

ORIGINAL RESEARCH

Soleus Muscle Flap Application for Reconstruction of the Middle Third of the Leg

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Introduction: Lower limb injuries are common in emergency rooms and surgery services. Many are extensive wounds and have complicated and extended treatment. A good option for reconstruction is the use of muscle flaps.

Purpose: The aim of this study is to analyze a case series of wounds in the middle third of the leg, using soleus muscle flap for reconstruction and evaluating its effectiveness.

Methods: Seven patients with wounds in the middle third of the leg were selected to demonstrate its reconstruction using soleus flap. The procedures occurred between 2015 and 2017.

Results: In six cases, the cause of the injuries was trauma, with bone exposure in all of them. One patient had osteomyelitis as the cause of the lesion. Partial skin graft from the flap was performed after two weeks. There was one case of infection, with no necrosis of flaps or suture dehiscence, neither systemic complications. None of them needed new surgical intervention. All patients had good evolution.

Conclusions: Soleus muscle flap is a reliable flap and it is valuable for closing the defects in the middle third of the leg.

Keywords: Case Reports; Surgical flaps; Wounds and Injuries; Plastic Surgery; Lower extremity

Introduction

Lower limb injuries are common in emergency rooms and surgery services. Most of them are related to trauma, such as car or motorcycle accidents, or run-over accidents. Many are extensive wounds and have complicated and extended treatment.

Lower limbs have some particularities that hinder the treatment, as skin with poor elasticity, little subcutaneous tissue and terminal arterial vascularization, besides the difficulty in venous return in the orthostatic position [9, 10]. Due to these anatomical characteristics, the decision about the best technique depends on some factors. Considering that, one of the best options for reconstruction is the use of muscle flaps.

Among the muscle flaps, the soleus seems to be the best option to cover wounds in the middle third of the leg, being possible to be used for injuries caused by trauma and for ulcers and osteomyelitis too [13]. The soleus is a large muscle, richly vascularized by the posterior tibial artery, giving excellent blood support to the tissues.

This flap is a good way to repair lesions, given that it is a simple technique and has great versatility, with a vast arc of rotation and volume, being able to cover bone areas [3]. Also, it is useful for controlling infection [1, 13] because muscle flaps allow the supply of antibiotics substances

[2]. In addition to that, this muscle flap has minimal complications and sequels [11].

Then, the aim of this study is to analyze seven cases that are unified by the fact that all of them are wounds in the middle third of the leg and, in all cases, soleus muscle flap was used for reconstruction. In addition, the aim is to evaluate the effectiveness of this specific technique, which, although old, may still show good results.

Methodology

This is a case series, designed by a retrospective study. To ensure quality and consistency in the delivery of the intervention, it was used previous guidelines. To relate correctly the case series, it was used the PROCESS criteria. For this study, seven patients with wounds in the middle third of the leg were selected to demonstrate its reconstruction using soleus flap. The patients were admitted to the Plastic Surgery Service of an academic and community hospital located in Porto Alegre, in the south of Brazil, after orthopedic procedures in the period from 2015 to 2017. The surgeon is a specialist member of the Brazilian Society of Plastic Surgery and has been working in the reconstruction area since his graduation, having performed many lower limb surgeries in this hospital. Most of the patients had trauma as the cause of the lesion, with bone exposure. Patients' ages ranged from 17 to 44, resulting in an average of 30,5. There was a predominance of males. As preoperative evaluation, some exams as hemogram, renal function test, proteins and glycemia

were required, besides clinical and cardiological evaluation. Anticoagulation with enoxaparin was used from the hospitalization to 24 hours before the surgery, returning the use 12 hours after that. Besides that, it was instituted a prophylactic antibiotic. The patients received regional anesthesia. To delimit the area, a line was drawn with methylene blue.

