VLNT in Lower Limb Lymphedema

Dr. Giulio Tarantino

Resident Surgeon in Plastic, Reconstructive and Aesthetic Surgery

Policlinico Universitario Agostino Gemelli – Rome, Italy

Co-funded by the European Union

LYMPHEDEMA

- *DEFINITION*
- *ETIOLOGY*
- *EPIDEMIOLOGY*
- *STAGING*
- *TREATMENT*

LYMPHEDEMA

DEFINITION

Chronic, progressive and debilitating disease characterized by **subcutaneous fluid retention causing tissue swelling of the limbs.**

Grada AA, Phillips TJ. Lymphedema: Pathophysiology and clinical manifestations. J Am Acad Dermatol. 2017 Dec;77(6):1009-1020. doi: 10.1016/j.jaad.2017.03.022. PMID: 29132848.
Executive Committee of the International Society of Lymphology. The diagnosis and treatment of peripheral lymphedema: 2020 Consensus Document of the International Society of Lymphology. Lymphology. 2020;53(1):3-19. PMID: 32521126.

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ETIOLOGY

PRIMARY

< 50%

Congenital (< 2yo) **Praecox** (2-35 yo)
Tarda (> 35yo)

SECONDARY

> 50%

Any damage to LNs or LVs (infection, injury, cancer, RT, surgery)

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*Roughly **300 million** individuals*
*1st cause (worldwide) → **Filariasis** (70 million)*
*1st cause (western world) → **oncologic surgery** (50 million)*

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STAGING

Stage	Symptoms
0	Subclinical lymphoedema without oedema but evidence of impaired lymphatic function. This can exist months or years before overt oedema occurs
1	Reversible pitting oedema. No palpable fibrosis
2a	Pitting oedema that is not reduced by elevation
2b	Non-pitting oedema secondary to pronounced fibrosis
3	Lymphostatic elephantiasis. Progressive fibrosis, acanthosis (hyperpigmentation), hyperkeratosis and papillomatosis (warty growths)

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TREATMENT

CONSERVATIVE

Compression

CDT

SURGICAL

Reductive

Physiologic (reconstructive)

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LOWER LIMB LYMPHEDEMA

- **GYNECOLOGIC ONCOLOGY-RELATED LYMPHEDEMA (GORL)**
- GENITOURINARY ONCOLOGY-RELATED LYMPHEDEMA
- MELANOMA-RELATED LYMPHEDEMA
- SARCOMA-RELATED LYMPHEDEMA

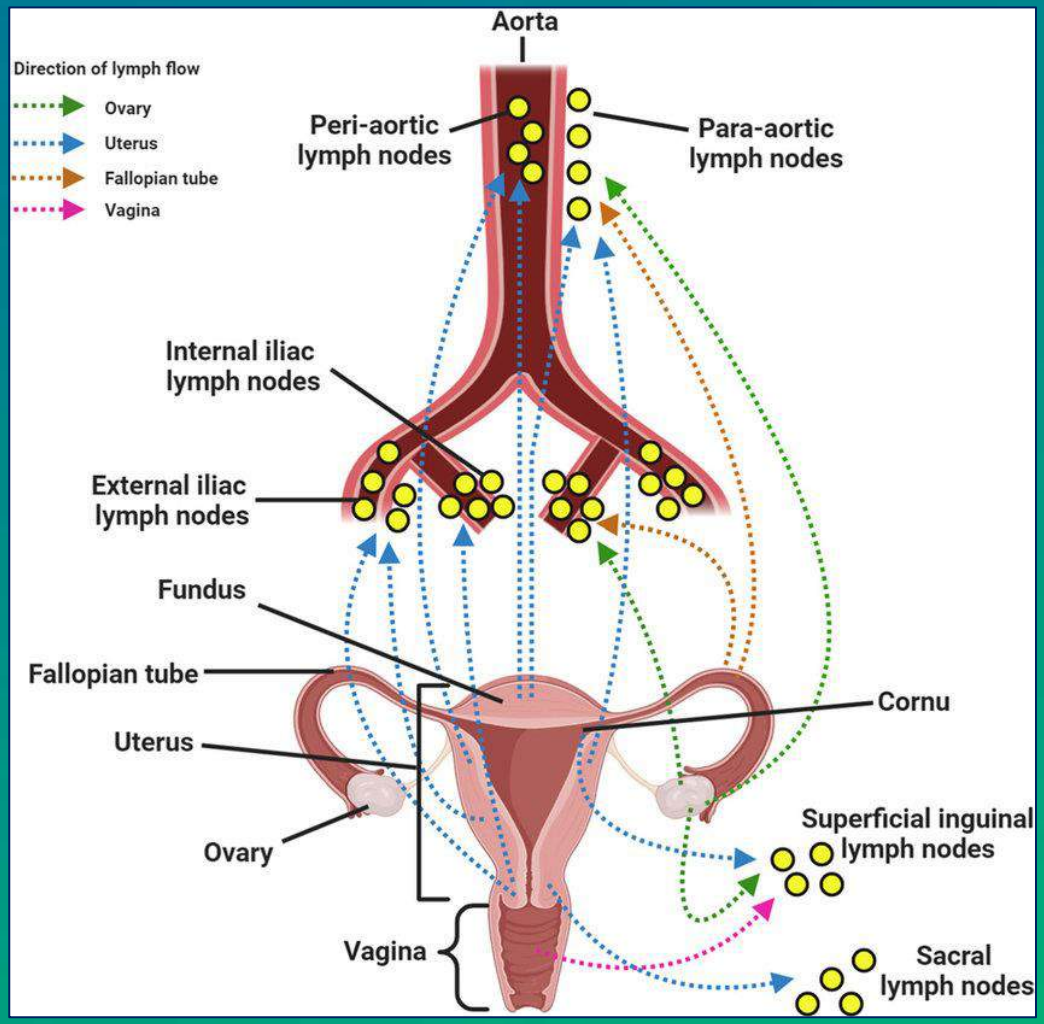
Dessources K, Aviki E, Leitao MM Jr. Lower extremity lymphedema in patients with gynecologic malignancies. Int J Gynecol Cancer. 2020 Feb;30(2):252-260. doi: 10.1136/ijgc-2019-001032. Epub 2020 Jan 7. PMID: 31915136; PMCID: PMC7425841.

GYNECOLOGIC ONCOLOGY-RELATED LYMPHEDEMA (GORL)

ANATOMY

INCIDENCE

RISK FACTORS



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GYNECOLOGIC ONCOLOGY-RELATED LYMPHEDEMA (GORL)

ANATOMY

Pelvic
Para-aortic
Inguinofemoral

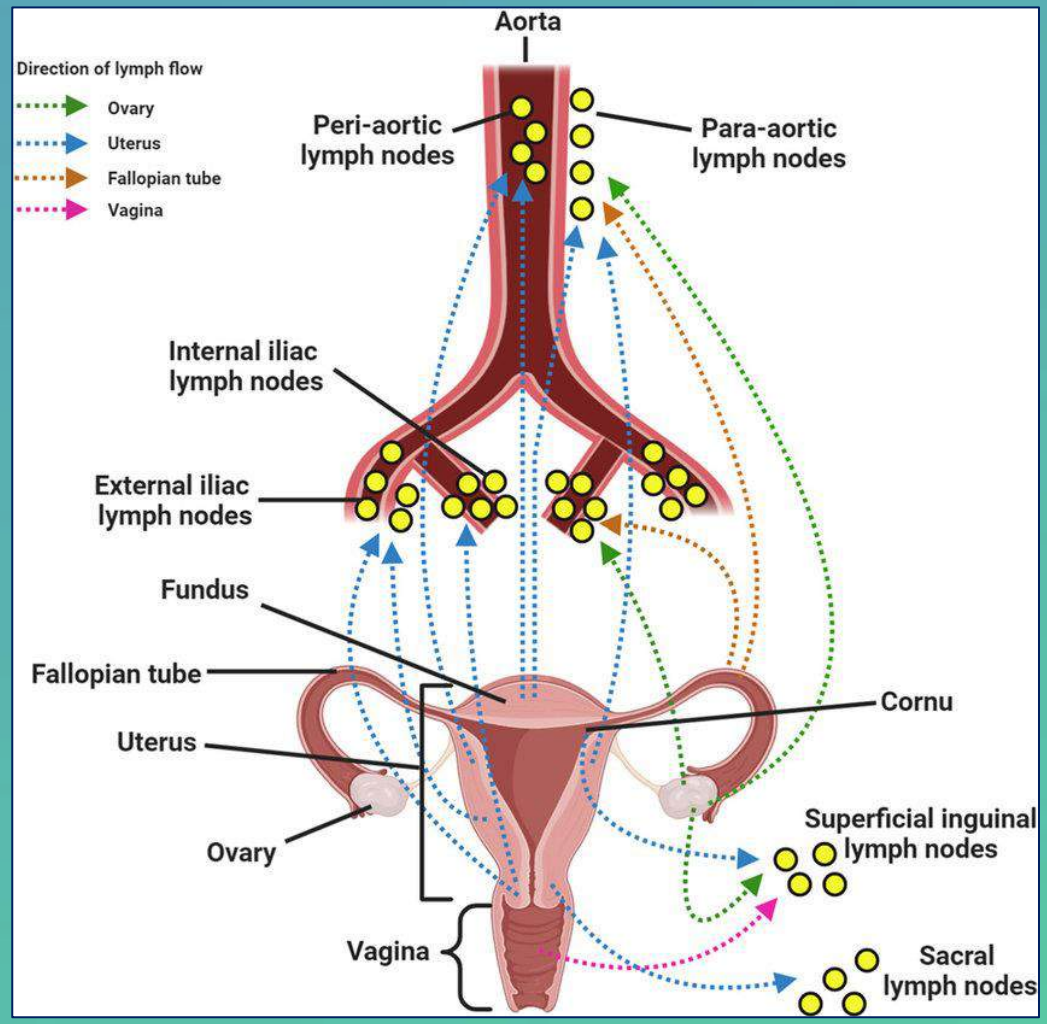
INCIDENCE

Endometrial cancer 1%-47%
→ *(most common)*
Cervical cancer 0-60%
Ovarian cancer 5-41%
Vulvar Cancer 10-73%

→ 75% within 12 months of surgery

RISK FACTORS

Surgical aggressiveness,
Number of LNs removed,
Removal of specific LNs,
Adjuvant RT,
Patient characteristics



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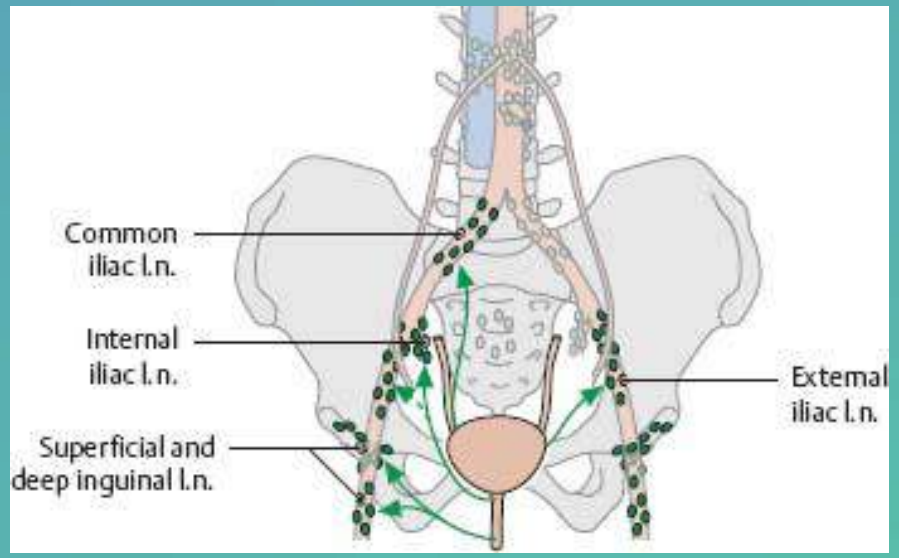
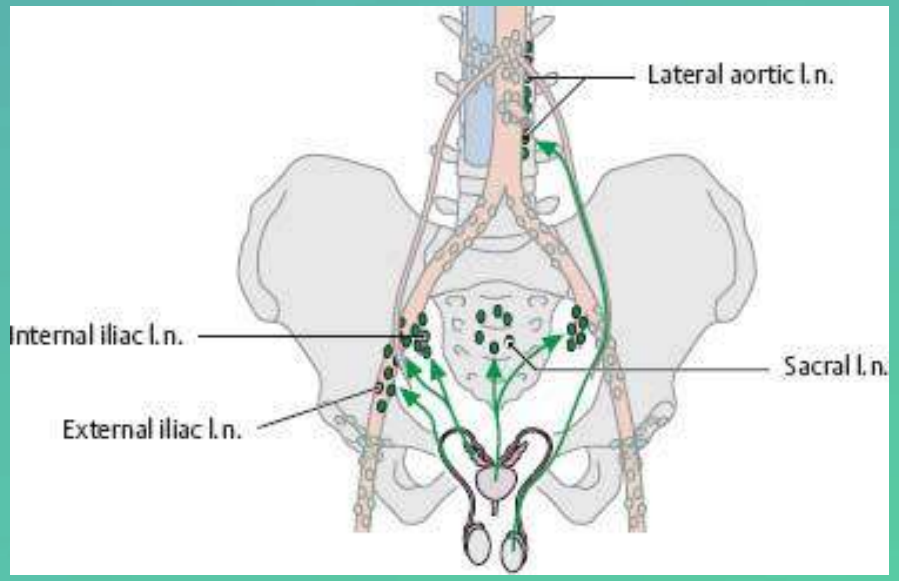
GENITOURINARY ONCOLOGY-RELATED LYMPHEDEMA (GORL)

