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A Systematic Approach to the Surgical Correction of Combined Hallux Valgus and Metatarsus Adductus Deformities

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ABSTRACT

The presence of metatarsus adductus (MTA) adds complexity to the diagnosis and treatment of hallux valgus (HV). Identification and careful analysis of these combined deformities is of paramount importance. The inability to completely correct HV and an increased incidence of recurrence has been established when MTA deformity is present. We present an option for correction of the combined deformities with multiplanar angular correction arthrodesis of the first, second, and third tarsometatarsal (TMT) joints.

Metatarsus adductus (MTA) is a congenital deformity in which all 5 metatarsals are angulated into adduction. MTA is found in approximately 0.1% of the general population and up to 35% of HV patients (1-4). It is important to identify and carefully analyze patients with these combined deformities as the proximity of the first and second metatarsals can prevent complete surgical reduction of the HV deformity when MTA is unaddressed.

Various soft tissue and osseous procedures have been described in the pediatric and adult population with variable results and complications (5-14). Two-dimensional HV reduction procedures have been shown to have high rates of recurrence when MTA is present and left unaddressed. Long-term outcome studies specifically evaluating HV reduction surgery results show a 30% recurrence with the Scarf procedure at 10 years, 65% recurrence following proximal opening wedge osteotomy at 2.4 years, 73% recurrence after distal chevron at 8 years, and 73% and 78% recurrence rates after Scarf and chevron, respectively, at 14 years (15,16). Other reports indicate approximately 30% recurrence of HV in patients with MTA undergoing multiple procedures including a 26% and 47% recurrence after Mitchell osteotomy and 10% and 16% recurrence after Chevron (17-21). A retrospective study of 15 patients undergoing isolated HV surgery in the presence of HV/MTA reported a 40% patient dissatisfaction with a “striking undercorrection” following a variety of Scarf, Akin and medial eminence resection procedures (22). A negative impact has also been reported in Visual Analog Scale and Foot and Ankle Outcome Scores when comparing patients who have undergone HV surgery without the MTA being addressed (23).

MTA hinders anatomic correction of the first ray when using isolated first ray procedures and poses a significant surgical challenge regardless of the adjunctive procedures selected. Aiyer et al found that a modified Lapidus with realignment arthrodesis of the second and third tarsometatarsal joints yielded the best results when addressing combined HV and metatarsus adductus (23). The purpose of our paper is to present a transverse plane corrective arthrodesis of the lesser TMT joints and triplanar arthrodesis of the first TMT to provide robust and complete correction of both the MTA and the HV at their respective anatomic apexes.

Operative Technique

Radiographic Evaluation

Prior to considering an operative approach, appropriate weightbearing radiographs should be obtained. Proper evaluation of the foot in the

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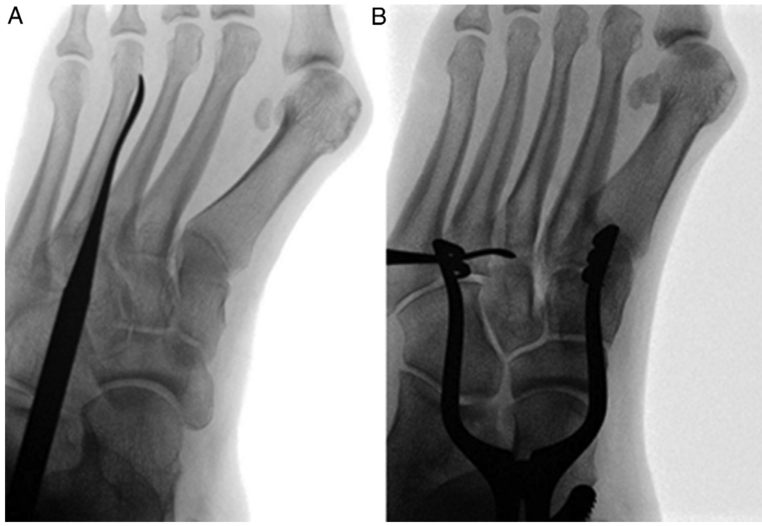

Fig. 1. A metal marker is placed along the lateral base of the third metatarsal (*A*); placing a metal marker at the anticipated tarsometatarsal (TMT) joint level (*B*).

