International Journal of Surgery 26 (2016) 25–31

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Reconstruction of complex soft-tissue defects in the extremities with chimeric anterolateral thigh perforator flap

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HIGHLIGHTS

- Chimeric ALT flap is one of the best choice for reconstruction of complex soft-tissue defects.
- The various tissue components with maximal freedom and flexibility can be offered by chimeric ALT flaps.
- Chimeric ALT flap could be harvested by performing one of the three types of dissection.

ARTICLE INFO

Article history:
Received 2 August 2015
Received in revised form
1 December 2015
Accepted 11 December 2015
Available online 29 December 2015

Keywords:
Anterolateral thigh perforator flap
Lateral circumflex femoral artery
Free tissue transfer
Extremity

ABSTRACT

Introduction: The reconstruction of extensive three-dimensional defects in the extremities is a difficult challenge. Many attempts have been made to reconstruct such defects using the chimeric flap concept, enabling flaps with larger surface areas to be used while maintaining economical tissue use. The anterolateral thigh (ALT) chimeric flap is one of the most useful tools for the reconstruction of complex three-dimensional defects in the extremities.

Methods: From January 2010 to March 2012, Twenty-two patients underwent extremity reconstruction using chimeric ALT perforator flaps, which consists of a skin component on its isolated perforator and a portion of the fascia and muscle flaps on the same pedicle from the descending branch of the lateral circumflex femoral artery (LCFA). The defects were in either a lower (n = 10) or an upper extremity (n = 12). The area of the soft tissue defects ranged from 43 × 35 cm to 19 × 9 cm (mean, 25 × 18 cm), containing extensive, irregular, ring-like soft tissue defects or degloving injuries.

Results: The mean dimension of skin flap was 19.8 × 11.2 cm. The mean dimension of fascia flap was 8.9 × 7.1 cm. The mean dimension of muscle flap was 11.1 × 7.5 cm. No total flap loss occurred. One patient presented with venous thrombosis, and re-anastomosis and vein grafting were performed. Two cases exhibiting partial skin graft loss at the site at which the fascia flap was inset were treated via secondary skin grafts. During a follow-up period of 18 months–30 months, patients were satisfied with the functional and aesthetic outcome. No serious donor-site complications occurred.

Discussion: Chimeric anterolateral thigh perforator flap can be one of the best choice for reconstruction of complex soft-tissue defects in the extremities.

Conclusions: The various tissue components and maximal freedom offered by chimeric tissue flaps associated with the same descending branch of the LCFA provide versatile coverage of large, complex, and irregular soft-tissue defects in the extremities.

1. Introduction

The primary goal of extremity reconstruction is to restore and maintain extremity function, and skeletal reconstruction resulting in stable soft-tissue coverage is essential for achieving this goal. In

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http://dx.doi.org/10.1016/j.ijsu.2015.12.035
1743-9191/

cases of initial reconstruction failure, additional tissue and functionality might be lost [1]. Therefore, it is crucial to devise an appropriate treatment plan. However, reconstructing complex injuries of extremities containing extensive, irregular, ring-like soft tissue defects or degloving injuries remains a challenge for reconstructive microsurgeons, as very few flaps contain large amounts of tissue and multiple components are required to fulfill the functional and cosmetic requirements for correcting the recipient defect while inducing minimal donor-site morbidity.

Since its first description by Song et al., in 1984, the anterolateral thigh (ALT) flap has become one of the most popular flaps for extensive soft-tissue defect reconstruction [2] because of its large skin area and reliability [3]. In addition, the ALT flap is versatile in that multiple tissue components can be harvested in various combinations and configurations, thus fulfilling all of the requirements for reconstruction [4]. For extensive, complex, and irregular wounds in the extremities, the chimeric ALT perforator flap is among the most popular members of the perforator flap family. A large tissue flap can be designed that includes multiple tissue components, such as muscle, fascia, and skin, each of which is supplied by a separate perforator based on the same lateral circumflex femoral artery (LCFA) [5]. This chimeric flap enables the use of multiple, spatially independent components of various tissue types to reconstruct complex three-dimensional defects in the extremities via a single vascular anastomosis. From this chimeric flap, a small area of skin at the donor site can be harvested to yield the largest amount of tissue possible for the reconstruction of massive defects in the extremities with minimal loss of function at the donor site.

In this report, we describe the use of this technique for harvesting a chimeric ALT flap consisting of a skin component isolated on its perforator in combination with a portion of the fascia and/or muscle flaps, all of which are pedicled on the same descending branch of the LCFA, for the reconstruction of complex three-dimensional and massive defects in the extremities.

