doi: 10.48095/ccachp202450

History of surgical treatment of lymphatic drainage at the Department of Plastic and Aesthetic Surgery, St. Anne's University Hospital in Brno

J. Veselý, M. Hubová, P. Hýža, T. Kubek, L. Streit, M. Kubát, M. Knoz, Z. Dvořák

Department of Plastic and Aesthetic Surgery, Faculty of Medicine of Masaryk University, and St. Anne's University Hospital, Brno, Czech Republic

Summary

The Department of Plastic and Aesthetic Surgery, St. Anne's University Hospital in Brno, and Faculty of Medicine of Masaryk University, Brno, has a long history of surgical treatment of lymphedema and elephantiasis, which started in 1970s. There were many types of surgeries described and performed at our department – starting with prof. Bařinka's radical operation of elephantiasis, then lower limb end-to-side lymphovenous anastomosis pulled through the wall to the great saphenous vein, and genital lymphedema reduction. We call this era "the first period" of surgical lymphedema treatment. "The second period" started in 2016 by using free flaps with lymph nodes or vascularized lymph nodes and using microsurgical techniques of end-to-end, end-to-side and side-to-end lymphovenous anastomoses to the subcutaneous veins of a small calibre, which then drain the lymph into the blood stream. "The third period" started 2 years ago after the visit of prof. Yang from Taiwan – we started to use the method of single stitch end-to-side anastomosis to big subcutaneous veins like the great saphenous vein or the cephalic vein.

Key words

radical operation of elephantiasis according to Bařinka – lymphovenous anastomoses – DIEP transfer with lymph nodes – vascularized lymph nodes transfer

Veselý J, Hubová M, Hýža P et al. History of surgical treatment of lymphatic drainage at the Department of Plastic and Aesthetic Surgery, St. Anne's University Hospital in Brno. Acta Chir Plast 2024; 66(2): 50–59.

Introduction, overview of surgical methods

Our department has a long history of treatment of patients with lymphedema or elephantiasis. In 1970–1980s, there was an important era of prof. Bařinka's radical operations [1]. This kind of operation was indicated especially in elephantiasis patients. It comprised of radical fascia-deep removal of hypertrophic skin tissue *en bloc* to fascia whilst the lower limb was hanging up and was exsanguinated by Esmarch's tourniquet. After releasing the tourniquet, one team of surgeons took care of haemostasis, and the second team harvested the skin grafts from the removed skin tissue using so called superdermatoma. Usually, there were three blocks of skin grafts of an approx. width of 60 cm harvested. First of all, the subcutaneous tissue affected by lymphedema was separated from the hypertrophic corium. Then the corium was removed so that the hypertrophic skin graft was as thin as possible. In many cases, the full splitness skin graft had to be used because of the fragility of the skin due to oedema. The skin graft was then preserved in the fridge for 3 days and the lower limb was powdered with haemostatic Traumacel powder and temporarily fully covered with the corium. After 3 days, the corium was removed and the skin grafts were applied to the wound – they had to be applied in an oblique axis in order to prevent formation of scar contractures in the popliteal or dorsal foot regions. According to clinical experience of prof. Bařinka, the areas where the skin graft wasn't fully healed after 1 month were treated with necrectomy and compression, following another skin transplantation in the 3rd month – these skin grafts usually took more than 2 months to be fully healed. Basically, all patients were fully healed not sooner than 3 months after primary surgery. They usually went through a catabolic phase or even sepsis (Fig. 1–9).

In the late 1980s, thanks to collaboration with the Department of Radiology lead by prof. Benda, a new method of lymphography started to be used in

Fig. 1. Elephantiasis of left lower limb.

Fig. 4. Prof. Bařinka holding removed tissue affected by elephantiasis.

Fig. 2, 3. Ischemisation of lower limb and fascia-deep removal of affected tissue.

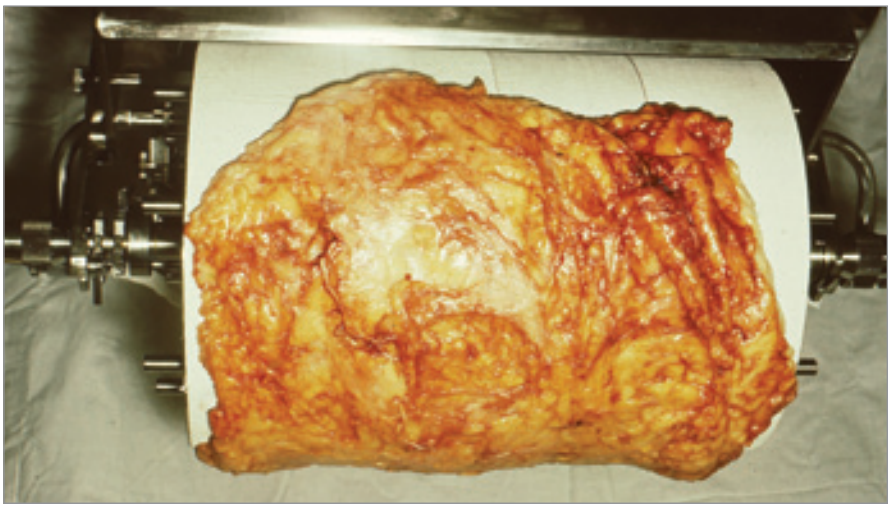

Fig. 5. Superdermatoma with removed tissue affected by elephantiasis.

