13 Lift, Drill, Fill, and Fix (LDFF): A New Arthroscopic Treatment for Talar Osteochondral Defects

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13.1 Introduction

An osteochondral defect (OCD) of the talus is an injury to the articular cartilage of the talus and its underlying subchondral bone. Although a number of studies described vascular and genetic etiologies of the particular injury, the lesions are most frequently caused by traumatic events, such as ankle fractures and sprains [1–4]. The injury can rigorously affect daily activities of patients leading to a deterioration of the quality of life [5]. The treatment protocol is usually initiated by a conservative protocol by means of shared decision-making (SDM) [6–9]. However, in case of persistence of symptoms, one can opt for one of the many existing surgical procedures. For the primary and smaller defects, a bone marrow stimulation (BMS) procedure can be carried out. However, this surgical intervention may solely be reserved for defects that are less than 107.4 mm^2 in area [10]. Moreover, a number of studies showed that the clinical efficacy of BMS deteriorates over time, most probably due to the fact that osteoarthritis of the ankle joint is being observed at long-term follow-up [11, 12]. The osteoarthritis can be caused by a depressed subchondral bone plate, which is frequently present at midterm [13–15]. Furthermore, the procedure does not aim at mirroring the natural congruency of the ankle joint, being an alternative or combined explanation of the declining clinical efficacy [16–18]. For larger and secondary defects, more aggressive surgical treatment options are probably necessary in order to relieve the patient's symptoms. Even though a recent systematic review by Lambers et al. [19] stated that the authors could not identify a best surgical strategy for these type of lesions, osteo(chondral) transplantation procedures and chondrocyte implantation procedures seem to be effective strategies for secondary defects.

As an alternative to performing bone marrow procedures, cartilage implantations, and osteo(chondral) transplantations, one could execute a fixation procedure for large primary defects as well. A fixation procedure would theoretically preserve the cartilage of the affected region of the talar dome, prevent the degradation of the subchondral bone, and restore the natural congruency of the joint and it would be possible to treat

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large defects with this surgical intervention. In this chapter we present a novel promising arthroscopic internal fixation technique, known as the Lift, Drill, Fill, and Fix (LDFF) technique. Furthermore, we describe the historical perspective of talar osteochondral defects.

13.2 Historical Perspective

The treatment of talar osteochondral defect was most probably initiated in 1743, when Hunter [20] mentioned the following: "From Hippocrates down to the present age, ulcerated cartilage is a troublesome disease; when destroyed, it is not recovered." In 1856, Monro [21] reported on the presence of cartilaginous loose bodies in the ankle joint, and it was the year of 1870 when Paget described these lesions in the knee joint [22]. However, when it comes to the first description of something similar to "osteochondral defects," it was the German surgeon Franz König who was the first to utilize the term "osteochondritis dissecans" when referring to loose bodies originating from the articular surfaces of different joints [23]. The German reasoned that the underlying etiology of these corpora libera was of necrotic nature, thereby accompanying some type of inflammation. Actually, the first description of the term osteochondritis dissecans in the ankle was executed by Kappis, who found great similarities of osteochondral defects in the knee to the ones recognized in the ankle joint [24]. A decade thereafter, in the year of 1932 it was Rendu [25] who published on the etiology and the treatment of an intra-articular fracture of the talus. The terminology and the knowledge behind the etiology and therefore indirectly the treatment of talar osteochondral defects took a turn, when in 1953 Rödén et al. [26] indicated that talar OCDs located on the lateral side of the talar dome were secondary to trauma. This finding suggested that the definition of osteochondritis dissecans seemed to be a misnomer as rather the primary underlying mechanism of etiology was of a traumatic nature. In 1959, the famous article by Berndt and Harty [27] was published. They indicated that not solely lateral lesions of the talar dome could be a consequence of traumatic events, but also medial lesions of the talar dome were prone to be secondary to traumatic events, thereby posing that generally speaking the etiology of the majority of the talar osteochondral defects is posttraumatic. Currently, different descriptions for talar osteochondral defects are being utilized: osteochondral defects, osteochondral lesions, osteochondritis dissecans, transchondral talar fractures, osteochondral talar fractures, talar dome fractures, and flake fractures of the talus. Since the influential publication in 1959, a great number of different surgical techniques have been developed and subsequently published in the literature ever since.