2. Materials and methods

From January 2010 to March 2012, a total of 22 patients with large and complex three-dimensional defects in the extremities underwent reconstructive procedures that included chimeric ALT flap transfer. One patient was female, and 21 patients were male. The patients' mean age was 36.5 years (range, 16–57 years). The mean body mass index was 25.2 ± 5.1 (range, 15.5 to 42.2). The mechanisms of injury were traffic accidents (n = 8) and industrial injuries (n = 14). The defects were in either a lower (n = 10) or an upper extremity (n = 12). In these 22 patients, the area of the soft tissue defects ranged from 43 × 35 cm to 19 × 9 cm (mean, 25 × 18 cm). In ten, six, five, and one patient, these flaps were used for the treatment of a traumatic limb amputation, a circumferential or near-circumferential de-gloving injury, or an open fracture with an associated skin defect or to cover a soft-tissue defect without a fracture, respectively. The recipient site was the lower leg in five patients, the ankle and foot in five patients, the hand and fingers in six patients, and the forearm in six patients. Details related to these patients are provided in Table 1.

2.1. Operative procedures

All of the flaps were harvested in a similar manner. A line connecting the anterior superior iliac spine and the lateral border of the patella on the donor thigh with the patient in the supine position is drawn. The position of perforators usually around the midpoint of this line should be mapped with a Doppler probe. A longitudinal skin incision is made on the medial side of the flap. Then dissection is carried out over the deep fascia until the perforators are encountered. All the perforating branches of the descending or transverse LCFA in their intramuscular or intraseptal courses are identified at first. Elevation of the flap is continued by dissecting the descending branch toward the proximal and distal sides from the division of the perforator. Then, a minimum of two perforators from the descending branch of the LCFA are required to be preserved within the area of skin, fascia, or muscle to be included in the flap, and the perforators are freely dissected until the main trunk of the descending branch of the LCFA is reached (Fig. 1A). The chimeric ALT perforator flaps are designed and harvested based on findings during the operation and the reconstructive requirements of the recipient sites; Flap dimension is slightly larger than defect and slightly longer pedicle. These chimeric flaps should be designed to be included independent skin, fascia, or muscle flaps associated with the same descending branch of the LCFA. The skin and muscle flaps always contain individual paddles supplied by two separate perforators. However, the fascia flap could be harvested by performing one of the following three types of dissection depended on the different origins of pedicle: Type I, in which the fascia flap is associated with one independent perforator that could be rotated up to 180°; Type II, in which the vascular pedicle of the fascia flap is a separate branch from the source vessel or is located on a side branch of the skin flap; or Type III, in which the many tiny perforators could not be freely dissected with the fascia flap, and a fascial pedicle with a width of 2–3 cm is required to ensure a sufficient blood supply (Fig. 1B–D). The muscle flaps are harvested from the partial vastus lateralis muscle, leaving the remaining muscle innervated and functionally intact. The entire flap can then be isolated on the two or more perforators and the descending branch of LCFA. The skin flaps are used to cover important tissues, such as vessels, nerves, and bones. The fascia flaps are used to cover tendinous tissues, followed by skin grafting. If the flap covered the soft tissue defect insufficiently or if severe contamination was caused by a bone defect or an empty cavity, an additional muscle flap is designed for additional bulk to eliminate any dead space or to enhance resistance to infection. If the injured extremities are associated with soft-tissue defect and major arterial damage, the pedicle vessels of the flap can be interposed into the vascular defect in the extremity to revascularise ischaemic extremities. The donor site can be closed primarily if the width was less than 8 cm, or with skin graft if the width was over 8 cm.

The postoperative monitoring techniques include evaluation of color, capillary refill, turgor, surface temperature, presence of bleeding, skin graft adherence, and auditory assessment of blood flow. The flaps should be monitored frequently, especially in the initial postoperative period. Emergent exploration and repair must be performed soon after obstruction occurs if it is to be successful.

3. Results

The skin flap dimensions ranged from 33 × 13 cm to 8 × 7 cm (mean, 19.8 ± 7.6 × 11.2 ± 3.2 cm). The fascia flap dimensions ranged from 15 × 10 cm to 6 × 4 cm (mean, 8.9 ± 3.3 × 7.1 ± 2.0 cm). The muscle flap dimensions ranged from 22 × 12 cm to 6 × 4 cm (mean, 11.1 ± 5.3 × 7.5 ± 2.5 cm). There were 14 cases in which a Type I flap was used, 5 cases in which a Type II flap was used, and 3 cases in which a Type III flap was used (Table 2). The mean surgery duration for flap harvesting was 5.4 ± 1.3 h.

One case exhibited a vascular complication (venous thrombosis). In this case, a thrombus was evident at the site of anastomosis. Therefore, the thrombus was removed immediately, and re-anastomosis and vein grafting were performed. Reperfusion was achieved, and only the partial margin of the 3 × 4 cm skin flap exhibited necrosis. On postoperative day 14, this patient was