Case Report

Metatarsophalangeal Joint Reconstruction Using Talar Osteochondral Allograft following a Failed Dorsal Cheilectomy

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Dorsal cheilectomy is often used as a first-line surgical treatment for hallux rigidus; however, revision surgery is needed in nearly 9% of cases. One option for revision surgery is interpositional arthroplasty, which is designed to preserve joint motion and is favorable in young, active populations. This case discusses a young female patient with persistent, painful hallux rigidus and a large osteochondral defect despite prior dorsal cheilectomy. We performed an interpositional arthroplasty of the first metatarsophalangeal joint using an osteochondral allograft from the talus. At three-year follow-up, she had greatly improved function and was able to run without pain. To our knowledge, this is the first documented use of an osteochondral allograft from the talus in conjunction with metatarsophalangeal joint interpositional arthroplasty for treatment of hallux rigidus and a severe osteochondral defect. This technique introduces osseous subchondral scaffolding as well as mature hyaline cartilage into an osteochondral lesion, thereby reestablishing proper joint architecture and congruent articulation and ultimately improving range of motion and reducing pain. We present this technique as an experimental treatment option for restoring both the integrity and function of the metatarsophalangeal joint following trauma, osteochondritis dissecans, or prior operative failure in patients who wish to delay metatarsophalangeal joint fusion.

1. Introduction

Hallux rigidus is a common source of foot pain that is caused by osteoarthritis of the first metatarsophalangeal (MTP) joint. Symptomatic hallux rigidus is estimated to be present in nearly 8% of adults and is the most common degenerative joint disease of the foot [1, 2]. Dorsal cheilectomy has been proposed as a first-line surgical treatment for this condition; however, a systematic review indicated that 8.8% of isolated cheilectomies required revision surgery [3]. Decompression osteotomy is also commonly used to treat hallux rigidus and results in beneficial long-term outcomes with a lower rate of revision than dorsal cheilectomy; however, decompression osteotomy is typically more difficult to perform and poses more risk to the patient [4, 5]. Arthrodesis is an option for hallux rigidus revision surgery that has a high success rate in pain relief, but is not ideal in younger populations due to loss of joint motion and activity limitations [6]. For similar reasons, implant arthroplasty and resection arthroplasty are not favorable for young, active patients [7]. Interpositional arthroplasty, which uses a biologic as a spacer in the MTP joint, was developed in response to these limitations. In prior studies, interpositional arthroplasty of the MTP joint has been performed with Silastic material, regenerative tissue matrix, and bioresorbable implants, as well as autograft transfer from the medial and plantar aspect of the ipsilateral talar head [8–12]. Since interpositional arthroplasty is designed to preserve more
bone and joint motion, thereby improving function, it has
great potential to improve outcomes in active patients [13].

Osteochondral lesion of the first MTP joint in hallux
rigidus requires additional consideration. Current arthro-
scopic treatments of osteochondral defects of the first MTP
joint include sesamoid excision, synovec- tomy, debridement,
and partial cheilectomy, which can be painful procedures
[14]. Microhole drill and micro fracture techniques are
additional options; however, in general, marrow-inducing
approaches have not been shown to sustain long-term
benefits due to the inferior biomechanical properties of
the fibrocartilage repair tissue [14, 15]. Osteochondral
autograft implantation is also used to treat osteochondral
lesions, but subsequent pressure on the donor site can
increase morbidity [15, 16]. Autologous chondrocyte
implantation (ACI) poses less risk of donor site morbidity,
but requires two sequential procedures of harvesting and
implantation, which can be time-consuming and inconve-
nient for the patient [17, 18].

Osteochondral allograft (OCA) transplantation is
regarded as a salvage procedure for large osteochondral
lesions, including patellofemoral and talar that are too large
for other reparative or restorative procedures [15, 19].
Recent studies have examined the use of fresh OCA to cor-
rect hallux rigidus and have found this approach to be a via-
able option [20, 21]. However, these cases have focused on
treatment of either early hallux rigidus or end-stage progres-
sive arthritis, so little is known about the efficacy of OCA for
the treatment of large osteochondral defects of the metatar-
sal head due to causes such as trauma, osteochondritis disse-
cans, or prior operative failure.

