

Upper extremity resurfacing via an expanded latissimus dorsi musculocutaneous flap for large circumferential defects: the “spiral” reconstruction technique

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Abstract We present an expanded latissimus dorsi musculocutaneous (LDMC) flap to treat circumferential upper extremity defects via resurfacing and “spiral reconstruction” in 5 patients during a 17-year period. Five patients with different indications for tissue expansion from burns to congenital hairy nevi were operated. The expansion was done in a longitudinal direction, and a rectangular tissue expander (TE) was inserted under the LD muscle to expand the flap in a longitudinal direction thereby forming a “long” flap rather than a “wide” one. After excising the circumferential lesion, the expanded “elongated” flap was wrapped spirally around the extremity to cover the defect; the donor site was closed as usual. The 5 patients we treated via LDMC flaps in a spiral fashion were free of complications, and all were satisfied with the outcome. All the flaps survived and the spiral reconstruction allowed

for a tension-free donor site closure and near complete recipient coverage. This technique is indicated for large circumferential extremity skin defects and deformities. Application of expanded LDMC flaps in a spiral fashion can be used by the reconstructive surgeon to resurface large circumferential upper extremity lesions when indicated. The idea of a long and thinned expansion flap must be in a longitudinal direction and we need this long expanded and thin flap to “spiral” it around the extremity to cover a large defect. The “spiral” flap coverage introduced here for large circumferential extremity defects enables the surgeon to cover the defect with simultaneous donor site closure and good results.

Keywords Expanded latissimus dorsi musculocutaneous flap · Circumferential defects · Reconstruction

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Introduction

Circumferential lesions of the hand caused by burns, trauma and extensive unattractive nevi may cause emotional, aesthetic and functional sequelae. Treatment of circumferential lesions of the hand is often difficult. Hypertrophic scars are usually difficult to repair using local tissues, and use of skin grafts may cause further injuries to donor sites. The introduction of tissue expanders (TE) was the start of a new era and a breakthrough in the treatment of patients with burns, scars, nevi and other lesions; for they provide skin of the same color and texture, sensitive and with adnexes, facilitating harmless primary closure of the donor site. The procedure can be repeated on the same segment (re-expansion) if necessary [1–3]. However, *n* nearly all the literature at hand are for face and neck reconstruction or covering extremity defects by expanded



Fig. 1 Giant hairy nevus of the hand, dorsal aspect



Fig. 2 The nevus at the volar aspect of forearm and hand

free or pedicled flaps. And although tissue expansion and flap transfer is not new what we are presenting here is overcoming the problem of covering huge extremity skin defects by “longitudinally expanded flap” and “spiraling” it around the extremity to cover the defect. This has not been addressed in the current literature.

We used expanded latissimus dorsi musculocutaneous (LDMC) flaps to treat circumferential upper extremity defects via resurfacing and reconstruction in a “spiral” fashion. Five patients were treated during a 17-year period. This technique is indicated for large circumferential skin defects of the hand (Figs. 1, 2). Herein, the indication and outcomes are presented.

Table 1 Patient demographic and treatment data

	Etiology	BSA involved (%)	TE volume (cc)	Infused volume (cc)	Type of flap	Number of secondary operations
Case 1	Burn scar	6	2,000	2,450	Free flap	Three
Case 2	Car accident	5	2,000	3,000	Pedicle flap	Four
Case 3	Hairy nevus	7	1,000	1,240	Free flap	Five
Case 4	Burn scar	6	2,000	2,100	Pedicle Flap	Three
Case 5	Hairy nevus	4	450	550	Free flap	Two



Fig. 3 The LD MC flap expanded and ready for transfer

Materials and methods

Five patients with different indications for tissue expansion (i.e., burns, hairy nevi, etc.) were operated (Table 1). The expander was inserted through a lateral small incision at the border of the muscle and skin or the auscultatory triangle. The pocket was fashioned in a longitudinal direction, and care was taken not to dissect the pocket excessively so the expander would not migrate or rotate inside. We used rectangular TE from 400 cc in the youngest patient to 2,000 cc in adults. The average wait period was 3.5 months. The timing of secondary operations is usually 3–4 months after the main procedure and contouring of the flap is by removing the muscle beneath the skin to cosmetically correct the bulkiness of the flap (Fig. 3).

The difference between the adults and children are only in the size of the tissue expander used (Fig. 4).

After excising the circumferential lesion, the expanded “longitudinal” LDMC flap was wrapped spirally around the extremity covering the defect of the extremity and sutured; the donor site was closed as usual (Fig. 5).

Results

In this study, 5 patients including 2 women and 3 men were treated. Average age of our patients was 21.9 years



Fig. 4 The nevi resected from the forearm and abraded off the fingers



Fig. 6 The result at 6 years



Fig. 5 The expanded LD was transferred as a free flap and survived the spiral reconstruction

(4.5 months–64 years old). Two cases of giant hairy nevus of upper extremity and one case of extremity avulsion due to car accident and two cases of circumferential burn scars are included in this series and depicted in Table 1. Tissue expanders were inflated for a period of 3–5 months with an average of 3.45 ± 2.29 months (Fig. 6).