clinical practice – the deep lymphatic collectors were marked by a contrast substance applied into the interdigital webspace and then dissected. Usually, there were approx. 8–12 lymphatic collectors in the surrounding of the great saphenous vein, with approx. 5 collectors in patients with congenital hypoplasia of the lymphatic system. In the same period, the first microsurgical lymphovenous end-to-side pull through the wall of the great saphenous vein anastomoses were performed at our Department. The end of the lymphatic vessel was placed and fixed with two stitches approx. 2–4 mm proximally of the incision in the big vein down the bloodstream flow (Fig. 10). There were usually 2–4 anastomoses of this kind created.

Reduction of congenital lymphedema of the external genitalia and occasional

Fig. 6, 7. Harvesting 3 blocks of skin grafts.

liposuction have become the only and relatively infrequent lymphatic transport disorder surgeries in the coming years at the Department of Plastic and Aesthetic Surgery. Although technically simple operations, reduction of skin and subcutaneous tissue of the genitalia requires a good imagination of a plastic surgeon, primarily to avoid the formation of contracting scars. This period is now referred to as the first period of lymphedema treatment at our department.

The second period of lymphedema treatment at the Department of Plastic and Aesthetic Surgery – lymph node transfer and lymphovenous anastomoses (LVAs) to small subcutaneous veins in the deep inferior epigastric artery perforator (DIEP) flap for the treatment of upper limb lymphedema is among the current techniques used, dating back to 2016 at our department. It is preceded by a relatively complex preoperative procedures. When the lymph nodes are connected with DIEP flaps, the patients are women who have undergone partial or radical mastectomy with axillary exenteration followed by the development of ipsilateral secondary lymphedema of the upper limb.

Fig. 8. Skin graft applied to the defect of lower limb 3 days after original surgery.

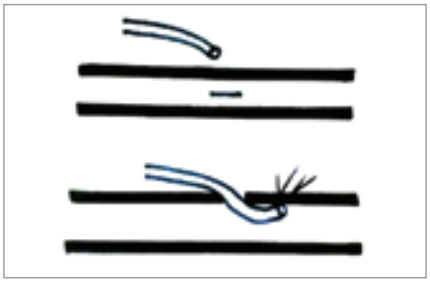

Fig. 10. LV anastomosis end-to-side.

Fig. 9. Long-term result of radical operation.

Using scintigraphy, the lymph nodes in the lateral side of the groin are selected, and those not draining the lower limb are marked with a radionuclide the day before surgery and then elevated and taken into the expanded DIEP flap during surgery [2]. This flap is usually harvested with two vascular pedicles – the first one are deep inferior epigastric vessels nourishing the flap from the abdomen, sutured end-to-end to the internal mammary vessels. The second pedicle consists of the superficial circumflex iliac vessels nourishing the lymph nodes, usually sutured to the lateral thoracic vessels or less often to the thoracodorsal vessels. For a good functional result, at least 3 lymph nodes have to be present

Fig. 11. Pacient (No. 5) before bilateral profylactic mastectomy, in right groin marked lymph nodes for drainage of left upper limb.

Fig. 12. Mild lymphedema of left upper limb after axillary dissection.

in the flap. Currently, the use of indocyanine green (ICG) appears as a very promising and less demanding method of lymph node imaging, eliminating the need for radionuclide marking the day before, for patients in whom the depth of the subcutaneous tissue does not exceed 2 cm, which is the visualizing distance of ICG imaging for lymphatic collectors (Fig. 11–16).

Transfer of selected lymphatic nodes in a small skin flap is another effective method for lymphedema treatment in indicated patients [3]. This kind of a lymph node flap can be harvested from various parts of the human body, usually the neck or the lateral chest wall, and together with the donor artery and vein, it is sutured to the designated site on the affected limb. Lymphatic transport to the bloodstream is then ensured using vascularized nodes in this flap. The desired effective number of nodes in the flap should be 3 or more (Fig. 17–21).