ANATOMY

INCIDENCE

RISK FACTORS





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GENITOURINARY ONCOLOGY-RELATED LYMPHEDEMA

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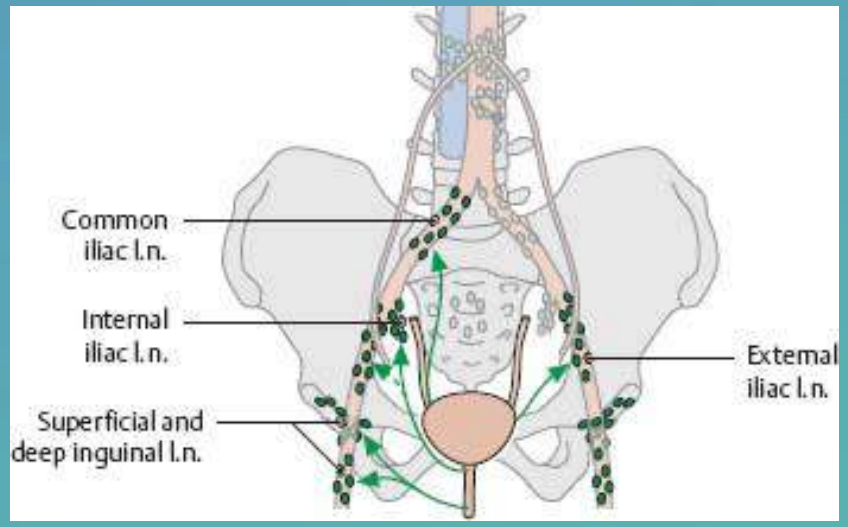
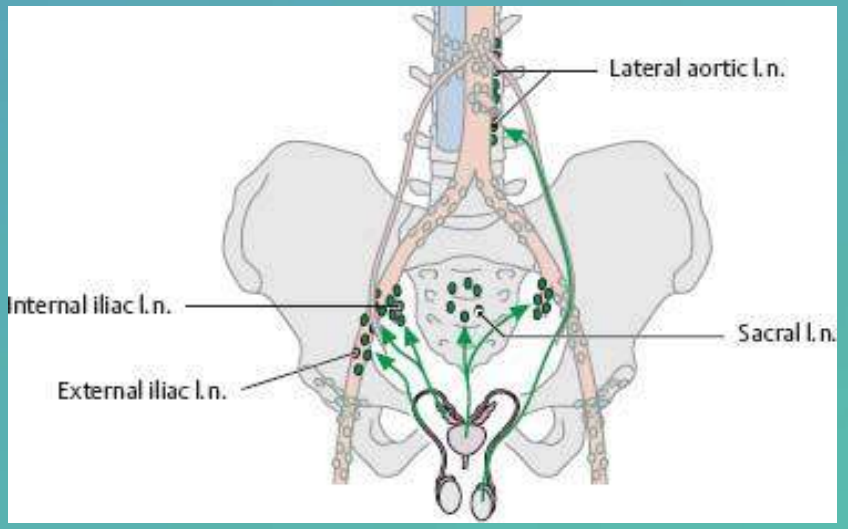




INCIDENCE

Prostate cancer 4%
Bladder cancer 16%
Penile cancer 20% (up to 70%!)

RISK FACTORS

Radical cystectomy,
Bilateral pelvic lymphadenectomy,
Adjuvant RT

Okeke AA, Bates DO, Gillatt DA. Lymphoedema in urological cancer. Eur Urol. 2004 Jan;45(1):18-25. doi: 10.1016/j.eururo.2003.08.010. PMID: 14667510.

DIAGNOSIS

MEDICAL HISTORY & CLINICAL EXAM

Differential diagnosis

LIMB CIRCUMFERENCE ASSESSMENT

LEL index

INSTRUMENTAL IMAGING

Rest/stress Lymphoscintigraphy
ICG lymphography
Doppler ultrasound
Lympho-MRI

DIFFERENTIAL DIAGNOSIS – LOWER LIMB SWELLING

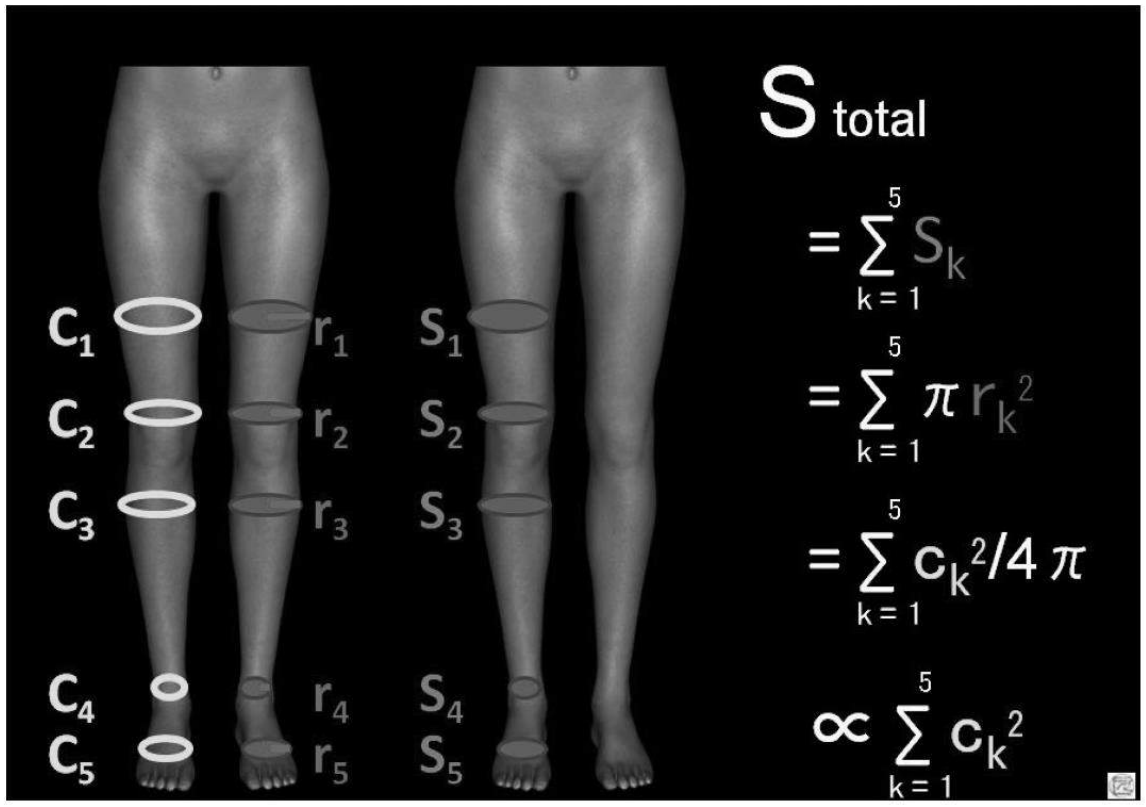
- **Site of swelling** → unilateral or bilateral
- **Symmetry** → symmetric or asymmetric
- **Variations** → changes that occur with its severity with position and time of day
- **Associated symptoms** → aching, pain, heaviness, fatique, brusies
- **Timing of onset** → acute vs chronic
- **Skin changes**
- **Foot involvement** → spared in lipedema
- **Complete history and comorbidities** → venous disorders (varicose veins, VTE, prior events, coagulation panel), trauma, prolonged bedrest, malignancy, radiation therapy
- **Family history**
- **Surgical history** → lower limb surgery (joint arthroplasty, arterial interventions, vein harvesting), abdominal or pelvic surgery
- Medications → anti-hypertensive drugs

Unilateral		Bilateral	
Recent[a]	Chronic[b]	Recent[a]	Chronic[b]
Unilateral DVT	Primary venous disease	Bilateral DVT	Chronic venous disease/ post-thrombotic syndrome
Ruptured Baker's cyst	Post-thrombotic syndrome	Acute heart failure	Pulmonary hypertension
Ruptured leg muscle	Iliac vein compression	Acute renal/liver failure	Heart/renal/liver failure
Compartment syndrome	Lymphedema	IVC thrombosis	Idiopathic edema
Intramuscular hematoma	Vascular malformation	IVC tumors	Chronic IVC occlusion, IVC aplasia/hypoplasia
Infection	Reflux sympathetic dystrophy	Drugs	Drugs (see Table 2)
Superficial vein thrombosis	Mass/tumor[c]	Bilateral infections	Lymphedema
Mass/tumor[c]	Venous advential cystic disease		Lipedema
Fracture	Infection		Pregnancy, premenstrual edema
Sprain/strain	Static foot disorders		Obesity
Insect/animal bites	Radiation		Malabsorption syndrome, hypoalbunemia
	Atrophy/hypertrophy		Spinal cord injury/immobility
	Overgrowth syndromes		Static foot disorders
			Thyroid disease
			Obstructive sleep apnea

Gasparis AP, Kim PS, Dean SM, Khilnani NM, Labropoulos N. Diagnostic approach to lower limb edema. Phlebology. 2020 Oct;35(9):650-655. doi: 10.1177/0268355520938283. Epub 2020 Jul 6. PMID: 32631171; PMCID: PMC7536506.

LOWER LIMB CIRCUMFERENCE ASSESSMENT

Lower Extremity Lymphedema (LEL) Index → the sum of the squares of the circumference in 5 areas of a lower extremity and dividing it by BMI.
The index correlates well with the conventional clinical stages and can be useful in determining the severity of a condition or efficacy of treatment, enabling evaluation regardless of the body type by means of absolute values.



$$\text{LEL index} = \sum_{k=1}^{5} c_k^2 / \text{BMI}$$

Lower extremity circumference measurements:

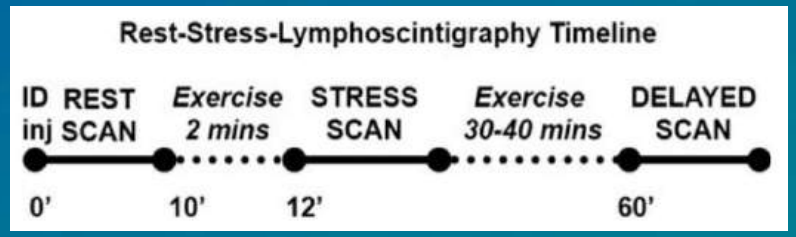
1. superior edge of the patella
2. 10-cm above the patella
3. lateral malleolus
4. 10-cm below the patella
5. dorsum of the foot

TABLE 3. LEL Index and LEL Stage

LEL Stage	LEL Index
Stage I	−250
Stage II	250–300
Stage III	300–350
Stage IV	350

Yamamoto T, Matsuda N, Todokoro T, Yoshimatsu H, Narushima M, Mihara M, Uchida G, Koshima I. Lower extremity lymphedema index: a simple method for severity evaluation of lower extremity lymphedema. Ann Plast Surg. 2011 Dec;67(6):637-40. doi: 10.1097/SAP.0b013e318208fd75. PMID: 21407058.

