Case Report

SAGE Open Medical Case Reports

SAGE Open Medical Case Reports
Volume 9: 1–6
© The Author(s) 2021
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/2050313X211046732
journals.sagepub.com/home/sco

Staged salvage of diabetic foot with Chopart amputation and intramedullary nailing

Alexandre Leme Godoy-Santos[1,2], Fábio Correa Fonseca[2], Cesar de Cesar-Netto[3], Katrina Bang[3,4], Eduardo Araujo Pires[1] and David G Armstrong[5]

Abstract

We present a stepwise surgical approach that can be used, in lieu of a transtibial amputation, to preserve the lower limb in the setting of severe diabetic foot infections. A 63-year-old male status post left midfoot (Lisfranc's) amputation presented to our hospital with a 4-year history of a left foot diabetic ulcer with associated purulent drainage and intermittent chills. On initial exam, the patient's left foot amputation stump was plantarflexed, grossly erythematous, and edematous. The associated diabetic foot ulcer was actively draining purulent fluid. Following workup with radiography and ultrasound, the patient was diagnosed with a post-operative infection of the midfoot at the level of the amputation stump secondary to diabetic neuropathy. Our approach to management was a staged and included (1) surgical irrigation and debridement of the distal stump wound, (2) provisional negative pressure therapy, (3) a second-look procedure, and (4) a tibiotalocalcaneal fusion was performed using a lateral transfibular and plantar approach, after wound closure and resolution of active infection was achieved. At 36-month follow-up, the patient was fully weight-bearing in stiff sole sneakers with no gross overt alteration of gait pattern. The patient scored 79 points when assessed by the hindfoot American Orthopaedic Foot and Ankle Society Ankle-Hindfoot outcome score. In the patient with diabetes and cardiological restrictions, a Chopart amputation is preferred due to the decreased level of energy expenditure required for ambulation as compared to over more proximal levels of amputation.

Keywords

Diabetic foot, infection, limb salvage, Chopart, diabetes

Date received: 28 April 2021; accepted: 30 August 2021

Introduction

Recent studies have shown that the overall rate of diabetes-related complications such as myocardial infarction and death from hyperglycemic crisis have substantially decreased in the past two decades. Yet, the rates of clinically devastating lower extremity complications such as diabetic foot ulcers (DFUs) and infections have generally risen.[1] Such complications frequently lead to significant functional loss, decreased quality of life and socioeconomic impairment that renders a significant burden on patients, their families, and the healthcare system.[2]

Limb salvage is the mainstay of treatment following an unsuccessful primary amputation. The process is time-consuming and complex, often requiring staged levels of treatment and promising uncertain outcomes with variable levels of post-operative functioning.[3] Limb salvage techniques such as the Chopart amputation maintain limb length and increasing residual limb lever arm length when compared to

[1]Department of Orthopedic Surgery, Hospital Israelita Albert Einstein, São Paulo, Brazil
[2]Lab. Prof Manlio Mario Marco Napoli, Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo, São Paulo, Brazil
[3]Department of Orthopedics and Rehabilitation, The University of Iowa, Iowa City, IA, USA
[4]School of Medicine, St. George's University, St. George's, Grenada
[5]Southwestern Academic Limb Salvage Alliance (SALSA), Department of Surgery, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Corresponding Author:
Eduardo Araujo Pires, Department of Orthopedic Surgery, Hospital Israelita Albert Einstein, Av. Albert Einstein, 627, Morumbi, São Paulo, SP 05652-900, Brazil.
Email: dreduardoaraujopires@gmail.com

transtibial, Pirogoff, and Syme amputations. Such limb-preserving qualities thereby decrease the energy requirements of walking, augment the rate of post-operative recovery, and enable patients to ambulate earlier than those who receive amputations at more proximal levels.[4]

In the United States alone, the gross expenditure for the treatment of diabetic limb complications totals approximately US$17 billion dollars annually—a figure that well exceeds the direct costs associated with treating the five most costly cancers in the United States combined.[5] Diabetic foot infections are also associated with higher rates of lower limb amputations, with estimated yearly costs of at least US$ 200 million in the United States[6] and 43 million pounds in the United Kingdom.[7] Such financial implications are compounded by the fact that diabetic patients have a 50% chance of having the contralateral limb amputated within 2 years.[8]

Here, we present a case wherein a multidisciplinary approach was used to successfully treat an infected midfoot amputation using a diabetic limb salvage procedure. Our multidisciplinary approach involved, first accurate diagnosis, then a series of staged surgical procedures, an antibiotic treatment regimen, pharmacologic and clinical diabetic management strategies, and finally tibiotalocalcaneal fusion.

