

# SUBTALAR JOINT FUSION

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### INTRODUCTION

Reconstruction and arthrodesis play a dominant role in the surgical treatment of various disorders of the hindfoot. Subtalar joint (STJ) arthrodesis has accomplished favorable results in the treatment of various disorders such as primary and secondary osteoarthritis, rheumatoid arthritis, neuromuscular disorders, congenital deformity, and adult hindfoot pathology. Likewise, STJ fusion provides relief for talocalcaneal coalition for the ~3% of the population with this condition. Results of STJ arthrodesis procedures are documented as good to excellent. When performing a hindfoot arthrodesis, there are important goals one must attain to insure a successful outcome, specifically elimination of pain from arthritic and or unstable joints, fusing the foot in a plantigrade position to offer a stable platform for weightbearing, and cessation of a progressive deformity to prevent worsening disability.

The STJ allows translation of transverse rotation occurring in the tibia onto the foot. Pathologic stiffening of the joint may not only cause STJ pain, but may also relay discomfort to adjacent joints of the foot and ankle. Persistent ankle pain secondary to a sprain may actually be secondary to talocalcaneal joint pathology. Another clinical presentation of a congenitally stiffened talocalcaneal joint occurring is a ball-and-socket type of ankle joint seen with clubfoot and certain forms of arthrogryposis. More commonly, patients present with difficulty walking on uneven surfaces due to the loss of the normal accommodating motion of an arthritic STJ.

Arthrodesis of the STJ has proven to be a reliable salvage procedure to stabilize a deformed or degenerative hindfoot. A review of historic indications and technical applications of the STJ arthrodesis are discussed here. Reported complications as well as preoperative factors associated with successful versus unsuccessful surgical outcomes are examined. Modifications of this procedure are also analyzed such as internal fixation approach and open versus arthroscopic management of the talocalcaneal joint.

### HISTORIC REVIEW OF INDICATIONS

Among the indications for fusion of the STJ, primary arthrodesis for fracture of the calcaneus has been studied extensively. In 1942, Bankart wrote “The results of treatment of crush fractures of the os calcis are rotten...It would seem that the best result that can be expected from a fracture of the os calcis involving the sub-astragaloid joint is a completely stiff but painless foot of a good shape, and with free movement of the ankle joint.” In 1943, Gallie provided a technical guide for a prone STJ fusion through a posterolateral approach with the addition of autogenous bone graft. Gallie lists pain with walking and standing, acute pain with heel strike on uneven surfaces, limitations in ordinary joint movement, and definite roentgenographic evidence of irregular joint surfaces as indications for primary STJ fusion. He conceded that correction of deformity in regard to the talus relative to the os calcis was not attempted, and if the primary deformity is of a varus heel, the procedure should not be performed. Reporting on 50 operations the author states: “...a simple and safe procedure, requiring not more than thirty minutes of anesthesia, and one from which a quick arthrodesis and a complete relief from pain can be confidently expected.” Dick in 1953 reported that there were 3 possibilities of STJ damage post calcaneal fracture. He offers that the fracture may only be a crack without distortion of the joint surface, the joint damage could be so severe that the joint fuses spontaneously, or thirdly the damage to the joint may be such that traumatic arthritis ensues. The author states that delay in primary STJ fusion of the last group is undesirable because of unnecessary prolonged disability, patient suffering, and possible development of a “pain pattern” in the cerebral cortex.

### HISTORIC REVIEW OF TECHNIQUE

It is said that the earliest arthrodeses occurred around 1878 for the correction of paralytic foot deformities. In 1879, Albert of Vienna performed an ankle joint fusion

for stabilization of a paralyzed foot while Nieny (1905) operated on the midtarsal joint to produce a fusion. About this time, Gwilym G. Davis describes accomplishing ankylosis by roughening adjacent articular joint surfaces. Grice (1952) examines the progressive valgus deformity prevalent among children at the time. Poliomyelitis is described as a pathologic process leading to paralysis of the anterior and posterior tibial muscles. Subsequently the heel is displaced into eversion by the unopposed action of the peroneal muscles. Thus, the talar head loses its normal support and is allowed to fall into equinus. Grice writes "Unlike the pronated foot with good musculature, the paralytic valgus foot usually becomes progressively worse. It is difficult to prevent the development of this deformity with the use of supportive apparatus such as arch supports, braces, or casts." If the deformity persisted for a significant period, secondary adaptive changes occurred, requiring surgical restoration.