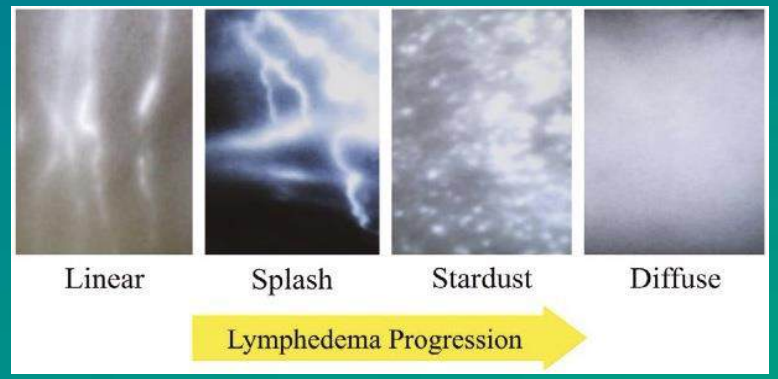
Rest Stress Lymphoscintigraphy



- **Rest** scan after tracer injection
- (99mTc-HSA-nanocolloidal)
- **Stress** scans after stepping for 2 mins
- **Late** scans at 60 mins after walking
- Lymphoscintigraphy gives **TI**

ICG Lymphography

Dermal Backflow staging



Linear → normal collectors
Splash → compensatory collaterals,
Stardust → collaterals and precollectors at their outlet in the dermal plexus,
Diffuse → capillary dermal blackflow predominate

INDOCYANINE GREEN LYMPHOGRAPHY FINDINGS IN PRIMARY LEG LYMPHEDEMA

Proximal Dermal Backflow Pattern

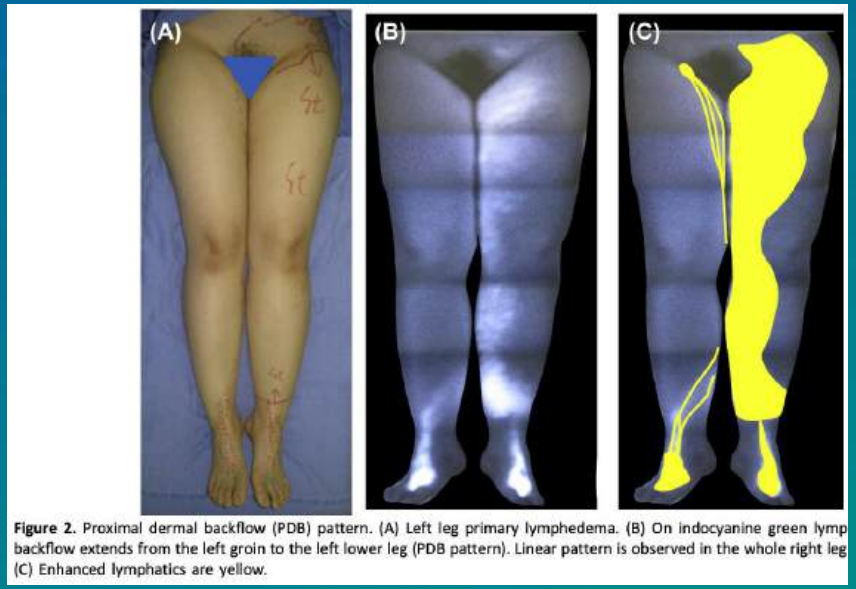


Figure 2. Proximal dermal backflow (PDB) pattern. (A) Left leg primary lymphedema. (B) On indocyanine green lymp backflow extends from the left groin to the left lower leg (PDB pattern). Linear pattern is observed in the whole right leg (C) Enhanced lymphatics are yellow.

Less Enhancement Pattern

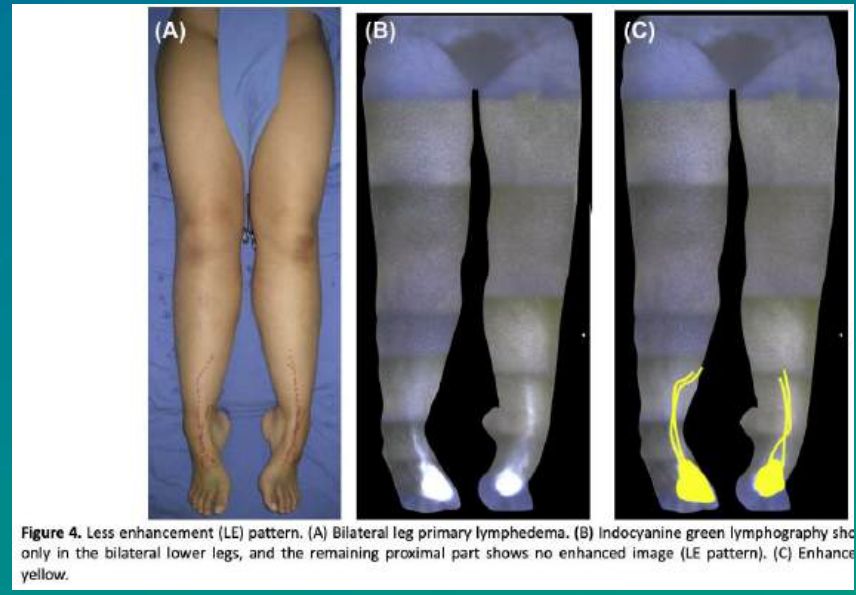


Figure 4. Less enhancement (LE) pattern. (A) Bilateral leg primary lymphedema. (B) Indocyanine green lymphography sho only in the bilateral lower legs, and the remaining proximal part shows no enhanced image (LE pattern). (C) Enhance yellow.

Distal Dermal Backflow Pattern

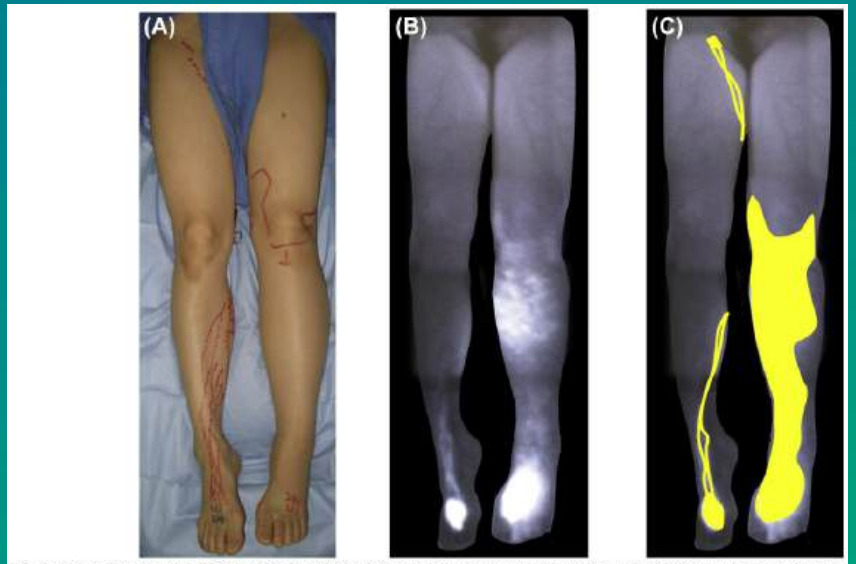


Figure 3. Distal dermal backflow (DDB) pattern. (A) Left leg primary lymphedema. (B) On indocyanine green lymp backflow pattern is observed distal to the left knee (DDB pattern). Linear pattern is observed in the whole right leg (no Enhanced lymphatics are yellow.

No Enhancement Pattern

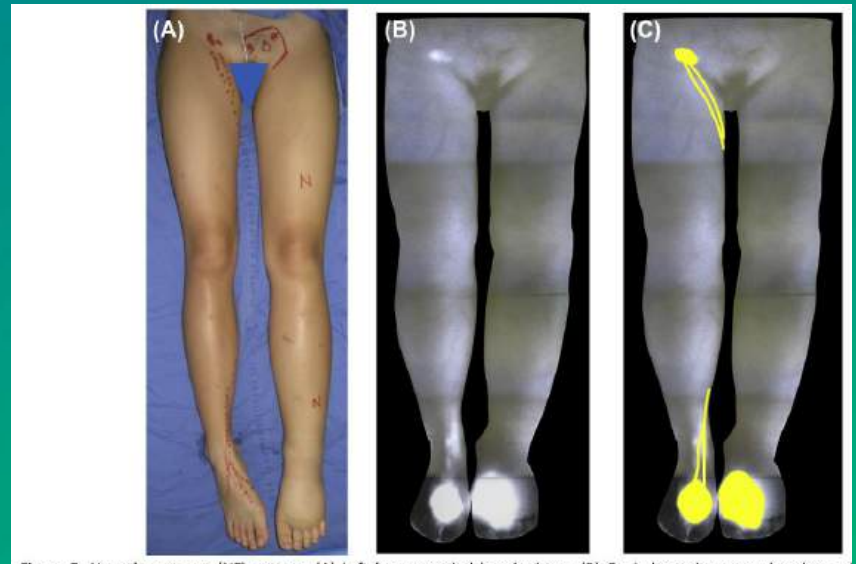


Figure 5. No enhancement (NE) pattern. (A) Left leg congenital lymphedema. (B) On indocyanine green lymphograp lymphatic image is observed in the left leg other than the dorsum of the left foot where indocyanine green was inject Linear pattern is observed in the whole right leg (normal pattern). (C) Enhanced lymphatics are yellow.

Yamamoto T, Yoshimatsu H, Narushima M, Yamamoto N, Hayashi A, Koshima I. Indocyanine Green Lymphography Findings in Primary Leg Lymphedema. Eur J Vasc Endovasc Surg. 2015 Jan;49(1):95-102. doi: 10.1016/j.ejvs.2014.10.023. PMID: 25488514.

VASCULAR LYMPH NODE TRANSFER

INDICATIONS

HISTORY

EFFICACY

FLAP PHYSIOLOGY

VASCULAR LYMPH NODE TRANSFER

1949, Kazanjian and Converse → supraclavicular
1982, Claudius → Groin flap
1991, Trevidic and Cornier → Lateral thoracic

HISTORY

Table 1. Summary of Experimental Studies on Lymph Node Transfer

Study	Species	Lymphedema Model	Transferred Tissue	Vascularized?	Successful Take?
Jaffe and Richter, 1928[4]	Guinea pigs	Acute	Intact LN	No	No
	Rats	Acute	Intact LN	No	Yes
Didukh, 1967[5]	Mice	Acute	Intact LN	No	Yes
Pabst and Rothkötter, 1988[6]	Minipigs	Acute	LN fragments	No	Yes
Blum et al., 2007[7]	Minipigs	Acute	LN fragments	No	Yes
Fu et al., 1998[8]	Rabbits	Acute	LN fragments	No	Yes
Blum et al., 2010[9]	Minipigs	Acute	LN fragments	No	Yes
Tilak and Howard, 1965[10]	Frogs	Acute	LN fragments	No	No
			Intact LN	Yes	Yes
Shesol et al., 1979[11]	Rats	Acute	LN flap	No	No
			LN flap	Yes	Yes
Chen et al., 1990[12]	Dogs	Chronic	LN flap	Yes	Yes
Tobbia et al., 2009[13]	Sheep	Acute	Intact LN	No	*
			LN flap	Yes	Yes
Tammela et al., 2007[14]	Mice	Acute	LN fragments	No	Yes
Lähteenvuo et al., 2011[15]	Pigs	Acute	Intact LN	Yes	Yes
Aschen et al., 2014[16]	Mice	Acute	Intact LN	No	Yes
Joseph et al., 2014[17]	Mice	Acute	Intact LN	No	Yes

VASCULAR LYMPH NODE TRANSFER

INDICATIONS

HISTORY

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FLAP PHYSIOLOGY

VASCULAR LYMPH NODE TRANSFER

INDICATIONS

- Resistance to convervative treatment
- History of recurrent lymphangitis
- Advanced disease
- Transport Index > 30
- ICG lymphgraphy (stardust, diffuse pattern)

