Treatment of metatarsalgia by neck shortening osteotomy and intramedullary fixation (NESHOIF): a pilot study

Tratatamento da metatarsalgia através da osteotomia de encurtamento do colo metatarsal com fixação intramedular: estudo preliminar

José Antônio Veiga Sanhudo[1], G Jammes Sammarco[2]

Abstract

Objective: Neck shortening osteotomy is a common treatment for metatarsalgia. The goal of this pilot study was to present the clinical and radiological results of neck shortening osteotomy and intramedullary fixation. **Methods:** Seven patients (nine feet) were treated for metatarsalgia by neck shortening osteotomy and intramedullary fixation and evaluated retrospectively after a follow-up period of at least 2 years. All patients underwent preplanned concomitant procedures. Pre- and postoperative American Orthopaedic Foot & Ankle Society (AOFAS) scores were compared, and union was assessed on the 6th, 10th and 14th postoperative weeks. **Results:** Radiographic union was observed on the 6th week of follow-up in all but one patient, who underwent shock wave treatment on the 10th postoperative week and had X-ray evidence of union after 4 weeks. The AOFAS scores improved by an average of 52 points after the procedure (mean pre- and postoperative scores were 41 and 93, respectively). All patients were satisfied with the procedure and said they would have it again under the same circumstances. **Conclusion:** Neck shortening osteotomy and intramedullary fixation appeared to be a simple and effective treatment for metatarsalgia, with few associated complications. Level of Evidence: IV – case series.

Keywords: Metatarsalgia; Osteotomy; Orthopedic fixation devices; Treatment outcome

Resumo

Introdução: A osteotomia de encurtamento do colo é uma indicação frequente no tratamento da metatarsalgia. Objetivo: apresentar os resultados clínicos e radiograficos iniciais da osteotomia de encurtamento associada a fixação intramedular. (NESHOIF). **Método**: Sete pacientes, nove pés foram tratados de metatarsalgia com NESHOIF e foram avaliados,

Corresponding author
José Antônio Veiga Sanhudo
Av. Praia de Belas, 2124/701
CEP 90110-000 – Porto Alegre, RS, Brasil

Received on
16/11/2014
Accepted on
17/11/2014

[1] Doutor em Medicina pela Universidade Federal do Rio Grande do Sul.
[2] Past-President of American Orthopedic Foot Ankle Society. Professor of Orthopaedic Surgery Department of Orthopaedic Surgery Tulane University school of Medicine New Orleans, Louisiana. Volunteer Professor of Orthopaedic Surgery Department of Orthopaedics University of Cincinnati Medical Center Cincinnati, Ohio.

Conflict of interest: No.

Erratum
Na versão impressa do artigo "Treatment of metatarsalgia by neck shortening osteotomy and intramedullary fixation (NESHOIF): a pilot study" publicado pela Rev ABTPé. 2014; 8(2): 51-5, foi omitido o nome do primeiro autor José Antônio Veiga Sanhudo.
Onde se lê: G Jammes Sammarco, leia-se José Antônio Veiga Sanhudo[1], G Jammes Sammarco[2].

retrospectivamente, após um periodo de seguimento mínimo de dois anos. Todos os pacientes foram submetidos ao planejamento pré operatório para uniformização da técnica cirúrgica. A avaliação pré e pós-operatória foi feita pela escala AOFAS, e o parametro consolidacao ossea d foi observada nas quarta, decima e decima-quarta semanas. **Resultados:** A consolidação radiografica foi obtida após a sexta semana em oito pés. O pé no qual não ocorreu consolidação foi submetido as ondas de choque, a partir da decima semana e houve integração após a quarta semana. A escala AOFAS melhorou em media de 52 pontos após o procedimento (variação de 41 a 93, respectivamente). Todos os pacientes ficaram satisfeitos com o procedimento e repetiriam se fosse necessário. **Conclusão:** NESHOIF se constitue em uma técnica simples, fácil e efetiva para o tratamento da metatarsalgia com poucas complicacões associadas.

