CHAPTER **23**

OSTEOCHONDRAL ALLOGRAFT OF FIRST METATARSAL HEAD LESIONS

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INTRODUCTION

Hallux limitus is a progressive arthritic condition with limited motion and function of the first metatarsophalangeal joint. The pain can become debilitating, deep, sharp, and achy. Injury to articular cartilage can be caused by mechanical degradation with gradual deterioration of the articular surface. There are several theories on the etiology of hallux limitus including dynamic biomechanical foot imbalance, an elongated first metatarsal, an elevated first metatarsal, genetics, inflammatory diseases, and trauma (acute or repetitive stress) (1-3). Through repetitive microtrauma, jamming of the joint or an acute joint injury, osteochondral defects can occur (Figure 1). A less violent incident may cause fibrillation or softening of the articular surface, while an incident of greater intensity could lead to a complete transchondral fracture with subchondral necrosis and result in osteochondritis dessicans (4).

Osteochondritis dessicans usually includes symptoms of localized swelling and pain with difficulty walking. Osteochondritis implies an inflammatory process of the bone and cartilage. The term dissecans implies a loose fragment of bone or cartilage. Many times a traumatic event can lead to the insult causing an osteochondral fracture. The traditional definition of osteochondritis dessicans is a loss of blood supply to a segment of bone and cartilage that may result in a small fracture or collapse of the joint surface (5).

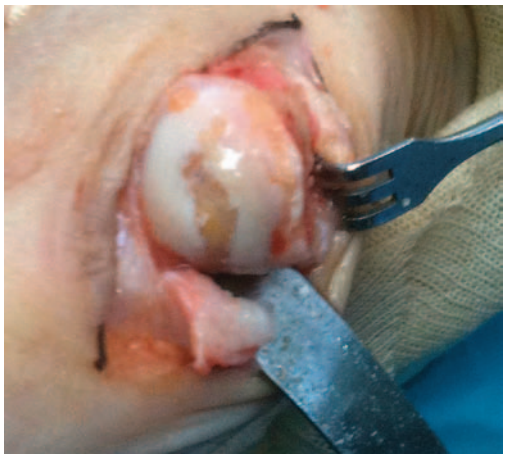

Figure 1. An example of an osteochondral lesion of the first metatarsal head.

Continued problems with an osteochondral lesion may cause a persistent joint effusion and a generalized ache in the joint. Patients may also feel a catching sensation within the joint in certain positions. This is caused by the chip getting caught in the joint as it moves (Figure 2). In the beginning, clinical suspicion is necessary in establishing a diagnosis of an osteochondral lesion since radiographic findings usually fail to demonstrate the extent of articular damage (6). Obviously, biomechanical abnormalities, genetics, inflammatory conditions, and structural first metatarsal pathology will add to the repetitive stress on the joint. The author believes hallux limitus arises most commonly from osteochondral degradation whether acute or chronic, which over time leads to an associated osteocartilagenous lesion.

Osteochondritis dessicans can eventually result in severe arthritis. The early diagnosis of osteochondritis dessicans may be suggested by the medical history and physical examination. Radiographs may or may not show subchondral cystic changes in the area of cartilage tearing. (Figure 3). McMaster implicated characteristic chondral and subchondral lesions of the first metatarsal head that resulted in limited dorsiflexion. He noted the lesion is usually subchondral in origin (6). It is important to evaluate the viability of the articular cartilage and whether or not there is subchondral bone pathology. Cartilaginous fractures can violate the subchondral bone plate allowing motion at the osteochondral defect. Synovial fluid can then accumulate into the area leading to progressive cystic degeneration and avascular necrosis (5). Special tests such as computerized axial tomography (CT scan) or magnetic resonance imaging (MRI) may be necessary to determine the full extent of the area involved. Staging of osteochondral defects is the same in the metatarsal heads as it is in the talar dome. Staging ranges from I to IV (7). MRI is useful to identify the cystic changes and evaluating the marrow edema in the involved bone (Figure 4). MRI is very good in evaluating the subchondral bone and marrow edema but is not as good at detecting the cartilage damage.

