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Research Article

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Percutaneous Bunionette Correction: A Cadaveric Study

Frederick Michels*, **Stéphane Guillo, Guillaume Cordier, Nikita Stevens and Arne Burssens**

AZ Groeninge Kortrijk, Kortrijk, Belgium

***Corresponding author:** Frederick Michels, M.D, AZ Groeninge Kortrijk, Kortrijk, Belgium, Tel: 0032497317576; E-mail: frederick_michels@hotmail.com

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Abstract

Purpose: The purpose of this study was to evaluate a percutaneous technique to treat a bunionette deformity.

Methods: Twenty-four lower extremity cadaveric specimens were used. An osteotomy of the fifth metatarsal was performed using a standardised technique. Sixteen specimens were treated by a surgeon with experience in percutaneous foot surgery, the other 8 specimens were treated by an inexperienced surgeon. The feasibility to perform the technique and the risk of iatrogenic lesions to the surrounding structures was assessed.

Results: The inter-digital nerves were intact in all specimens. In one of the specimens a partial rupture of the extensor tendon was found. The osteotomies were performed in the desired plane. The technique performed by the inexperienced surgeon had similar results to the technique of the experienced surgeon.

Conclusion: The described technique, which involves a percutaneous osteotomy of the fifth metatarsal is a viable option to treat bunionette deformity. This technique is reproducible and safe with regard to the surrounding anatomic structures. The learning curve is low.

Keywords: Bunionette deformity; Percutaneous surgery; Anatomy; Cadaveric; Metatarsal osteotomy; Tailor's bunion

Introduction

Minimally invasive surgery (MIS) in foot and ankle surgery is becoming increasingly popular [1]. Recently, several studies about minimally invasive or percutaneous [2-6] treatment of bunionette deformity have been published. The first techniques of percutaneous treatment of bunionette deformity were published by Stephen Isham and Mariano de Prado. As interest increases, more research becomes necessary [7]. The lack of direct vision of the surgical field and poor appreciation of anatomy raises some concern regarding complications related to MIS.

The purpose of this study is to assess the feasibility of performing the technique and the risk of iatrogenic damage to the surrounding anatomical structures.

Material and Methods

This study used 24 lower limbs from 12 fresh frozen cadavers. The specimens were obtained via the Human Body Donation programme of the University. Specimens with previous foot surgery or trauma have been excluded. All surgery was performed by two surgeons. One surgeon was a foot and ankle surgeon with over 5 years of experience with percutaneous surgery. The second surgeon was a 4th-year registrar in the speciality of orthopaedic surgery. The experience in percutaneous foot surgery was limited to one training session on cadaveric specimens.

The procedures were carried out in a cadaveric lab. The limbs were positioned on standard dissection tables and thawed 24 hrs prior to the experiments. The first 16 surgeries were performed by the first (experienced) surgeon, the other 8 surgeries were performed by the second surgeon.

The skin incision was performed using a Swann Morton 64 Beaver mini blade. A Shannon 44 Long burr was connected to an electrical power driven system of the “de Prado” type. The base power was controlled by a foot pedal allowing the surgeon to keep his hands free for surgery. The osteotomy was performed by making a supination movement with the dominant hand holding the Shannon 44 Long burr. The maximum speed of the burr was 7000 rpm. According to the dominant hand of the surgeon, the technique was slightly different when operating on the right or left foot. Both surgeons were right-handed. When performing surgery on a right foot, the incision was slightly medial to the shaft of the metatarsal on the distal third of the diaphysis. Only the skin was incised making a stabbing movement with the blade orientated in a longitudinal direction. An incision of the skin with a length of 2 mm was obtained. The burr was introduced searching for the medial border of the metatarsal. Small gliding movements of the burr (without using the motor) allow the surgeon to feel the position of the bone and to detach the soft tissues. Prior to performing the osteotomy, the burr was positioned approximately 45 degrees to the metatarsal shaft to obtain an oblique osteotomy from dorsal distal to plantar proximal. Using the incision as a pivot point, a sweeping movement allowed the surgeon to perform the osteotomy (Figure 1). The osteotomy was performed from medial to lateral in the right foot. Spontaneously, the distal part migrated medially (Figure 2). The osteotomy could be checked by moving the metatarsal head while holding the base of the metatarsal. The translation could be maximised by applying external manual pressure to the metatarsal head in a medial direction. For a left foot, the skin incision was slightly lateral to the metatarsal shaft and the osteotomy was performed from lateral to medial.

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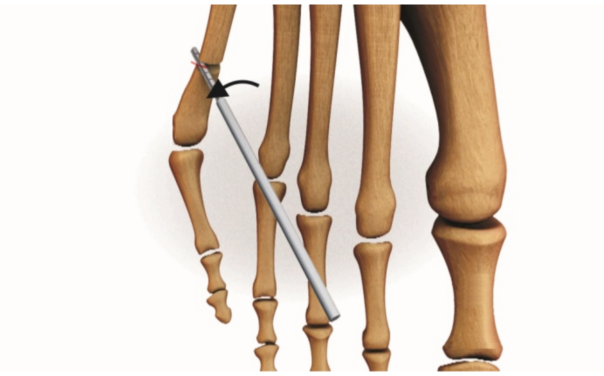

Figure 1: Osteotomy with Shannon burr.

