

## Case Report

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# A Simple Modified Trephine Technique for Lesser Tarsometatarsal Joints-in Situ Arthrodesis Using a Commercially Available Bone Graft Harvester

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## Abstract

Arthritis of the lesser tarsometatarsal joints (TMT) is a frequent pathology encountered in the foot and ankle consultation that can lead to disability and chronic pain. It can be present alone or with any other foot deformities. After exhausting conservative treatment, the standard of care is surgery consisting on fusion of the affected joints. Many surgical techniques have been described for the first TMT arthrodesis but there are few with regard to the lesser TMT joints.

We propose as simple technique using one trephine to prepare the joint to be fused and to remove the autograft from the calcaneal bone. Once the graft is harvested, it can be placed in a press-fit fashion at the site of arthrodesis. We use a staple to maintain fixation, taking advantage also of its compression properties.

**Keywords:** tarsometatarsal arthritis; arthrodesis; midfoot; autograft; lesser tarsometatarsal joints

## Introduction

The midfoot tarsometatarsal joint (also known as Lisfranc joint) [1] can be divided into three columns: medial, central and lateral. The medial column corresponds to the first TMT (tarsometatarsal) joint, the central to the second and third TMT joints, and the lateral to the fourth and fifth TMT joints [2]. The arch configuration of the midfoot in the coronal plane is due to the wedge-shaped dorsally based cuneiforms. Metatarsal bases also have a similar shape. The second metatarsal is more proximal positioned versus the other four metatarsals, assuming the position of the keystone. This disposition of bones and the capsule-ligamentous elements surrounding them, give the Lisfranc joint its inherent stability [1, 3].

The metatarsal bases are attached by strong interosseous ligaments, except between the first and second. The Lisfranc ligament, the strongest in this complex, goes obliquely plantarwards from the medial cuneiform to the base of the second metatarsal. The peroneus longus tendon also supports the entire configuration [1]. Arthritis of the TMT joint is a challenging problem to treat. Non-operative treatment can consist of shoe modifications,

orthotics, nonsteroidal anti-inflammatories and corticosteroid injections [1, 4, 5]. If this fails, operative treatment is indicated in the appropriate patient. Arthrodesis of the affected joint(s) is considered the definitive surgical treatment of TMT joint arthritis [1]. Arthrodesis is not without its pitfalls as a nonunion rate of up to 11% has been reported.[6] One explanation for this high nonunion rate is shown in a cadaveric study by Johnson et al [7] in which traditional methods of prepping the Lisfranc joints for arthrodesis via curettage, demonstrated a residual layer of calcified cartilage covering the subchondral plate. This was theorized to prevent bony healing at the fusion site.

Multiple techniques have been described for fusion of the TMT joints. These include curettage and fenestration of the joints, with or without bone grafting, using a variety of fixation techniques [1]. Use of autogenous bone grafting, regardless of fixation type, has been found to decrease nonunion rate [6]. Trephine arthrodesis of the TMT joint has gained popularity recently. This technique was first described in the Spine surgery literature [8] and has since been adapted in foot and ankle surgery [9]. Johnson and Johnson [10] first described the use of a trephine