If osteochondritis is recognized early, nonweightbearing may be a successful conservative treatment however, if it is not recognized early, the bone fragment may not heal and may continue to cause problems. Surgery may then be required to treat the symptoms. Operative interventions for injuries to

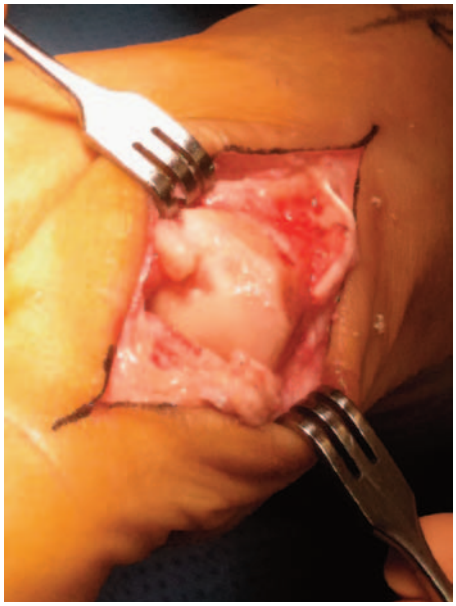

Figure 2A. A loose body is seen within the first metatarsophalangeal joint.

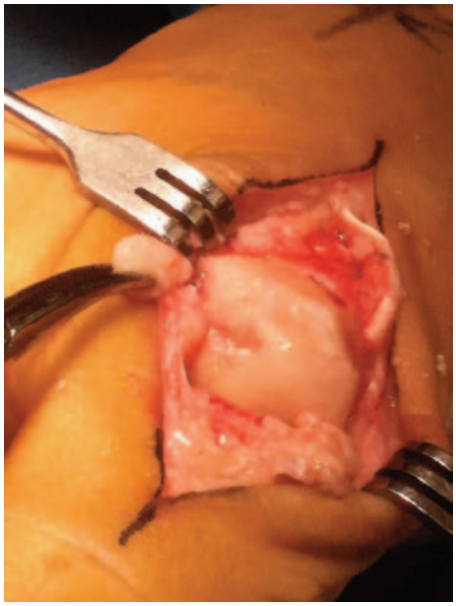

Figure 2B. An osteochondral defect is seen underneath after removal of the loose body.

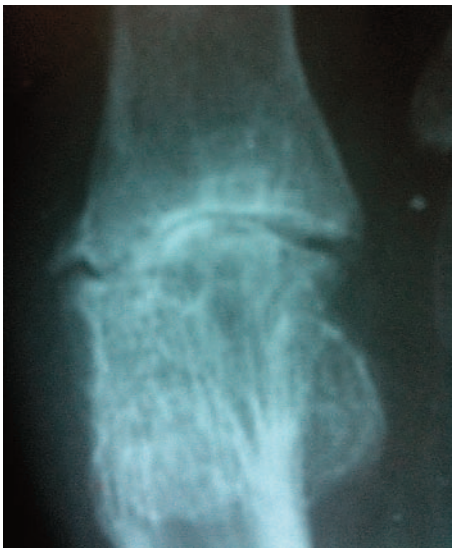

Figure 3. Radiographic appearance of end stage OA with several subchondral cystic changes.

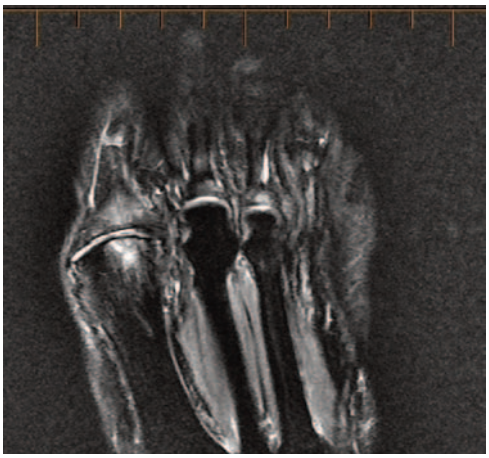

Figure 4. MRI reveals subchondral cystic changes and marrow edema associated with an OCD.

