FussSprungg 19 (2021) 218—228

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Staged management of Lisfranc complex injury - Case report and literature review

Stufenweises Management einer Lisfranc-Komplex-Verletzung - Fallbericht und Literaturübersicht

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Received 6 July 2021; accepted 6 September 2021
Available online 14 October 2021

KEYWORDS
Lisfranc fracture-dislocation;
Complex foot trauma;
Soft tissue management;
Staged surgery

Abstract

Background: There is an increase in the numbers of high energy tarsometatarsal / Lisfranc fracture dislocation. In this type of trauma, the specialist in orthopedics and traumatology cannot consider only the fracture as the challenge to be overcome, the injury to the soft tissues of the foot ends up being of equal or greater importance throughout the treatment. Our aim is to demonstrate, through a case report and literature review, that staged multidisciplinary surgical treatment is a good option for the treatment of these complex cases.

Case: We report a case of a 28-year-old female victim of a motorcycle collision with a car. She was diagnosed with complex lesion of the right foot (fracture the medial cuneiform, fracture of the lateral cuneiform, cuboid fracture and loss of the intermediate cuneiform, detaching wound of dorsal skin, loss of the extensor hallux longus tendon, anterior tibial artery and deep peroneal nerve). In the emergency

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https://doi.org/10.1016/j.fuspru.2021.09.001

setting the patient was submitted to an initial debridement and gross reduction fixation with Kirschner wires. The further course was complicated with local infection and need for staged debridements, modification of the fixation and negative pressure wound dressing. She was later submitted to a flap coverage at the dorsum of the foot and in a last approach, arthrodesis of the medial tarsometatarsal and navicular joints.
Conclusions: Lisfranc complex injuries continue to be an important source of pain and disability for patients worldwide. This case description show decision making challenges in a scenario without all resources available. The literature review demonstrates thar 2 phases of treatment principles must be respected: early damage control and definitive treatment. The key factors for improved outcomes are: early soft tissue coverage and restore axial, sagittal, and coronal alignment of the medial and lateral columns of the foot.

SCHLÜSSELWÖRTER
Lisfranc-Luxationsfraktur;
Komplexes Fußtrauma;
Weichteilmanagement;
Schrittweise Behandlung

Zusammenfassung

Hintergrund: Die Zahl der Hochenergietraumata mit Lisfranc-Luxationsfrakturen nimmt zu. Bei dieser Art von Trauma kann der Facharzt für Orthopädie und Traumatologie nicht nur die Fraktur als die zu bewältigende Herausforderung betrachten, die Verletzung der Weichgewebe des Fußes ist letztendlich von gleicher oder größerer Bedeutung bei der Behandlung. Unser Ziel ist es, anhand eines Fallberichts und einer Literaturübersicht zu demonstrieren, dass die stufenweise chirurgische Behandlung eine gute Option für die Behandlung dieser komplexen Verletzugen darstellt.
Fall: Wir berichten ber ein weibliches 28-jähriges Opfer einer Motorradkollision mit einem PKW. Es wurde eine komplexe Läsion des rechten Fußes diagnostiziert (Fraktur des medialen Keilbeins, Fraktur des lateralen Keilbeins, Kuboidfraktur und Verlust des mittleren Keilbeins, Ablösungswunde der dorsalen Haut, Verlust der Extensor hallucis longus - Sehne, der Arteria tibialis anterior und des N. peroneus profundis). In der Notaufnahme wurde ein erstes Debridement und eine Fixierung mit Kirschner-Drähten durchgeführt. Es entwickelte sich eine lokale Infektion und es mussten weitere Debridements mit Verfahrenswechsel und Vakuum-Versiegelung durchgeführt werden. Die definitive Therapie bestand in einer Lappendeckung am Fußrücken und einer Arthrodese des naviculocuneiforme- und medialen Lisfranc - Gelenkes.
Schlussfolgerungen: Lisfranc-Komplex-Verletzungen sind nach wie vor eine wesentliche Quelle für Schmerzen und Behinderungen bei Patienten weltweit. Diese Fallbeschreibung zeigt die Herausforderungen bei der Entscheidungsfindung in einem Szenario ohne alle verfügbaren Ressourcen. Die Literaturübersicht zeigt, dass 2 Phasen der Behandlung beachtet werden müssen: frühe Schadensbegrenzung und definitive Behandlung. Die Schlüsselfaktoren für verbesserte Ergebnisse sind: frühe Weichteildeckung und Wiederherstellung der axialen, sagittalen und koronalen Ausrichtung der medialen und lateralen Säulen des Fußes.

