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The Mau-Reverdin Osteotomy: A Short-Term Retrospective Analysis

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ABSTRACT

We reviewed 33 consecutive Mau-Reverdin osteotomies in 23 patients performed for correction of hallux abducto valgus from November 2010 to May 2013. All patients were followed up and evaluated for a mean of 401 days and median of 360 days after surgery. In each foot, the preoperative first intermetatarsal angle, hallux abductus angle, and proximal articular set angle were obtained. The mean correction of these angles was as follows: intermetatarsal angle 10.5° ± 3.31°, hallux abductus angle 24.4° ± 8.8°, and proximal articular set angle 28.39° ± 11.2°. Furthermore, we evaluated for metatarsus elevates, and no statistically significant first metatarsal elevation was present in any of the 33 feet ($p < .0001$). Additionally, 21 of the 33 feet (63.6%) were available for first metatarsophalangeal joint American Orthopaedic Foot and Ankle Society scale score evaluation. The mean preoperative score was 25.5 ± 16.7. After correction, the mean American Orthopaedic Foot and Ankle Society scale score had increased to 95.4 ± 5.7. All these differences were statistically significant ($p < .0001$), and the patients had a very high level of satisfaction. In all 33 feet, no deep infection, malunion, nonunion, avascular necrosis of the first metatarsal, or hardware failure developed. One patient developed hallux varus deformity. The Mau-Reverdin osteotomy is a very effective and reproducible procedure that successfully corrects large bunion deformities and provides patients with a high level of satisfaction and a low complication rate.

Hallux abducto valgus (HAV) is a complex deformity. It has been widely accepted that a combination of bone and soft tissue procedures is required to obtain the optimal correction. A multitude of osteotomies and procedures has been described for deformities in which a large intermetatarsal angle (IM) angle exists, and/or an articular deviation is present. Osteotomies of the first metatarsal can be divided into 3 types: translational, wedge, and rotational. These osteotomies are most commonly performed at 3 locations to correct for the bunion deformity. These are at the head, the shaft, and the proximal metatarsal, including the metatarsal cuneiform joint (1).

In cases in which a capital translational osteotomy, such as a chevron, is no longer sufficient for correction, opinions have varied regarding which osteotomy would be best. Many have suggested the Lapidus procedure, which is a fusion of the first metatarsal–cuneiform joint. The Lapidus procedure can stand alone as a positional fusion procedure or can be performed with wedge resection. Metatarsal base wedge-type osteotomies, such as a closing or opening type wedge, are also options (2–4). Others have advocated the scarf osteotomy, which is a mid-shaft translational procedure (5). Additionally, crescentic osteotomies, which are rotational, have been described (6).

In our practice, we often choose the Mau and Reverdin procedures, in combination, to achieve the necessary correction. We choose this combination of osteotomies for several reasons: ease of execution, intrinsic stability to ground reactive forces, ease of fixation, and avoidance of fusion of the first metatarsal–cuneiform joint. Additionally, the combination of these procedures will achieve decompression of the metatarsophalangeal joint (MPJ) with minimal shortening, allowing for increased range of motion of the first MPJ and relaxation of the bowstrung and abducted extensor hallucis longus tendon (7–10). In addition to osteotomies, an aggressive soft tissue release is performed in all the patients. See the surgical technique description for details.

The Mau osteotomy began as a modification of the Ludloff procedure in the early 20th century. The Ludloff osteotomy was not fixated, and the Mau osteotomy challenged its inherent instability to ground reactive forces, which would cause displacement of the dorsal fragment (Fig. 1*A* and *B*). Mau described the reverse osteotomy, from dorsally and distally to plantarly and proximally, producing a stable rigid dorsal shelf to resist the ground reactive forces (Fig. 1*C* and *D*). Most recently, this procedure was modified by a longer proximal cut entering the metaphyseal bone to allow fixation with compression screws (8).

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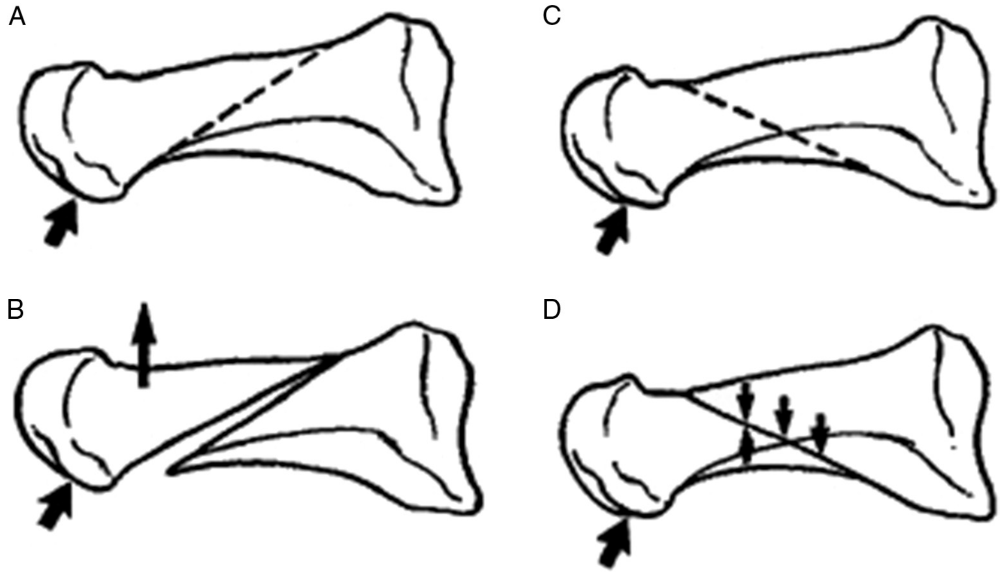

Fig. 1. Effect of ground reactive forces (*A*) on Ludloff osteotomy (*arrow*). (*B*) Note dorsal displacement of the capital fragment with the Ludloff osteotomy in response to ground reaction force (*arrows*). (*C*) Effect of ground reactive forces on Mau osteotomy (*arrow*). (*D*) Note the dorsal shelf of Mau osteotomy prevents dorsal displacement of the capital fragment and promotes stability in response to ground reaction forces (*small arrows*).

