HOHMANN BUNIONECTOMY: Dinosaur or Versatile Gem?

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Osteotomy for hallux valgus is not a new concept and has evolved from simple transverse or oblique osteotomy to more complex designs. In the process, fixation constructs have become more sophisticated, incorporating the AO concepts of rigid internal fixation.

First metatarsal osteotomy for hallux valgus may vary in location, head and neck osteotomy versus shaft and basal procedures. Osteotomy may be a single transverse or oblique osteotomy or a more complicated multiple cut configuration such as the Z or Scarf procedure (Table 1).

Distal osteotomy has remained one of the most popular options due to its combination of simplicity and efficacy combined with a limited morbidity and complication rate versus proximal procedures. Chevron osteotomy has been one of the most popular and frequently performed but probably best indicated in mild to moderate deformities. Results in more severe deformities may be less than ideal.

The Hohmann osteotomy is an alternative distal osteotomy that appears to have more potential for correction in the more severe cases of hallux valgus. The Hohmann osteotomy was described almost 100 years ago and may be found in German literature (1,2) in the early 20th century. The text by Kelikian (3) is useful as an accurate historical reference to the large number of procedures of hallux valgus. Kelikian called the Hohmann procedure a dual-plane displacement osteotomy, within the metatarsal neck region as Hohmann described both lateral and plantar displacement in addition to a medially based trapezoidal wedge. With more than 30 years of personal experience, variants of this osteotomy have remained a valuable option in the treatment of hallux valgus.

Hallux valgus is a complex multiplanar deformity that varies in severity from patient to patient. Surgical management has always emphasized a need to tailor the surgical approach to the given deformity (4). The Hohmann osteotomy allows for modification useful for a large variety of bunion deformities (Table 2).

OSTEOTOMY

The Hohmann osteotomy was originally described as an extra-articular osteotomy, although today it is usually performed in conjunction with other procedures, for example, capsule tendon balance of the first metatarso-phalangeal joint (MPJ) and resection of the medial eminence. The osteotomy itself is usually performed as a closing-wedge-type osteotomy in the first metatarsal neck (7) (Figure 1).

The transverse plane orientation of the osteotomy in relationship to the long axis of the second metatarsal determines whether the first metatarsal will shorten or

Table 1

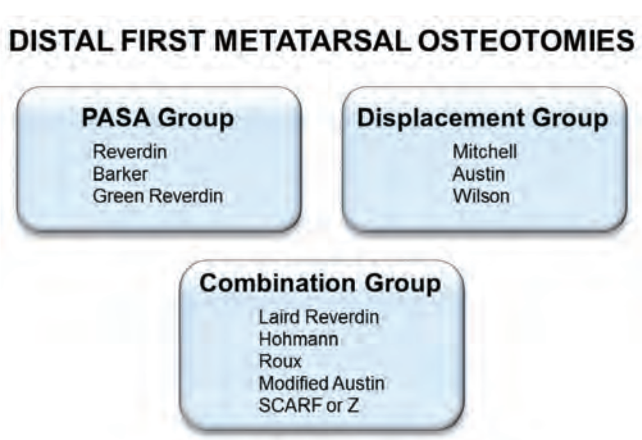

Table 2

HOHMANN OSTEOTOMY FOR HALLUX VALGUS

Segment of Deformity	Corrective Maneuver
Elevated PASA	Medial wedge
Elevated IM angle	Lateral transposition
Tight joint	Shorten Axis Orientation
Elevatus or short metatarsal	Plantar transposition
Valgus axial rotation	Rotation of capital fragment

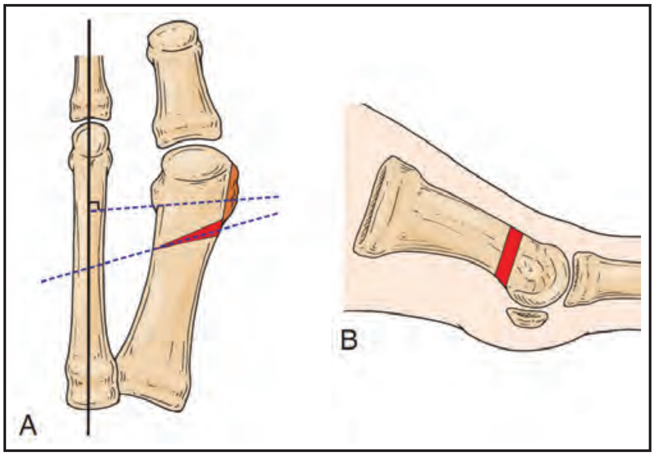

Figure 1. (A) and (B) The proposed modified Hohmann osteotomy is generally performed as a closing-wedge osteotomy with a medially-based wedge.

