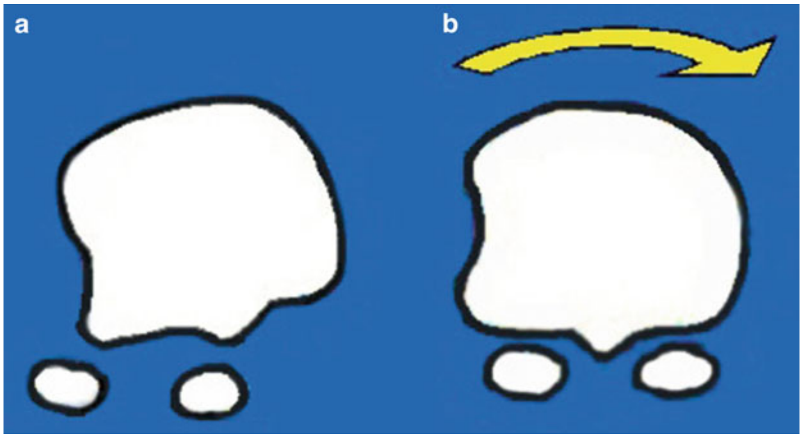

Fig. 8 Outline showing the derotation of the metatarsal head to assess the pronation of the metatarsal bone if present

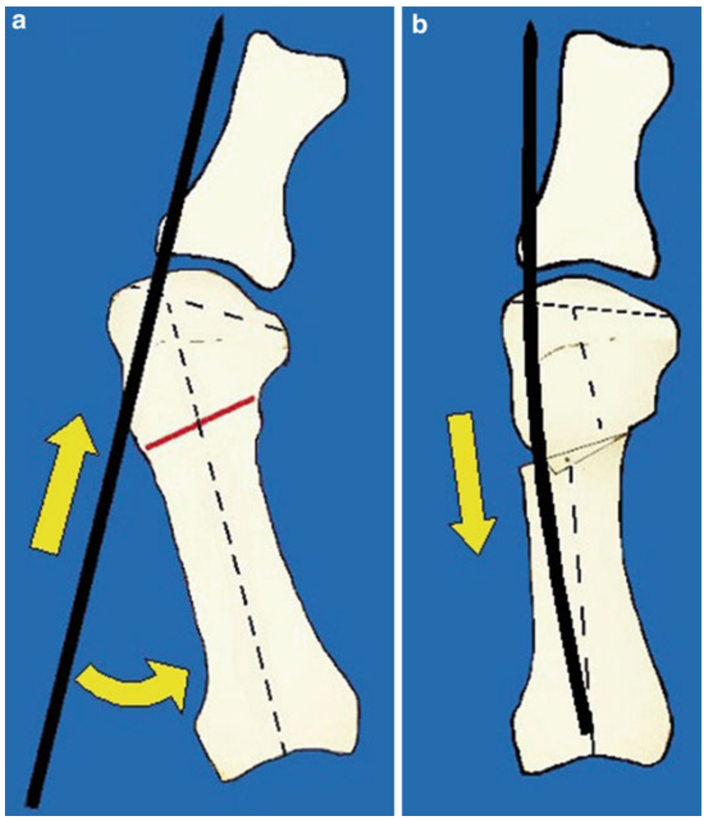

Fig. 9 Outline showing the correction of the distal metatarsal articular angle (*DMAA*). The K-wire is inserted into the soft tissue with a mediolateral inclination according to the correction of the DMAA (**a**). After the medial tilting of the head, the K-wire is introduced in a distal-proximal direction into the diaphysis (**b**)

occurred more than 4 months after surgery. Three feet (5.5 %) underwent a skin inflammatory reaction around the K-wire outlet at the tip of the great toe, and one patient sustained a deep vein thrombosis. All fair and poor results are the results of an incorrect indication, such as severe arthritis, or incorrect surgical technique with an incomplete correction. In 4 ft (7.4 %), transfer metatarsalgia with plantar callosities under the second and third metatarsal head is considered poor.

Fig. 10 Illustrative case: hallux valgus deformity in an anteroposterior view (**a**). Postoperative X-ray at 36-month follow-up. Good bone remodeling is evident (**b**, **c**)

Postoperative Management

After the operation, a gauze compression dressing is applied, and a control radiograph (anteroposterior and oblique views) is acquired to confirm the placement of the osteotomy and the correction of any characteristics of the deformity. Ambulation is allowed immediately using "talus" shoes, and foot elevation is advised when the patient is at rest. K-wire fixation resulting from wire bending on insertion produces a very stable and elastic stabilization, maintaining the same position obtained during surgery and favoring early healing of the osteotomy combined with early weight bearing (Fig. 11). After 1 month, the dressing, the suture, and the K-wire are removed. Passive and active exercises such as cycling and swimming are advised, and wearing comfortable, normal shoes and gradually returning to former footwear are recommended. As a general rule, postoperative swelling does not linger for more than 1 month.

Conclusion

This minimally invasive technique enables surgeons to treat approximately 80–90 % of all hallux valgus deformities without removal of the eminence and without open lateral release,

Fig. 11 The very stable and elastic stabilization produced by the bent K-wire, combined with early weight bearing, favors an early healing of the osteotomy

performing only a manipulation of the big toe, with more than 90 % excellent and good results after the learning curve. This technique is simple and is performed under direct vision and without radiation. It is inexpensive because no particular instrumentation is needed, a short surgical time is spent, and fewer complications are reported.

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