articular cartilage of the first metatarsal have been historically treated with resection, arthrodesis, decompression, replacement, and restoration (8). Traditionally, surgery usually involves removing the loose fragment of cartilage and bone from the joint and subchondral drilling small holes into the injured bone or abrasion chondroplasty (Figure 5). This allows new blood vessels to grow and helps scar tissue (fibrocartilage) to form in the area. Eventually this new tissue smoothes out and allows the joint to move more smoothly. If there are dynamic biomechanical changes like functional metatarsal elevatus or an elongated first metatarsal, a decompression osteotomy is considered as well (Figure 6).

However, if there is a lot of localized subchondral inflammation seen on the MRI, drilling may not be adequate and osteochondral grafting is considered. Replacement of articular surface injury through transplantation of allograft or autograft has been described (4, 8-12). The ultimate goal of replacing damaged cartilage is to preserve the anatomical, biomechanical, and functional properties of native articular cartilage, which will have resultant improvement in the arthritic clinical symptoms. Options for grafting include bioengineered graft, autologous graft, or allograft (9).

Autograft eliminates the issues with graft acceptance but has the disadvantage of donor site morbidity and limited availability of similar osteocartilagenous tissue that will match the topography of the recipient lesion. Multiple donor sites have been described for foot and ankle transplantation in

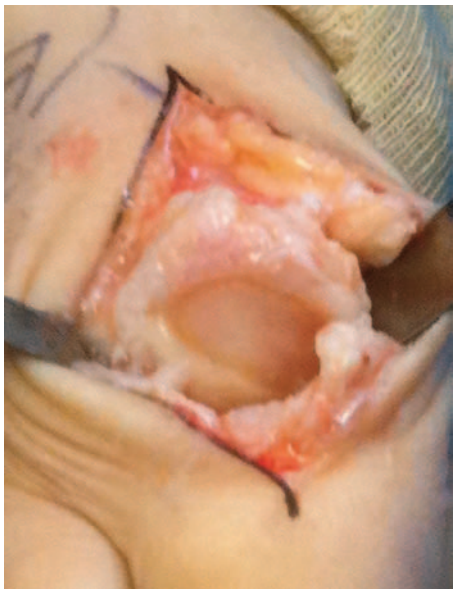

Figure 5A. Hallux limitus changes within a first MPJ with a large cartilaginous erosion and dorsal exostosis.

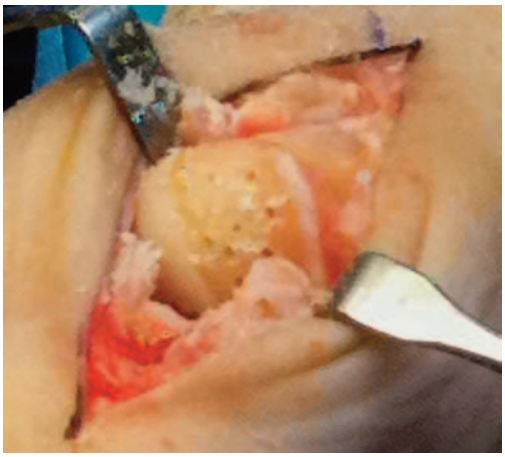

Figure 5B. Intra-operative appearance of the first MPJ after cheilectomy and subchondral drilling of the first metatarsal head prior to decompression osteotomy.

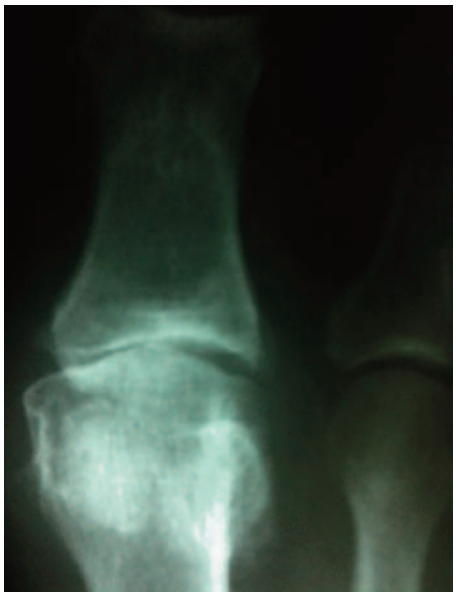

Figure 6A. Preoperative AP radiograph of the joint seen in Figure 4A reveals the medial joint space narrowing.