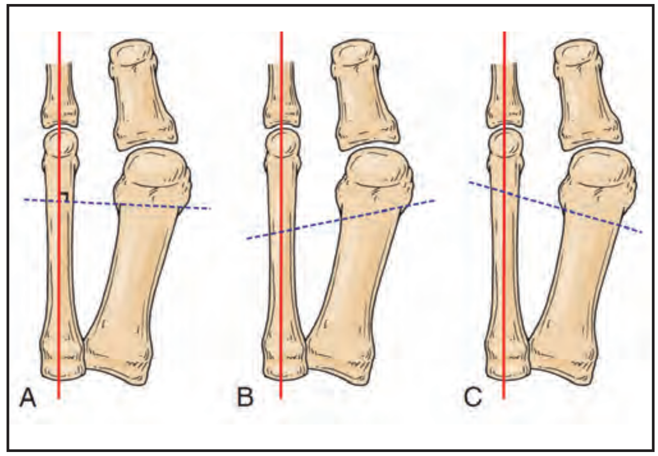

Figure 2. Axis of the osteotomy. (A) osteotomy performed perpendicular to the long axis of the second metatarsal will neither lengthen nor shorten the first metatarsal following lateral displacement (B) medial distal to proximal lateral orientation provides for shortening of the first metatarsal, (C) medial proximal to distal lateral provides for lengthening.

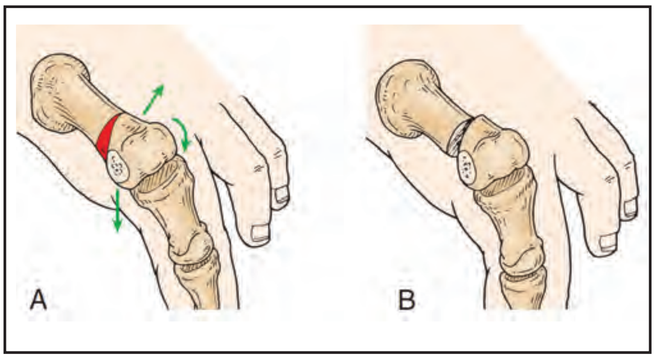

Figure 3. Corrective maneuvers of the osteotomy include (A) lateral and plantar transposition as well as axial rotation (B) subcapital closing wedge allows for reduction of PASA.

lengthen as a result of the lateral transposition of the capital fragment (Figure 2). The Hohmann osteotomy has been effective particularly in its ability to reduce lateral adaptation of the articular surface of the first metatarsal or the proximal articular set angle (PASA). If this is elevated, the surgeon may reduce the PASA through a medially based, cuneiform-shaped osteotomy. If the PASA is within normal limits, the osteotomy is performed as an oblique single cut. After removal of the medial wedge of bone, the lateral hinge is feathered, and the osteotomy is then completed so as to provide optimal bone-to-bone contact.

Whether a wedge of bone is removed or simply a solitary osteotomy is performed, the osteotomy is completed through the lateral cortex. This allows for transpositional and rotational movements of the capital fragment (Figure 3). Lateral transposition indirectly reduces the intermetatarsal angle while de-rotation of the capital fragment reduces valgus rotation. Shortening of the first metatarsal is not a completely negative variable; allowing for decompression of the first MPJ and augments correction of the hallux abductus. Effects of shortening of the first metatarsal may be minimized through plantar transposition of the capital fragment. Keep in mind that only a certain amount of transposition of the capital fragment is possible before bone-to-bone contact is significantly reduced.

The procedure is particularly beneficial in the reduction of the PASA and intermetatarsal angles to as much as 18 degrees. In cases of a mild deformity in a rigid foot type, this procedure has been useful in providing joint decompression with shortening aiding reduction of deformity. The capital fragment may also be transposed plantarly. This is desirable in cases of mild to moderate metatarsus primus elevatus or to compensate for the shortening that may have occurred. Caution is recommended as both lateral and plantar transposition may significantly reduce bony contact between the metatarsal head and shaft. The capital fragment may also be rotated in the frontal plane before fixation to accomplish reduction of hallucal axial rotation or an oblique track-bound range of motion. It is recommended that the toe be placed through its range of motion before and after preliminary fixation. Adequate and good-quality range of sagittal plane motion is an objective.

