Egypt, J. Plast. Reconstr. Surg., Vol. 36, No. 2, July: 161-166, 2012

The Role of Free Rectus Femoris Muscle Flap in Savage of Upper and Lower Limb Complex Defects

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ABSTRACT

Skin and soft tissue coverage for defects in the distal parts of the extremities has always posed a challenge, as this area is more susceptible to skin and soft tissue loss. Tendons and bones are commonly exposed, which predisposes them to delayed healing and infection. Local and regional flaps using muscle or skin and fascia are the first choice in the coverage of areas of exposed bone, tendon, nerves, or vessels. However, these flaps may be compromised in a severely traumatized limb. Free muscle flaps with skin graft coverage had added reconstructive and esthetic refinements to the reconstructive surgeons' armamentarium. These flaps allow durable closure of difficult wounds with superior contour characteristics and minimal functional and cosmetic morbidity at the donor site.

The rectus femoris muscle flap is well known for its reliable anatomy, the ease with which it can be harvested, and its great versatility where it can provide coverage of large defects in the upper and lower limbs with satisfactory aesthetic and functional outcome.

In this study, 11 free rectus femoris muscle flaps were performed for coverage of post traumatic soft tissue defects; five cases with upper limb and six cases with lower limb defects. Apart from one flap explored on the 1st post-operative day due to venous congestion and completely salvaged, there was no failure in this series with satisfactory result. No significant disability of the donor limb was encountered. Easy approach, rapid harvest, a single dominant neurovascular pedicle with large vessel diameter, easy primary closure of the donor site, and minimal donor site morbidity, all make the rectus femoris flap a good alternative flap for free tissue transfer.

INTRODUCTION

According to the reconstructive ladder, there are many reconstructive tools for reconstruction of the distal parts of upper and lower extremities as local, regional and free flaps **[1]**. Pedicled flaps **[2,3]** have been widely employed since the 1980s. However, these flaps are more useful for more proximally located defects, but the more distal defects continue to be a source of concern for surgeons, especially in cases of acute trauma with significant soft tissue defects.

Free flaps have been used to manage these defects, with good results, but they require microsurgical expertise and have a higher complication rate than loco-regional flaps **[4]**.

An ideal flap should be technically easy to harvest, reliable and have a high success rate with minimal donor site morbidity **[5]**.

The rectus femoris muscle flap is well known for its reliable anatomy, the ease with which it can be harvested, and its great versatility. It is used as a pedicled or free flap, to cover soft-tissue defects and to recreate motor function **[6,7]**.

In 1970, using microsurgical techniques, Tamai et al. **[8]** reported the first successful experimental transplantation of a completely isolated rectus femoris muscle of the dog. The first clinical use of this muscle as a free transplant in humans was reported by Schenck **[9]**, in 1977, to repair traumatic loss of all forearm flexors. Tsuyama's group **[10]** used it in brachial plexus injury as a functioning free muscle transplantation (FFMT). Koshima et al. **[11]** employed it for facial paralysis.

Wei et al. **[12]**, within 10 years period, from 1985 to 1995, and out of 54 free rectus femoris muscle flaps performed, they used it in 26 patients for large wound coverage following severely crushed limbs, tumor ablation, ischemic necrosis, and deep chronic wounds. The purpose of this paper is to present our experience in using rectus femoris muscle as a free microsurgical reconstructive option for reconstruction of soft tissue defects of the upper & lower limbs.

MATERIAL AND METHODS

This study included 11 male patients, their ages ranged from 23 to 51 years. They presented by traumatic soft tissue defects (5 cases in the upper limb, 6 cases in the lower limb). Free rectus femoris muscle flap with skin graft applied over it used for reconstruction of these defects. The defect sizes ranged from 8x6cm to 9x23cm.

Pre-operative clinical evaluation of the patients for proper assessment of the site and size of the defect and the underlying exposed critical structures. Also, plain X-ray and Doppler examination for assessment of the bone and vascular status of the injured limb. In addition, basic routine investigations and anesthesia assessment done for all patients.

Operative technique:

Two teams were operating simultaneously; one team was harvesting the rectus femoris muscle flap, while the other team was preparing the recipient vessels at the site of the defect.