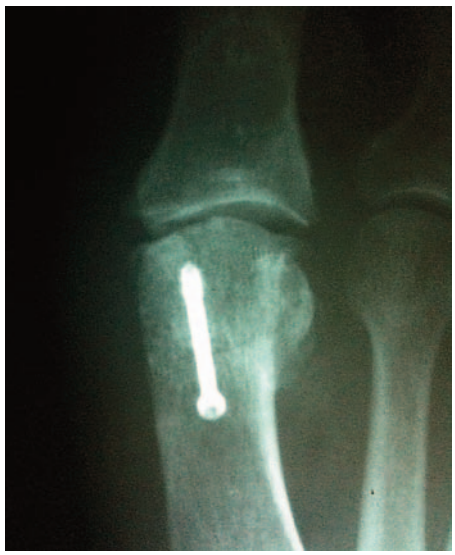

Figure 6B. Postoperative AP radiograph of the joint seen in Figure 4B after decompression first metatarsal osteotomy.

order for the transplanted articular cartilage to obtain the original histologic arrangement of hyaline cartilage (4, 9-11). There is also research using autologous chondrocyte transplantation for the treatment of osteochondral lesions, but it is not yet FDA approved in the foot and ankle (9).

Allogenic osteochondral grafting can be also very useful for this condition. An advantage of allograft is the absence of donor site morbidity with disadvantages that include possible slower graft take, extended recovery and limited chondrocyte viability. The author uses the Osteocure Composite Bone Plug (OCP; Tornier, Inc.) for this condition. The OCP is a cylindrical press fit graft that has an innovative, resorbable scaffold made of polylactide-co-glycolide (PLG; Polygraft, a trademark of OsteoBiologics, Inc.) copolymer, which facilitates structure and calcium sulfate for the enhancement of the bone graft. The copolymer is amorphous (noncrystalline) and resorbs over six to nine months. The scaffold mimics normal bone. The graft has hydrophilic properties and its porous nature enables easy absorption of fluids (blood, cells, protein). The absorption of blood, protein, and fluid allows tissue ingrowth and increases new tissue formation (12).The intent of this report is to describe a simple but very effective, reproducible surgical treatment with allograft for first metatarsal osteochondral lesions. This technique has been described and used successfully in the talar dome (12).

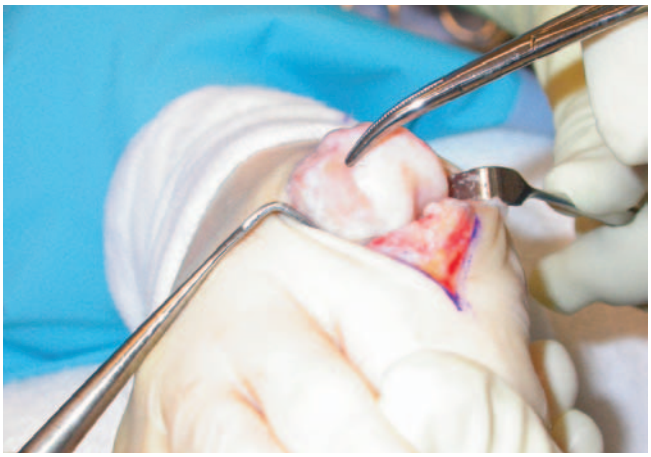

Figure 7. Visualization of the entire metatarsophalangeal joint allows for evaluation of the osteochondral lesion .

