SURGICAL CORRECTION OF HALLUX VARUS AND METATARSUS ADDUCTUS

Gerard V. Yu, D.P.M.
D. Richard Di Napoli, D.P.M.

Numerous procedures have been advocated and described for the correction of congenital hallux varus associated and metatarsus adductus. Selection of the most appropriate procedure(s) is based upon a number of factors including the patient's age and osseous maturity, severity of the deformity, flexibility or rigidity of the deformity, and the presence or absence of other deformities such as pes valgus deformity or equinus.

Soft tissue procedures may consist of tenotomies, capsulotomies, ligament releases and tendon transfers. Tendon lengthenings and recessions may be performed as isolated procedures or in combination, as well as with osseous procedures. An example of a combination is seen with the modified Thomson procedure (MT) in conjunction with an osseous procedure when a hallux varus is present with a metatarsus adductus deformity.

Osseous procedures consisting of various metatarsal osteotomies, medial column lengthening, and lateral column shortening procedures have been proposed for older individuals. The most commonly performed osseous procedure today consists of closing abductory base wedge osteotomies of each of the metatarsals (Modified Berman-Gartland procedure) or the more recently introduced rotational base osteotomies (Lepird procedure). Current fixation techniques have contributed greatly to improved results with multiple metatarsal osteotomies. The application of rigid internal compression fixation with small cortical bone screws has greatly enhanced our surgical technique and results in this area.

The purpose of this paper is to emphasize the practical aspects of the surgical techniques and procedures commonly employed for correction of both congenital hallux varus and metatarsus adductus. A detailed review of the indications, contraindications, and litrature concerning these procedures is deliberately excluded from this paper.

Soft Tissue Procedures

Hayman, Herndon and Strong Procedure (HH&S)

The Hayman, Herndon and Strong procedure consists of mobilization of the tarsometatarsal articulations of one through five by transection of the tarsometatarsal and intermetatarsal ligaments and joint capsule.

The procedure is performed under pneumatic tourniquet through two or more, commonly three, dorsal longitudinal incisions. One incision is centered over the first metatarsal and medial cuneiform, the second between the bases of the second and third metatarsals and their respective cuneiforms, and the third between the bases of the fourth and fifth metatarsals and the cuboid bone. Utilizing blunt dissection techniques, the neurovascular structures are identified and retracted medially and laterally. The extensor digitorum brevis tendon will be encountered and should be separated along the course its septa via blunt dissection techniques. With manipulation of the metatarsal distally, one is able to identify the articulation between the metatarsal base and its adjacent cuneiform or cuboid bone.

Utilizing a #64 or #61 blade, the dorsal, interosseous, and plantar ligaments along with the joint capsule are carefully transected. The plantar lateral ligaments and the capsule are left intact to prevent excessive instability at Lisfranc's articulation as the foot is manipulated to obtain corrected alignment. Preservation of these structures as well as the insertion of the peroneus brevis tendon and the lateral capsule and ligaments of the fifth metatarsocuboid joint create a functional hinge about which successful manipulation and reduction of deformity can be achieved. Use of a hemostat as a spreader between the metatarsal bases following division of the intermetatarsal, dorsal, and medial capsular and ligamentous structures will greatly facilitate exposure of the plantar ligaments. Extreme care must be taken at all times to avoid damage to the articular surfaces.

Following release of the ligaments and joint capsule, the forefoot is manipulated into abduction and maintained in a well molded weight-bearing cast for at least three months. The cast should be changed several times during this period (approximately one to two week intervals) to inspect the surgical wounds and to remanipulate the foot into further correction if needed.

Should Lisfranc's joint become unstable during surgery

Kirschner wires (K-wires) should be employed to improve the stability and maintain alignment. Most commonly, the first metatarsocuneiform joint and the fifth metatarsocuboid joint are fixated with a single K-wire. It is generally not necessary to fixate the central three rays unless gross instabilty is present.

In releasing the first metatarsocuneiform joint particular attention must be given to avoid mistaking the epiphyseal growth plate for the metatarsocuneiform joint. This joint should be clearly identified with a Freer elevator or similar instrument before actual transection of the ligaments and capsule in this area occurs. One must also be aware of the insertion of the tibialis anterior tendon into the cuneiform at this level.

(Modified) Thomson Procedure

The Thomson procedure as originally described consists of resection of the entire abductor hallucis muscle to remove its dynamic influence from both the hallux and first metatarsal segment. Modifications of the procedure are more commonly performed today to accomplish the same effective result without the extensive dissection required to resect the entire muscle belly.

