

Research Article

Clinical evaluation of tibiocalcaneal arthrodesis with retrograde intramedullary nail fixation in diabetic patients

Raffaele Vitiello , Andrea Perna , Marco Peruzzi , Dario Pitocco , Galli Marco

Department of Orthopedic Surgery, Fondazione Policlinico Universitario A. Gemelli IRCCS, Università Cattolica del Sacro Cuore, Roma, Italy

ARTICLE INFO ABSTRACT

Article history:

Submitted 1 August 2018

Received in revised form

9 April 2019

Accepted 1 March 2020

Keywords:

Charcot neuroarthropathy

Retrograde nails

Clinical outcomes

Tibiocalcaneal arthrodesis

Diabetes

ORCID iDs of the authors:

R.V. 0000-0003-2321-9665;

A.P. 0000-0002-2475-1955;

M.P. 0000-0001-9073-3379;

P.D. 0000-0002-6220-686X;

G.M. 0000-0002-2215-5201.

Objective: The aim of this study was to evaluate clinical and functional outcomes in diabetic patients undergoing tibiocalcaneal arthrodesis using a retrograde nail.

Methods: A total of 12 diabetic patients [8 men and 4 women; mean age at intervention: 56.8 years (range: 27-76 years)] who underwent tibiocalcaneal arthrodesis by a retrograde nail were enrolled in this study. The indication for surgery was massive talar osteonecrosis in four patients, Charcot arthropathy in another four patients, and various severe ankle/hind-foot derangements in four patients. All surgeries were performed by the same surgeon. All patients were evaluated by their American Orthopedic Foot and Ankle Score (AOFAS) score, and radiographic follow-up was performed.

Results: The mean follow-up time was 59.5 months (range: 27-121 months). Ten patients (83.3%) healed and were able to walk with full weight bearing without crutches. Among them, nine patients (75%) achieved union with solid bone healing. The mean overall improvement in the AOFAS score was 72.5% (preoperatively: 40 points vs postoperatively: 69 points; $p < 0.001$). We observe a complication in 50% of our patients. Minor complications included two cases of dehiscence of the surgical wound, one case of soft tissue irritation owing to hardware protrusion, and one cause of lymphedema. Two patients had deep infection and underwent surgical removal of hardware, debridement, and antibiotic treatment: one healed after the treatment but never recovered full weight bearing and the other one died from other complications. These two deep infections occurred after 23 months of follow-up.

Conclusion: Tibiocalcaneal arthrodesis using retrograde nails is a salvage technique extremely effective in ankle and hind-foot disorders in a diabetic patient. This procedure allows good functional outcomes and pain relief. When correctly indicated, it is a safe procedure with good clinical outcomes and low risk of below-knee amputation.

Level of Evidence: Level IV, Therapeutic study

Diabetic patients are prone to all common ankle diseases that cause intractable pain and loss of function. When conservative methods or other less invasive treatments fail, surgical intervention should be considered. Ankle arthrodesis or tibiocalcaneal arthrodesis is the most reasonable surgical option in such patients because diabetics are exposed to lower limb vascular and neurologic complications, ulcers, and infections (1, 2). Tibiocalcaneal arthrodesis is a well-known salvage surgical procedure that became popular with the introduction of retrograde intramedullary ankle nails into clinical practice. Its goal is to restore proper foot-ankle-leg alignment in order to provide the patient with stable and painless support. Its indications are restricted as a con-

sequence of the noticeable loss of function owing to the sacrifice of ankle and subtalar movement (3). Its main indications are primary ankle and subtalar osteoarthritis, rheumatoid arthritis with extensive articular damage, massive avascular necrosis of the talus, post-traumatic tibial pilon and rear foot nonunion, and severe deformity linked Charcot arthropathy (4).

Tibiocalcaneal arthrodesis with intramedullary nail fixation has demonstrated good short- and long-term clinical outcomes in general practice (4). However, few studies have investigated outcomes in diabetic patients and most of them considered Charcot arthropathy alone (5). The present study aimed at contributing to the un-

Corresponding Author:

Vitiello Raffaele

lele.vitiello@gmail.com



Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Cite this article as: Vitiello R, Perna A, Peruzzi M, Pitocco D, Marco G. Clinical evaluation of tibiocalcaneal arthrodesis with retrograde intramedullary nail fixation in diabetic patients. *Acta Orthop Traumatol Turc* 2020; 54(3): 255-61. DOI: 10.5152/j.aott.2020.03.334.

derstanding of clinical outcomes and complications of tibiocalcaneal arthrodesis with retrograde intramedullary nail fixation in diabetic patients.

