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PII: S0958-2592(17)30221-3
DOI: https://doi.org/10.1016/j.foot.2018.04.005
Reference: YFOOT 1538

To appear in: *The Foot*

Received date: 6-12-2017
Revised date: 26-4-2018
Accepted date: 27-4-2018

Please cite this article as: Kennedy James, Berg Andrew, Welsh Luke, Mehta Jaysheel.Single Incision Lateral Release for Hallux Valgus Using A Cervical Biopsy Blade: A Cadaveric Study.*The Foot* https://doi.org/10.1016/j.foot.2018.04.005

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Title:
Single Incision Lateral Release for Hallux Valgus Using A Cervical Biopsy Blade: A Cadaveric Study

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Highlights

What is already known:

- Lateral release is considered an important part of some hallux valgus corrections
- Despite controversy in the literature most authors agree that the lateral metatarsosesamoid suspensory ligament, lateral collateral ligament and lateral capsule should be divided to achieve lateral release.
- There is no gold standard to the approach of lateral release with a number of techniques having been described.

What this study adds:

- Lateral release can be achieved safely and reproducibly using a curved blade placed inferior to the metatarsal head and neck through a medial incision

Abstract:
The role of lateral release is widely accepted and regarded as a key step in management of hallux valgus. There remains however debate in literature in regards to which structures should be divided and the method of approach. We therefore developed a technique of lateral release using a curved blade placed inferior to the metatarsal head to divide the lateral metatarsosesamoid suspensory ligament and incise the lateral joint capsule. This technique was performed on fourteen fresh frozen cadaveric specimens which were then dissected. In all cases the lateral metatarsosesamoid suspensory ligament was divided and the lateral capsule incised to the joint line. One case of iatrogenic injury to the oblique head of adductor hallucis tendon was noted. No cases of neurovascular injury were noted. We conclude this method of lateral release to be safe and reproducible in a cadaveric model in achieving lateral release for the management of hallux valgus.

Abbreviations:
Not Applicable

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Keywords:
Hallux Valgus, Lateral Release, Cadaveric Study

1. Introduction

Hallux Valgus is a condition of both bony deformity and dynamic soft tissue imbalance [1,2]. More than 140 surgical procedures have been described in the treatment of hallux valgus (HV) [3], the aim being to relieve symptoms through correction of the deformity. The most common of these procedures include scarf or chevron osteotomy of the 1st metatarsal in combination with Akin osteotomy of the proximal phalanx of the first ray. In mild to moderate deformities an additional soft tissue release procedure may not be required [4] but a lateral soft tissue release is largely accepted, and regarded, as a key step in the surgical management of more severe Hallux Valgus deformities without which "the correction may be inadequate" [5].

Debate remains within the literature as to the structures which should be divided to achieve an adequate soft tissue release, particularly whether to divide the conjoint tendon (adductor hallucis and flexor hallucis brevis), lateral sesamoid suspensory ligament, phalangeal band insertion and transverse metatarsal ligament [4,6,15,7–14]. Despite this, the majority of authors advocate release of the lateral sesamoid suspensory ligament, lateral collateral ligament and lateral capsulotomy.

Traditionally, the lateral release has been performed through a dorsal webspace incision. However, this has raised concerns due additional incision, wound infection, decreased range of movement at the Metatarsal Phalangeal Joint (MTPJ), digital neuritis, poor cosmesis and risk of avascular necrosis (AVN) of the metatarsal head [4,9,10,13]. Alternative procedures including trans-articular, trans-osteotomy, medial single incision, dorsal and plantar sub-periosteal elevation and minimally invasive techniques have been described in an effort to minimise these complications [9,13,16]. However, alternative techniques may require additional soft tissue stripping, retraction and additional equipment and expertise.

The aim of this cadaveric study was to evaluate the technique of lateral release using a curved cervical biopsy blade placed inferior to the metatarsal shaft, head and neck to achieve division of the lateral metatarosesamoid suspensory ligament.

2. Methods

This study had ethical approval under the University of Keele Human Tissue Act licence. In line with this, informed consent had been previously obtained for experimentation with human subjects and photography of the cadaveric specimens provided.

