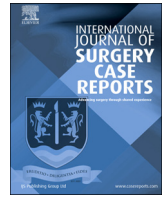




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Controversial case: Revascularization of a popliteal vascular injury of poor prognosis

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ABSTRACT

INTRODUCTION: Popliteal injuries are significant health risk that could induce permanent functional impairment, limb loss, and in some cases death. Currently, there is a controversy about the required treatment between amputation and a limb salvage surgery, which in some cases could cause more prominent functional impairment than the amputation. Different indicators help to predict, in some extent, the risk of amputation, however most of them were described two decades ago.

PRESENTATION OF CASE: A patient with a prolonged hot ischemia and in critical conditions, which had no favorable clinical indicators for revascularization is shown and discussed. By means of intraoperative analysis, it was decided to perform a revascularization for limb salvage, progressing with a positive outcome.

DISCUSSION: Advancements in medical and vascular surgery, such as osteovascularized grafts, the use of flaps to cover large defects, the Ilizarov method for bone elongation and stabilization, the use of growth factors, negative pressure therapy, and the use of extracellular matrix, the improvements of intensive care units (ICU), among others, make necessary to revisit and reevaluate these indicators. The accuracy of these indicators has dropped significantly, and currently the medical evaluation cannot longer only depend on them.

CONCLUSION: Our results suggest the need to revisit and improve the predicting indicators scores for amputation prognosis that should include a preoperative and transoperative analysis.

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1. Introduction

Vascular injury (VI) represents 1–2% of all injuries in trauma, where among limb injuries could reach the 20–50% of VI. The higher VI incidence is found in the age range from 30 to 40 years old (70–90%), and penetrating trauma is responsible for 95% of the deaths, in which 78% are from injuries of the lower extremities. However, the overall mortality of the lower extremity vascular injury (LEVI) is only 2.8% [1].

Popliteal artery injuries (PAI) are 20% of the LEVI, where 40% from those are penetrating, and 60% are from closed trauma. In the case of penetrating injuries of the lower extremity, 40% are associated with fractures, 35% with popliteal vein injury, 30% with an important soft tissue lost and 10% with nerve injury [2]. During the Second World War, the PAI were managed with ligation, resulting in a 73% rate of amputations. Nevertheless, advances in vascular surgery made during the Korea and Vietnam wars have helped to

lower this incidence up to 30% in military scenarios [3]. Today, for non-war LEVI cases, nearly 9.7% require amputation, whereas when they are associated with polytrauma, it rises to 52%. Nevertheless, the overall amputation rate could be considered of 6–13% in all LEVI [1].

There are multiple scales for predicting the risk of amputation. The most widely used is the Mangled Extremity Severity Score (MESS) described in 1990 from a 25-patients study with a 100% of accuracy in predicting amputation, which is based in hot ischemia time; clinical signs; age; the presence of shock, and the trauma mechanism [4]. It is currently reported for the MESS a sensitivity and a specificity of 78 and 69% respectively [5]. There are other scales, such as: Limb Severity Index (LSI); the Predictive Salvage Index (PSI); the Nerve Injury, Ischemia Time, Soft Tissue Injury, Skeletal Injury, Shock and Age of Patient (NISSSA), among others, which has showed a sensitivity of 83, 40 and 33%, and a specificity of 82, 79 and 13%, respectively [5].

In this work a clinical case from a patient treated with revascularization of a PAI of poor prognosis, which was initially intended for amputation, is presented. Based on this case it is discussed the complexity involving a trauma patient, the importance of intraoperative findings, as well as the need to renew the prognostic scales based

