



Pantalar Arthrodesis: Surgical Technique and Review of Literature

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ABSTRACT

Surgical options for treatment of tibiotalar, subtalar, and transverse tarsal joint arthritis are limited. Pantalar arthrodesis can produce a stable and braceable if not painless foot in the plantigrade position. This article presents a review of etiology, clinical evaluation, procedural technique and outcomes reported in literature.

Keywords: Pantalar, Arthrodesis, Fusion, Technique.

Shi G, Gross CE, Huh J, Parekh SG. Pantalar Arthrodesis: Surgical Technique and Review of Literature. *The Duke Orthop J* 2015;5(1):48-52.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

The concepts involved in selective joint arthrodesis have well been utilized by foot and ankle surgeons since 1879. It was not until 1911 when Lorthioir reported the first case of a pantalar arthrodesis by removing the talus, denuding the chondral surfaces, and reinserting the talus as a graft to treat an equinovarus foot¹ that the pantalar concept was born. The term pantalar arthrodesis refers to the fusion of all joints about the talus, specifically the tibiotalar, subtalar, and the transverse tarsal joints. This collection of fusions, when successful, leaves the patient with a rigid, stable and pain-free plantigrade foot. Since its original description, this procedure is often viewed as the final operative procedure prior to amputation.²

ETIOLOGY

The pantalar arthrodesis has been used in various clinical settings to address ankle and hindfoot pain, instability and deformity that otherwise has failed nonoperative treatment. Historically, it was employed to create a functional plantigrade foot for those who had late sequelae of untreated clubfoot, poliomyelitis,

various congenital neuromuscular diseases, and Charcot neuroarthropathy.^{1,3} Additionally, it is offered to those who have painful joint degeneration and destruction resulting from avascular necrosis of the talus, inflammatory arthritides, such as rheumatoid arthritis, as well as primary osteoarthritis.^{4,5} The pantalar fusion is not typically considered unless pain, deformity or instability and involves the transverse tarsal joints as well as the ankle and subtalar joints.

HISTORY AND PHYSICAL EXAMINATION

Clinical history, physical examination and correlative weight-bearing radiographs are routinely performed in determining the symptomatic joints that should be considered in the arthrodesis.

Patients may present with multiple pain epicenters, reflecting the involvement of multiple joints. Arthritic ankle pain is often described as a deep dull ache that is associated with stiffness and made worse with activity. Patients may complain of restricted range of motion with walking. Difficulty negotiating uneven ground and pain in the sinus tarsi are suggestive of subtalar joint arthrosis. The history should include any prior traumatic or atraumatic insults that may result in talar AVN.

Preoperative examination should focus on the standing alignment, not only of the hindfoot, midfoot and forefoot but also the hip and knee joints. Flexibility of the questioned joints should be assessed as well as an attempt to illicit symptoms. Neurovascular examination is important in the post-traumatic, neuropathic and inflammatory arthropathic patients, as blood supply or protective sensation may be attenuated. Careful skin and soft-tissue envelope evaluation is critical in surgical candidates with systemic conditions and those who have had prior surgical procedures with undesirable scarring locations or contractures that can compromise outcome.

Selective local anesthetic agent injection may be of value in equivocal physical examination findings. Physical examination-guided, fluoroscopic-guided or ultrasound-guided injections can be performed to ensure that the joints of interest are appropriately injected.

Weight-bearing anteroposterior, lateral and oblique views of the foot and ankle may show radiographic findings of degenerative joint arthrosis, which is represented by combinations of joint space narrowing,

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osteophyte formation, subchondral sclerosis and periarticular cysts. The degenerative changes may also result in accentuated loss of normal alignment and subsequent clinically-evident deformity. Additional radiographic examination should focus on talar head uncovering, Meary's angle, and varus or valgus tibiotalar tilt. A standing Saltzman view is helpful to reveal the tibial-hindfoot relationship⁶ (Figs 1 to 4).

Beyond weight-bearing radiographs, computed tomography (CT) can show the extent of joint degeneration. It is also used to visualize those joints, such as the subtalar joint, that can be obscured on standard radiograph by angular or rotational deformities. Although magnetic resonance imaging (MRI) can show cartilage wear, subtle bone edema and suspicious avascular necrosis or osteomyelitis, it does not routinely alter management.

TREATMENT

In those patients who are not candidates for surgery, weight loss, medications, activity modification, custom

bracing, rocker bottom shoes and selective injections may be alternatives. However, relieving painful fixed deformities with these measures are often unsatisfactory and poorly tolerated.