In this case, a young patient presented with persistent
hallux rigidus and 50% surface area loss of the metatarsal
head following a failed dorsal cheilectomy. Due to the large
size of the osteochondral defect and the patient’s desire for
long-term joint mobility, we felt OCA and interpositional
arthroplasty were the best approach. We used fresh OCA
to restore anatomical joint architecture and articulation in
the MTP joint of the great toe. We believe this is the first
documented case in which OCA of the talus was used in
conjunction with MTP joint interpositional arthroplasty to
treat hallux rigidus and a large osteochondral lesion follow-
ing failure of first-line treatment.

2. Case Report

A 24-year-old female was under our care for three years.
At presentation, she had no past medical history or perti-
nent family medical history and was not taking any med-
ications. She was referred to our office for treatment of her
right great toe, at which point she was 11 months status
post a right great toe dorsal cheilectomy performed by an
outside physician. She reported making an incomplete
recovery with regard to pain and functionality despite
three cortisone injections and postoperative physical ther-
apy. She presented with pain at the MTP joint of her right
great toe associated with swelling, weakness, limited range
of motion, and instability.

2.1. Treatment. Weightbearing anteroposterior, lateral, and
oblique radiographs of the patient’s right foot taken at her
initial visit showed evidence of previous dorsal cheilectomy
with no fractures or dislocations (Figures 1 and 2).

Her initial clinical examination was concerning for cap-
sulitis versus osteomyelitis, due to persistent postoperative
edema and erythema. An ultrasound-guided aspiration of
her right great toe was attempted at her initial visit, but no
fluid was aspirated. She was advised to continue physical
therapy and wear a postoperative shoe. Following three
months of physical therapy, the patient’s right great toe pain
and symptoms had improved only slightly. Due to her per-
sistent pain and reduced function, T1, T2, and STIR mag-
netic resonance imaging (MRI) sequences of the right foot
were obtained in the sagittal, axial, and true and oblique cor-
oral planes. The imaging, which was obtained 14 months
status post dorsal cheilectomy, showed evidence of prior first
metatarsal head cheilectomy/osteotomy with contour defor-
mity dorsally and persistent marrow edema thought to be
related to postoperative changes. Also noted was 50% sur-
face area loss of the first metatarsal head (Figure 3).

Following review of the MRI, operative treatment
described as an allograft spacer versus a fresh allograft trans-
plant was discussed, and the patient ultimately decided to
proceed with surgery. Given the surface area loss of the
metatarsal head observed on MRI, we believed that OCA
transplantation would best restore congruence of the meta-
tarsal head and correct the posterior subluxation of the first
MTP joint.

2.2. Surgical Technique. Examination under anesthesia of the
first MTP joint demonstrated the patient’s range of
motion to be limited to 30 degrees of dorsiflexion and
40 degrees of plantarflexion. The contralateral healthy side
demonstrated 70 degrees of dorsiflexion and 90 degrees of
plantarflexion.

A standard incision was made over the dorsomedial
aspect of the first MTP joint (Figure 4). The dorsal nerve
was identified and retracted posteriorly. This was followed
by a capsulotomy, exposing the MTP joint. Severe adhesions
were elevated anteriorly, which were scarred to the exposed
medullary bone from the previous cheilectomy. A large
osteophyte at the medial aspect of the first metatarsal head
that had caused red, swollen, and inflamed skin was identi-
fied and excised with a small saw blade. The resection was
flushed with the remaining metatarsal neck. A rongeur and
a hand rasp were used to smooth the metatarsal, thereby
completing the open bunionectomy.

Postbunionectomy, the hallux rigidus correction with
implant was performed. Dorsiflexion of the first MTP joint
demonstrated articulation of the dorsal aspect of the prox-
imal phalanx with exposed medullary bone on the metatarsal
head. This articulation might have deteriorated much of the
cartilage to the point where the dorsal half of the metatarsal
head was absent, including the articular cartilage, yielding
bone-on-bone articulation.

A saw blade was used to gently freshen the soft and oste-
oporotic bone on the dorsal metatarsal head. Approximately
1 millimeter (mm) was resected from the metatarsal head to
obtain fresh medullary bone for healing surface. At least 50% of the dorsal osteochondral aspect of the metatarsal head had been abraded through dorsiflexion, as measured intraoperatively and shown on the preoperative MRI. Cartilage from the proximal phalanx was seen articulating on the bone of the distal metatarsal with Outerbridge classification grade IV chondromalacia on the dorsal aspect.

