THE MITCHELL & ROUX BUNIONECTOMIES

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Over the years, many different approaches have been published advocating a variety of osteotomies for the correction of the hallux abducto valgus deformity. Distal metaphyseal osteotomies are among the most common procedures performed today with the Austin bunionectomy and its modification being the most popular of the various distal osteotomies. In recent years, numerous modifications have been described to alter the length, sagittal plane position, and even the alignment of the articular cartilage of the first metatarsal bone. Other commonly performed procedures include the Reverdin bunionectomy and its modifications and more recently the Scarf or "Z" bunionectomy. A procedure which has become only of historical interest for all too many is the Mitchell bunionectomy.

The purpose of this paper is to reintroduce the Mitchell bunionectomy to the profession as a useful distal metaphyseal osteotomy for the correction of certain hallux abducto valgus deformities with specific clinical and radiographic findings. Emphasis will be placed on the surgical indications and pearls of the surgical technique.

HISTORICAL REVIEW

The Mitchell operation for hallux valgus deformity was first described in 1945 by Hawkins and Associates.[1] In 1952, Mygind described a similar procedure.[2] C. Leslie Mitchell subsequently published an article in 1958 describing this procedure,[3] and from this point forward, it has become known as the Mitchell bunionectomy.

Mitchell's original description of the surgical procedure included an osteotomy in the distal portion of the first metatarsal with lateral displacement and angulation of the metatarsal head. The procedure included concomitant exostectomy and capsulorrhaphy.[3] The surgical procedure was performed through a dorsomedial incision with a "Y"" shaped capsular and periosteal incision. Subperiosteal and subcapsular dissection were performed, exposing the neck and the shaft of the metatarsal. Emphasis was placed on preservation of the lateral capsular attachments to avoid damaging the blood supply to the head.

Two drill holes were made to assist in the execution of the osteotomy. The first drill hole was half an inch from the articular surface of the first metatarsal and the other one inch. The holes were placed slightly medial to the lateral cortex and drilled from dorsal to plantar in a perpendicular orientation to the shaft of the metatarsal bone. A #0 chromic gut suture was placed through the holes by means of a ligature carrier or straight needle.

A double incomplete osteotomy orientated perpendicular to the shaft of the metatarsal was then performed three-quarters of an inch from the articular surface between the two drill holes. The thickness of the bone between the two cuts depended upon the amount of shortening of the metatarsal that was necessary to relax the contracture of the lateral structures. Usually, 2.0 or 3.0 mm (1/8 inch) of bone was sufficient. The size of the lateral shelf or spur depended upon the amount of metatarsus primus varus to be

reduced by the lateral shift of the distal metaphyseal fragment. In a moderate deformity, one-sixth of the width of the shaft was left to form the lateral spur, although in more severe deformities, one-third of the shaft remained as the lateral spur. The osteotomy was completed along the more proximal cut with a thin saw blade. The metatarsal head was then shifted laterally until its lateral spur locked over the proximal shaft. Slight plantar displacement or angulation was described as being desirable. At this stage, the osteotomy was fixated by tying off the previously inserted sutures. Surprising stability to the osteotomy was reported. (Fig. 1)

Medial capsulorrhaphy was performed with the toe in slight overcorrection. A #2-0 chromic suture was commonly used for the medial capsular repair. Splints made of padded tongue depressors were applied to the toe to maintain the alignment and overcorrection as well as 5 degrees of plantarflexion. This was performed to avoid displacement or angulation of the osteotomy. The splints were worn for ten days followed by suture removal and the application of a short leg walking cast which incorporated the great toe.[4]

Since its initial description, the procedure has not changed significantly. In studies performed since 1958, the operation has been performed exactly as described by Mitchell without significant variation.[5,6] As late as 1987, the same suture material was still being used to fixate the osteotomy and, to some degree, is still used today.[7] The Mitchell osteotomy has proven itself repeatedly over time as a valuable procedure for the correction of certain hallux valgus deformities. Advancements in the techniques of osteotomy execution and fixation can further improve the predictable results of the Mitchell bunionectomy.

