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Compartimental harvesting of dual lymph node flap from the right supraclavicular area for the treatment of lower extremity lymphedema: A case series

Giuseppe Visconti[a,*], **Girolamo Tartaglione**[b], **Roberto Bartoletti**[c], **Marzia Salgarello**[a]

[a] *Department of Plastic and Reconstructive Surgery, Centre for Surgical Treatment of Lymphedema, Università Cattolica del "Sacro Cuore" – Fondazione Policlinico "A. Gemelli" IRCSS - Largo A. Gemelli 8, 00169 Rome, Italy*
[b] *Nuclear Medicine Unit - Ospedale Cristo Re, via delle Calasanziane, 25, 00167 Rome, Italy*
[c] *Oncologic Rehabilitation Service, IDI-IRCCS, via dei Monti di Creta, 104, 00167 Rome, Italy*

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Summary *Background:* We report our clinical experience of a supraclavicular lymph node flap (LNF) using a novel method of harvesting based on the compartimental lymphatic and vascular anatomy of the right posterior neck triangle, which allows to harvest two independent LNFs from the same donor site.
Patients and methods: We report a case series of 10 consecutive patients affected by cancer-related lower extremity lymphedema, who underwent compartimental dual LNF transfer from the right supraclavicular area to the affected lower limb, from August 2015 to March 2017. The superficial compartment flap (venous flap along the external jugular vein) was anastomosed in a flow-through fashion along the course of the great saphenous vein in the knee region, whereas the deep compartment flap (transverse cervical artery/vein flap) was anastomosed in an end-to-end fashion to the medial sural artery and comitantes vein. Flap viability was checked by color Doppler ultrasound postoperatively. Patients were assessed preoperatively and underwent follow-up at 6 and 12 months after surgery. Data were prospectively collected.
Results: All the flaps resulted to be viable. No major postoperative complications were observed neither at the donor nor at the recipient sites. Patients did not report dysesthesia of

* Corresponding author.
E-mail address: giuseppe.visconti@policlinicogemelli.it (G. Visconti).

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the homoteral chest. An overall reduction in the lower extremity lymphedema (LEL) index (mean ± SD: 33.7 ± 22.5) and an improvement in the lymph flow and tracer appearance time at postoperative lymphoscintigraphy were observed. All the patients reported an improved quality of life after surgery.

Conclusions: Compartimental supraclavicular dual LNF harvest seems promising in the treatment of peripheral lymphedema. Sparing of supraclavicular nerves might reduce the morbidity associated with the conventional surgical approach. Larger studies are needed to confirm our findings.

Level of Evidence: IV, therapeutic study.

Introduction

In the recent few years, the microsurgical treatment of lymphedema is gaining widespread popularity with promising clinical results.[1-3]

The described donor sites for lymph node flap (LNF) are the groin area, the submental area, the lateral thoracic region, the supraclavicular region, and the visceral sites.[4-10] These LNFs are based on arterial inflow and venous outflow to assure flap viability, as for other microsurgical flaps. Thus far, there is no consensus on the best LNF donor site in terms of efficacy.

The aim of this paper is to report our clinical experience of LNF using a novel method of harvesting based on the compartimental lymphatic and vascular anatomy applied to the right posterior neck triangle, which allows to harvest two independent LNFs from the same donor site.

Patients and methods

Between August 2015 and March 2017, 10 patients affected by cancer-related lower extremity lymphedema (LEL) underwent compartimental dual LNF transfer from the right supraclavicular area to the affected lower limb. Flap viability was checked by color Doppler ultrasound postoperatively. Patients were assessed preoperatively and underwent follow-up at 6 and 12 months after surgery. Data were collected prospectively (Table 1).

Table 1 Demographics.