Descritores: Metatarsalgia; Osteotomia; Dispositivos de fixação ortopédica; Resultado do tratamento

INTRODUCTION

Metatarsalgia, especially of the second ray, is a common condition. It may occur in isolation or, more frequently, in association with hallux valgus. The shortening of the corresponding metatarsal is often indicated for patients refractory to conservative treatment. Various types of osteotomy have been used for this purpose with varying results regarding symptom control and residual discomfort.[1,2] Despite the high incidence of complications, Weil's osteotomy is still widely used in the treatment of metatarsalgia, largely due to its positive results in terms of symptom relief.[3-8] Sammarco and Carrasquillo have explored the use of fixation with smooth intramedullary rods for the treatment of nonunion and malunion of metatarsal fractures.[9] The present study described the clinical and radiological features of nine feet treated for mechanical metatarsalgia by shortening osteotomy of the metatarsal neck and intramedullary fixation using a small segment of a Steinmann pin. The goal of this study was to evaluate the results of this procedure with respect to indications, technique, and outcome to determine its efficacy as a surgical option in the treatment of symptomatic metatarsalgia.

METHODS

This was a retrospective study of seven consecutive patients (nine feet) with mechanical metatarsalgia treated by shortening osteotomy of the metatarsal neck and intramedullary fixation with small segment of a Steinmann pin, between October 2011 and July 2012. All patients showed clinical evidence of mechanical metatarsalgia on preoperative examinations, including pain and hyperkeratosis under the metatarsal head. Conservative treatment proved unsuccessful for all cases, leading patients to opt for surgery. Claw deformities were identified in five feet, and four of these had some degree of coronal deviation. Both the Lachman and plantar plate provocation tests were positive in these four cases.[10,11] Shortening of the second ray was performed in eight cases, while one case underwent shortening of the third ray (Table 1). All seven patients also required at least one of the following additional procedures, including: bilateral chevron shaft osteotomy (n=3), first metatarsophalangeal fusion (n=2), homolateral chevron shaft and Sponsel osteotomy (n=1), and second toe DuVries interphalangeal arthroplasty (n=1). Mean age at the time of surgery was 53 years (range: 48 to 73 years). The sample included six women and one man. Operations were performed on three left feet and two right feet, while two patients were operated bilaterally. All patients provided written consent before surgery. Patients were followed for at least 24 months (mean: 27 months). None were lost to follow-up. Patients' demographic characteristics are shown in table 1.

Pre-and postoperative American Orthopaedic Foot & Ankle Society (AOFAS) scores were obtained at last visit

Table 1 - Demographic characteristics and pre and post-operative American Orthopaedic Foot & Ankle Society (AOFAS) scores

Patient	Age*	Follow-up**	Side	AOFAS pre-op	AOFAS post-op	second toe deformity
1	30	33	bilateral	47	100	claw
2	73	32	left	19	100	overlapping
3	50	27	right	52	93	overlaping
4	48	25	bilateral	32	100	claw
5	68	24	right	32	85	overlaping
6	55	24	left	57	88	overlaping
7	52	24	left	52	90	claw

* years, ** months.

from patient records. One of the authors examined all patients before and after the surgery. In addition to the presence of deformities, the mobility and stability of interphalangeal and metatarsophalangeal joints (MTPJs) and the presence of hyperkeratosis were also examined. Anteroposterior and lateral X-rays were taken prior to surgery, as well as on the first postoperative day before hospital discharge, and after 6 and 10 weeks. Joint alignment and the presence of osteotomy bone fragments were evaluated on postoperative X-rays, while the remaining two examinations were performed to evaluate bone consolidation.

