CHAPTER 21

THE CLOSING BASE WEDGE OSTEOTOMY REVISITED

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The treatment of hallux abductovalgus deformities entails great consideration and operative decision making. The foot and ankle surgeon possesses a multitude of procedure choices for treatment dependent on the nature of the deformity. As is well accepted, patients presenting with rigid, large intermetatarsal angles most often require a more proximal metatarsal osteotomy or joint arthrodesis for sufficient correction. The original description of a closing wedge osteotomy by Loison in 1901, involved a laterally based wedge through the proximal metaphysis of the first metatarsal that was traditionally fixated with Kirschner wires.[1]

The modern version of the oblique wedge osteotomy of the first metatarsal was originally created at the Podiatry Institute in 1977. The procedure was designed for the specific purpose of fixation with small fragment screws. Over time, the osteotomy has undergone many transitions and is now performed as an oblique wedge osteotomy with a medial hinge at the base of the first metatarsal that easily accommodates two screw fixation. Historically base wedge osteotomies have been maligned because of apparent excessive shortening and elevation of the first metatarsal. Schuberth et al noted an average of 3.2mm of shortening and an elevation of 6.68 degrees.[2] Elevation of the first metatarsal was, in most cases the cause of postoperative complications such as lesser metatarsalgia and stress fracturing. This elevation was most likely produced by early weight bearing and failure to properly employ the hinge axis concept. With the introduction of the hinge concept and the AO techniques of internal fixation, the closing base wedge osteotomy can be performed with a high degree of success in cases of severe hallux abductovalgus.

INDICATIONS

Traditionally, the closing base wedge osteotomy is indicated for abnormally high intermetatarsal angles of 12 degrees or greater in an adducted foot or 15 degrees or greater in a rectus forefoot.[2] Schuberth et al, found a relative reduction of 8.058 degrees[2] and Nigro et al found a reduction of 6.11 degrees[3] with the performance of the base wedge osteotomy. This osteotomy effectively reduces the metatarsus primus adductus component which is associated with severe hallux abductovalgus deformities. This results in a more rectus and narrow medial column. A proximal osteotomy will also allow the sesamoids to assume a more anatomic position which will enhance the function of the first MPJ.[4]

With the high degree of success of the distal Chevron osteotomies, the closing base wedge osteotomy has been reserved for more severe deformities which specifically include a rigid first ray segment. A flexible first ray that is manually reducible indicates that there is a large soft tissue component to the deformity rendering it a dynamic deformity. In this case, a more distal osteotomy with lateral soft tissue release may be adequate for correction. If the first ray is rigid and non-reducible manually, this indicates that there is a structural deformity present and excessive lateral metatarsal head translocation or bone resection would be needed to correct for the high IM angle if a distal procedure were selected. This could result in a c-shaped metatarsal post-operatively and could also compromise the amount of bone on bone contact at the osteotomy site. Juvenile hallux abductovalgus deformities, recurrent HAV and excessive elevatus of the first ray are other indications for the closing base wedge osteotomy (Figure 1). The evaluation of hallux abductovalgus deformities in the presence of metatarsus adductus can be difficult. Banks et al. found that in a series of patients with juvenile HAV that 48 of 72 cases had a metatarsus adductus angle greater than 15 degrees. Radiographically the IM angle may appear to be small, however the patient has a large clinical deformity. It is necessary to determine the true intermetatarsal angle utilizing the formula:

True intermetatarsal angle =
(MA angle – 15 degrees) + IM angle

Contraindications to the use of the closing base wedge osteotomy would be the presence osteoporosis or poor bone stock, tobacco usage, an excessively narrow first metatarsal or patient compliance issues with non-weight bearing.