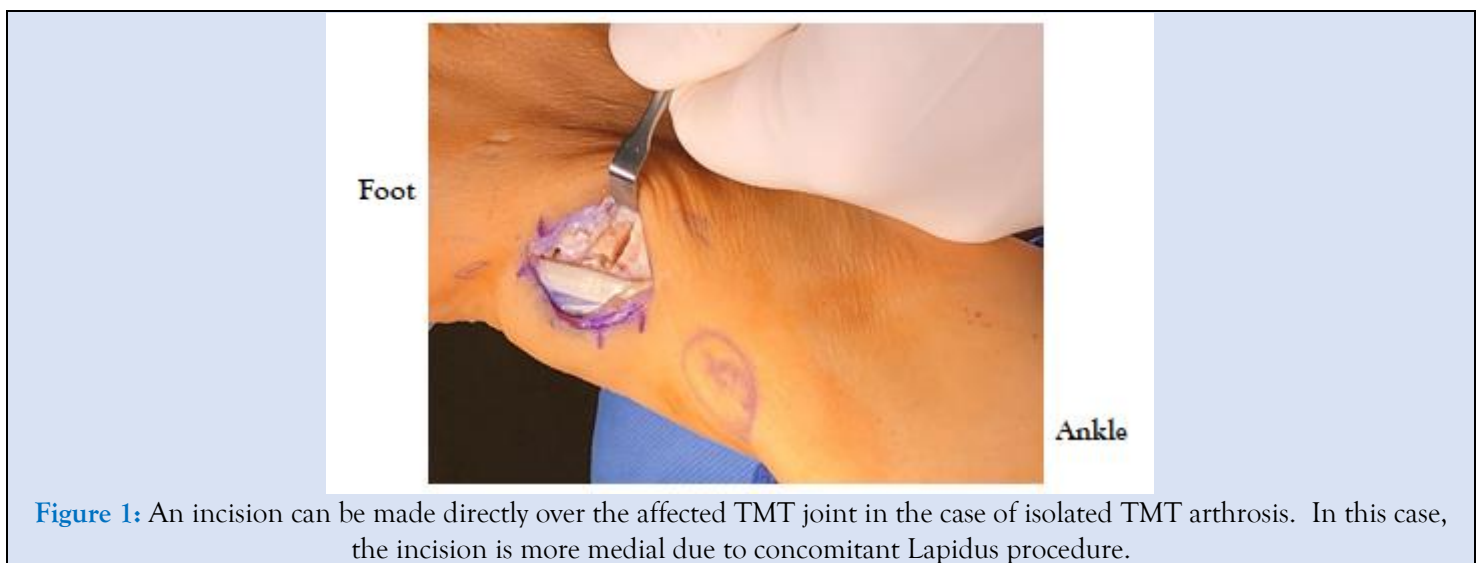
arthrodesis technique for lesser metatarsal arthrodesis in which a corresponding dowel graft was taken from the iliac crest and fitted into the previously trephined areas of the Lisfranc joint. Whitney described a similar technique however the dowel graft was obtained from the calcaneus [11].

The technique in this report describes the use of a commercially available bone graft harvester, (In2Bones®, Memphis TN) which is used as a trephine to prepare the TMT joint for fusion as well as obtain cancellous autograft from the ipsilateral calcaneus. Rather than using a cortico-cancellous dowel graft, which may involve taking a large diameter area of lateral wall of the calcaneus or distal tibia, a

six- or eight-millimeter cortical window is made with the bone graft harvester.