Introduction

Lisfranc (tarsometatarsal) joint injury represents less than 1% of all body fractures, with an incidence of 1/55,000 cases per year [1—3]. This injury leads to rupture of the medial arch of the foot causing the midfoot and forefoot region to become unstable and deformed. Often this fractures and/or dislocation are associated with lesions of the cuneiforms, other metatarsals and cuboids [1].

Obtaining an anatomical reduction in Lisfranc dislocation fractures is a critical part to obtain good treatment results [1].However, in high-energy trauma, this ideal alignment is often not possible and the goal of the initial surgery is to reduce major deformities and thus allow the improvement of local tissue conditions to perform a second surgery later and calmly and at that moment try to obtain the most anatomical reduction possible [1,2,4].

In this same sequence of thoughts, there are studies showing the importance of soft tissue management either in the limb as a whole or in the foot, as possible defining factors of prognosis [2,5,6]. In this management, in addition to serial surgeries with extensive debridement and re-approaches within 72 hours, we have options for adjuvant techniques in tissue care, such as dead space fillers, negative pressure dressings and flap and/or graft

Figure 1. X-ray image at patient admission A) Antero-Posterior (AP) view B) Lateral view C) Oblique view.

techniques to cover myofasciocutaneous defects [7,8].

The aim of this article is to discuss a treatment option for a complex soft tissue trauma to the foot, associated with a Lisfranc fracture-dislocation through the description of a case and, later, discussion of the literature on the subject.

Case report

A 28-year-old female patient, victim of motorcycle collision with a car. She was admitted to our facility on July 14, 2013, where a fracture-dislocation of the tarsometatarsal region of the right foot was diagnosed (fracture the medial cuneiform, fracture of the lateral cuneiform, cuboid fracture and loss of the intermediate cuneiform), with a severe soft tissue lesion of dorsal mid and forefoot, leading to a loss of the extensor hallux longus tendon, anterior tibial artery, deep peroneal nerve and a degloving wound of dorsal skin, a with good distal perfusion and preserved plantar sensibility. (Fig. 1)

At admission, antibiotic prophylaxis according to the institutional protocol was introduced, as well as analgesia, immobilization of the limb and referred the patient for emergency surgery for an extensive debridement of the devitalized tissues and irrigation with saline solution, gross reduction and stabilization of fractures-dislocations with use of Kirschner wires (KW) and suture of the open wound.

The patient remained hospitalized for antibiotic therapy and postoperative wound management, however, she developed necrosis of the dorsal skin of the foot and discharge of purulent secretion.

Therefore, on the 3rd postoperative day (PO), she underwent a repeat surgery in which all the devitalized tissue of the foot was resected, the previous implants were removed and a new reduction and fixation with KW was performed, this time with a more stable assembly. The bone defect was filled with a polymethylmethacrylate spacer with vancomycin, to decrease the dead space. (Fig. 2)

Because there were clinical signs of local foot infection during the operation, bone and soft tissues specimens were collected for culture. The lab results showed a white blood cell (WBC) count of 9,04 mil/mm^3, a C-reactive protein (CRP) of 23,3 mg/L (normal limit < 5 mg/L) a erythrocyte sedimentation rate (ESR) of 80 mm (normal < 10) and bone culture of Enterococcus Fecalis Multisensitive. As the foot necrotic skin was resected, it was decided to apply a negative pressure wound dressing (NPWD). (Fig. 2)

After 3 days, the patient underwent to a planned repeat debridement surgery in which it was possible to verify improvement of the local infectious conditions, with granulation tissue, without

Figure 2. X-ray image after the first emergency procedure A) AP view B) Lateral view C) Oblique view.

tissue necrosis or secretion. The bone and soft tissue culture of this approach had a negative result, so it was planned to perform soft tissue coverage with an anterolateral thigh flap in the next surgical approach within 3 days.