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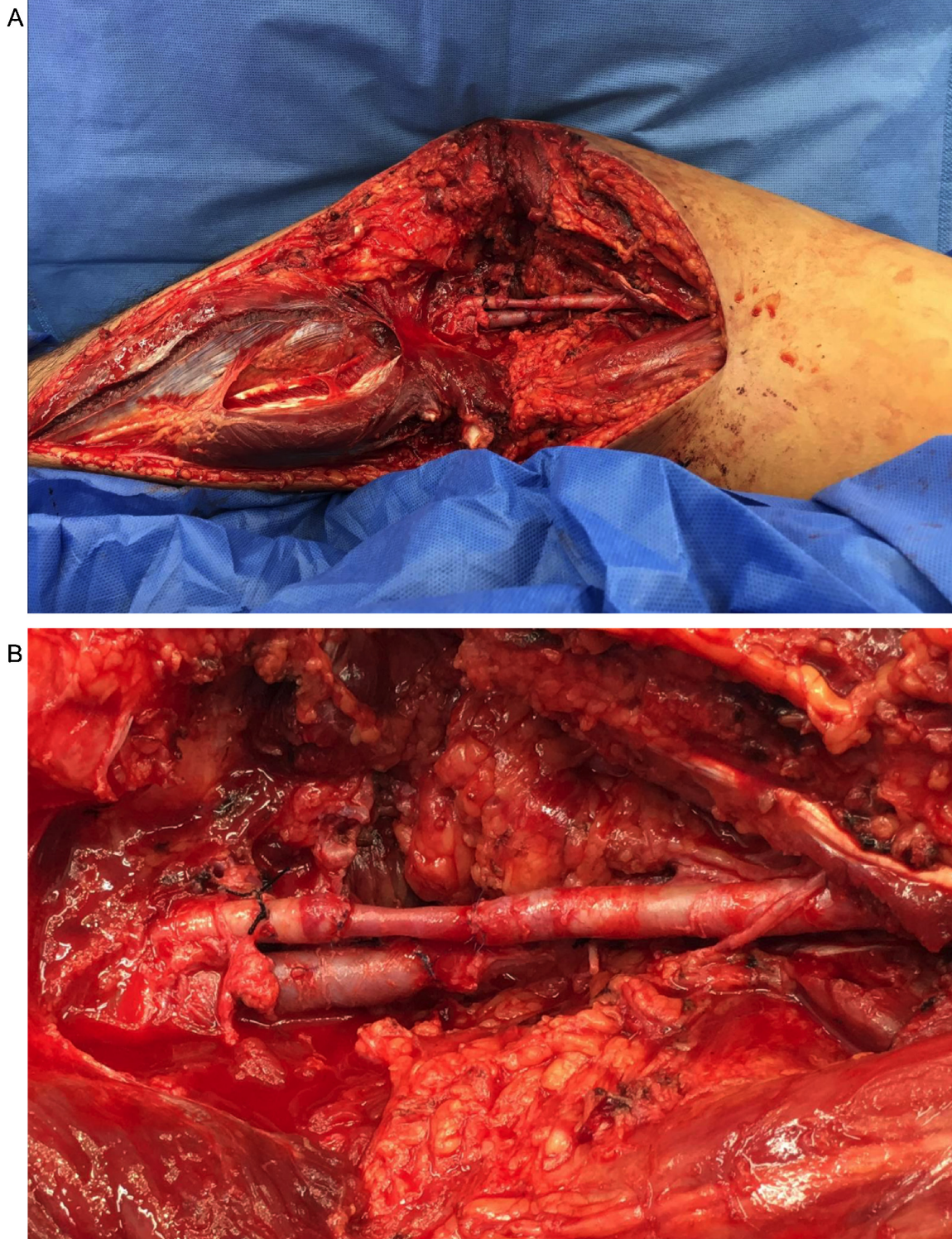


Fig. 1. A patient with 23-cm long laceration in the medial aspect of the distal third of the thigh and proximal right knee after the anastomosis (A) with the 4 cm of reversed lesser saphenous vein graft, and end-to-end vein anastomosis (B).

on the current medical advances. This work has been reported in line with the SCARE criteria [6].