13.3 Arthroscopic LDFF: Indications, Contraindications, and Preoperative Planning

The indication for an arthroscopic lift, drill, fill, and fix procedure is a large (anterior-posterior or medial-lateral diameter >10 mm on computed tomography (CT) scan) primary, acute, or chronic osteochondral defect of the talus [28]. Additionally, the patient needs to have undergone and subsequently failed a conservative protocol for a minimum of 6 months. It should be mentioned that a symptomatic displaced fragment in all patients or a non-displaced fragment in a skeletally mature patient can be fixed as soon as possible; this, so that one minimizes potential intra-articular damage and one maximizes the healing potential [28]. Contraindications for the procedure are loose chondral lesions, ankle osteoarthritis grade II or III, advanced osteoporosis, infectious pathology, and malignancy [28]. There is no contraindication concerning a particular age of the patient as no violation of the growth plate takes place during the arthroscopic LDFF procedure. As preoperative planning for assessment of the talar OCD location, the size, the morphology, and the degree of displacement of an osteochondral fragment, a preoperative CT scan in maximum plantar flexion is advisable to assess the right accessibility of the talar OCD [29–31].

13.4 Surgical Technique: Arthroscopic Lift, Drill, Fill, and Fix (LDFF) Procedure

The arthroscopic fixation procedure has a number of surgical steps that will be outlined hereafter: lift, drill, fill, and fix (LDFF) [32]. The operation is carried out as an outpatient procedure either under general or spinal anesthesia and the patient is positioned in a supine position with slight elevation of the ipsilateral buttock by placing a support at the contralateral side of the patient's pelvis. In order for the surgeon to be able to plantar- or dorsiflex the injured ankle by leaning against the foot sole, the heel of the affected foot is positioned on the end of the operating table. By means of this special position, the surgeon can use the operating table as a lever in case maximum plantar flexion is necessary. When this is required, the surgeon can use a noninvasive soft-tissue distraction device. The surgeon then pays attention to creating the commonly used anteromedial and anterolateral arthroscopic portals. When these have been created, the ankle joint can be visualized. In order to create a proper facilitation of access to the ankle joint, the distal tibial rim is removed. Subsequently, by means of a probe the precise location of the osteochondral defect on the talar dome can be assessed. The first step of the LDFF procedure is the lifting step. In order to prepare for the first step of the LDFF technique, a beaver knife is used to create a sharp osteochondral flap (Fig. 13.1a, b)**.** It should be mentioned that the orthopedic surgeon should pay great attention to leaving the posterior side of the flap purely intact. This flap should be left intact and may then be used as a lever which facilitates an anterior lift by means of a chisel (*lift*) (Fig. 13.1c).