At that moment, it was decided to maintain the stabilization obtained with the KW, as a definitive treatment for the 5th, 4th, 3rd metatarsals and cuboid, and provisional for the 1st and 2nd rays. After the flap heals, arthrodesis of the 1st and 2nd rays would be performed.

After 2 months of the initial trauma, it was considered that the flap was mature enough to be detached from its edges and that there was no more local infection on the foot, thus arthrodesis was performed between the navicular, medial cuneiform, 1st and 2nd metatarsals, with interposition of iliac crest corticocancellous bone graft in bone failure. (Fig. 3) The labs showed a WBC of 4,79/mm^3, CRP of 3,3 mg/L, ESR of 3 mm and the last culture of bone and soft tissue where all negative.

The patient progresses without pain or limitations to activities of daily living, despite not having a direct injury to her ankle, because of the soft tissue scarring after complex injury she presents a slight loss of active dorsiflexion. (Fig. 4)

Discussion

Complex injury to the foot

The literature defines the term "complex trauma to the foot and ankle" as fractures associated with severe soft tissue damage, neurovascular and articular involvement [9,10]. Currently, the most common mechanism of complex trauma is traffic accidents, followed by falls and work-related trauma. In the last few decades, we have also seen a crescent description of similar cases in battlefields, associated with high-caliber ammunition and landmines [9—12]. Direct traumas are more prevalent in this type of injury, since the energy of trauma is greater and injures more tissues [13,14].

In order to try to standardize the care of these patients, some classifications about soft tissue injuries were developed, the most classic being Gustilo-Anderson, Oestern and Tscherne for soft tissue injuries in closed and open fractures and the AO classification for injuries of parts soft in closed or open fractures [9,10,15—17]. The most used still remains the classic by Gustilo-Anderson, however it presents high inter-observer disagreement [10]. The ideal classification would be the one that is easy to access, with good intra and inter-observer

Figure 3. Images during the 1st and 2nd of the patient A and B showing the lesion and suffering of the soft tissue before the reapproaches; C and D after the incision showing.

reproducibility and that helps in determining the conduction of the case. Figure 5

The next step after assessing fractures, soft tissue and clinical conditions is to define whether limb salvage / reconstruction measures should be attempt or whether to go for amputations [18,19].

There are several scores to assist in this choice through defining the severity of injury. However most of them have a high specificity while sensitivity ranges from 60-70%, and is not complete determinant to choose amputation or reconstruction, especially when the value of the score is above the cutoff, since there is no certainty that the attempt to reconstruction also does not bring a good result [6,9—12,20].

The psychological impact of treatment must be taken into account when defining which path to follow [9,21]. Amputation generates an immediate and definitive trauma for the patient, while attempts at reconstruction at the beginning can be more easily accepted by patients, however, it should be emphasized the possibility that the patient has to undergo several reconstruction procedures and sometimes without final success. One should note, that the final satisfaction rate of the two procedures is similar, so the definition of treatment must take into account the patient's final expectation and rehabilitation [6,10,11,21].

Another important point in this definition is related to treatment costs [21]. In amputee