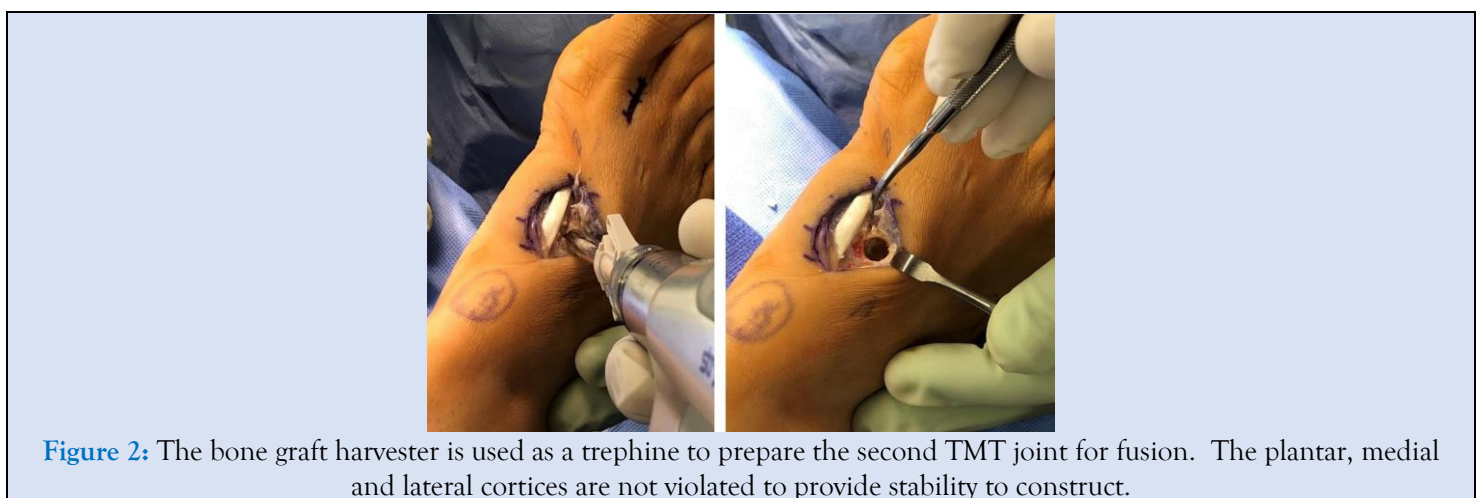
### Technique

An incision is made based on whether a single or multiple TMT joints are being fused. In the example of an isolated second TMT fusion, a 2.5 cm incision can be made directly over the second TMT joint. In the case of a Lapidus procedure with second TMT fusion, the incision can be made slightly longer and more medial. The TMT joint is then curetted down to subchondral bone (figure 1).



The 8mm diameter bone graft harvester is placed centrally over the TMT joint and reamed down to, but

not through the plantar cortex of the base of the metatarsal and cuneiform (figure 2).



To remove the bone, the outer sleeve of the harvester is disassembled. Viable bone graft can be obtained from the trephine remainings as the bone tends to 'layer out' with the sclerotic subchondral bone and cartilage

tend to remain in the central portion of the remainings with the metaphyseal bone on either side of the joint to the right and left to it (figure 3).



**Figure 3:** Reamings from the bone graft harvester can be used to fill the defect. The central portion of the reamings tends to be sclerotic bone and cartilage, which can be separated prior to filling the defect.

This metaphyseal bone can be saved for use later in the case. Attention is then brought to the lateral hindfoot where a 1cm incision is made in the safe

zone of the calcaneus. The same bone graft harvester is used and multiple passes at different angles can be made to obtain more bone graft (figure 4).



**Figure 4:** Bone graft from ipsilateral calcaneus is obtained with the same trephine.

Cancellous bone graft from the calcaneus is then mixed with the bone saved earlier in the case and

packed into the fusion site (fig 5). A single Nitinol Compression staple is used to fix the fusion.



**Figure 5:** The place of the fusion is packed with the bone graft. The desired fixation method is placed we usually use a single Nitinol Compression staple.

## Case report

The patient was informed that data concerning the case would be submitted for publication, and she provided consent. Female patient of 52 years-old. Presents with a history of symptomatic bunion, lesser TMT arthritis and bunionette of the right foot. After conservative treatment was exhausted (CAM boot,

icing, anti-inflammatories, orthopaedic shoes and activity modification), the patient is taken to surgery (Lapidus procedure, second TMT joint fusion with the technique described, and fifth metatarsal MIS osteotomy). Preoperative x-rays are shown in figure 6. After surgery, the patient was put into an AO type splint.



**Figure 6:** Preoperative x-rays of the right foot. AP (A), oblique (B), and lateral (C). Hallux valgus, bunionette, and arthritis of the second and third TMT joints.

Postoperative protocol consisted of non-weightbearing (WB) for 6 weeks, progressed weightbearing as tolerated over the following 6 weeks and full weightbearing at 12 weeks. Passive range of movement starts during their early postoperative period. Complete healing of the TMT joint fusions was observed after 12 weeks in radiographs. In last follow-up after a year, the patient was pain free. 1-year post-operative x-rays are shown in figure 7.