OBJECTIVE

The goals of surgery are correction of the hallux valgus deformity and restoration of a functional and pain-free first MPJ. This procedure is indicated in cases of moderate to severe hallux valgus. My use of the Hohmann osteotomy is similar to the objectives of the derotational, angulational, transpositional osteotomy (DRATO) described by Johnson and Smith (6); that is, multiplanar correction with a single osteotomy. The Hohmann osteotomy for hallux valgus is always performed in conjunction with soft tissue components of capsule/tendon balance, which may include medial capsulotomy and capsulorrhaphy, lateral release, and fibular sesamoidectomy or adductor transfer, in addition to removal of the medial eminence (Table 2).

SURGICAL TECHNIQUE

The procedure may be performed from a medial or dorsal longitudinal incision. The dorsomedial approach is preferred, as it allows for greater ease of first intermetatarsal space exposure. In cases with a very large medial eminence or a large hallux abductus, a significant amount of capsule is removed with the capsulotomy. This may be performed either with a lenticular or an inverted L capsulotomy, as both allow for excision of a portion of capsule. The capsulotomy and subsequent subperiosteal dissection must allow adequate exposure to the first metatarsal for performance of the osteotomy and its fixation.

Subperiosteal dissection is carried out dorsally and medially with severing of the medial collateral ligaments. A screw will be placed from the dorsal cortex of the first metatarsal, and therefore this area is included in the dissection. Consideration must be given for the potential of avascular necrosis with distal first metatarsal osteotomies, and thus no dissection of the plantar or lateral aspects of the metatarsal is performed at this time. If osteophytosis or periarticular lipping of either the phalangeal or metatarsal segment is present, then a decision to remodel these areas would necessitate greater exposure and dissection.

The first intermetatarsal space is entered between the first and second MPJs. A long transverse incision is made into the lateral joint capsule along the upper aspect of the sesamoidal bulge. This is deepened between the sesamoid and joint capsule laterally to dissect it free from the conjoined adductor tendon. Subsequently, the fibular sesamoid may be systematically released through severing its proximal and distal attachments to the lateral head of the flexor hallucis brevis and oblique head of adductor hallucis tendon/aponeurosis. Adequate lateral release allows for medial capsulorrhaphy to derotate the sesamoid complex back into position under the metatarsal head. The conjoined tendon is usually left undisturbed from its insertion into the lateral aspect of the proximal phalanx. On rare occasions, the fibular sesamoid may be completely excised in the presence of severe deformity or degenerative changes. Symptoms associated with the sesamoids should be assessed preoperatively.

The medial eminence of the first metatarsal is resected. Caution should be taken with removal of the bump, erring on the side of less resection. The medial eminence is usually resected slightly oblique in the coronal plane so that the tibial sesamoidal groove is left intact plantarly. The osteotomy is then marked on the bone with an osteotome and mallet before its actual performance to allow assessment of the geometry of the cuts. The osteotomy is made in a cuneiform orientation with the base medially. The most distal cut begins just behind the tibial sesamoid, and the second is proximal enough to correct the lateral adaptation of the articular surface. The lateral apex is oriented somewhat proximal so that some degree of shortening even with single cut osteotomies occurs. Shortening is proportional to lateral shift of the capital fragment and angulation of the cut proximal (Figures 2,3).

Before the actual performance of the osteotomy, some additional dissection is required. Lateral and plantar subperiosteal dissection is performed at the exact site of the marked osteotomy. Usually only the width of a #15 blade is all the dissection that is necessary, in an effort to preserve the vascular integrity of the first metatarsal head. The osteotomy is then begun perpendicular to the medial resected surface at both the proximal and distal arms of the wedge. Once the osteotomy is begun, the cuts may be redirected proximally as outlined or marked on the bone. (This just helps to ensure the desired amount of bone is removed.) The wedge is completed before cutting through the lateral cortex so that the hinge may be feathered and allow flush apposition of the cut surfaces (Figure 4). As a result of even slight shortening, decompression of the joint and displacement (lateral or plantar) of the capital fragment is accomplished quite readily.