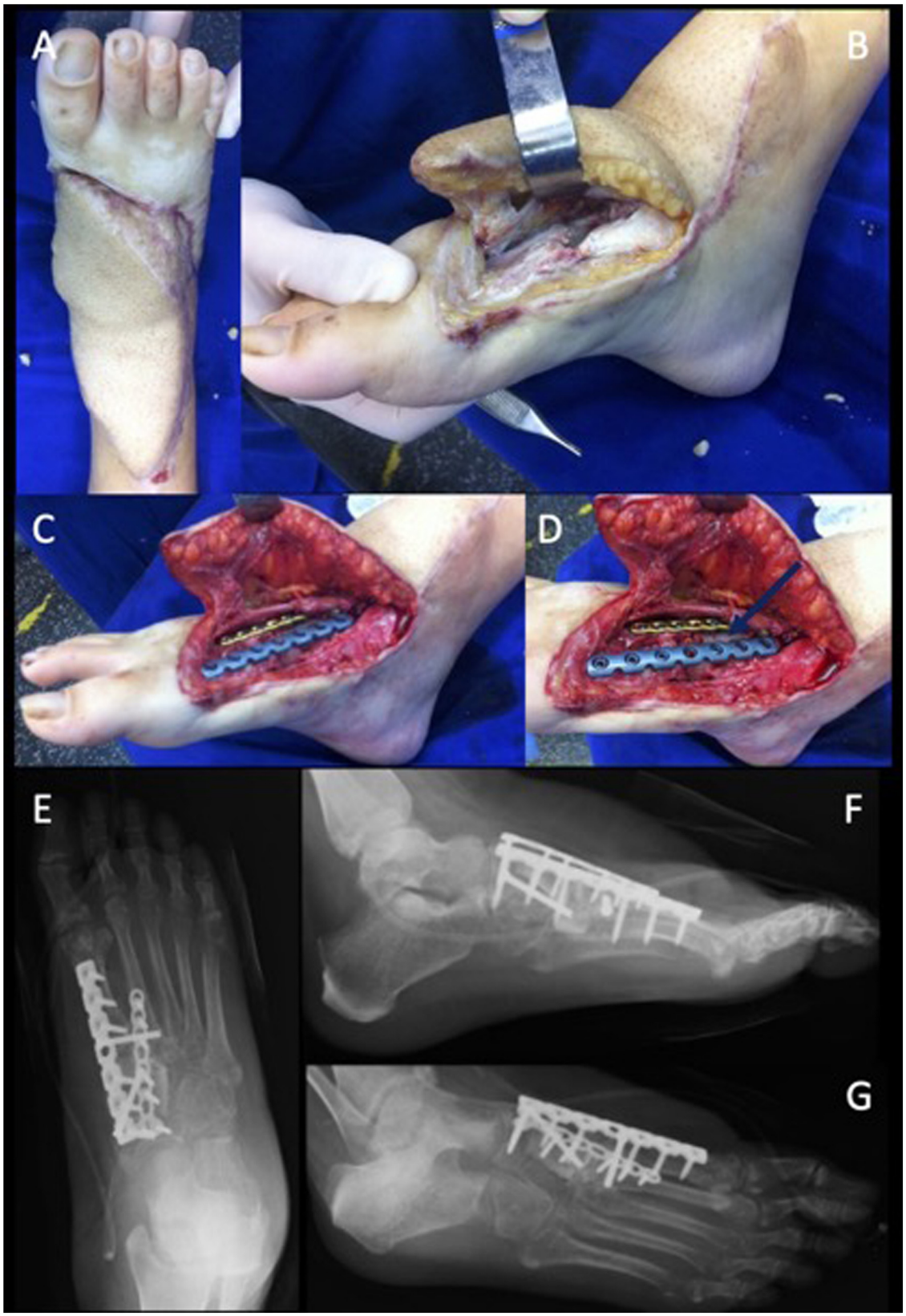

Figure 4. A) The aspect of the flap before the final surgery B) incision trough the border of the flap C and D) position of the.