EVALUATION

The hallux is placed through full range of motion preoperatively with both the first metatarsal unreduced and reduced in the transverse plane. If range of motion is increased with manual reduction, this indicates some flexibility to the deformity and a more distal type of osteotomy may be adequate. The inability to reduce the deformity indicates that a structural component exists and a more proximal procedure may be necessary. This test should be repeated intraoperatively after the complete lateral soft tissue release sequence is performed. If adequate reduction of the first metatarsal in the transverse plane is obtained, a proximal osteotomy may no longer be needed. The range of motion of the first metatarsal cuneiform joint should also be evaluated at this time. If excessive sagittal plane motion of this joint is present, it may be necessary to perform a Lapidus type of arthrodesis to control motion. The position of the sesamoids and any adaptive changes that may have occurred should be noted. An AP radiograph showing increased articulation between the bases of the first and second metatarsal bases may indicate that less mobility will be present in the transverse plane.[4]

SURGICAL TECHNIQUE

Anatomic Dissection / Periosteal Maintenance

The first metatarsal cuneiform joint is identified and the skin incision is carried back proximal to the first metatarsal cuneiform joint. Principles of anatomic dissection are observed with attention to the presence of the medial marginal vein and the medial dorsal cutaneous nerve which commonly intersect the incision line.

The deep fascia is incised with a Metzenbaum scissor along the medial aspect of the extensor hallucis longus tendon. This allows for lateral retraction of the extensor complex. Maintenance of the periosteal tissues is of critical importance in the closing base wedge procedure. The periosteum contains an outer fibrous layer and an inner cambrial layer that contains osteo-progenitor cells that differentiate into osteoblasts which are involved in bone formation.[5] Not only does the periosteum provide the blood supply to the healing osteotomy site, it also is a point of stability for the intact hinge . In the case of hinge fracture, the intact periosteum will limit some of the proximal migration of the distal fragment giving greater medial stability. The periosteum is maintained by orienting it in a medial-lateral v-type fashion with the apex of the V present laterally. The proximal arm of the V follows the direction of the planned osteotomy while the distal portion will allow for the fixation devices to be inserted easily. This V of periosteum may then be closed with absorbable suture after final fixation.

Osteotomy Mechanics

The key in the orientation of the osteotomy is the proximal cut of the wedge. This cut determines the final angle of the osteotomy and the length of bone the final fixation has to cross.[6] The angle of the proximal cut should be no more than 45 degrees, preferably 35-40 degrees, to the long axis of the first metatarsal (Figure 2). An angle much greater than this will create a shorter osteotomy that will be difficult to fixate with two screws. An excessively long proximal osteotomy will cause the distal arm to exit the lateral cortex in the subchondral bone or even the joint.

A more proximal axis of the osteotomy on the medial surface of the metatarsal creates a longer radius arm of rotation of the metatarsal. A longer radius arm creates greater lateral movement of the metatarsal head which leads to greater correction. Also, the more proximal the apex of the osteotomy gives a longer radius arm of rotation allowing the first metatarsal to come closer to the second metatarsal.

Axis Guide / Hinge Concept

Historically, the closing base wedge osteotomy was performed with the axis guide oriented perpendicular to the first metatarsal. The shortening and elevation of the base wedge osteotomy that was previously noted is in part attributed to this orientation of the hinge. The osteotomy is now performed with the axis oriented perpendicular to the weight bearing surface. The axis guide is driven in a dorsal to plantar orientation just distal to the first metatarsal cuneiform joint. The hinge of the osteotomy is the axis of rotation for the distal fragment. Biomechanically, an axis that is perpendicular to a plane causes all motion to occur in that plane. For example, if an axis lies completely in the sagittal plane, all motion will occur in the transverse plane. As an axis deviates from a plane, more motion will occur in that plane. If an axis guide is driven perpendicular to the first metatarsal, it deviates from both the frontal and transverse planes due

Figure 1. Note the relatively large intermetatarsal angle with a mild amount of metatarsus adductus present. The growth plate at the base of the first metatarsal appears to be closed with open growth plate presence of the phalanges.

