CHAPTER **52**

THE FRONTAL PLANE DEROTATIONAL HEAD OSTEOTOMY FOR CORRECTION OF VALGUS ROTATION OF THE HALLUX

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Correction of the hallux valgus rotation in bunion surgery has largely depended on repositioning of the sesamoidal apparatus under the metatarsal head. In certain individuals there is a torsional abnormality of the first metatarsal responsible for this valgus rotation of the hallux. This intrinsic frontal plane rotation of the metatarsal should be corrected when pathologic. This paper addresses identification of the cause of the valgus rotation of the hallux and a method of correcting this torsional abnormality of the metatarsal so that the axis of motion of the first metatarsophalangeal joint can be restored to the sagittal plane.

FIRST METATARSOPHALANGEAL JOINT

The first metatarsolphalangeal joint (FMTPJ) is considered a ginglymus (hinge) type joint. The majority of the motion is in the sagittal plane. There also is a small amount of transverse plane motion.[1] Frontal plane motion at the FMTPJ is considered abnormal.[1] Coronal plane valgus rotation of the hallux is often seen as a component of the hallux abducto valgus deformity. The components of the FMTPJ include the head of the first metatarsal, two sesamoids, and the base of the proximal phalanx. For normal motion to occur at the joint the sesamoids must glide within the longitudinal grooves on the plantar aspect of the first metatarsal head. The sesamoids function to create stability of the joint much like a knee cap does in the knee. When the sesamoids glide anterior, this allows for the base of the proximal phalanx to glide dorsally, allowing for dorsiflexion of the hallux to occur in the sagittal plane.

Causes of Valgus Rotation of the Hallux

There are generally two causes responsible for the frontal plane valgus rotation of the hallux. Commonly, there is a subluxation of the sesamoidal apparatus associated with the Hallux Abducto Valgus deformity. This occurs when the fibular sesamoid rides into the first interspace around the lateral aspect of the metatarsal head. The tibial sesamoid also rides up on the crista plantar to the first metatarsal head. This is often seen radiographically on both the dorsoplantar (DP) view and sesamoidal axial (SA) view. Clinically this subluxation of the sesamoidal apparatus is evidenced by either a tracking or track bound motion of the joint as dorsiflexion of the hallux occurs.

Less frequently, the cause of the rotated hallux is a torsional abnormality of the first metatarsal. The base of the proximal phalanx and the sesamoids are all congruous within their respective articulations, however there is a frontal plane valgus rotation of the head of the first metatarsal. Radiogrpahically this can be seen on both the dorsoplantar (DP) view and the sesamoid axial (SA) view, however the distinguishing factor is that the sesamoids are congruous within the longitudinal sagittal grooves plantar to the first metatarsal head. This can often be evidenced clinically. As the hallux is taken through a purely sagittal plane range of motion, tracking or track bound motion will be present, however if the axis of the joint is deviated in accordance to the amount of frontal plane torsion of the metatarsal head, the motion will be smooth without tracking.

Combinations of torsional rotation of the metatarsal and subluxation of the sesamoidal apparatus may also be responsible for the valgus rotation of the hallux. Radiographically this may be evaluated by the same radiographic views. On the DP view, the tibial sesamoid often appears to be laterally displaced. The tibial sesamoid position (TSP) may or may not be an accurate measurement of the true location of the sesamoids. To better evaluate the congruity of the sesamoids, the sesamoidal axial (SA) view will give a more accurate evaluation of the congruity and location of the sesamoids in relation to the plantar metatarsal head. It is helpful to evaluate the angulation of the weight bearing surface compared to the plantar metatarsal head in order to determine if there is a torsional rotation of the metatarsal head. The rotation of the sesamoids due to subluxation can also be determined with the SA view.

Evaluation of the Rotated Hallux

The rotated hallux should be evaluated both radiographically and clinically. There are some distinct things that should be looked for when trying to determine the exact causes of the rotated hallux. Radiogrpahically, the dorsoplantar, lateral and sesamoidal axial views are important. On the dorsoplantar

view, a commonly used classification is the tibial sesamoid position (TSP).[2] This gives an indication of where the sesamoids are in a two dimensional plane (Figure 1), however does not take into account any rotational abnormalities in the metatarsal itself. It is impossible to distinguish between the subluxed sesamoidal apparatus compared to the congruous sesamoidal apparatus with a frontal plane torsional abnormality of the first metatarsal. The dorsoplantar radiograph will also allow for determination of the intermetatarsal angle, the width of the metatarsal and the length of the metatarsals. These should all be taken into account when determining the best method for correction of the deformity.

