

REVISIONAL SUBTALAR JOINT FUSIONS: WHAT YOU SHOULD KNOW

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INTRODUCTION

An isolated subtalar joint arthrodesis has proven over the years to be a successful procedure in the management of numerous hindfoot problems. Outside of an isolated fusion, a successful subtalar joint arthrodesis has been an integral component of a triple arthrodesis in hindfoot pathology. Still, with any procedure, complications arise including nonunions. Authors have reported high rates of patient satisfaction, low rates of complications, and low rates of nonunion (1-6). Rates of union range from 86-100% for primary isolated subtalar joint fusions (2-4, 7-14). Even with encouraging union rates, complications arise and a revisional subtalar joint arthrodesis may be warranted. The rate of union has shown to be diminished following failure of previous subtalar arthrodesis (9). The focus of this article will be the revisional procedure and challenges of a subsequent osseous union.

As with any revisional surgery, challenges with respect to anatomy, fixation, bone stock, and function are common. The increase in scar tissue or fibrosis limits function and ease of surgical positioning. Fibrotic tissue also tends to be less vascular in nature, rendering an increase in wound complications. Anatomic dissection and preservation of structures outside of arthrodesis are key. This remains important in minimizing adhesions. Bone morphology status post fixation or previous surgery can also be complicated. Previous hardware forces a surgeon to alter further placement of fixation. Likewise, areas of bone deficit exist, forcing one to use a variety of fixation techniques and or bone graft. Features of revisional fusions are unique.

INDICATIONS FOR REVISION

Subtalar arthrodesis is often performed when the joint is arthritic or destroyed. It is also performed to stabilize the rearfoot in progressive pathology. There are numerous etiologies for joint destruction of the lower extremity including trauma, congenital deformities, pathological biomechanics, Charcot neuroarthropathy, infection, and inflammatory arthritides. With each broad category

fixation may change while the basis behind arthrodesis remains the same. One fuses the joint to eliminate pain and or reduce deformity.

The indications for revisional arthrodesis vary as compared to primary fusion. A primary fusion is one centered upon a painful arthritic joint or the need to create a rigid structure. Now, the joint can be painful and arthritic for a spectrum of reasons. A revisional fusion, on the other hand, is performed to manage a failed primary fusion or fix a greater deformity.

Indications for revisional subtalar fusions include traumatic arthritis or trauma, malalignment, nonunions, progressive Charcot neuroarthropathy, subsequent infection, and inflammatory arthritides. Often, there are greater systemic causes that lead to failed primary fusions and need for revision. Systemic illnesses and co-morbidities play a role in the demise of bone healing. Likewise, controllable factors such as smoking, obesity, and malnutrition impede osseous unions. The need for revision stems from malaligned successful unions, as well. For example, a varus or excessively valgus hindfoot may warrant revision of the primary arthrodesis site. It is the malaligned fused joint which causes pain elsewhere. Obstacles can arise in any revisional surgery, yet well-planned surgery assists with success.

TRAUMA

Traumatic injuries of the subtalar joint are generally secondary to calcaneal fractures or talus fractures. Joint incongruity following trauma, whether neglected or reconstructed, expedites arthritis of the talocalcaneal joint. In these cases, incongruent joint motion is eliminated via arthrodesis to reduce pain. Quite often, joint depression and bone loss are present with intraarticular calcaneal fractures.

The most common indication for subtalar arthrodesis is disruption of the intraarticular surface of the calcaneus by fracture, subsequent depression of the bone, loss of height, secondary malalignment of the talus through the talonavicular joint, and development of a dorsiflexion deformity in the ankle (15). A Saunders IV or highly comminuted calcaneal fractures may warrant a primary



Figure 1. Saunders IV calcaneal fracture: significant comminution makes anatomic reduction challenging. Primary or future arthrodesis is an option.



Figure 2. Medial dislocation of talus.

arthrodesis as anatomic reduction is difficult. (Figure 1) Likewise with lateral wall blow out, intraarticular comminution and bone loss, graft may be used in the primary fusion. With the loss of bone, and significant destruction a nonunion may occur. This creates a scenario for revisional surgery. Also, calcaneal fractures are associated with wound complications and subsequent infection, which may force one to remove hardware and perform a revisional subtalar fusion. External fixation, bone block distraction, bone graft application, and new orientation of hardware may be implemented.