Materials and Methods

Study design and aim

The present analysis is a retrospective study of diabetic patients who underwent tibiocalcaneal arthrodesis at our institution from May 2008 to December 2016. The study met the national ethics criteria (Codice di etica dell'Istituto Superiore di Sanità. Version 1.13 / January 2015) and was performed in accordance with the Declaration of Helsinki. The aim of the study was to evaluate the functional and radiological outcomes of diabetic patient who underwent tibiocalcaneal arthrodesis with intramedullary retrograde transcaneal nail fixation.

Inclusion and exclusion criteria

All diabetic patient with massive talar osteonecrosis, Charcot arthropathy, or severe ankle and peritalar joint derangement who underwent tibiocalcaneal arthrodesis with intramedullary retrograde transcaneal nail fixation were potentially eligible for the study. We set as exclusion criteria a previous history of ankle or hindfoot infection, the presence of ulcers, and prior surgery.

Patient characteristics

Twelve diabetic patients (8 men, 4 women) met the inclusion criteria. The mean age at intervention was 56.8 years (range: 27-76 years). The mean follow-up period was 59.5 months (range: 27-121 months). Table 1 shows the patient's clinical characteristics, and Table 2 provides the main data (age, surgical indication, comorbidities, type of union achieves, AOFAS score and follow-up) of each patient included in the study.

Surgical technique

A senior orthopedic with proven experience in foot surgery (M.G.) operated all patients. In all patients a dedicated nail was used for ankle arthrodesis (Table 2). In all cases, surgery was performed by the modified Kelikian procedure. All patients received a parenteral antibiotic prophylaxis (intrave-

Table 1. Clinical characteristics of diabetic patients

Mean age (years)	56.8
Sex (male/female)	8/4
Mean HbA1c (mmol/L)	60.6
Mean preoperative glycemia (mg/dL)	160
Mean creatinine (mg/dL)	0.99
PVD	2/12
History of CVD	7/12
Ulcers	0/12

PVD: peripheral vascular diseases; CVD: cardiovascular diseases



Figure 1. Bone consolidation – Lateral radiographic views showing a good tibiocalcaneal bony union at the one year follow-up

nous cefazolin, 2 g). All patients received anticoagulation prophylaxis until total loading was allowed.

Clinical and radiographic follow-up

Ankle and hindfoot clinical outcomes were quantitatively measured using the American Orthopedic Foot and Ankle Score score. The assessment was carried out before surgery and at the 6-month follow-up. Bone union was judged clinically and radiographically (Figure 1). Patients without radio-

HIGHLIGHTS

- Ankle disease is very common in diabetic patients and can cause deterioration in the quality of life.
- Tibiocalcaneal arthrodesis with a retrograde nail represent a salvage technique effective in ankle and hindfoot disorders in a diabetic patient.
- After a long follow-up a good pain improvement and functional reflect the high overall patient satisfaction.

Table 2. Main clinical and surgical data

Patient	Sex	Age at surgery	Surgical indication	Main comorbidities	Union	AOFAS score		Follow-up	
						Preop	Postop	Months	Complications
1	M	57	Osteonecrosis of the talus, left	Ischemic heart disease	Fibrous	30	64	121	
2	M	72	Osteonecrosis of the talus, left	Ischemic heart disease Heart failure	Bony	52	70	33	Lymphedema
3	M	27	Osteonecrosis of the talus, left		Bony	46	83	54	
4	M	40	Osteonecrosis of the talus, right	Kidney transplant	Bony	24	70	97	Dehiscence of the surgical wound and superficial infection
5	M	60	Talar and subtalar post-traumatic arthrosis, left	Psoriatic arthritis	Bony	50	83	36	
6	F	60	Rheumatoid arthritis with subtalar pronation, left	Rheumatoid arthritis	Fibrous	38	81	36	
7	F	53	Pseudarthrosis due to talar and subtalar arthrodesis, left	Tibial pilon fracture	Bony	37	48	27	Hardware removal owing to deep infection
8	F	76	Tibiotalar arthrosis and subtalar pseudarthrosis, right	Peripheral vascular diseases Rheumatoid arthritis	Bony	50	68	39	Hardware removal owing to deep infection
9	M	71	Charcot arthroneuropathy, right	Ischemic heart disease Obesity	Bony	26	51	74	Dehiscence of the surgical wound and superficial infection
10	F	52	Charcot arthroneuropathy, left	Ischemic heart disease Neuropathy	Fibrous	41	69	105	One soft tissue irritation
11	M	44	Charcot arthroneuropathy, right	Peripheral vascular diseases	Bony	38	81	65	
12	M	70	Charcot arthroneuropathy, right	Ischemic heart disease	Bony	48	61	28	