Table 2. Summary of Study Methodologies of Published Clinical Series on Vascularized Lymph Node Transfer

Study	No. of Patients	Lymphedema Severity	Postoperative Physiotherapy	Outcome Measures	Follow-Up (Mean)	Study Design	Level of Evidence
Becker et al., 2006[3]	24	3 mo–15 yr duration, treatment resistant, excluding elephantiasis	Daily for 3 mo then biweekly for 3 mo	Rate of cellulitis, limb circumference, qualitative LS	5–11 yr (8.3 yr)	Retrospective	IV
Lin et al., 2009[30]	13	4–84 mo duration	No comment	Subjective patient survey, limb circumference, qualitative LS	6–96 mo (56.3)	Prospective	IV
Gharb et al., 2011[31]	21	Early stage II (ISL)*, resistant to at least 6 mo of conservative therapy	No comment	Subjective patient survey, rate of cellulitis, limb circumference	Standard group: 26–120 mo (46 mo) Hilar group: 38–50 mo (40 mo)	Retrospective	IV
Cheng et al., 2012[32]	7	36–120 mo duration, stage II and III (ISL)*, treatment resistant	Not routinely used	Subjective patient survey, rate of cellulitis, limb Circumference,	2–22 mo (8.7 mo)	Prospective	IV
Saaristo et al., 2012[25]	9	6–120 mo duration, excluding longstanding severe edema	Three times per week for 1 mo then twice weekly for 2 mo	Limb circumference, quantitative LS	8–24 mo	Prospective	IV
Cheng et al.. 2013[33]	10	12–84 mo duration, stage II (ISL)*	Nil	Subjective patient survey, rate of cellulitis, limb circumference	39.1 ± 15.7 mo	Prospective controlled	III

VASCULAR LYMPH NODE TRANSFER

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VASCULAR LYMPH NODE TRANSFER

LYMPHATIC BRIDGING

LYMPHATIC PUMP

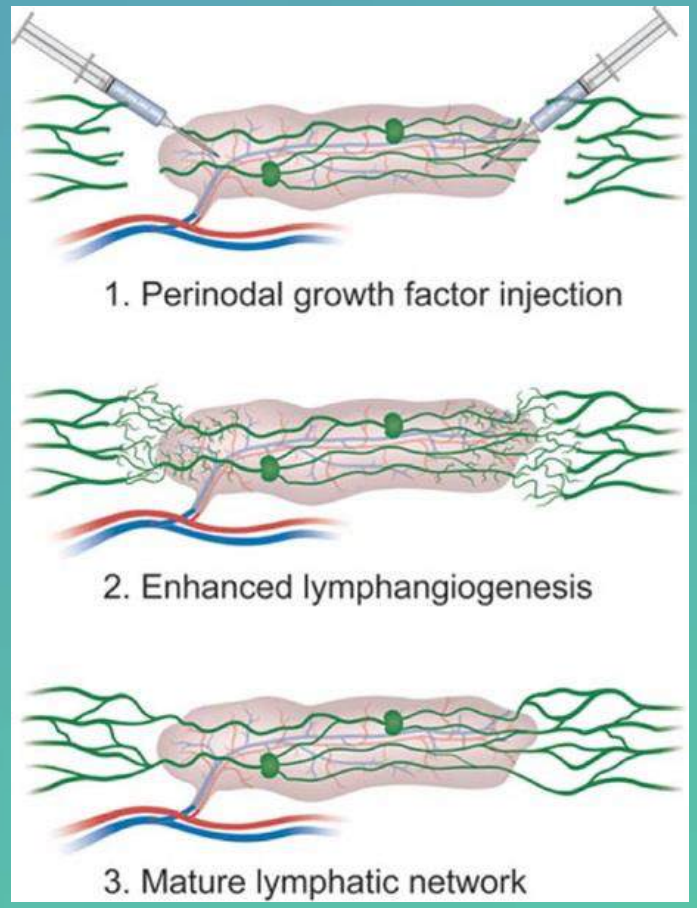
LYMPHATIC HOMING

FLAP PHYSIOLOGY

LYMPHATIC BRIDGE OR "WICK" THEORY

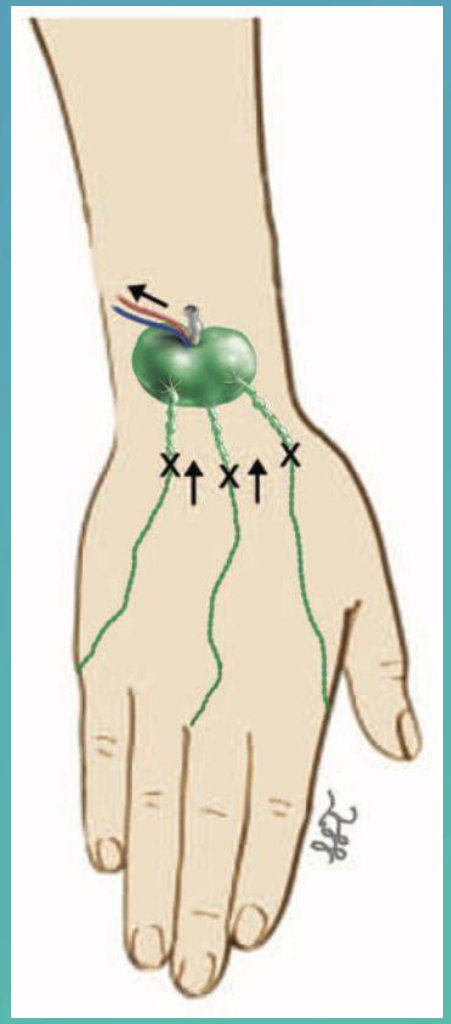
Honkonen, 2013

Lymphangiogenesis with new lymphatic collateral pathways connecting with **adjacent lymph nodes** to **restore outflow**, mediated by lymphatic growth factor secretion from the transplanted lymph nodes, in particular **vascular endothelial growth factor C (VEGF-C)**



Honkonen KM, Visuri MT, Tervala TV, Halonen PJ, Koivisto M, Lähteenvuo MT, Alitalo KK, Ylä-Herttuala S, Saaristo AM. Lymph node transfer and perinodal lymphatic growth factor treatment for lymphedema. Ann Surg. 2013 May;257(5):961-7. doi: 10.1097/SLA.0b013e31826ed043. PMID: 23013803.

LYMPHATIC PUMP



Lin & Chen, 2009

Neo-lymphangiogenesis establishing **new lymphatico-venous drainage** within the transplanted lymph nodes, with the **“pumping” mechanism** driven by **perfusion gradients** between arterial inflow and venous outflow.

Lin CH, Ali R, Chen SC, Wallace C, Chang YC, Chen HC, Cheng MH. Vascularized groin lymph node transfer using the wrist as a recipient site for management of postmastectomy upper extremity lymphedema. Plast Reconstr Surg. 2009 Apr;123(4):1265-1275. doi: 10.1097/PRS.0b013e31819e6529. PMID: 19337095.

LYMPHATIC HOMING

Suami, 2016

Lymphatic homing mechanism allows the severed lymphatic vessels to connect to adjacent LN at the time of LN clearance (i.e. collateral lymphatic pathway forms connections to contralateral LN).
With the same homing mechanism, **VLNT may create new collateral pathways** (i.e. new connection to the internal mammary LN via the transferred LN in the axilla for ULL) **instead of bridging the original pathway → VLNT as biological beacon?**

Histological examination:

- Control inguinal lymph node → **lymphoid follicles with germinal centers** in the outer cortex and a **medullary cord** in the medulla.
- Transferred inguinal node → **diffuse vacuolar degeneration** in both the cortex and the medulla

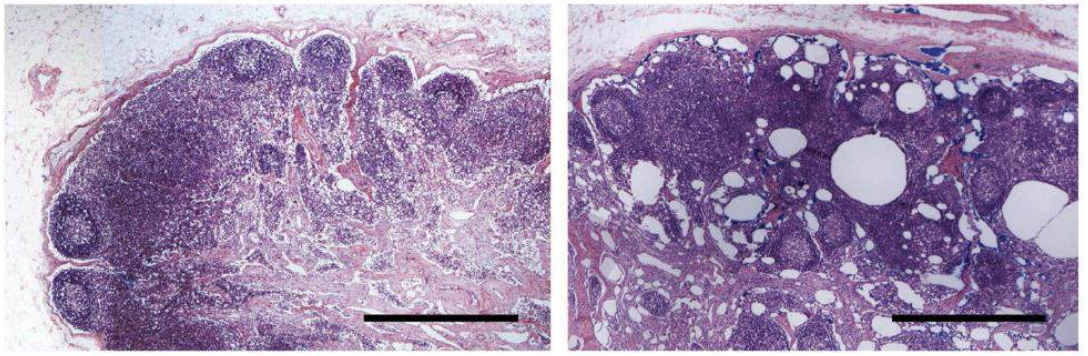


Fig. 9.
Hematoxylin- and eosin-stained images of inguinal lymph nodes in canine A. An inguinal node from the control is shown on the left, and the transferred node in the axilla is shown on the right. Diffuse vacuolar degeneration can be seen in the transferred node. Scale bars, 5 mm.

Suami H, Scaglioni MF, Dixon KA, Tailor RC. Interaction between vascularized lymph node transfer and recipient lymphatics after lymph node dissection-a pilot study in a canine model. J Surg Res. 2016 Aug;204(2):418-427. doi: 10.1016/j.jss.2016.05.029. Epub 2016 May 26. PMID: 27565078; PMCID: PMC5002893.

VASCULAR LYMPH NODE TRANSFER

INDICATIONS

HISTORY

EFFICACY

FLAP PHYSIOLOGY

VASCULAR LYMPH NODE TRANSFER

PRIMARY vs SECONDARY

OPEN

PRS GLOBAL OPEN ORIGINAL ARTICLE

Outcomes
and Lymph
of Primary

LYMPH NODE FLAP TRANSFER FOR PATIENTS WITH SECONDARY LOWER LIMB LYMPHEDEMA

BERNARDO N. BATISTA, M.D.,[1,2*] MICHEL GERMAIN, M.D., Ph.D.,[3] JOSÉ CARLOS M. FARIA, M.D., Ph.D.,[1,2] and CORINNE BECKER, M.D.[3]

Vascularized Lymph Node Transfer From Thoracodorsal Axis for Congenital and

N, DNB,

adu, India

EFFICACY

Received: 15 March 2021 |
DOI: 10.1002/micr.30855

CLINICAL ARTIC

Combined l
in lymphede

Alberto Bolletta M
Luigi Losco MD[1,2]
Diego Ribuffo MD

ALONE vs IN COMBINATION

NON SURGICAL

SURGICAL

1. *Exicsional procedures*
2. *Suction-assisted lipectomy*
3. *LVA*
4. *Pre-fabricated LVA*

Received: 17 February 2017 | Revised: 17 July 2017 | Accepted: 25 August 2017
DOI: 10.1002/micr.30234

MDPI

CLINICAL ARTICLE

WILEY MICROSURGERY

al
Clinical
rm

Improvement of the efficacy of vascularized lymph node transfer for lower-extremity lymphedema via a prefabricated lympho-venous shunt through lymphaticovenular anastomosis between the efferent lymphatic vessel and small vein in the elevated vascularized lymph node