End-to-end or side-to-end LVAs are other less invasive surgical method used at our department. While end-to-side anastomoses have been utilized since the late 1980s, the authors have been using side-to-end LVA since 2019. Although end-to-end LVAs have been known since O'Brien's time [4], their boom was demonstrated at the World Congress of the World Society of Reconstructive Microsurgery (WRSM) in 2019 when several departments in Japan and South Korea mastered this issue in specialized centers performing numerous LVAs on limbs using supermicrosurgical suturing of vessels smaller than 1mm, utilizing ICG for lymphatic vessel visualization. Preoperative ICG examination with a coloured contrast agent is now possible for our patients as well thanks to the capabilities of the Novadaq ICG device. Intraoperatively, ICG camera incorporated into the Mitaka MM51 supermicroscope can visualize the course of lymphatic vessels, lymph nodes or sites with lymph accumulation. Based on clinical findings, the surgeon then selects suitable veins for suturing several end-to-end and side-to-end LVAs.

To complete the discussion of LVA suture techniques, it should be noted that end-to-end anastomoses can be sutured without significant magnification according to Campisi [5,6],with the lymphatic vessel telescopically inserted into

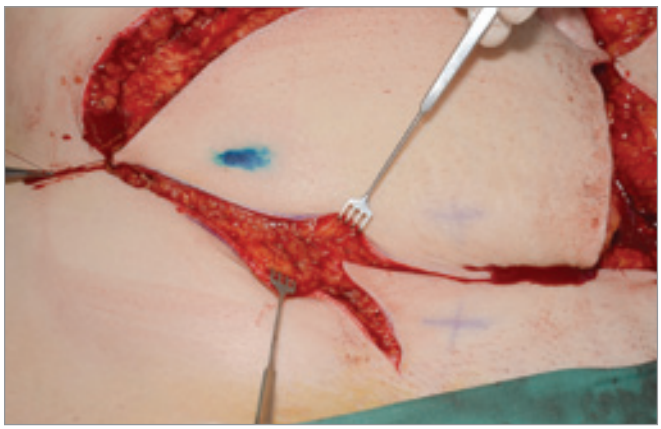

Fig. 13. Bilateral profylactic skin sparing mastectomy and primary reconstruction with two DIEP flaps. Right-sided DIEP flap enlarged with fat tissue containing three lymph node and then transferred on left hemithorax.

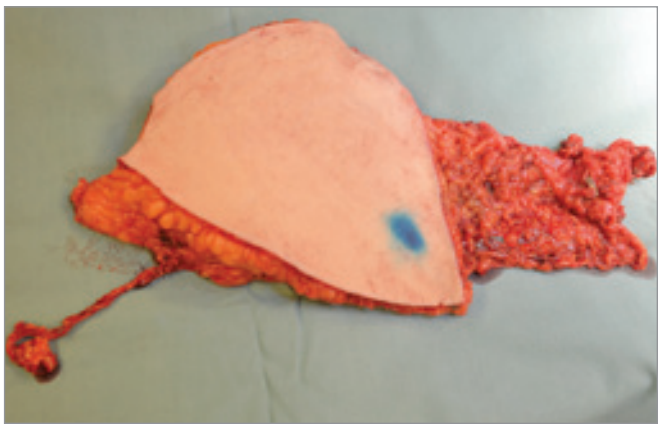

Fig. 14. Right-sided hemiDIEP with lymph nodes and two pedicles transferred to left hemithorax as left breast and drainage for left axilla.

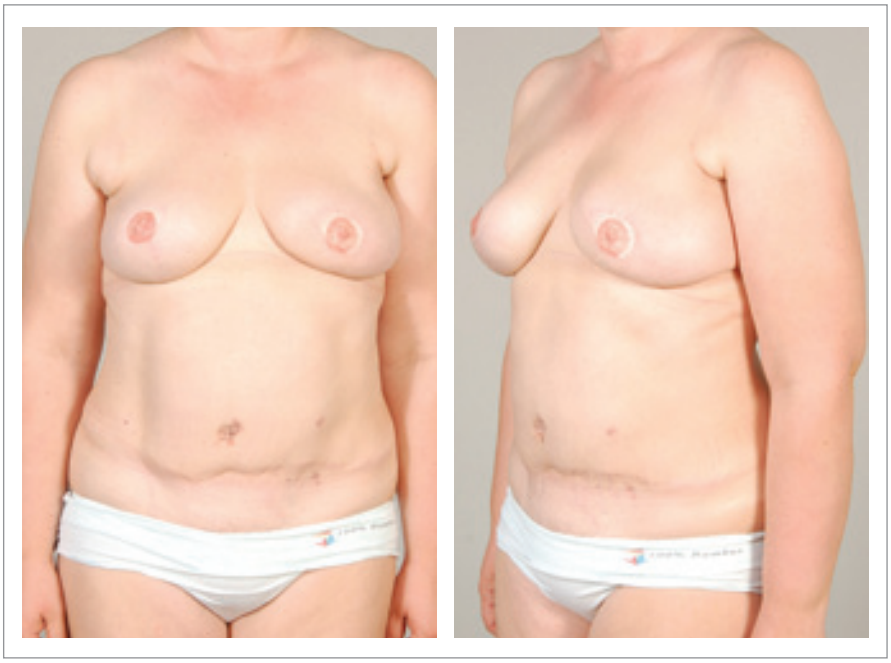

Fig. 15, 16. Final result after secondary nipple reconstruction and nipple-areolar tattoo.