INDICATIONS

The primary indication for the Mitchell bunionectomy is a moderate hallux abducto valgus deformity with typical symptomatology. These may include medial eminence pain, aesthetic dissatisfaction, ill-fitting shoe gear, associated metatarsalgia, and hammer toe deformity of the second ray.[4] Mild limitation to motion of the first metatarsophalangeal joint may also be a presenting com-

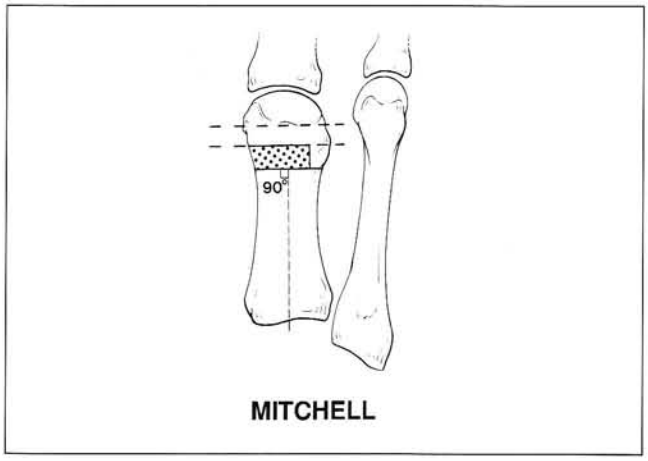

Fig. 1. Standard orientation of the Mitchell bunionectomy.

plaint, and in situations where joint preservation procedures are viable, the Mitchell bunionectomy may prove valuable.

Radiographic evaluation provides information which is most useful in determining whether the Mitchell bunionectomy is indicated over the more traditional distal metaphyseal osteotomies. The authors recommend weightbearing angle and base of gait, dorsoplantar, lateral, forefoot axial, and medial oblique views. The five basic radiographic parameters to be assessed are the hallux abductus angle (HAA), proximal articular set angle (PASA), distal articular set angle (DASA), intermetatarsal angle (IMA), and most importantly, the relative length of the first metatarsal. Other radiographic factors should include the quality of bone, degree of osteoarthritis of the joint, tibial sesamoid position, and overall width of the metatarsal head.

The authors do not follow strict guidelines in regard to the radiographic assessment, but rather adhere to the common parameters used by the profession. Good results have been consistently reported with the hallux abductus angle up to 35 degrees.[7,8] Angles greater than 40 degrees have been reported to be associated with poor results.[8,9] The average amount of reduction of the hallux abductus angle with the Mitchell osteotomy is more dependent upon the surgeon performing the operation. The reduction is not only influenced by the osteotomy itself, but appropriate muscle tendon balancing procedures about the joint. Although an "average degree" of correction has been reported in the literature, these reports are very sporadic and inconsistent.[6,7,10,11,12]

Assuming that sound surgical techniques are employed, the authors believe that the hallux abductus deformity is readily corrected to the normal range of 10-15 degrees with the Mitchell procedure as with other distal metaphyseal osteotomies.

The upper limit of the intermetatarsal angle which can be corrected by the Mitchell procedure is also controversial. Some authors have suggested that the maximum angular relationship should not exceed 15 degrees;[3,5,9] others have advocated the Mitchell procedure with intermetatarsal angles as high as 28 degrees.[4] The authors do not advocate routine use of the Mitchell procedure for intermetatarsal angles exceeding 15 degrees. In such cases, proximal metaphyseal osteotomies are more appropriate and will provide more effective structural correction.

The length of the first metatarsal is perhaps the most important criteria to be assessed. It is obvious that the Mitchell bunionectomy is a shortening osteotomy, to a much greater extent than other distal metaphyseal osteotomies such as the Reverdin or Austin type procedures. On an average, 4.9 mm of shortening from the Mitchell procedure has been reported.[7] Interestingly, Mitchell found no correlation between the amount of shortening and subsequent second metatarsalgia, although other authors have reported metatarsalgia to be a problem.[4] Reports suggest that shortening in excess of 7 mm is likely to yield poor results.[3,5] It is logical to conclude that if the first metatarsal bone is already short preoperatively, the procedure is likely to produce further undesirable shortening, which will likely result in lesser metatarsalgia.

