Gastrocnemius Muscle Flap for Middle Third Leg Defects

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ABSTRACT

Background: Middle third leg defects represent a major challenge to the plastic surgeon due to liability to trauma and shortage of soft tissue around, many techniques was described for coverage of the middle third leg defects. Gastrocnemius muscle and musculocutaneous flap is one of the famous flaps and has a versatile and liable vascularity but it can reach only the upper third.

Aim of this Study: Use many modifications to the Gastrocnemius muscle flap for covering a large defects in the middle third of the leg in form of island proximally based medial head Gastrocnemius flap, distally based hemigastrocnemius flap, and extended medial head Gastrocnemius myocutaneous flap.

Patients and Methods: This study performed in the plastic, Reconstructive and Burn Department, Al-Hussein University Hospital, 20 patients 16 males and 4 females presented with post-traumatic middle leg defects with exposed tibia. Their ages ranged from 15 to 60 years. 9 patients were reconstructed with proximally based island muscle flap, 7 patients were reconstructed by the inferiorly based hemigastrocnemius muscle flap, and 4 patients were reconstructed by extended myocutaneous medial head Gastrocnemius flap.

Results: The wound healed soundly. No complication was recorded to the flaps, one case lost graft and need another grafting. As regard donor site morbidity, no functional deformity, but wound dehiscence occurred in one patient healed by local wound care, and hematoma in the donor site needed for drainage.

Conclusion: The gastrocnemius muscle flap is considered the first option and working horse for reconstruction of the middle third of the leg. It is a simple technique allowing rapid, durable and reliable coverage of a major defects without sacrificing a nerve or a major vessel. No donor site morbidity as functional deformity.

INTRODUCTION

One of the most challenging areas in plastic and reconstructive surgery is closure of soft tissue defects of the middle third leg. Traumatic wounds, burns, or tibial fractures in the lower leg frequently expose the bone because of the thinness and small quantity of local tissue available for reconstruction. The poor vascularization and subsequent poor healing encountered in this region often lead to prolonged exposure of bone or tendons, resulting in infection or necrosis [1].

Methods for coverage have evolved from simple relaxing-calf incision, local random flaps and cross-leg pedicle flaps to local muscle flaps, fasciocutaneous flaps and microvascular free flaps. The choice of flap in lower extremity is determined by the location, and the size of the defect, donor site morbidity, and the status of the recipient vessel. Many techniques are available for leg reconstruction but each technique has its inherent limitations and costs. These techniques include the neurocutaneous sural flap, the distally based lesser saphenous venofasciocutaneous flap, the anterior tibialis flap, distally based sural fasciocutaneous cross leg flap, the medial adiposofascial flap, the soleus flap and the free flaps [2]. Muscle flap have gained wide popularity since their first use by Ger [3]. Early cover has been found to reduce the incidence of complication. The gastrocnemius muscle flap is the workhorse of all muscle flaps for soft tissue coverage in the leg.

The purpose of this study was to evaluate the results of the gastrocnemius muscle flap with many modification in form of island proximally based, distally based hemigastrocnemius and extended myocutaneous flap, for exposed middle third leg defects.

Anatomical consideration:

This type I muscle flaps with their unique and independent vascular anatomy, one pedicle (sural artery) at the level of the knee joint situated close to its origin provide blood supply to the heads of the gastrocnemius muscle. These vessels arise from the popliteal artery. Each course a few centimeters with its venae comitantes before entering the anterior aspect of the proximal muscle belly with the
innervating branches of the tibial nerve [4]. The fact that the size of the muscle belly, its location in the dissection field and its transfer does not adversely impair function of the limb make it an ideal flap to cover wound in the leg [8].

The inferiorly based hemigastrocnemius muscle flap may be useful for reconstruction of the middle third of the leg. The arterial communication between the gastrocnemius muscle heads has been reported in the literature [6,7]. Tsosonis revealed a mean number of 5.8, the majority of these arterial communications are arranged in bundle. The bundles are consisted of arterioles and concomitant venules as well. Regarding arterial cross supply, it is clearly evident that each head can be vascularized solely from the contralateral one, mostly through these bundles. Not only does arterial cross-supply between the heads exist, but maintenance of arterial vasculature from one head to the other can be expected as well [8]. The main clinical application that could be suggested is an inferiorly based hemigastrocneimus muscle flap for defects of the middle third of the leg. The vascular basis of this flap is the vessels across the distal half of the raphe between the muscle heads [6,7,8].

Gastrocnemius myocutaneous flap is based on previous works [9,10] showed that skin overlying the muscle gain their blood supply through perforating vessels from the muscle, at least 5cm of the skin is kept attached to the muscular part of the muscle it is save to raise an extension of skin paddle 5cm beyond the musculotendinous junction.