Modifications of the procedure are performed through a longitudinal medial approach over the first metatarsophalangeal joint. Emphasis is placed on identification of the mal-insertion of the abductor hallucis tendon. Normally this tendon inserts into the sesamoid apparatus and then progresses via a conjoined tendon with the flexor hallucis brevis muscle into the base of the proximal phalanx. In a pathological situation it may be found inserting as far distally as the interphalangeal joint of the hallux or more proximally into the medial aspect of the first metatarsal head. After identification the tendon may then be transected and a short segment of the tendon excised. Its insertion may also be altered if desired. A final alternative is to lengthen the tendon in "Z-plasty" formation although this is rarely done.

If persistent adduction of the hallux is seen, a medial capsulotomy of the first metatarsophalangeal joint alone or in combination with a release of the medial head of the flexor hallucis brevis may also be necessary. Additional soft tissue release and/or osteotomies are performed as needed.

Postoperative management consists of immediate weightbearing and ambulation in a Reese surgical shoe with appropriate bandaging to maintain corrective alignment unless performed in conjunction with other procedures which will dictate an alternative postoperative care plan. The hallux should be observed closely for an extended period of time to ensure that a hallux abducto valgus deformity does not ensue.

Osseous Procedures

Modified Berman-Gartland Procedure

Osteotomies of the first through fifth metatarsals are frequently necessary to obtain structural realignment of the forefoot in older children and in cases resistant to other treatment efforts. This procedure is primarily utilized in individuals with significant structural abnormality of all five metatarsal bones. A number of modifications have replaced the originally described crescentic type osteotomies of Berman and Gartland to improve the results and lessen the frequency of complications.

Multiple osteotomies are generally performed through three dorsal longitudinal incisions and under pneumatic tourniquet. Careful surgical technique should be employed during periosteal reflection to ensure anatomic closure of this layer following execution of the osteotomies. This is critical and necessary if one is to minimize the likelihood of osseous bridging between adjacent metatarsal segments postoperatively.

The most common modification of the Berman-Gartland procedure consists of transverse base wedge osteotomies of the first through fifth metatarsals with K-wire fixation. The osteotomy of the first metatarsal should be distal to the epiphyseal growth plate. Each osteotomy should be fixated with either a 0.045-inch Kirschner wire or 28 gauge stainless steel wire. An alternative technique involves the use of small scaphoid compression staples.

When K-wires are employed the direction of penetration and placement recommended is from dorsal-distal-medial to plantar-proximal-lateral. Cross K-wire fixation of the first metatarsal osteotomy is recommended if there is any question or doubt as to the stability with a single Kirschner wire. The K-wire may be left exiting the skin or may be buried within the subcutaneous tissues and removed at a later date. Stability of the osteotomies depends on the careful preservation of the medial cortical hinge for each osteotomy. When well preserved on the lesser metatarsals a single stainless steel wire loop at the lateral aspect may be sufficient fixation. Failure to fixate each osteotomy encourages postoperative complications and is highly discouraged.

With the recent advances in fixation techniques and widespread use of cortical and cancellous bone screws, further modifications of the technique have been performed employing oblique closing abductory wedge osteotomies of the first and fifth metatarsal segments. Fixation of the first and fifth metatarsal segments in this

manner provides a more stable medial and lateral pillar. The osteotomy of the three central metatarsals may be performed as either transverse or oblique wedge osteotomies.

Restoration of normal anatomic alignment of the metatarsals requires accurate wedge resections of bone from each of the affected metatarsals. Depending on the severity of deformity, wedges of varying sizes will be required with the largest ones from the medial-most metatarsals and the smallest wedges from the lateral-most metatarsals. Maintenance and preservation of the then-intact cortical hinge becomes increasingly more difficult as the size of the bone wedge increases. To ensure proper bone wedge resection and corrective alignment of each of the metatarsals, intraoperative radiographs should be obtained.

It is critical to maintain proper orientation of the medial cortical hinge with respect to the longitudinal axis of the metatarsal bone itself, as well as the transverse weight-bearing plane of the foot. In most cases, when only pure transverse abduction is desired, the medial cortical hinge should be oriented perpendicular to the plantar aspect of the foot and thus will be just short of perpendicular to the long axis of the metatarsal bone. When executed perpendicular to the metatarsal the osteotomy results in not only abduction but also a slight degree of dorsiflexion. At times this may be desirable. Failure of the surgeon to understand the biomechanical implications of axes and motion as they pertain to surgical osteotomies is likely to compromise the final outcome.

Postoperative management consists of a non weight-bearing short leg cast for a period of six to eight weeks or until a satisfactory consolidation of all of the osteotomy sites has been achieved. This should be confirmed by the use of multiple radiographs. Forces generated across the osteotomy from early weightbearing will result in fracture of one or more of the cortical hinges and metatarsus elevatus. Such a result could have devastating effects on the mechanical function of the foot in later years.