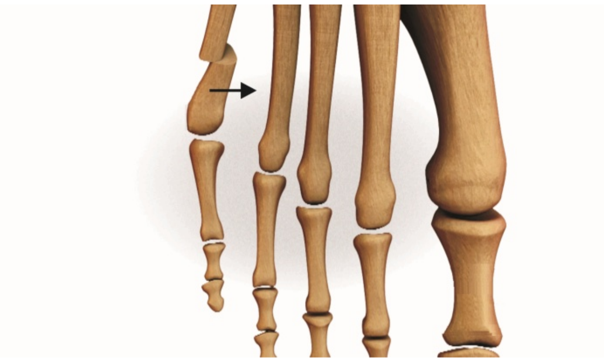

Figure 2: Translation of the distal part.

After the procedure, the cadaveric specimens were exposed and carefully dissected to identify any nerve or tendon injury. The skin was removed to visualise superficial nerves (Figure 3). Further dissection allowed for assessment of the extensor tendons. The plane and completeness of the osteotomy were reviewed in detail. Further dissection allowed for examination of the flexor tendons and the plantar nerve structures.

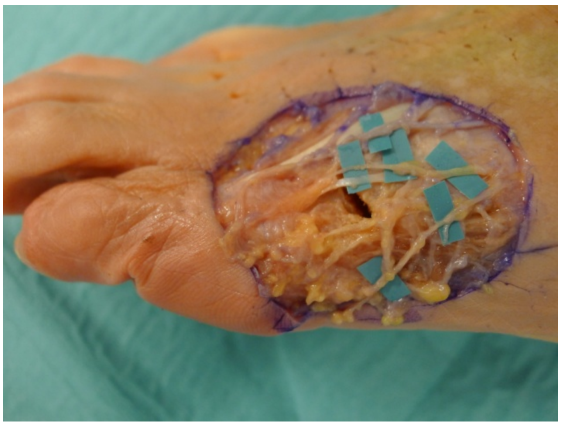

Figure 3: Dissection of the digital nerves.

Results

The dorsal and plantar inter-digital nerves were all intact in all of the specimens. The dorsal interdigital nerve was always located laterally of the centre of the fifth metatarsal. Evaluation of the tendons revealed one partial lesion of the extensor tendon of the fifth toe, approximately one third of the tendon diameter in size (Figure 4).

Figure 4: Partial lesion extensor tendon.

Further dissection allowed for assessment of the osteotomy (Figure 5). A complete osteotomy was found in all procedures. The direction of the osteotomy plane was more vertical than anticipated. The plane of the osteotomy formed an angle with the fifth metatarsal between 45 and 60 degrees. The procedures performed by the inexperienced surgeon had a slightly greater angle.

Figure 5: Oblique orientation of the osteotomy plane

Discussion

This study supports the hypothesis that this percutaneous technique to treat bunionette deformity is safe and efficient.

Abnormalities of the fifth ray and lateral metatarsals are very good indications for percutaneous surgery. Very good results are obtained rapidly, with few iatrogenic complications and a fairly short learning curve [1]. This is also confirmed by this study.Several minimally invasive techniques have been published to treat bunionette deformity. De Prado published several types of percutaneously performed closing wedge osteotomies [3]. Martinelli published a distal metatarsal osteotomy performed with a standard oscillating saw, using a small lateral incision [2]. Michels published the results of a percutaneous technique in 21 patients [5]. No hardware was needed and a very low risk of complications was found. A percutaneous osteotomy of the fifth metatarsal was performed on all patients. This was combined with a condylectomy in 16 patients. Currently, we estimate that a condylectomy is only necessary if a sharp exostosis on the metatarsal head is found. In the other cases it unnecessarily complicates this surgery and places the cartilage of the fifth metatarsophalangeal joint at risk.

The osteotomy is orientated in an oblique direction. The aim is to elevate the osteotomised bone surface to encourage bone healing on the one hand. On the other hand it helps to avoid dorsal displacement, which could lead to pseudoarthrosis or transfer metatarsalgia. Recently Laffenêtre published similar good results with a percutaneous technique [4]. Dhukaram performed a cadaveric study to investigate the risk of iatrogenic neurovascular and tendon injury in percutaneous hallux valgus correction and distal metatarsal osteotomy of the 2nd, 3rd and 4th ray [8]. As in this study, no lesions of the surrounding neurovascular structures or nerves were found.

This study contains certain limitations. The technique used only assesses the macroscopic damage to the surrounding structures. We can imagine that a macroscopic intact digital nerve could be damaged at a microscopic level by heat or compression and causing loss of function. Further clinical studies are necessary to reveal this hypothesis. Some technical points are important to avoid microscopic damage. The burr should only start rotation when it is situated in the correct position. Constant cooling by dripping water on the burr helps to avoid raising temperature of the burr. The skin incision was placed medially when operating a right foot and laterally when operating a left foot. In our study the dorsal digital nerve was always located laterally. Considering this finding, we would recommend a medial approach if possible. However further anatomic studies would be interesting.

A possible weakness of this study is the lack of use of fluoroscopy, which was not available in the lab. In our result, this had no negative impact on the results and the completeness of the osteotomy could be checked manually. However, we recommend using fluoroscopy when performing this technique in patients. Bunionette deformities are often associated with an underlapping or overlapping toe, which can be operated percutaneously. Those associated procedures were not involved in this study but would be an interesting item for futures studies.

Conclusion

The described percutaneous osteotomy of the fifth metatarsal is a viable option to treat bunionette deformity. This technique is reproducible and safe with regard to the surrounding anatomic structures. The learning curve is low. However, we recommend the use of cadaveric training before implementing this technique into clinical practice.

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