AP, lateral, oblique, and sesamoid axial views is essential. Incorrect foot position will result in an inaccurate diagnosis as these changes influence deformity appearance radiographically. A supinated foot position will reduce the perceived intermetatarsal angle (IMA) and tibial sesamoid position (TSP), while a pronated position will artifactually increase the radiographic parameters.

Dorsolateral Approach to the Lesser TMT Joints

A dual-incision approach reduces unnecessary skin tension, avoids narrow skin bridges, and provides dorsolateral and dorsomedial access to the lesser and first TMT joints, respectively. A metal marker is placed along the lateral base of the third metatarsal and observed under oblique fluoroscopy to localize the dorsolateral incision placement (Fig. 1*A*). Dissection is carried through the skin, subcutaneous tissue and fascia. The extensor digitorum brevis muscle belly is mobilized from the extensor hallucis brevis and gently retracted or transected. The second and third TMT joints are identifiable under fluoroscopy by placing a metal marker at the anticipated foci (Fig. 1*B*). Soft tissue or bone overgrowth may require removal to facilitate joint visualization.

The anticipated second and third TMT bone cuts can be traced with a marker or bovie. TMT cartilage and subchondral bone cuts parallel to the sagittal plane of the intermediate and lateral cuneiforms limit inappropriate angulation and volume loss. The authors recommend a single cut resection of the second and third metatarsal bases for a reliable reduction with reduced tourniquet time. This is performed with the wedge's apex at the medial second metatarsal and the base at the lateral third metatarsals (Fig. 2*A*). Cut angle and bone removal may fluctuate depending upon anatomy and degree of correction. Alternatively, individual TMT resection is a viable option, especially if a significant second to third cuneiform step off is present. Orthogonal views should be taken following bone resection to ensure the surfaces are flush and appropriately prepared (Fig. 2*B*). The removal of osseous fragments that may hinder appropriate bone contact is critical. Liberal fenestration of the bone surfaces with a 2.0 mm drill bit will promote fusion and cancellous calcaneal autograft can backfill anatomic incongruities.

The preservation of the plantar TMT ligaments and the ligaments between the second and third metatarsals is important to avoid destabilization of the joints during deformity reduction. The soft tissues between the third and fourth metatarsal bases must be transected to

Fig. 2. Combined bone cut at the second and third metatarsal bases (*A*); care taken to ensure the metatarsal and cuneiform surfaces are flush and appropriately prepared (*B*).

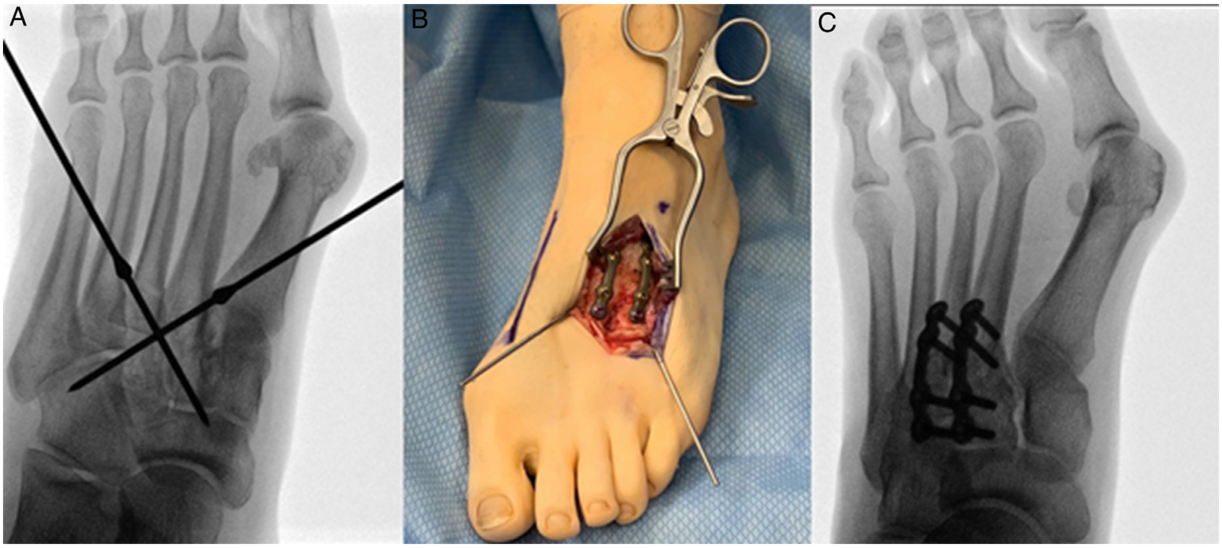

Fig. 3. Provisional lesser tarsometatarsal (TMT) fixation following “gate-hinge” "up and out" pivot technique (*A*); locking plate construct (*B*); fixation with maintenance of lesser metatarsal/tarsometatarsal (TMT) reduction (*C*).