2. Case presentation

A 23-year-old patient was referred to the Emergency Department after a firework powder explosion. He presented multiple punctate burns and lacerations on the thorax and abdomen, as well

as multiple penetrating injuries, secondary to metal splinters. A 3-cm injury in the left flank, and a 3-cm on the lateral aspect of the left thigh, and a 23-cm long in the medial aspect of the right knee associated with complete laceration of the popliteal vein and artery. The patient had a vascular exploration with the insertion of a temporary arterial shunt (with a 10 Fr Nelaton catheter) in the popliteal artery. After 12 h from the incident, it was referred to our unit in critical conditions, on mechanical ventilation and vaso-

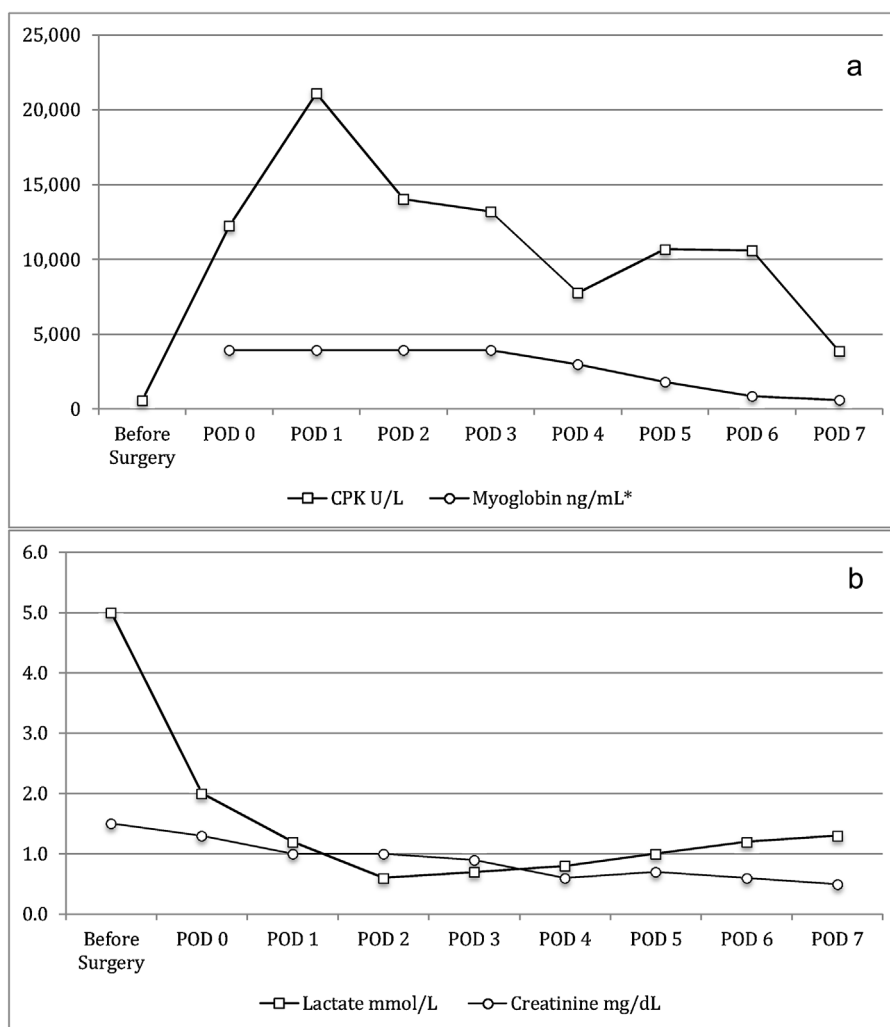


Fig. 2. Signs of reperfusion syndrome; and how did it not had any permanent damage and how all the laboratory values return too normal. Comparing the progress of (A) creatinine phosphokinase (CPK) and myoglobin; (B) creatinine; and lactate.