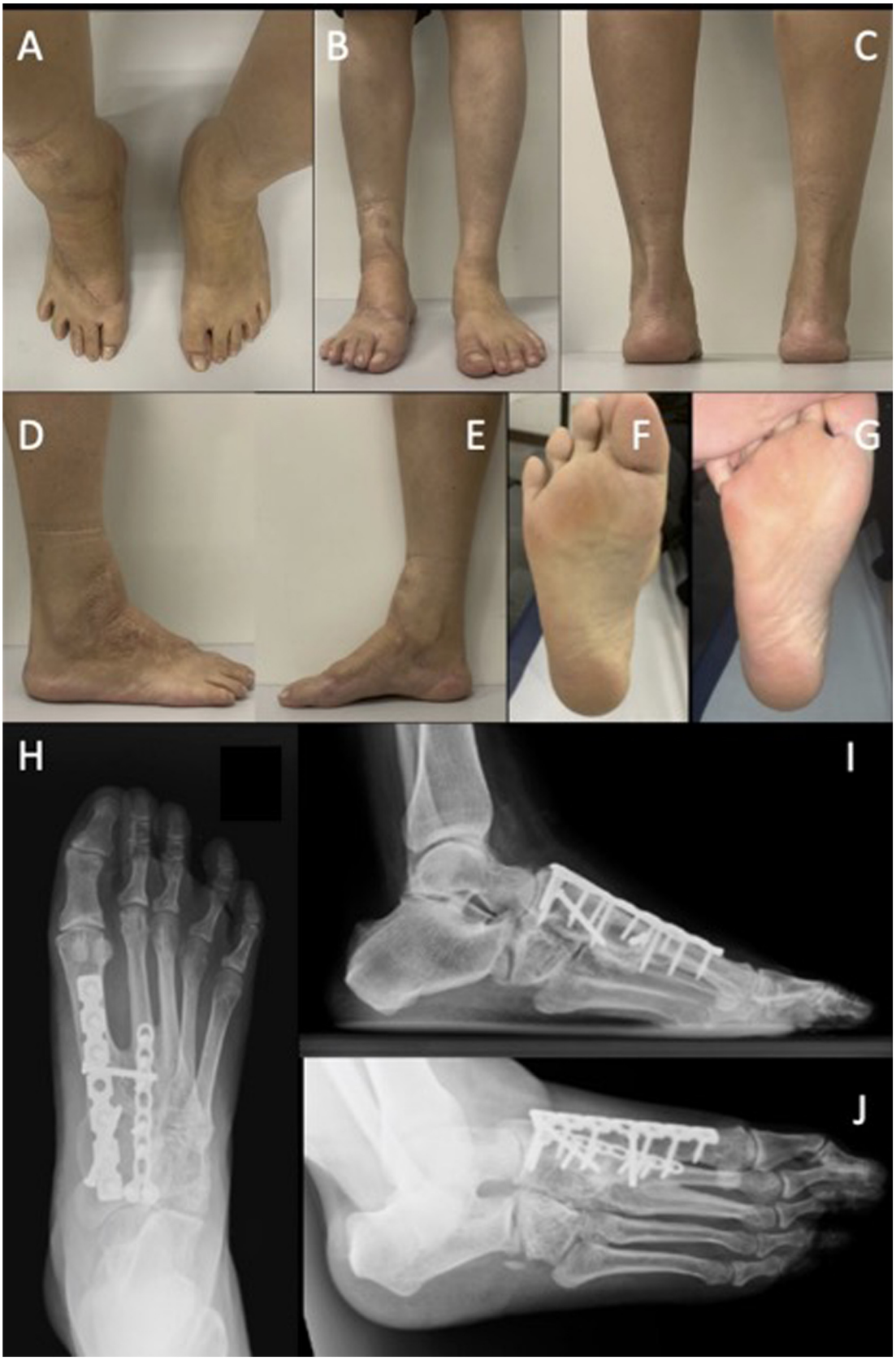

Figure 5. 2021images of the patient A) Dorsal image of the feet B) Anterior image of the ankle C) Posterior Image of the ankle D) Lateral aspect of the right foot E) Medial aspect of the right foot F and G) plantar aspect of the right foot H) AP X-ray of the right foot I) Lateral X-ray of the right foot J) Oblique X-ray of the right foot.

patients, the cost of rehabilitation, re-adaptation, prosthetics and labor impact must be computed. In patients undergoing reconstruction, we must consider the greater number of hospitalizations and surgical procedures, in addition to rehabilitation. Some authors analyzed these costs and found that between amputation below the knee and reconstruction, the cost to the health system was lower in those who underwent reconstruction [9,22].

In the reconstruction of complex lesions of the foot, it is often not possible to perform anatomical reductions and wound closure, as these traumas are often associated with bone and muscle losses, among other covering tissues [3,14]. In several of these situations the functional result of the limb is extremely limited due to extensive scarring, muscle loss, sensitivity and joint lesions. In severe cases, it is already accepted that the patient will have post-traumatic osteoarthritis in the future, but that until then, the patiente will have a functional limb that allows him to carry out daily activities and sometimes return to his previous function [2].