The lateral radiograph should also be evaluated. This will show whether there is any elevation of the first metatarsal. Both intrinsic and extrinsic elevations[3] of the first metatarsal should be noted. This is also helpful for determining the relative length of the metatarsals.

The sesamoidal axial (SA) view is the most important view for distinguishing the cause of the rotated hallux. It is important that a true weight bearing sesamoid axial view be taken, as the rotation of the first metatarsal changes as the first ray goes through it's range of motion.[1] The angulation of the plantar metatarsal head in relation to the weight bearing surface should be determined (Figure 2). This angle is called the Metatarsal Head Rotation Angle (MHRA). Also the congruity of the sesamoidal apparatus with the plantar metatarsal head should be determined. There may exist both subluxation of the sesamoidal apparatus and a torsional rotation of the metatarsal head. Kuwano et al. described the importance of the sesamoidal axial view in evaluating the sesamoidal rotation in hallux valgus.[4] They coined the term sesamoidal rotation angle (SRA). This SRA will be the same as the metatarsal head rotation angle (MHRA) (Figure 3) if a congruous articulation of the sesamoidal apparatus exists. With lateral subluxation of the sesamoidal apparatus, the SRA will be greater than the MHRA.

Clinical Evaluation of the Rotated Hallux

It is often possible to identify the cause of the rotated hallux clinically. When subluxation of the sesamoids is present, the range of motion of the hallux will exhibit a tracking or track bound motion as a result of the lateral position of the sesamoids in relation to the longitudinal grooves on the plantar metatarsal head. With dorsiflexion of the hallux a distinct pull or clunk will be evident as the non-congruous articulation between the sesamoids and the plantar metatarsal head go through a range of motion and the fibular sesamoid slips over the plantarlateral metatarsal head into the first interspace.

When there is a torsional frontal plane rotation of the metatarsal with a congruous sesamoidal first metatarsal head articulation present, the clinical motion of the joint exhibits a distinct range of motion. If the hallux is taken through a purely sagittal plane range of motion, the tracking or track bound motion is often exhibited as the sesamoids ride up the crista and sides of the longitudinal grooves as the hallux is taken through its range of motion with dorsiflexion. However, if the range of motion with dorsiflexion and plantarflexion is deviated to take into account the torsional rotation of the metatarsal head, a smoother excursion of the joint will be exhibited. The excursion of the hallux will be from dorsomedial to plantarlateral as a result of the deviated joint axis.

A combination of subluxation of the sesamoidal apparatus and torsional rotation of the metatarsal head may exist. In this case the axis of rotation of the hallux will be

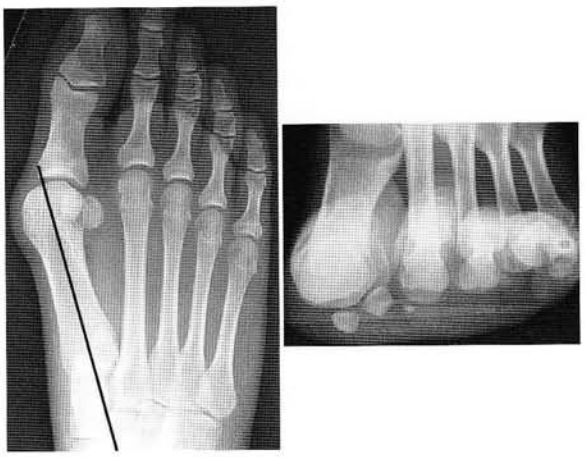

Figure 1A. Tibial Sesamoid Position (TSP) of 6. Figure 1B. Congruous articulation of sesamoidal apparatus and the plantar first metatarsal head. It is impossible to accurately determine the relationship of the sesamoids to the plantar metatarsal head without evaluating the Sesamoidal Axial (SA) view.