Case report

A 63-year-old male with long-term uncontrolled type 2 diabetes presented to our foot and ankle center facility with a 4-year history of DFU and associated episodes of purulent drainage with intermittent chills. The patient's cardiologic history included three open revascularizations and five endovascular stents within the previous 6 years, and placement of an implantable cardioverter defibrillator (ICD). In addition, he reported an endovascular stent due to arterial stenosis in the affected limb 3 years ago.

Lower extremity physical examination revealed erythema and edema of a midfoot (Lisfranc's) amputation stump with active purulent drainage from a DFU (Figure 1). The patient's left foot amputation stump was plantarflexed, grossly erythematous, and edematous. The associated DFU was actively draining purulent fluid and was associated with wound dehiscence. The wound was probed to bone readily and revealed necrosis of the cuneiforms and cuboid. Dorsalis pedis and posterior tibial pulses were palpable bilaterally, with as no overt signs of peripheral artery disease. After clinical, radiographic (Figure 2), and ultrasound assessment, patient was diagnosed with a post-operative infection at the amputation stump of midfoot of a neuropathic diabetic foot. Panels 1 and 2 show radiological and clinical presentation of the infected foot over the course of treatment.

Clinical treatment

Day 1. Broad-spectrum antibiotic therapy—ertapenem and clindamycin—was initiated with the intention of narrowing based on culture results. Tight blood glucose control was initiated, with a combination of regular, intermediate-acting, and long-acting insulin. Desired levels were 70–130 mg/dL before meals and 180 mg/dL after meals.

Day 4. Bacterial and fungal growth was only observed in pre-debridement tissue cultures. Right now, the patient's antibiotic therapy was narrowed following the susceptibility tests. He was treated by the combination of levofloxacin, sulfamethoxazole-trimethoprim, and fluconazole.

Week 8. All antibiotics therapy was discontinued.

Surgical treatment

A staged approach to treatment was designed and performed based on clinical and imaging findings.

Day 1. Surgical irrigation and debridement of the distal stump wound—debridement of all devitalized and infected bones (cuneiforms, cuboid, and navicular) and soft tissue was performed. Pre- and post-debridement tissue samples were collected for cultures of aerobic and anaerobic bacteria, fungi, mycobacteria, and antibiotic susceptibility testing. Achilles tenotomy was performed percutaneously, the wound was primarily closed, and then provisional negative pressure wound therapy (PICO®, Smith & Nephew, London, UK) was installed (80 mm Hg) and set to continuous mode for 72 h (Figure 1).

Day 3. A second-look irrigation and debridement were performed with additional tissue samples being sent for cultures. No evidence of progressive infection or necrosis was observed. Negative pressure wound therapy was applied (80 mm Hg) and set for the next 11 days. The result of cultures collected at second-look procedure from remnant tissues was negative.

Day 14. The wounds were noted to be completely closed with no signs of active infection, blood inflammatory tests—erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP)—continued to fall. Based on these criteria and negative cultures at the second-look procedure, the decision was made to proceed with the next stage of treatment. We then performed a tibiotalocalcaneal fusion using lateral transfibular approach and a plantar approach (Figures 1 and 2). A conventional dressing was maintained for 14 days.

Day 28. We then performed a total contact casting (TCC_EZ®, Integra, 1100 Campus Road, Princeton – NJ08540) and the patient initiated a weight-bearing rehabilitation protocol (Figure 1). The TCC was changed every 2 weeks.

Week 12. Radiographs revealed good bone healing (Figure 2). Total contact cast was then discontinued. The

Figure 1. Figures (a)–(l) showing clinical aspects and surgical technique. (a) Clinical picture of the infected foot during admission to our outpatient clinic. Plantar view—extensive distal stump ulceration, purulent drainage, probe-to-bone test positive for cuneiforms and cuboid. (b) Surgical debridement of infected soft tissues and bones. (c) Specimens collected from soft tissues (superficial and deep) and from bones (navicular, cuneiforms, and cuboid) submitted separately for culture. (d) Clinical condition after first surgical irrigation and debridement (I&D). Resection of all infected tissues. Note the healthy exposed talar head and calcaneal anterior process and healthy soft tissues maintained. (e) Plantar view complete closure of ulcer. (f) Incisional negative pressure wound therapy applied above surgical site. (g) Plantar view during TTC arthrodesis showing plantar incision for intramedullary nail stabilization. (h) Total contact cast applied on right lower limb 2 weeks after TTC fusion. (i) Clinical picture anterior view of surgical sites 6 weeks post-op. (j) Clinical picture plantar view of surgical sites 6 weeks post-op. (k) Clinical picture showing patient wearing regular footwear and total weight-bearing. (l) Final clinical outcome. Note the symmetrical alignment in hindfoot with complete healing of the soft tissue.

patient was able to walk independently in a stiff sole shoe with a custom-made orthotic.

