CHAPTER 13

THE SAGITTAL Z OSTEOTOMY FOR CORRECTION OF METATARSUS PRIMUS ELEVATUS

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Elevation of the first metatarsal can lead to significant destruction of the first metatarsophalangeal joint as well as the second metatarsophalangeal joint. The importance of maintaining or correcting the proper sagittal plane position of the first metatarsophalangeal joint should not be overlooked when performing hallux valgus surgery or when addressing deformities involving the second metatarsophalangeal joint.

Numerous methods of correcting hallux limitus have been described including cheilectomy, phalangeal osteotomies, enclavement, variations of the chevron and other distal osteotomies, tilt-up osteotomies, diaphyseal osteotomies, fusion of the first met-cuneiform joint, resection arthroplasty, and fusion of the first metatarsophalangeal joint. These corrections all have their place when dealing with this entity. There is no panacea when surgically correcting hallux limitus. The best results will be obtained when each component of the deformity is addressed.

There are many etiologic factors for hallux limitus which have been described including: flexible pes valgo planus, uncompensated varus of the forefoot or rearfoot, heredity, arthritis, abnormalities in metatarsal length, neuromuscular disorders, trauma, abnormalities of the sesamoidal apparatus, and iatrogenic causes. Roukis et al demonstrated the relationship between first ray elevation and the range of motion of the first metatarsophalangeal joint (FMTPJ). They found that an elevation of 4 mm decreased the dorsiflexion of the FMTPJ by 19%. Furthermore, an elevation of 8 mm decreased dorsiflexion by 34.7% compared to the neutral, non-elevated weight bearing ray. Regardless of the cause of the elevation of first ray, this elevation prevents the normal motion about the joint causing a jamming effect which can further accelerate the degenerative process at the FMTPJ. Camasta described the pathophysiology associated with the evolution of hallux limitus/rigidus and described the importance of the gliding motion of the sesamoidal apparatus in maintaining proper motion at the FMTPJ. The loss of the normal weight bearing parabola as a result of the elevated first ray can lead to overloading of the second metatarsophalangeal joint leading to a sub-2 syndrome. This overload may act as a causative factor in the development of instability about this joint which can lead to metatarsalgia, hammertoe formation and a predislocation syndrome.

When evaluating deformities involving the first and second metatarsophalangeal joints, it is important to assess the relationship between the weight bearing parabola of the lesser metatarsal heads in relation to the first. A thorough biomechanical evaluation can help identify deficits in the first ray's ability to maintain this relationship. A clinical evaluation can easily identify a medial column which is elevated in relation to the lesser metatarsals. The deformity may be either extrinsic or intrinsic to the first metatarsal. Iatrogenic deformities are the most common cause of an intrinsic deformity with an elevated first ray. Any previous osteotomy of the first metatarsal, which has displaced dorsally, can lead to elevation of the first ray. Radiographic evaluation will often help to determine where the deformity lies. Camasta described the normal relationship between the articular surface of the metatarsal base to the dorsal cortex of the first metatarsal as 90 degrees. If this angle is greater than 90 degrees, this generally refers to an intrinsic elevatus (the deformity is within the metatarsal). A normal angulation of 90 degrees between the base and dorsal cortex of the metatarsal is found with an extrinsic elevatus, however, there is a divergence between the dorsal cortices of the first and second metatarsals. A sesamoidal axial view may also be helpful in identifying the position of the metatarsal heads in relation to one another. Other factors which should not be overlooked include the length of the metatarsal, 2nd ray deformity, presence of arthritic processes in both the first metatarsophalangeal joint and the first metatarsal cuneiform joint, range of motion of the first ray, the amount of sagittal vs. transverse plane deformity between the first and second metatarsals, the bone stock available, and the presence of any spastic conditions which may be responsible for the elevation of the first ray.

Chang outlined a stepwise approach to the correction of hallux limitus. It is necessary to know the indications and limitations of the various procedures available for the correction of the condition. Distal osteotomies have been recommended for elevation of the

first ray < 5 mm. For elevation >5 mm, a more proximal osteotomy is recommended in order to restore the weight bearing parabola. The relative amount of transverse and sagittal plane deformity must be taken into account when selecting the procedure(s) which will be utilized.