graphic appearance of bone union who could walk with full weight bearing and no pain were judged to have healed by fibrous union (Figure 2). Standard radiographies were performed monthly for 6 months and at 1-year after surgery. Patients were discharged without any adjunctive external immobilization such as plasters or orthotics. Total off-loading was prescribed for at least 50 days. Patients with Charcot arthropathy were prescribed a longer period of off-loading (at least 3 months). Weight bearing was gradually allowed on the basis of the radiographic and clinical appearance. Wounds

were followed in outpatient care. Rocker bottom shoes and in-let soles were supplied to patients who suffered from Charcot arthropathy.

Outcomes

The primary outcome was the functional and clinical results (AOFAS score). Secondary outcomes were the failure of arthrodesis as a consequence of the following conditions: loosening or breakage of the hardware, deep intractable infection, and nonunion with unstable or painful hindfoot.

Table 3. AOFAS score before surgery

Patient		1	2	3	4	5	6	7	8	9	10	11	12
Pain (max. 40 points)		0	20	20	0	20	20	20	20	0	30	20	20
Function (max 50 points)	Activity limitation	4	4	4	4	4	4	4	4	4	0	4	4
	Maximum distance walking	2	2	2	2	2	2	0	2	2	0	0	2
	Walking surface	0	0	3	0	0	0	0	3	3	0	0	0
	Gate abnormality	4	4	4	4	0	0	0	4	4	0	0	4
	Sagittal motion	4	4	0	4	4	4	0	4	0	0	4	0
	Hindfoot motion	3	0	0	0	0	3	0	0	0	3	0	0
	Ankle-hindfoot stability	8	8	8	0	8	0	8	8	8	8	0	8
Alignment (max 10 points)		5	10	5	10	10	5	5	5	5	0	10	10
Total before surgery		30	52	46	24	50	38	37	50	26	41	38	48

Table 4. AOFAS score after surgery

Patient		1	2	3	4	5	6	7	8	9	10	11	12
Pain (max. 40 points)		30	40	40	30	40	40	20	30	20	40	40	30
Function (max 50 points)	Activity limitation	7	7	7	7	7	7	4	7	4	4	7	4
	Maximum distance walking	2	4	5	4	5	5	2	2	2	2	5	2
	Walking surface	3	3	5	3	5	3	0	3	3	3	3	3
	Gate abnormality	4	8	8	8	8	8	4	8	4	4	8	4
	Sagittal motion	0	0	0	0	0	0	0	0	0	0	0	0
	Hindfoot motion	0	0	0	0	0	0	0	0	0	0	0	0
	Ankle-hindfoot stability	8	8	8	8	8	8	8	8	8	8	8	8
Alignment (max 10 points)		10	10	10	10	10	10	10	10	10	10	10	10
Total before surgery		64	70	83	70	83	81	48	68	51	79	81	61

Results

Ten patients (83.3%) healed and were able to walk with full weight bearing without crutches. In this group, the rate of achieving union by solid bone healing was 75% (nine patients). Three patients (25%) presented symptom-free, mechanically competent, fibrous union (Table 2).

Tables 3 and 4 present the AOFAS score. The mean preoperative score was 40 points (range: 24-52 points). The mean postoperative score was 69 points (range: 48-83 points), with a mean overall improvement rate of 72.5% (the ratio between the preoperative score and the difference between post- and preoperative scores multiplied by 100; statically significant difference by Student's *t*-test, $p < 0.001$).