## Discussion

The fusion technique using autologous bone is a cost-effective technique and has demonstrated less rates of nonunion in foot and ankle surgery [6]. In our technique, we use an autograft taken from cancellous bone from the calcaneus with minimal disruption of the cortex. Taking cancellous bone from the calcaneus and excluding cortical bone from the graft provides less structural damage to the calcaneus and lower

donor site morbidity [11]. The use of autograft with only cancellous bone provides better osteoconductive, osteo inductive and osteogenic properties compared to cortical autograft and with any other type of graft and substitute [12].

Claaßen et al describes the surface anatomy of the first, second and third TMT joints in a group of 100 patients (females and males) and reports the average value measured with computed tomography (CT). The distal articular surface width and height of the medial cuneiform are  $19.0 \pm 5.9$  mm and  $22.6 \pm 6.4$  mm respectively. The distal articular surface width and height of the intermedium cuneiform are  $13.7 \pm 4$  mm and  $15.9 \pm 4.2$  mm respectively. The distal articular surface width and height of the lateral cuneiform are  $12.9 \pm 3$  mm and  $12.5 \pm 2.5$  mm respectively [13].

Considering the range of values corresponding to the width of the intermedium and lateral cuneiform, and being able to remove the full depth of the joint, the 8 mm trephine used will prepare for fusion 45% to 82%

of the second TMT joint and 50 to 81% of the third TMT joint. Dorsey et al [14] demonstrated that a minimum of 33% bone bridging across the fusion site accurately corresponds with clinical stability during arthrodesis of the ankle and/or arthrodesis of the subtalar joint. Bone bridging depends on many mechanical and biological factors, but the size of surface contact achieved with our technique grants that threshold. The remaining surround of joint provides the structural stability for the fusion, that later will be reinforced by the placement of the implant, in this case a staple.

Between all the options for TMT fusion fixation, staples are a fast and technically simple method that requires less soft tissue dissection and offers a quicker joint preparation. Aiyer et al demonstrated that

staples afford better dynamic fixation and sustained compression across the TMT joint when used for arthrodesis as compared to claw plating and crossed screws [15].

Thompson et al described a technique using nitinol staples for lesser TMT fusion in 21 joints.[16] The authors report less soft tissue burden compared to dorsal plate and a stable fixation construct with 100% radiographic fusion after 6 months of surgery [16]. The removal of the cartilage across the joint to be fused is a crucial step in order to promote further healing. Exposure of the cancellous bone is the basis of a successful fusion. Preparation with curettage has previously shown preserved cartilage layers in cadaveric studies, being a potential reason for non-union [11].



**Figure 7:** 1-year Postoperative x-rays of the right foot. AP (A), oblique (B), and lateral (C). Arthrodesis of the first TMT joint, second TMT joint, and Akin osteotomy fixed. Site of fusion healed. Osteotomy of the fifth metatarsal healed.

## Conclusion

We propose a technique that uses the same trephine to harvest the graft, to prepare the fusion site at the TMT joint and to position the autograft. The device is delivered in sterile, single-use kit for rapid harvest. Obtaining morselized cancellous autograft bone also allows to press-fit the graft in the place of fusion over the TMT joint and will enhance the bone healing.

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**Cite this article:** Solangel R Materon. (2023). A Simple Modified Trephine Technique for Lesser Tarsometatarsal Joints - in Situ Arthrodesis Using a Commercially Available Bone Graft Harvester. *Journal of Clinical Rheumatology and Arthritis*, BioRes Scientia Publishers. 1(1):1-6. DOI: 10.59657/2993-6977.brs.23.005

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**Article History:** Received: June 26, 2023 | Accepted: July 13, 2023 | Published: August 24, 2023