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The procedure was conducted on fourteen fresh frozen cadaveric below knee specimens. This is comparable to the previous literature using a cadaveric model in which 10 to 30 specimens were used [7,12,17,18]. Of the fourteen specimens four clinically exhibited hallux valgus deformity. There were three paired specimens. The mean donor age was 80.1 years (range 68-89 years) with a male : female ratio of 10:4.

Specimens were stored at -20^{o}C. Thawing was conducted at 5^{o}C for a period of 96 hours. Lateral release was performed in all specimens by the same surgeon using the technique described below. The primary outcome was division of the lateral metatarsosesamoid suspensory ligament and preservation of the neurovascular bundle.

The specimens were then dissected independently by a second investigator. Extensile dorsal and plantar 1st web space incisions were made and with loupe magnification the integrity of the dorsal and plantar neurovascular bundle, lateral suspensory ligament, lateral collateral ligament, lateral capsule, adductor insertion and deep transverse metatarsal ligament were assessed and recorded.

2.1 Surgical Technique

A medial incision was made inline with the longitudinal axis of the proximal phalanx and first metatarsal shaft of the hallux (Figure 1).

The incision was advanced to the capsule overlying the first MTPJ and developed in the dorsal and plantar planes. A longitudinal capsulotomy was performed in line with the incision (Figure 2). The soft tissues were dissected from the metatarsal neck and shaft in preparation for the required osteotomy. Care was taken to preserve the plantar soft tissue attachments proximal to the metatarsal head in order to reduce the risk of avascular necrosis (Figure 3).

The sesamoid bones were visualised (Figure 4). The curved end of a McDonald elevator was placed over the dorsal surface of the lateral sesamoid (Figure 5).

A cervical biopsy blade (Swann Morton Cervical Biopsy Blade 2001) (Figure 6) was inserted over the McDonald elevator with its curved blade passed in a dorso-lateral direction around the metatarsal (Figure 7). The blade was advanced proximally and distally using tactile feedback to divide the lateral suspensory ligament (Figure 8).

3. Results

Four of the specimens utilised to examine this technique clinically exhibited hallux valgus deformity.

All fourteen dissected specimens demonstrated division of the lateral metatarsosesamoid suspensory ligament and preservation of the dorsal and

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plantar neurovascular bundles. In addition, the lateral MTPJ capsule was divided to the level of the joint line. The lateral collateral ligament and deep transverse metatarsal ligament were preserved in all cases. One case of iatrogenic laceration to the oblique head of the adductor tendon was identified under loupe magnification. This laceration was estimated to be less than 25% of the tendon's cross sectional area.

4. Discussion

Our study evaluated the safety of lateral release using a curve cervical biopsy blade placed inferiorly to the metatarsal head through a medial incision in a cadaveric model. Silver et al. described the importance of restoring the metatarsal sesamoid relationship [19]. Radiological evaluation of hallux valgus correction has changed to translation of the metatarsal head over the sesamoids rather than reduction of the sesamoids with a lateral release, leading some authors to question the rationale behind performing such a release [19,20]. Woo et al. compared the lateral sesamoid position with and without lateral soft tissue release and concluded that although there was no difference in lateral sesamoid position between the techniques, clinical and radiological outcomes were improved with the addition of lateral soft tissue release [21].

Debate remains on which structures should be divided in lateral release. In our study the lateral metatarosesamoid suspensory ligament was released. Schneider et al. performed sequential release of 15 fresh frozen cadavers and demonstrated that division of the lateral metatarsosesamoid suspensory ligament, lateral collateral and lateral capsule allowed correction of Intermetatarsal (IMA) and HV angles. No effect was observed with release of the deep transverse metatarsal ligament or adductor hallucis. Division of the lateral phalangeal suspensory ligament and plantar capsule, however, led to over correction [22,23]. Furthermore, the transverse metatarsal ligament is not contracted in hallux valgus and protects neurovascular structures, suggesting that it should not be divided [7,8]. Indeed if the transverse metatarsal ligament were to be divided this would lead to an increase mobility in all planes [8]. In clinical practice Augoyard et al. demonstrated through progressive division of the metatarosesamoid suspensory ligament and phalangeal insertional band that lateral soft tissue release was achieved in most cases whilst adductor release from the lateral sesamoid had limited value [24].