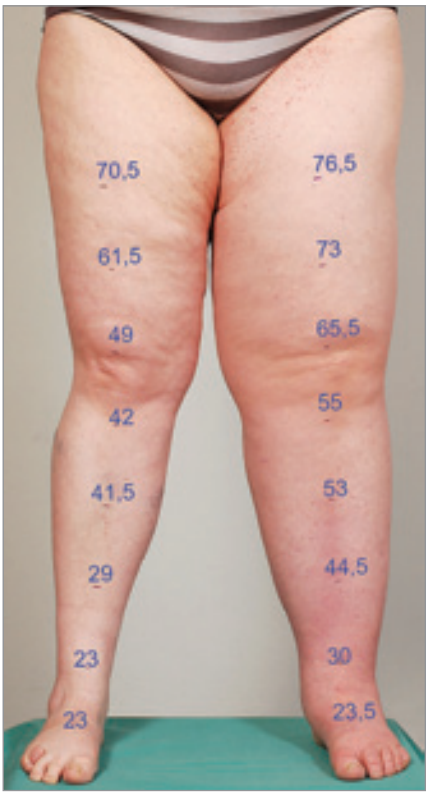

Fig. 17. Pacient (No. 6) with more severe lymphedema of left lower limb.

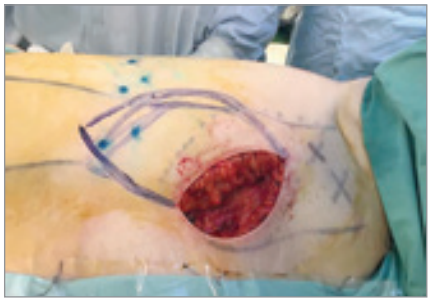

Fig. 18. Isolation of pedicle of thoracic skin flap with detected lymph nodes.

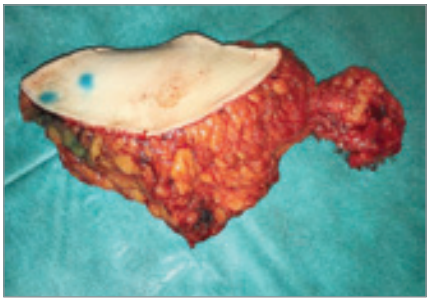

Fig. 19. Harvested vascularized lymph nodes flap.

Fig. 20. Healed vascularized flap with lymph nodes, microanastomoses end-to-side to tibialis posterior vessels.

Fig. 21. Long-term result.

Fig. 22. Lymphedema of right lower limb after multiple surgeries of recurrent lipoma of groin (patient No. 8).

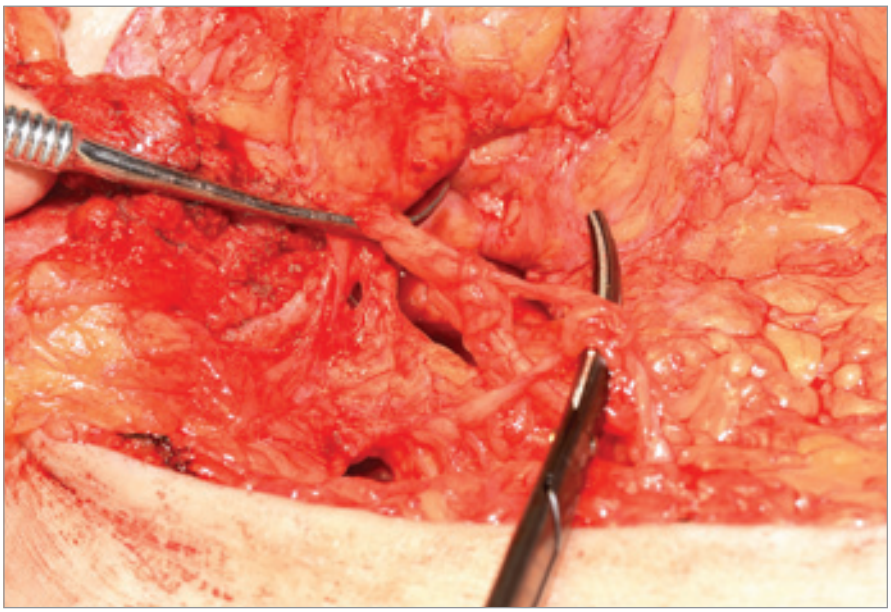

Fig. 23. Four lymphatic vessels coloured by patent blue.