Operative technique

All surgeries were performed under general anesthesia and adjuvant ankle block. All procedures began with the alignment of the first or fifth rays. After adequate preparation and draping, a 2 to 3cm curvilinear incision was made on the dorsal region of the metatarsal neck. The extensor longus and brevis tendons were then laterally retracted to expose the metatarsal neck. A transverse osteotomy was initiated – but not completed – with a micro-saw at the narrowest portion of the metatarsal neck. A second osteotomy was then performed parallel and distal to the first, reaching the inferior cortex at a pre-established distance of 2 to 3mm depending on the amount of shortening required to align the metatarsal head with the adjacent metatarsal heads, restoring the metatarsal parabola. The osteotomy is then completed and the bone slice was removed (Figure 1).

A 2.5-mm Steinmann pin was used as a reamer and introduced into the medullary canal of the proximal and distal metatarsal fragments. A 3-cm length of 3-mm Steinmann pin was then partially introduced into the proximal intramedullary canal, with the pointed distal end protruding 10mm distally. The distal fragment of bone with the metatarsal head was then attached to the end of the Steinmann pin, and pushed in a proximal direction in relation to the metatarsal axis, resulting in the intramedullary fixation of the osteotomy (Figures 2A, 2B and 2C). Primary stability was evaluated during surgery so that a thicker Steinmann pin could be placed, if required. The position of the fragment and of the intramedullary Steinmann pin were determined with X-ray image. Subcutaneous tissue and skin closure were then performed and all patients received bandage as a post-operative immobilization. All patients wore a heel support postoperative shoe, and weight-bearing was encouraged from the first postoperative day. The shoe was worn until the 6th week, at which point an X-ray was taken to confirm bone consolidation (Figure 3).

Figure 1 - Transoperative view: (A) parallel osteotomies; (B) slice removal; and (C) fragments after fixation.

RESULTS

AOFAS scores improved from 41 (19-57) preoperatively to 93 (85-100) after a mean follow-up of 27 months (p=0.02225). The greatest source of discomfort for patients was the prolonged postoperative edema, present in all patients at the 6 months post-operative visit. All participants were satisfied with the procedure and said they would have it again under the same circumstances. Osteotomy consolidation after 6 weeks was confirmed by X-ray in all but one patient, who received shock wave therapy after clinical and radiological evidence of delayed union were detected on the 10th week of follow-up. Four months after surgery, union was achieved and all residual symptoms had disappeared. In all cases, the metatarsal remained longer than its lateral counterparts, and a satisfactory metatarsal alignment was

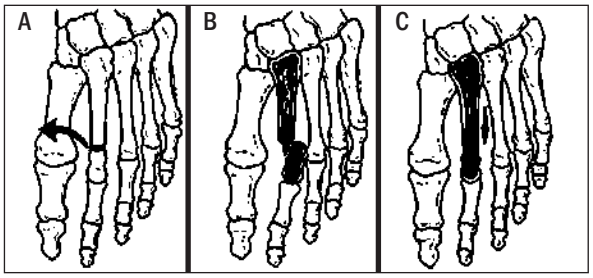

Figure 2 - Schematic representation of the procedure. (A) Slice removal from the metatarsal neck. Slice thickness was determined by the amount of shortening required. (B) Insertion of the K-wire into the proximal medullary canal. (C) Attachment of the K-wire to the distal fragment and osteotomy stabilization.

Figure 3 - Pre- and postoperative X-rays showing bilateral hallux valgus correction and shortening osteotomy of the second ray with K-wire fixation.

achieved. No clinical signs of transfer metatarsalgia were detected at follow-up.

Statistical analysis

Given the small sample size, pre- and postoperative AOFAs scores were compared using Wilcoxon signed-ranks test. Significance was considered at 5%. Analyses were performed using the Wilcox test function in R (version 3.0.3). The statistical analysis demonstrated a significant improvement in the AOFAS score after the procedure.