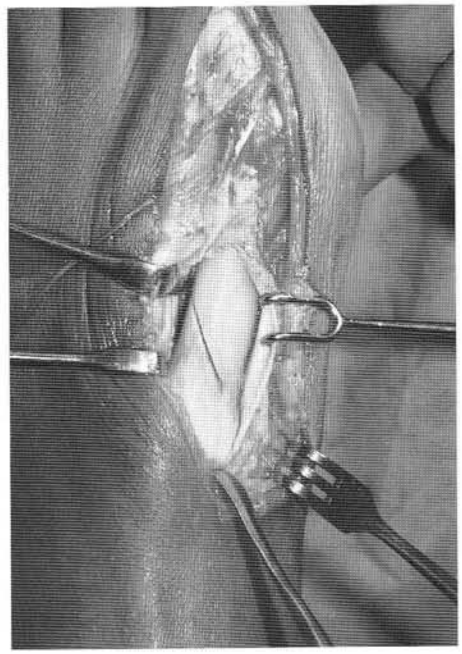

Figure 2. Note the angle of the proximal arm of the osteotomy is not greater than 45 degrees to the long axis of the bone which allows adequate length for the placement of two 4.0mm screws.

to the declination of the first metatarsal.[7] This causes increased motion in the frontal and transverse planes. It is the motion in the frontal plane which causes loss of ground contact of the first metatarsal head by elevation.[7]

The metatarsal can also be manipulated from the transverse plane by deviating the axis in the frontal plane. If the superior pole of the axis is deviated laterally so a dorsal medial hinge is created, the metatarsal will be plantarflexed when the osteotomy is closed. Conversely, if a plantar medial hinge is created by deviating the axis medially, the metatarsal will be dorsiflexed with closure. These concepts give the surgeon tools for correction structural deformities however, they should be observed carefully so as to not create deformity unintentionally.

Technique

As previously stated, the axis guide is driven from dorsal to plantar about 1 cm distal to the first metatarsal cuneiform joint. It should be located in the area where the medial and central 1/3 of the metatarsal meets. This is to ensure that the hinge will have adequate cortex medially to prevent breakage when the osteotomy is closed. In pediatric patients, it is important to identify the growth plate in the base of the first metatarsal and stay distal to it. When an open growth plate is present, a safe distance for the apex of the osteotomy is approximately 6.0mm[8] from the epiphyseal plate. This will also allow a feathering technique to be performed without the concern for violation of the growth plate or cutting through the medial cortex.

The position of the k-wire is evaluated with the foot placed in a simulated weight bearing position. This can be accomplished by loading the foot with a flat surface such as the lid to the small fragment set or the bottom of the irrigation basin. This will enable the surgeon to accurately assess if the k-wire is perpendicular to the weight bearing surface or not. Position of the k-wire in the frontal plane should also be assessed for medial or lateral deviation.

An oscillating saw is commonly used to create the osteotomy and the saw blade is kept in line with the axis guide at all times. The proximal arm of the osteotomy should be created first, as it is the key point to which the internal fixation must cross. The distal arm of the osteotomy is then created and it should intersect the proximal arm just distal to the axis guide (Figure 3). This is done so a "squaring off" effect is not created at the apex of the hinge. This "squaring off" at the apex will prevent adequate and tight closure of the hinge. A thin, often C-shaped section of bone is then removed from the ostetomy site (Figure 4). The axis guide pin is removed and the osteotomy is feathered to create a flexible but intact medial cortical hinge. The metatarsal is grasped with either double sharp bone clamps or an alligator

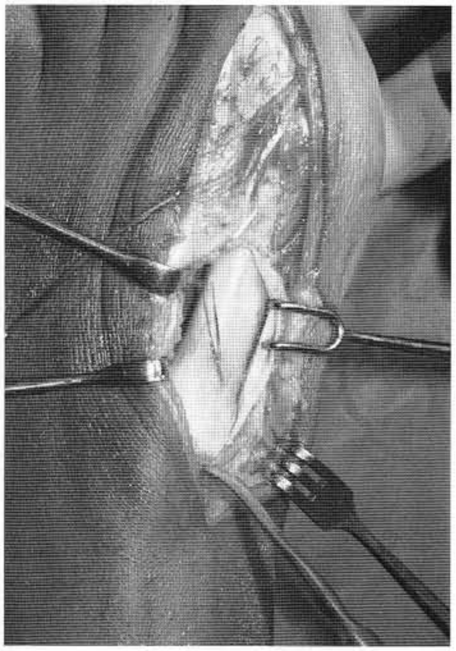

Figure 3. The distal arm is created and intersects the proximal arm distal to the apex.

