RESEARCH ARTICLE

Effectiveness of the Gastrocsoleous Flap for Coverage of Soft Tissue Defects in Leg with Emphasis on the Distal Third

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Abstract

Background: The standard methods for reconstruction of soft tissue defects in the leg include gastrocnemius flap for proximal third defects, soleus flap for middle third and free flap in the distal third. However, there are problems with the use of free flap, like increased operative time, damage of major vessels and the need for experienced microsurgeon.

Methods: This prospective study was undertaken on 23 patients (20 male and 3 female) with the mean age 32.13 years (14 to 65). This group consisted of all of the patients referred to Dr Bahonar Hospital, Kerman with soft tissue defects between April 2011 and April 20012 and would give informed consent for participation in the study and treatment of the defect with muscle flaps. 8 patients with proximal third defects were treated with were treated with gastrocnemius flap, 4 with middle third defects with soleus flap and 3 with reverse soleus flap and 8 with distal third defects with reverse soleus flap. The patients were followed up for at least 1 year. Finally the results were analyzed by SPSS 16.

Results: In patients with soft tissue defect in proximal and middle third of leg repair was successful in all. In 5 patients with soft tissue defect in distal third of leg repair was complete but in 3 of them flap failure was seen. Overall success rate for reverse soleous flap was 72.7%.

Conclusion: The success rate of the flap for the upper and lower thirds was similar to other studies and seems that this is the standard method. In the distal third defects the reverse soleous flap failed in 3 cases and it seems that preoperative investigations such as angiography must be performed before embarking on such a procedure.

Key Words: Gastrocnemius, Muscle flap, Reconstruction, Soleus

Introduction

Leg and tibia bone are common sites that need reconstruction repair because of soft tissue defects. The subcutaneous location of the tibia and anatomic location of the leg, which are easily exposed to trauma, cause tibia fractures - becoming the most common fractures of long bones and the most common site for open fractures of long bones. Also, poor blood flow of this region easily allows complications after open fractures and surgical operations (1-2). Overall, soft tissue defects are common and it is difficult to manage complications in this region.

Gastrocnemius muscle flap with its constant artery has become one of the most reliable body flaps and is the first choice to cover soft tissue defects of the proximal third of the leg. It has been suggested that by keeping half of the gastrocnemius and the soleus intact, the functional deficit defect will be minimum. In fact, the gastrocnemius is composed of two separate muscles in which each of these parts can be used as a flap, but the medial head - considering its ease in rotating and its longer length - has made it a more favorable flap (3, 4).

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Figure 1. Reverse soleous flap in distal third defect.

Figure 2. Reverse soleous flap in distal third defect.

The unique anatomic features of the soleous have made it a suitable muscle to repair soft tissue defects in the middle third of the leg. This muscle is the longest and the largest one below the knee and its binary blood flow allows us to cut it into two longitudinal parts (5- 7).

Tibia injuries in the distal third commonly occur after motor vehicle accidents. Successful coverage of soft tissue defects in the distal one third of the tibia is vital in the union of tibia fractures in this site and it is a known problem when selecting a proper treatment method (8-12). Nowadays free-flap is the choice method to cover soft tissue defects in the distal third of the leg, but it has major disadavantages (13-17). Microsurgery instruments should be made available, the surgeon should be familiar with this method and recipient site should have suitable vessels - which are serious problems in tibial fractures. Moreover, this operation is extremely difficult in obese patients, the duration of the operation is long (4-10 hours) and the free-flap has a high chance of failure (10-30%).

The reverse soleus flap was designed and suggested by Tobin in 1985 (18). In fact, four segmental vessels that separate from the main artery in the length of the soleus muscle has provided this opportunity to perform as a flap with a distal base and to cover the soft tissue defects of the distal of the leg. This flap has been the center of much attention, but results have been controversial, so that while Pu considers it as a suitable flat to cover any soft tissue defect less than 50 cm sq in the distal third of the leg, others have voted against it (19- 23). Also, it has been suggested that the angiosome principle should be considered in its use.

In this survey we are going to answer the question of how can the gastrocsoleous flap be used to cover leg soft tissue defects in order to avoid complex and difficult procedures.

Methods

This prospective study was undertaken on 23 patients (20 male and 3 female) with the mean age of 32.13 years (14 to 65). This group consisted of all of the patients referred to Dr. Bahonar Hospital, Kerman with leg soft tissue defects between April 2007 and April 2012.

After fully explaining to the patients about the possible options of soft tissue coverage, they were operated on. Those patients whose soft tissue defects could have been repaired by other ways such as skin graft or skin flap were excluded from this study.

The cause of soft tissue defect in all patients was a motor vehicle accident. Initially, in all of the patients the tibia fracture was fixed with an intramedullary nail, external fixator, or plate and screws. In case of soft tissue defect, first debridement was performed several times and finally after the wound was ready the flap was designed and performed.

We used gastrocnemius flaps in soft tissue defects in the proximal third of the leg. For this purpose under spinal or general anesthesia with tourniquet on the upper thigh, a longitudinal incisison was made in the medial border of the tibia and gastrocnemius was dissected and splitted in the middle. The muscle was separated as a proximally based flap with particular attention to the defect size. Then it was carried subcutaneously and sutured to the skin.

For soft tissue defcts in the middle third of the leg, we used a similar incision, but more distally and the soleous musle was used for soft tissue defects. For distal third defects, the skin incision was extended from the middle distal third junction of the leg to distally above the Achilles tendon. The soleous was separated from the flexor haollucis longus and the tibialis psoterior tendon was protected carefully. The medial half of the soleus was separated from the midline distal to the middle distal third and the flap was rotated as a reverse distally based one [Figure 1; 2].