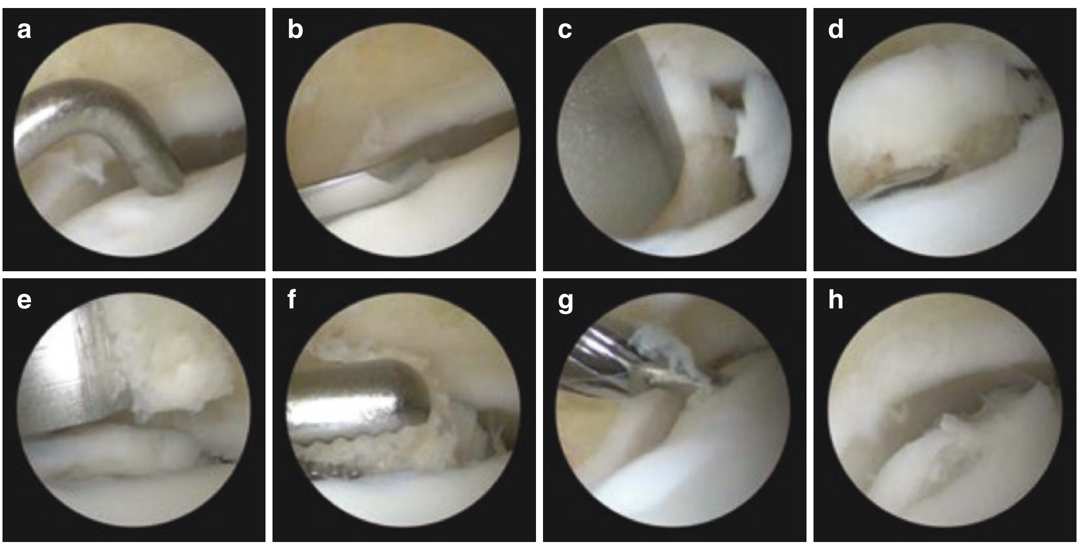

Fig. 13.1 Arthroscopic images of the lift, drill, fill, and fix (LDFF) procedure, a medial osteochondral lesion of the left talus. (**a**) The surgeon palpates the diseased cartilage with a probe in order to identify the precise location of the talar osteochondral defect; this step can be performed when the ankle is held in plantar flexion. (**b**) The orthopedic surgeon creates an osteochondral flap by utilizing a beaver knife. (**c**) The flap is lifted by a chisel (lift). (**d**) The drilling step consists of drilling the bone flake of the fragment with a Kirschner wire and a shaver blade; this so that one promotes revascularization of the subchondral bone. It needs to be mentioned that one has to be careful not to loosen the iatrogenically created osteochondral fragment at its posterior side. (**e**) A 4 mm chisel is utilized to harvest cancellous bone from the distal tibial metaphysis. (**f**) Thereafter, the harvested cancellous bone is transported into the osteochondral defect by an arthroscopic grasper (fill). (**g**) In order to prepare one of the last steps of the procedure (fix), a cannulated system is utilized to perform predrilling and tapping of a compression screw. (**h**) An absorbable screw 1–2 mm recessed relative to the surrounding hyaline cartilage is placed. Due to the diameter and the compression strength, one prefers the non-cannulated screw (*figure reproduced with permission from* Reilingh et al. [33])

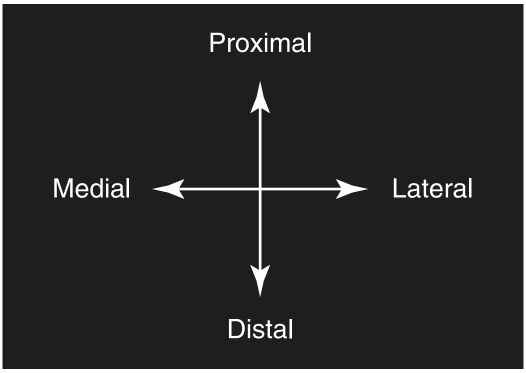

Fig. 13.1 (continued)

The step hereafter is the second step, namely the *drilling* step. During this step, one aims at the promotion of revascularization. The surgeon debrides the osteosclerotic area of the bed and osteochondral fragment (Fig. 13.1d). It is important that the surgeon pays clear attention to debriding and puncturing any subchondral cysts that may be present in selected cases. The subsequent penultimate step of the LDFF procedure is the step during which the debrided and drilled defect will be filled with bone *(fill)*. Cancellous bone is harvested from the distal tibial metaphysis by means of a chisel, after which these harvested bony flakes are transported into the defects by means of a grasper (Fig. 13.1e, f). The last step of the LDFF procedure (*fix*) consists of fixating the fragment that has been created during the first step of the LDFF. A clinically important condition prior to initiating the fixation procedure itself is that the surgeon needs to have achieved a correctly aligned osteochondral fragment. For the fixation procedure itself, Bio-Compression (Arthrex Inc., Naples, USA) or metal screw(s) can be used (Fig. 13.1g, h). Additional bioabsorbable dart(s) or pin(s) can be utilized to prevent rotation.