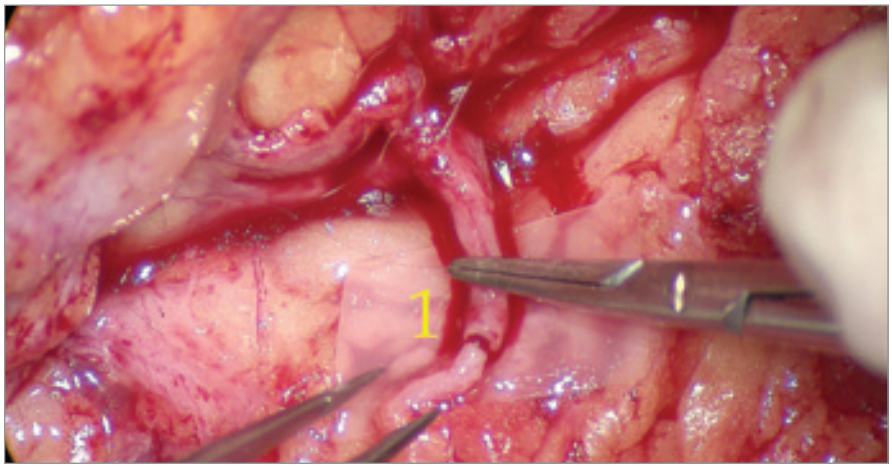

Fig. 24. First end-to-end LVA. Vein upwards. Lymphatic collector with first stitch downwards.

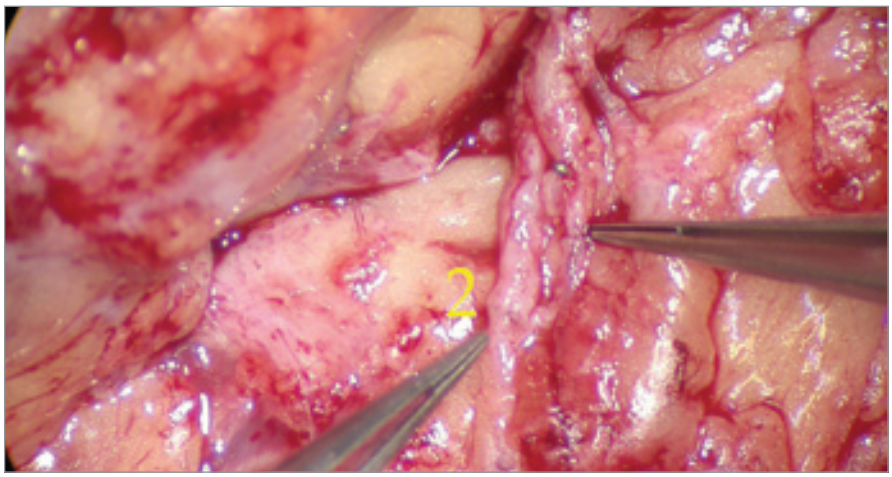

Fig. 25. Three LVAs labelled with numbers.

the vein and fixed with an 8/0–10/0 suture vessel to vessel, and then the anastomosis is reinforced with perivascular fat sutured with a 8/0–7/0 stitch [7].

At our department, end-to-end and side-to-end LVAs are performed strictly microsurgically with several stitches 11/0–12/0 placed around the vessels (Fig. 22–26). For those lymphatic collectors that drain lymph well, there is an assumption of successful transfer of secondary lymphedema stasis into the

Fig. 26. Patient (No. 8) 1 year after surgery.

Tab. 1. Patient assessment and results.