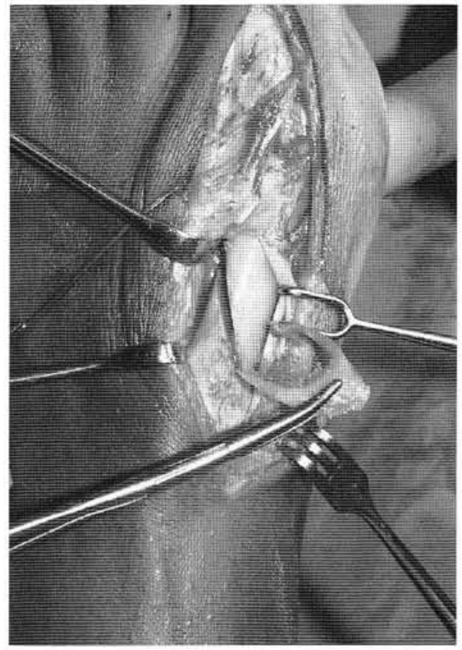

Figure 4. The thin, C-shaped wedge of bone is removed from the osteotomy site with the apex of the osteotomy maintained.

clamp and the osteotomy is closed. The clamp should not grasp the metatarsal where the planned fixation will enter the bone or the clamp will have to be removed and the reduction may be lost. If the osteotomy does not close easily, additional feathering of the hinge may be necessary. This is done by inserting the saw blade into the osteotomy, closing the hinge down against the blade, and then moving the blade dorsal to plantar toward the apex of the hinge taking care to not cut through the hinge. This maneuver thins the cortical bone of the hinge allowing it to close easily. After adequate closure has been attained, the bone clamp is applied in a position that will not impede fixation placement.

Two 4.0mm partially threaded cancellous screws are recommended for fixation. The first screw inserted is the anchor screw which runs perpendicular to the long axis of the metatarsal distal to the hinge and is the more proximal of the two screws (Figure 5). The purpose of this screw is to prevent shortening or telescoping of the osteotomy if the hinge fails.[6] The anchor screw is gently tightened to two-finger tightness to prevent distal shift of the metatarsal. The compression screw is then placed slightly inferior and distal to the anchor screw in the medial cortex and perpendicular to the osteotomy. (Figure 6). The compression screw is now maximally tightened followed by tightening of the anchor screw. After the fixation is inserted, the bone clamp is removed and stability of the osteotomy and metatarsal position are evaluated.

Closure

Upon osteotomy completion and the insertion of adequate fixation, anatomic closure at the surgical site is performed. The closure of periosteum over the osteotomy site is carried out meticulously as this is the blood supply and a point of stability for the healing bone. Careful preservation and closure of this layer may contribute to reductions in the rate of non-union at the osteotomy site. This closure is usually done with a 3-0 absorbable suture such as Dexon or Vicryl. Any distal capsular work is closed with a 2-0 absorbable suture and the deep fascial layer followed by skin is then closed.

Postoperative Management

Postoperative management of the oblique base wedge osteotomy includes a minimum of 6 weeks of non-weight bearing. This will help to prevent fracture of the medial hinge, the development of delayed or non-union and elevation of the first metatarsal. The patient is placed in a below-knee non-weight bearing cast and administered the ambulatory assistance device of choice. Commonly physical therapists will evaluate the patient for all home and weight bearing needs and make a recommendation. The knee walker with 5 inch wheels has been the device of choice for many patients.