Lepird Procedure

Over the last several years we have used a new osseous procedure for correction of metatarsus adductus. This procedure allows accurate and precise correction with mantenance of the osteotomies by using small cortical and/or cancellous bone screws without the need for wedge resections of bone from each of the metatarsals.

The procedure is performed through three dorsal longitudinal incisions as described earlier under pneumatic tourniquet. Each of the five metatarsals is identified and subperiosteal dissection completed exposing the proximal one-third to one-half of the metatarsal segment. An oblique abductory wedge osteotomy is performed on the first metatarsal just distal to the epiphyseal groove plate. The osteotomy of the remaining metatarsals involves a single through and through oblique cut oriented from dorsal distal to plantar proximal.

As the osteotomy is performed a small area of cortex is temporarily preserved to prevent motion while the sequence of steps is performed for insertion of the cortical bone screw. This precludes the need for a bone forceps to immobilize the segments while the screw is being inserted. With the osteotomy incompletely transected, fixation is readily and easily accomplished with a 2.7 mm (most often used) or a 3.5 mm cortical bone screw. The screw is inserted in a perpendicular orientation to the osteotomy. It is critical that the screw is inserted in this fashion. The screw is then temporarily removed and the osteotomy is completed, sacrificing the small area of cortex initially preserved and left uncut. The screw is immediately reinserted.

Before final securing of the screw the distal fragment is rotated laterally into a corrected position. The screw is then tightened to maintain position and to achieve compression across the osteotomy interfaces. If additional or less correction is desired, the screw is loosened, the distal fragment repositioned, and the screw is resecured. Intraoperative x-rays are obtained when necessary to confirm final position and alignment of each osteotomy.

The direction, orientation, and placement of the osteotomy is critical to the success of this procedure. The osteotomy should closely parallel the ground supporting surface, that is, the plantar aspect of the foot. If the osteotomy is performed in too vertical an orientation rotation of the distal fragment will merely translate into frontal plane inversion and eversion rather than transverse plane abduction. In most cases only transverse plane correction (pure abduction) is desired. In these cases the leading edge of the saw blade will enter nearly parallel to the transverse weight-bearing plane of the foot while viewed in the frontal plane from the distal aspect of the foot where the surgeon most commonly stands during surgery. When viewed from the lateral aspect of the foot the saw blade should be nearly parallel to the plantar aspect of the foot. The osteotomy begins dorsally and distally at the junction of the central and proximal one-third of the metatarsal segment and proceeds obliquely plantarly and proximally.

Subtle manipulations of the sawblade in the frontal plane can be performed to obtain simultaneous dorsiflexion or plantarflexion as the distal fragment is rotated laterally into the desired positon of correction. This surgical biomechanical principle is clearly understood by simulating the procedure with bone models of the foot. It should not be attempted without a clear understanding of these surgical principles.

Postoperatively, patients are maintained in a short leg, non weight-bearing cast for a period of five to eight weeks. Absolutely no weightbearing should be permitted prior to six weeks. Serial radiographs are used to monitor bone healing and consolidation. In a predictable and compliant patient, the cast may be bivalved after two weeks to allow passive and active range of motion without weightbearing. Following removal of the cast, appropriate orthotic devices are employed to maintain alignment of the foot and to avoid excessive pronation and its sequelae. When necessary, second stage surgery may be performed to correct other concomitant deformities such as pes valgus or varus or valgus alignment of the rearfoot complex.

The introduction of a Lepird procedure for correction of metatarsus adductus represents significant refinements and improvements over the more traditional osseous procedures. The small cortical bone screws provide rigid internal compression fixation resulting in primary bone healing and thus greatly reduce the likelihood of osseous bridging between adjacent metatarsals.

The nature and design of the osteotomy precludes the need for wedge resections of bone which may be difficult at times. In addition it provides an increased area of surface contact between bone segments. Undercorrection and overcorrection are easily altered during surgery. An additional advantage of the osteotomy is the lack of need to preserve and maintain cortical hinges. Alterations of the osteotomy within the frontal plane permit biplanar correction to be obtained if desired. Because there is no direct communication from the external environment as with Kirschner wires there is less opportunity for postoperative infections. An earlier return to normal function can be expected based on our experience.

A number of disadvantages warrant comment. Should the planned fixation fail stabilization of the osteotomy may be extremely difficult due to its inherent through and through design. Fixation in such cases will likely require combinations of stainless steel wire and K-wires. If the screw fixation fails several weeks following the surgery it may act as a distracting force and thus result in delayed union, nonunion, or pseudoarthrosis. Finally, the long term effects of screws remaining in the young individual throughout life have yet to be documented. This remains an area of ongoing research and study.