# Identification of Portals and Evaluating Their Safety for MIS Arthrodesis of the 1st Tarsometatarsal Joint


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## STATEMENT OF PURPOSE

To identify portals for minimally invasive arthrodesis of the 1st Tarsometatarsal Joint(TMTJ) and determine their safety to surrounding structures.

## LITERATURE REVIEW

There has been an increasing interest in MIS foot surgery utilizing high torque/low speed drill units and Shannon burrs with percutaneous internal fixation. Published literature has grown in many aspects of MIS techniques within the foot and ankle which include percutaneous osteotomies and arthroscopic preparation of joints for arthrodesis. Currently there is no published literature on MIS preparation for arthrodesis of the 1st TMTJ.

The goal of MIS surgery is to obtain outcomes similar to those of an open procedure but through smaller incisions, which minimizes soft tissue disruption and surgical site morbidity(1).

MIS procedures in the forefoot for the 1st metatarsal, lesser metatarsals, and digits have been previously described in detail(1,2,3). As the indication for MIS surgery grows, the need for its safety to surrounding neurovascular structures also needs to be evaluated. There has been literature published on safety of surrounding structures for 1st metatarsal and calcaneal osteotomies(4). We present the only study showing the safety of utilizing multiple different portals surrounding the 1st TMTJ in preparation for arthrodesis.

## Methodology and Procedure

10 fresh cadavers were utilized for our study. A single experienced surgeon in MIS technique prepped the joints. Radiopaque dye was utilized to evaluate the free space within the joint before and after prepping(Fig 1). K-wires were utilized to define the depth of the joint prep with the burr(Fig 2). Portal sites were marked using fluoroscopy(Fig 3a). There were 3 portals chosen for the initial 2 cadaveric specimens. The portals included the corners of the joint that were most superficial, which were dorsal lateral, dorsal medial, and plantar medial. An 18 gauge needle was inserted through the dorsal lateral portal into the joints and radiopaque dye was injected to ensure access as well as for irrigation during prep. The 2x20mm front and side cutting Shannon burr was initially inserted through the dorsal medial portal and the joint was prepped using tactile sensation and fluoroscopy(Fig3a). The burr was then inserted through the plantar medial and dorsal lateral portals for additional joint prep.

For the next 8 cadavers, only the dorsolateral and a direct medial portal was utilized with similar technique for joint prep. Also, this time a 3mm wedge burr was utilized.

Each cadaver was then dissected to evaluate the viability of local neurovascular structures, tendon, and joint surfaces(Fig 3b 5, and 6). The structures at risk that were evaluated are Deep Peroneal nerve(DPn), Dorsalis Pedis artery(Dpa), Extensor Hallucis Longus tendon(EHL), Medial dorsal cutaneous nerve(MDCn), and Medial marginal vein(MMv).

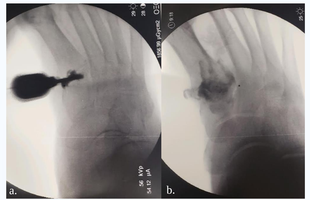


Fig 1. Pre(a) and Post(b) joint prep injection of radiopaque dye

Fig 2. Insertion of k-wires for depth of joint prep

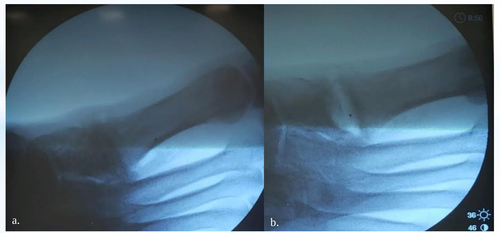


Fig 4. Pre and post fluoroscopy of joint prep

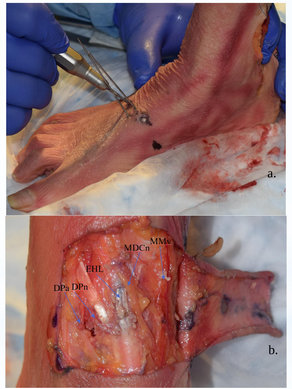


Fig 3. Joint prepping(a) and dissection(b) showing violation of DPn, DPa, and partial EHL tendon

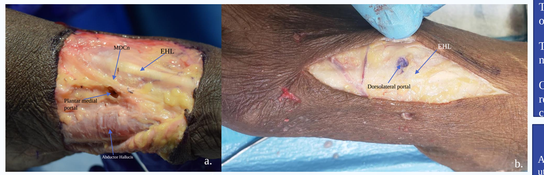


Fig 5. Plantar medial(a) and dorsal lateral(b) portals showing no violation of the neurovascular or tendon structures after joint prep


Fig 6. 1st metatarsal(a) and medial cuneiform(b) cartilaginous surfaces showing complete cartilage resection down to medullary bone. The joint can be seen completely reduced with good bone apposition on x-ray(c).

## RESULTS

Of the 10 cadavers, only the first specimen showed disruption to the deep peroneal nerve and DP artery using the dorsal lateral portal and a partial tear to medial portion of EHL tendon when utilizing the dorsal medial portal. The second specimen did not result in damage to the 3 structures when utilizing these portals. No damage occurred to the structures at risk when utilizing the plantar medial portal.

The remaining 8 specimens were prepped with the dorsolateral and direct medial portals. Utilizing these portals, no damage occurred to the structures at risk using the 3mm burr.

Of the 10 cadavers, 9/10 cadavers were noted to be consistently under prepped. Complete prep of the joint with resection of all the cartilage was only noted in the second to last specimen. The portion of the joint in which the cartilage was not removed appeared to be consistently in the dorsal lateral segment.

## ANALYSIS AND DISCUSSION

An initial cadaveric study is presented to evaluate the safety and effectiveness of MIS preparation of the 1st TMTJ for arthrodesis utilizing multiple different portals. The surgical preparation was performed by an experienced MIS surgeon. The results show that the dorsal lateral and dorsal medial portals were safe from harm to the structures at risk majority of the time with harm only noted in the first specimen. The dorsal lateral and any of the remaining medial portals were shown to be safe from any harm to the structures at risk in the remaining 9 specimens. The dorsal lateral portal that was proven to be safe was measured between 0.1-0.3cm lateral to the EHL tendon. The medial portal that was proven to be safe was measured to be approximately 1-2cm medial to EHL. The study also showed that the joint can easily be under prepped, even by an experienced surgeon. The only joint that was adequately prepped was in the second to last cadaveric specimen, which correlates with improvement in repetitive training. This shows the need for the surgeon to become proficient in this procedure with adequate training. During open dissection to evaluate the joint prep, it was also noted that several thin wafers of cartilage had remained even after thorough irrigation, which can possibly be the result of the smaller incisions and act as antigraft. This can potentiate the need for possible future arthroscopic evaluation of the joint during prep.

The potential advantages of this procedure are smaller incisions that decrease chances of wound complications, pain and infection. Disadvantages include large learning curve, non-union, malunion, and prolonged non-weight bearing due to type of internal fixation that can be employed with minimally invasive technique. Further research on improving this technique is warranted as well as creating a reproducible efficient method for prepping the 1st TMTJ

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