Minimally invasive techniques have been suggested to be beneficial due to shorter surgical times, less soft tissue damage, decreased risk of osteonecrosis and improved cosmesis, their use being advocated in medically compromised patients and patients at risk of poor healing [1,16]. However complications of minimally invasive techniques include digital nerve injury, iatrogenic articular cartilage injury, flexor hallucis brevis tendon injury, insufficient release due to inadequate visualisation, fibrosis, stiffness, intra-articular debris and pain [1,13,16]. In addition minimally invasive techniques require specialised equipment and training. The alternatives would include open release or single incision techniques.

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Sammarco et al. describe a single incision technique similar to our own utilising a 15 blade under direct vision to divide the lateral capsule and adductor tendon through the medial incision inferior to the 1st metatarsal [2]. However, achieving adequate exposure to perform this under direct vision may require extensive periosteal release and retraction. In current practice avascular necrosis (AVN) of the metatarsal head is rare following corrective osteotomy and lateral release in the first ray but may lead to severe consequences [25]. To avoid vascular injury authors advocate particular care at the dorsal and lateral aspects of the metatarsal head and to minimise periosteal stripping [26–28]. Meier et al. historically described a high incidence of neuronal damage and AVN associated with excessive soft tissue disruption and advocated the use of a single medial incision [29]. Rothwell et al. went as far as to suggest avoiding a separate incision for lateral release due to the risk of AVN [25]. Our senior author developed the use of a single medial incision using a curved blade to achieve lateral release in Hallux Valgus without requiring visualisation of medial structures.

Our approach using a curved blade passed inferior to the metatarsal head demonstrated it to be a safe and reproducible technique in dividing the lateral metatarsosesamoid suspensory ligament without evidence of iatrogenic injury to neurovascular structures. Compared with existing literature our method achieves both division of the lateral metatarsosesamoid suspensory ligament and incision of the joint capsule without articular surface damage or joint distraction whilst preserving the adductors, transverse metatarsal ligament and lateral collateral ligament.

The main limitation of this study is the use of cadaveric models. Despite fresh-frozen specimens being used, these tissues do not reflect the true nature of living tissue in handling, elasticity, tactile feedback and haemostasis. Additionally, of the fourteen specimens available and appropriate for this study, four demonstrated clinically apparent hallux valgus deformity. The hallux valgus angle and inter-metatarsal angles were not measured using weight-bearing radiography, which would be the most widely utilised method of quantifying these parameters. Further evaluation of this technique is warranted in clinical practice to address these limitations.

5. Conclusion

This cadaveric study has investigated the structures released by a Hallux Valgus lateral release technique in which a curved cervical biopsy blade is passed inferior to the metatarsal shaft, head and neck through a standard medial incision. Our findings suggest that this technique is safe. The curved biopsy blade (Swann Morton 2001) is available in most operating departments minimising any additional cost to the foot & ankle department. This technique requires further investigation in surgical practice in terms of clinical outcomes and neurovascular compromise to establish its safe and effective use.

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Funding Sources:
This work was support by Swann-Morton Limited, Owlerton Green, Sheffield, S6 2BJ, United Kingdom.

Conflict of interest;
None

Acknowledgements
Dr Menos Lagopoulos
Mr Richard Fairweather

Appendix

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Captions for figures

Figure 1: Incision in line with medial border of first metatarsal shaft and proximal phalanx