Indications for pantalar arthrodesis include uncontrollable ankle and hindfoot pain, deformity and instability in patients who have failed nonoperative care. Pantalar arthrodesis is a surgical salvage alternative to amputation.⁷ Its goal remains to create a stable, rigid, plantigrade platform for pain-free gait. The literature has supported the use of pantalar fusions in patients with ankle, hindfoot, and transverse tarsal joints deformity and arthritis secondary to poliomyelitis, spasticity, rheumatoid and post-traumatic arthritis.^{2,8-11}

The biomechanics of the native ankle and foot are significantly altered following pantalar fusion. Gellman demonstrated the lack of residual motion in the foot and ankle after selective fusions in a biomechanical simulation. In a pantalar arthrodesis model, 82% of plantar flexion, 62.8% of dorsiflexion, 71.7% of inversion and



Fig. 1: Saltzman hindfoot alignment view



Fig. 2: Weight-bearing AP views of bilateral feet



Fig. 3: Weight-bearing AP view of the left ankle demonstrating varus talar tilt and pantalar arthritic changes



Fig. 4: Lateral weight-bearing view of the left foot demonstrating a loss of Meary's line

67.4% of eversion were lost.¹² Significant reduction in foot inversion and eversion were noted when incorporating the transverse tarsal joints into the fusion.

Pantalar arthrodesis is a technically challenging salvage option for those patients who search for a surgical option to alleviate painful deformities without amputation. Regardless of a staged *vs* single approach, implants used, a history of trauma or diabetes, the AOFAS and SF-36 postoperative outcome scores demonstrate modest improvement.⁷

TECHNIQUE: PANTALAR ARTHRODESIS

Anesthesia

The femoral and sciatic divisions must be blocked. Therefore, a number of permutations achieve this goal.

- General and popliteal block
- General, popliteal and muscle relaxation
- Femoral and sciatic block
- Popliteal and saphenous
- Femoral and popliteal

Imaging

- A C-arm or mini C-arm fluoroscope is often adequate.
- If a full-sized C-arm is needed, it should be placed on the opposite side of the operative extremity.

Positioning

- Place the patient supine onto a radiolucent operative table with a significant bump underneath the ipsilateral buttocks to internally rotate the foot, or
- Use a modified lateral decubitus position ('sloppy' lateral or semilateral) to allow easy access to both medial and lateral sides of the ankle. One must ensure that the greater trochanter and the fibular neck are well padded.
- The leg is prepped and draped in the usual sterile manner.

Required Equipment

- Five millimeter pineapple burr
- Straight and curved curettes
- Large screws at least 6.5 mm
- Two 6.5" lamina spreaders
- Hand tray for small Hohmann retractors, Littlers, Senn retractors, small key elevator, osteotomes, freer
- Hintermann distractor

Ankle Arthrodesis

- Extend the previously-described lateral incision proximally over the lateral malleolus.

- The lateral malleolus is stripped of soft tissue and osteotomized 2 cm proximal to the level of the joint.
 - The osteotomized fibula is removed and can be used later for autograft or as an onlay supplement to the ankle fusion construct.
- The ankle is then distracted with the use of a laminar spreader or with supination and adduction of the foot.
- The ankle is then debrided.
- The remainder of the procedure proceeds as described above.
- The ankle is reduced and placed in the appropriate position. An anterior plate or two medial and lateral screws are placed across the tibia into the talus. Instead of screw fixation, once all the joints have been debrided, an Ilizarov or circular frame can be placed to compress the joints.

Triple Arthrodesis

- Using the lateral approach, make a 6 cm longitudinal incision centered over the sinus tarsi from the tip of fibula to the 4th metatarsal.
 - Avoid the intermediate branch of the superficial peroneal nerve, which is encountered with an oblique incision.
- Isolate and coagulate bleeders; retract the nerve superiorly, if seen.
- Identify the peroneal tendon sheath and fat in the sinus tarsi.
- Incise the peroneal tendon sheath and retract the tendons superiorly with a Hohmann retractor.
- The fascia of the extensor digitorum brevis (EDB) is incised in line with the skin incision.
- Dissect off the EDB as a distally based flap off the calcaneus
- Sharply incise the sinus tarsi fat pad to expose the tarsal canal.
- Identify the posterior facet of the subtalar (ST) joint lateral to tarsal canal. Distract the talus upward and supinate the foot to better see the joint.
- Using a key elevator, subperiosteally dissect along the posterior facet.
- Using a laminar spreader without teeth, distract and debride the posterior facet.
- Place a small Hohmann distal to the calcaneocuboid (CC) joint to identify and release the capsule dorso-laterally.
- Identify the talonavicular (TN) joint and remove the capsule.
- Proceed medially and debride the lateral TN joint and naviculocuboid articulation.
 - One can usually get about 75% of the TN joint laterally.



