RECONSTRUCTIVE SURGERY OF THE FOREFOOT

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Iatrogenic forefoot deformities include the most challenging types of deformities that we face. There is nothing mystical about surgical salvage, but it requires that the surgeon and the patient have realistic expectations as to what further surgery may accomplish. The return of normal foot function is not possible in a large majority of such patients. Our goal for this presentation is to demonstrate a logical approach to repairing the surgically deformed forefoot. Such approach will allow the surgeon to formulate a thorough solution without being overwhelmed. It is important to avoid simplistic approaches which may result in further deformity. The cases presented will by no means demonstrate every way that a certain problem may be addressed, but will represent techniques which have been tried and proven.

DIGITS

A good approach for examining the patient is to begin distally with the toes and work proximally. One should not underestimate the potential influence the digits may exert on the iatrogenically deformed forefoot. Digits may have a direct and/or an indirect deforming effect . Many times a toe will require surgery although it has not been previously disturbed. It may cause symptoms indirectly in a number of ways. Simple digital contractures may require surgery because of pressure lesions of the toes or because of retrograde pressure of the toes against the metatarsal heads. The latter situation will exacerbate any metatarsalgia already present.

Digital instability may also be created following lesser metatarsal surgery. Resection of a metatarsal head or excessive dorsiflexion following osteotomy will result in failure of the ray to load on weightbearing and result in insufficient loading of the flexor plate. This will eliminate plantar purchase of the digit leading to accomodative contracture of both the toe and the metatarsophalangeal joint. Deformities will soon develop in other areas as well. An example is seen when a second metatarsal head has been resected. The associated digital instability leaves a void which will soon be filled by the adjacent toes leading to a hallux abductus as well as deformities at the third toe and metatarsophalangeal joint (Fig. 1).

An additional example is seen where previous surgery has been performed on the digit making problems more or less difficult. Resection of the phalangeal base as an isolated procedure may similarly destroy digital stability leading to further contracture and a floppy uncontrollable toe. Recurrent deformity may be seen following arthroplasty of the proximal interphalangeal joint when the nature of the deforming force (i.e., extensor substitution) is not recognized before surgery. Restoration of digital stability generally involves either arthrodesis or syndactyly. Arthrodesis of the proximal interphalangeal joint will allow the deforming influence of the long flexor to become a source of plantarflexion at the metatarsophalangeal joint. Thus a deforming force becomes corrective and eliminates retrograde pressure against the metatarsal head. However, in cases where the metatarsal head has been resected, arthrodesis of the interphalangeal joint may not prove adequate. Insufficient loading of the flexor plate will persist and the long flexor will not have the mechanical advantage needed.

Despite cosmetic limitations, syndactyly will minimize further retraction of the toe and eliminate retrograde forces from the metatarsophalangeal joint. This is based upon the assumption that the adjacent member is satisfactorily stable. Arthrodesis of the proximal interphalangeal joint may be needed on both members to ensure the optimum circumstances. Should the floating toe be primarily due to previous surgery on the metatarsal, then attention may need to be directed to this more proximal level as well (Fig. 2).

METATARSALS

The next sequential step is to evaluate the metatarsals. One of the more common symptomatic problems seen in the surgically deformed foot is an aberrant metatarsal parabola. This may be seen as a result of metatarsal head resection, or as a result of excessive dorsiflexion, or nonunion following osteotomy. There are three primary means of dealing with the compromised metatarsal parabola: lengthening, shortening, or osteotomy of the affected metatarsal(s) and/or the adjacent bones.

Metatarsals may be lengthened in several ways. Bone grafting is one of the more common means and is perhaps best suited for the isolated metatarsal deformity or where there is a nonunion. The benefits are a close reapproximation to a functional weightbearing length while directly addressing the deformity. Obvious drawbacks are the prolonged recovery period, technical aspects of the procedure itself, and the increased potential for complications. Future procedures may be required for removal of internal fixators. Patients who have had the metatarsal head resected may require reconstruction of a joint at a later time.

