



Clinical Study

Radiological evaluation of hallux valgus after application of Mini TightRope: Short-term results

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Received 10 May 2013; revised 13 September 2013; accepted 14 September 2013

المخلص

هدف البحث: يعد إبهام القدم الأرواح أكثر التشوهات شيوعاً لإبهام القدم ويوجد عدد كبير من الجراحات التقليدية المعنية بذلك، والمشتملة على قص العظم، ومع تعدد هذا النوع من الجراحات وشدته فإنه لم يثبت تفوق أي منها. ويبدو جهاز "الحبل الصغير المشدود" أحد الخيارات الجراحية الخفيفة التي لا تحتاج إلى قص العظم هذا البحث يدرس قدرة جهاز "الحبل الصغير المشدود" على تقليص الزاوية مابين المشطين وكذلك زاوية الإبهام الأرواح في الحالات ذات الدرجة الخفيفة والمتوسطة لإبهام القدم الأرواح.

طرق البحث: خضع أربعة مرضى لعملية تركيب جهاز "الحبل الصغير المشدود" وكان متوسط أعمارهم 30.5 عاماً وقد تمت معاينتهم قبل وبعد العملية واستمرت متابعتهم لمدة عام، وكان احتساب مقدار التعديل بناء على الزاوية بين المشطين وزاوية الإبهام الأرواح وكذلك وضع العظام السمسمانية تحت المشط الأول.

النتائج: انخفضت قيمة الزاوية بين المشطين من 15.75 درجة، إلى 4.5 درجة باستخدام جهاز "الحبل الصغير المشدود"، ومتوسط زاوية الإبهام الأرواح من

31.25 درجة إلى 5.75 درجة.

الاستنتاجات: بالمقارنة مع عمليات القص العظمي فإن عملية جهاز الحبل الصغير المشدود تعد خياراً جراحياً أخف وأبسط وقادراً على تقليص الزاوية بين المشطين وزاوية الإبهام الأرواح بشكل جيد في الحالات ذات الدرجة الخفيفة والمتوسطة لإبهام القدم الأرواح. ولقلة عدد الحالات وقصر مدة المتابعة فإن الدراسة تقترح دراسة عدد أكبر ومدة أطول للمتابعة.

الكلمات المفتاحية: وكعة؛ جهيضة زرية؛ إبهام القدم الأرواح؛ فحج المشط الأول؛ الحبل الصغير المشدود

Abstract

Objectives Hallux valgus is the most common deformity of the great toe. Many traditional forms of osteotomy are available, but none has proven to be superior, despite their aggressiveness. The Mini TightRope® (Arthrex Inc.) procedure

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Peer review under responsibility of Taibah University.



appears to be a less invasive alternative, and the objective of the present study was to test the hypothesis that the procedure is an effective surgical option for reducing the intermetatarsal angle (IMA) and hallux valgus angle (HVA) in cases of hallux valgus of mild-to-moderate severity.

Methods: Four patients (four feet) with hallux valgus underwent the Mini TightRope procedure. All the patients were women, and their mean age was 30.5 years. All patients were reviewed before and after the procedure, with an average post-operative follow-up of 1 year. The IMA, HVA and sesamoid bone position were the radiological indicators of correction.

Results: In the four operated patients, the mean IMA decreased from 15.75° to 4.5° and the mean HVA from 31.25° to 5.75°.

Conclusion: The Mini TightRope procedure is a simpler, more effective, less invasive surgical option than other procedures and seems to correct IMA and HVA satisfactorily in cases of hallux valgus of mild-to-moderate severity. In view of the small number of cases and short follow-up, further studies with more cases and longer follow-up are needed.

Keywords: Bunion; Button device; Hallux valgus; Metatarsus primus varus; Mini TightRope

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Introduction

Hallux valgus is not simply a lateral deviation of the great toe, as the name implies, but is a complex deformity consisting of a medial shift of the first metatarsal and lateral deviation of the hallux, with elements of malrotation (usually pronation) as well as a bunion formation on the medial aspect of the first metatarsal head.¹ Comprehensive understanding of the mechanism by which the deformity develops is essential for successful correction. Females are more frequently affected than males,² and there is a strong association between wearing high-heeled, tight shoes and hallux valgus formation.^{1,2} Many hypotheses have been proposed for its pathogenesis, including structural abnormalities, genetic predisposition, muscle imbalance and ligamentous hyperlaxity.³