13.5 Arthroscopic Osteochondral Fragment Fixation: Postoperative Management

A short-leg, non-weight-bearing cast is applied at the operation theatre for a period of 4 weeks postoperatively. When having completed this 4-week period of immobilization, the ankle is placed in a short-leg walking cast in a neutral flexion and neutral hindfoot position—having full weight bearing allowed. One removes the cast at 8 weeks postoperatively. A referral to a physiotherapist for functional physiotherapy is performed in order to help the patient concerning functional recovery and range of motion (dorsiflexion and plantar flexion) exercises. This, so that the patient can progress to full weight bearing in a time frame of about 2 weeks. The important aim of the whole medical team is to supply a well-designed personalized after-treatment protocol in which it is key to focus on balance, proprioception, and ankle functionality. By these means, one can progress to a normal ambulation pattern and achieve full strength as well as propriocepsis. Depending on the patient, running abilities, and personal wishes, as well as sport-specific training, the team can subsequently prepare the patient for a timing of return to sports. It is advised to personalize after treatment after the 3-month period based on the clinical exam and the CT scan of the patient. In general, the patient should be advised to prevent performing any type of activities that consist of peak mechanical forces around the ankle (walking on toes, running, etc.) until after 6 months postoperatively. After these 6 months, the team can gradually start the preparation of return to sports, such as football, running, and other high-impact sports.

13.6 Arthroscopic LDFF: Results

In 2016, the first results of the arthroscopic LDFF procedure were published. This publication consisted of a patient group of seven patients whose clinical and radiological results were analyzed at short term (mean follow-up 12 months, SD 0.6) [32]. The mean preoperative size of the defects was 15.7 mm (SD 3.0) in the anteroposterior direction, 9.6 mm (SD 3.2) in the mediolateral direction, and 6.7 mm (SD 1.4) in the craniocaudal direction. In each and every patient, the LDFF procedure resulted in significant improvements in both American Orthopedic Foot and Ankle Society score (AOFAS) and the numeric rating

