Evolution of the Triple Arthrodesis During the Last 100 Years:

After Von Lesser had published the procedure of an ankle arthrodesis in 1879 and Edwad Alber in 1882 introduced the idea of operative fusion of joints which he called arthrodesis, the fusion of the subtalar joint was considered a large and complicated operation. It was rarely carried out. However, foot deformities caused by poliomyelitis and other neurologic diseases, particularly cavovarus deformity of the feet led to ever increasing interest in corrective surgery.

Because of the difficulties in exposing the subtalar joint and the Chopart joint, Erich Lexer in 1907 used an autologous tibia graft to cross the joint without opening it. A somewhat similar attempt was carried out by Peter Bade in 1908 who used ivory plugs with the same aim. The immobilization of the joint was perfect, however, only for short periods of time since the bone graft as well as the ivory plug were resorbed and the deformity which seemed to have been corrected recurred. To avoid this Paul Frangenheim in 1909 used metallic rods.

Forty years following the publication of Von Lesser’s procedure, Naughton Dunn in 1919 developed surgical methods which involved resection of the subtalar joint and of the head of the talus and part of the cuboid leading to a triple arthrodesis. Since the access to the subtalar joint and the Chopart joints was still considered to be difficult, Hoke in 1921 decided to resect the head of the talus temporarily to ease the access to these joints for the resection of the cartilage. Later on, he temporarily resected the talus for better access to the triple complex. In 1923, Ryerson introduced the term triple arthrodesis and standardized the correction of the deformity through the subtalar joint with the addition of talonaviclar as well as the calcaneocuboid fusion.

In an attempt to correct severe cavovarus deformities Lambrinudi in 1927 described a new method: an extensive resection of the subtalar joint which included the inferior part of the head and neck of the talus relatively lengthened the Achilles tendon and allowed correction of varus, cavus and equines through the Chopart joint. This idea was improved upon in the operations of Robert Siffert and Otto Boehne.

To maintain the correction of the deformity during the healing period, plaster of Paris was the original means of fixation. Internal fixation started with silver wires which were introduced by Edward Albert. Metalics staples and external fixation devices were used to appose and compress the denuded bone surfaces and with the development of modern technology screws and plates came into their own.
Triple Arthrodesis Techniques and Indications: Now: 2009

Presenting:

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Triple arthrodesis, and its variants, are useful operations for correction of deformity and alleviation of pain from arthritis. A triple arthrodesis typically involves the talo-calcaneal, talo-navicular and calcaneo-cuboid joints. However, reports have suggested that even a well-done triple does not lead to good patient outcome. It is unclear if this lack of patient satisfaction is the result of older techniques or from the restriction of motion. Newer techniques lead to better correction of deformity with maintenance or re-establishment of more normal alignment. This functional reconstruction helps prevent increased stresses and subsequent breakdown on adjacent joints, which may in fact be one of the main reasons for lack of satisfaction with the older triple techniques. Older techniques made use of large wedge bony resections to achieve fusion. The presence of fusion was thought of as a “successful” surgery when in fact it led to further deformity. This then led to further stresses on adjacent joints and further arthritis sometimes even requiring adjacent joint fusion with further loss of extremity motion and function. Often, for example, the presence of a painful rigid flatfoot deformity in an adolescent, with subsequent diagnosis of coalition, was treated with in situ triple arthrodesis. Unfortunately, this led to ankle and midfoot breakdown by the time the patient reached their mid twenties.

What changed? The knowledge gained from advances in trauma treatment and the related advances in internal fixation allowed orthopedic surgeons to apply these principles to foot & ankle functional reconstruction. Specifically, mechanical alignment was achieved so that when fixation was used, the joints and structural elements of the foot were made proper. Biological advances also played a part. Proper joint preparation instead of big wedge resections allowed column length to be maintained or reestablished. Fixation then held these newly aligned elements. Joint surfaces are prepared to maintain the subchondral bone, which further allows maintenance of alignment and length. The subchondral bone is properly prepared by removing the articular surface, drilling the subchondral bone to allow access to the joint surface by marrow elements and the use of bone graft or newer biological substitutes. Shear-strain relief grafting hastens peripheral fusion. This rapid peripheral “spot weld” then allows the further fusion to progress by eliminating shear-strain across the joint. Shear stresses lead to fibrous tissue and non-union.

Internal fixation, whether plates or screws or other newer devices, hold the bones in alignment and where desired, add compression across the joint to be fused. But, in certain areas, compression may encourage recurrence of the deformity and is to be avoided. For example, if an advanced flatfoot (PPAV) is corrected, the lateral column and the calcaneo-cuboid joint are lengthened. Compression then across this joint in a standard “triple” is counterproductive. The CC joint may be addressed with a stabilization screw without compression or by non-compression plating. The gap, if significant, might be grafted with structural graft. Sometimes, the CC joint is left unfused. This does not affect results as the CC joint is an expansion joint anyway.

Newer thoughts on “triple” would extend the fusion down the medial column, to the naviculo-cuneiform or even the TMT joints. The intertarsal joints may also be involved. This stabilization of the medial column protects or recreates the arch and prevents later breakdown through these joints, which can occur after a more typical triple.

Associated conditions such as tight Achilles/heel cord complex, which leads to equinus contracture, must be addressed at the time of surgery. Equinus contracture may prevent proper reduction of the hindfoot, which prevents realignment of the foot. It must be done before correction and fixation can be correctly accomplished. Also, release prevents undue stresses on the midfoot, which may result in later breakdown.

Technical tips and tricks will be further reviewed and cases examples will be discussed.