DEFINING THE LIMITS OF THE MODIFIED AUSTIN BUNIONECTOMY

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An ongoing retrospective analysis of the modified Austin bunionectomy has prompted reconsideration of both the application and technical limits of the procedure. (Fig. 1A & 1B) A thorough understanding of soft tissue forces about the first metatarsophalangeal joint has afforded surgeons the opportunity to modify the Austin technique, and thereby reduce intermetatarsal angles far in excess of previously published limitations.

Peri-articular soft tissue structures (primarily the extensor hallucis longus and flexors hallucis longus and brevis) exert distinct forces on the first metatarsophalangeal joint. When viewed in transverse plane, they may be summated into two vectors. The first, a larger, proximally oriented vector of force of compression. The second, a smaller, medially directed force generated via the laterally displaced tendonous structures and sesamoid complex. Soft tissue tension may be considered as a primary deforming influence leading to the progressive increase of the intermetatarsal angle associated with hallux valgus deformity. (Fig. 2)

With the routine sub-capital osteotomy techniques (Austin, Reverdin, etc.) the hallux and peri-articular soft tissues are relocated dorsally and plantarly in a more rectus alignment. The first metatarsophalangeal joint is simultaneously restored to a congruous position, in effect lengthening the soft tissues which cross the joint. Thus, the previously directed medial vector of force is converted into a proximally oriented vector of a similar magnitude. With summation of these vectors, there builds a significant compressive force at

Fig. 1A. Moderate splay-foot deformity.

Fig. 1B. 3 year postoperative.

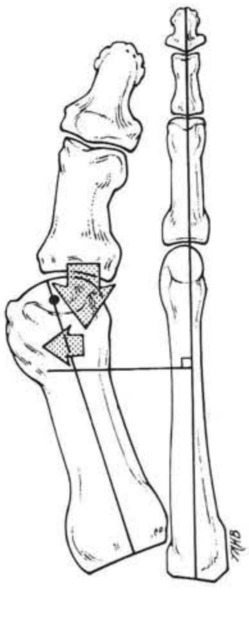


Fig. 2. Vectoral analysis of forces at the subluxed 1st MPJ (transverse plane).

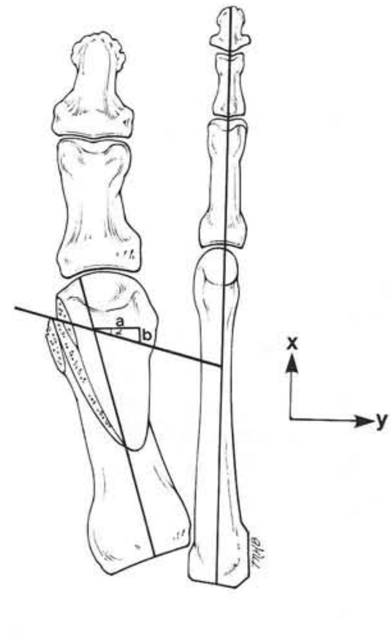


Fig. 4A. Axis guide alteration to affect 1st metatarsal shortening.

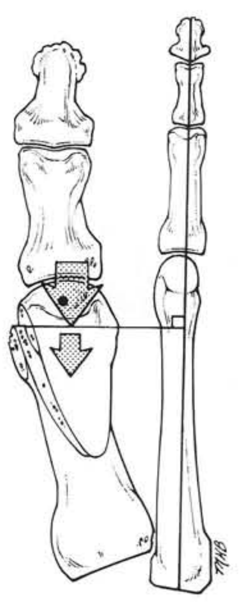
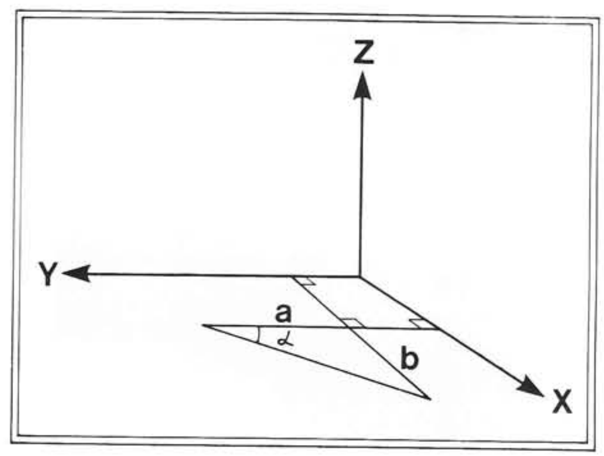