Shinsuke Akita, MD, PhD[1] | Yoshihisa Yamaji, MD[1] |
Hideki Tokumoto, MD, PhD[2] | Yoshitaro Sasahara, MD[1] |
Yoshitaka Kubota, MD, PhD[1] | Motone Kuriyama, MD, PhD[3] |
Nobuyuki Mitsukawa, MD, PhD[1]

ylor & Francis

Check for updates

VASCULAR LYMPH NODE TRANSFER

VLNT DONOR SITES

VLNT RECIPIENT SITES

VASCULAR LYMPH NODE TRANSFER

VLNT DONOR SITES

VLNT DONOR SITES

- SUPRACLAVICULAR FLAP
- LATERAL THORACIC FLAP
- GROIN FLAP

VASCULAR LYMPH NODE TRANSFER

VLNT DONOR SITES

VLNT RECIPIENT SITES

VLNT RECIPIENT SITES

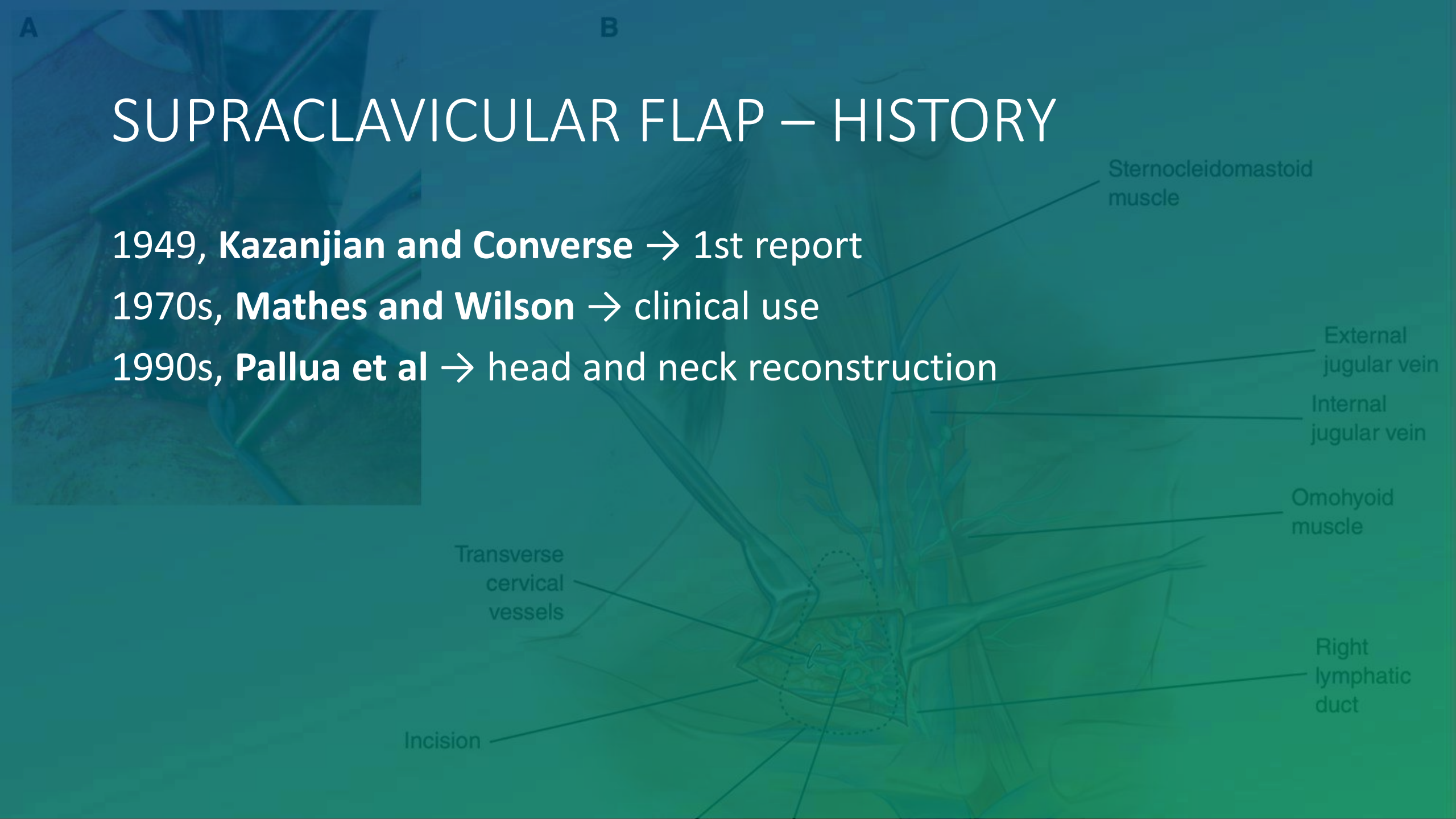
- *GROIN*
- *KNEE*
- *ANKLE*

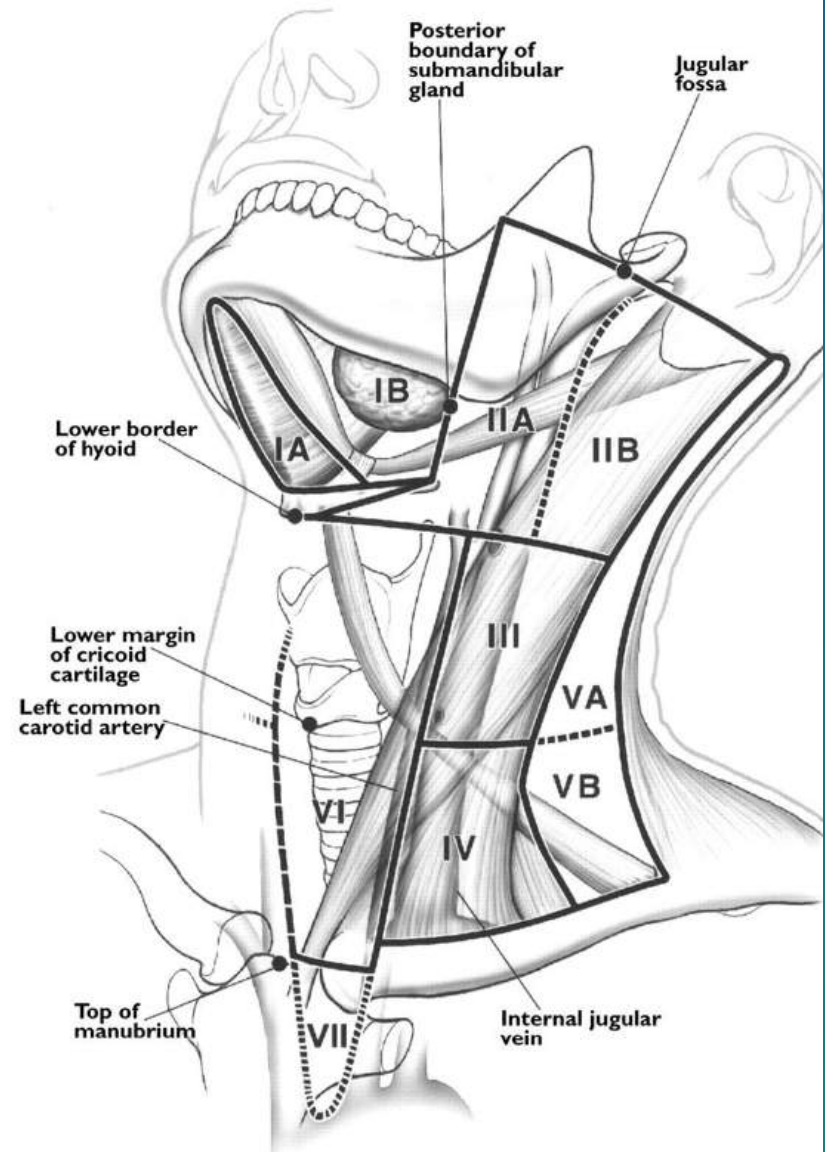
SUPRACLAVICULAR FLAP – HISTORY

1949, **Kazanjian and Converse** → 1st report

1970s, **Mathes and Wilson** → clinical use

1990s, **Pallua et al** → head and neck reconstruction





SUPRACLAVICULAR FLAP ANATOMY

Supraclavicular artery (1.0–1.5 mm) → 3–4 cm from the **transverse cervical artery**

- triangle between the **dorsal edge of the sternocleidomastoid muscle**, the **external jugular vein**, and the **medial part of the clavicle**

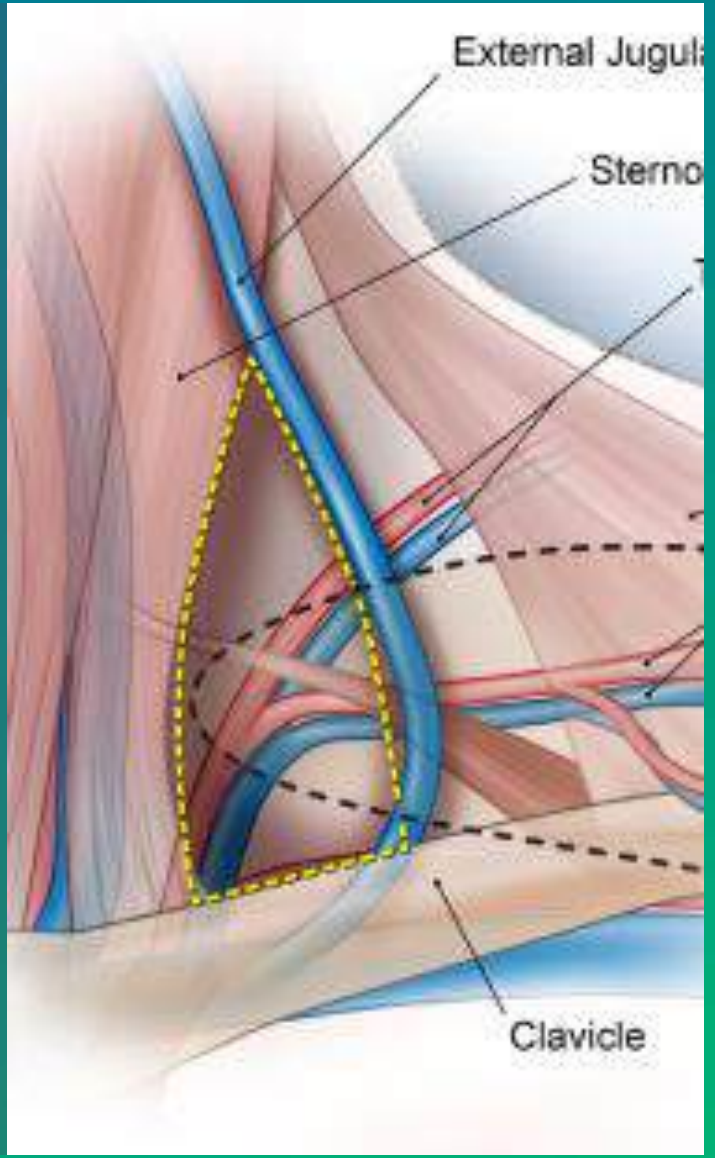
Supraclavicular vein (1.0–1.5 mm) → drain into the **transverse cervical vein**

Innervation → **cervical nerves** (C3–C4)

Free lymph node transfer wio skin component → branches of transverse cervical artery and vein

Lymphatic drainage → **level Vb level**

Efferent lymphatics → typically 2–3, form the SC trunk



SUPRACLAVICULAR FLAP – FLAP HARVESTING

TRADITIONAL EN-BLOC HARVEST

COMPARTIMENTAL HARVESTING

SUPRACLAVICULAR FLAP – FLAP HARVESTING

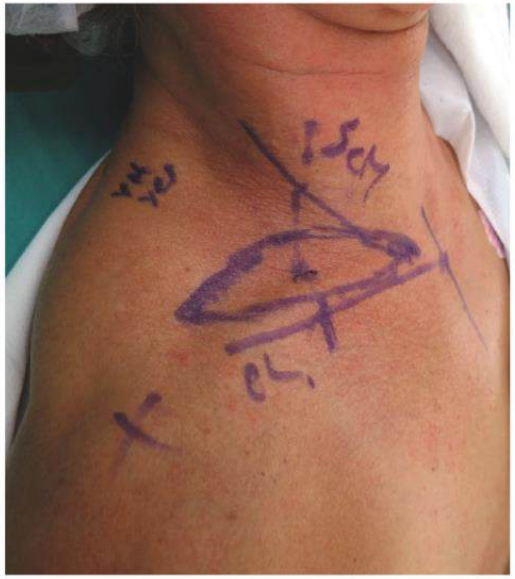
TRADITIONAL EN-BLOC HARVEST

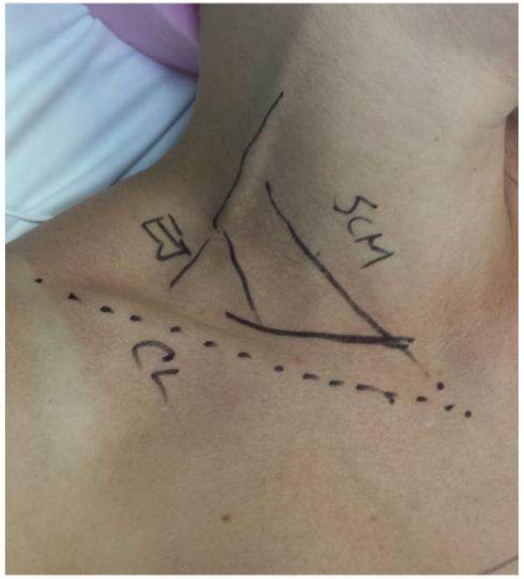
Effective lymph nodes → single LNF
Iatrogenic lymphedema risk → low
Complications → hypo/anesthesia, spinal or phrenic nerve injury, donor site lymphedema; (right side only)
Donor site cosmesis → contour deformity