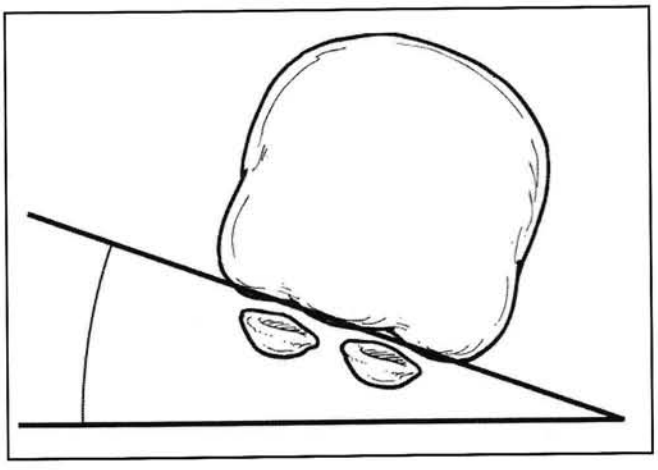

Figure 2. The Metatarsal Head Rotational Angle (MHRA) will help identify torsional rotation of the first metatarsal.

deviated similar to the congruous joint with the hallux excursion from dorsomedial to plantarlateral, however tracking or track bound motion will also be present. The amount of tracking will decrease as the hallux excursion is deviated from the sagittal plane as dictated by the torsional rotation of the metatarsal head.

SURGICAL CORRECTION OF FRONTAL PLANE VALGUS ROTATION OF THE HALLUX

The method of correction of the valgus rotation depends on where the deformity is present. In the subluxed sesamoidal apparatus, the correction depends largely on release of the tightened adductor hallucis tendon and fibular sesamoidal suspensory ligament. In conjunction with the standard distal metaphyseal osteotomy these maneuvers allow for relocation of the sesamoidal apparatus under the metatarsal head. The adductor tendon transfer further functions to help derotate the sesamoidal apparatus under the metatarsal head.[5]

Correction of the torsional abnormality of the first metatarsal has largely been overlooked. The method presented will derotate the metatarsal head to realign the axis of the first metatarsophalangeal joint and help restore the proper sagittal plane motion of the first metatarsophalangeal joint. A thorough understanding and application of the axis guide technique is requisite for proper correction.[6] The angle of the MHRA should be determined on the sesamoid axial view. The angular degree of the MHRA will be utilized for the degree of the axis guide wire. Thus, the axis guide angle (AGA) will equal the MHRA (Figure 4). Higher degrees of the AGA and MHRA will require that the placement of the axis guide wire will have to be more dorsal in order to avoid the articular surface of the plantar metatarsal head. A 90 degree Chevron type osteotomy is then performed (Figure 5). A medially based wedge of bone is then removed off of the plantar medial wing of the capital fragment. The apex of this wedge should extend two thirds of the width of the metatarsal head (Figure 6). This will allow for complete contact of the capital fragment with only a one third lateral shift. The angle of the wedge should be five degrees less than the axis guide angle or MHRA (Figure 7). This will still leave a five degree valgus rotation of the metatarsal head when the derotation and lateral shift have taken place. As the capital fragment is laterally translocated along the angle of the axis guide (AGA), it is also plantarflexing to make up for the elevation obtained from the removal of the medial based wafer of bone (Figure 8). The reason the medial based wedge of bone is taken off the metatarsal wing instead of the metatarsal itself is to limit the amount of elevation of the capital fragment as the derotation of the head is performed. With a $^1/_3$ lateral shift, complete congruity can be obtained at the osteotomy by removing a medially based wedge that extends $^2/_3$ of the way across the metatarsal head. With a $^1/_4$ lateral shift, the apex of the wedge needs to extend $^3/_4$ of the way across the metatarsal to obtain complete congruity. Fixation is generally performed with a 2.7 mm screw from proximal dorsal to distal plantar. However, fixation may vary depending on surgeon preference.

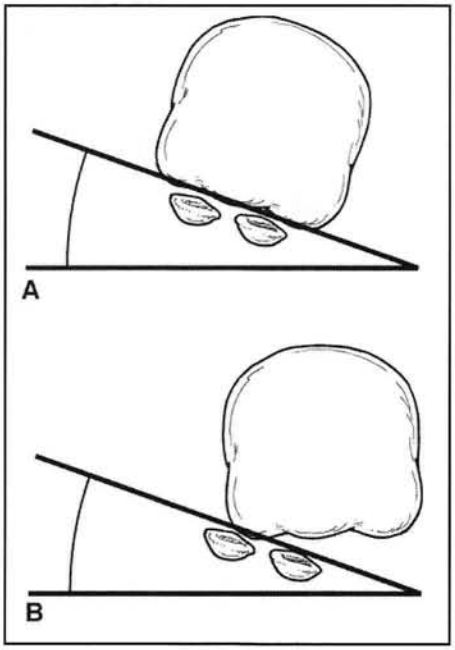

Figure 3. The Metatarsal Head Rotation Angle (MHRA) will equal the Sesamoid Rotation Angle (SRA) if there is a congruous articulation of the sesamoidal apparatus and the plantar metatarsal head. If there is lateral subluxation of the sesamoidal apparatus, the SRA will be greater than the MHRA.