In these cases, the staged treatment becomes the most recommended. In the initial stage one should strive to stabilize fractures and dislocations and then, in a second stage, make larger approaches with previous planning, already knowing better the local tissue viability [2,6]. In these situations, it is common for the attempt at treatment in a single operation to lead to local complications requiring further re-approach by these patients [6,23].

The staged treatment starts with an early surgical approach, for the treatment of exposed lesions with aggressive debridement of the wounds using saline solution at low pressure and resection of all dead and devitalized tissue in the region, as well as loose bone fragments and foreign bodies [10—12,18,24,25]. To perform this exploration, it is usually necessary to enlarge the patient's exposure wound and allow a better assessment of the compartments, one of the most important points is to ensure that after debridement there is only tissue that the surgeon considers viable, whether bone or soft tissue [11].

If during the procedure the surgeon is suspicious of the possibility of compartment syndrome, fasciotomies and release of the foot compartments should be performed generously [26].

After the end of the procedure, the ideal is to adapt the margins of the wounds without tension with simple sutures, the fasciotomy wound should be covered with either collagen-based skin substitutes, sterile dressings or preferably with NPWD [10].

Antibiotic prophylaxis should start when the patient enters the hospital in the presence of open fractures. It is also worth mentioning that more than 90% of infections in these patients are hospital-acquired infections, which is why each hospital must have its own treatment protocol, following its predominance of germs [10].

These patients should be serially re-approached with debridement until there is confirmation that there is no further infection in progress. These re-approaches usually occur between periods of 24-72 hours after the previous procedures [10,12,19]. This allows the surgeon to evaluate the evolution of the gray zone, showing its viability or necrosis, justifying the extent of debridement, reducing the spread of infection [9,17].

In our case, because it is a complex trauma of the foot with great loss of substance, but with signs of good quality of the limb, we decided to invest in reconstruction with staged treatment.

Intraoperative

In cases of complex foot injuries, with programmed damage control and staged treatment, we will seek the best possible alignment in the first approach, quickly, without adding additional injuries, even if it is not anatomical. In sequential approaches, with local and systemic clinical improvement, it is possible to redo the reduction in a more anatomical position.

For these provisional stabilizations there is a discussion mainly between fixations with KW or the use of external fixators (EF). Kadow et al. demonstrated in his article the effectiveness of the use of external fixators to gain length and alignment of the foot [4]. Other authors mention the advantage of the EF to allow alignment with simple distractions using Schanz pins outside the fracture zone, helping to recover traumatized tissues and avoiding formation of compression or neurovascular injuries [3,6,12]. Another advantage of the EF is that it allows a more rigid and stable alignment than other temporary implants, which reduces local tissue aggression and, if necessary, it can be used as a form of definitive treatment [6,27,28]. However, as the pins of these fixators are not the usual ones, many institutions do not have them available all the time, which can cause a delay in the time of the surgery [1,3]. The EF are normally used in the first or fifth rays, and is they do not allow alignment of the central rays [29].

Herscovici et al. discussed the use of KW to make the provisional fixation of these patients, since this type of implant is available in almost all hospitals that perform orthopedic procedures

with different diameter sizes [1]. It was also found that despite the wires passing through the joints, this problem could be minimized by using wires of smaller diameters. Furthermore, fixation with Kirschner wires makes it easier to use concomitant aspiration dressings when compared EF [2]. Just like EF, it is possible to pass Kirschner wires out of the injured areas, reducing local suffering [27]. One of the main criticisms of this method is the fact that it stabilizes less rigidly than other fixation methods, motivating its association with other methods, like EF, even in the initial phase [3,6,14].

The main complication of both methods is infection of the pin track, since they are in contact with the external environment, but regular pin care helps to prevent this complication. It is ideal to avoid passing the pins or wires in the position of the final fixation [1,2,4,28].

In this case, we chose the KW to fixate the luxations and fractures. Although the external fixator provides more stability for the first and fifth rays, we would need to stabilize the central rays with KW. Thus, we decided to fixate all the five rays with KW.

Another increasingly frequent complication with high-energy trauma is the loss of bone substance with or without loss of soft tissue coverage. This creates a dead space problem that increases the chance of infection and hinders local reconstructions. To treat this situation, some surgeons use bone cement (polymetylmethacrylate) with or without antibiotics as spacers, until the foot conditions allow a definitive reconstruction using autologous bone grafts, or allografts, or myofascial flaps to fulfill the gap [12,24].