Month 36. The patient was fully weight-bearing in stiff sole sneakers with no gross overt alteration of the gait pattern. During this period, he remained in complete remission and wounds remained completely healed with no signs of infection. Patient demonstrated full range of motion of the hip and knee joints, with a 5+/5+ muscle power for flexion, extension, adduction, and abduction. When assessed by the hindfoot American Orthopaedic Foot and Ankle Society (AOFAS) outcome score, patient reached 79 points (Figures 1 and 2).[9] We informed patient that the data concerning this case would be considered for publication, and he consented to it.

Discussion

Restoration and optimization of ambulatory mobility are one of the primary goals in the rehabilitation of individuals who have undergone lower extremity amputation. Energy expenditure and walking speed are generally recommended for use as measures of status and outcome for walking.[10]

Vllasolli et al.[11] in a prospective cross-sectional study measured the physiological cost index (PCI) and comfort walking speed (CWS) at three levels of lower limb amputation. The authors demonstrated that higher levels of amputation are associated with less energy-efficient walking and lower walking speeds, while stump length was shown to have a major impact on PCI and CWS.[11] Although the development of modern ankle–foot prostheses has improved

Figure 2. Figures (a)–(l) showing radiographic features. (a) Radiographic findings at admission in the outpatient clinic—lateral view. (b) Radiographic findings at admission in the outpatient clinic—anteroposterior view. (c) Intraoperative fluoroscopic lateral view of foot and ankle after infected soft tissues/bones resection and percutaneous Achilles tendon lengthening—first procedure. (d) Intraoperative fluoroscopic lateral view of foot and ankle during ankle and subtalar joint prepared for tibio-talo-calcaneal (TTC) fusion. (e) Intraoperative fluoroscopic lateral view of foot and ankle getting stump anatomical position for arthrodesis with K-wire. (f) Intraoperative fluoroscopic anteroposterior view of foot and ankle after intramedullary stabilization with intramedullary nail. (g) Intraoperative fluoroscopic lateral view of foot and ankle after intramedullary stabilization with intramedullary nail. (h) and (i) Radiographic findings lateral and anteroposterior view 6 weeks after TTC fusion. (j) and (k) Weight-bearing radiographic findings lateral and anteroposterior view 3 months after TTC arthrodesis. Note total fusion of subtalar and ankle joint. (l) Weight-bearing lower limbs panoramic X-ray showing lower limbs symmetry. Note 0.2 cm difference between right and left lower limb.

dramatically, such advances often are not enough to improve the energy savings of transtibial amputees. For these reasons, limb salvage is preferred over proximal amputation and is well established in cases of infected neuropathic diabetic foot.[12] Before proceeding with amputation, the goals of surgery should be thoroughly considered. In this patient, the initial surgical goals were similar to those of damage-control trauma surgery, namely, reducing the risk of immediate morbidity and mortality by eliminating the infected and necrotic tissue. While secondary surgical goals after medical optimization include establishing mobility, function, and medium to long-term quality of life.[13] Should the surgeon decide to proceed with amputation, the surgeon should optimize the residual limb length, as the level of amputation has functional and quality-of-life implications for the patient. Longer residual limbs require less energy expenditure for ambulatory activities than shorter residual limbs.[11]

In Chopart-level amputations, the heel often deviates into equinus and varus alignment. This deviation is often due to a lack of healthy anterior soft tissue that does not allow for rebalancing tendon transfers to the talar head.[13] The consequences of such malalignment are anterior and lateral wound dehiscence and ulceration that may later necessitate a higher-level amputation and resultantly, considerable loss of function.[14] Brodell et al.[15], in a series of cases with 11 patients who underwent Chopart amputation without hindfoot nail stabilization, observed 94% of complications with the surgical wound, requiring surgical revision with an increase in the amputation level in 56% of the sample.

Despite such drawbacks, Chopart amputees have a full-length extremity, sound terminal weight-bearing, "barefoot" walking capacity on soft ground, and a cosmetically acceptable appearance of the stump if the hindfoot is reduced and stabilized with an ankle arthrodesis. Studies show that stabilization of the hindfoot with a nail reduces the number of re-ulcerations after starting weight-bearing in patients with and without diabetes, consequently, the need to raise the amputation level.[16–18]

Patients are ideally fitted with a custom-made orthotic and soft socket for the heel in a stiff sole footwear, maximizing functionality while minimizing the energy expenditure associated with walking and weight-bearing.[14] These characteristics give advantage to this amputation when compared to the Syme amputation (SA), because the discrepancy in limb length in SA makes it difficult to move around without using the prosthesis, in addition to its prosthesis becoming more difficult due to the reduced distance from the stump to the soil, contributing to the emergence of new ulcers.