Age, years (mean ± SD)	59 ± 8
BMI, kg/m^2 body surface (mean ± SD)	27.2 ± 3.4
Months since disease onset (mean ± SD)	64.7 ± 89.4
Cancer-related lymphedema	
Prostate cancer	3
Endometrial cancer	6
Melanoma	1
Radiation therapy	7 (70%)
Male *n* (%)	3 (30%)
Female *n* (%)	7 (70%)
Preoperative LEL (mean ± SD)	357.2 ± 55.8
Preoperative ISL stage	
1 *n* (%)	0 (0%)
2a *n* (%)	0 (0%)
2b *n* (%)	10 (100%)
3 *n* (%)	0 (0%)

Surgical technique

The day before surgery, right upper limb reverse mapping was performed by indocyanine green lymphography, and for patients with hot spots in the right supraclavicular area, we opted for a different LNF donor site. This happened only in one patient who underwent lateral thoracic LNF transfer. The left supraclavicular area was not considered as a donor site because of the potential risk of thoracic duct injury.

A 4-cm lazy-S incision was outlined parallel and 2-cm above the clavicle, and superior and inferior skin-platysma flaps were raised enough to expose all the anatomical landmarks of the posterior neck triangle, hence avoiding damages to the spinal accessory nerve. The external jugular vein (EJV) was deroofed up to its confluence into the subclavian vein and the superficial compartment, and a lymphatic flap of 3 × 5 cm was drawn, centered on the EJV. The flap was left connected and carefully dissected along the plane defined by the supraclavicular nerves to spare them. Then, the dissection proceeded along the lateral border of the sternocleidomastoid (SCM) muscle and internal jugular vein to identify the omohyoid intermediate tendon and middle cervical fascia. After dividing it, the transverse cervical artery and vein (TCA and TCV, respectively) were identified just above the deep cervical fascia. Robbins level VB deep compartiment nodes were harvested based on the TCA and TCV in a medial to lateral direction, staying just above the deep cervical fascia, thus avoiding damages to the phrenic nerve, which lies just below the vascular pedicle and to the brachial plexus. The omohyoid muscle was preserved. The TCA and TCV were ligated distally before entering the trapezius muscle.

At the end of dissection, two LNFs were raised:

1) a venous flow-through lymphatic LNF based on the EJV, which included the skin lymphatic system - superficial compartment; and
2) an LNF based on the TCA and TCV containing the Robbins level VB lymph nodes - deep compartment (Figure 1)

The anatomical plane between the two compartments was defined by the supraclavicular nerves laterally and the middle cervical fascia medially.

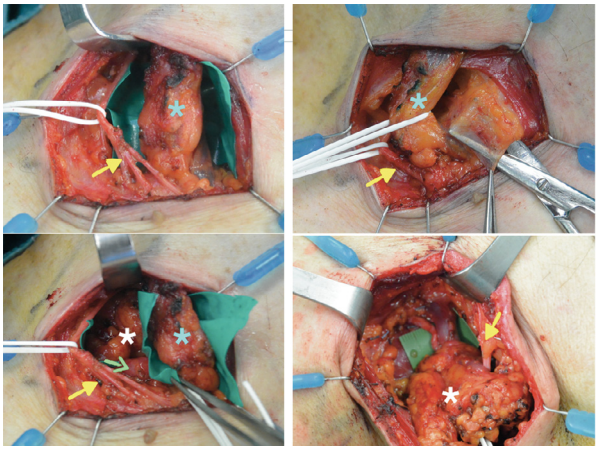

Figure 1 (Above, left) Intraoperative picture of compartimental supraclavicular lymph node flaps showing the dissected venous EJV-based LNF – superficial compartment – (light blue *) and the spared supraclavicular nerves (yellow arrow). (Above, right) The anatomical plane, which separates the superficial and deep compartments, is defined medially by the middle cervical fascia (spread scissors below it). (Below, left) The superficial (venous EJV LNF flap – light blue *) and the deep (TCA/V LNF – white *) LNFs have been fully dissected, sparing supraclavicular nerves (yellow arrow) and the omohyoid muscle (green arrow). (Below, right) The deep compartment TCA/V LNF (with *) with TCA and TCV dissected on top of the anterior scalene muscle. The yellow arrow shows the more superficially located and spared supraclavicolar nerves. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

