

Osteochondral Fresh Allograft Transfer to Address Osteochondral Defect of the First Metatarsal Head in Early Hallux Limitus

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Statement of Purpose

The aim of this study was to review the clinical results of adult patients with early hallux limitus and focal first metatarsal head osteochondral defects that underwent osteochondral fresh allograft transfer. Patient demographics, outcomes, and radiographs were reviewed to better define the indications and expected outcomes for osteochondral defect of the first metatarsal head addressed with osteochondral fresh allograft transfer.

Level of Evidence

Level IV, Case Series

Methodology & Procedure

- Retrospective review
- Surgery performed between August, 2011 - January, 2019, by a single board certified surgeon (SMH)
- Inclusion criteria included:
 - use of the osteochondral fresh allograft to resurface an osteochondral defect on the first metatarsal head in adult patients
 - 18 years or older
- All included patients had no previous cartilage resurfacing procedures or surgery of the first metatarsophalangeal joint
- 12 of 14 patients included in study
- Radiographs of the operative foot and foot examination performed preoperatively and postoperatively
- Postoperative evaluation included:
 - range of motion at the first metatarsophalangeal joint
 - joint pain
 - swelling
 - overall function and limitations in desired activity
- American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-Interphalangeal Scale questionnaire and patient satisfaction survey were used

Surgical Technique



- Osteochondral defect identified at the first metatarsal head, debrided with curette
- Harvesting of osteochondral fresh allograft from first metatarsal allograft
- Osteochondral fresh allograft plug
- Transfer of fresh osteochondral allograft

Literature Review

Hallux limitus is a term used to describe degenerative arthritis of the first metatarsophalangeal joint. Advanced hallux limitus, also known as Hallux Limitus Grade 3 and Grade 4 as described by Coughlin et al., is characterized by significant, or complete, loss of motion, near constant pain, radiographic joint space narrowing and sclerosis, and substantial osteophytic formation. Early hallux limitus, Coughlin Hallux Limitus Grade 1 and Grade 2, may be associated with mild pain and demonstrate minimal joint space narrowing or even normal radiographs (1) (Fig. 1). Early hallux limitus may also include focal damage to the articular cartilage, also called an osteochondral defect (OCD). Untreated OCDs can be a source of pain and can progress over time leading to degenerative joint disease (2). There is significant literature on the treatment for osteochondral lesions in the knee and ankle but very few studies that address OCDs of the first metatarsal head.

Literature Review (cont.)

Treatment for an osteochondral lesion in the first metatarsophalangeal joint, associated with hallux limitus, may include conservative options or surgical intervention. Non-operative treatments include activity modification, shoe gear changes, corticosteroid injections, platelet-rich plasma/growth factor injections, topical and oral anti-inflammatory medications, and orthotics (2). The most commonly utilized operative treatments to address OCDs include subchondral microfracture, cheilectomy, arthroplasty, and arthrodesis (3,4). Microfracture is a marrow-stimulating procedure that aims to form new fibrocartilage in the area of the articular cartilage defect. This is the only mainstay surgical treatment that directly addresses a focal articular defect (1). This marrow-stimulating technique only produces fibrocartilage, which has different and inferior properties than the native hyaline cartilage (5). Unfortunately, hyaline cartilage also contains a limited amount of chondrocytes making it difficult to regenerate on its own (6).

Fibrocartilage is a dense connective tissue that contains both type I and type II collagen arranged in a thick parallel formation. This composition makes fibrocartilage durable, however, may often be more restrictive and inferior in shock absorption (7). Hyaline cartilage is abundant in type II collagen with fewer collagen fibers, making it less compact. In addition, hyaline cartilage contain glycosaminoglycans. The glycosaminoglycans help trap water aiding in shock absorption and joint mobility. Lastly, the main disadvantage of fibrocartilage is that it does not have the same durability in maintaining pain free range of motion as hyaline cartilage (8).

Osteochondral fresh allograft transfer provides an articular donor plug of bone and cartilage to precisely fit the site of existing chondral injury. This technique was originally done to address OCDs on the weight-bearing surface of femoral condyles, but has become a viable treatment option for similar defects in other joints. This technique replaces the defect with fresh allograft bone and hyaline cartilage cap rather than fibrocartilage; this is a fundamental goal for the advancement of cartilage defect treatment. The use of a fresh osteochondral allograft to resurface OCDs have shown favorable outcomes in literature on the knee and ankle, but limited literature exists regarding the application of this technique to the first metatarsal head. Fresh donor grafts include first metatarsal, talus and femoral hemi condyles for use in the lower extremity.