Frontal plane position is determined by placing the toe through a range of motion, thus aligning the toe and its excursion of motion in the sagittal plane. This usually involves varus rotation of the capital fragment. Preliminary fixation with a Kirschner wire is accomplished and correction of deformity as well as assessment range of motion is performed. Definitive fixation may then be accomplished by osteosynthesis of choice.

OSTEOSYNTHESIS

The osteosynthesis provides stability in order to achieve osseous union, but more importantly rigid internal fixation should maintain the optimal position of the osseous fragments in correction until bony union is achieved. For the Hohmann, this is usually in the form of screw fixation. A screw from the proximal and dorsal surface of the metatarsal shaft directed in a distal and plantar direction is the preferred fixation. There are numerous variations of the exact direction of the screw, the screw utilized, and the technique, but the principles of interfragmentary

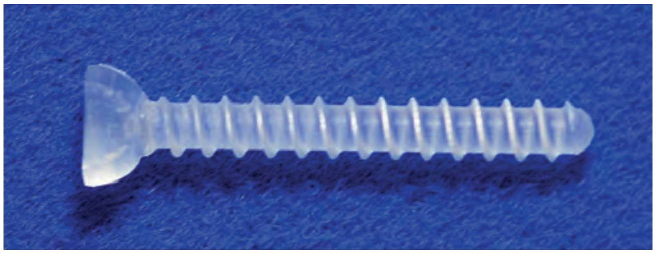

Figure 4A. Absorbable fixation with a 3.5 mm fully threaded PLLA screw was a long-time primary fixation device for interfragmentary compression. 3.5 mm absorbable screw.

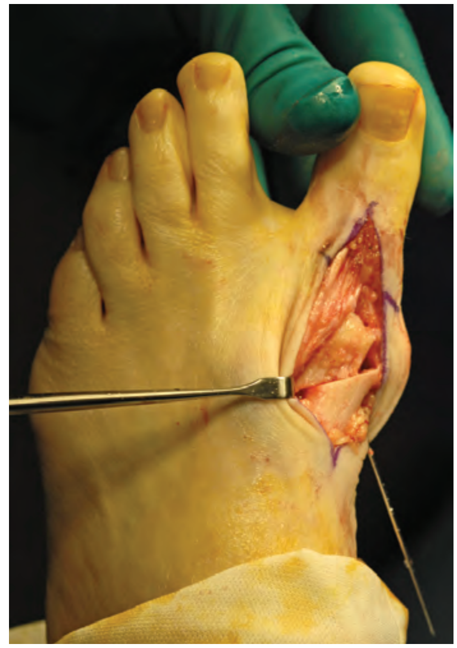

Figure 4B. Osteotomy cut and displacement.

Figure 4C. Intraoperative photograph showing "melting" of screw head to surface of first metatarsal.

compression with a lag technique are followed. Generally, a partially-threaded screw is chosen that purchases only the cancellous bone of the capital fragment (Figures 5-7). The lag geometry of the screw draws the capital fragment into or up against the shaft tightly so that there is no movement between the two.

Alternatively, a headless compression screw is also useful and avoids any dorsal subcutaneous prominence. In addition to an interfragmentary screw, a second point of fixation is recommended as this is a through-and-through planar osteotomy. This second point of fixation will protect the screw from rotatory and potentially disruptive forces as well as increase the overall rigidity of the osteosynthesis. Of course, a second screw may be utilized but a buried Kirschner wire was often employed as the neutralization pin described. Currently, my preferred technique is augmentation of an interfragmentary headless screw with two segments of a 1.5 mm absorbable pin (Figure 8).

Large deformities often require capsuloplasty/ capsulorrhaphy. Once the osteotomy is fixated, the necessity for additional capsulorrhaphy can be evaluated. Generally, subcutaneous dissection of skin/subcutaneous tissue from the joint capsule is continued medial to the level of the tibial sesamoid allowing for derotation of the sesamoid pulling the medial joint capsule upward restoring sesamoid position under the metatarsal head.