In all cases, after the operation the patient's limb was wrapped in a warm blanket and was elevated. After 24 hours, the dressing was opened and flap viability was assessed by its color, muscle tone, and the absence of necrosis. After 5 to 7 days of the operation, if the flap was viable, it would be covered with skin graft. The amount of bleeding and pain at the operation site was

Figure 3. Reverse soleous flap in middle third defect one year after surgery.

Figure 4. Reverse soleous flap in upper half of distal third defect one year after surgery.

assessed and recorded. The patients were visited 2, 6, and 24 weeks and finally one year after discharge. The flap and skin graft situation was recorded and assessed by skin color and the presence or lack of necrosis and skin repair [Figure 3; 4]. We also assessed fracture union at 6 months and one year and the results were recorded.

Results

In this time table, 28 patients were ennrolled in the study and 23 of them, (20 men and 3 women), age 14- 65 years old were followed completely. Soft tissue defect was in the right leg of 13 patients and left leg of 10 patients. Eight patients had soft tissue defects in the proximal third, 7 in the middle third, and 8 in the distal third. Eight patients with a wound in the proximal third of the leg were repaired with the gastrocnemius flap. Seven patients had a defect in the middle third, four of which were repaired with the soleus flap, and 3 patients' defects were repaired with the reverse soleus flap. In 8 patients with a distal third defect, we used the reverse soleus flap.

All defects in the proximal and middle third were repaired successfully with no sign of necrosis and flap failure. Distal leg wounds in 5 patients were without any partial or complete necrosis and were repaired on the fifth day with skin grafts. Twenty-four hours after surgery, flap discoloration and necrosis signs appeared in 3 patients and the flap failed gradually. The average operation time was 92 minutes (75-125 minutes). The average hospitalization time in the orthopedic ward to perform a flap was 9 days (7-12) days. The pain at the flap site was reported moderate and patients were treated with routine orthopedic analgesics.

In 2 patients bloody pus discharge was produced in the second week that responded to suitable antibiotics and none of the patients developed fever or sepsis. After the operation none of the patients had any plantarflexion problem in the operated limb. In order to examine the patients we asked them to stand on his/her toes consequently and asked them if they experiences any difficulty.

Discussion

The local flaps to repair soft tissue defects in the distal third of the leg are limited. Creating a flap from the opposite leg is rarely done because of high morbidity and patient intolerance. Other flaps such as flexor digitorum longus and peroneus brevis can also be used as local flaps to cover soft tissue defects in the distal third, but based on the studies perfromed, in comparison with the hemi soleus flap, these flaps have less rotation and more failure rate (15, 24).

The distal third of the soleus in its entire length is nourished by perforating arteries from the posterior tibial artery, but these perforating arteries are absent in 26% of individuals (2, 25). Diameter and location of distal perforating arteries are variable, if these arteries are present with an adequate diameter, the muscle may be used in a reverse manner to cover soft tissue defects in the distal area provided the perforating arteries are protected. Interesting to note is the 28% flap failure in the present study.

The success rate of the flap in the proximal and middle third defects in this study was the same as other studies

Table 1. Location, number and success of the flaps

	Successful flaps number	Distal third	Middle thired	Proximal third	Success rate
Gastrocnemius Flap	8	_	_	8	100
Soleous flap	4	_	4	_	100
Reverse soleous flap	8	8	3	_	72/72

(2-6, 26). However, noting that three of the failed flaps had been used to cover the lower half of the distal third of the leg, and all the four flaps for the upper half of the distal third remained viable, it is possible to conclude that the defects in the upper half of the distal third can be covered successfully and this flap may be a good choice. However, for repairing soft tissue defects of the lower half of the distal third of the leg it was not successful and so it is not suggested.

Though we could not prove the ability of the reverse soleus flap to cover soft tissue defects in the distal third of the leg, we believe that free flaps must not be viewed as the first choice. Free-flap coverage has many disadvantages and is not possible at times, so many surgeons still prefer local flaps, and in case of their failure the free-flap will be a good choice (27-29).

Reverse soleus flap has been used by surgeons in the past to cover soft tissue defects, but it seems that the results have been subject to overstatement and, especially, it must be noted that the anatomy of the soleus actually disqualifies its success in all cases (11, 12, 19-22, 30, 31). In concordance with the findings of the present study Kauffman et al. encountered a 25% failure of the reverse soleus flap and a high complication incidence (23). Again, the lack of attention to this flap may be due to its frequent failure. We could not find a "recent" paper on the topic and so the "successful" experiences with it are related to many years ago (19, 21, 22). We think that the reverse soleus flap is a valuable option in selected cases and perhaps performing an angiography before it is a suitable intervention (25).

On the other hand the soleus flap proved its ability to cover the middle third defects of the leg, both as a reverse and proximally based flap. This is in concordance with the findings of others, and Pu for example describes his experience with 10 middle third defects that were covered without failure in 10 patients with this flap in 2 years (30-32).

Perhaps the most important limitation of this present study is the fact that we did not have a control group to compare the results. In other words, the 28% failure rate that is undoubtedly a high one would have had another meaning in the presence of such high rates in a control group. Also, the relatively low sample size of the present study is a limitation, as a larger number of patients would have changed the result.

The gastrocsoleous flap has the ability to cover the proximal two thirds of the leg and can be a viable option in distal third defects as well. The free flap may be considered in case of failure of the flap.

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