The surgical reformation of the deformity is governed by 4 objectives described by the author. The calcaneus must be maintained in relation to, and replaced beneath the talar body. Tendon transplantation should be performed to restore muscle balance. The deforming influence of the peroneal muscles should be negated and active inversion and dorsiflexion should be restored. Also the procedure is indicated in young children, thus it should not interfere with the subsequent growth of the foot. To realign the calcaneus relative to the talus, the technique first described in 1945 by Green of using bone grafts placed in the sinus tarsi to obtain an extra-articular STJ arthrodesis was utilized. Placing a screw distally across the talocalcaneal joint alleviated difficulty maintaining position. When the valgus deformity was mild to moderate, transferring one of the peroneal muscles to the base of the second metatarsal aided dorsiflexion. When the deformity was severe, the longus tendon would be transferred beneath the head of the talus to add support and prevent recurrence. The author reported on 52 cases of which 41 were described as having a good result (a foot demonstrating good function and satisfactory cosmetic appearance). Of the 11 patients found to have poor outcomes, 7 were a result of inadequate correction while 4 were secondary to overcorrection of the deformity. Specifically, improper graft placement within the sinus tarsi, inadequate realignment of the calcaneus beneath the talus, and failure to correct a sagittal plane equinus component of the deformity together produced poor outcomes.

Induction of a varus deformity was the chief complication reported on by Pollock in 1964 in a series of 112 "Grice" procedures between 1955 and 1959. Simultaneous transplantation or sectioning of both the peroneus longus and brevis tendons was identified as the

root cause of such deformity. Of 30 unsatisfied patients, 18 had both peroneals transferred to the mid-dorsum of the foot while 12 had peroneal relocation to the heel. These historic methods of performing STJ fusion have evolved with modifications of technique. Likewise, thorough examination reveals that the causes of complications have expanded amid the evolution.

## COMPLICATIONS

As previously mentioned, STJ fusion has been recommended for post-traumatic osteoarthritis, talocalcaneal coalitions, neurologic disorders, and primary osteoarthritis. In the hands of an accomplished surgeon, performing an isolated STJ fusion to correct these deformities may produce varying complications. Complicating causative factors are numerous, including but not limited to postoperative patient compliance, intraoperative technique, and preoperative morbidity of the deformity and or patient lifestyle. Nevertheless, some believe the complication rates are underreported. Catanzariti et al sought to identify the complications and patient satisfaction associated with STJ arthrodesis and found the prevalence of complications was slightly higher than previous reports. Forty patients were retrospectively evaluated based on complications due to minor (resolving with nonoperative treatment) and major (resistant to nonoperative treatment) factors. The overall union rate was 90%, however the reported complication rate was 37.5%. Major complicating factors such as complex regional pain syndrome and nonunion affected 12.5% of patients. Minor factors affecting 55% of patients included painful internal fixation, sural neuritis, wound dehiscence, stress fractures, and residual postoperative pain.

### Intraoperative Considerations

It has been suggested that STJ fusion leads to stress and degeneration of surrounding joints. It has been reported in the literature that after simulated arthrodesis of the STJ, 26% and 56% of motion remained in the talonavicular and calcaneocuboid joint, respectively. Mann and Baumgarten observed 11 STJ fusions retrospectively and found radiographic changes at the midtarsal joint, which were clinically insignificant. Banks et al examined the role of joint resection on residual stress conveyed to the talonavicular joint. Consideration was given to the vertical dimension of the talus relative to the navicular. If all 3 talar joint surfaces are excessively resected, the author suggests plantar displacement relative to the navicular will induce talonavicular stress. Likewise if only the posterior facet is resected, posterior tilt of the talus may ensue and create stress dorsally at the talonavicular joint.