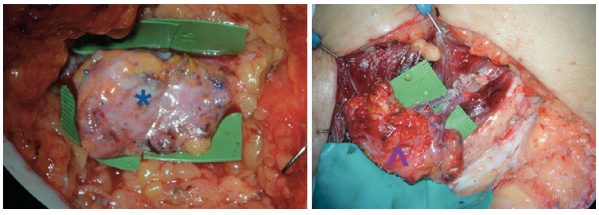

Figure 2 (left) The venous LNF has been transferred in a flow-through fashion along the great saphenous vein above the knee. (Right) The deep compartment LNF has been transferred to the sural area and revascularized in an end-to-end fashion using medial sural artery and comitantes vein.

The superficial compartment LNF was anastomosed in a flow-through fashion along the course of the great saphenous vein in the knee region, whereas the deep compartment LNF was anastomosed in an end-to-end fashion to the medial sural artery and comitantes vein (Figure 2).

The supraclavicular donor site was closed under one suction drain.

Results

The mean age of the patients was 59 years (range: 47–69, SD ± 8). No patient was a smoker. One patient was of normal weight (BMI range: 18.5–24.5 kg/m^2 body surface), seven patients were overweight (BMI range: 25–29.9 kg/m^2 body surface), and two patients were obese class 1 (BMI range: 30–33.9 kg/m^2 body surface) (Table 1).

The EJV was on average 5 mm in diameter (range: 4–6.5 mm). The TCA was on average 1.3 mm (range 0.9–2 mm). The TCV was on average 1.5 mm (range: 1–3.5 mm).

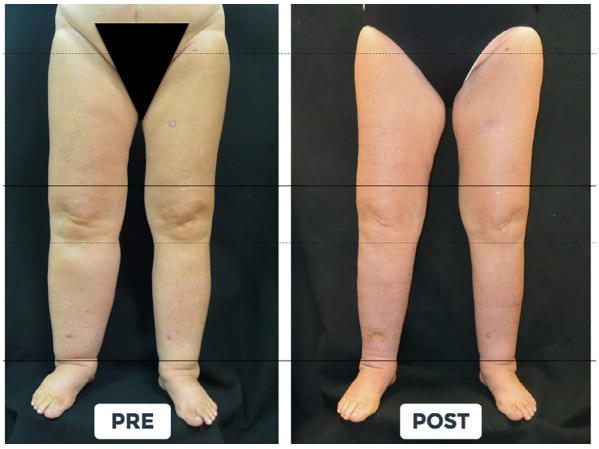

Figure 3 (left) Preoperative picture of bilateral lower extremity lymphedema secondary to ovarian cancer surgery and pelvic dissection. Lymphedema onset was 14 years before. Right lower extremity showed distal dermal backflow and no visualization of the inguinal nodes. Preoperarive LEL index was 494.6 – (right) 1 year after compartimental supraclavicular LNF transfer to the right lower extremity. Postoperative LEL index was 413.9.

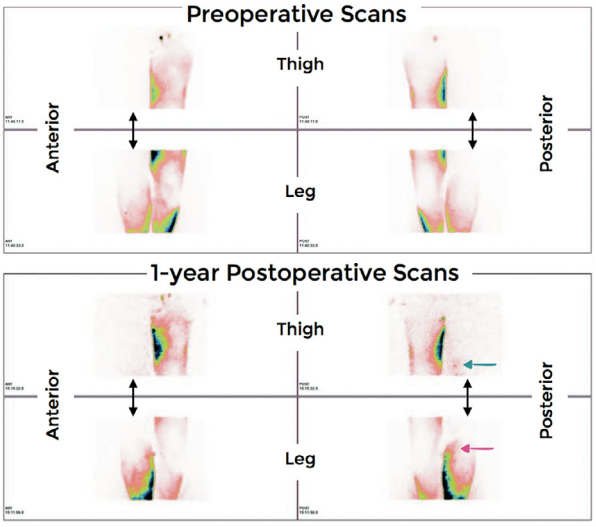

Figure 4 (above) Preoperative lymphoscintigraphy of lower extremities lymphedema secondary to endometrial cancer surgery, pelvic dissection, and adjuvant radiation. Lymphedema onset was 4 years before. Preoperative scans showed distal dermal backflow only and no flow above the middle leg and no visualization of inguinal nodes on the right side. (below) Postoperative lymphoscintigraphy showing an increased flow toward the sural area (recipient site of arterovenous LNF – pink arrow) and tracer appearance at the knee area (reciepient site of venous LNF – blue arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