No major complication, total or near total flap failure, was observed and only minor complications such as minimal distal flap skin necrosis and seroma formation under the donor (LD) were observed. The spiraling of the LD around the circumferential defect enabled us to cover these problematic patients with ease and since the flap is “long” rather than “large” the donor closure can be easily affected. The 5 patients we treated via LDMC flaps in a spiral were satisfied with the outcome. All the flaps survived and the longitudinal flap which is not too wide allowed for a tension-free donor site closure and near complete recipient coverage due to the nature of spiraling (Fig. 7).



Fig. 7 The donor site at 6 years

Discussion

Treatment of circumferential lesions of the hand caused by burns, trauma and extensive unattractive nevi cause emotional, aesthetic and functional sequelae. Lesions with hypertrophic scars are usually difficult to repair using local tissues, and the use of skin grafts may cause further injuries to the donor sites.



Fig. 8 A circumferential hypertrophic burn scar, volar aspect

In the past, reconstruction procedures generally included use of split thickness skin grafts. Incomplete graft take resulted in recurrent scarring and pigment imbalances with reduced aesthetic outcome. TE on the other hand allows large areas of burn scar to be resurfaced and provides tissue of similar texture and color and has the advantage of minimal donor site morbidity. Furthermore, the expanded tissue displays high vascularity [1–6]. The concept of TE in surgery was first reported 1957 primarily for breast reconstruction. Skin expansion represents a major development in reconstructive surgery particularly as a valuable approach for reconstruction in burn patients [1–4]. The introduction of tissue expanders [1] with or without expansion and “free” or “pedicled” was the start of a new era and a breakthrough in the treatment of these patients by bringing new skin to the defect and facilitating primary closure of the donor site. Additionally, the procedure can be repeated on the same segment (re-expansion) for repair of very extensive lesions if necessary [2] (Fig. 8).

The use of tissue expansion has been popularized among plastic surgeons and has become the treatment method of choice for many congenital and acquired defects in children and adults [1–3].

Expanders are silicone envelopes that have self-sealing injection port. At weekly intervals, saline is progressively injected through the port and into the expander. As the volume inside the expander increases, tension on the overlying and adjacent tissues increases [4]. The expanded skin undergoes histological changes that are well documented: the epidermis exhibits increased mitotic activity, there is recruitment of adjacent tissue, which is believed to contribute to the additional skin. The dermis thins considerably but is often masked clinically by the thick fibrous capsule that forms around the TE. Skin expansion is an excellent option in the treatment of burn sequelae [1–5]. Expansion allows for generation of precious tissue with



Fig. 9 The same patient after spiral reconstruction with LD MC flap transferred as a free flap



Fig. 10 Ventral view

optimal vascularity to cover defects using local skin of appropriate color, texture and adnexal structure [6–8]. In order to fully harness these advantages and ensure success, the expansion process must aim to minimize complications. Although the procedure is based on a simple concept, this technique may be associated with complications. Despite the great benefit conferred, TE has resulted in some morbidity. Complication rates of 20–40% when performing tissue expansion in children have been reported [8]. Patients with high risk of complication should be identified [9].

Indications should be for repair of severe functional and/or aesthetic injuries, and must meet the criteria of healthy skin, the possibility of regular expansion, and psychologically stable patients. The cost-benefit of the procedure should always be compared to other approaches involving lower morbidity rates.

TE is used increasingly in reconstructive surgery for the treatment of a variety of problems in children and adults. The reconstruction of many congenital and acquired defects has been made possible through the use of this technique [3]. In selecting patients, consideration must be given to certain difficulties such as: limited donor site, involvement of several areas, patients who are emotionally unstable, the need for repeated surgical procedures or



Fig. 11 Forearm flexion 5 years postoperatively



Fig. 12 Finger flexion

several expanders, and long-term treatment or follow-up. Treatment of circumferential lesions of the upper extremity is very difficult and a overall successful technique with a long-term follow-up to reconstruct these circumferential defects is lacking in the literature.

Use of expanded LDMC flaps to treat circumferential upper extremity defects via resurfacing and reconstruction is not new. However, we used it in a “spiral” fashion which had the benefits of transferring expanded skin to the defect without donor site morbidity, easy coverage of large circumferential defects and tension-free closure. Because TE is done in the longitudinal direction (via a rectangular



Fig. 13 Extension

TE) and LDMC flap is used via “skin wrapping” (Figs. 9, 10, 11, 12, 13).

Conclusion

We present the “Spiral Flap Reconstruction” of the upper extremity by a “Longitudinally” expanded latissimus dorsi musculocutaneous (LDMC) flap to treat circumferential upper extremity skin problems in 5 patients during a 17-year period. In this technique, we expand the LDMC flap in a longitudinal fashion to create a long flap which can as a free or pedicled flap can be wrapped around the extremity to cover the defect by one flap in one setting.

Use of expanded LDMC flap constitutes an excellent option in the treatment of a variety of defects. In the form of flaps, it provides skin of color and texture similar to the surrounding skin, adnexes and sensitivity without damaging the donor site. It also allows the harvesting of large full skin while allowing primary closure of the donor site. Flaps are stable at a late follow-up, and the procedure may be repeated when necessary (re-expansion). Application of expanded LDMC flap in a “spiral” manner seems to be a valuable and reliable technique for the reconstruction of “circumferential” defects of the upper extremity. The “spiral” flap coverage introduced here may be indicated for large circumferential extremity defects and enables the surgeon to cover the defect with simultaneous donor site closure and excellent results.

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