allow for metatarsal mobility and reorientation. Reduction of the lesser TMTs and metatarsus adductus angle (MAA) is achieved through a “gate-hinge” "up and out" pivot technique. The Lisfranc ligament serves as a tethering point at the second metatarsal base around which rotation of the second and third metatarsals occur. Mobility of the lateral column typically allows for spontaneous correction of the fourth and fifth metatarsals.

Temporary pin fixation is deployed from the base of the third metatarsal to the intermediate cuneiform. A second pin is driven from the distal second metatarsal base across the lesser tarsometatarsal joint. Fluoroscopy ensures adequate correction of the second and third rays (Fig. 3*A*) with oblique images being helpful in this assessment. This surgical approach utilizes a mini-locking plate construct to stabilize each of the lesser TMT arthrodesis sites and encourage physiologic micromotion and healing (Fig. 3*B*) (24). Care is taken to avoid proximal migration of each plate during provisional fixation to prevent screws entering the navicular-cuneiform joints. The distal aspect of each plate should bisect the longitudinal axis of the respective metatarsals. The plates will appear oblique on the AP view due to the foot’s keystone architecture and will appear flush and well-aligned on oblique images (Fig. 3*C*). Alignment of the second and third metatarsals with the true longitudinal axis of the foot uncovers the “True IMA” on AP image intensification (20). After the second and third TMT joints are reduced and permanently fixed, triplanar HV correction via first TMT arthrodesis can be initiated.

Dorsomedial Approach to the First TMT Joint

The dorsomedial incision is carried directly to the first TMT just medial to the extensor hallucis longus tendon. Subperiosteal dissection with TMT release is performed to facilitate 1st ray positional realignment. The first MTP joint suspensory ligament and lateral joint capsule are percutaneously released to foster first metatarsal frontal plane correction. A fulcrum is introduced between bases of the first and second metatarsals. A stab incision is initiated at the second metatarsal proximal midshaft. A bone tenaculum or similar instrument is utilized between the first and second metatarsals to reduce the HV deformity and correct the “True IMA” (Fig. 4*A* and *B*). The instrument

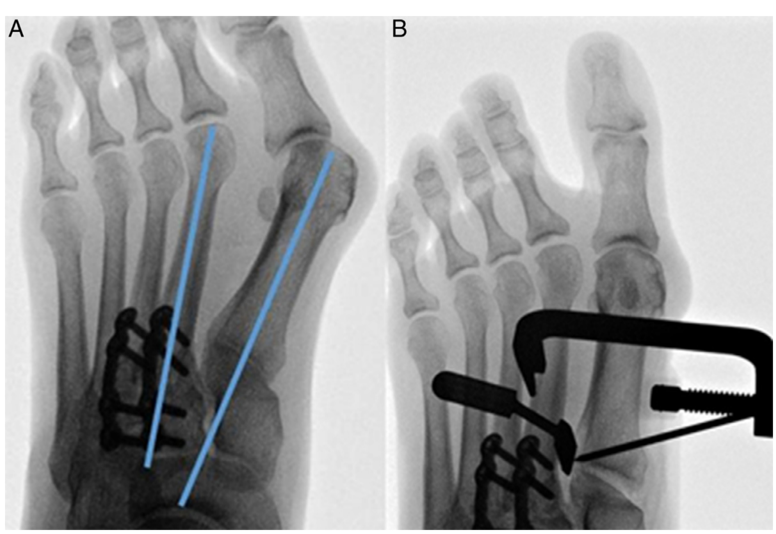

Fig. 4. Uncovering of the “True IMA” (*A*); instrumented triplanar correction of the first ray position (*B*).

Fig. 5. First tarsometatarsal (TMT) biplanar plating construct.

approximates the first and second metatarsals as it is tightened, promoting correction in all 3 cardinal planes. The majority of correction is carried out in the transverse plane, as opposed to the large frontal plane component observed in patients with isolated HV (25).