General anesthesia was used for 8 cases and epidural anesthesia for 3 cases with lower limb soft tissue defects. The patient is placed in the supine position. A line is drawn from the anterior superior iliac spine to the midpoint of the upper border of the patella, as the axis of the muscle flap.

The muscle was harvested over a slightly curved ("lazy S") incision at the anterior thigh. The incision is carried vertically down to the muscle fascia. Then, the muscle is elevated from distal to proximal and from lateral to medial until the dominant pedicle is identified (Fig. 1).

There is a plane of loose areolar tissue between the rectus femoris and vastus lateralis over the lower third of the muscle, where one can easily identify the rectus femoris muscle.

After raising the inferior half of the rectus femoris belly from the underlying vastus intermedius, dissection is continued proximally along the deep margin of the rectus femoris to the neurovascular pedicle in the proximal third approximately 10cm below the inguinal ligament. A vascular pedicle of more than 5cm usually can be included with the free rectus muscle transfer. By dividing the muscle at least 6cm above the patella, the tendinous insertion is preserved.

The tendons of the vastus lateralis and medialis are centralized with nonabsorbable sutures to preserve full knee extension. The muscle is then isolated on its pedicle, and if the other team had already prepared the recipient vessels, the muscle will be detached from its origin (Fig. 2), and the donor defect is closed primarily. In case that only one team is working, the muscle will be kept attached to its vascular pedicle until preparing the recipient site.

Exploration of the recipient vessels in the vicinity of the defect, debridement and preparation of the wound, transfer the flap to the defect, and microsurgical anastomosis of the vascular pedicle of the muscle with the prepared recipient vessels of the injured limb. Insetting of the flap over the defect, and skin grafting of the muscle completed the procedure.

Case presentation:

Free rectus femoris muscle flap with skin graft was used for soft tissue coverage for all cases; five cases with upper limb and six cases with lower limb defects.

We present 4 cases; two cases with upper limb soft tissue defects (Figs. 3,5) and two cases with lower limb soft tissue defects (Figs. 4,6).

RESULTS

The operative time ranged from 5-8 hours. The operative course was smooth. All flaps had survived completely. One flap was explored on the 1st postoperative day due to venous congestion and completely salvaged. Partial skin graft loss occurred in two cases and managed conservatively until complete healing. All the donor sites healed smoothly, without affection of the extension of the knee joint. The aesthetic appearance of the reconstructed limbs and the functional recovery were comparable to the results of other studies, and patients' satisfaction was high. All patients were followed post-operatively for a period ranged from 6 to 24 months.

DISCUSSION

Severe limb injuries remain a frequent and significant occurrence leading to a reduction in quality of life and employment potential. Despite better safety awareness, faster life styles, busier roads and more active leisure pursuits have resulted in a steady stream of such injuries. Complex upper and lower extremity defects are usually the result of trauma and considerations for reconstruction of these complex wounds depend on the specific defect, donor site morbidity, and medical center capabilities **[13]**.

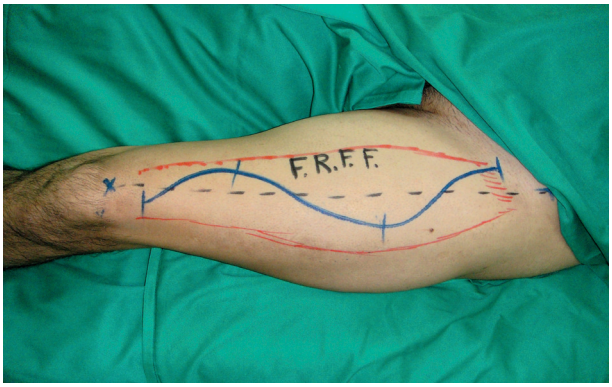

Fig. (1): The design of the Rectus Femoris muscle flap.