Surgical technique

After the debridement of devitalized tissues, the best choice for covering the defects was the soleus flap. A medial incision was made in the leg, from the medial malleolus to the upper third of the tibia. With the muscles exposure, it was possible, in an easy way, to dissect the soleus to the gastrocnemius. The secondary pedicles were identified and tied with silk 2.0. The Achilles tendon was separated, allowing a good arc of rotation and covering the entire exposed tibia. Moreover, cuts were made in the aponeurosis muscle in order to lengthen the flap, without tension in the muscle borders. The stitches were made in three planes, using nylon 2.0, 3.0 and 4.0. A drain was placed in the posterior region of the leg to drain out collections and it was removed in about four days later. Postoperatively, the patients were hospitalized for approximately two weeks, and then the stitches were removed. After that, the patients were followed up in an outpatient basis.

Results

Among these seven patients, there were five men (71,4%) and two women (28,5%). The ages ranged from 17 to 44, resulting in an average of 30,5. In six cases, the cause of the injuries was trauma, with bone exposure in all of them (85,7%), being motorcycle accidents the most prominent (83,3%), followed by run-over accidents (16,6%). One patient had osteomyelitis (14,3%) as the cause of the lesion. As comorbidities, there was one case of hypertension, one of diabetes and one of smoking. (Table 1). Partial skin graft from the flap was performed after two weeks, in order to avoid bleeding-related graft loss caused by the flap. Four days after the graft, patients were discharged. Thus, the hospitalization period was around 20 days. After that, the patients were followed up in an outpatient basis in 1, 3 and 6 months and one year. There was one case of infection, with no necrosis of flaps or suture dehiscence, neither systemic complications. None of them needed new surgical intervention, being categorized in Grade 1 in accordance with the

Clavien-Dindo Classification. Considering that the main expected result was the coverage of the lesioned area and the protection of deep structures, all the patients had good evolution.

Below, three cases are presented to better illustrate the use of the soleus muscle flap in our service:

Case 1: Male, 23 years-old, motorcycle accident (Figure 1).

Case 2: Male, 31 years-old, running-over (Figure 2).

Case 3: Male, 26 years-old, motorcycle accident (Figure 3).

Discussion

Currently, the majority of lesions in the lower leg are caused by trauma [3], being related to car or motorcycle accidents or run-over accidents, resulting in extensive wounds and in tissue viability damage. Moreover, many of them have complicated and extended treatment. In addition to that, most patients are part of the society that is economically active, causing a significant social impact, affecting directly the productive capacity. Thus, the aim of the reconstruction is the maximum preservation of the muscle function for the patient to return to work activities as soon as possible [6, 10].

Lower limbs have some particularities that hinder the treatment, as skin with poor elasticity, little subcutaneous tissue and terminal arterial vascularization, besides the difficulty in venous return by the orthostatic position [9, 10]. Due to these anatomical characteristics, the decision about the best technique depends on some factors as the location of the defect in the leg, injury extension, viability of tissues, circulatory conditions, and patient general conditions, besides the surgeon experience with reconstruction techniques [2, 14, 15].

In order to cover lower limb substance losses, the leg is divided in thirds (proximal, middle and distal) [2, 10]. For the proximal third of the tibia, the gastrocnemius muscle flap is the best choice. For the middle third, the soleus muscle flap is a good option, being frequently used [2, 7, 8]. Sural flaps can reconstruct the distal third of the tibia, for example. Besides that, free flaps are an option to all regions, though, in case of trauma, it is harder to prepare the receiving area after 72 hours because of fibrosis formation and tissue devitalization. After this procedure, grafts can be necessary to cover skin [9].

Table 1: Relation between patients, sex, age, etiology of injuries and complications.

Case	Sex	Age	Comorbidity	Etiology	Complications
1	M	23	–	Trauma	–
2	M	31	Smoking	Trauma	–
3	M	26	–	Trauma	–
4	F	29	–	Trauma	–
5	M	17	–	Trauma	–
6	M	35	–	Trauma	–
7	F	44	Hypertension, Diabetes	Osteomyelitis	Infection