Fig. 3. Conversion of medial force vector to proximally oriented vector increases compression of joint.



Case 1: Subcapital Osteotomy
Austin Bunionectomy
note: met 2 is $\perp$ to y axis

w = width of met 1 (w = 15mm)
α = hinge axis angle measured from a $\perp$ to met 2. ($0 \leq \alpha < 90°$)
a = translation in y direction of met 1 ($0 \leq a \leq \frac{w}{2}$)
b = shortening of met 1 due to a + α

$$\boxed{b = a \tan \alpha}$$

let a = ½w = 7.5mm
let α = 30°
then b = 7.5 tan 30°

$$\boxed{b = 4.33\text{mm}}$$

Fig. 4B. Trigonometric derivation of 1st metatarsal shortening.

the joint. Ostensibly, this additional joint tension may be responsible in generating postoperative hallux limitus (Fig. 3).

These technical considerations have prompted us to create a distal first metatarsal osteotomy that measurably shortens the ray by design. Via alterations of the axis guide, one is capable of creating osteotomies that shorten the first meta-

Fig. 5A. Preoperative splay-foot.

Fig. 5B. 1 year postoperative (note significant shortening of 1st metatarsal).

tarsal predictably (Fig. 4A & 4B). This affords reproducible relaxation of soft tissues about the joint and subsequently increases the postoperative dorsal range of motion. This application has proven invaluable in hallux limitus repair as well as in the correction of hallux valgus (Fig. 5A & 5B).

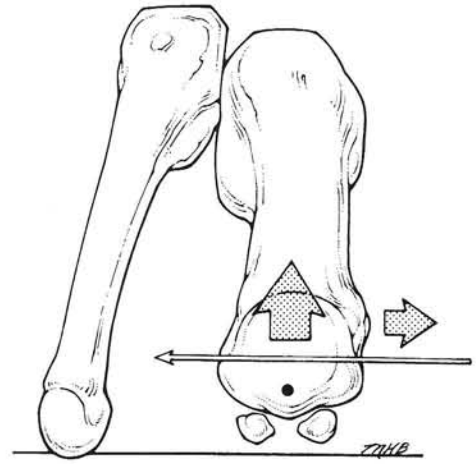


Fig. 6A. Vectoral analysis of forces of the subluxed 1st MPJ. (Frontal plane).

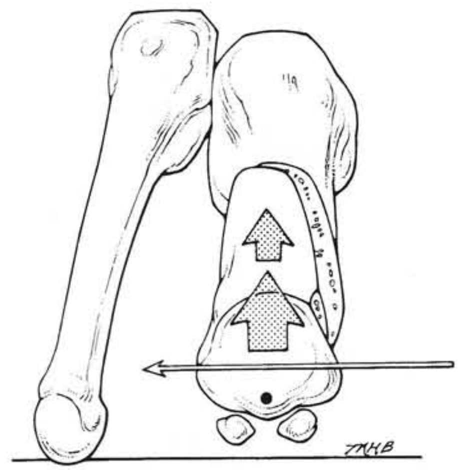


Fig. 6B. Translocational osteotomy converts medially directed vector into further dorsiflexory force.