Although the pathophysiology of hallux valgus is not yet fully understood, many authors consider that medial deviation of the first metatarsal is the primary deformity, while lateral deviation of the hallux is secondary. As a result, the normal anatomical relationship and biomechanics are distorted. The adductor hallucis, through its insertion at the base of the proximal phalanx, works as a deforming force, facilitating further progression of the deformity. As the deformity progresses, the lateral capsule of the metatarsophalangeal joint is contracted, whereas the medial capsule is attenuated.⁴

More than 130 corrective procedures for the treatment of hallux valgus have been described in the literature.⁵ The aim of all these surgical interventions is to achieve adequate correction with less invasive methods and fewer complications;

however, it appears that none of these procedures satisfactorily fulfils these criteria.⁶

The treatment outcomes for hallux valgus depend on optimal restoration of the anatomical relationship. The goal of the recently introduced Mini TightRope procedure (Arthrex Inc.,



Figure 1: Preoperative dorsoplantar X-ray of weight-bearing feet, showing an increased intermetatarsal angle and hallux valgus angle, as well as medial subluxation of the sesamoid bones.



Figure 2: (A) Postoperative weight-bearing dorsoplantar X-ray showing marked reduction in the intermetatarsal angle and hallux valgus angle. Sesamoid bones are visible in their normal location. (B) Postoperative X-ray showing proper placement of the Mini TightRope device in the first and second metatarsals.

USA) is to bring the medially shifted first metatarsal back to its normal position, thereby correcting the primary deformity. The secondary deformity (the lateral deviation of the hallux) will be corrected subsequently. Realignment of the hallux can be achieved with various types of bony procedures and osteotomies, regardless of the primary deformity. The Mini TightRope procedure, however, can realign the deviated great toe in relation to the primary deformity, making the resulting correction more consistent with the normal anatomy and, therefore, more functional.

The aim of the present study was to validate use of the Mini TightRope procedure as an effective means of restoring the normal values of the intermetatarsal angle (IMA), the angle between the long axes of first and second metatarsal bones, and hallux valgus angle (HVA), the angle between the long axis of the hallux proximal phalanx and the first metatarsal long axis, in patients with hallux valgus of mild-to-moderate severity.

Materials and Methods

The study included four patients with hallux valgus of mild-to-moderate severity who underwent the Mini TightRope procedure on a single foot. All the patients were women aged 27–42 years of age who had been admitted to the orthopaedic ward. The patients were followed-up for a minimum of 1 year, with post-operative re-evaluations at 2 weeks, 6 weeks, 3 months, 6 months and 1 year. The exclusion criteria included advanced age, high distal metatarsal articular angle ($>15^\circ$) and severe hallux valgus (HVA $>40^\circ$ and IMA $>16^\circ$). Data were collected from radiological evaluations, and the IMA, HVA and sesamoid bone position were determined from standing dorsoplantar radiographs obtained before and after surgery to assess the degree of correction achieved [Figure 1](#). X-rays obtained after 1 year were used to measure radiological correction indicators with Centricity Picture Archiving and Communications System (PACS) software.

Surgical technique

The Mini TightRope procedure is technically simple. It consists of five steps: incision of the medial capsule, excision of the medial eminence, lateral soft tissue release, insertion of the Mini TightRope and medial capsulorrhaphy. All operations were conducted under regional anaesthesia with a tourniquet, in the supine position. The surgical approach consists of two longitudinal incisions: one approximately 2 cm in length over the medial aspect of the first metatarsal head and the other dorsally between the first and second metatarsals.⁷

The medial part of the first metatarsophalangeal joint capsule should be incised through the medial skin incision in a manner that facilitates subsequent capsulorrhaphy. After identification of the sulcus between the articular surface of the first metatarsal head and the medial eminence, excision of the medial eminence should start just medial to the sulcus with an oscillating saw or osteotome. The attachment of the adductor hallucis to the base of proximal phalanx should then be released through the dorsal skin incision. The cleavage between the sesamoid bones and the undersurface of the first metatarsal head must be identified and separated to enable reduction of the sesamoid bones back to their normal position.⁸ The

contracted lateral part of the first metatarsophalangeal joint capsule should be weakened by multiple perforations.