Complications

No complications were observed during surgery, and no reinterventions were required. The patient with delayed union underwent shock wave therapy 10 weeks after the procedure, which led to successful union and symptom resolution. There were no cases of infection, nonunion, malunion, persistent metatarsalgia, transfer metatarsalgia, or floating-toe deformity on follow-up (Figure 4). Restoration of the metatarsal alignment was radiographically confirmed in all feet. Although the patient with delayed union had residual deformities on the last follow-up, no floating was observed in any of the patients.

DISCUSSION

Weil's osteotomy is a widely used surgical procedure, and has generally proved successful in symptom relief, despite its high rate of complications.[3,4,7,8,12,13] The most common of these is floating, caused by a loss of contact between the operated toe and the ground as a result of biomechanical imbalance after metatarsal head lowering. The downward displacement of the capital fragment during shortening leads the intrinsic muscle axis to move above the rotational axis of the MTPJs, resulting in a loss of flexor activity and, consequently, floating.[11]

Figure 4. Clinical aspect of the foot after hallux valgus correction and second ray shortening osteotomy. The patient shows good alignment, no floating deformity (A) and full flexion at the second metatarsophalangeal joints (B).

Biomechanical and trigonometric studies have proposed several modifications to the original Weil's osteotomy technique with the aim of reducing the incidence of floating.[6,8,14-20] However, given the anatomical location of the osteotomy, it is difficult to achieve shortening without lowering the metatarsal head. Highlander et al. evaluated the incidence of complications following Weil osteotomy in 17 studies involving 1,131 procedures. Floating was the most common complication, reported in 233 cases (36%). Metatarsalgia recurred in 15% of cases, transfer metatarsalgia was reported in 7%, and delayed union, malunion or nonunion were noted in 3% of procedures.[3]

Sammarco and Carrasquillo described the treatment of six patients with acute metatarsal fractures using open reduction and smooth intramedullary fixation. Mean time to union was 6 weeks. Eight cases of nonunion, two cases of malunion and three stress fractures were then treated using double-threaded compression screws placed in an intra-articular position. In these cases, union was observed after 8 to 16 weeks.[9,21]

Neck shortening osteotomy and intramedullary fixation is a simple technique and has the advantage of being entirely extra-articular. Additionally, since shortening is performed along the metatarsal axis, metatarsal head lowering is not required, avoiding biomechanical complications and leading to good alignment, with no floating deformity (Figure 4). The use of the commonly known Kirschner wire and the low cost of the implant are additional advantages of this technique.[12,22-24]

In summary, after a follow-up period of at least 2 years, neck shortening osteotomy and intramedullary fixation led to significantly improved AOFAS scores, a low incidence of complications, a high rate of primary union and no recurrences. Given the short follow-up period and the small sample size of the present study, additional investigations are required to confirm the efficacy of this technique. However, the results of the present study, together with the low incidence of floating are promising.

REFERENCES

1. Espinosa N, Maceira E, Myerson MS. Current concept review: metatarsalgia. Foot Ankle Int. 2008;29(8):871-9.

2. O'Kane C, Klimartin TE. The surgical treatment of central metatarsalgia. Foot Ankle Int. 2002;23(5):415-9.

3. Highlander P, Von Herbules E, Gonzalez A, Britt J, Buchmann J. Complications of the Weil ostetotomy. Foot Ankle Spec. 2011;4(3):165-70.

4. Hofstaetter SG, Hofstaetter JG, Petroutsas JA, Gruber F, Ritschl P, Trnka HJ. The Weil osteotomy: a seven-year follow-up. J Bone Joint Surg Br. 2005;87(11):1507-11.

5. Khurana A, Kadamabande S, James S, Tanaka H, Hariharan K. Weil osteotomy: assessment of medium term resilts and predictive factors in recurrent metatarsalgia. Foot Ankle Surg. 2011;17(3):150-7.

6. Pérez-Muñoz I, Escobar-Antón D, Sanz-Gómez TA. The role of Weil and triple Weil osteotomies in the tretment of propulsive metatarsalgia. Foot Ankle Int. 2012;33(6):501-6.