Talus fractures also change the normal joint contour. A greater problem is avascular necrosis of the talus with subsequent collapse. Avascular necrosis is a surgical challenge. Precarious blood supply and collapse can lead to degenerative changes and disability of the ankle and subtalar joints. Following talar fractures, the risk of subtalar osteoarthritis has been shown to be 53.3% while avascular necrosis is 16.6% (16). Hence, the need for primary and subsequent revisional subtalar fusion is possible (Figure 2).

NONUNIONS

The most common complication associated with arthrodesis is nonunion or fibrous union (17). As for isolated subtalar joint fusions, the nonunion rates range from 0-16.3% (2, 3, 7, 9, 18-22). Even with advances in fixation and surgical technique, nonunions do occur. Now research is focusing on

the methods of joint preparation to assist with improving union rates. The joint curettage technique with manual instrumentation was recently studied (17). This technique was found to leave a residual histologic barrier that may inhibit or predispose the fusion site to forming a fibrous or nonunion (31). Further research shall be conducted to evaluate and compare joint preparation techniques. At the present time, the author is in favor of denuding all cartilage down to the subchondral plate, scaling to expose bleeding bone and attempting to maintain joint contour.

Revisional arthrodesis procedures performed following a nonunion present some challenges. Surgery may involve autograft or graft products. Nonunions, following hardware removal may entail new orientation of hardware or different hardware selection. In general, internal fixation or external fixation can be appropriate. A primary fusion that provided fixation directed from the posterior calcaneus to anterior talus may now benefit from redirection of hardware with use of bone graft.

Patient selection is important in this case. A nonunion secondary to Charcot neuroarthropathy may now require an external fixator frame while further patients may not be capable of accepting various products due to religious or cultural background. Nonunions are also associated with detrimental factors such as smoking and diabetes, which are on the rise. All in all, revisional surgery requires a well thought-out plan of action with alternative ideas.

MALALIGNMENT AND DEFORMITY

A successful union can be maligned rendering the need for revisional surgery. Often it is not the successful union that is painful but it is the anatomic site where load is transferred that become painful. A subtalar fusion with varus or excessive valgus of the heel can cause pain and deformity elsewhere. In these situations, revision of the subtalar arthrodesis is warranted. Adjunctive procedures are common including arthrodesis of multiple joints.

Neglected congenital deformities, recurrence of deformities, or progressive deformities may render patients subject to subtalar fusions with further need for revision. Congenital deformities, which have been operated on before, may present with an abundance of scar tissue or retracting fibrosis such as clubfoot. Often the deformity if under corrected presents with degenerative joint changes. Further deformities such as talocalcaneal coalitions, adult acquired flatfoot, posterior tibial tendon dysfunction and various neuromuscular diseases also benefit from subtalar fusions.

CHARCOT, INFECTION, AND INFLAMMATORY ARTHRITIS

The biology behind Charcot neuroarthropathy places patients at great risk of nonunions and progressive breakdowns of previous fusion sites. The pathogenesis of Charcot continues to be studied. Recently, Pitocco et al, determined an association between genetic regulation of bone in Charcot neuroarthropathy (23) (Figure 3).

Hence, breakdown of previous fusion sites and need for revisions occur. Often internal fixation, if present, is removed and external fixation is utilized. External fixation may also be employed during the primary arthrodesis. Osseous deformity can be corrected over time with external fixation or osteotomies in conjunction with external fixation are implemented. Infection or inflammatory arthritis can also lead to removal of hardware and need for alternative correction. Locking technology can provide assistance in osteoporotic bone.



Figure 3. Charcot neuroarthropathy with deformity of subtalar joint.

SURGICAL APPROACH

The surgeon's surgical approach and fixation selection can vary. The deformity at hand, previous incisions or trauma, adjunctive procedures, and fixation selection can guide ones approach in the operating room. The operative technique should be tailored to each patient's particular pathological findings (9).