Lykoudis et al. described another way of dealing with this problem of significant bone loss [8]. In a case report, they described an approach to a severe Lisfranc lesion with severe loss of soft and bone parts, and to overcome this situation using a vascularized fibula flap that would allow to fill part of the lost space and maintain part of the functionality of the foot. In the follow-up, they verified that the patient returned to the previous functionality, but maintained mechanical complaints.

NPD therapy has been proven to be used for temporary coverage of gaps between revision surgeries or for stimulating local granulation tissue either for primary healing or formation of a graft bed [6,7,30,31]. In addition, it was found that its pressure power by removing interstitial fluids and local vasodilation helps in the treatment of local infections.

For the definitive coverage of soft tissue defects, with bone exposure, the ideal is the use of a flap, because if the wound to heal by second intention, it probably would ends up with retractions, prolonged treatment time and increases the chance of contamination and infection.

Since the 1980s, the use of flaps has been advocated for this function of covering the defects [24,32]. Some studies show that patients who are unable to cover within 5 days of the trauma suffer from more local complications such as infection and pseudoarthrosis, which may partly be the fault of trauma of greater energy, establishing the concept of early closure of the soft tissue envelope, after definitive reconstruction, "fix and flap"[33,34]. On the other hand, some authors show that delayed coverage of the soft tissue envelope, waiting for the definition of the area that needs coverage, aided by serial debridement, does not affect the final result [24,35].

Currently, there are several flap techniques that can be used to cover foot defects, and it is a multidisciplinary decision - the microsurgeon together with the orthopedist — which flap is more indicated for the location, taking into account the issue of vascularity, skin type, if you also need myofascial tissue or cutaneous only [19,25,32].

In this case, in the second surgery, there were signs of infection, thus we preferred to perform debridement before cover the soft tissue envelope, removing all the infected tissue and control the infection. The patient evolved with normal levels of laboratorial exams, and in the third surgery was observed adequate local condition. Therefore we proceed with the soft tissue coverage, using a microsurgical muscle flap to help to fulfill the dead space of the lack of bones and soft tissue [12,24,25].

Due to the diagnosis of acute osteomyelitis at the beginning of the case, we found more prudent to perform the definitive reconstruction of the medial rays of the foot with bone graft after the healing of the flap and longer evolution time and antibiotic therapy. In this way, we would have more security that the environment is free of infection, reducing the chance of biofilm formation and re-approaches due to the maintenance of an infectious condition.

Outcome

The expected outcome for these patients should be adjusted for the severity of the trauma [6,9,19]. These patients should not be expected to progress perfectly, without complications such as osteoarthritis or pain from major exercise. What should be aimed at are functional limbs (plantigrade, painless and stable) that allow the patient to resume the activities previous to the trauma and can return to work and exercise, sometimes at a slightly lower intensity [2,14,19,27]. The joint

injury that the patient suffered will directly influence the final result of this recovery [6].

Our patient was able to return to previous activities with a slight limitation, to the point of not finding that these range of motion limitations interfere with the activities she performs, demonstrating that some patients adjust their expectations according to the severity of their trauma.

Conclusion

Complex foot trauma is increasingly prevalent, requiring standardized treatment. Lisfranc complex injuries continue to be an important source of pain and disability for patients worldwide. This case description show decision making challenges in a scenario without all resources available.

The literature review demonstrate 2 phases of treatment principles must be respected: early damage control and definitive treatment. The key factors for improved outcomes are: early soft tissue coverage and restore axial, sagittal, and coronal alignment of the medial and lateral columns of the foot.

Author Contributions

Substantial contributions to research design, or the acquisition, analysis or interpretation of data: D.L.R. and R.B.S. Drafting the paper or revising it critically, approval of the submitted and final version: all authors.

Ethical Statement

This article was submitted for analysis by the Ethics Committee and the Scientific Committee of the Institute of Orthopedics and Traumatology at USP. With approval and control number IOT 1499.

Conflict of interest

No conflict of interest.

Funding

The authors declare that this paper had no funding or sponsoring.

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