The authors reserve the Mitchell bunionectomy for those situations in which an Austin or other similar type of distal metaphyseal osteotomy would provide similar correction and reduction of the intermetatarsal angle, but where significant shortening is desirable. (Fig. 2) This includes situations in which the first metatarsal bone is clearly longer than the second and/or third metatarsal bone. The overall goal is to shorten the first metatarsal segment providing a "more normal" metatarsal parabola without inducing problems beneath the adjacent lesser metatarsal segments. Shortening accomplished by the Mitchell procedure is more predictable than that accomplished by alterations of the apex of the Austin osteotomy (hinge axis concept) or the typical double Chevron cut. Shortening of the first metatarsal segment also creates more laxity of the periarticular soft tissue structures and may be helpful in decreasing postoperative hallux limitus, especially in those situations where a decreased range of motion was identified preoperatively.

Every attempt should be made to correlate radiographic metatarsus primus elevatus with the clinical findings. In situations where mild to moderate metatarsus primus elevatus is present and the Mitchell procedure is still felt to be the procedure of choice, the distal fragment should be displaced plantarly prior to final fixation. In other cases where metatarsus primus elevatus is not identified preoperatively, a plantar shifting of the distal fragment may also be desirable to compensate for the shortening which occurs as a result of the procedure.[13]

Finally, the orientation of the articular cartilage of the first metatarsal should be assessed by determination of the proximal articular set angle (PASA). If the surgeon desires to correct the deviation of the first metatarsal articular cartilage, a modification of the procedure is then employed and will be described later. In most cases, the authors believe that the final orientation of the cartilage should be one of 90 degrees with respect to the long axis of the second metatarsal

Fig. 2. Typical indication for a Mitchell bunionectomy including a long 1st metatarsal bone.

bone. This has been previously referred to as the tangential articular set angle (TASA). Reduction of the proximal articular set angle to 0-8 degrees is performed only in those cases in which the intermetatarsal angle will clearly be reduced to 0-8 degrees as well. If metatarsus primus adductus is allowed to persist (> 5-8 degrees) following reduction of the proximal articular set angle to 0 degrees, a congruous joint alignment will create a varus or adductus hallux position. In situations where the great toe is allowed to maintain its position parallel or in close proximity to the second digit, the first metatarsophalangeal joint is likely to be deviated on dorsoplantar x-rays. If a congruous joint is maintained, it results in a large separation between the hallux and second digit. This may be cosmetically unacceptable and cause difficulty with fitting of normal shoe gear.

In summary, the authors have found the Mitchell bunionectomy to be an ideal procedure when significant shortening of the first metatarsal segment is desirable in the correction of a mild to moderate hallux abducto valgus deformity, with or without mild limitation to range of motion.

CONTRAINDICATIONS

Contraindications of the Mitchell bunionectomy are the same as those commonly described for other distal metaphyseal osteotomies. The only significant and specific contraindication is an individual with a normal or short first metatarsal segment. The Mitchell osteotomy, like other distal metaphyseal osteotomies, may be contraindicated in the presence of significant degenerative joint disease, severe osteoporosis or cystic changes within the head, previous distal osteotomies, or an excessively large intermetatarsal or hallux abductus angle. Significant increases in the proximal articular set angle require a modification of the Mitchell procedure (i.e., Roux bunionectomy).

SURGICAL TECHNIQUE

The authors prefer a dorsomedial incisional approach. This provides the greatest overall exposure, particularly if dissection within the interspace area is to be performed. Where a complete lateral release is not required, a medial incisional approach may be preferred for cosmetic reasons. Dissection is carried down through the subcutaneous tissues and hemostasis acquired. Vital neurovascular structures are retracted.

Attention is then directed to the first interspace where the deep transverse intermetatarsal ligament is identified and transected. The conjoined tendon of the adductor hallucis is identified, released from its attachment at the base of the proximal phalanx, and dissected proximally. A 2.5 cm segment of the tendon is excised in toto, or the tendon is tagged for later transfer. The fibular sesamoidal ligament is suspended and transected. Complete release of a lateral sesamoid apparatus is confirmed. In cases of severe deformity, it may be necessary to release the lateral head of the flexor hallucis brevis tendon. When necessary, the hallux is then manipulated in a plantar and medial direction to effectively accomplish a lateral capsulotomy without the use of a surgical blade. In some cases, a lateral soft tissue release may not be necessary. The extent of the release is determined by the amount of transverse and frontal plane deformity. In rare circumstances where it is difficult to relocate the fibular sesamoid due to hypertrophy or severe adaptation, it may be necessary to excise the fibular sesamoid.