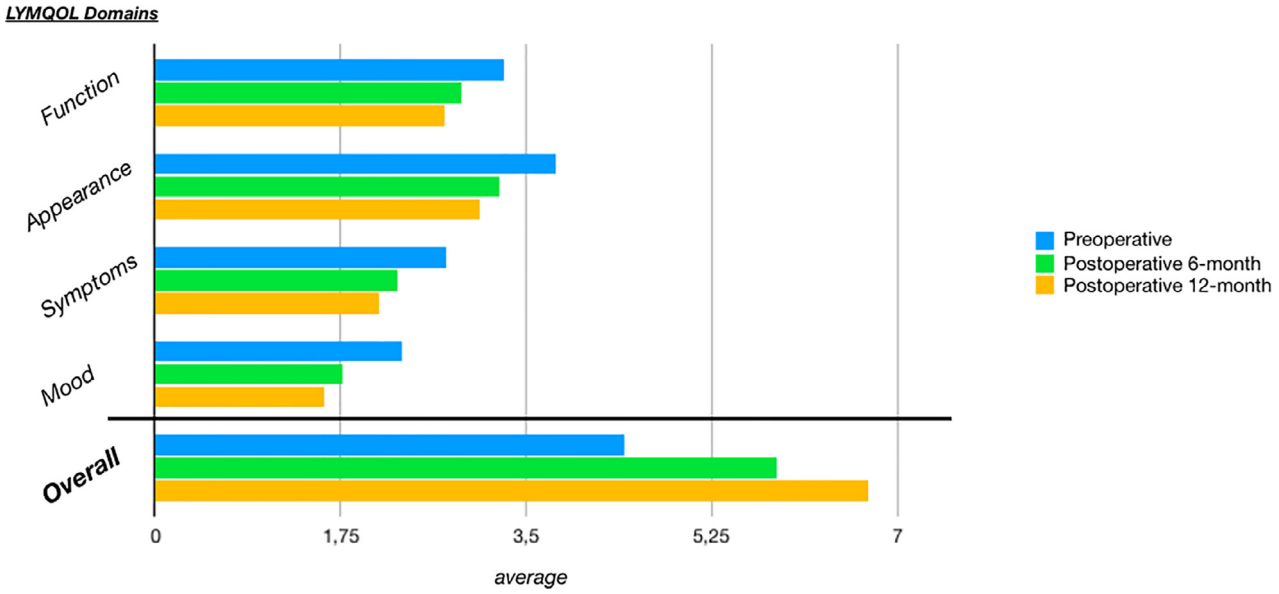

Figure 5 Quality of life (QoL) assessment using the LYMQOL questionnaire. The bar graph shows preoperative (blue bar), 6-month post-operative (green bar), and 12-month postoperative (orange bar) mean scores for each of the four domains and for the overall QoL. According to LYMQOL questionnaire and scoring system for all the domains, the higher the scores, the worse is the QoL; for the overall QoL, the higher the score, the better is the QoL. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

All the flaps resulted to be viable at the color Doppler assessment. No major postoperative complication was experienced neither at the donor nor at the recipient sites. Three patients suffered a minor (<1 cm) wound dehiscence at the sural recipient site, which healed spontaneously using a conservative approach with dressing changes.

All the patients showed an overall improvement in terms of both LEL index reduction (33.7 ± 22.5) (Figure 3) and improved lymph flow and tracer appearance time at postoperative lymphoscintigraphy (Figure 4). All of them reported an improvement in their quality of life (Figure 5). Patients did not experience dysesthesia on the homoteral chest.

