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INTRODUCTION

Minimally invasive surgery (MIS) of the forefoot has recently gained popularity as an alternative to some open procedures. MIS offers smaller incision sites, minimal soft tissue dissection, and quicker operation times.¹ MIS may speed post-operative recovery, while reducing post-operative pain and improving cosmesis. MIS bunion surgery has been shown to be an effective treatment of mild to moderate hallux valgus.¹⁻³ A recent literature review suggests MIS for distal metatarsal osteotomy bunion correction offers similar results to traditional open distal metatarsal osteotomy.² Borgan et al.³ showed there was no statistical significance between groups in terms of screw removal, revision, recurrence, paresthesia, pain, or stiffness when comparing MIS and traditional open distal osteotomy for bunion correction.

While reports show good outcomes of MIS bunion correction, there is concern for the potential to damage vital structures that are not under direct visualization. There are several techniques described in the literature for MIS bunion correction.¹⁻⁴ Dhukaram et al.⁴ performed a cadaveric study to evaluate at risk structures utilizing MIS techniques. They reported minimal risk to surrounding neurovascular and tendon structures. However, the described technique, did not report the use of a burr to remove the remaining medial eminence of the 1st metatarsal, which can be vital step in resolving bunion associated pain and improve cosmesis. Lam et al.¹ describe a technique in which the burr is used to resect the remaining medial eminence, reporting good outcomes with a minimal complication rate. The purpose of this study is to evaluate the structures at risk in MIS distal chevron osteotomy with burr resection of the remaining medial eminence.

METHODS

An MIS distal chevron osteotomy and medial eminence burr resection were performed on ten fresh-frozen cadaveric feet by one surgeon. The surgeon learned the procedure by studying the technique described by Lam et al.¹ The surgeon was also assisted by a consultant who is specialized in the technique.

Incisions were made as shown in Figure 1. The periosteum was elevated off the 1st metatarsal with a periosteal elevator in order for the burr to remain subperiosteally. Next a 2 x 20 mm shannon burr was used through incision B to create the chevron osteotomy under standard technique. Once the osteotomy was made, the metatarsal head was reduced laterally with a specially designed reduction tool through incision A. Next, the osteotomy was pinned into position with a k-wire through incision C to simulate fixation. Through incision B, the periosteal elevator was used to elevate the periosteum off the bone and the 3.1 mm wedge burr was used to remove the remaining prominent medial eminence after the reduction. A mini C-arm was utilized to guide the osteotomy and confirm accurate reduction. The cadavers were then fully dissected in the area of the procedure to identify structures injured during this surgery. The structures that were evaluated included the medial neurovascular bundle, 1st metatarsophalangeal joint (MTPJ) capsule, extensor hallucis longus tendon (EHL), flexor hallucis longus tendon (FHL), adductor hallucis tendon, and the sesamoid apparatus.



Figure 1: Incision Placement (reproduced from Lam et al. 2016)



Figure 2. Available Burrs and sizes used in the procedures

RESULTS

The EHL, FHL, adductor hallucis tendon, and sesamoid apparatus were all intact and uninjured in all 10 specimen. The 1st MTPJ capsule was uninjured apart from the small hole used to insert the reduction wire and burr. The only structure found to be injured was the dorsal medial cutaneous nerve (DMCN). The DMCN was fully transected in 4 cadavers, partially injured in 1 cadaver, and intact/uninjured in 5 cadavers..

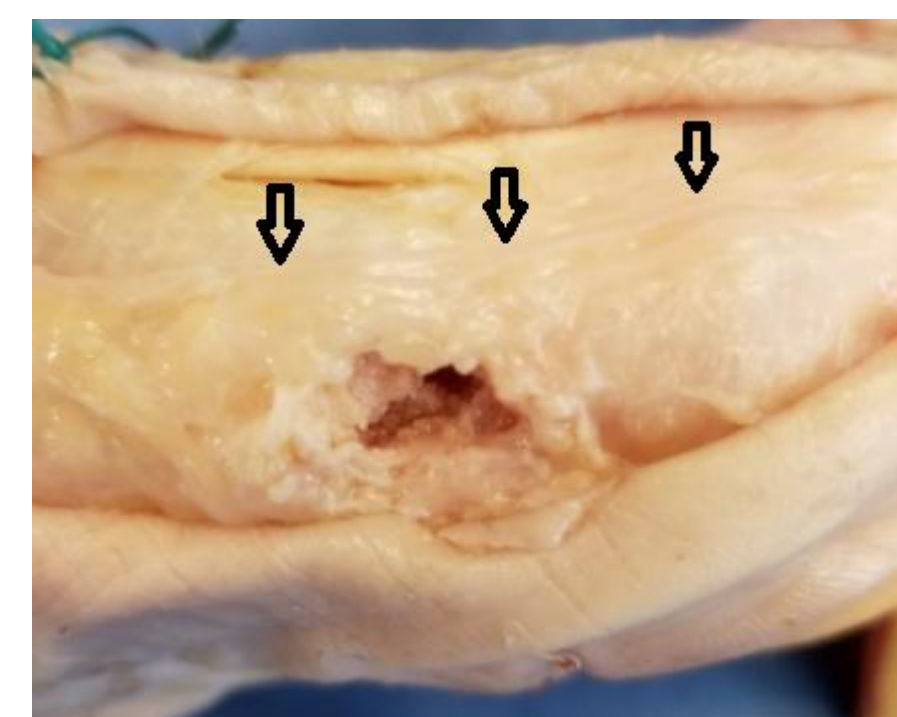


Figure 3. Chevron cut through the periosteum with intact neurovascular bundle.