Neglecting sagittal motion and hindfoot motion scores that are obviously 0 in the postoperative evaluation, the overall

mean improvement in the postoperative AOFAS score was 89.3%. The best subset of clinical improvement is given by functional recovery and pain.

The rate of minor and major complications was 50% (six patients). Minor complications included two cases of dehiscence of the surgical wound (patients 4 and 9), one case of soft tissue irritation owing to hardware protrusion (patient 10), and one case of lymphedema (patient 2). Dehiscence of the surgical wound healed after medication and specific oral antibiotic therapy. Soft-tissue irritation required surgical screw removal. Lymphedema was managed with lymphatic drainage.

Two patients had a major complication that resulted in treatment failure, and data are reported in Table 2. Two patients had deep infection and underwent surgical removal of hardware, debridement, and antibiotic treatment: one healed after



Figure 2. a, b. Bony and Fibrous union - Lateral (a) and frontal (b) radiographic views of a Charcot patient, (a) and (b) In this patient we could see the achievement of a bony union in the tibiocalcaneal joint but a fibrous union in the subtalar joint

treatment, but never recovered full weight bearing (patient 7) and the other was treated in another hospital and died from other complications (patient 10).

Discussion

Patients suffering from diseases or clinical conditions that cause either remarkable derangement of the joints surrounding the talus or massive talar bone loss are eligible for tibiocalcaneal arthrodesis. Tibiocalcaneal arthrodesis can surgically be achieved by internal or external fixation. In diabetic patients, external fixation is mandatory in case of deep infection, osteomyelitis, and poor soft tissue coverage (6). Poor patient compliance, frequent pin tract medications, long duration of patient surveillance, and frequent medical visit discourage the use of external fixation and favor internal fixation when feasible.

Retrograde intramedullary ankle nail fixation has gained popularity because of its undisputed mechanical advantages (7). It can provide the patient with stable fixation such that adjunctive external immobilization devices such as plasters or braces are generally felt unnecessary. Bone union rates vary between 88% and 100% among nondiabetic patients treated without adjunctive immobilization (8, 9). In our practice, we adopted the same behavior irrespective of whether the patient was diabetic. Enhancement of the overall stability through external immobilization was performed only when there was concern that solid internal fixation could not be obtained because of poor bone stock. This behavior was also found in patients affected with Charcot arthropathy where external immobilization was always neglected because of solid internal fixation. All our patients with Charcot arthropathy had good functional recovery with full weight bearing on the affected side. In all cases,

satisfactory consolidation was observed, bone union was observed in three cases, and solid fibrous union was observed in one case (Figure 2). Two different Italian research groups provided their patient with Charcot with adjunctive immobilization such as a cast for 3 months (5, 10). Dalla Paola and others achieved bone union in 14 of 18 patients and fibrous union in 4 of 18 patients in their study population (5). In their study, the percentage of limb salvage was 100% in the follow-up period. Caravaggi et al. obtained a bone union rate of 71%; fibrous union was achieved in 21% of the cases; limb salvage was always achieved, but in one case, it required below-knee amputation (10).

Only a few studies in the literature have focused on clinical evaluation with an appropriate score (11-13). Franceschi et al., in a recent review of the literature about the use of tibiocalcaneal arthrodesis by an intramedullary nail, showed that until 2016, no study performed clinical evaluation by the AOFAS score (11). Chrmain et al. demonstrated a rise of 46.22 points (from 25.3 to 71.5) in the AOFAS score in a series of 18 patients with hindfoot arthrodesis with retrograde compression intramedullary nail fixation in Charcot neuroarthropathy (12). Oesman et al. presented the results of a two-patient case series for calcaneotalotibial arthrodesis by retrograde intramedullary nail fixation for Charcot neuroarthropathy, demonstrating an improvement of 25 points (from 58 to 83) in the AOFAS score, but only in one patient were these data correctly recorded (13). Though we reported AOFAS improvement according to the literature, the improvement in our study appears lower than that in the study by Chrmain et al. probably because our patients initially had a higher AOFAS score (mean 40 vs 25) (13).