Discussion

The supraclavicular LNF transfer to treat peripheral lymphedema was initially described by Chang et al in 2013.[8] Recently, the same authors reported their clinical experience on this flap describing their surgical technique and their results on 100 consecutive cases.[9-10] In brief, the supraclavicular LNF was harvested as an en bloc LNF based on the EJV, TCA, and TCV without skin island. According to the authors' view, the EJV or its branches could be used as an additional venous discharge when the TCV is small or insufficient. In the cited studies, the omohyoid muscle and supraclavicular nerves were sacrificed, with a reported dysesthesia over the pectoralis area.[9-10]

Ciudad et al provided a comparison of different LNFs, including the supraclavicular one. They reported no significant differences with regard to the long-term efficacy among the flaps evaluated.[11]

LNFs can be divided into two categories according to the lymphatic drainage features: (1) skin LNFs (i.e., lateral thoracic and groin), which drain skin and subcutaneous tissues, and (2) visceral LNFs (i.e., splanchnic – gastroepiploic and ileocecal). Since the initial classification of the cervical lymph nodes by Rouviere in 1932,[12] lymphatic drainage features of the neck have been widely studied for neck dissection. Presently, the most commonly used system for neck lymph node classification is the one proposed in 1991 by the American Academy of Otolaryngology updated in 2002, including the addition of sublevels.[13] This system is also known as Robbins Classification. The laterocervical region or posterior neck triangle is anatomically defined superiorly by the confluence of the trapezius and SCM muscles, inferiorly by the clavicle, anteriorly by the posterior margin of the SCM muscle, and posteriorly by the anterior margin of the trapezius muscle. The posterior neck triangle is classified as Robbins level V and subdivided into level VA (above; lymph node of the spinal chain) and level VB (below; supraclavicular nodes) by an imaginary horizontal line marking the inferior border of the cricoid cartilage.[13] Within the Robbins level V, the superficial lymphatic tissue and the lymph nodes along the EJV are responsible for the skin drainage of the posterior scalp, whereas level VB lymph nodes drain both head and neck skin as well as the oral cavity, thyroid gland, lungs, and breast. In this perspective, supraclavicular LNF should be seen as a hybrid lymphatic flap containing both skin and visceral nodes. The average number of level V lymph nodes reported in the literature on neck dissection is 7. The few dedicated studies on the supraclavicular LNF showed no univocal results with regard to the number of lymph nodes included in the harvested flap.[14-15] Moreover, the reported LNFs included both superficial and deep lymph nodes with no distinction among them. Larger intraoperative analysis is needed to define the average number of lymph nodes included in the supraclavicular LNF and to

clarify whether the number of lymph nodes included affects the surgical outcome.

The applied anatomy of supraclavicular region shows two distinct compartments, which are constantly divided by a fascial plane including supraclavicular nerves laterally and by the middle cervical fascia originating from the posterior belly of the omohyoid muscle medially.

Based on these peculiar anatomical and lymphatic functional features of the supraclavicular area and according to our recent experimental and clinical studies on venous LNF[16-18], we designed a novel technique of supraclavicular LNF, which allows to harvest two flaps from the same donor-site, thus reducing the morbidity related to the sacrifice of supraclavicular nerves and the omohyoid muscle.

Conclusions

We proposed a new surgical technique of harvesting LNF based on compartimental anatomy of the right supraclavicular fossa, which allows to harvest two LNFs from the same donor site. Larger studies with longer follow-up are needed to further confirm our promising preliminary results.

Conflict of interest

None.