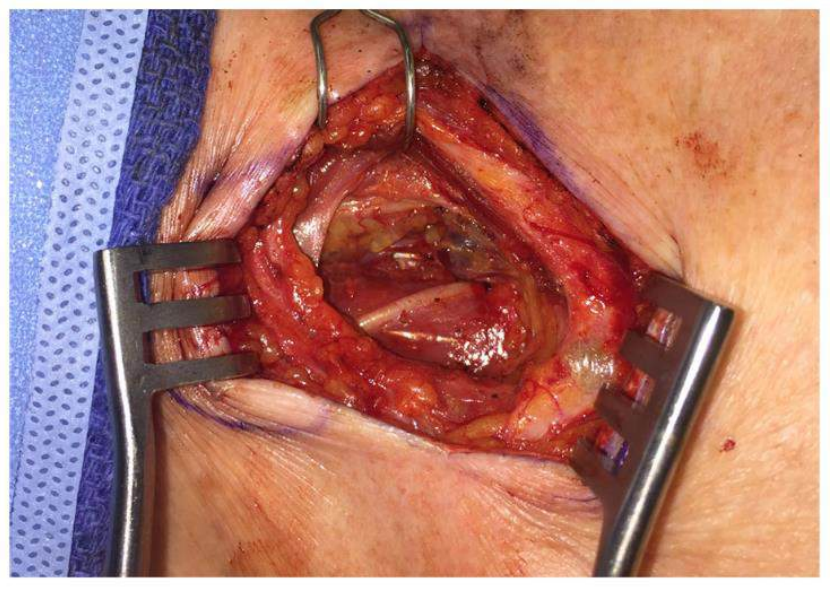
SUPRACLAVICULAR FLAP – FLAP HARVESTING

TRADITIONAL EN-BLOC HARVEST

Effective lymph nodes → single LNF
Iatrogenic lymphedema risk → low
Complications → hypo/anesthesia, spinal or phrenic nerve injury, donor site lymphedema; (right side only)
Donor site → contour deformity







Maldonado 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 Jan;115(1):68-71. doi: 10.1002/jso.24351. Epub 2016 Jul 22. Erratum in: J Surg Oncol. 2018 Sep;118(4):721. PMID: 27449974.

SUPRACLAVICULAR FLAP – FLAP HARVESTING

TRADITIONAL EN-BLOC HARVEST

COMPARTIMENTAL HARVESTING

SUPRACLAVICULAR FLAP – FLAP HARVESTING

COMPARTIMENTAL HARVESTING

Effective lymph nodes → double LNF
Iatrogenic lymphedema risk → very low (reverse mapping)
Complications → spinal or phrenic nerve injury, lymphorrea, donor site lymphedema (right side only)
Donor site → contour deformity

SUPRACLAVICULAR FLAP – FLAP HARVESTING

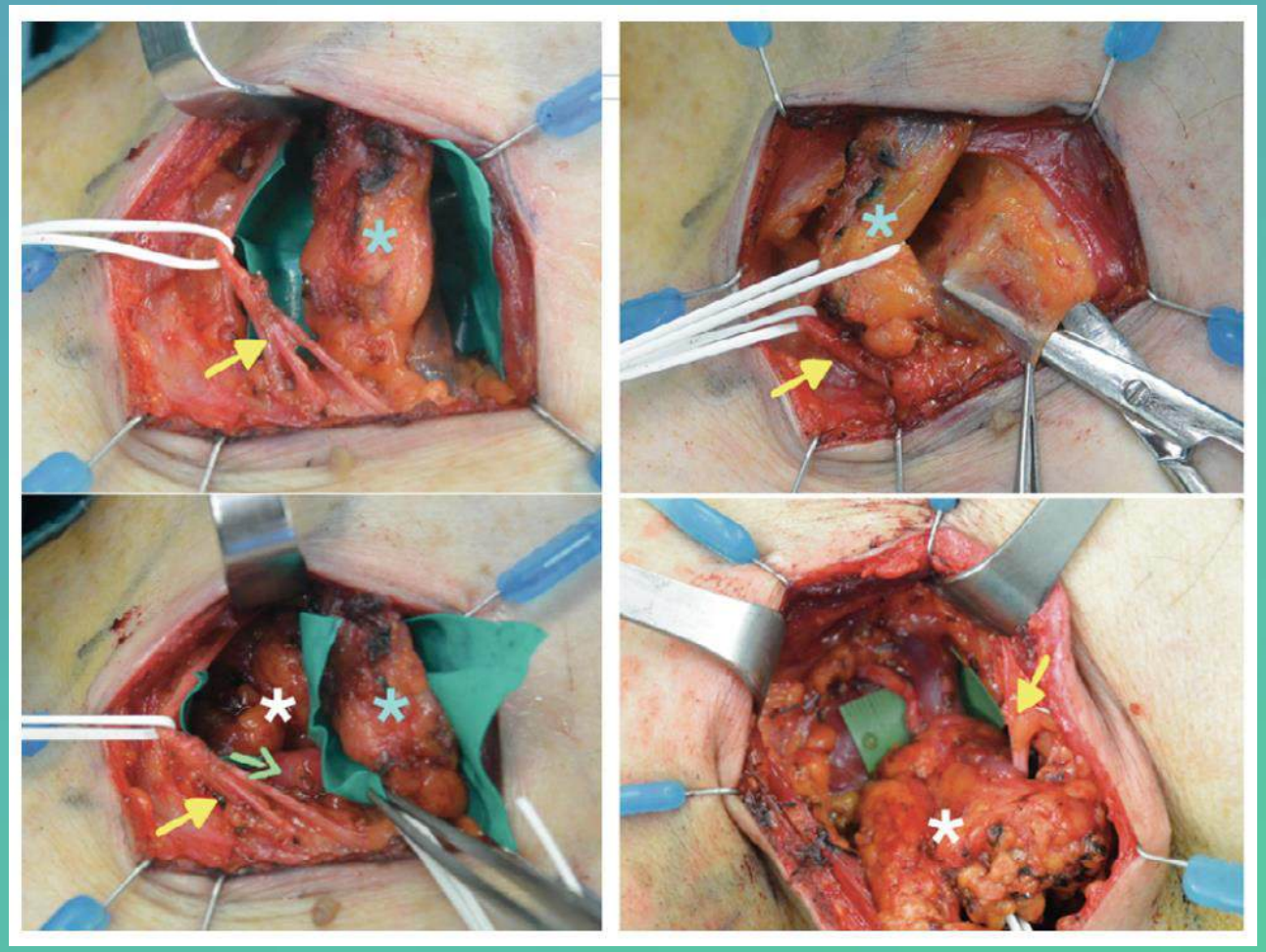
COMPARTIMENTAL HARVESTING

FIGURE 1
LIGHT BLUE * venous EJV-based LNF – superficial compartment
YELLOW ARROW → spared supraclavicular nerves

FIGURE 2
middle cervical fascia – *spread scissors below it*

FIGURE 3
LIGHT BLUE * superficial (venous EJV LNF flap)*
WHITE * deep (TCA/V LNF)
YELLOW ARROW → supraclavicular nerves
GREEN ARROW → omohyoid muscle

FIGURE 4
WHITE * deep compartment TCA/V LNF with TCA and TCV dissected on top of the anterior scalene muscle
YELLOW ARROW → supraclavicular nerves



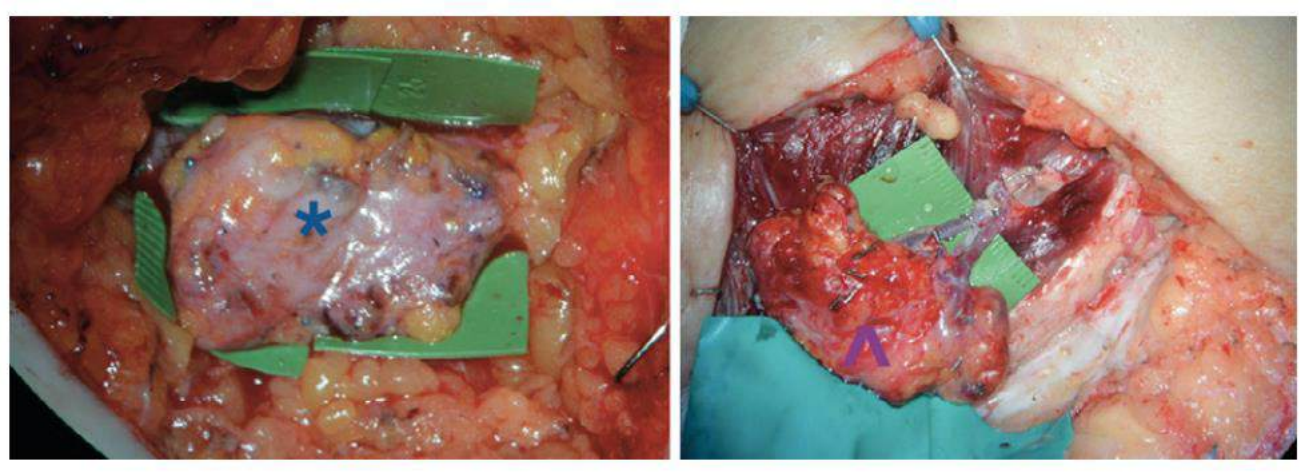
Visconti G, Tartaglione G, Bartoletti R, Salgarello M. Compartimental harvesting of dual lymph node flap from the right supraclavicular area for the treatment of lower extremity lymphedema: A case series. J Plast Reconstr Aesthet Surg. 2019 Feb;72(2):211-215. doi: 10.1016/j.bjps.2018.10.010. Epub 2018 Nov 19. PMID: 30503371.

SUPRACLAVICULAR FLAP – FLAP HARVESTING

COMPARTIMENTAL HARVESTING

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**



Visconti G, Tartaglione G, Bartoletti R, Salgarello M. Compartimental harvesting of dual lymph node flap from the right supraclavicular area for the treatment of lower extremity lymphedema: A case series. J Plast Reconstr Aesthet Surg. 2019 Feb;72(2):211-215. doi: 10.1016/j.bjps.2018.10.010. Epub 2018 Nov 19. PMID: 30503371.

SUPRACLAVICULAR FLAP – PROS & CONS

PROS

Well-hidden scar
No increased risk of iatrogenic lymphedema
Flap dimensions and size are considerably smaller

CONS

Significant vascular anatomic variability
- thyrocervical trunk (80%)
- subclavian artery (20%)
- Other (IMA)

Meticulous dissection
Skin paddle → poor flap monitoring

SUPRACLAVICULAR FLAP – OUTCOMES ???

Comparison of vascularized supraclavicular lymph node transfer and lymphaticovenular anastomosis for advanced stage lower extremity lymphedema (Akita et al, 2015)

→ ***Advanced stage LEL***

The use of supraclavicular free flap with vascularized lymph node transfer for treatment of lymphedema: A prospective study of 100 consecutive cases (Maldonado et al, 2017)

→ *2 donor site infections*
no cases of secondary lymphedema,
well-healing scars,
satisfaction with the aesthetic result of the donor site by most patients.