Charcot arthropathy is a severe complication of diabetic lower limb neuropathy and mainly affects foot joints, with ankle joint involvement being less frequent (about 5% of cases). In the acute stage, Charcot arthropathy causes progressive joint destruction and a noticeable inflammatory response with local edema and swelling. In responsive patients, there is prompt recovery from edema and swelling after immobilization in a total contact cast or a pneumatic brace in association with off-loading (14). Casts are applied in the preoperative period to change the acute stage of the disease to the subacute or quiescent stage in order to perform surgery in more favorable clinical conditions.

In our patients with Charcot arthropathy, no postoperative cast immobilization was used and limb salvage was achieved in all cases, with one case of fibrous consolidation among four patients (25%).

Diabetes mellitus (DM) is a well-recognized risk factor for postoperative complication such as nonunion, malunion, hardware failure, and surgical site and deep infections (15). In a case-control study comparing complication rates for di-

abetic patients with a matched group of nondiabetic patients undergoing Open Reduction and Internal Fixation (ORIF) of ankle fractures, the incidence of significant complications in diabetic patients was 42.3% (16).

Infection in diabetics is a major problem and can lead to amputation in 42% of the cases and mortality in 11% after failed ankle fracture osteosynthesis (16, 17).

As tibiocalcaneal arthrodesis is indicated only in selected cases of severe derangement involving the ankle and hindfoot in patients without a history of local deep infection, it is difficult to find studies enrolling large series of diabetic patients. A recent study tried to evaluate the results of retrograde intramedullary nail fixation for the severe ankle/hindfoot pathology in a group of patients with diabetic neuropathy and compare them to a cohort of nondiabetic patients. Although a postoperative complication was experienced in 59% of cases with DM compared to 44% without DM, the difference did not reach statistical significance owing to the fewer number of patients available (18).

Currently, high rates of postoperative complication are encountered in diabetics undergoing tibiocalcaneal arthrodesis, independent of the internal fixation construct that has been utilized. Studies reporting the largest series of diabetic subjects have been conducted in patients with Charcot arthropathy where nail fixation has a broader indication. In Charcot arthropathy, retrograde intramedullary nail fixation is advocated for ankle arthrodesis, irrespective of the contemporary involvement of the hindfoot. It is considered a salvage procedure, and the nail is used to form a so-called "super-construct" (19, 20). In a super-construct, internal fixation is used to bridge the area of the diseased joint and extend fixation into areas uninvolved by Charcot arthropathy. Its purpose is to increase stability and decrease the likelihood of fixation failure.

In the literature, infection rates reflect the occurrence of infection in the postoperative period because the mean follow-up is short term (5, 7, 10). In our study, two cases of deep infections occurred after 23 months of follow-up. Given the small number of cases, statistical significance is poor; nonetheless, tendency toward mid-long-term infections emerges that might be explained by the well-known susceptibility to infection of diabetics coupled with bulky features of the internal fixation device.

To conclude, our results suggest that tibiocalcaneal arthrodesis with retrograde nails may be an effective salvage procedure in an ankle and hindfoot disorder in diabetic patients with good clinical outcomes. The greatest improvement was recorded in functional recovery and pain improvement; overall patient satisfaction was high. As with any surgical procedure, it was affect-

ed by complications that may lead to below-knee amputation. Deep infection is a dreadful complication in the postoperative period, but it might have late onset. Removal of hardware might be considered after achieving solid bone union.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethical Committee of Fondazione Policlinico Universitario (Version 1.13 / January 2015).

Informed Consent: Written informed consent for scientific purposes and clinical data collection was obtained from surgeon before the surgery according to institutional protocol.