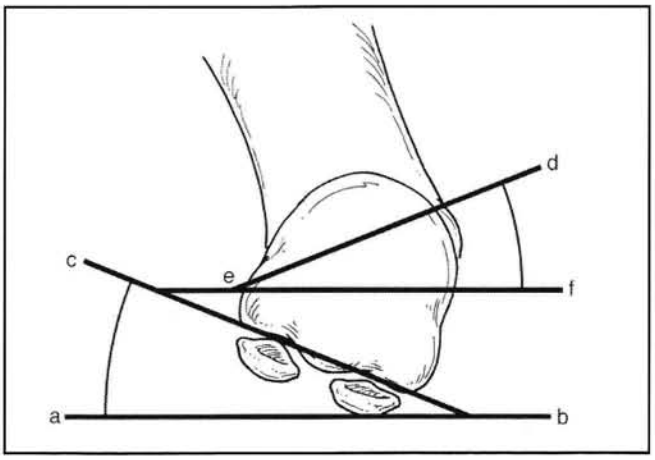

Figure 4. Angle ABC = Metatarsal Head Rotation Angle (MHRA) = Angle DEF = Axis Guide Angle (AGA). Angles ABC and DEF are corresponding angles.

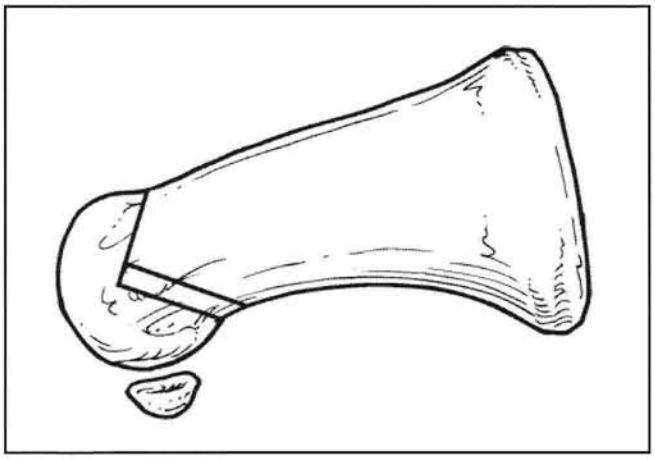

Figure 5. Medial view of first metatarsal depicting osteotomy cuts. Note that the medial based wedge should be taken off the plantarmedial wing of the capital fragment.

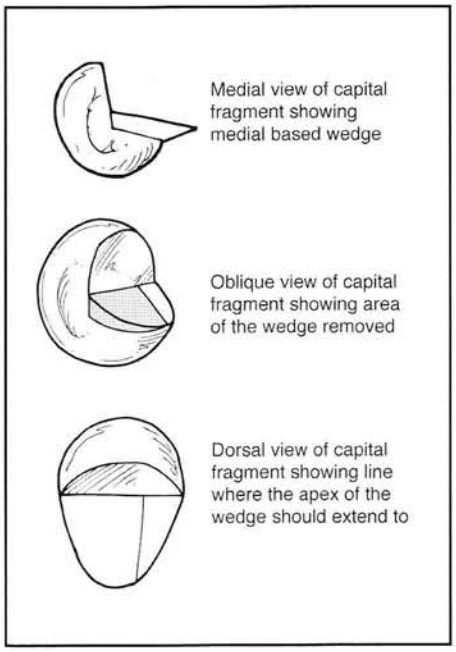

Figure 6. Medial, oblique and dorsal views of the capital fragment showing the medial based wedge of bone that is removed for the Frontal Plane Derotational Head Osteotomy (FPDHO).