To address the large osteochondral lesion, a fresh talus allograft was matched with the metatarsal head to create a graft that measured 10 mm in height by 15 mm in length by 15 mm in width. The aspect of the talus that articulates with the navicular matched the metatarsal head exactly. The portion of talonavicular joint cartilage that matched the contour of the metatarsal head measuring 10 × 15 × 15 mm was resected from the talus. The OCA was matched to the metatarsal head for a flush fit and the proximal aspect of the graft was further contoured to match the angle of the abraded metatarsal head. Finally, the graft was positioned on the deficient metatarsal head to test the graft’s articulation with the proximal phalanx. Intraoperative tests showed no evidence of proximal phalanx bone-on-bone articulation in either dorsiflexion or plantarflexion with excellent dorsiflexion and cartilage-on-cartilage articulation. Demonstration of the graft with the metatarsal head also showed restored stability, as compared to preoperative MRI findings, which originally revealed joint instability with

**Figure 1:** Preoperative right foot anteroposterior radiograph taken at the time of presentation.

**Figure 2:** Preoperative right foot lateral radiograph taken at the time of presentation showing prior dorsal cheilectomy.
volar subluxation of the metatarsal head and dorsal subluxation of the proximal phalanx due to the lack of a dorsal metatarsal head (Figure 3).

The metatarsal head was further contoured and affixed to the first metatarsal using a 2.5 × 18 mm screw implant® (Stryker, Kalamazoo, MI). The headless screw, inserted from dorsal to volar, avoided the articular cartilage and provided excellent finishing and compression. Biplanar C-arm fluoroscopy views ensured the appropriate screw length without plantar exposure to prevent the patient from stepping directly on the screw. We then used a pineapple burr to shape the graft to match the contour of the metatarsal head. The dorsal aspect of the graft was secured to the remaining metatarsal with excellent stability (Figure 5). Following the hallux rigidus correction with the implant, dorsiflexion and plantarflexion increased by 20 degrees during the operation.

Figure 3: Preoperative right foot MRI performed 14-month status postdorsal cheilectomy demonstrating 50% loss of the first metatarsal head.

Figure 4: Dorsomedial incision of the first MTP joint shows Outerbridge classification grade IV chondromalacia with 50% of metatarsal head cartilage missing.

Figure 5: Fresh talonavicular joint cartilage implant increased dorsiflexion and plantarflexion by 20 degrees during the operation.
plantarflexion increased to about 50 and 60 degrees, respectively. This completed the hallux rigidus correction with OCA implantation on the metatarsal head.

To further correct the bunion deformity, the medial capsule was over sewn with a No. 1 Vicryl in a horizontal mattress stitch. Subcutaneous tissue was closed with a 3-0 Vicryl in inverted fashion, and the skin was closed with a 4-0 nylon interrupted horizontal mattress fashion. Xeroform was applied, and a gauze was placed between the first and second toes to keep the great toe in a varus position. Finally, a posterior plaster splint was applied in 90 degrees of ankle dorsiflexion.

2.3. Outcome and Follow-Up. The patient returned to our office six days postoperatively with improved range of motion and reduced pain. The patient was advised to weight bear as tolerated and begin a formal postoperative physical therapy program with an emphasis on foot and ankle

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**Figure 6:** Postoperative lateral radiograph of the right foot demonstrating hallux rigidus correction with OCA implantation on the metatarsal head.

**Figure 7:** Postoperative oblique radiograph of the right foot demonstrating hallux rigidus correction with OCA implantation on the metatarsal head.

**Figure 8:** Anteroposterior radiograph of the right foot taken three years post-OCA implantation with complete resolution of hallux rigidus.
strengthening and proprioception. She returned to our office five weeks thereafter and reported continued improvement of range of motion. She was advised to discontinue use of crutches and begin walking with a cast shoe. Postoperative radiographs taken at three month follow-up revealed correction of the hallux rigidus and osteochondral lesion with no fractures or dislocations (Figures 6 and 7). She returned to the clinic four months following surgery and reported improved pain and function of the right first MTP joint. Compared to preoperative range of motion, her postoperative dorsiflexion increased by 15 degrees from 30 to 45 degrees and plantarflexion increased by 25 degrees from 45 to 70 degrees. However, at one year following surgery, the patient reported worsening pain and difficulty walking. Her symptoms were suspected to be related to painful hardware, and the 2.5 mm headless screw implant was removed. Over the next nine months, she received additional treatment including a cortisone injection, physical therapy, and home exercises with improvement of symptoms.