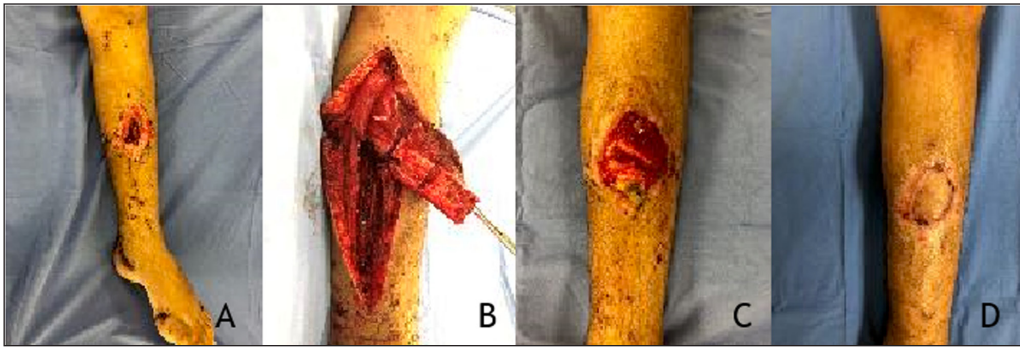


Figure 1: **A:** soft-tissue loss in the middle third of the leg with bone exposure; **B:** soleus muscle cut in its insertion; **C:** total coverage of injury by the muscle; **D:** two months after skin graft.



Figure 2: **A:** extensive lesion with soft-tissue loss from the anterolateral leg with bone exposure; **B:** bone coverage by soleus muscle; **C** and **D:** three months after partial skin graft.



Figure 3: **A:** Injury with bone exposure in the middle third of the leg. **B:** Soleus muscle flap dissection; **C** and **D:** six months postoperative.

One of the best options for regional reconstruction is the use of muscle flaps, due to its ability to cover injuries, increase local circulation and fight infections [3]. The muscle also provides a good environment for osteogenesis, because of the expression of transforming growth factor- β (TGF- β), interleukine-6 (IL-6) and fibroblast grow factor-2 (TNF-2) [4, 5]. Another option is the fasciocutaneous flap, that is less invasive than the muscle flap and has higher blood flow and tissue oxygen tension. Despite that, the muscle has a greater and faster wound repair, considering the facts mentioned above [4]. Another one is the perforator propeller flap, that has good blood supply and preserves the vascular axes of the limb, although it needs a meticulous dissection to isolate the vessels, being careful not to damage them. Besides that, primary closure of the donor site is allowed in most of the cases [12]. If all of these flaps were compared, fasciocutaneous and perforator propeller

flap provide a relative facility of elevation if a secondary procedure was necessary [5], but muscle flaps are still the best option for covering leg wounds.

Among the muscle flaps, the soleus seems to be the best option to cover wounds in the middle third of the leg. It was indicated for injuries caused by trauma and had clinical application in ulcers and osteomyelitis too [13].

The soleus is a large muscle, located in the deep posterior region of the leg and originated in the superior part of the fibula, in the intermuscular septum and in the soleus muscle line in the tibia [1, 2, 3]. It is richly vascularized by the posterior tibial artery and its secondary pedicles [1, 2, 8]. As a muscle flap, it has been used to ensure a rich vascular supply to skin flaps [13]. Its major function is the plantar flexion of the foot [3], but when the muscle is cut, it loses its function, being taken over by the gastrocnemius [2, 16].

The use of this flap is a good way to repair lesions because it is an easy technique [8] and has great versatility, with a vast arc of rotation and volume, being able to cover bone areas [3]. Also, it is useful for controlling infection [1, 13] because muscle flaps allow the supply of antibiotics substances [2]. In addition to that, this muscle flap has minimal complications and sequels [11].

Conclusions

In this study, the soleus muscle flap was used to repair middle third of the leg wounds in selected patients. This is an easy procedure, with good coverage and satisfactory results. Moreover, it has minimal functional sequelae. In all cases, the objective was achieved with a great evolution. Therefore, the value of this paper is to reiterate the fact that even though it is an old technique, muscle flaps should not be forgotten, as they may, in some occasions, be a valuable option as local flap.

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Competing Interests

The authors have no competing interests to declare.

Author Contributions

Douglas Severo Fraga: final approval of the manuscript, management of the project, performing of procedures, writing, preparation of the original, review and supervision.

Aline Carrer Bortolini: analysis and interpretation of data, conception and design of the study, writing, review and editing.

Guarantor

Aline Carrer Bortolini is the guarantor.

Peer Review

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