Figure 2: Longitudinal medial capsulotomy

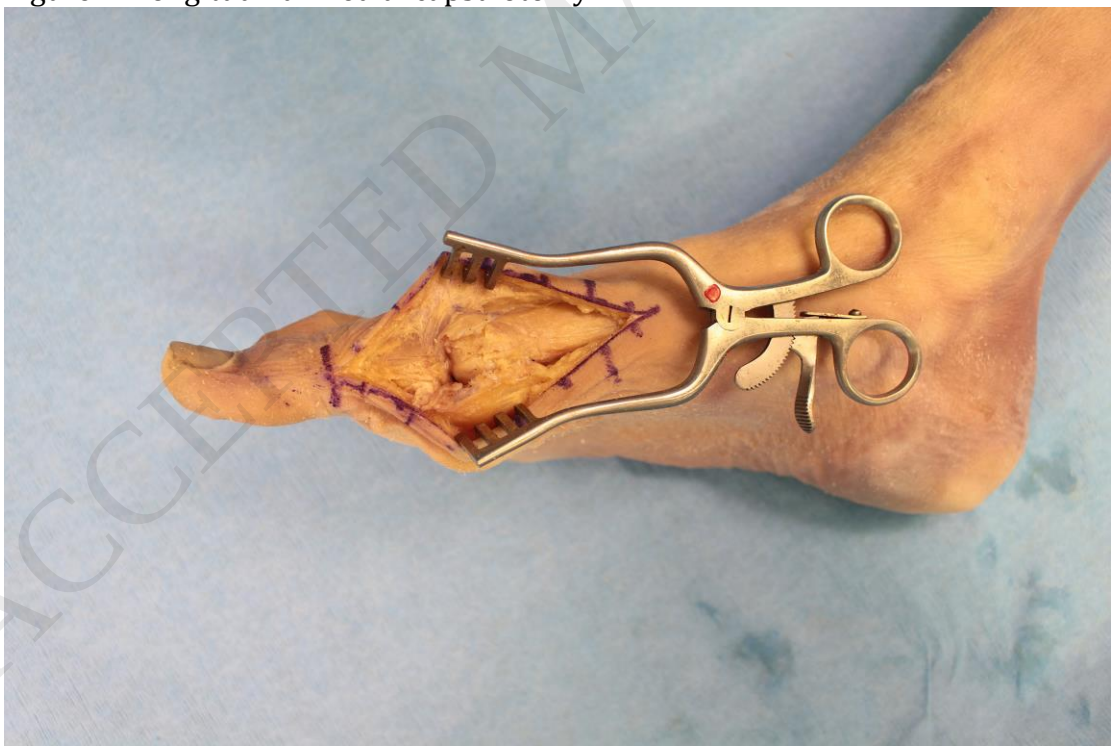

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Figure 3: Plantar soft tissues attachments to metatarsal neck are preserved.

Figure 4: Lateral and Medial sesamoids are identified

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Figure 5: McDonald Dissector is placed dorsal to the sesamoids