At one year and nine months postoperatively, a right foot MRI without contrast was performed to evaluate for graft integrity. The MRI revealed that there was no full-thickness defect or chondral delamination and no evidence of tendon tear or tenosynovitis. At two and a half year follow-up, the patient returned and reported great improvement to her symptoms. She denied swelling, locking/catching, or instability, and physical examination showed excellent strength and range of motion. She was also able to ambulate with ease and was pain-free. At three-year follow-up, the patient was able to run up to two miles without pain and had begun weightlifting. She reported that her right foot symptoms had entirely resolved. Radiographs taken at that time revealed complete resolution of hallux rigidus (Figures 8–10).

3. Discussion

Although osteochondral lesions of the MTP joint are not as common as knee or ankle joint osteochondral lesions, they pose a risk for severe pain and limited activity due to their weightbearing character. Osteochondral lesions
of the MTP joint may present with severe mechanical symptoms, such as grinding, as well as disrupted flexion of the great toe, causing an inability to walk [9]. There are few studies that describe treatment of large osteochondral lesions of the MTP joint; therefore, the optimal form of treatment for this condition remains unknown. Literature regarding OCA treatment of osteochondral lesions in other weightbearing joints exhibited its promise for our particular case [22, 23]. OCA has been used as a salvage procedure for patients who are poor candidates for arthroplasty procedures and sustain large osteochondral lesions [15].

This case study presents OCA as a feasible option for treating hallux rigidus with a severe osteochondral lesion following a great toe cheilectomy with incomplete recovery. By using a portion of the talus that articulars with the navicular as the OCA, we were able to restore congruent articulation, improve range of motion, and reduce pain. The restorative approach of OCA contrasts with reparative approaches that aim to relieve symptoms but do not necessarily restore articular cartilage architecture. Restorative approaches achieve complete reconstruction of the microarchitecture of articular cartilage to restore the biomechanical and physiological properties of the affected joint [24]. The technique used in this case, modeled after OCA treatments for osteochondral defects in the knee, introduces both subchondral bone and mature hyaline cartilage to a previously damaged articular surface. Hyaline cartilage—as compared to fibrocartilage generated through reparative techniques like microfracture—is ideal for transplantation because it is avascular, aural tissue that is protected from host immune detection, as its chondrocytes are embedded within the cellular matrix [25].

Currently, OCA is the only biomimetic technique that restores mature, architecturally appropriate hyaline cartilage to an articular surface lesion [25]. Prior case studies investigating the efficacy of OCA in the patellofemoral joint have shown encouraging graft survivorship and patient satisfaction ratings [18, 24]. Increased accessibility of fresh donor tissue coupled with rising patient and physician demand for technological advancements in articular cartilage repair has fueled the growth of biologic resurfacing as an alternative to joint replacement [17, 25]. In light of these advances as well as the advantages of OCA described above, this report offers OCA as a novel methodology for operative treatment of hallux rigidus following a dorsal cheilectomy with incomplete recovery.

In this case, OCA with concurrent interpositional arthroplasty has been shown to be an effective method for restoring both the integrity and function of the MTP joint and has the potential to be used following trauma, osteochondritis dissecans, or first-line operative failure. This procedure had an extended recovery, as the patient did not reach maximum function until more than two years after surgery and required additional treatment in the form of cortisone injections and physical therapy. Therefore, patients and clinicians should be prepared for a long-term recovery if they utilize this surgical technique in the future. Given that hallux rigidus is a debilitating condition that affects a large number of adults, it is important to better understand possible treatment approaches, especially in the case that first-line operative treatment fails. This restorative technique introduces osseous subchondral scaffolding as well as mature hyaline cartilage into an osteochondral lesion, thereby reestablishing proper joint architecture and congruent articulation following a failed cheilectomy. Since this is a novel approach to treating an established pathological condition, additional cases should be described to determine the practicality and value of this procedure on a broader basis.

Data Availability

Data can be accessed by contacting Dr. Christopher Lee at chrisleemd08@gmail.com or 818-848-3030.

Additional Points

The patient in the case study paid for her medical services through insurance and self-pay.

Conflicts of Interest

The authors do not have any conflicts of interest.

References