Surgeons should be cautioned not to tighten the instruments used to reduce the IMA aggressively due to the potential to disrupt the second TMT arthrodesis site. The first metatarsal should migrate to its anatomic home with relatively effortless manipulation if the appropriate soft tissue releases have been carried out at the first TMT and MTP joints. If acceptable tentative HV deformity reduction is achieved fluoroscopically, a temporary pin is used to fixate the proximal segments of the first and second metatarsals prior to making bone cuts. The authors prefer the use of a joint seeker/cutting jig construct aligned parallel to the midline of the first metatarsal and orthogonal to the first TMT joint. Jig alignment is assessed visually and fluoroscopically prior to initiating the first TMT joint resection to assure the anticipated bone cuts are appropriately orientated in the sagittal plane. The resected joint surfaces are removed, fenestration of the bone surfaces is carried out and the joint is axially compressed and held with 2 crossing wires. First ray correction is evaluated under fluoroscopy, and final fixation is applied utilizing a biplanar locking mini-plate construct. The initial plate is applied along the dorsolateral aspect of the first TMT joint and the second plate is applied medially across the first TMT joint 90 degrees to the dorsolateral plate (Fig. 5).

A metatarsal 1-2 “splay” test should be performed in all cases of HV to assess for first to second intercuneiform joint instability which has been found to be prevalent in this population (26–31). An intercuneiform screw is used to secure this unstable joint to avoid a springing open of the IMA (28–30). This technique can also be used in the presence of an eroded crista to stabilize the sesamoids at the first MTP joint through extensor and flexor tendon vector control at the hallux.

With the first TMT joint stabilized, focus is then directed to the first MTP joint. A small dorsomedial incision is used to address and remove capsular hypertrophy or dorsal bone prominences due to capsular traction. Aggressive bone resection at this level is not indicated. A phalangeal osteotomy may be beneficial if hallux valgus interphalangeus is present. Any remaining lesser toe deformities may also be addressed. However, these deformities tend to spontaneously reduce with TMT joint correction which offsets the need for further intervention. The operative incisions are copiously irrigated and closed in the standard fashion.

Postoperative Protocol

Patients may undergo an initial period of non-weightbearing for up to 6 weeks. Following surgery, they are placed in a standard short leg splint. Patients are counseled on strict elevation to help control postoperative edema. The operative limb is fitted for a pneumatic cast boot at 2 weeks, allowing patient removal to work on MTP and ankle ROM exercises 4 to 5 times daily. Patients are transitioned to protected weightbearing in the boot by postoperative week 6 and advanced to a supportive running shoe at week 12. Physical therapy is initiated by

Fig. 6. Preoperative (left) and postoperative (right) AP radiographs depicting a reduction in osseous foot width.

Fig. 7. Preoperative (left) and postoperative (right) sesamoid axial radiographs depicting a reduction in tibial sesamoid position (TSP).

week 6 and is centered on joint mobility, maintaining strength and edema management. All patients are released to activities as tolerated and sports after 4 months with a custom foot orthotic.

Discussion

A systematic correction of the MTA deformity through wedge resection and lesser TMT fusions provides a powerful and reproducible method of correction, uncovers the "True IMA" and allows for a complete correction of the concomitant HV deformity in all 3 planes (Figs. 6 and 7). If left unaddressed, the MTA bone blockade restricts procedural choices with poor outcomes and increased recurrence. Isolated 1st metatarsal osteotomies provide little improvement in correcting HV, forefoot width and the angular relationships amplified by moderate to severe MTA (5-14). Instances exist when an isolated HV correction outcome may be accomplished successfully but only in the presence of a moderate to high IMA and a mild MAA. Adjunctive procedures such as a phalangeal osteotomy and intercuneiform stabilization are recommended to maximize the clinical first ray alignment. It is essential to set patient expectations accordingly to avoid dissatisfaction, as an isolated approach may result in a borderline correction.

In conclusion, the recurrence rate of HV is substantially higher in patients with concomitant MTA. Both HV and MTA must be properly addressed to reduce the risk of clinical recurrence. The authors hope to provide the reader with a viable and reproducible systematic surgical approach to the reduction of combined hallux valgus and metatarsus adductus deformities.

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