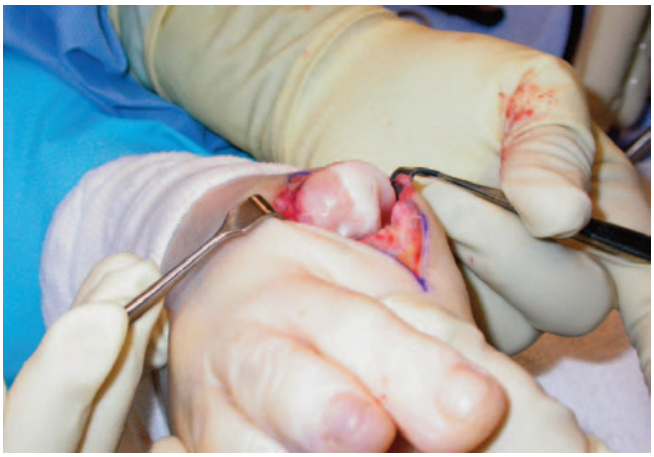

Figure 8. Once the edges of the lesion are prepared the complete extent of the osteochondral lesion is noted.

SURGICAL TECHNIQUE

Under your anesthesia of choice an incision is made just dorsal medial to the extensor hallucis longus tendon from the metatarsal neck distal to the base of the phalanx. Anatomic dissection follows through skin into subcutaneous tissue taking care to avoid and address neurovascular structures. Dissection then proceeds to the deep fascia over the extensor tendon. An inverted L capsular and periosteal incision is made medial to the extensor tendon and just proximal to the first metatarsophalangeal joint. Elevate the capsule and periosteum off the bone, working from within the joint. Perform a complete release of the capsule and collateral ligaments so you can visualize the entire joint. A McGlamry elevator may be beneficial to release adhesions plantarly with the sesamoids.

After exposing the MPJ, one can identify the osteochondral lesion (Figure 7). The lesion may be caused by a loose body, previous trauma, or repetitive micro-trauma from faulty biomechanics/genetics. Once the lesion is visualized it is important to clean up the frayed or loose edges of the lesion with bone curettes or a 15 blade (Figure 8). The implants come in a variety of diameters to suit the varying sizes of the lesions. The instrument set is color coded by size and comes in 5 mm (green), 7 mm (red), 9 mm (blue), and 11 mm (purple) implants (Figure 9). The lesion size is noted and measured trying to encompass the entire lesion. Next, an obturator is placed within a thin-walled drill sleeve, which corresponds to the size of the lesion. A pronation/supination maneuver is used to gently advance the drill sleeve through the cartilaginous surface. It is critical that the drill sleeve is inserted perpendicular to the articular surface to ensure that the graft lies flush after its insertion. The depth of insertion can be seen via the calibrated millimeter markings on the outside of the drill sleeve. A mallet can be used to drive the drill sleeve further into the metatarsal head to the desired depth. Then the metallic cap is removed from the drill sleeve and the corresponding drill is introduced, drilling until the drill contacts the drill sleeve. Once the defect has been drilled out, the drill sleeve is removed and the defect is visualized and ready to be grafted (Figure 10).

Next, the cylindrical graft is obtained. The graft comes packaged in a delivery device. The device has a plunger on the opposite end of the graft. Proceed to insert the plunger end into the lesion and press it firmly into place. This forces a portion of the graft out of the end of the delivery device, effectively sizing the graft. The redundant portion of the overhanging graft is trimmed with a sharp knife included in the kit. The delivery device is then flipped over to hold the graft side down. The plunger on the proximal end of the device is compressed firmly advancing the graft into the defect. It is helpful to advance the graft out a few millimeters of the delivery device prior to inserting the graft into the defect. The graft can be gently tamped flush with the articular surface.

Sometimes if a lesion is large enough it may require multiple smaller grafts (mosaic pattern) to address the entire lesion. Figure 11 shows only a portion of the lesion is addressed with the first graft. Figure 12 reveals a second graft in place addressing the entire defect. Once the graft or grafts are in place proceed to test the MPJ for range of motion intraoperatively. Decompression osteotomy may be necessary to address the biomechanical faults that have aggravated the condition. Osteotomies can be done per surgeon preference as deemed necessary based on the range of motion evaluation. Closure is then accomplished in layers. Apply a compressive dressing. The patient is instructed to remain nonweightbearing for four weeks. Range of motion exercises begin immediately with aggressive therapeutic exercise once weightbearing is reinstituted.