Great emphasis should be placed on avoiding extensive subcapsular or subperiosteal dissection of the lateral aspect of the metatarsal head, as this is presumed crucial in maintaining viability of the distal capital fragment.

The deep fascia, periosteum, and capsular tissue are then incised medially. The authors' preference is for an inverted "L" or "T" capsular approach. The subcapsular and subperiosteal dissection are completed, exposing the entire distal metatarsal head with exception of its lateral attachments. The diaphyseal-metaphyseal junction is identified. The sesamoid bones are then protected by use of a flexible malleable retractor. A "fail-safe" hole is then drilled from dorsal to plantar perpendicular to the long axis of the metatarsal bone. Its distance from the articular cartilage will vary, but is typically just distal to the diaphyseal-metaphyseal junction. Its distance from the lateral border of the metatarsal will depend upon the amount of lateral displacement desired. The hole is typically placed one-fourth to one-third of the width of the metatarsal head. This hole represents the medial border of the lateral shelf which is critical to the overall stability

of the osteotomy when completed. A 2.0 mm drill or similar size Kirschner wire may be used to perform this step. The drill or Kirschner wire may be removed or left in place to serve as an apical axis guide for execution of the distal osteotomy.

Utilizing an oscillating or sagittal saw, the distal osteotomy is then performed in line with the apical axis guide or drill hole. The osteotomy may be performed from dorsal to plantar or from medial to lateral. Regardless of the type of saw and direction of the osteotomy, the surgeon must ensure that underlying sesamoids are not damaged and that the osteotomy does not extend laterally beyond the fail-safe hole.

A second osteotomy is then performed proximal to and at a variable distance from the first osteotomy but oriented parallel to the distal osteotomy. The distance will depend on the amount of shortening desired. The osteotomy may be performed from dorsal to plantar or from medial to lateral and will transect the entire metatarsal bone. In some cases, the proximal cut is angled slightly proximally from a dorsal to plantar direction to allow slight plantarflexion and reorientation of the articular cartilage in the sagittal plane.

A third osteotomy is then performed perpendicular to both cuts. The fail-safe drill hole is used as a starting point. This cut will then connect the two osteotomies, creating a lateral shelf and a rectangular or trapezoidal segment of bone. This section of bone is removed. The capital fragment is then displaced or shifted laterally and proximally. If additional plantarflexion is desired, the capital fragment is shifted plantarly. If necessary, final adjustments are made to improve the fit between the proximal and distal components of the osteotomy.

The osteotomy is then fixated with two crossing 0.062-inch Kirschner wires. The first is directed from dorsal-medial-proximal to plantar-lateral-distal. The second is inserted from plantar-distal-medial to dorsal-proximal-lateral. It is critical that manual compression is maintained at the osteotomy interface as the fixation devices are inserted. (Fig. 3)

If preferred, small cortical or cancellous bone screws may be utilized. The authors on occasion have used the small Herbert bone screw as well. In some cases, only one Kirschner wire may be utilized.[4] Additional stabilization can then be achieved with small bone staples at the medial aspect of the osteotomy.

The osteotomy is then inspected and the toe manipulated to confirm the alignment and stability. Proper placement of the internal fixation devices is confirmed; the devices should not violate the joint space. The wound is irrigated with normal sterile saline. The deep fascia, capsule, and periosteum are then reapproximated. If desired, muscle tendon balancing procedures such as the adductor tendon transfer are performed. The subcutaneous layer and skin are then reapproximated with the suture material of choice.

ROUX MODIFICATION

Roux has been credited with a modification of the Mitchell procedure to correct for deviations of the articular cartilage of the first metatarsal.[15] Like the Reverdin type osteotomy, this modification is designed to correct for an abnormal proximal articular set angle identified on x-ray and confirmed intraoperatively. When performing this modification, the distal cut is aligned parallel with the articular cartilage. The second or proximal cut is performed as previously described, perpendicular to the long axis of the metatarsal bone at the diaphyseal-metaphyseal junction. The resultant

Fig. 3. Postoperative alignment and fixation for a Mitchell bunionectomy.