Number	Patient birth year	Cause of lymphedema	Type of surgery	Follow-up (months)	Difference in cimcumferences pre-op and post-op (cm)	Assessment of patient	Result
1	J. B. 1970	secondary lympedema of left upper limb after bilateral mastectomy 2007, exenteration of left axilla 4/2008	22. 3. 2016 DIEP 2×, lymph nodes on the left side	69	16. 1. 2022 R: –0.5, –0.5, –0.5, –0.5, –2.0 L: –1, –0.5, –2, –1, 0, –1.2, 0	subjectively without lymphemdema not using bandaging	A
2	V. B 1956	partial mastectomy with exenteration of left axilla 2004, radical bilateral mastectomy 2014	18. 5. 2016 DIEP 2×, lymph nodes on the left side	67	R: +2.5, +3, 0, –0.5, –1 5 years post-op L: +1, +1.5, +2, +1, –3, –1.5	content with result gained weight	A
3	J. P. 1973	secondary lympedema of left upper limb after mastectomy 5/2014	20. 9. 2016 secondary DIEP, lymph nodes on the left side	63	R: +1.5, +3, –1.5, +3.5, –1, +1.5 L: +1.5, +2.5, –1, +4, –1, +1	content with result gained 12 kg	A
4	A. M. 1958	secondary lympedema of left upper limb after mastectomy and exenteration of lef axilla 10/2002	6. 9. 2017 secondary DIEP, lymph nodes on the left side	51	16. 1. 2022 R: –1.5, –1, 0, x, +1, +2.5 L: 0, +2, 0, x, +0.5, +2.5	feels better, lymphedema milder lymphatic drainages once a week	B
5	H. V. 1976	secondary lymphedema of the left upper limb after partial mastectomy l.sin. 2015 and exenteration of left axilla 4/16	3. 10. 2017 SSM 2×, DIEP 2×, 3–4 lymh nodes on the left side	50	R: +3, +3, +3, +3.5, +0.5, +0 L: +1.5, +1.5, +2, +3.5, +1.5, +0.5	lymphedema milder not using bandaging for 2 years gained weight	A
6	J. Š. 1972	bilateral lymphedema of lower limbs after surgery for uterine cancer 2007	21. 6. 2018 chest flap with 3 lymph nodes transferred above left ankle	42	R: –3.5, –2.5, –2, –1, –2.5, +1, +2, +0 L: –3.5, –7, –4.5, –5, –7, –8.5, +2, –0.5	post-op 8× erysipelas, feels better uses bandaging	A
7	O. M. 1957	right breast deformity after partial mastectomy with right axillary dissection	28. 2. 2019 DIEP 1× + lymph nodes on the right side	38	no data pre-op	feels better, objectively improvement on the arm and forearm	A
8	J. J. 1953	lymphedema of right lower limb after multiple surgeries of recurrent lipoma of groin, 2018	24. 6. 2019 3× LVAs end-to-end	30	L: –1, 0, 0, +1.5, 0, 0 R: –3.5, –2, +1, 0, 0, 0	feels very good, walks 7 km every day	A

DIEP – deep inferior epigastric artery perforator, SSM – skin-sparing mastectomy, LVA – lymphovenous anastomoses, x – missing or unavailable data

Tab. 1 – continuing. Patient assessment and results.

Number	Patient birth year	Cause of lymphedema	Type of surgery	Follow-up (months)	Difference in cimcumferences pre-op and post-op	Assessment of patient	Result
9	B. J. 1958	radical bilateral mastectomy, recurrence on the right, lymphedema of right upper limb for 13 years	2. 3. 2020 1× LVA on superficial system, vein 0.6 mm, lymphatic vessel 0.4 mm	21	no data pre-op	lymphedema stays on the arm and below elbow, improvement only on the hand dorsum; pre-op recurrent erysipelas 5×, post-op no erysipelas	B
10	L. V. 1960	panhysterectomy with paraaortal lymphadenectomy for uterine cancer	12. 10. 2020 right lower limb: 1× LVA side-to-end of proximal leg, 1× end--to-end of distal leg left lower limb: 1× side-to-end	14	no data pre-op	significant improvement on the left lower limb, worsening on the right	A D
11	J. L. 1949	radical resection of malignant melanoma 2017, secondary lymphedema of right lower limb	12. 10. 2020 2× LVA side-to-end, 1× LVA end-to-end	14	R: –3, +2, –1, –1, –1.5		A
12	B. M. 1990	ca cervicis uteri, panhysterectomy, lymphadenectomy of lesser pelvic region and retroperitoneal region 2012	13. 10. 2020 L: 1× LVA side-to-end, 2× LVA end-to-end on the thigh	14	L: +2, +2, +2, +1.5, +2 R: +4.5, –4, +1.5, +0.5, +2.5	wears bandaging permanently, if not the lymphedema gets bigger especially on the medial upper thigh below the scar and in pubic region	D

DIEP – deep inferior epigastric artery perforator, SSM – skin-sparing mastectomy, LVA – lymphovenous anastomoses

venous system below the site of the lymphatic flow barrier.

Results of the selected methods mentioned above

The results of Bařinka's radical operations were limbs devoid of elephantiasis and covered with scarred skin similar to healed burns. Some patients came back with hyperkeratosis around the toes, with lymphorrhea in scars, but with significant relief of the limb from elephantiasis, sometimes even tens of kilograms lighter. End-to-side lymphovenous anastomoses were mainly performed for primary lymphedema patients in the second half of the 1980s. The benefit for patients was the fact, that the lymphedema did not enlarge throughout their lifetime.

The results of modern operations in the second stage of lymphedema treatment since 2016 focused on node transfer and end-to-end and side-to-end LVAs are shown in Tab. 1. This is a series of 12 patients treated at our department for secondary lymphedema with a follow-up period of at least 12 months. The results were evaluated objectively based on the difference in limb circumferences at predilection sites before and after surgery and subjectively by patient assessment. A total of 9 results were rated as A (permanent improvement), once as B (temporary improvement), once as C (no change), and once as D (worsening).