Avoidance of unrestricted weightbearing is essential to maintaining the integrity and compression of the osteosynthesis. Functional bracing in the form of a below-knee walker is recommended for 4 to 6 weeks until the osteotomy is clinically solid. The use of bracing offers the advantage of early range of motion of the joint reconstruction while allowing for easy dressing changes and wound care. Postoperatively, dressings are continued for 3 to 4 weeks followed by the use of splinting for several weeks including use of a bunion splint at night.

At about 4 weeks postoperatively if the osteotomy is deemed clinically stable, transition from the below-knee walker to regular shoes is begun. The patient is usually able to put on a pair of gym shoes immediately when coming out of the brace. Initially, it is better to wean the patient from the immobilization device by first allowing use of gym shoes around the house. Ambulation and activities should be guarded until approximately 6 weeks postoperative following reassessment. Radiographs are recommended at

Figure 5. Fixation of this Hohmann osteotomy was peformed with an 3.5 mm fully threaded PLLA (poly L-lactide) screw combined with 2 segments of a similar PLLA absorbable pin. Preoperative radiograph.

Figure 5B. Radiograph at 2 weeks postoperative.

Figure 5C. Radiographic view 1 year post-operative.

Figure 6A. Metallic lag screw - 4.0 mm bunionectomy screw was utilized for this osteotomy combined with percutaneous Kirschner wire as second point of fixation. Preoperative anterior-posterior radiograph showing severe deformity with lateral joint subluxation and hallucal axial rotation

Figure 6B. Anterior-posterior view 6 weeks postoperative

Figure 6C. Radiograph at 1 year post-operative.

Figure 7A. Headless screw is currently the preferred technique of fixation. Cannulated 3.0 mm compression screw has been the ideal compromise of size and stability.

Figure 7B. Orientation of screw insertion - dorsal and proximal to plantar and distal.

2 and 6 weeks, and at 3 months, postoperatively. If any resorption is noted at the 6-week radiograph, the stability of the osteosynthesis is questioned. Immobilization of the patient should be continued and the patient monitored closely until osseous union is observed.

DISCUSSION

The Hohmann osteotomy has continued to show its usefulness with over 30 years of experience. This procedure fills a gap between distal osteotomy of the Austin/Kalish or short Z modalities and the closing-base wedge of the first metatarsal. When comparing the Hohmann and chevron-type distal metatarsal osteotomies, the use of the Hohmann procedure has been reserved for the more severe deformity or the more rigid foot type. In the more severe, long-standing hallux valgus deformities, an increase in the intermetatarsal angle is usually accompanied by lateral joint adaptation at the head.

The Hohmann osteotomy has been useful in allowing correction of both segments of the deformity with a single osteotomy. Certainly there are limits, but the Hohmann has been effective in intermetatarsal angles upwards of 18 to 19 degrees, depending on the flexibility of the forefoot. The Hohmann also allows correction of the frontal plane bunion deformity, that of hallucal axial rotation. Not only is the

Figure 7C. Preoperative anterior-posterior radiograph.

Figure 7D. Anterior-posterior view 6 weeks postoperative.

Figure 7E. Radiograph at 6 months postoperative.

Figure 7F. Lateral radiograph at 6 week postoperative, illustrating orientation of screw to osteotomy.

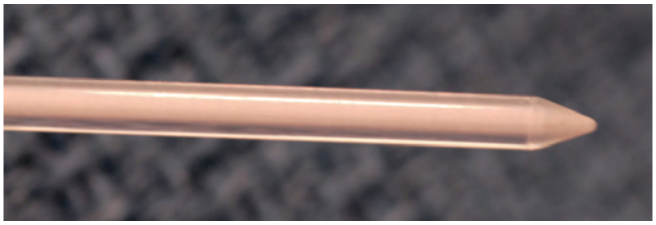

Figure 8A. Secondary point of fixation is necessary and an absorbable pin has been very useful. 1.5 mm absorbable pin (note, tapered point).

Figure 8B. Insertion with power is preferred.

Figure 8C. Anterior-posterior radiograph showing orientation of insertion dotted line - medial proximal and plantar to lateral distal and dorsal, second pin, dashed line - medial plantar and distal to proximal lateral and dorsal.

Figure 8D. Lateral radiograph showing orientation of insertion dotted line - medial proximal and plantar to lateral distal and dorsal, second pin, dashed line - medial plantar and distal to proximal lateral and dorsal.

cosmetic appearance of the toe restored but the procedure also provides for a return of improved sagittal plane motion. This is unique in hallux valgus procedures, and it certainly fills a void when the indications present.