Plantarflexory osteotomy of an excessively elevated metatarsal may also employ the use of a bone graft. An oblique incomplete osteotomy of the metatarsal base is effectedd with the hinge plantarly located. The metatarsal is plantar flexed to the desired level and a wedge of bone graft introduced. Internal fixation such as a screw or staple is desireable to prevent excessive compression against the bone graft. Excessive compression may cause absorption of the graft.

Another manner of lengthening the metatarsal is to create a long oblique osteotomy completely through the bone which will allow a slide lengthening to be accomplished. The use of rigid internal fixation is highly recommended as this is a very unstable osteotomy which may easily displace. This procedure may be useful when the metatarsal has been shortened and where there is good bone substance. Relative benefits and drawbacks are essentially the same as that for metatarsal grafting, although the procedure may be easier to perform. One must also determine whether the metatarsal is of sufficient width to withstand the forces of weightbearing once lengthened. Performing these procedures on multiple metatarsals increases the likelihood of a less than satisfactory result.

Shortening osteotomies may be performed to reestablish the metatarsal parabola. This has most commonly been used following severe shortening of the first ray. Grafting procedures to lengthen the first metatarsal are not indicated in every patient. One may attempt to restablish a normal parabola by shortening the lesser metatarsals while preserving the joint integrity. Bone may be removed in a variety of ways, either through chevron, cylindrical, or step-down resections.

The necessary amount can be predetermined and then reproduced intraoperatively. Advantages of this approach are the ease of execution and shorter recovery period as opposed to grafting. Disadvantages are the variables of accurately restoring multiple metatarsals to an appropriate length and transverse plane level, as well as shortening of the foot (Fig. 3).

A

B

Fig. 1. A. and B. Subsequent to base resection of the proximal phalanx of the second toe an acute loss of digital stability developed. The floating toe left a void which was filled by an abducted hallux and an adducted third toe.

Other osteotomy techniques may be employed. A previously elevated metatarsal head may be restored to a more physiologic position by a subsequent plantarflexory osteotomy. But it is also possible to rectify an aberrant metatarsal parabola by dorsiflexing adjacent members. While technically easier to perform, this approach is not without problems. Except for the opening wedge osteotomy discussed above it is rare that an osteotomy does not result in some degree of shortening. Consequently, the plantarflexory osteotomy may result in additional shortening to the metatarsal, perhaps nullifying any beneficial effects. Either dorsiflexory of plantarflexory osteotomies may result in a rather high rate of recurrence or transfer, especially if an adjacent metatarsal head has been resected. Such may end with the surgeon chasing the lesion from one area to another, and at times leaving the patient no better off than prior to surgery.

One of the more reliable procedures which may be employed by the surgeon is the pan metatarsal head resection. This is best suited for the patient with multiple metatarsals involved, especially where previous metatarsal head resection has been performed. One prerequisite is that the metatarsal shafts still be on their normal planes. Generally speaking, metatarsal head resection is an all or none situation. Either all of the heads are resected or none at all. The procedure is easy to perform and generally results in a satisfactory resolution of forefoot complaints. Requisite to success of the procedure is preplanning of the amount of bone to be resected. Generally, the length pattern following surgery should be from longest to shortest 2-1-3-4-5. Because of its angle of declination the second must remain slightly longer than the first in order to bear any weight at all.

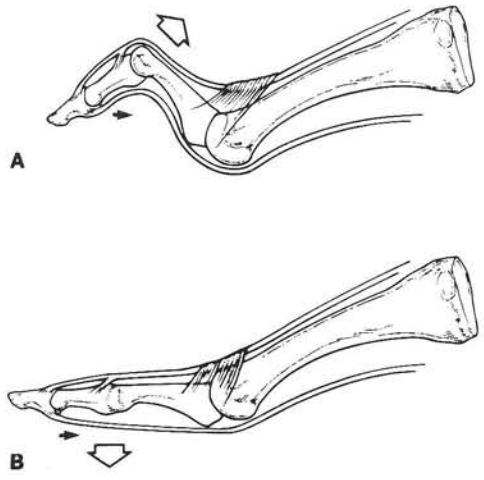

Fig. 2. A. In the contracted digit the long flexor acts to buckle the proximal interphalangeal joint and create plantar retrograde force against the metatarsal head.