The third stage of limb lymphedema treatment with LVAs to the major subcutaneous veins such as the v. saphena magna and the v. cephalica has not yet been evaluated in terms of results due to a small number of patients and a short follow-up.

Discussion

It is necessary to understand the differences between elephantiasis as a stationary condition and lymphedema as a dynamic condition. Massive to monstrous elephantiasis patients may not benefit from small surgical reductions.

Fig. 27. Planning of LVAs on the left thigh of patient No. 12.

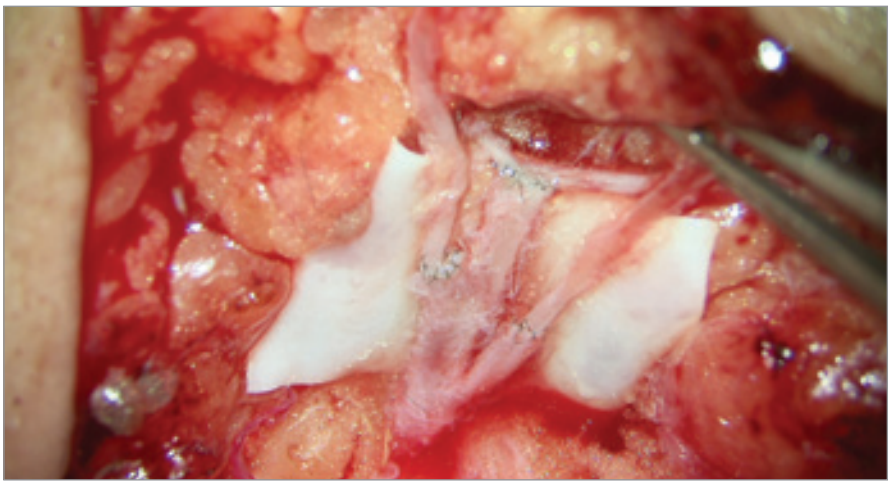

Fig. 28. Three LVAs sutured into one vein with three branches, side-to-end anastomoses in the middle.

It is questionable whether, in a completely individual case, Bařinka's operation (modified Charles operation) would not be more beneficial for the patient if a way to finance treatment with long hospitalization and modern wound healing concepts had been found [1]. On the other hand, in today's era with a developed network of lymphological centres, the development of elephantiasis should not occur at all, and if it does, the patient is likely non-compliant.

Our and O'Brien's experience with microsurgery LVAs in primary lymphedema are similar – they did not bring significant improvement but maintained lymphedema so it did not enlarge [4]. On the other hand, Koshima reports good results even for this indication [8,9]. The question then arises whether stable and non-enlarging lymphedema is a success. There is a reflection on the differences in surgical technique of anastomoses – the authors of this article sutured deep and relatively large collectors into the great saphenous vein, while Koshima preferred to suture small superficial collectors into the small subcutaneous veins. According to the authors of this article, this is justified by the misconception that there is less blood pressure in small veins than in large ones. On the contrary, the authors believe that the closer to the heart, the lower the pressure in the veins is – even negative pressure, otherwise blood would not flow against gravity.

For patients with long-term secondary lymphedema and obliteration of deep collectors, the transfer of vascularized lymph nodes is an effective solution according to the authors of this article. The question remains whether to transfer the nodes onto the distal part of the limb or below the site of a lymph flow blockade. Another point of discussion is the timing of liposuction for lymphedema treatment considering the planning of LVA or node transfers. These considerations should be the subject of closer cooperation between experienced centres capable of creating clinically and scientifically based algorithms and initiate beneficial collaboration between departments and specialities.

Fig. 29. Result after 6 months.

Good results with effective lymphatic drainage were basically achieved by all flaps containing vascularized lymph nodes with their own vascular

pedicle [10]. These were usually extended DIEP flaps. A satisfactory outcome was also achieved with a chest flap with lymph nodes transferred to the distal thigh. During the long-term flow-ups, the outcome was also affected by changes in the patient's weight compared to preoperative weight, hormonal changes, and the regularity of compression bandaging. LVAs generally had a positive effect on reducing lymphedema.

ICG visualization of lymphatic collectors through the skin and with an ICG camera incorporated in the operating microscope was used in 6 patients of the second stage of lymphedema treatment, of which 3 cases results with corresponding follow-up time are shown in Tab. 1. The ICG examination results were evaluated by our team in 1.5 and 2.5 hours after application, unlike dr. Vidím and dr. Hradecká from Kolín, Czech Republic, who evaluate the results of ICG examination the following day with a camera connected to a computer monitor [11]. Their team operates without optical magnification by a microscope or loupes.