Decompression is usually accomplished by shortening of the osseous segment, thereby widening or increasing the adjacent joint space. Such techniques are useful to provide a restoration of normal joint motion or at least to attempt to maintain a reasonable joint excursion. Joint decompression is a useful adjunct in correcting severe transverse plane abnormalities associated with hallux valgus, recurrent hallux valgus deformities with limited joint motion, or in cases of hallux valgus rigidus.

The Hohmann also has been effective in the rigid foot type of deformity. The deformity might not be that severe, but soft tissue releases are inadequate to allow freedom of joint excursion and correction of the deformity. These are feet that are probably best described by the European label of hallux valgus rigidus in which aspects of both pathologies coexist. The Hohmann osteotomy is an excellent technique to provide for joint decompression of the first metatarsophalangeal joint. The Hohmann provides joint relaxation, probably as a result of some shortening, this allows repositioning of the hallucal proximal phalanx on the metatarsal head and improved joint movement. Currently, the form of fixation most often utilized has been a 3.0 mm, headless compression screw. This screw is placed in a dorsal-proximal to plantar-distal direction. The screw should cross the osteotomy in the plantar half (Figure 7). In this manner, the screw orientation provides an optimal vector of mechanical stability opposing any ground reactive forces that would tend to cause either dorsal displacement of the entire head or simply a dorsal tilt. Alternatively, a medial to lateral orientation of the screw also in the proximal to lateral direction does allow perforation of the lateral cortex for purchase of the screw but at the expense of limiting adequate resection of the medial aspect of the first metatarsal shaft. This medial to lateral screw placement also offers less mechanical stability to ground reactive forces that tend to displace the osteotomy.

A second point of fixation is always recommended. This has usually been performed with an obliquely placed, 0.062-inch Kirschner wire, but our use of power driven absorbable pins has largely replaced this practice (Figure 8).The absorbable pin or Kirschner wire may be placed from plantar medial and proximal and to dorsal-lateral and distal, piercing the medial dorsal cortex at the margin of the articular surface. An alternative technique or a secondary pin technique is often utilized that pierces the extreme plantar medial articular and is driven out the dorsal lateral side of the first metatarsal shaft.

Regardless of how stable the osteosynthesis appears, it is still recommended to limit weightbearing through the limb and operated foot although crutches are generally not necessary. Early weightbearing may result in loss of fixation, dorsal tilt of the capital fragment, pathologic fracture of the dorsal cortex, and prolonged morbidity or reoperation from osseous displacement or nonunion. Part of the discontent with this and similar procedures results from the complications of osteotomy displacement and malunion. Careful attention to the osteosynthesis and adherence to the prescribed postoperative course minimizes their occurrence.

A consideration for the performance of this or for that matter any osteotomy is an adequate bone density to allow some type of fixation. Union is fairly predictable so long as the stability of the fixation is maintained during the post-operative period. Even the postmenopausal female with some degree of osteopenia is capable of undergoing this osteotomy, but control of the postoperative weight-bearing is essential. Rigid fixation is probably the major contribution to my success with this procedure.

Excessive shortening may be a problem and a relative contraindication to the procedure would be a short first metatarsal, index minus of more than 4 mm. Our results from several hundred procedures do show that lateral weight transfer may be an occasional problem, but that capsulitis/metatarsalgia is responsive to orthotic management and that a keratotic lesion is generally unlikely unless already present preoperatively or displacement of the osteotomy occurs before clinical union. Judicious use of plantar transposition is the best cure for this problem. The modified Hohmann osteotomy has become a versatile procedure that allows correction for some very difficult types of deformities of the first MPJ.

In conclusion, my experience with the Hohmann-type procedure verifies favorable comments and encourages more widespread use. Rigid fixation is probably the major contribution to the success of this procedure. This osteotomy is powerful in its ability to correct deformity particularly when combined with joint decompression (shortening), fibular sesamoid release, and medial capsulorrhaphy. Caution is suggested, as hallux varus has occurred with overzealous capsule-tendon balancing techniques and excision of the fibular sesamoid is generally avoided. The Hohmann osteotomy has continued to show its usefulness during my 30 years of utilization. It is particularly valuable for more severe bunions wherein correction at more than one level of deformity is desirable.

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