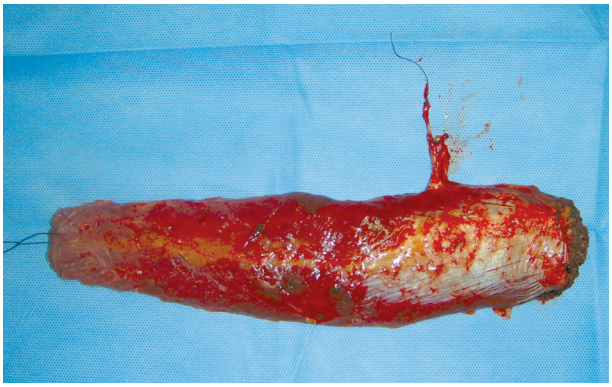

Fig. (2): The free rectus femoris muscle flap.

CASE I

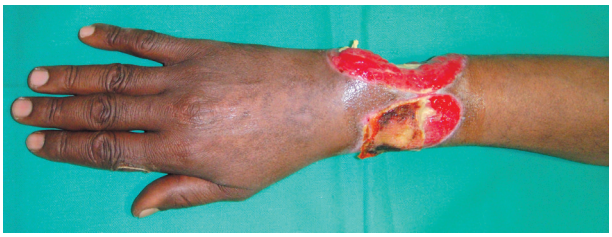

Fig. (3A): Neglected traumatic soft tissue loss of the right forearm with exposed tendons and distal ulna.

Fig. (3B): Same lesion (ulnar view).

Fig. (3C): The free rectus femoris muscle flap after transfer and insetting over the defect.

Fig. (3D): The skin graft applied over the muscle flap.

Fig. (3E): The final outcome after healing of the flap and the skin graft (ulnar view).

Fig. (3F): The final outcome after healing of the flap and the skin graft (dorsal view).

CASE II

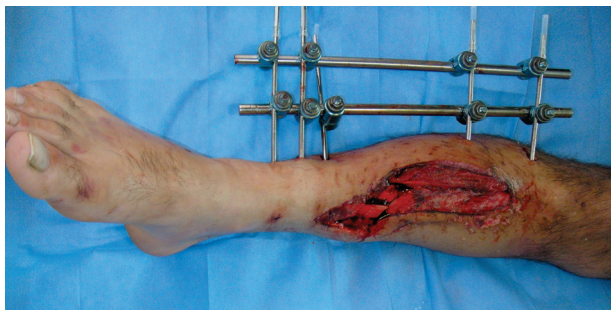

Fig. (4A): Traumatic soft tissue defect of the Rt. Leg.

Fig. (4B): The free rectus femoris muscle flap insetted over the defect after the microsurgical anastomosis.

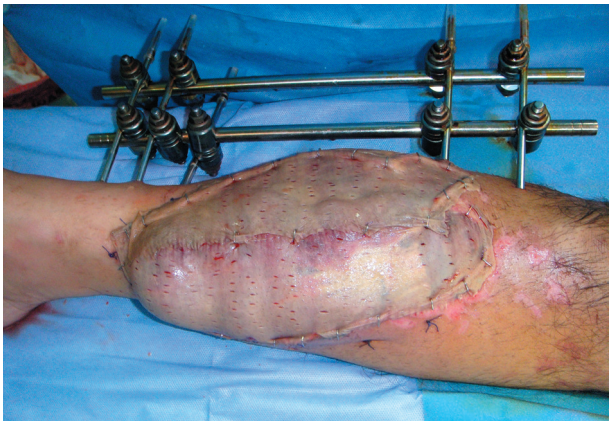

Fig. (4C): Split-skin graft applied over the flap.

Fig. (4D): The final outcome after complete healing.

CASE III

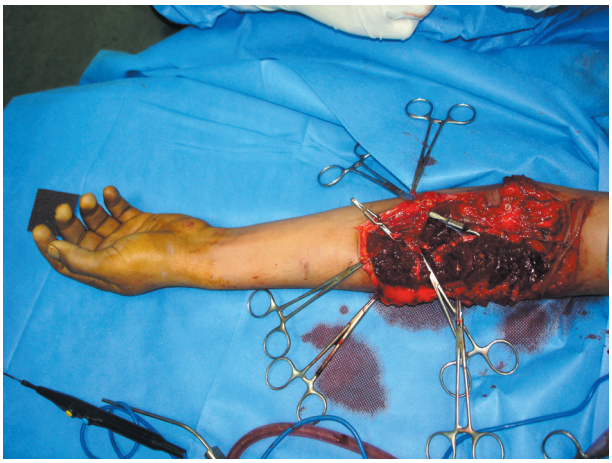

Fig. (5A): Soft tissue defect, left elbow & forearm.