Compartmental harvesting of dual lymph node flap from the right supraclavicular area for the treatment of lower extremity lymphedema: A case series (Visconti et al, 2018)

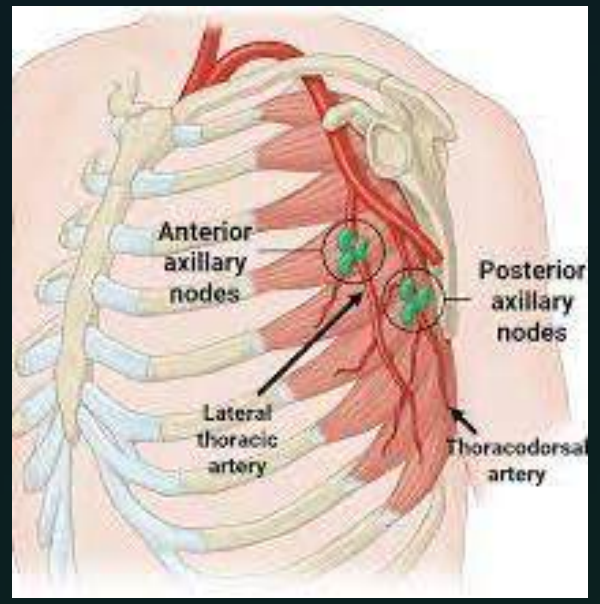
→ ***Supralavicular hybrid lymphatic flap***

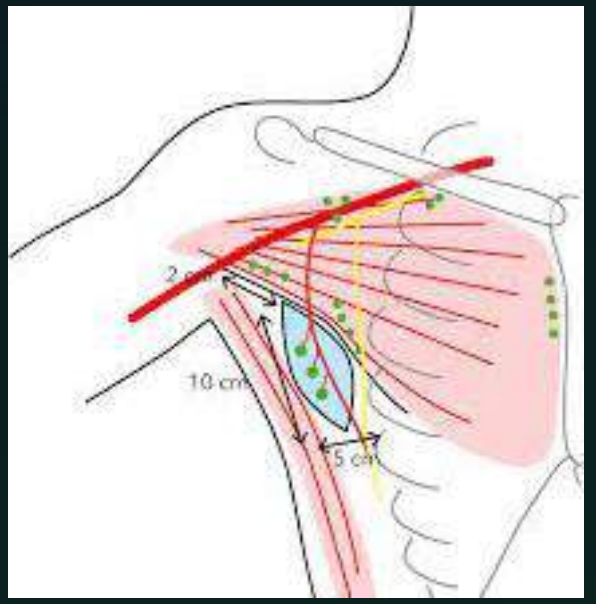
Preliminary outcomes of combined surgical approach for lower extremity lymphedema: supraclavicular lymph node transfer and lymphaticovenular anastomosis (Chung et al, 2022)

→ *stage II or III*

Additional LVAs could reinforce the effect of VLNT

LATERAL THORACIC FLAP – HISTORY





- 1978, Harii et al → The first free lateral thoracic fasciocutaneous head and neck, trunk, and extremities.
- 1991, Trevidic and Cormier → LT flap containing lymph nodes and used for the treatment of lymphedema
- 2014, Barriero et al → cadveric study (40 flaps) and in vivo (7 patients)

Harii K, Torii S, Sekiguchi J. The free lateral thoracic flap. Plast Reconstr Surg. 1978 Aug;62(2):212-22. doi: 10.1097/00006534-197808000-00009. PMID: 353844.

TrevidicP,CormierJ.Freeaxillarylymphnodeflap.Proceedingsofthe XIIIth International Congress of Lymphology Paris, France, September 29–October 5, 1991.

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 Jul;30(6):389-96. doi: 10.1055/s-0034-1372482. Epub 2014 Jun 13. PMID: 24926871.

LATERAL THORACIC FLAP – ANATOMY

The lateral thoracic lymph node flap → **lower part of the axilla between the anterior and posterior axillary lines**

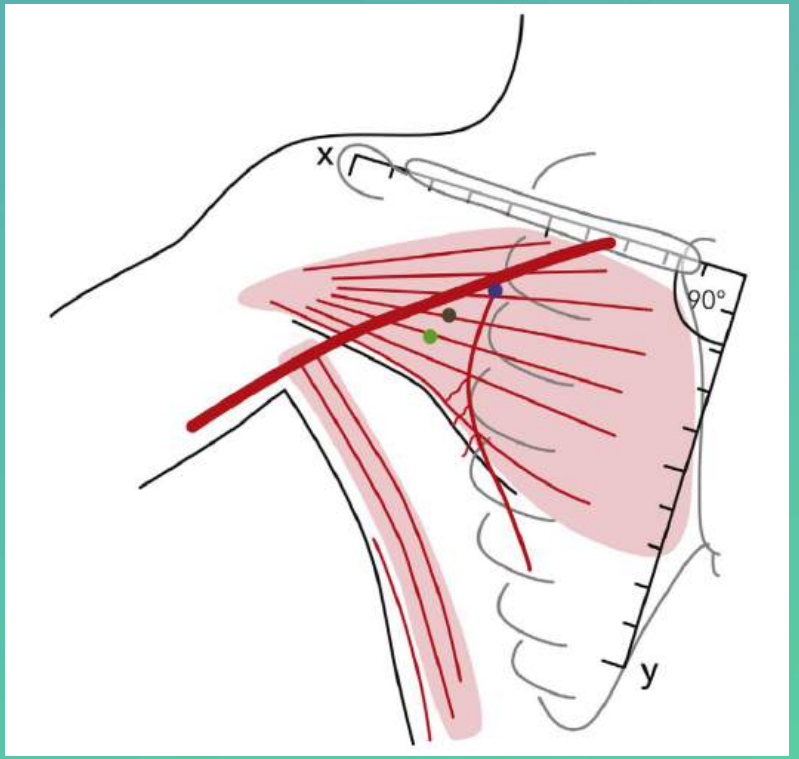
Anatomical studies:

- discrete organization of the sentinel lymph node drainage of the **thorax and upper extremity**, and this forms the basis of lymph node transfer from this region
- average of 13.4 +/- 3.13 **lymph nodes** within the flap
- Perforators to the overlying skin were present in 87.5%

The dominant vascular supply → **lateral thoracic artery and vein**

FREE and **PEDICLED** flaps

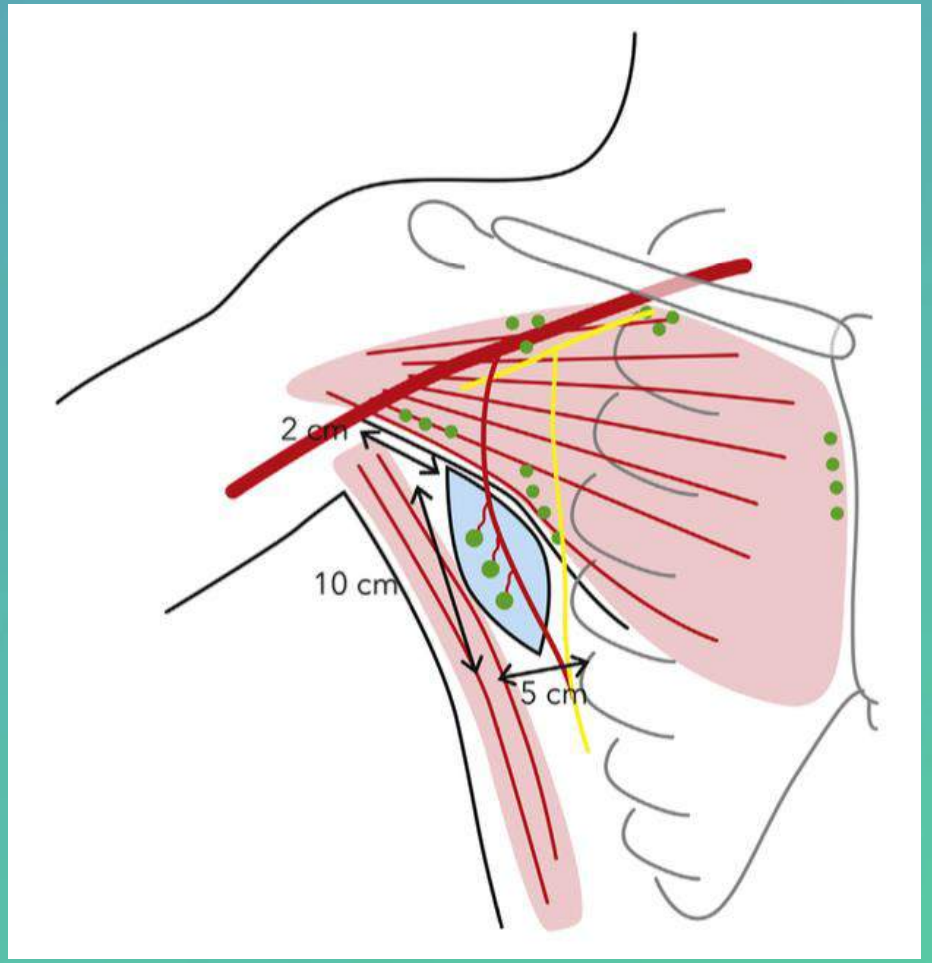
Anatomic variability → absent in 12.5% of sides (thoracodorsal, accessory lateral thoracic, or cutaneous branch from TD)



blue, location of the origin of the lateral thoracic artery;
brown, origin of the additional lateral thoracic artery;
green, origin of the thoracodorsal artery.

LATERAL THORACIC FLAP – FLAP HARVESTING

- **Flap markings** were made on the skin between the anterior and posterior axillary line in dimensions of 10 × 5 cm, flap's cranial position 2 cm below the point where the axillary neurovascular bundle traverse the pectoralis major muscle
- 10 cm vertical Incision along **anterior axillary line**, and dissection is performed in the **suprafascial plane** as far cephalad as the lateral border of the pectoralis minor and the second intercostal brachial nerve.
- Dissection of the pedicle is continued until sufficient arterial diameter is achieved
  - Arterial caliber 1.3 mm
  - venous caliber 2.6 mm
- Macroscopically visible LNs below the lower edge of the PM **muscle (level I)** surrounding the pedicle while sparing the cranially located lymph nodes (level II and III).



Tinhofer IE, Meng S, Steinbacher J, Roka-Palkovits J, Györi E, Reissig LF, Cheng MH, Weninger WJ, Tzou CH. The surgical anatomy of the vascularized lateral thoracic artery lymph node flap-A cadaver study. J Surg Oncol. 2017 Dec;116(8):1062-1068. doi: 10.1002/jso.24783. Epub 2017 Aug 7. PMID: 28782246.

LATERAL THORACIC FLAP – PROS & CONS

PROS

- **Inconspicuous scar**
- Relatively consistent anatomy
- Longer pedicle length
- Skin flap monitoring

CONS

- **Upper limb lymphedema**

Reverse lymphatic mapping is imperative!

LATERAL THORACIC FLAP – OUTCOMES

Lymph fasciocutaneous lateral thoracic artery flap: anatomical study and clinical use (Barriero et all, 2014)

Limited published clinical evidence is available.

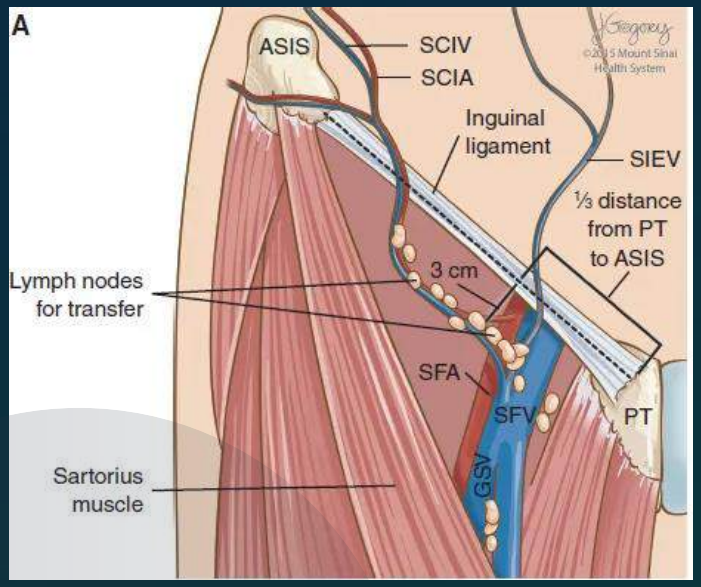
Of a series of seven patients, with good outcomes and functioning lymph nodes demonstrated on lymphoscintigraphy.