### Preoperative Patients Morbidity Considerations

Primary subtalar arthrodesis due to calcaneal fracture and secondary arthrodesis due to post-traumatic arthritis as a result of calcaneal fracture are indications frequently discussed in the literature. Calcaneal fractures involving the STJ produce morbidities such as subtalar incongruity, calcaneal depression, lateral wall blowout with tendon or nerve impingement, and varus/valgus hindfoot. Thus, it is not unusual for painful sequelae to perpetuate for reasons other than arthrosis after calcaneal fracture. Chandler et al isolated specific factors in 19 patients that inhibited satisfaction post in situ subtalar arthrodesis. Peroneal tendonitis, sural neuritis, anterior ankle pain, and calcaneocuboid tenderness were found to cause significant disability. Chahal et al more specifically evaluated radiographic and functional outcomes of 88 patients after subtalar arthrodesis to identify patient factors associated with poor outcome. Radiographic outcomes were assessed by independent musculoskeletal radiologists. Functional outcomes were graded based on self-administered functional outcome questionnaires. Radiographic evidence confirmed that smokers were 3.8-fold more likely to go on to nonunion than were nonsmokers. In addition, older smokers were more likely to not fuse than their younger counterparts. Noninsulin-dependent diabetic patients were 18.7 times more likely to result in varus malunion. Patients receiving a bone block distraction arthrodesis fused at higher rates compared with patients fused without bone graft (95.2% versus 65%). No significant difference in union rates between worker's compensation and third-party insured patients was found. However, functional outcome questionnaires revealed poorer outcomes among worker's compensation patients. Overall the poorest function outcome scores were of patients with diabetes. Complications have evolved with ever changing technical modifications of this procedure. Whether preoperative, intraoperative, or postoperative, there are multiple factors one must be aware of so these complications may be avoided.

### Modifications of Technique

In recent years, technical variations of the talocalcaneal fusion have been examined. Practicing physicians have devised alternate techniques affording consistent union rates with reduction of complications. Early inlay bone-block fusions as described by Grice, were associated with difficulties such as loss of position and nonunion. Grafts could not definitively occupy the STJ space, and fixation was not routinely used. In recent years, autogenous iliac-crest bone graft is described as a viable adjunct to STJ fusion. Russotti et al described the technique in which moldable iliac crest morsels were

packed within the subtalar arthrodesis site to aid internal fixation. In addition, iliac crest graft site morbidity has led authors to investigate harvesting autograft locally from the tibia, fibula, and or calcaneus.

Numerous authors have focused on variations in screw fixation. When considering STJ fusion, 2 techniques are often used. The posterior-to-anterior approach orients a screw obliquely from the posterior calcaneal tuberosity exiting the junction of the talar neck and body. A commonly described disadvantage of this approach is the need for screw removal because of soft tissue irritation caused by a prominent screw head. An anterior-to-posterior approach orients a screw obliquely from the mid-talar neck exiting the central plantar calcaneal tuberosity. Cited disadvantages of this approach include anterior ankle impingement, talar neck stress riser, and possible compromise of the blood supply to the talar head. However, the pullout force of the anterior-to-posterior orientation is significantly increased compared to the posterior-to-anterior approach. A third method of screw fixation for isolated subtalar fusion orients a screw superiorly from the plantar calcaneus dorsally into the talar body. Gosch et al showed a consistent compression force when comparing this plantar-to-superior orientation versus posterior-to-anterior orientation. The author describes the plantar-to-superior approach as an alternative method in revisional cases where the screw is not purchasing with adequate compression because of failed attempts at screw placement from posterior-to-anterior and anterior-to-posterior. All techniques considered, Yu et al cited that there could be significant motion around a single point of fixation. Thus the author published a technique guide including 2-screw fixation for the isolated talocalcaneal fusion.

Perioperative morbidity and disruption of blood supply were fundamental concerns of authors Parisien and Vangness. The authors described the first STJ arthroscopy in 1985, which led to the development of arthroscopic subtalar fusion as a surgical procedure in 1992. The procedure allows for minimal disruption of tissues when performing a talocalcaneal fusion. Similar indications exist for open versus percutaneous fusion such as rheumatoid arthritis, paralytic conditions, and osteoarthritis. However, correction of hindfoot malalignment cannot be achieved with the percutaneous approach. Greater than 15 degrees of valgus or more than 5 degrees of varus malalignment is a contra-indication for arthroscopic fusion. This minimally invasive modification to an already effective procedure garners a steep learning curve. Nevertheless, the procedure offers a viable addition to the podiatric surgeon's armamentarium.

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