B. Arthrodesis provides the rigid arm necessary for the long flexor to plantarflex the entire digit and relieve abnormal force against the metatarsal head.

The use of Kirschner-wires (K-wires) with or without digital procedures will maintain alignment of the metatarsophalangeal joint and allow for fibrotic tissue to fill the metatarsophalangeal space. This will assist in preventing later deviation of the toes and add to overall stability. Obvious drawbacks are the shortening associated with the procedure and the apropulsive foot which will result. However, it does provide a reliable means by which symptoms may be alleviated.

IMPLANTS

Implants have a limited use in surgical salvage of the forefoot. All deforming stresses must be eliminated from the joint or else the implant is doomed to failure. In addition implants are not designed to replace the weight-bearing function of a metatarsal. Simply using an implant in a patient with a metatarsal head resection may restore anatomical length to the ray, but not functional length. The digit may temporarily purchase the ground, but will soon retract dorsally as there is insufficient loading of the flexor plate. Metatarsalgia will remain a problem as the functional weight-bearing length of the forefoot has been unaltered.

Digital implants can restore limited function to the toes in carefully selected circumstances. Arthrodesis more effectively restores function about the joint. Digital implants may be appropriate where they may assist in restoring length and where bone stock is adequate to receive the stems of the implant.

Fig. 3. Severe shortening of the first metatarsal following osteotomy. Lengthening of the first metatarsal would be difficult and result in extreme tension being placed on the first metatarsophalangeal joint. This would more than likely result in a severe hallux limitus. Shortening of the lesser metatarsals either by osteotomy or resection may be more appropriate.

Implants may be used in the forefoot as spacers once the deforming influences about the joint have been successfully eliminated. In this sense they may assist in maintaining length and possibly retard further contracture.

NERVE ENTRAPMENT

Postoperative nerve entrapments are being seen more frequently at this institution. The characteristic sharp lancinating pain will be only one of many complaints. As the patient guards and attempts to protect the painful part a variety of other legitimate symptoms will develop. The key for the clinician is to avoid becoming entangled in the multitude of problems, and to first address the neuropathy. This is assuming that the neuropathy is the only iatrogenic condition. Should other iatrogenic problems be present then a more comprehensive approach may be in order.

SCAR

Regardless of the skill of the original surgeon scar tissue will have to be dealt with in the revisional procedure. If possible a good approach is to start at a level of previously undisturbed tissue to determine the normal tissue planes. One may then work into the other levels and maintain as much of the anatomic plane as possible. This is more difficult if the surgeon does not start from a known level of undistorted tissue. Scar tissue will typically bleed easier and demonstrate more capillary fragility.

The previous surgical scar may require revision either due to hypertrophy or contracture. A linear incision crossing the metatarsophalangeal joint upon normal wound contracture may pull the associated digit dorsally. In order to restore the normal plantar position of the toe the previous scar may need to be released utilizing a V-Y or Z-plasty technique. This may be avoided initially by placing a small amount of curve into the incision as one traverses the metatarsophalangeal joint. Normal wound contracture will then tend to straighten the incision without the associated deformity at the metatarsophalangeal joint since slack has been created in the line of contracture.

CONCLUSION

Although a challenging problem, the patient suffering from iatrogenic forefoot deformities may obtain relief through further surgical intervention. With careful planning and an organized approach the clinician may develop a procedure(s) which will be successful. The technique will vary from patient to patient depending upon individual circumstances.