The sagittal Z osteotomy and variations will be described. The sagittal Z osteotomy allows for correction mainly within the sagittal plane. Length issues can also be addressed by either stepping down the osteotomy or sliding the osteotomy out and bone grafting in order to restore length of a short metatarsal. A certain amount of transverse correction can be obtained by simply utilizing the concept of the axis guide so that the osteotomy runs from dorsal medial to plantar lateral. This will allow for a reduction in the transverse plane as the distal metatarsal segment is plantarflexed. The main advantage of this osteotomy is the simplicity and the ability to dial in the correction of the sagittal plane position of the head of the metatarsal in relation to the lesser metatarsals. This osteotomy is generally performed in addition to a modified McBride type of bunionectomy in order to address any contractures present within the interspace or deformity at the dorsomedial eminence. The disadvantages are the same as any other diaphyseal osteotomy. This requires strict non-weight bearing for generally six to eight weeks. This may be longer if a lengthening is performed and bone grafting is necessary. Fixation is obtained by screw fixation, generally 2.7 or 3.5 mm full thread screws.

PROCEDURE

A standard dorsomedial approach will allow for access to both the metatarsal shaft and the first metatarsophalangeal joint. The incision needs to extend to the first metatarsal cuneiform joint. Care should be taken to look for and identify the medial dorsal cutaneous nerve at the proximal incision site. The modified McBride bunionectomy is first performed. The periosteum is then incised medial to the extensor hallucis longus tendon. The periosteal tissues are then sufficiently released to allow for the osteotomy. Two 0.045 k-wires work well as axis guides if concomitant transverse plane correction is necessary. The proximal transverse osteotomy should exit medially and the distal transverse osteotomy should exit laterally. A through and through osteotomy in a Z configuration is performed. If length is required, the periosteum may need to be further reflected or transversely cut near the sites of the transverse osteotomies. The length necessary should be obtained by distraction, and then the metatarsal segments clamped while a 0.062 K-wire is placed at the site of one of the screws. The clamp may then be loosened and the distal metatarsal segment plantarflexed about the k-wire axis until the head of the first metatarsal is on the same plane as the other lesser metatarsals. The segments are then clamped again and the screws placed in standard lag fashion. The protruding portions of the metatarsal segments are removed dorsally and bone graft packed in the voids as necessary. A standard layered closure of the periosteum/capsular tissues, subcutaneous tissues, and skin are performed.

The patient should be strict non-weight bearing in either a below-knee cast or posterior splint with crutches, walker, or a wheelchair. X-rays are taken immediately postoperative and serially to assess osseous healing. When osseous healing is sufficient to allow for weight bearing (generally 6-8 weeks), the patient is allowed to progressively increase weight bearing by 25 lbs/week over a 3-4 week period in either a walking cast or CAM walker.

DISCUSSION

The sagittal Z osteotomy has been utilized in both the podiatric and orthopedic communities with good success. The main advantage it offers over plantarflexory wedge osteotomies is that of ease. Any other deformities should also be addressed. The best success will be achieved if the weight-bearing parabola is restored. In some cases significant arthritic changes are present at the first metatarsophalangeal joint which may necessitate a concomitant joint destructive procedure. This osteotomy can still be performed with a Keller arthroplasty if the parabola needs to be restored to address sub-2 symptomatology. Identification of the etiologic factor(s) responsible for the elevated first ray can also direct adjunctive procedures for a better result.

CASE REPORTS

Case 1

A 44-year-old female presented with significant pain in her left foot. She had originally undergone a Lapidus fusion at the first metatarsal cuneiform joint to correct a bunion with hypermobility of the medial column of the foot. At that time her main complaint was pain under the ball of her foot, not the bunion. She developed a painful non-union of the Lapidus which required a revisional fusion which was plated dorsally by the surgeon who did the first procedure. She was seen by me one and a half years after the second surgery, still complaining of pain

under the ball of her foot. On clinical examination she had a significantly elevated first ray approximately 1 ? cm elevated in relation to the second metatarsal head, and a spastic forefoot varus. She was taken to surgery where the plate and screws were removed. A split tibialis anterior tendon transfer was then performed to rebalance the deforming influence of the spastic tibialis anterior tendon. A sagittal Z osteotomy was then done to lengthen and bring the first ray down to the level of the other lesser metatarsals (Figures 1,2). A small amount of transverse plane correction was obtained by angulating the axis guide from dorsal-medial to plantar-lateral. At nine weeks postoperative, she was allowed to start weight bearing in a graduated fashion. She then started complaining of pain under the fourth metatarsal head and started to develop further spastic elevation of the medial aspect of the foot. Clinically it became evident that the fourth metatarsal head was plantarflexed in relation to the other metatarsal heads and this was confirmed radiographically with a sesamoid axial view (Figure 3). She was taken back to surgery where a tilt up osteotomy of the fourth metatarsal neck was done as well as a lengthening of the medial slip of the tibialis anterior in order to remove the deforming varus pull of the medial tendon slip. She is now 3 months status post the second surgery and is greater than 90% improved compared to her preoperative discomfort. She has returned to work in regular shoe gear and her only complaint is that her fourth toe doesn't move as well as the other toes.