Another concern about cast immobilization which is receiving much attention in the modern literature is the

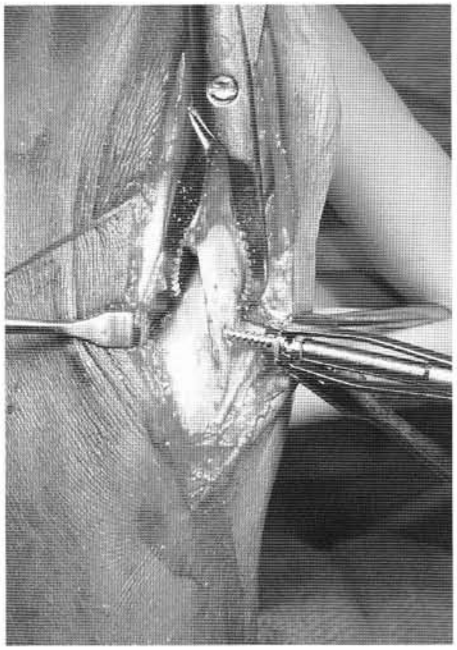

Figure 5. The osteotomy is easily closed down and the anchor screw is placed perpendicular to the long axis of the metatarsal. This screw is not tightened maximally at this point until the compression screw is placed.

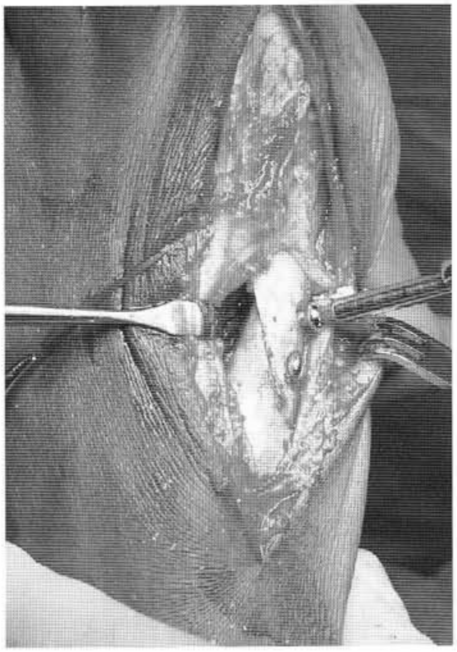

Figure 6. The compression screw is placed perpendicular to the osteotomy site and maximally tightened.

Figure 7. Two 4.0 fully threaded cancellous screws are placed in a lag fashion across the osteotomy site. The intermetatarsal angle has been adequately reduced without a relative increase in PASA.

development of DVT. The practioner must accurately and thoroughly assess the risk factors present in each patient and determine if the patient is a candidate for prophylaxis. If it is decided that the patient needs prophylaxis, the proper agent should be instituted along with regimented follow up care for anti-coagulation monitoring.

Radiographic evaluation should be done immediately postoperatively, at 3 and 6 weeks and other points in the postoperative course. If the patient experiences a falling accident or weight-bearing is suspected, radiographs should be taken and the results carefully documented. At 6 weeks postoperative, the patient is fitted with a cast walker and allowed to begin partial weight-bearing on the surgical foot. The patient should still be utilizing crutches or another weight-bearing modality and placing 25-50% of body weight on the surgical extremity. This is maintained for approximately 1 week and then the patient may progress to one crutch support if there is absence of pain or edema at the osteotomy site. The anticipated radiographic findings of uncomplicated healing of the osteotomy can be described as essentially no change from the initial postoperative view. Key radiographic points to look for that may indicate potential complications include shift of the osteotomy site, visualization or widening of the osteotomy line, fracture of the medial hinge or lucency around the fixation devices which may indicate motion at the site. Physical therapy and range of motion exercises may be used postoperatively to minimize the effects of cast disease.

CONCLUSION

The closing base wedge osteotomy is an accepted procedure utilized for the correction of severe or rigid hallux abductovalgus deformities. The mechanics of the osteotomy allow for greater correction of high inter-metatarsal angles that may not be possible with more distal procedures. Advances such as the hinge concept have allowed this procedure to evolve to a relatively easy to perform and a consistently favorable result producing method for deformity correction.

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