After complete release has been assured, medially directed stress is applied to the hallux until full correction is achieved. Subsequently, two holes are created in the shafts of the first and second metatarsals under direct vision. The holes should be positioned carefully and properly to avoid weak bony areas,⁹ and the Mini TightRope device is inserted through these holes and tightened after closure of the IMA by medio-lateral compression. The medial redundant capsule is closed in a manner that maintains the distal and inferior regions under maximum tension, to ensure that the hallux remains in the correct position and to prevent the inferior structures from sliding laterally.

Haemostasis is secured after deflation of the tourniquet. Following approximation of subcutaneous tissues and closure of the skin, a special dressing can be applied, with additional gauze between the first and second toes as a spacer. Postoperative care includes immediate full weight-bearing on the heel and avoiding forefoot weight-bearing.

Results

The mean preoperative IMA was 15.75° , which was reduced to 4.5° postoperatively. Similarly, the mean preoperative HVA was 31.25° , which was also markedly decreased to 5.75° postoperatively. Postoperative radiographs showed that the sesamoid bones were occupying their reduced positions [Figure 2A](#). Satisfactory radiological outcomes were observed during follow-up, with the exception of one patient who experienced dizziness secondary to hypocalcaemia, and no complications have been reported. The operating time never exceeded 30 min.

Discussion

In the present study, we found the Mini TightRope procedure to be simple, short in duration and minimally invasive. Three patients were able to mobilize the day after the procedure, and satisfactory radiological outcomes were observed during follow-up. We saw no complications during the relatively short follow-up, although several complications with mini TightRope procedure have been reported, particularly stress fracture of the second metatarsal, which was mainly attributed to improper placement of the drill hole at or close to the metatarsal neck or failure to place the drill hole centrally midway between the dorsal and plantar aspects of the second metatarsus [Figure 2B](#).⁷

In general, corrective osteotomy for the treatment of hallux valgus is considered to be an invasive procedure, and these interventions are associated with postoperative pain and prolonged recovery times. Non-union and avascular necrosis are known complications of osteotomy, which is likely due to damage to the blood supply. Introduction of the less invasive Mini TightRope procedure markedly reduced postoperative pain and recovery time. Non-union and avascular necrosis are unlikely to occur with this procedure.^{10–13}

The functional outcome was not addressed in this study, and no functional scoring system was used. Two similar studies reported a significant functional improvement according to the American Orthopaedic Foot and Ankle Society scale during an average follow-up of 20 months.^{8,9}

The Mini TightRope device is at risk of fatigue failure with cyclical loading generated by body weight, in addition to ground reaction forces during weight-bearing mobilization. Cano-Martinez et al. reported two cases of rupture of a mini TightRope device with subsequent loss of correction among 36 operated feet.⁸ Kayiaros et al. recorded pull-through of the button of a mini TightRope device with migration back through the metatarsal tunnel in two feet out of 44, resulting in the recurrence of deformity.⁹ A minor complication was irritation caused by the medially placed prominent knot, which disappeared after the knot was placed laterally.^{14–16}

Many questions about the efficacy of using the mini TightRope device in the treatment of hallux valgus remain to be answered. Is the device alone sufficient to correct hallux valgus, or should it be combined with other treatment modalities? Are there specific indications for removing a mini TightRope device, and, if any, what is the minimum time the device should stay in place in order to maintain the corrected position after removal? What is the true recurrence rate? What is the cost–efficacy of this procedure? These questions have not been clearly answered in the current literature, and further research is required before the mini TightRope procedure can be considered an effective surgical treatment for hallux valgus.

Conclusion

In our small series, the Mini TightRope procedure was a promising surgical option for the correction of IMA and HVA in cases of hallux valgus of mild-to-moderate severity. The outcome was favourable, and postoperative pain and recovery time were reduced. The osteotomy-related risks of non-union, shortening and avascular necrosis are eliminated with the Mini TightRope procedure, and its simplicity and minimal invasiveness are further strengths. If the outcomes of our patients remain satisfactory with longer follow-up, we may consider the mini TightRope procedure to be an effective surgical option for the treatment of cases of hallux valgus of mild-to-moderate severity.

Conflict of interest

All researchers declare that no financial or other ties of the investigators or a member of his family to any party directly or indirectly involved in the field of study.

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