Interpositional Arthroplasty with Human Amniotic Membrane Umbilical Cord Allograft In Treatment of Middle Facet Tarsal Coalition: A Case Series

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Abstract

Talocalcaneal coalition is an uncommon condition that usually manifests in early adolescence. Frequently, this condition is initially missed. Surgical treatment is required in many cases. Early surgical treatment usually involves resection. There have been many different interpositional grafts used in treating tarsal coalitions to prevent recurrence including fat, muscle, silicone sheets, and bone wax although the ideal graft in unknown at this time. These case reports present a technique for treatment of symptomatic tarsal coalition in a 27-year-old male and an 18-year-old female by resection with interpositional Human Amniotic Membrane Umbilical Cord allograft with short term follow up.

Introduction

Tarsal coalition is the union between 2 or more tarsal bones, which may be osseous (synostosis), cartilaginous (synchondrosis), or fibrous (syndesmosis) in nature. One theory suggests they occur due to failure of mesenchymal stem cells to distinctly differentiate appropriately.[1] The incidence of tarsal coalition is <1%. Calcaneonavicular and Talocalcaneal coalitions are the most common forms accounting for 90% of all tarsal coalitions.[2] Symptoms usually present in the 2nd decade of life, while ossification tends to occur between ages 12 and 16. Patients may present with chronic pain with activity, recurrent foot and ankle injuries, and/or rigid flat foot. In patients with talocalcaneal coalitions, pain will be localized to the sinus tarsi and will progress to a dull ache in the entire subtalar joint. Peroneal muscle spasm may occur with a tarsal coalition, usually involving peroneus brevis which in time can cause rigid peroneal spastic flat foot[3]

Radiographs should be the initial imaging of tarsal coalitions. A radiographic marker to be aware of in assessment of tarsal coalitions is the halo "C" sign on lateral radiographs.[4,5] This represents the absence of the middle facet with a sclerotic margin along the sustentaculum tali. Other secondary radiographic signs which may be present in talocalcaneal coalitions are talar beaking, hump back sign, and duck face sign. Talar beaking is a superior projection of the distal aspect of the talus on lateral radiographs resulting from abnormal stresses at the talonavicular joint. Hump back sign represents an osseous protuberance on the subtalar joint posteriorly on lateral radiographs. Duck face sign represents an osseous protuberance of the medial calcaneal joint over half of the medial malleolus on AP radiographs resembling a duck beak[6]. Harris-Beath views also allow for better visualization of the middle and posterior facets than standard AP views. In the Harris-Beath view in a normal patient, the middle and posterior facets are parallel. Patients with greater than 25^0 of angulation of the middle facet away from the posterior facet likely have subtalar coalition.[7] Computed Tomography (CT) and Magnetic resonance imaging (MRI) are also valuable imaging tools when coalitions are not apparent on standard radiographs. Conservative treatment is <30% efficacious.[8] Conservative treatments include NSAIDS, steroid injections, 4-6 weeks of cast immobilization, and rigid orthotics to limit STJ motion. If these treatments fail, the main two surgical options are resection and fusion. Many providers will attempt resection with interpositional graft to prevent recurrence if there is not severe osteoarthritis or severe deformity of the joint as a first line treatment before a joint destructive fusion. There have been many types of interpositional grafts used in treating tarsal coalitions to prevent recurrence including fat, muscle, silicone sheets, bone wax, and biologic grafts. This case report presents a treatment of a tarsal coalition with a human amniotic membrane umbilical cord (hAMUC) allograft which is rarely reported in current literature.