pressor infusion, with a previous transfusion of four red blood cells concentrates (RBC) and aggressive solution infusion. At his arrival the patient was unstable (BP 70/30 mmHg, HR 138 per min and a temperature of 34.5 °C), with a pulseless right limb, MESS of 9, Injury Severity Score (ISS) 21, PSI 9, LSI of 7 (without knowing the presence of a vascular shunt). The FAST US was positive, so he was sent for an exploratory laparotomy and right above the knee amputation since he was believed to suffer 12-hours hot ischemia and with apparent abdominal injuries. Thus, a 200 cc of clear fluid was found in the abdominal cavity, probably due to a previous mis-sive solution administration, with no apparent abdominal injury. Also, a complete transection of the right popliteal artery with the loss of approximately 6 cm was found. In addition, the presence of a nonfunctional shunt (with a 10 cm thrombus proximal to the zone of injury), and a complete popliteal vein transection. Being a young patient without comorbidities, with no evidence of posterior tibial nerve injury or any alteration in muscular contraction in the presence of electrical impulse, and adequate muscular color, it was decided to perform an end-to-end anastomosis of the popliteal vein and an arterial repair (with previous thrombectomy and local and systemic heparinization with 5000 units in the first bolus and 1500 units every hour). The procedure was performed with 5 cm reversed saphenous vein graft, adding 5 mL of Fibrin glue (TISSUCOL by Baxter AG, Vienna, Austria) after the repair (Fig. 1A, B). Also,

a four-compartment fasciotomy of the leg was performed in the patient prophylactic, through a medial and lateral incision.

The patient was admitted to the ICU, where he remained stable, requiring transfusions of five RBC and four fresh frozen concentrate plasma on the fifth day. During the 5th postoperative day (POD) he was discharged from the ICU without vasopressors, mechanical ventilation, signs of ischemia or reperfusion injury (Fig. 2A, B). On the sixth POD, *Burkholderia cepacia* was isolated in the lateral wound of the leg, thus systemic antibiotics were escalated, as well as wound care two times a day, and seven surgical debridements in which three had negative pressure dressings. The patient was discharged home in the 55th POD. After six months postoperatively, all scars have healed (Fig. 3) he was walking with walking aids, with minimal limitations for knee movement, but limited flexion and extension of the ankle, scoring 53 points (66.25%) on the Lower Extremity Functional Scale (LEFS).

3. Discussion

Malan and Tattoni in 1963 proposed the term “golden period” that referred to the six hours of ischemia, used as a cutoff for revascularization [7] and still many surgeons are using. However, a study done by Glass et al. [8] showed, in a Kaplan-Meier survival curve, that after the fourth hour of warm ischemia the muscle cells start to present necrosis; after six hours up to 20% of the muscle is usu-