Author Contributions: Concept - G.M.; Design - G.M.; Supervision - G.M., D.P.; Data Collection and/or Processing - M.P.; Analysis and/or Interpretation - R.V.; Literature Search - A.P.; Writing Manuscript - R.V., A.P.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. AOFAS - American Orthopaedic Foot and Ankle Society. Available from: (<http://www.aofas.org/footcaremd/conditions/diabetic-foot>)
2. Muller LM, Gorter KJ, Hak E, et al. Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus. *Clin Infect Dis* 2005; 41: 281-8. [\[Crossref\]](#)
3. Thomas R, Daniels TR, Parker K., Gait analysis and functional outcomes following ankle arthrodesis for isolated ankle arthritis. *J Bone Joints Surg Am* 2006; 88: 526-35. [\[Crossref\]](#)
4. Jehan S, Shakeel M, Bing AJ, Hill SO. The success of tibiotalocalcaneal arthrodesis with intramedullary nailing a systematic review of the literature. *Acta Orthop Belg* 2011; 77: 644-51.
5. Dalla Paola L, Volpe A, Varotto D, et al. Use of a retrograde nail for ankle arthrodesis in Charcot neuroarthropathy: A limb salvage procedure. *Foot Ankle Int* 2007; 28: 967-70. [\[Crossref\]](#)
6. Moeckel BH, Patterson BM, Inglis AE, Sculco TP. Ankle arthrodesis. A comparison of internal and external fixation. *Clin Orthop Relat Res* 1991; 268: 78-83.
7. Millett PJ, O'Malley MJ, Tolo ET, Gallina J, Fealy S, Helfet DL. Tibiotalocalcaneal fusion with a retrograde intramedullary nail: clinical and functional outcomes. *Am J Orthop (Belle Mead NJ)* 2002; 31: 531-6.
8. Klos K, Drechsel T, Gras F, et al. The use of a retrograde fixed-angle intramedullary nail for tibiocalcaneal arthrodesis after severe loss of the talus. *Strategies Trauma Limb Reconstr* 2009; 4: 95-102. [\[Crossref\]](#)
9. Takenouchi K, Morishita M, Saitoh K, Wauke K, Takahashi H, Nagashima M. Long-term results of ankle arthrodesis using an intramedullary nail with fins in patients with rheumatoid arthritis hindfoot deformity. *J Nippon Med Sch* 2009; 76: 240-6. [\[Crossref\]](#)
10. Caravaggi C, Cimmino M, Caruso S, Dalla Noce S. Intramedullary compressive nail fixation for the treatment of severe Charcot deformity of the ankle and rear foot. *J Foot Ankle Surg* 2006; 45: 20-4. [\[Crossref\]](#)

11. Franceschi F, Franceschetti E, Torre G, et al. Tibiotalocalcaneal arthrodesis using an intramedullary nail: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2016; 24: 1316-25. [\[Crossref\]](#)
12. Chraim M, Krenn S, Alrabai HM, Trnka HJ, Bock P. Mid-term follow-up of patients with hindfoot arthrodesis with retrograde compression intramedullary nail in Charcot neuroarthropathy of the hindfoot. *Bone Joint J* 2018; 100-B: 190-6. [\[Crossref\]](#)
13. Oesmana I, Asdib ARB. Calcaneotalotibial arthrodesis by retrograde intramedullary nailing using expert tibia nail for charcot osteoneuropathy of the foot: A case series. *Int J Surg Case Rep* 2019; 57: 9-14. [\[Crossref\]](#)
14. de Souza LJ. Charcot arthropathy and immobilization in a weight-bearing total contact cast. *J Bone Joint Surg Am* 2008; 90: 754-9. [\[Crossref\]](#)
15. Bibbo C, Lin SS, Beam HA, Behrens FF. Complications of ankle fractures in diabetic patients. *Orthop Clin North Am* 2001; 32: 113-33. [\[Crossref\]](#)
16. McCormack RG, Leith JM. Ankle fractures in diabetics. Complications of surgical management. *J Bone Joint Surg Br* 1998; 80: 689-92. [\[Crossref\]](#)
17. White CB, Turner NS, Lee GC, Haidukewych GJ. Open ankle fractures in patients with diabetes mellitus. *Clin Orthop Relat Res* 2003; 414: 37-44. [\[Crossref\]](#)
18. Wukich DK, Shen JY, Ramirez CP, Irrgang JJ. Retrograde ankle arthrodesis using an intramedullary nail: a comparison of patients with and without diabetes mellitus. *J Foot Ankle Surg* 2011; 50: 299-306. [\[Crossref\]](#)
19. Hentges MJ, Richardson PE, Loveland JD, Lamm BM, Mendicino RW, Catanzariti AR. Internal Fixation Constructs for correction of Charcot Midfoot Deformity. *Foot and Ankle Quarterly*, Summer 2013, Vol. 24, No. 2.
20. Galli M, Scavone G, Vitiello R, Flex A, Caputo S, Pitocco D. Surgical treatment for chronic Charcot neuroarthropathy. *Foot (Edinb)* 2018; 36: 59-66. [\[Crossref\]](#)