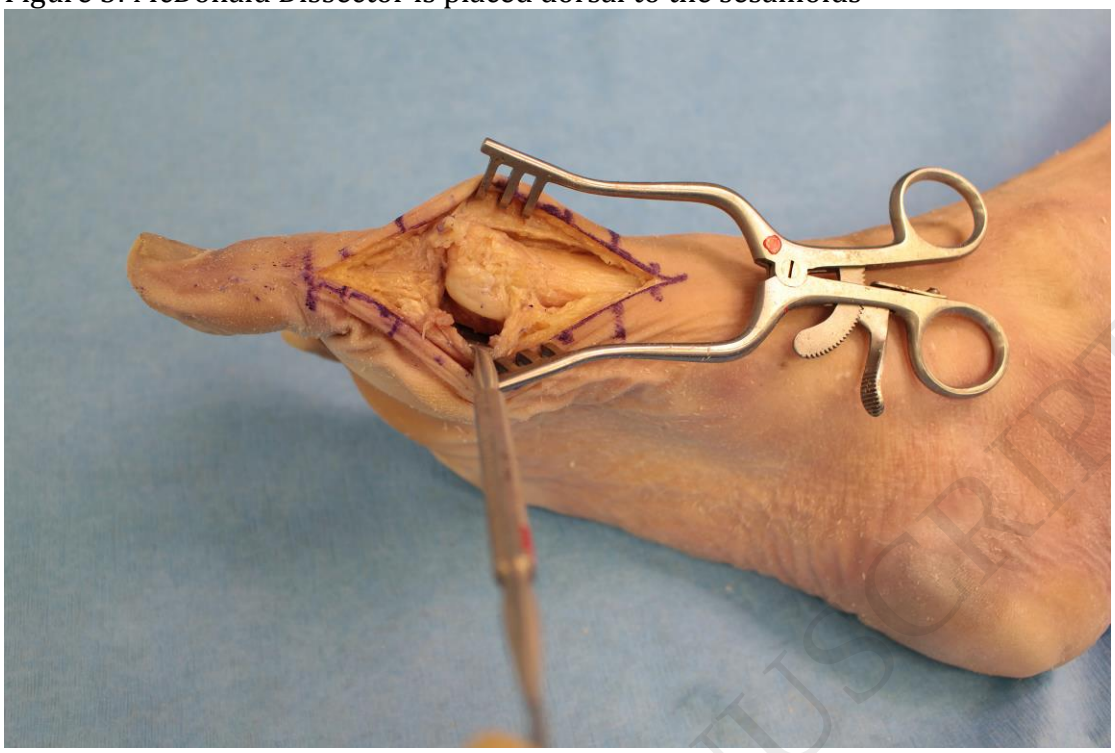

Figure 6: Swann Morton Cervical Biospy Blade 2001

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Figure 7: The Cervical Biopsy Blade is passed over the McDonald dissector

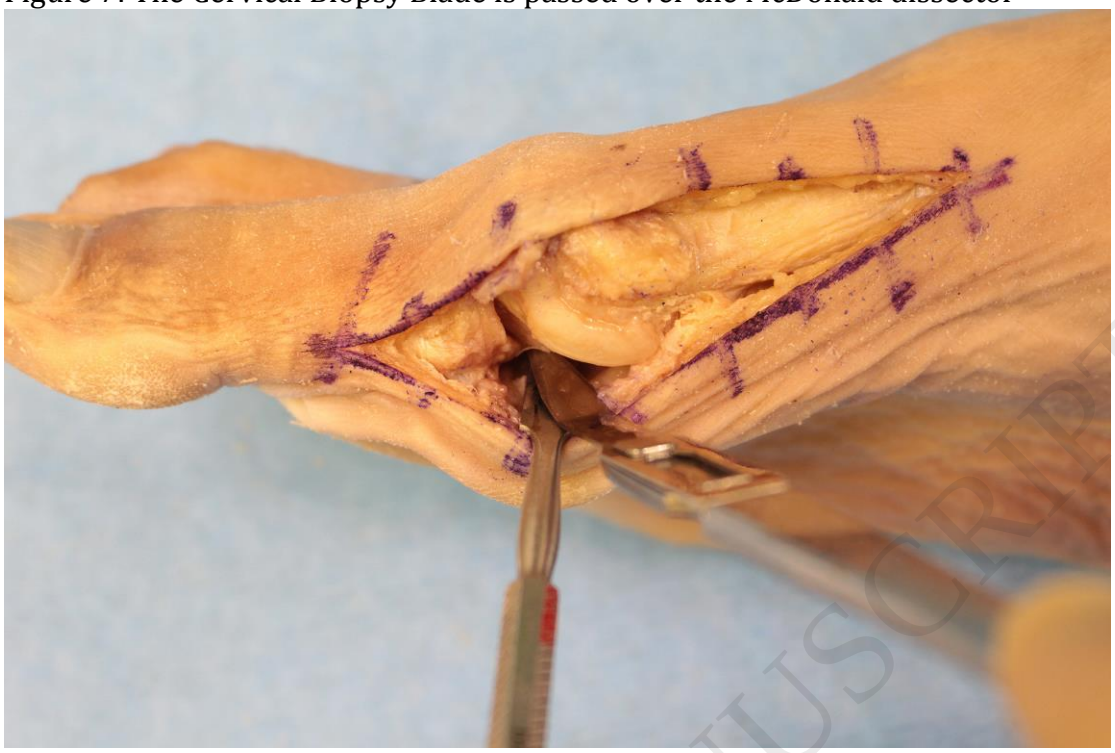

Figure 8: The blade is directed proximally and distally to perform the lateral release

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