The Reverdin osteotomy was first described for use in the bunion deformity by Reverdin in 1881. It was originally described as a procedure in which a wedge of bone was resected proximally to the articular surface of the head of the first metatarsal. This procedure results in correction of the proximal articular set angle (PASA). The Reverdin modification used is that of Laird. It was developed by Laird in 1977. Its added modification is performed by cutting through the apex of the wedge, which allows for lateral translation of the capital fragment and protection of the sesamoid, while allowing correction of the IM angle in addition to the PASA (11).

Hence, we use a combination of a rotational (Mau) and translational (Reverdin) osteotomy to achieve optimal correction. In contrast to midshaft translational osteotomies, which can cause troughing, rotational midshaft osteotomies have full bone-to-bone contact at the area of the proximal rotational axis, which does not allow for troughing. Furthermore, with primarily rotational IM closure, relatively little shortening occurs compared with proximal wedge-type osteotomies (7,8,12). Osteotomies exist that can also have the benefit of lengthening the metatarsal, such as the opening wedge-type osteotomy (13).

Patients and Methods

We analyzed 33 consecutive Mau-Reverdin osteotomies in 23 patients performed for correction of hallux abducto valgus (HAV) from November 2010 to May 2013. The mean patient age was 48 $\pm$ 15 (range 16 to 70) years. All 23 patients (100%) were women. All patients were followed up and evaluated for a mean of 401 $\pm$ 227 days after surgery. In each foot, the preoperative first intermetatarsal (IM) angle, hallux abductus angle (HAA), and PASA were obtained. Furthermore, we evaluated for metatarsus elevatus by examining the lateral weightbearing films, noting the relationship of the first metatarsal to the dorsal second metatarsal cortex at the level of the distal metaphysis. If more than one third of the first metatarsal was above the second metatarsal cortex, we considered this first metatarsal elevation. For the purposes of the present study, all radiographic measurements were performed on weightbearing radiographs by 1 of us (N.A.A.). The qualification criteria for the patients included in the study were as follows: (1) performance of a Mau-Reverdin osteotomy; (2) surgery performed from November 2010 to May 2013; (3) procedures performed by the same surgeon (T.B.D.). No age restrictions were in place, and revision surgery was not excluded. To determine which patients had undergone Mau-Reverdin osteotomy, a search was performed using the Common Procedural Terminology code 28299 (double osteotomy for correction of hallux valgus) within the billing software.

The surgical technique consists of a dorsal linear skin incision made medially and parallel to the extensor hallucis longus tendon. The incision is deepened to the periosteum and capsule, where an inverted medial L capsulotomy is performed. The capsule and full-thickness periosteum are reflected dorsally and plantarly, exposing the plantar surface of the metatarsal down to the base, where the flare will be palpable and visualized. Next, the medial metatarsal exostosis is resected with a sagittal saw. A first interspace soft tissue release is achieved with release of the conjoined adductor hallucis tendon and release of the fibular sesamoid metatarsal suspensory ligament. The hallux is then manipulated in the direction of maximum allowable adduction to release any further adhesions or scarring within the first interspace holding the toe in the abducted position. The fibular sesamoid is palpated to ensure it can be realigned under the metatarsal as the hallux is repositioned medially. Next, the foot is repositioned on the table, with the lateral aspect against the operative table and the dorsal, medial, and plantar aspect of the first metatarsal exposed and facing dorsally. We minimize lateral and dorsal dissection of the soft tissues surrounding the metatarsal head, thus protecting the blood flow to the head. A sagittal saw is then used to create the Mau osteotomy with a single cut starting distally and dorsally and ending proximally and plantarly. The osteotomy is started approximately 1.5 to 2 cm proximal to the first MPJ, extending into the shaft, and ending approximately 1 to 1.5 cm distal to the first metatarsal–cuneiform joint (Fig. 2). This creates a fixed dorsal shelf and a plantar segment that includes the metatarsal head. We attempt to have the cut parallel the weightbearing surface. The cut should be sufficiently long enough to allow for appropriate fixation, and it can extend into the metatarsal base at its flare, and, even if necessary, to the metatarsal at the edge of the medial cuneiform joint. Maintaining this position, the osteotomy is stabilized with a bone clamp, and the foot is then repositioned to face dorsally on the table. A 0.45-in. Kirschner wire is drilled at the proximal aspect, perpendicularly to the osteotomy from dorsally to plantarly to provide stabilization and a rotational axis. While accomplishing this, it is important to maintain the original length of the first metatarsal. Next, the clamp is removed, and the plantar shelf, which contains the head of the metatarsal, is rotated laterally under the stable dorsal shelf to reduce the IM angle. If desired, the metatarsal can be slightly lengthened or shortened, if clinically indicated, by sliding the plantar segment proximally or distally (see the discussion section for the effect on shortening with additional Reverdin). The fluoroscope is used intraoperatively to visualize the correction. Using a

Fig. 2. Medial view of the Mau osteotomy.