Therefore, the performance of partial amputations of the foot must be carefully planned in a staged manner. Infectious control, pre-operative revascularization in cases of peripheral arterial disease, and an accurate surgical planning are important steps in order to avoid future surgical approaches and major amputations.[18–20]

Conclusion

A Chopart amputation is preferred over more proximal levels of amputation because of the decreased energy expenditure that is required for ambulation, especially in patients with diabetes and cardiological restriction.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Written informed consent was obtained from the patient for his anonymized information to be published in this article.

ORCID iDs

Fábio Correa Fonseca https://orcid.org/0000-0002-8907-0472
Eduardo Araujo Pires https://orcid.org/0000-0001-6008-8671

References

1. Armstrong DG, Boulton AJ and Bus SA. Diabetic foot ulcers and their recurrence. *N Engl J Med* 2017; 376(24): 2367–2375.
2. Gregg EW, Li Y, Wang J, et al. Changes in diabetes-related complications in the United States, 1990–2010. *N Engl J Med* 2014; 370(16): 1514–1523.
3. Wade SM, Harrington C, Fleming M, et al. A combined distal tibial turn-up plasty and intercalary calcaneal osteocutaneous fillet flap for salvage of a transtibial amputation: a case report. *JBJS Case Connect* 2017; 7(4): e91.
4. Ladlow P, Nightingale TE, McGuigan MP, et al. Impact of anatomical placement of an accelerometer on prediction of physical activity energy expenditure in lower-limb amputees. *PLoS One* 2017; 12(10): e0185731.
5. Franklin H, Rajan M, Tseng CL, et al. Cost of lower-limb amputation in U.S. veterans with diabetes using health services data in fiscal years 2004 and 2010. *J Rehabil Res Dev* 2014; 51(8): 1325–1330.
6. Margolis DJ, Malay S, Hoffstad OJ, et al. Incidence of diabetic foot ulcer and lower extremity amputation among medicare beneficiaries, 2006 to 2008: data points #2. Data points publication series. Agency for Healthcare Research and Quality, Rockville, MD, 17 February 2011.
7. Kerr M, Barron E, Chadwick P, et al. The cost of diabetic foot ulcers and amputations to the National Health Service in England. *Diabet Med* 2019; 36(8): 995–1002.
8. Lavery LA, Van Houtum WH and Armstrong DG. Institutionalization following diabetes-related lower extremity amputation. *Am J Med* 1997; 103(5): 383–388.
9. Rodrigues RC, Masiero D, Mizusaki JM, et al. Tradução, adaptação cultural e validação do "American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale." *Acta Ortopédica Bras* 2008; 16: 107–111.
10. Czerniecki JM and Morgenroth DC. Metabolic energy expenditure of ambulation in lower extremity amputees: what have we learned and what are the next steps? *Disabil Rehabil* 2017; 39(2): 143–151.
11. Vllasolli TO, Zafirova B, Orovcanec N, et al. Energy expenditure and walking speed in lower limb amputees: a cross sectional study. *Ortop Traumatol Rehabil* 2014; 16(4): 419–426.
12. Godoy-Santos AL, Amodio DT, Pires A, et al. Diabetic limb salvage procedure with bone allograft and free flap transfer: a case report. *Diabet Foot Ankle* 2017; 8(1): 1270076.
13. Fiorito J, Trinidad-Hernadez M, Leykum B, et al. A tale of two soles: sociomechanical and biomechanical considerations in diabetic limb salvage and amputation decision-making in the worst of times. *Diabet Foot Ankle* 2012; 3: 18633.
14. Baumgartner R and Botta P. *Amputation und Prothesenversorgung der unteren Extremität*. 2nd ed. Stuttgart: Enke, 1989, pp. 1232–1241.
15. Brodell JD, Ayers BC, Baumhauer JF, et al. Chopart amputation: questioning the clinical efficacy of a long-standing surgical option for diabetic foot infection. *J Am Acad Orthop Surg* 2020; 28(16): 684–691.
16. Chiu YC, Chung TC, Wu CH, et al. Chopart amputation with tibiotalocalcaneal arthrodesis and free flap reconstruction for severe foot crush injury. *Bone Joint J* 2018; 100-B(10): 1359–1363.
17. Wagner A and Fuhrmann R. Korrektur des fersenauftritts am belastungsinsuffizienten Chopart-Stumpf. Tibiokalkaneare

arthrodese und intramedulläre marknagelosteosynthese. *Unfallchirurg* 2008; 111(1): 53–57.
18. DeGere MW and Grady JF. A modification of Chopart's amputation with ankle and subtalar arthrodesis by using an intramedullary nail. *J Foot Ankle Surg* 2005; 44(4): 281–286.
19. Brown ML, Tang W, Patel A, et al. Partial foot amputation in patients with diabetic foot ulcers. *Foot Ankle Int* 2012; 33: 707–716.
20. Dillon MP, Anderson SP, Duke EJ, et al. The lived experience of sequential partial foot and transtibial amputation. *Disabil Rehabil* 2020; 42(15): 2106–2114.