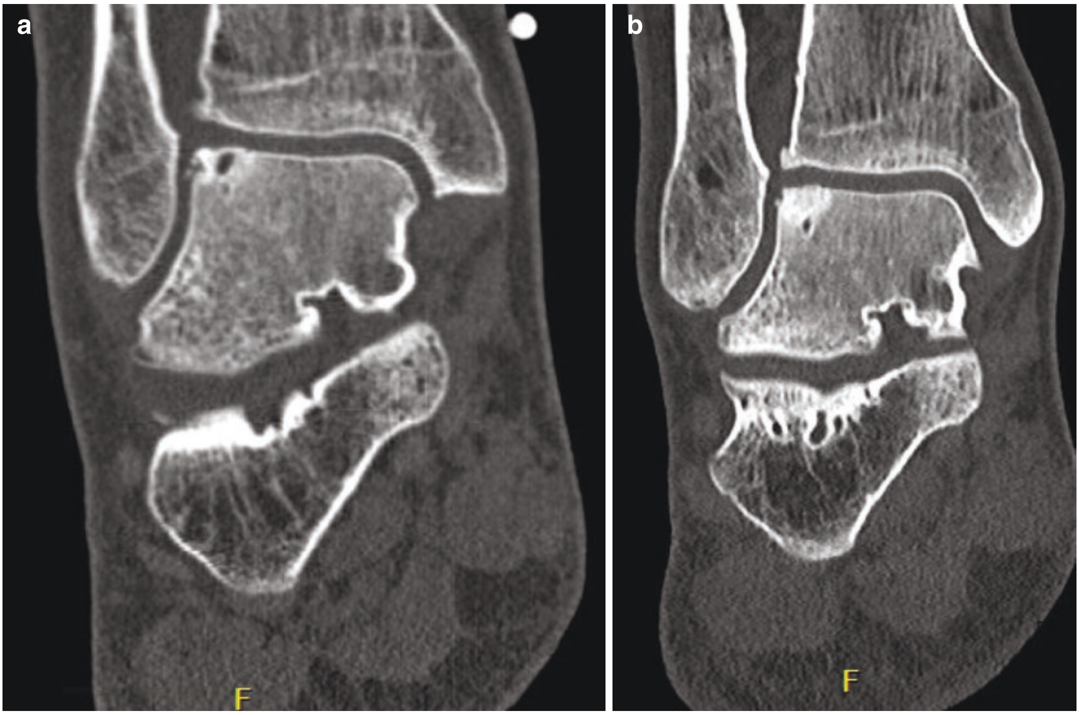

Fig. 13.2 Preoperative and 1-year postoperative computed tomography scans of a patient treated with an arthroscopic lift, drill, fill, and fix (LDFF) procedure. (**a**) Preoperative coronal CT scan. (**b**) 1-year postoperative coronal CT scan

scales (NRS) of pain at rest and during walking [34]. Additionally, all patients reported that they were satisfied about the procedure, and that they would be willing to undergo the surgery once again. Twelve months postoperatively, 71% of the patients showed remodeling and progressive bone ingrowth when assessed on CT scan (Fig. 13.2a, b).

More recently, in 2017, a prospective comparative case series was published by Reilingh et al. [35] and appeared in the KSSTA journal. This study evaluated the clinical and radiological results between arthroscopic LDFF and arthroscopic BMS in primary fixable talar OCDs at 1-year follow-up. Both the LDFF group and the BMS group consisted of 14 patients each. After the arthroscopic LDFF procedure, the AOFAS (preoperative score, 66 (SD 10.1), postoperative score 89 (SD 17.0), ($p = 0.004$)) and the NRS pain at rest (preoperative score 2.1 (SD 1.8), postoperative score 0.9 (SD 1.3), ($p = 0.043$)) as well as when running (preoperative score 7.4 (SD 1.9), postoperative score 2.5 (SD 3.1) ($p = 0.004$)) significantly improved. However, no significant differences were to be found between the arthroscopic LDFF procedure and the arthroscopic BMS procedure preoperatively as well as 1 year postoperatively concerning the functional results being measured by the AOFAS and the NRS. As opposed to the clinical results, there was a significant difference ($p = 0.02$) with regard to healing of the subchondral bone plate between both arthroscopic treatment groups. From the 14 patients that had undergone the arthroscopic BMS procedure, 11 patients were observed to have a depressed subchondral bone plate. Three of the fourteen actually contained a flush subchondral bone plate. On the contrary, 10 out of 14 patients in the arthroscopic LDFF group had a flush subchondral bone plate, and 4 had a depressed subchondral bone plate. Union of the osteochondral fragment was found in nine patients after arthroscopic LDFF.

In November 2017, 75 international experts in cartilage repair of the ankle representing 25 countries and 1 territory were convened and participated in a process based on the Delphi method of achieving consensus at the International Consensus Meeting on Cartilage Repair of the Ankle in Pittsburgh. One of the working groups concerned the treatment of osteochondral defects of the ankle by internal fixation [28]. The statements derived from the whole process indicated that a bone marrow stimulation procedure can be performed in the case of surgical treatment failure by internal fixation in lesions smaller than 15 mm in diameter. However, the authors concluded that there is no indication to perform fixation after a prior bone marrow stimulation procedure. Furthermore, it was stated by the consensus group that fixation techniques for osteochondral defects of the ankle are likely to facilitate healing of the cartilage and/or subchondral bone. Therefore, satisfactory clinical results can be expected when the right type of lesion is chosen for arthroscopic fixation.

13.7 Conclusion

Despite these clinical and radiological results demonstrating that the arthroscopic “Lift, Drill, Fill, and Fix” procedure for primary large and fixable talar osteochondral defects is a highly clinically promising surgical intervention, longer follow-up times are certainly required. A greater cohort of patients needs to be included for a larger statistical power, and it is highly important to assess the outcomes of the arthroscopic LDFF procedure in a prospective comparative randomized manner. Furthermore, it is of clinical importance that in case of clinical failure after an arthroscopic LDFF procedure, alternative surgical interventions (i.e., BMS and osteo(chondral) transplantations) are still possible.

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