In our cohort, there were two patients with only one performed LVA, both of whom felt improvement, one on the dorsum of the hand and the other on the left lower limb (although improved, this patient is not included in the Tab. 1 due to a short follow-up of 10 months). The Tab. 1 also includes a young thin patient (No. 12) with mild lymphedema of both limbs and three LVAs on the left, more affected, lower limb. This single patient is rated as "D", as postoperative measurements show an increase in limb circumferences. However, no visual deterioration is observed (Fig. 27–29). During her surgery, there were found and cut 3 lymphatic collectors in the area of stasis on the inner side of the thigh, as shown by preoperative ICG examination, but surprisingly the lymph did not flow out in an expected or corresponding manner. The surgeon, prof. Veselý, is now convinced that in such a mild manifestation of lymph stasis as in this thin patient, who underwent gynaecological surgery 9 years ago, suturing collectors into the great saphenous vein would be rather indicated.

Patients affected by lymphedema are now being managed and monitored in lymphological centres. The usual conservative treatment involving bandaging and lymphatic drainage of the limbs is sufficient and, in most cases, leads to a reduction or a halt in the gradual permanent increase of lymphedema. The goal of this treatment is also to prevent elephantiasis as an unchanging condition with enormous enlargement of the limb. Surgical treatment is indicated for increasing lymphedema of the limbs despite established conservative therapy, and lymphedema of the genital area is indicated for surgical treatment since childhood. The most promising methods are shown to be LVA technique and microvascular flap transfer with lymph nodes or a combination of these methods. In our cohort of patients with LVA, a reduction in circumferences in some parameters of up to 4 cm (3.5 cm) can be observed, and even more with lymphatic nodes transfer. If edema is increasing and neither of the mentioned surgical techniques can be used, liposuction or bandaging is a relieving method for affected patients.

Roles of the authors

Veselý J., Dvořák Z. – design of the article;
Svobodová K. – corresponding author;
Veselý J., Hýža P., Kubek T., Streit L., Knoz M., Dvořák Z. – performing surgeries, clinical investigators;
Svobodová K., Hubová M., Kubát M. – data collection and analysis.

Disclosure: The authors have no conflicts of interest to disclose. The authors declare that this study has received no financial support. All procedures performed in this study involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Bařinka L. Surgical treatment of the lymphedema of the extremities. *Brno* 1983: 84–91.
2. Becker C., Assouad J., Riquet M., et al. Postmastectomy lymphedema long-term results following microsurgical lymph node transplantation. *Ann Surg.* 2006, 243(3): 313–315.
3. Schaverien MV., Badash I., Patel KM., et al. Vascularized lymph node transfer for lymphedema. *Semin Plast Surg.* 2018, 32(1): 28–35.
4. O'Brien BM., Mellow CG., Kazanchi RK., et al. Long-term results after lymphatico-venous anastomoses for the treatment of obstructive lymphedema. *Plast Reconstr Surg.* 1990, 85(4): 562–572.
5. Campisi C., Boccardo F., Zilli A., et al. Long-term results after microlymphaticovenous anastomoses for the treatment of obstructive lymphedema. *Microsurgery.* 2001, 21(4): 135–139.
6. Campisi C., Belini C., Campisi C., et al. Microsurgery for lymphedema: clinical research and long results. *Microsurgery.* 2010, 30(4): 256–260.
7. Hradecká B., Vidim T. Lymfovenózní spojka horní končetiny – naše první zkušenosti. [online]. Available from: https://www.kongres.lympho.cz/Amca-Lympho/media/content/History/Lympho_2021_zaznam.pdf.
8. Koshima I., Nanba Y., Tsutsui T., et al. Long-term follow-up after lymphaticovenular anastomosis for lymphedema in the leg. *J Reconstr Microsurg.* 2003, 19(4): 209–215.
9. Koshima I., Inagawa L., Urushibara K., et al. Supermicrosurgical lymphaticovernular anastomosis for the treatment of lymphedema in the upper extremities. *J Reconstr Microsurg.* 2000, 16(6): 437–442.
10. Cormier JN., Rourke L., Crosby M., et al. The surgical treatment of lymphedema: a systematic review of the contemporary literature (2004–2010). *Ann Surg Oncol.* 2012, 19(2): 624–651.
11. Vidím T., Hradecká B. Úloha indocyaninové zeleně v operační léčbě lymfedému. [online]. Available from: https://www.kongres.lympho.cz/Amca-Lympho/media/content/History/Lympho_2021_zaznam.pdf.

Karolína Svobodová, MD
Departmnet of Plastic
and Aesthetic Surgery
St. Anne's University Hospital
Berkova 1204/34
612 00 Brno
Czech Republic
e-mail: karolina.svobodova@fnusa.cz

Submitted: 22. 2. 2024
Accepted: 6. 6. 2024