PATIENTS AND METHODS

This study performed in the Plastic, Reconstructive and Burn Department, Al-Hussein University Hospital. Al-Azhar University has included 20 patients 16 males and 4 females during the period from 2010 until 2014. All patients were presented with posttraumatic mid third leg defects with exposed tibia. Their ages ranged from 15 to 60 years. 9 patient were reconstructed with proximally island flaps, 7 cases distally based medial head Gastrocnemius muscle flaps, and 4 patients were reconstructed by extended myocutaneous medial head Gastrocnemius flap.

Surgical technique:

All nonviable and poorly vascularized tissue should be aggressively debrided. Preoperative marking for the skin paddle in extended myocutaneous flap was designed.

An incision is made along the upper part of the calf carried down to the deep fascia. Then the muscle is dissected and separated from the underlying soleus and other muscles and detached from the Achilles tendon keeping skin paddle attached to it in myocutaneous flap (Fig. 3).

The neurovascular pedicle from the popliteal artery and vein and the tibial nerve is carefully dissected and saved for the proximally based island flap and for the extended myocutaneous proximally based flap. Then the muscle origin from the femoral condyle and capsule of the knee joint is detached this will give length to the muscle to reach the defect about 5-7cm (Fig. 1).

Distally based flap the muscle origin from the femoral condyle and capsule of the knee joint is detached. The neurovascular pedicle from the popliteal artery and vein and the tibial nerve is carefully dissected and divided. Its attachment to Achilles tendon is left intact. The two bellies are separated from each other and the vascular bundles between them are divided and ligated except the lower bundles which supply the muscle flap at least leave 6-8cm proximally to the musculotendinous junction intact not dissected to keep interconnected blood supply (Fig. 2).

Then tunnel of the skin bridge between the flap and the defect is made. Then the flap is passed through this tunnel to be inserted in the recipient site after making sure that there is no tension on the pedicle. Suction drain is inserted at the donor site for 3 days. Then the hemigastrocneimus muscle flap is covered with a thin split thickness skin graft.

RESULTS

This study has included 20 patients 16 males and 4 females, presented with post-traumatic middle third leg defects with exposed tibia. All defects were reconstructed by a gastrocnemius muscle flap, 9 cases proximally island flaps, 7 cases distally based medial head Gastrocnemius muscle flaps, and 4 cases proximally based medial head Gastrocnemius myocutaneous flaps. Follow-up period ranged from 6 months to 2 years.

There was one case with postoperative hematoma and one case with wound dehiscence healed by local wound care, one case with lost skin graft needed regrafting. No functional deformity recorded in the donor site. The subjective aesthetic result, according to the patients was satisfactory. Representative clinical cases are shown in (Figs. 1-3).
Fig. (1-A): Preoperative upper middle third defect.

Fig. (1-B): Intraoperative after release of origin and estimated length gained by release of muscle origin.

Fig. (1-C): Intraoperative after transfer to defect.

Fig. (1-D): Early post-operative with graft take.

Fig. (2-A): Preoperative defect in the upper middle third.

Fig. (2-B): Marking the thirds and the defect.
Fig. (2-C): Distally based muscle marked 8cm proximal to musculotendinous junction with release of origin.

Fig. (2-D): After transposition of distally based flap to the defect.

Fig. (2-E): Late post-operative with full graft take.

Fig. (3-A): Preoperative with exposed lower upper third leg and all middle third tibia.

Fig. (3-B): Marking of thirds of leg.
Fig. (3-C): Design of muscle flap and its cutaneous extension, (cutaneous extension is the red marking).

Fig. (3-D): Intraoperative with release of origin of muscle and skin paddle attached to it.

Fig. (3-E): Intraoperative, flaps after tunneling to recipient site, the upper third covered by lateral head island flap, the middle third covered by extended medial head gastrocnemius myocutaneous flap.

Fig. (3-F): Early post-operative, graft take.

Fig. (3-G): Late postoperative, with sound healing.
DISCUSSION

Finding an appropriate soft-tissue grafting material without functional deformity and donor site morbidity to reconstruct lower extremity defects can be a difficult task because of the lack of intervening muscle between the skeletal elements and the skin, and the limited mobility of the overlying skin [11]. Although microsurgical procedures provide excellent results in the head and neck region, the success ratio is usually lower in the lower limbs, especially in infected cases [12]. Although the free flap covers the defect successfully in a one-stage operation, it requires a long operative time; experienced, skillful technique; and patent vascular status of the recipient site. Free flap transfer to the lower limb in chronic posttraumatic conditions is known to have a higher complication rate with flap loss in up to 10% of cases, mainly due to the recipient vessel [13].