- Debride the cubonavicular articulation, followed by the CC joint, taking care to debride the most plantar aspect of the joint.
 - After adequate debridement and reduction, debride the dorsal anterior surface of the calcaneus and inferior lateral talar neck.
 - Incision is centered over medial TN and extended proximally up the talar neck.
 - Retract the saphenous vein and incise the TN capsule.
 - Debride remainder of the medial joint.
 - Check Achilles tightness
 - If tight, perform a percutaneous three incision tendo Achilles lengthening.
 - With the talus reduced, place a large threaded screw from the posterolateral calcaneus to the dorsomedial talus.
 - Next, another screws can be placed either dorsal or plantar to the first screw.
 - Stabilize the TN joint with two staples or a 4.5 mm screw that is directed from the navicular to the talar neck.
 - The screw is placed at a shallow angle in a medial-lateral plane and angled slightly superiorly.
 - Countersink this screw.
 - The CC screw is fixed with two staples, a plate or a 4.5 mm cortical screw placed antegrade from the anterior process of the calcaneus to the cuboid.
 - Any fusion constructs can be supplemented with compression staples.
 - The EDB, peroneal tendons and fat of the sinus tarsi are now re-approximated over the fusion site.
 - The subcutaneous and skin layers are then closed with simple braided suture and vertical mattress nylon respectively.
- The patient is to remain nonweight-bearing until at least postoperative 6th week.

6th Week

- X-rays are performed to ensure the hardware is in good position and that there is radiographic evidence of healing.
- Partial weight-bearing is allowed for 3 weeks, followed by a transition into a hardsoled shoe.
- They should be full weight-bearing by 10 weeks.

3 Months

- X-rays are performed to analyze the fusion construct.
- Cycling and swimming is encouraged.

6 Months

- X-rays are performed and should demonstrate a full arthrodesis construct.
- At this point, the patient should be able to resume activities as tolerated.

Pearls

- To increase efficiency, feather with a ¼" osteotome and drill (2.0 mm) the articular surfaces as soon as they are debrided.
- In order to correct hindfoot varus/valgus, bone can be removed at the subtalar joint.
- The ankle is to be fused in neutral dorsiflexion and 5° of external rotation and the subtalar joint is fused in 5 to 10° valgus.
- Only the posterior facet of the subtalar joint needs to be debrided; however, it must have all cartilage denuded and the subchondral bone feathered with an osteotome.

Postoperative Protocol

- Following closure, the patient is placed into a bulky post-mold and sugar tong splint.
- Both procedures can be done on an outpatient basis as long as the patient is healthy and has adequate pain control.
- If the patient is admitted overnight, a patient-controlled analgesia pump and 24 hours of IV antibiotics should be considered.
- The patient is discharged when the patient's pain is controlled and he/she has cleared physical therapy.

Postoperative Clinic Visit Protocol

2nd Week

- Wound check, transition to CAM boot walker or short leg cast.
- The sutures may be removed if the incision is healed, otherwise these are left in for 2 more weeks.

COMPLICATIONS

A variety of complications have been reported secondary to pantalar arthrodesis attempts, including skin ulcerations, wound infections, malunions and nonunions. Complication rates after pantalar arthrodesis have been reported to range from 28 to 50%.^{2,4} Nonunions, with variable symptoms, remain the most problematic postoperatively, with rates up to 28%.⁵ They are most prevalent at the ankle joint. The nonunion rate is not affected by the approach: single *vs* staged procedure.¹³ Identifiable risk factors for nonunion include patient's smoking history, diabetic history, neuropathy, avascular necrosis and inadequate surgical fixation. Up to 32% of the diabetic patient population have neuropathic pain that may or may not be relieved by surgery.¹⁴

Long-term follow-up of 24 patients who had undergone pantalar arthrodesis for paralytic foot deformities secondary to poliomyelitis did show significant ipsilateral knee pain in most patients.²

CONCLUSION

The pantalar arthrodesis is a challenging salvage alternative procedure for patients with pain, deformity and instability. It is an acceptable option in those with degenerative and rheumatoid arthritis or paralytic disease involving the ankle, hindfoot and midfoot.

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