In hallux valgus deformity, there exists a functional metatarsus primus elevatus as a result of a hypermobile first ray. In the frontal plane, two vectors of force are generated by soft tissues. The first, and greater vector is directed dorsally, and is created principally by the long flexor. The second is a smaller, medially directed force which results from the laterally displaced joint structures. Following pure translocational osteotomies and realignment of the joint, the authors postulate that the smaller medial force is converted into an additional dorsal vector of similar magnitude. Therefore, the metatarsus primus elevatus is slightly augmented, and may encourage postoperative hallux limitus (Fig. 6A & 6B).

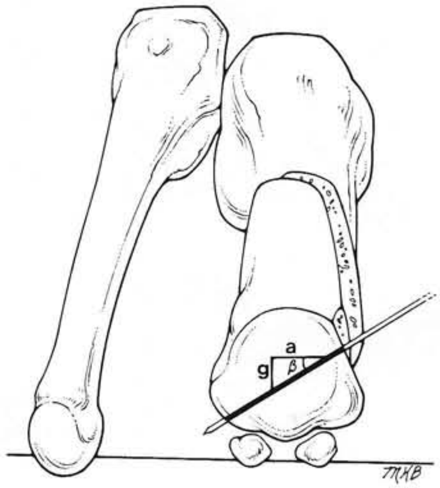
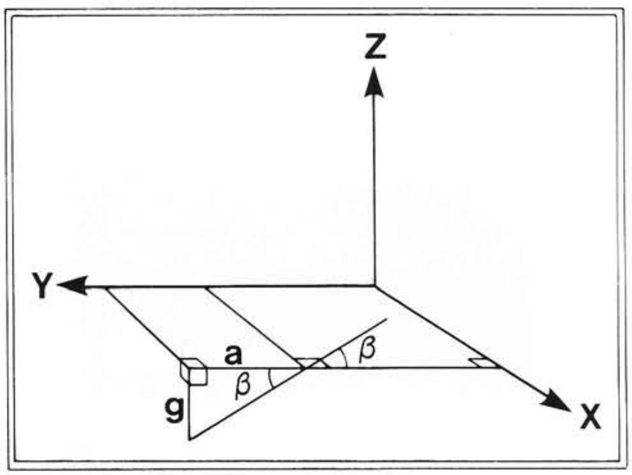


Fig. 7A. Axis guide orientation affording plantarflexion of 1st ray.



Case 2:

note: met 2 is $\perp$ to y axis

β = Hinge axis angle in frontal plane $(0 \leq \beta < 90°)$

g = translation downward due to β & a

a = translation in y direction

= a in case 1 $(0 \leq a \leq \frac{w}{2})$

w = width of met 1 (= 15mm)

$$\boxed{g = a \tan \beta}$$

let a = ½w = 7.5mm

β = 45°

then g = 7.5 tan 45°

$$\boxed{g = 7.5\text{mm}}$$

Fig. 7B. Trigonometric derivation of average excursion of plantarflexion.