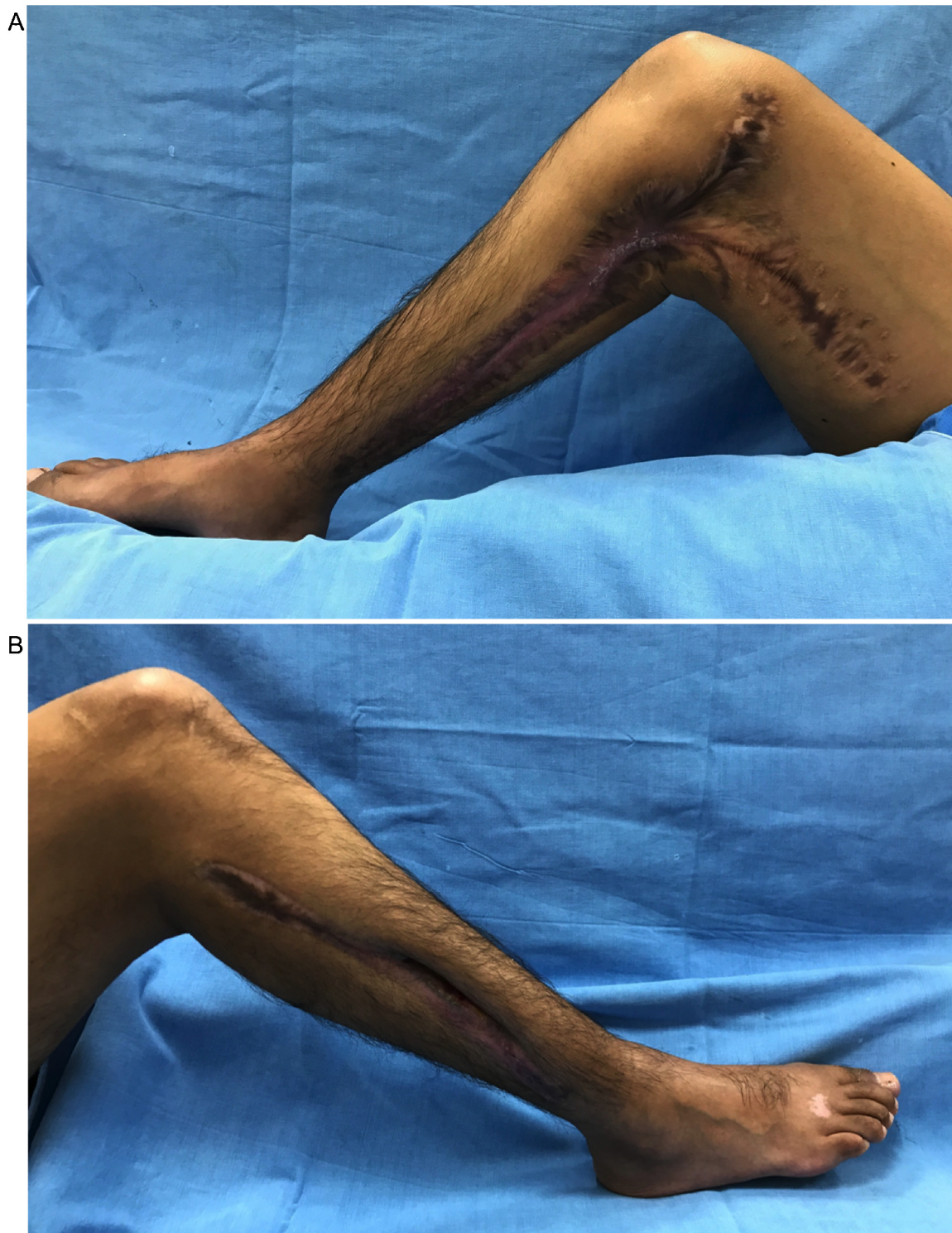


Fig. 3. The patient after six months, with all injuries healed. It is showed the medial injury with the hypertrophic scar, but no changes in color (A) and the lateral aspect of the leg, where the incision that was made to perform the prophylactic fasciotomy (B).

ally necrosed, and after 12 h up to 50%, refuting the used of 6 h of hot ischemia as indicator for amputation. However, this decision is more complex, since there are patients that after less than six hours they show evident signs of irreversible ischemia, while others after more than six hours showed promising recovery. Multiple variables could play a role in PAI, as reported by Dua et al. [9]. An inverse relationship between the flow of the genicular arteries and

the percentage of amputation has been found with values of 3.3 (± 1.3) permeable genicular arteries in patients with limb recovery versus 2.1 (± 1.8) in secondary amputations. Despite the limitations of this study, it demonstrates to be a significant indicator for considering a late revascularization in a salvage surgery. There are several other indicators that have been ruled out as poor prognosis markers. Another refuted sign, is the presence of plantar hypoes-

thetia after a LEVI, that was believed to be a nerve injury indicator, until Bosse et al. in 2005 [10] showed that patients who initially had hypoesthesia, after two years resulted with the same plantar sensitivity and functional mobility than those considered without this alteration, repealing the previous theory of nerve injury indication. As established by Lange et al. [11] the only indication for early amputation is the visualization of a complete transection of the posterior tibia nerve, accompanied by prolonged warm ischemia during more than six hours.

In the case here presented, since the patient had a shunt placed approximately after five hours from the injury, it was uncertainly the exact time of warm ischemia. However, when he was transferred to our unit, the presence of the shunt was unknown. The patient was having hard signs of vascular injury, and 12 h since injury, the amputation was recommended. During surgery the shunt was found clothed and revascularization was made since there were signs of muscle viability. As reported by Sasson et al. [12] the highest accuracy for muscular viability could be evaluated from all muscular macroscopic signs, the color and muscular contractibility.