Case #1

A 27 y/o healthy male with no significant past medical history presented to the office April 2016 with a chief complaint of pain in his right ankle for six years. He complained of increased pain and decreased range of motion over the last year with ambulation. He denied any recent falls or trauma. Upon examination, the patient's neurovascular status was intact to the bilateral lower extremity. Right ankle edema was present circumferentially around the right ankle and subtalar joints. Tenderness and limited range of motion were present in the right ankle and subtalar joints. Also with point tenderness along the achilles tendon, peroneal tendons, and at the sustentaculum tali. The right ankle was in neutral alignment with slight valgus deformity of the subtalar joint. The initial diagnoses were joint pain at the ankle and subtalar joints, tenosynovitis of the ankle joint, and achilles tendinitis. Initial AP, lateral and mortise radiographs were taken of the right ankle. These initial films show normal alignment of the ankle and hindfoot, no fractures appreciated, normal ankle joint space, but some mild arthritic changes to the ankle. Mild decrease in joint space of the subtalar joint with arthritic changes was noted. The patient declined immobilization in a boot or cast, physical therapy, and steroid injections, but agreed to undergo extracorporeal shock wave therapy(ESWT). (D-Actor 200 EPAT) After 3 treatments of ESWT, his pain and ankle range of motion significantly improved, but still had decreased subtalar joint inversion and eversion. To rule out a tarsal coalition, CT and MRI studies were performed. The right ankle CT showed osseous ridging and spurring along the posterior margins with fibro-osseous fusion of the calcaneus along the middle facet and posteromedial margins of the posterior facet of the subtalar joint. Mild degenerative changes to the talonavicular and calcaneocuboid articulations. MRI confirmed a fibro-osseous talocalcaneal coalition measuring 1.5cm x 1cm in width. Conservative and surgical treatments were discussed with the patient and he elected to undergo a surgical correction.

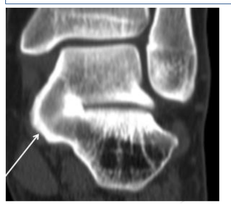

Figure 1. CT depicting middle facet coalition

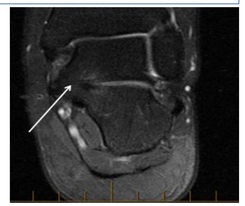

Figure 2. MRI depicting intact cartilage and coalition

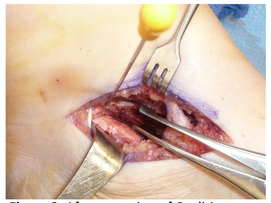

Figure 3. After resection of Coalition

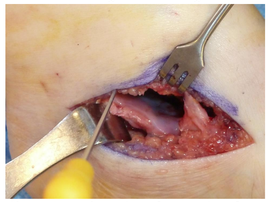

Figure 4. Implantation of HAMUC graft

Case #2

An 18-year-old female with past medical history of Benign Rolandic epilepsy presented to the office with the chief complaint of swelling and pain with range of motion of the left foot and ankle. She states that she has intermittent pain in her left hindfoot which she describes as a dull ache for a few months. Pain is worse with physical activity. She denies any recent trauma, but admits to multiple ankle sprains in the past. On physical exam, neurovascular status is intact to the bilateral lower extremity with no edema or evidence of a traumatic injury. Left subtalar joint range of motion is decreased and painful. The left rearfoot is in a valgus position clinically. No peroneal pain or spasm noted. ROM of the right foot and ankle are within normal limits and non-painful. Muscle strength is 5/5 to all quadrants of the bilateral lower extremity. Initial radiographs had increased radiopacity of the left middle facet. A CT and MRI were performed of the left foot and ankle due to suspicion of a tarsal coalition. The CT as shown in Figure 1 was positive for a 2.5cm x 1.9cm osseous union of the middle facet without involvement of the anterior and posterior facets of the subtalar joint. On MRI as shown in Figure 2, there is no involvement of the posterior facet, no osteochondral lesions noted, and no tendinous or ligamentous pathology noted. The treatment options were then discussed with the patient and her mother. Risks and benefits involved with resection and interposition of an hAMUC graft versus hindfoot fusion were discussed with the patient and her mother. The former surgical option was recommended because if the resection fails, we can always revert to a fusion. The patient agreed to undergo resection of the coalition with interpositional hAMUC graft.