Disclosure

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

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References

1. International Society of Lymphology 2013 Consensus document of the international society of lymphology. *Lymphology* 2013 March;**46**(1):1–11.
2. Kung TA, Champaneria MC, Maki JH, Neligan PC. Current concepts in the surgical management of lymphedema. *Plast Reconstr Surg* 2017 April;**139**(4):1003e–1013e.
3. Basta MN, Gao LL, Wu LC. Operative treatment of peripheral lymphedema: a systematic meta-analysis of the efficacy and safety of lymphovenous microsurgery and tissue transplantation. *Plast Reconstr Surg* 2014 April;**133**(4):905–13.
4. Becker C, Assouad J, Riquet M, Hidden G. Postmastectomy lymphedema: long-term results following microsurgical lymph node transplantation. *Ann Surg* 2006 March;**243**(3):313–15.
5. Cheng MH, Chen SC, Henry SL, Tan BK, Lin MC, Huang JJ. Reply: vascularized groin lymph node flap transfer for postmastectomy upper limb lymphedema: the flap anatomy, recipient sites, and outcomes. *Plast Reconstr Surg* 2014 March;**133**(3):428e–429e.
6. Cheng MH, Huang JJ, Nguyen DH, Saint-Cyr M, Zenn MR, Tan BK, Lee CL. A novel approach to the treatment of lower extremity lymphedema by transferring a vascularized submental lymph node flap to the ankle. *Gynecol Oncol* 2012 Jul;**126**(1):93–8.
7. Barreiro GC, Baptista RR, Kasai KE, dos Anjos DM, Busnardo Fde F, Modolin M, Ferreira MC. Lymph fasciocutaneous lateral thoracic artery flap: anatomical study and clinical use. *J Reconstr Microsurg* 2014 July;**30**(6):389–96.
8. Althubaiti GA, Crosby MA, Chang DW. Vascularized supraclavicular lymph node transfer for lower extremity lymphedema treatment. *Plast Reconstr Surg* 2013 January;**131**(1):133e–135e.
9. Mardonado AA, Chen R, Chang DW. The use of supraclavicular free flap with vascularized lymph node transfer for treatment of lymphedema: a prospective study of 100 consecutive cases. *J Surg Oncol* 2017 January;**115**(1):68–71.
10. Ooi AS, Chang DW. 5-step harvest of supraclavicular lymph nodes as vascularized free tissue transfer for treatment of lymphedema. *J Surg Oncol* 2017 January;**115**(1):63–7.
11. Ciudad P, Agko M, Perez Coca JJ, Manrique OJ, Chang WL, Nicoli F, Chen SH, Chen HC. Comparison of long-term clinical outcomes among different vascularized lymph node transfers: 6-year experience of a single center's approach to the treatment of lymphedema. *J Surg Oncol* 2017 November;**116**(6):671–82.
12. Rouviere H. *Anatomie des lymphatiques de l'homme*. J Am Med Assoc. 99 (20): 1716. *12 November 1932*.
13. Robbins KT, Clayman G, Levine PA, et al. Neck dissection classification updaterevisions proposed by the american head and neck society and the american academy of otolaryngology–head and neck surgery. *Arch Otolaryngol Head Neck Surg* 2002;**128**(7):751–8.
14. Steinbacher J, Tinhofer IE, Meng S, Reissig LF, Placheta E, Roka-Palkovits J, Rath T, Cheng MH, Weninger WJ, Tzou CH. The surgical anatomy of the supraclavicular lymph node flap: a basis for the free vascularized lymph node transfer. *J Surg Oncol* 2017 January;**115**(1):60–2.
15. Gerety PA, Pannucci CJ, Basta MN, Wang AR, Zhang P, Mies C, Kanchwala SK. Lymph node content of supraclavicular and thoracodorsal-based axillary flaps for vascularized lymph node transfer. *J Vasc Surg Venous Lymphat Disord* 2016 January;**4**(1):80–7 Epub 2015 Sep 12. PubMed PMID: 26946900. doi:10.1016/j.jvsv.2015.06.004.
16. Visconti G, Constantinescu T, Chen HC. The venous lymph-node flap. *Microsurgery* 2016 September;**36**(6):527–8.
17. Visconti G, Constantinescu T, Chen PY, Salgarello M, Franceschini G, Masetti R, Chen HC. The venous lymph node flap: concepts, experimental evidence, and potential clinical implications. *J Reconstr Microsurg* 2016 October;**32**(8):625–31.
18. Visconti G, Constantinescu T, Araki J, Salgarello M, Chen HC. The venous lymph node flap for the treatment of peripheral lymphedema: preliminary evidence. *Microsurgery* 2017 January;**37**(1):86–7.