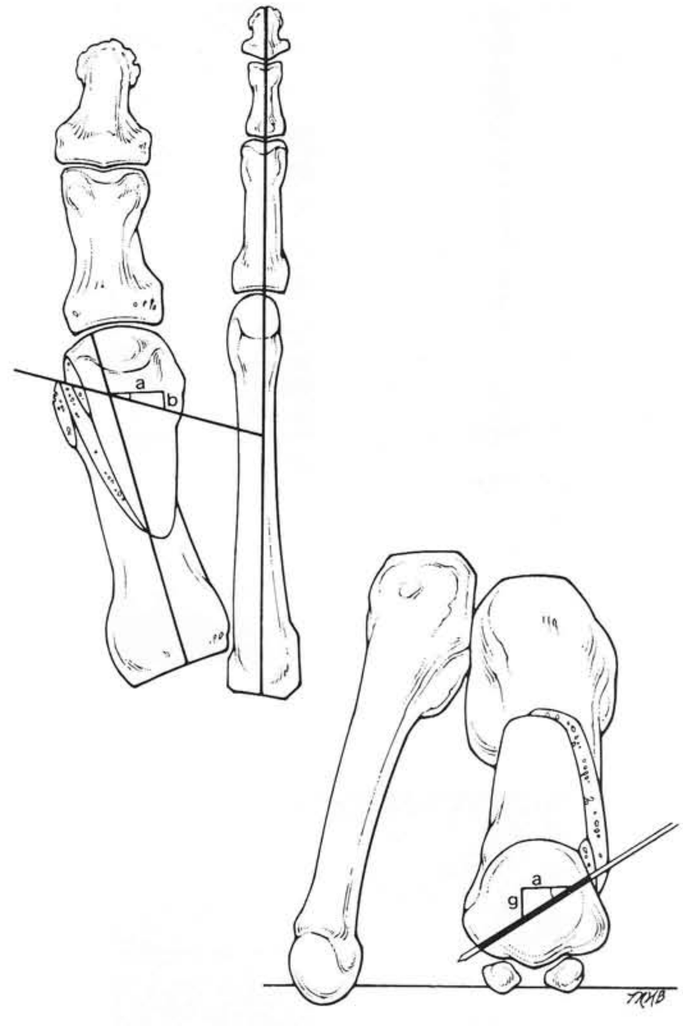


Fig. 8. Axis guide orientation to achieve plantarflexion and simultaneous shortening of 1st metatarsal.

Historically, the Austin technique was indicated for patients with intermetatarsal angles of 14 or 15 degrees or less. Moreover, the original, purely translocational osteotomy was susceptible to post-operative hallux limitus. Patients with hallux abducto valgus deformity may present with coexisting functional metatarsus primus elevatus and functional hallux limitus deformities. Accordingly, we have altered the original technique of the osteotomy. With appropriate orientation of the axis guide, an osteotomy is fashioned to both plantarflex and shorten the first ray. Significant plantarflexion of the capital fragment (>7mm) is thereby achieved, effectively restoring weight bearing function of the first metatarsal. Concomittantly, the functional metatarsus elevatus is eliminated, promoting an increased dorsal excursion of the joint postoperatively (Fig. 7A, 7B, 8). Therefore, restoration of adequate first metatarsal weightbearing is accomplished in conjunction with significant relaxation of trans-articular soft tissues.

Fig. 9A. Preoperative 19 degree intermetatarsal angle.

Fig. 9B. 1 year postoperative.

Fig. 10A. Preoperative 21 degree intermetatarsal angle.

Fig. 10B. 1 year postoperative.

Benefits of the modified procedure include an unrestricted dorsal range of motion and the capacity to significantly reduce intermetatarsal angles more effectively than previously appreciated (Fig. 9A & 9B).

With intraoperative application of these mechanical concepts, intermetatarsal angles of greater than twenty degrees are capable of satisfactory reduction (Fig. 10A & 10B).

Fig. 11A. Preoperative hallux limitus. (Metatarsus primus elevatus.)

Fig. 11B. Shortening and plantarflexory osteotomy. (Note: Relaxed joint space.)

Fig. 12A. Hallux limitus with long 1st metatarsal.

Fig. 12B. Shortening osteotomy with satisfactory metatarsal parabola.

Similarly, modifications of this technique have proven quite applicable in hallux limitus correction. The majority of patients with hallux limitus deformity have either metatarsus primus elevatus or long first metatarsals. Therefore, significant plantarflexion and shortening of the first metatarsal accomplishes profound relaxation of the peri-articular soft tissues, (Fig. 11A & 11B) and restores the dorsiflexory range of motion (Fig. 12A & 12B).

Summarily, these modifications of the Austin osteotomy afford a powerful application in the surgical repair of both hallux abducto valgus and hallux limitus deformities. By no means is this technique intended to supplant base wedge osteotomy in severe metatarsus primus adductus deformity. Alternatively, it does allow for significant shortening of the ray as desirable component of correction if necessary.

References

1. Smith T: The hinge concept in base wedge osteotomies. In Schlefman B (ed): *Doctors Hospital Podiatry Institute 12th Annual Update.* Doctors Hospital Podiatric Education and Research Institute, Tucker, 1983, pp 155-170.