The dissection of these vessels often leads to refractory spasm, due to the so-called post-traumatic vessel disease (PTVD) [14]. Despite recent advances in microsurgical techniques, leading to major improvements in the quality of lower limb reconstruction, coverage of lower leg defects by loco regional flaps remains indicated in selected cases. A local random-pattern skin flap has an indistinct perfusion pattern and is limited in size.

The disadvantages of muscle flaps are that it may lead to functional deformity and donor site morbidity [15]. Defects of the middle third of the tibia can be covered with the soleus flap [16]. Fascial and fasicocutaneous flaps can provide an excellent alternative for coverage of defects, even when bone has to be covered [1]. The medial adiposofascial flap based on the vascular network supplied by the saphenous artery and the posterior tibial artery perforators can be harvested on the anteromedial aspect of the leg and can be mobilized to cover defects located between the patella and the heel [2]. But it causes a relative hypoesthesia at the donor site. The cross-leg flap has the disadvantages of long-term immobilization and several operative stages [17]. Perforator pedicle flaps provide an excellent solution, because all these flaps spare the major vessels of the limb [18]. Reconstruction with neurocutaneous flaps is a versatile alternative to the use of local or distant muscle flaps [19]. The neurocutaneous sural flap is well described for reliable coverage of the lower leg defects without sacrificing a major vessel to the foot, but the major donor deficit of this flap is the loss of sensibility along the lateral aspect of the foot and leaves ugly donor-site scars because of the need for skin grafting [20]. The anterior tibialis flap procedure is a useful option for providing soft tissue to cover open tibial injuries in the middle and distal thirds of the tibia. It is limited by the transition of the muscle to the tendon in the distal third of the tibia [21,22]. The gastrocnemius musculodipofascial flap based on the fascial plexus and cutaneous perforators of gastrocnemius muscle can be used for soft tissue reconstruction of wider and longer areas used by the classic gastrocnemius muscle flap [22,23]. Muscle flaps have been one of the most significant developments in the management of compound fractures [3]. Their importance has increased specially in management of compound tibial fractures because of the poor vascularity of the region and subcutaneous nature of the bone and the time taken waiting for possible closure by granulation tissue generally increase the risk of infection [23-26]. Muscle flaps, by virtue of their excellent intrinsic blood supply and moldable nature that fills in the irregular cavities of the bone, are the best solution for such defects [25-27]. The medial head of the gastrocnemius muscle in adult measures 15-20cm in length and 8cm in width. The corresponding skin territory of each head measures 23cm in length and 10cm in width. The area of potential wound closure is greater for the myocutaneous flap than for the muscle flap alone [26,27]. Authors [7,16,27,28,29] described the gastrocnemius distally based flap that is based on another head of gastrocnemius muscle.

In this study, we have treated 20 cases presented with post-traumatic defect on the middle third of the tibia using an island proximally based medial head Gastrocnemius muscle after release of its origin and get more length 5-7cm allowing the flap to reach upper part of the middle third of the leg in 9 cases, also I used inferiorly based medial head hemigastrocnemius muscle flap based on the blood supply through communicating arteries with the lateral head to cover the defects in the middle third of the leg in 7 cases, also I used an extended fasicocutaneous flap of the medial head Gastrocnemius muscle, extended skin flap varied from 15-20cm in length and 8-10cm in width, keeping at least 5cm of skin attached to the fleshy part of the medial head of the Gastrocnemius which contain skin perforator that supply extended skin paddle in 4 cases with alto cover a large defect in the middle third leg. Follow-up period ranged from 6 months to 2 years.

There was no flap necrosis or failure, one case lost graft and need regrafting, one case with hematomas in the donor site and one case with wound dehiscence healed by local wound care.
Like any other flaps, the gastrocnemius flap has few disadvantages. It causes some contour deformity in the leg and when a large skin paddle is harvested, skin grafting of the donor site is mandatory. However, this was acceptable by all patients. The gastrocnemius muscle contributes significantly to ankle plantar flexion and is important in power push off: Nerveless removal of one head does not result in significant functional loss.

**Conclusion:**
The gastrocnemius muscle and musculocutaneous flap is the workhorse muscle flaps for soft tissue reconstruction of the middle third leg I think that this flap might be established as a primary reconstructive option for the upper two-thirds of the tibia. It is a simple technique allowing rapid, durable and reliable coverage of these defects without sacrificing a nerve or a major vessel. There are many related advantages of this flaps; it is a one stage reconstruction, it is present in the dissection field, its skin territory can cover a large area, the unique vascularization of the muscle, namely the presence of one pedicle to each head, the size of the flap, and the easy dissection. This decreases the rate of complications and improves the functional outcome. Deformity of the contour of the calf from loss of muscle bulk and functional deficit should be of little importance.

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**REFERENCES**