Figure 1A. Preoperative status post a revisional Lapidus for a non-union. Note the shortening and elevation of the first metatarsal.

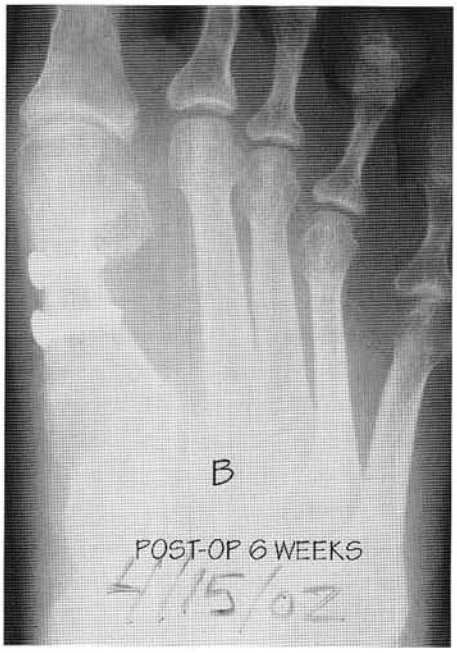

Figure 1B. 6 weeks postoperative a sagittal Z lengthening and plantarflexory osteotomy with a split tibialis anterior tendon transfer.

Figure 1C. 6 weeks postoperative the second surgery to lengthen the medial slip of the tibialis anterior tendon and do a tilt-up osteotomy of the fourth metatarsal.

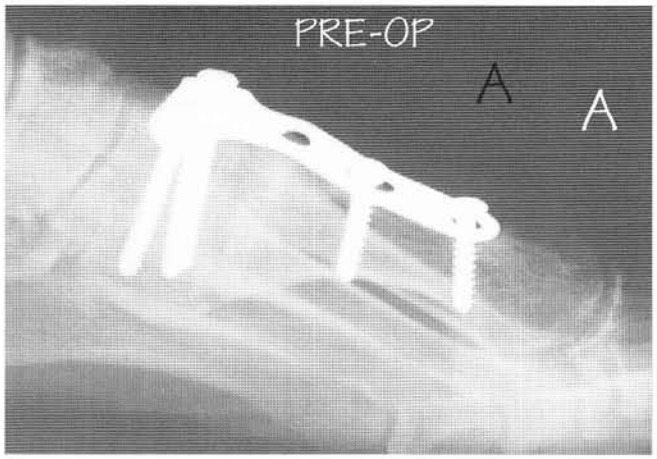

Figure 2A . Preoperative status post a revisional Lapidus for a non-union.

Figure 2B. 6 weeks postoperative a sagittal Z lengthening and plantarflexory osteotomy with a split tibialis anterior tendon transfer. Note the prominent fourth metatarsal head.

Figure 2C. 6 weeks postoperative the second surgery to lengthen the medial slip of the tibialis anterior tendon and do a tilt-up osteotomy of the fourth metatarsal. Note the sagittal plane position of all the metatarsal heads.

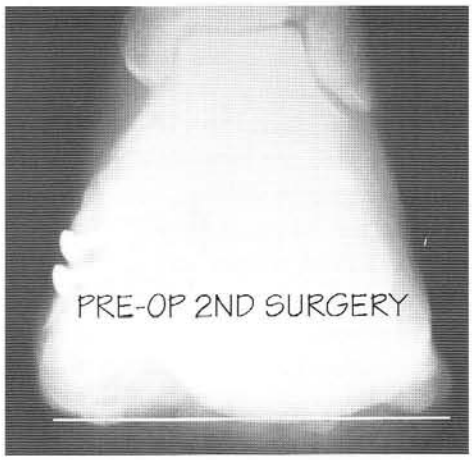

Figure 3A. Preoperative second surgery sesamoidal axial radiograph demonstrating the plantarly prominent fourth metatarsal head.