7. Trieb K, Hofstaeltter SG, Panotopoulos J, Wanivenhaus A. The Weil osteotomy for correction of the severe rheumatoid forefoot. Int Orthop. 2013;37(9):1795-8.

8. Trnka H-J, Nyska M, Parks B. Dorsiflexion contracture after the Weil osteotomy: results of cadaver study and three-dimensional analysis. Foot Ankle Int. 2001;22(1):47-50.

9. Sammarco GJ, Carrasquillo HA. Intramedullary fixation of metatarsal fracture and nonunion-Two methods of Treatment. Orthop Clin North Am. 1995;26(2):265-72.

10. Sanhudo JAV. Plantar plate provocative test: a clinical sign for identification of the plantar plate lesion. Foot Ankle Specialist. 2014;7(4):291-2.

11. Thompson FM, Hamilton WG. Problems of rhe second metatarsophalangeal joint. Orthopedics. 1987;10:83-9.

12. Klammer G, Baumann G, Moor BK, Farshad M, Espinosa N. Early complications and recurrence rates after kirschner wire transfixion in lesser toe surgery: a prospective randomized study. Foot ankle Int. 2012; 33(2):105-12.

13. Migues A, Slullitel G, Bilbao F, Carrasco M, Solari G. Floating-toe deformity as a complication of the weil osteotomy. Foot Ankle Int. 2004;25(9):609-13.

14. Garg R, Thordarson DB, Schrumpf M, Cataneda D. Sliding oblique versus segmental resection osteotomies for lesser metatarsophalangeal joint pathology. Foot Ankle Int. 2008;29(10):1009-14.

15. Grimes J, Coughlin M. Geometric analysis of the Weil osteotomy. Foot Ankle Int. 2006;27(11):985-92.

16. Herzog Jl, Gofort WD, Stone PA, Paden MH. A modified fixation technique for a decompressional shortening osteotomy: a retrospective analysis. J Foot Ankle Surg. 2014;53(2):131-6.

17. Lau JT, Stamatis ED, Parks BG, Schon LC. Modifications of Weil osteotomy have no effect on plantar pressure. Clin Orthop Relat Res. 2004;(421):194-8.

18. Melamed EA, Schon LC, Myerson MS, Parks BG. Two modifications of the Weil osteotomy: analysis on sawbone models. Foot Ankle Int. 2002;23(5):400-5.

19. Trask DJ, Ledoux WR, Whittaker EC, Roush GC, Sangeorzan BJ. Second metatarsal osteotomies for metatarsalgia: a robotic cadaveric study of the effect of osteotomy plane and metatarsal shortening on plantar pressure. J Orthop Res. 2014;32(3):385-93.

20. Wagner E, Ortiz C, Keller A, Espinosa M, Arellano S, Fuente P, Wagner P. A new elevating metatarsal osteotomy: geometrical design and aplli-cations. J Surg Orthop Advances. 2013;22(4):1-5.

21. Sammarco GJ, Scioli MW: Metatarsal osteotomy using a double threaded compression screw: An adjunct to revision forefoot surgery. Foot and Ankle. 1989;10(3):129-39.

22. Holinka J, Schuh R, Hofstaetter JG, Wanivenhaus AH. Temporary Kirschner wire transfixation versus strapping dressing after second MTP joint realignment surgery: a comparative study with ten-year follow-up. Foot Ankle Int. 2013;34(7):984-9.

23. Lee KB, Seo CY, Hur CI, Moon ES, Lee JJ. Outcome of proximal chevron osteotomy for hallux valgus with and without transverse Kirschner wire fixation. Foot Ankle Int. 2008;29(11):1101-6.

24. Vopat BG, Lareau CR, Johnson J, Reinert SE, DiGiovanni CW. Comparative study of scarf and extended chevron osteotomies for correction of hallux valgus. Foot Ankle Spec. 2013;6(6):409-16.