Procedure

The patient was taken to the OR and placed on the operating table in a supine position. The patient went under general anesthesia and a local anesthetic ankle block was performed using 20cc of 0.5% Marcaine plain. A sterile ankle tourniquet was placed on the patient after the right leg was prepped and draped in the usual sterile fashion. A 5cm curvilinear incision was made medial to the sustentaculum tali just posterior and distally to the medial malleolus. Dissection was then performed down to the subtalar joint with care taken to avoid the medial neurovascular structures. A pin was driven from the sinus tarsi laterally in to where the middle facet would lie to help us identify the area of the middle facet coalition without using an intra-operative CT to determine the location. Osteotomes were then used to excise the fibro-osseous union at the middle facet resulting in immediate increased range of motion at the subtalar joint. Figure 3 shows an intraoperative image after resection of the coalition. It was noted that the remainder of the anterior and posterior facets had relatively healthy cartilage. Fibrin glue was applied over the raw surfaces of the bone, where the fibro-osseous coalition was located and a cryopreserved hAMUC allograft was set over the fibrin glue as seen in Figure 4. The incision was then closed deep to superficial using 3-0 Vicryl and skin was closed using 3-0 Prolene. A posterior splint was applied to the right leg and the patient was then taken to the post anesthesia recovery unit with vital signs stable and intact.

Discussion

Subtalar coalitions can be congenital or acquired by degenerative joint disease, inflammatory arthritis, infection and clubfoot deformity.[9] After failure of conservative treatment, many factors should be considered when choosing the correct surgical procedure. These factors include age, activity level, presence or absence of degenerative changes, and pes planovalgus deformity. If greater than 33% of the total joint is affected by the coalition or greater 50% of the posterior facet involved, patients tend to have poor results when resection is performed.[10,11] Wilde et al. and Luhmann et al. found poor results when patients had a hindfoot valgus of greater than 16^0 and 21^0 respectively.[12,13] In cases where resection is necessary it is recommended that some type of interposed graft is used after resection of a tarsal coalition, although the ideal interposed graft is unclear.[1] (Lemley) Surgeons have used interposed fat,[14] bone wax,[15] fibrin glue,[16] silicone sheet,[17] and flexor hallucis tendon[18] with good to excellent results. Tower et al. presented a technique using interposition of juvenile hyaline cartilage allograft with successful short term results for treating symptomatic middle facet coalitions.[19]

The use of hAMUC grafts have been used as an interposition after resection of a coalition with recent success. Covell et al. presented a case series using interpositional hAMUC allograft after resection of tarsal coalitions. With 89% improvement in VAS score and 29% recurrence rate after 18months, they concluded that interpositional arthroplasty using hAMUC allograft is a viable option for treatment of tarsal coalitions.[20] Amniotic membranes demonstrate anti-scarring, anti-inflammatory, antimicrobial, non-immunogenic, and regenerative properties. They also have an epithelial barrier which allows for side dependent adhesive or anti-adhesive properties. Many of the anti-scarring abilities of amniotic membranes can be attributed to abundant interleukin-10 (IL-10), and transforming growth factor B (TGF-B) among others which regulate cell matrix interactions and adhesiveness. They also function in downregulation of scar forming genes. IL-10 decreases Interleukin-6(IL-6). Low levels of IL-6 are the hallmark of scar-less fetal healing. Abundant IL-10 is also responsible for anti-inflammatory properties of amniotic membranes. It blocks IL-6, tumor necrosis factor-alpha, and interleukin-8 which promotes neutrophil and granulocyte migration to the site of inflammation.[21] In a study performed by Cooke et al in 2014, they studied cryopreservation of hAMUC grafts versus dehydrated human amniotic membrane with chorion grafts(DHAMC). Cryopreservation of hAMUC grafts showed no significant structural difference compared to fresh tissue. They also determined that it preserves structural integrity of the matrix components essential for anti-inflammatory and anti-scarring effects. The DHAMC grafts showed both amniotic membrane and chorion layers were dramatically compacted with altered structural integrity. They found decreased active growth factors compared to cryopreserved tissue, concluding that cryopreserved amniotic membrane grafts are superior to dehydrated amniotic membrane grafts.[22] The graft used in the study was a cryopreserved hAMUC allograft which has a thickness of 1mm allowing for increased durability when compared to thinner biologic grafts.

In conclusion our patients had excellent results in the short term follow up, but long term results are necessary to determine the durability and efficacy of the hAMUC graft. The hAMUC graft was chosen due to its anti-scarring, anti-inflammatory, and side dependent anti-adhesive properties which make it an excellent interpositional graft in resection of a tarsal coalition. Although there are many different types of grafts that can be interposed in a resection of a tarsal coalition, there are no comparative studies identifying the ideal graft. Long term prospective studies are needed to determine the most efficacious interpositional graft after resection of tarsal coalitions.

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