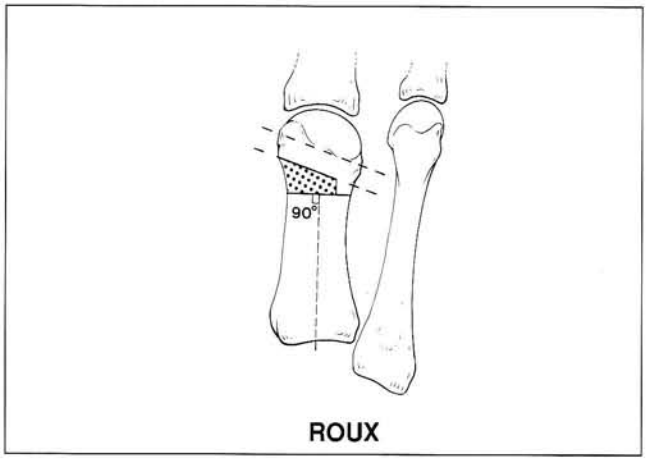

Fig. 4. Configuration of a Roux bunionectomy.

trapezoidal wedge of bone is removed, allowing for reduction of the intermetatarsal angle, shortening of the first metatarsal bone, as well as redirecting the articular cartilage of the first metatarsal. In addition, the capital fragment may also be displaced plantarly if desired. (Fig. 4) Fixation is essentially identical to that described for the Mitchell bunionectomy.

POSTOPERATIVE CARE

The authors' preference is for an initial period of non-weightbearing (2-3 weeks) followed by weightbearing in a surgical shoe (3-4 weeks). In cases where the patient will be weightbearing immediately, a modification to the surgical shoe should be made consisting of half an inch layer of cork or firm felt with a cutout of the first metatarsal area to eliminate or decrease weightbearing in this area. This decreases the likelihood of dorsal displacement of a capital fragment although this has not been a problem to date.

Serial radiographs are taken to ensure healing of the osteotomy. In addition, long term serial x-rays are taken to monitor for avascular necrosis of the distal fragment. Dorsoplantar, lateral, and medial oblique x-rays are recommended at 3-4 weeks, 6-8 weeks, and subsequent follow-up films at 3 months, 6 months, and 1 year.

When clinical and radiographic union is achieved, the patients are allowed to return to conventional shoe gear as tolerated. Physical therapy modalities to eliminate residual edema and restore range of motion are instituted. In cases where significant transverse plane deformity was present preoperatively, a bunion retaining splint is instituted for 4-6 months.

COMPLICATIONS

Complications from the Mitchell or Roux bunionectomy are similar to those of other hallux valgus procedures, especially those related to distal metaphyseal osteotomies. These include overcorrection, under-correction, recurrence of deformity, delayed union, nonunion, pseudoarthrosis, malunion, postoperative limitus, and avascular necrosis. None of these complications is unique to the Mitchell or Roux procedure. Their frequency is heavily influenced by the technique and expertise of the individual surgeon.

A main concern with either the Mitchell or Roux procedure is the exacerbation or development of lesser metatarsalgia. While this is known to occur with certain procedures with greater frequency[16] (e.g., Keller procedure or implant arthroplasty), it is not a routine complication of distal metaphyseal osteotomies unless there is loss of weightbearing function to the first metatarsal. This could be a problem with the Mitchell or Roux procedure if performed in a patient with a relatively normal length pattern of the first metatarsal. In addition, inadequate fixation may result in a malunion which may also lead to development of lesser metatarsalgia. Interestingly, while Mitchell found no correlation between the amount of shortening and metatarsalgia, other authors have noted this to be a problem in long-term follow-up analysis.[4] Shortening in excess of 7 mm has been shown to yield poor results.[3,5] It is then logical to conclude that if a first metatarsal bone is short preoperatively or of normal length, and significant shortening occurs, lesser metatarsalgia is likely to follow.

SUMMARY

The Mitchell bunionectomy is one of many distal metaphyseal osteotomies for the correction of the moderate hallux valgus deformity with or without mild hallux limitus. The procedure has proven successful in individuals with a long first metatarsal bone confirmed radiographically. The procedure has clear advantages over the Austin type of osteotomy in those situations where shortening of the first metatarsal is clearly

desired. When performed properly, a favorable outcome can be expected with minimal complication. Accurate surgical technique with appropriate fixation is most important to ensure a successful outcome. It is the authors' opinion that this procedure, although not commonly indicated, has a place in the armamentarium of the foot surgeon.

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