Other existing controversy is repairing the vein in the presence of LEVI due to the presence of a high occlusion index (45–100% at 72 h), as reported by some authors [13]. However, it is believed that most of the occlusions of the popliteal vein anastomosis may be transient, since studies have shown that at 12 weeks, 85% of the vein anastomosis are permeable. Comparing it to ligation, it shows an acute transitory edema, up to 51% of the popliteal injuries and when they are anastomose a decrease of the edema is presented in 13% [14]. Also, the use of systemic anticoagulation in trauma patients with VI. In the present case, a systemic anticoagulation, once it was establish no apparent abdominal trauma, and a limb salvage surgery was decided. The patient did not show signs of anastomosis thrombosis or active bleeding through the incisions or the other injuries. As reported by Wagner et al. [15], promising results with the use of systemic heparin, proposing its use for limb salvage surgery. In this study, it was reported that up to 8% of the patients with a secondary amputation had used heparin, while 31% of the group that had a successful limp salvage showed systemic heparin infusion. Consistently, the study performed by Loja et al. [16] on 31 popliteal lesions, reported that systemic anticoagulation reduced the anastomosis thrombosis from 60 to 15%, and thus decreased the number of amputations by 5%.

Since the traumatic patient is very complex and many variants should be considered to develop a new scale that accurately predict the risk of amputation. However, many modifications have been proposed to be according to modern needs, like those reported by Yen et al. [17]. They reported as indicative for salvage surgery, a MESS value ≤ 6 or 7–9 but with an ISS ≤ 18 , and they suggest a primary amputation if the patient shows a MESS of 7–9 with an ISS value ≥ 18 or a MESS ≥ 10 , since there was a 95, 60, 26 and 0% of limb salvage, respectively. All these indicators could be improved, still with an adequate functional and patient satisfaction, due to the progress of vascular and microsurgical techniques, as well as other new available treatments and procedures that were not available fifteen years ago, when most of this scales were described. It is well known that attempts at revascularization on this type of patients are no longer associated with an increase in mortality during a salvage surgery, and having a 53% chance of keeping a functional limb, with an initial value of MESS up to 2 points above the cut-off point [17]. The modification of these scales seems to be necessary, adding preoperative finding, probably, such as the venous pH of the affected limb, as reported by Wilgis in 1971 [18], where venous pH correlates with ischemia time induced by a tourniquet; as well as transoperative ones (color and muscular contractility, besides others). Thus, it is imperative to always actualize the scales according to the current medical advances.

In previous years it was believed that an early amputation followed with a prosthetic treatment offered a quick recovery at low cost. However, in a multicenter study with 569 patients, it was reported no difference in recovery time. Moreover, the cost adjusted for life expectancy appeared to be three times more expensive in the amputated group [19]. Similarly, a meta-analysis presented by Akula et al. [20], showed that two and seven years after the amputation, only the 53 and 47% of the patients were working, compared with a 49 and 62% of the revascularized patients. This finding reveals that the revascularized patients had greater integration to their normal life than those where amputations was performed. In addition, a greater psychological morbidity in the amputated group is found, than those who presented a successful rehabilitation surgery, or even a secondary amputation after a failed rehabilitation surgery [20].

4. Conclusion

The decision of which patients should be amputated and which should go through a salvage surgery is a difficult task. The criteria and indicators to decide an amputation are still controversial. It is imperative to revisit them and actualize them according to current medical advances. It seem important to consider the revascularization especially in all young patients without significant concomitant injuries and lack of comorbidities, as in the case analyzed in this work.

Conflicts of interest

The authors declare that they have no competing interests.

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Ethical approval

Approval has been given by the ethics committee for the publication of this case.

Consent

Written informed consent was obtained from the patient.

Author contribution

Hanson-V participant in surgery and in the follow up of the case, planned and drafted the manuscript, data acquisition, analysis and interpretation of data, as well as revised and finalized all aspects of the article. Gonzalez-R was a participant in surgery and in the follow up of the case, as well as data acquisition, analysis and interpretation of data. Garcia-V was the surgeon in Charge for the case and follow up and approval of the final version of the manuscript for publication. Gonzalez-C is the chief surgeon of emergency surgery department and did follow up of the case and approval of the final version of the manuscript for publication.

Registration of research studies

This was as case report, not applicable.

Guarantor

Mariel González-Calatayud MD.

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