Figure 9. The instrument set is color coded by size in a variety of diameters to suit the varying sizes of the lesions. The available sizes are 5, 7, 9, 11mm implants. This diagram shows the 5 mm green instrument set.

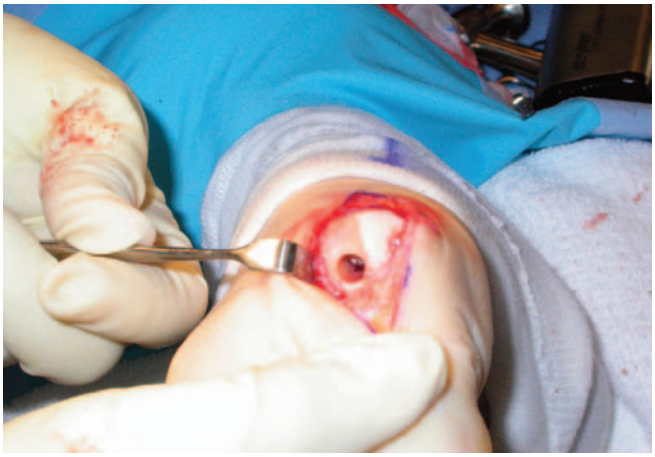

Figure 10. The defect is visualized after drilling and removal of the drill sleeve. It is ready to be grafted.

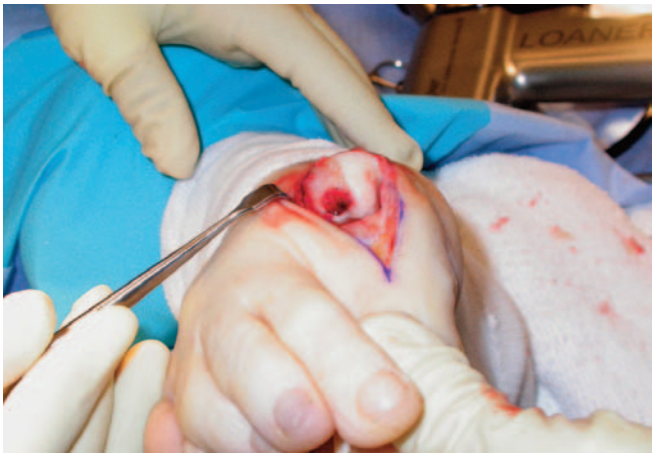

Figure 11. Only a portion of the lesion is addressed with the first graft.

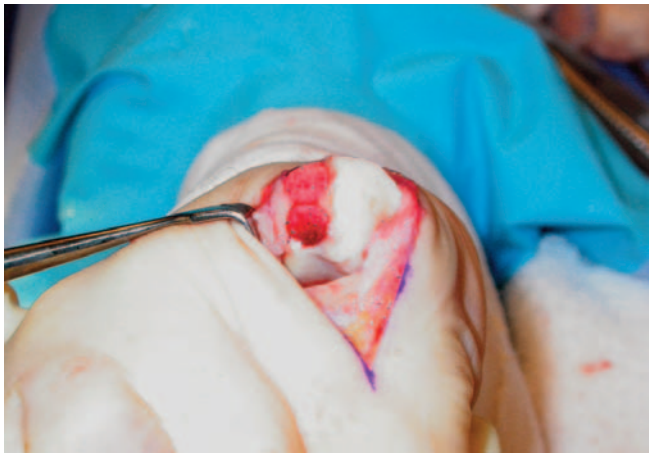

Figure 12. A mosaic pattern graft with a second graft in place addresses the entire defect.

DISCUSSION

There are multiple surgical treatment options for osteochondral defects of the first metatarsal head. The goal is to restore function by recreating the articular congruity and reduce the potential for a progressive degenerative arthritic process. The Osteocure composite bone plug allograft allows for a simple transplantation of the osteochondral lesion with no donor site morbidity or second surgical site potential complications. It incorporates slowly but successfully reduces pain and symptoms of first metatarsal osteochondral lesions.

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