Often a lateral skin incision is utilized starting at the tip of the lateral malleolus and coursing distally to the calcaneocuboid joint or the fourth metatarsal. The incision is located superior to the peroneal tendons and sural nerve. The incision is carried out deeply to the level of the deep fascial layer. In a primary subtalar arthrodesis, a communicating branch between both sural nerve and intermediate dorsal cutaneous nerve may exist. Often the nerve is sacrificed for exposure.

The extensor digitorum brevis muscle is visualized below the deep fascia. An inverted L- type incision is fashioned in the deep fascia. The deep fascia and extensor digitorum muscle belly are retracted as one structure. The sinus tarsi is evacuated and both middle and posterior facets are usually visible. Further incision of the calcaneofibular ligament and lateral talocalcaneal ligament can aid in visualization of the posterior facet.

In revisional surgery there may be considerable fibrosis and rigidity. Following removal of previous hardware, the osseous union or failed union must be reconstructed and repositioned into good alignment. Often revision is secondary to malalignment so resection or wedging, with addition of bone, may be required for correction of deformity.

Joint preparation or revisional arthrodesis site preparation is imperative. Good bleeding bone surfaces should be obtained. Even in primary subtalar arthrodesis, types of fixation and fixation orientation have been debated. Typically, screw fixation includes both posterior to anterior and anterior to posterior approaches (3, 24). Specifically, screws are oriented from the posterior calcaneus into the talar body or screws are oriented from the talar neck toward the calcaneal body (Figures 4, 5). Common sizes include 6.5 mm or 7.3 mm screws. Cannulated or noncannulated systems are appropriate. External fixation and IM nails may be used, as well, especially in revisional cases with greater deformity.

Pathology often assists with fixation selection. Breakdown of the subtalar joint in Charcot neuroarthropathy may benefit from pristine joint preparation, and use of external fixation whereas late complications of neglected displaced intraarticular calcaneal fractures may benefit from posterior bone block distraction arthrodesis. Numerous



Figure 4. Subtalar joint arthrodesis with screws oriented posterior to anterior. Multiple screws may be utilized.

fixation options exist and there is not one correct method of fixation. Position should always be evaluated intraoperatively via C-Arm or fluoroscopy.

The postoperative course often includes a Jones compression dressing for the first 10 days to 2 weeks to minimize edema. The patient is generally nonweight bearing in a cast for 8-12 weeks. Surgeons should monitor clinical pain and radiographic osseous consolidation. The patient is then transferred into an equalizer boot with protective weightbearing for 2 weeks. Regular supportive shoegear follows thereafter. The rate-limiting factor tends to be edema. The foot can easily be swollen for up to 1 year. Often patients will have stable arthrodesis sites yet are too edematous to transfer into their shoegear. An edematous foot with lack of consolidation per radiograph is concerning. Computed tomography scans can assist with evaluation of the arthrodesis site (Figure 6).

CHALLENGES OF REVISIONAL SURGERY

Revisional surgery can be more challenging than the primary procedure for many reasons. A surgeon must take into account the variation in anatomy. Hence there may be a change in vascularity, bone composition, soft tissue, and skin integrity. One can encounter fibrosis of soft tissue and bone loss. Also with change in skin integrity, there is a greater risk for wound complications. Preservation of surrounding tissue planes and vascular structures is important.

Each patient should be evaluated on an individual basis. Incisions are guided by deformity to be corrected and placement of previous incisions. Fixation strategy is also



Figure 5. Calcaneal axial view revealing heel in neither varus nor excessive varus. Heel should be positioned in a rectus manner.



Figure 6. Radiographic monitoring for subtalar joint consolidation

specific to the pathology. Quite often biology behind the failed arthrodesis dictates use of conventional internal fixation, external fixation, or IM nails. Also, preoperatively bone loss and need for osseous correction should be evaluated. Tricortical block bone graft can be harvested from the iliac crest. Surgeons must determine the level of deformity and the need for osteotomies or wedging.

Revisional surgery can be successful. One must have a well thought out surgical plan with alternatives. In addition, respect for the anatomy and pathology is key. A great deal can be learned from the complications of any procedure. To date, pristine joint preparation and fixation is essential. More research comparing histological analysis of joint preparation techniques would be beneficial.

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