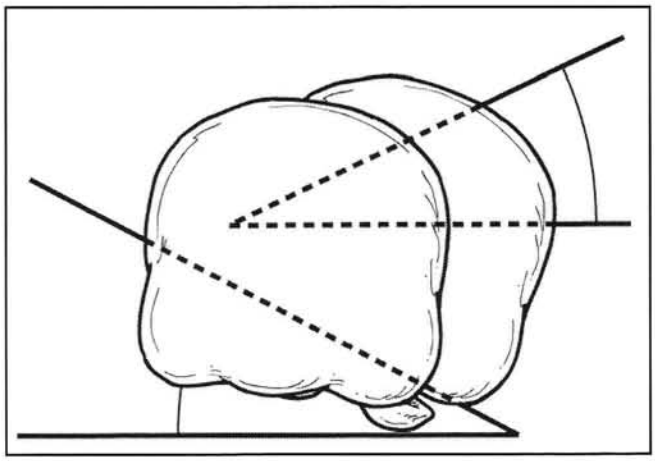

Figure 7. The angular degree of the wedge of bone removed from the plantar wing of the capital fragment should be five degrees less than the Metatarsal Head Rotation Angle (MHRA) and Axis Guide Angle (AGA). The apex of the wedge of bone should extend two thirds of the way across the width of the metatarsal head.

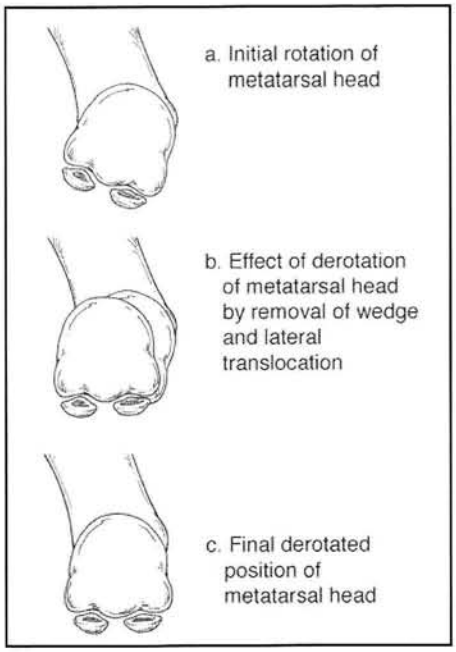

Figure 8A. Sequence showing the initial rotation of the metatarsal head. Figure 8B. The effected derotation of the metatarsal head by removal of the medial based wedge of bone and the plantarflexion obtained by lateral translocation along the Axis Guide Angle (AGA). Figure 8C The final derotated position of the metatarsal head and restoration of appropriate sagittal plane position.

CASE STUDY 1

17-year-old female presented with painful bunions which had been present as long as she could remember. They had become painful with any enclosed shoe gear or physical activity. Clinically there was pain over the dorsomedial eminence. Range of motion within the sagittal plane was track bound, however improved as the axis of motion of the hallux was deviated to accommodate for the frontal plane rotation of the metatarsal head. Radiographs revealed an intermetatarsal angle of 16 degrees and a TSP of 6 on the DP view, however on the SA view, the sesamoidal apparatus was completely congruous with the plantar first metatarsal head (Figure 9). It was noted that there was a 20 degree valgus rotation of the metatarsal head on the right foot and 15 degrees on the left.

A derotational frontal plane head osteotomy was performed to correct the right foot. The angulation of the axis guide wire was placed at 20 degrees to correspond with the MHRA noted on the sesamoid axial (SA) view. A 13 degree medially based wedge of bone was removed off the plantar wing of the capital fragment with the apex extending two thirds of the width of the metatarsal head. The capital fragment was then laterally translocated one third of the width of the metatarsal head. Fixation was obtained with a 2.7 mm screw measuring 22 mm in length oriented from dorsal proximal to plantar distal. The adductor tendon was then transferred subperiosteal to the extensor hallucis tendons and was sutured into the medial capsular flap. The patient was allowed to ambulate immediately postoperative in a postoperative shoe. She returned to tennis shoes at six weeks with no real complaints other than some joint stiffness. She is now 3 months postoperative and is planning on having the other foot done in the summer.

Figure 9. Case 1. Preoperative and 9 week post-operative dorsoplantar (DP) and sesamoid axial (SA) radiographs. Note the improved sesamoid position on the DP radiographs and the derotation of the metatarsal head on the postoperative views.

CASE STUDY 2

A 64-year-old female presented with a complaint of the painful bunion on her right foot. Her main complaint was pain in shoes that increased with activity. She had tried orthotics, NSAIDS, and shoe gear changes without significant improvement. She had previously had her left bunion removed in two years earlier by another doctor. Clinically she was painful over the dorsomedial eminence. The hallux had a 25 degree hallux abductus angle and there was approximately 25 degrees of valgus rotation of the hallux clinically. The range of motion was completely track bound when taken through a purely sagittal plane range of motion, however this motion became fairly smooth with minimal tracking when the axis of motion of the hallux was deviated to accommodate for the frontal plane rotation of the metatarsal head. Radiographically there was a TSP of 6 with an intermetatarsal angle of 15 degrees. The SA view revealed a metatarsal head rotational angle (MHRA) of 27 degrees with complete congruity of the sesamoidal apparatus (Figures 10, 11).