Results

Table 1. Osteochondral Defect Description and Concomitant Procedures. (N=12)

Patient	OCD Size (mm)	OCD Location	Number of Plugs	Graft Size (mm)	Graft Donor Location	Concomitant Procedures
1	Majority of cartilage surface	central	1	10.0	Fresh Talus	Microfracture Metatarsal
2	5.0	dorsal/central and plantar/medial	2	6.0	Fresh Metatarsal	Cheilectomy
3	6.4	dorsal/central	1	8.0	Fresh Metatarsal	Cheilectomy
4	7.2	central/medial and central/lateral	2	6.0	Fresh Metatarsal	Cheilectomy
5	7.2	central/plantar and dorsal/central	2	6.0	Fresh Femoral Hemi condyle	Cheilectomy, Modified McBride Bunionectomy
6	12.1	central/medial	1	12.0	Fresh Metatarsal	Cheilectomy
7	6.4	central/lateral	1	8.0	Fresh Metatarsal	Cheilectomy, Microfracture Metatarsal
8	10.0	central	1	10.0	Fresh Metatarsal	Cheilectomy, Microfracture Proximal Phalanx
9	10.0	central	1	10.0	Fresh Metatarsal	Cheilectomy
10	Dorsal 1/2 of cartilage surface	dorsal 1/2	2	8.0	Fresh Metatarsal	Cheilectomy
11	6.4	plantar/medial	1	8.0	Fresh Talus	Modified McBride Bunionectomy
12	10.0	central	1	10.0	Fresh Metatarsal	Cheilectomy, Microfracture Metatarsal
Mean	8.2		1.3	8.5		

Table 2. Number of Allograft Plugs versus AOFAS Score. (N=12)

Patient	Number of Plugs	AOFAS Score
1	1	77
3	1	77
6	1	59
7	1	73
8	1	85
9	1	59
11	1	57
12	1	74
	Mean AOFAS Score	70.1

Patient	Number of Plugs	AOFAS Score
2	2	77
4	2	77
5	2	55
10	2	77
	Mean AOFAS Score	71.5

Results (cont.)

Table 3. Patient Outcomes. (N=12)

Patient	Total Follow Up (months)	Pre-op Activity	Return to Activity?	Subjective Satisfaction	Further Operative Intervention	Post-op Complications	AOFAS total	AOFAS pain	AOFAS function	AOFAS alignment
1	89.1	walk	yes	Very Satisfied	no	none	77	30	32	15
2	68.3	walk	yes	Very Satisfied	no	none	77	30	32	15
3	63.9	walk	yes	Very Satisfied	no	none	77	30	32	15
4	55.6	walk, golf, swim	yes	Very Satisfied	no	none	77	30	32	15
5	52.5	walk, swim	yes	Satisfied	no	none	55	20	27	8
6	50.4	run	no	Satisfied	no	erythema, oral antibiotics	59	20	24	15
7	46.3	walk	yes	Satisfied	Hallux ORIF	none	73	30	35	8
8	38.7	dance, heels	yes	Very Satisfied	no	none	85	30	40	15
9	37	dance, heels	no	Satisfied	no	none	59	20	24	15
10	4.8	walk	yes	Very Satisfied	no	none	77	30	32	15
11	5.1	dance, heels	no	Satisfied	no	none	57	20	29	8
12	3.5	walk	yes	Very Satisfied	no	none	74	30	29	15
Mean	42.9						70.6	26.7	30.7	13.3

Analysis & Discussion

- Statistically significant difference in mean AOFAS total score between Coughlin Hallux Limitus Grade 1 vs. Grade 3 and Grade 1 vs. Grade 2, p<0.05 (t-test)
- Statistically insignificant difference between number of plugs and mean AOFAS total score, p= 0.4 (t-test)
- Statistically insignificant difference between defect size and mean AOFAS total score, p= 0.628 (linear regression)
- No correlation between BMI and mean AOFAS total score
- No revisional surgery or reoperation has been reported in this study
- All twelve patients reported improvements from their preoperative conditions and symptoms

Conclusion

An overall improvement in preoperative symptoms and patient satisfaction was documented. This procedure can be beneficial in addressing osteochondral defects in patients with early hallux limitus. Coughlin Hallux Limitus Grade 1. Furthermore, this procedure should be discussed as a surgical option in patients who maintain reasonable activity and shoe expectation.

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