Fig. (5B): Post operative result.

CASE IV

Fig. (6A): Traumatic ulcer, Lt. medial maleolus.

Fig. (6B): Post operative result.

Early, vascularized soft tissue coverage of vital structures is a reconstructive priority for successful limb salvage. Many techniques to reconstruct limb defects have previously been described, including skin grafting, locoregional flaps **[14,15]**, distant flaps **[16,17]**, and free flaps **[18-21]**. Each reconstructive option depends on the institution and is individualized to the patient and type of the defect.

Loco-regional flap reconstruction is limited by the size of the defect, arc of rotation, and amount of available surrounding tissue. Additional insult from flap harvest and the resultant donor defect is not without risk. Whether local or free flaps are used in the upper or lower extremity depends on the zone of injury, the blood supply to the extremity, surgeon's capability, and patient's associated co-morbid factors.

If we follow the guidelines of the reconstructive ladder, certainly our first choice would be to perform a local flap versus a free tissue transfer.

However, pedicled flaps are not always available after injuries of these regions because the rotational axes are usually damaged **[22]**.

Microvascular free tissue transfer has revolutionized the treatment of limb injuries with associated bone, soft tissue, and muscle loss, and with exposure of bone and vital structures.

With the development of microsurgical procedures, free flap has become a very convenient tool for reconstructive surgery, especially for reconstruction of extremities and treatment for traumatic tissue defects **[23,24]**. A muscle flap with skin graft has the advantages of a low profile and high stability. More importantly, muscle flaps have good vascularity, which is helpful in the treatment of infection and has a positive effect on bone healing. Yazar et al. **[25]** have indicated that grossly tridimensional defects need free muscle flaps because they can conform better to such complex defects. Anthony et al. **[26]** have demonstrated that debridement and immediate muscle flap coverage provide effective, single-stage treatment for wounds complicated by chronic osteomyelitis, and allow antibiotics to be restricted to short-term use.

The rectus femoris muscle offers the following advantages: (1) The harvesting technique is easy, simple, and rapid. It is possible to have simultaneous operations by two teams with the patient in the supine position; (2) A large muscle flap can be raised for coverage of extensive cutaneous defects; (3) The single dominant pedicle, with adequate diameter and sufficient length of the femoral nerve, makes this muscle-musculocutaneous donor tissue desirable for transplantation; (4) Donor site is closed primarily; and (5) No significant limitation in the strength of the donor leg is seen after removal of the rectus femoris muscle, and consequently there is no significant functional donor-site morbidity.

A mild but functionally not significant deficit in terminal knee extension was mentioned by Bhagwat et al. **[27]** but the patients had regained excellent strength and had been able to climb stairs by adaptation of the adjacent muscle groups.

Wei et al. **[12]** reported no significant loss of leg function and minimal patient complaints. Rohrich et al. **[28]** described harvest of the rectus femoris muscle as being associated with some donor site morbidity, particularly, weakening of quadriceps function. Freedman et al. **[29]** noted that transposition of the rectus femoris would not permanently affect active extension of knee, particularly if remaining quadriceps muscles were centralized. Koshima et al. **[30]** denied any loss of leg function.

The free rectus femoris muscle flap is well known for its constant and reliable neurovascular pedicle **[10]**. Harvesting is technically easy and quick. The flap can be taken as a pure muscle flap, or a myocutaneous flap for covering soft-tissue defects **[11,12,31]**.

The rectus femoris flap also has its disadvantages: Short pedicle length, a long scar over the anterior thigh, and only moderate excursion when used as a functioning muscle transfer.

In conclusion, our clinical experience supports use of the free rectus femoris flap for soft tissue defects reconstruction. It may not be the flap of first choice, but it is a good alternative flap for microsurgical free tissue transfer. Overall free rectus femoris muscle transplantation can provide a durable soft-tissue coverage of the limbs without any loss of function at the donor site.

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