A derotational frontal plane head osteotomy was performed to correct the bunion on the right foot. The angulation of the axis guide wire was placed at 27 degrees to correspond with the MHRA noted on the sesamoid axial (SA) view. A 22 degree medially based wedge of

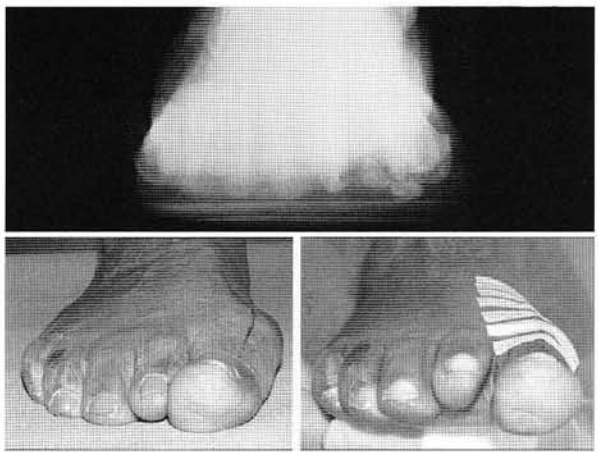

Figure 10. Case 2. Shows sesamoid zxial (SA) pre-operative view and clinical axial photographs demonstrating the preoperative rotation of the hallux and the immediate postoperative derotated position of the hallux.

Figure 11. Case 2. Preoperative clinical and dorsoplantar (DP) radiograph. Note tibial sesamoid position (TSP) of 6.

Figure 12. Case 2. Immediate postoperative clinical and dorsoplantar (DP) radiograph. Note the improved position of the sesamoids under the metatarsal head and the 1/3 lateral shift of the capital fragment.

bone was removed off the plantar wing of the capital fragment with the apex extending two thirds across the width of the metatarsal head. A lateral translocation of one third of the width of the metatarsal head was then performed (Figure 12). Fixation was obtained with a 2.7 mm screw measuring 20 mm in length and was oriented from dorsal proximal to plantar distal. An adductor tendon transfer was performed and sutured into the medial capsular flap. Immediately post-op there was a significant improvement in the rotation of the hallux as well as a decrease in the size of the bunion deformity.

POSTOPERATIVE MANAGEMENT

The postoperative course is the same as any other distal chevron type osteotomy. Immediate post-op weight bearing is generally allowed in a post operative shoe. Dressings are maintained per surgeon preference. Progression into regular shoes is generally at six weeks according to radiographic findings. Weight bearing status may however be limited by concomitant procedures.

DISCUSSION

Long term correction of the valgus rotation of the hallux depends on correct identification of where the deformity lies. The manner of correction should depend on the pathology. The weight bearing sesamoidal axial view is essential for proper identification of the cause of the valgus rotation of the hallux. For subluxation of the sesamoidal apparatus, release of the adductor tendon and suspensory sesamoidal ligaments with an adductor tendon transfer in combination with the standard chevron type osteotomy is generally adequate. For cases where there is a torsional abnormality of the first metatarsal, a frontal plane bony re-alignment of the metatarsal head is necessary to correct the valgus rotation. In some cases there may be a combination of both subluxation of the sesamoids and torsional abnormality present. In these cases a combination of techniques will prove most successful to correct the deformity.

The method described by the author offers the same advantages of any other distal chevron type osteotomy. It allows for immediate postoperative weight bearing and is amenable to rigid internal fixation. It has many of the same limitations of any other distal metaphyseal osteotomy. The degree of correction that can be obtained depends on surgeons ability, the degree of intermetatarsal angle, the width of the metatarsal head, and the quality of the bone present where the osteotomy is to be performed. This procedure is also amenable to decompression osteotomies by simply removing the dorsal wafer of bone off the metatarsal after the derotational wedge of bone has been removed off of the plantar arm of the capital fragment. Care should be taken to avoid over correction, as this can lead to a hallux varus with an abnormal frontal plane varus plane rotation of the hallux due to too large of a wedge of bone being removed. For this reason it is recommended to leave five degrees of valgus rotation of metatarsal head.

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