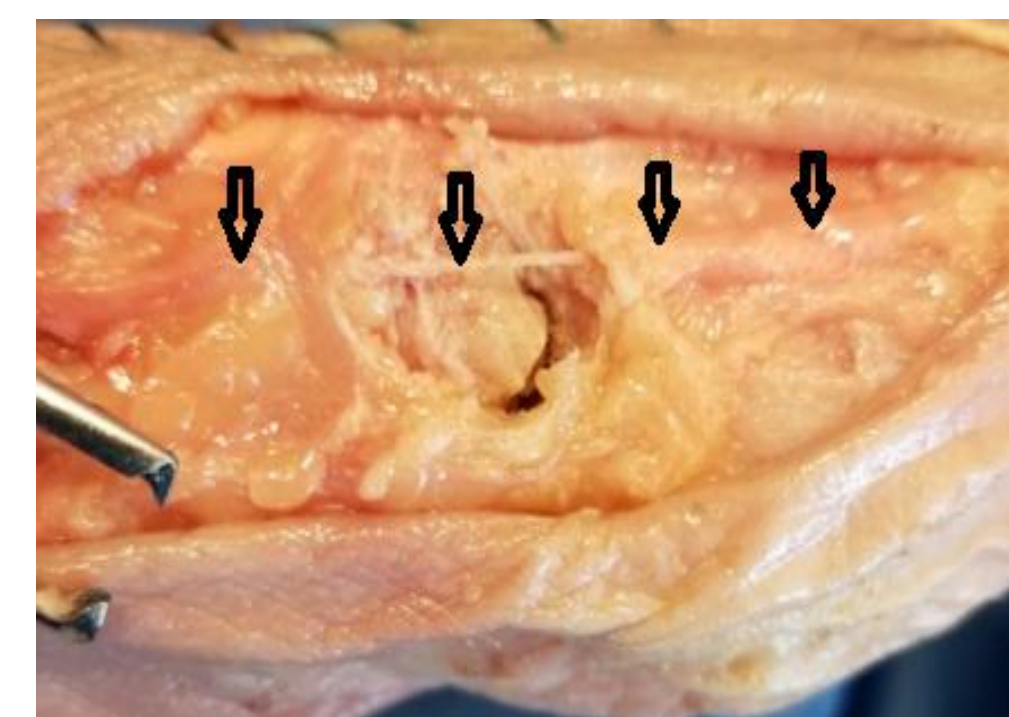


Figure 4. Chevron cut through the periosteum and partially injured DMCN

Specimen ID	Capsule	DMCN	Adductor Tendon	FHL Tendon	EHL Tendon	Medial Sesamoid	Lateral Sesamoid	Other Structure
1	N	N	N	N	N	N	N	NA
2	N	Transected	N	N	N	N	N	NA
3	N	Transected	N	N	N	N	N	NA
4	N	N	N	N	N	N	N	NA
5	N	N	N	N	N	N	N	NA
6	N	Transected	N	N	N	N	N	NA
7	N	N	N	N	N	N	N	NA
8	N	N	N	N	N	N	N	NA
9	N	Transected	N	N	N	N	N	NA
10	N	Injured, not transected	N	N	N	N	N	NA

Table 1. Description of specimen and structures at risk

Abbreviations: DMCN - Dorsal Medial Cutaneous Nerve.
 N - not injured
 NA - not applicable

DISCUSSION

We speculate that the DMCN was most likely injured during the medial eminence burr resection. During the creation of the osteotomy, the cutting edges of the burr were inferior to this nerve. While the burr is intraosseous, the nerve is protected by the capsule and periosteum. The flexor/extensor tendons running directly above this remained uninjured in all cases and were inspected for any iatrogenic damage. The capsule, sesamoid apparatus and adductor hallucis tendon remained uninjured by the burr throughout the osteotomy procedure. The most dangerous part of the procedure is likely the resection of the remaining medial eminence. Some advocate removing the eminence from inside-out, but this also risks either injuring the nerve or leaving bone fractured off under the skin and incompletely removed. Previous studies advocate for extensive training of the surgeon prior to performing this procedure on patients as there is a definite learning curve.¹⁻⁴ The authors of this study agree and believe this study demonstrates that a surgeon with little experience in minimal incision procedures should practice this MIS technique in a lab with the guidance of an experienced proctor. It also may be prudent to extend the medial incision slightly or make an accessory incision medial to the prominence to insert a retractor in order to protect the DMCN, especially early on with this procedure. In conclusion, MIS chevron distal osteotomy and medial eminence resection can be a safe procedure, but has certain concerns. The resection of the medial eminence may iatrogenically injure the DMCN but the high rate. Further study of MIS bunionectomy with burr resection of the medial eminence is needed and there may need to be modifications to provide protection to all vital structures

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Financial Disclosure: The cadavers and study instruments were provided through an industry sponsor for the development of this study.