Case 2

A 33-year-old female presented with a complaint of a painful bunion in shoe gear and with physical activity. She was also experiencing some problems with balance and discomfort under the second metatarsal head. Clinical evaluation revealed a very mobile medial column which was approximately one centimeter elevated in relation to the lesser metatarsal heads. Range of motion of the FMTPJ was mainly within the sagittal plane without crepitation. There was pain with palpation under the second metatarsal head, however, there was no deformity present. Radiographs revealed an extrinsic metatarsus primus elevatus with divergence between the dorsal cortices of the first and second metatarsals (Figures 4, 5). The majority of the deformity was within the sagittal plane. The patient was taken to surgery where a modified McBride bunionectomy and sagittal Z plantarflexory osteotomy was performed to restore the weight bearing parabola. At six weeks, the patient was allowed to start weight bearing in a gradual fashion. At 10 weeks postoperative, she was allowed to return to regular shoes and activities other than jogging. Her balance has improved, the bunion pain has gone away and there is no more pain under the second metatarsal head. Her FMTPJ is still a little stiff, however, is not painful.

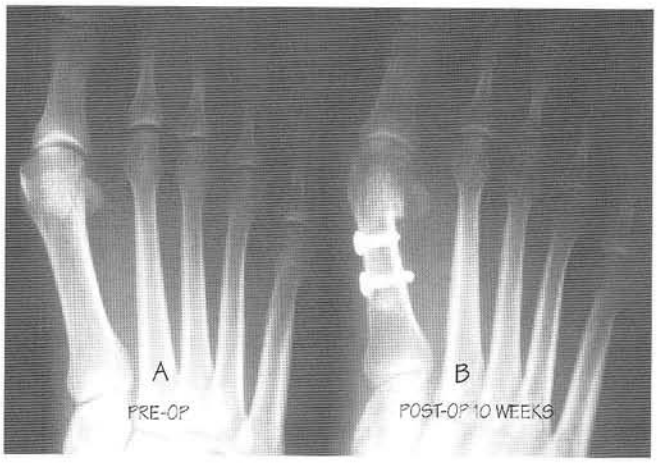

Figure 4A. Preoperative DP radiograph with a relative absence of transverse plane deformity. 10 weeks postoperative DP radiograph with osseous consolidation.

CONCLUSION

The sagittal Z osteotomy is an easy method for restoring the weight bearing parabola due to elevation of the first ray. It also allows for lengthening or shortening of the metatarsal. Although the main correction will be obtained in the sagittal plane, a significant amount of transverse correction can be achieved by utilizing the axis guide principle. Elevation of the first ray can cause pathology to both the first and the second metatarsophalangeal joints. In instances where the first ray is elevated and the joint cannot be salvaged, it is still important to restore the weight bearing parabola to prevent further overload of the second metatarsophalangeal joint. The sagittal Z can be done either alone, or in conjunction with other procedures in order to address all aspects of the deformity present.

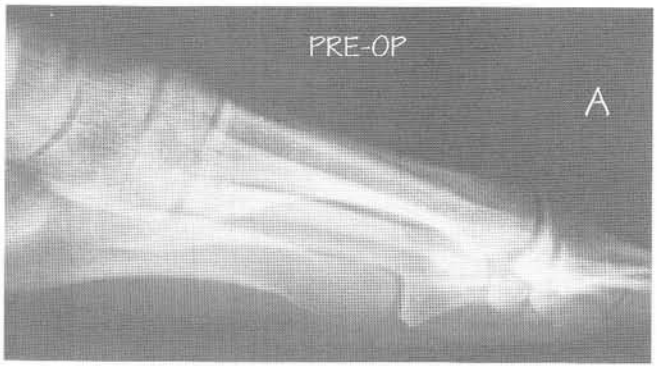

Figure 5A. Preoperative Lateral radiograph with approximately 1 cm of elevation of the first ray. Note the divergence of the dorsal cortices of the first and second metatarsals.

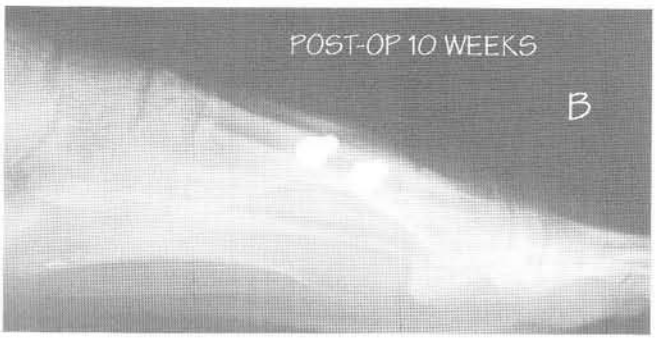

Figure 5B. Lateral radiograph at 10 weeks postoperative. Note the restoration of the plantar weight bearing parabola of the medial column.

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