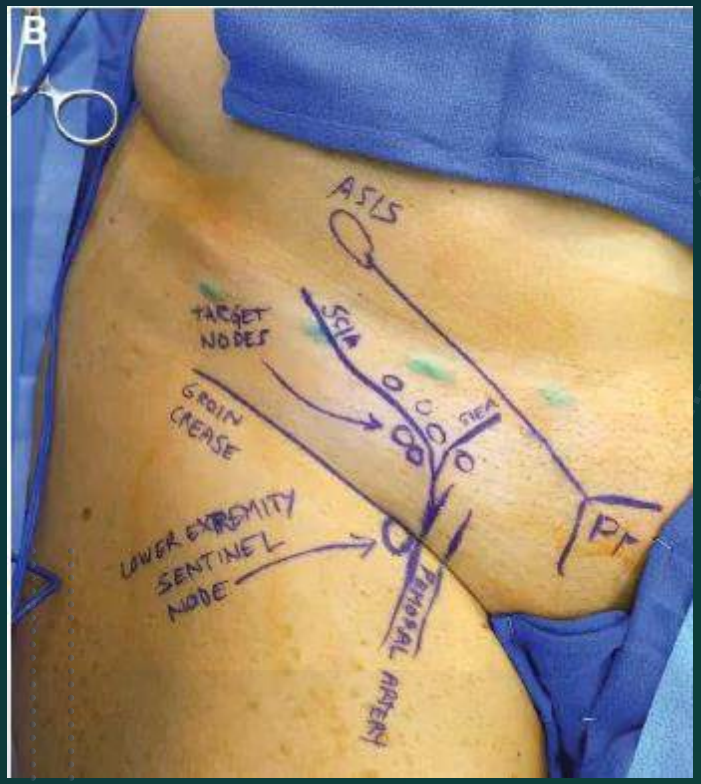
Further clinical reports are necessary to further establish the efficacy and safety of the lateral thoracic lymph node flap.

Table 1 Patients demographics and outcomes

Patient	Sex	Age	Disease	Recipient area	Flap size (cm)	Complication
1	F	56	Recurrent sarcoma	Right anterior shoulder	12 × 7	Prolonged flap edema
2	M	37	Lower limb lymphedema	Left foot dorsum	16 × 5	Prolonged donor site edema
3	F	20	Burn axillary contracture	Left axilla	10 × 5	None
4	M	48	Axillary hidradenitis	Left axilla	11 × 6	None
5	M	32	Burn axillary contracture	Right axilla	12 × 5	None
6	F	41	Axillary hidradenitis	Right axilla	10 × 6	None
7	M	54	Melanoma	Left anterior shoulder	9 × 9	Minor donor area dehiscence

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 Jul;30(6):389-96. doi: 10.1055/s-0034-1372482. Epub 2014 Jun 13. PMID: 24926871.





GROIN FLAP – HISTORY

- 1982, **Claudius** → first use of the groin VLN flap to treat lymphedema
- 1990, **Chen and O'Brien** → introducted groin VLNT to treat lymphedema in a canine model
- 2009, **Tobbia** → introducted groin VLNT to treat lymphedema in a sheep model

GROIN FLAP – ANATOMY

- In the groin region, the **anatomic boundaries** of the drainage patterns of the lower abdomen and the lower extremity are separated by distinct fascial boundaries.
- **Superficial lymph node basin** → drain the **lower abdomen** and is the target of the VLN harvest from this region
- **Deeper lymph node basins** → adjacent to the femoral vessels; drainage patterns from the **thigh and lower extremity**
- superficial lymph node → average of 3-4 nodes
- These nodes are flanked by the **superficial circumflex femoral and superficial inferior epigastric vessels** and can been found superficially located to the deep fascia of the thigh.
- Preservation of deeper lymphatics draining the lower extremity.

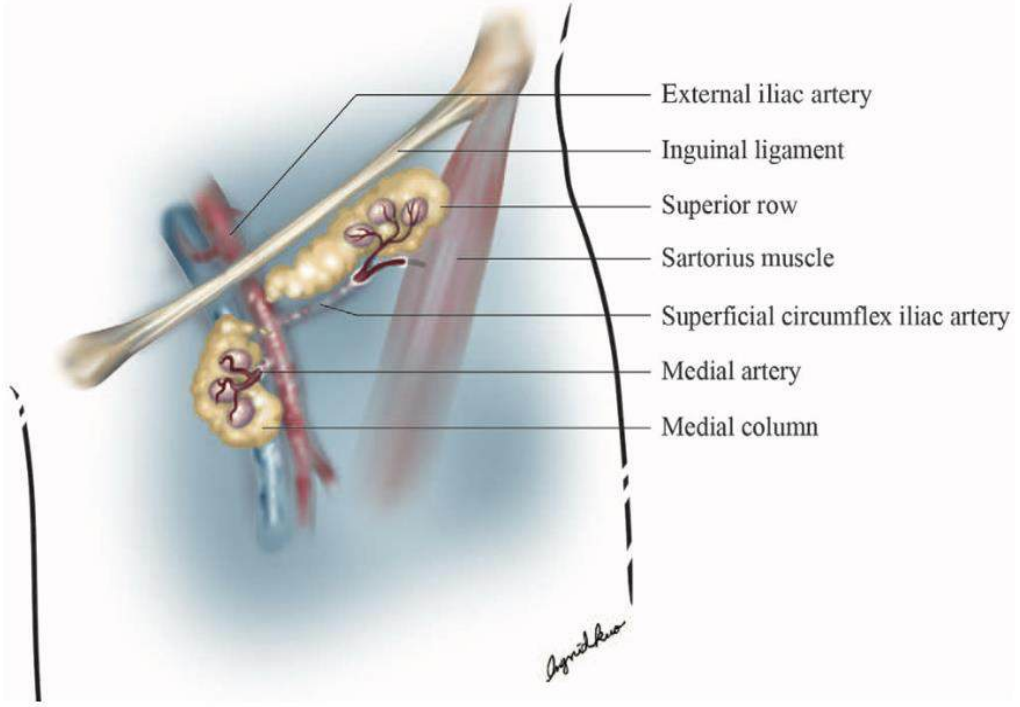
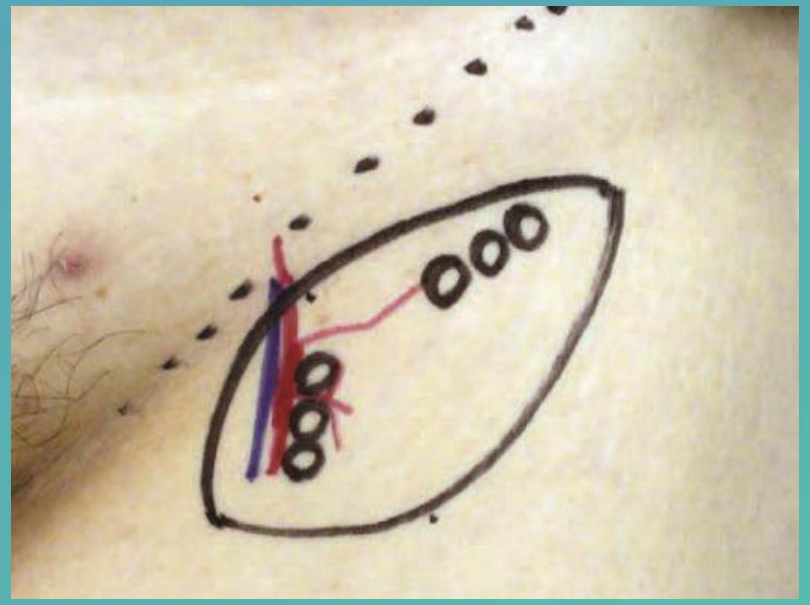


Fig. 2. A summary of the anatomical study, with a mean 6.2 ± 1.3 superficial groin lymph nodes. The medial column, with a mean 2.8 ± 1.5 nodes, was nourished by the medial artery and the other superior row, with a mean 3.4 ± 0.3 nodes, was nourished by the superficial circumflex iliac artery.

Cheng MH, Chen SC, Henry SL, Tan BK, Chia-Yu Lin M, Huang JJ. Vascularized groin lymph node flap transfer for postmastectomy upper limb lymphedema: flap anatomy, recipient sites, and outcomes. Plast Reconstr Surg. 2013 Jun;131(6):1286-1298. doi: 10.1097/PRS.0b013e31828bd3b3. PMID: 23714790.

GROIN FLAP – FLAP HARVESTING

- Skin flap is marked **below the inguinal ligament** and **medial to the sartorius**
- **5 cm x 10 cm elliptical skin paddle** is designed with its long axis parallel and 4cm inferior to the inguinal ligament
- **Skin incision** is performed on a line between iliac crest and pubic bone
- **Identify vessel origin** from the femoral vessels**;**
- Dissection remains **superficial to the femoral vessels (lateral to medial)**
- **Vascular supply → superficial circumflex iliac artery,** small medial branch of the **femoral artery (Cheng, 2013) or the superficial inferior epigastric vessels (Becker, 2012)**



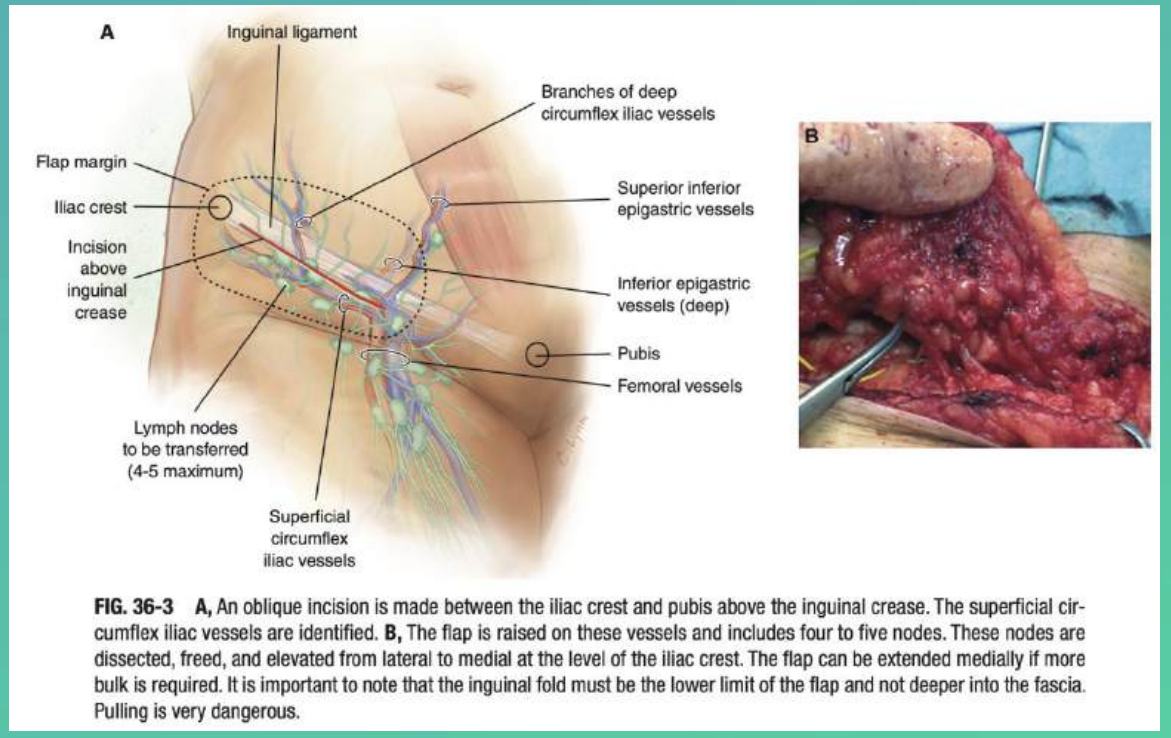


FIG. 36-3 **A,** An oblique incision is made between the iliac crest and pubis above the inguinal crease. The superficial circumflex iliac vessels are identified. **B,** The flap is raised on these vessels and includes four to five nodes. These nodes are dissected, freed, and elevated from lateral to medial at the level of the iliac crest. The flap can be extended medially if more bulk is required. It is important to note that the inguinal fold must be the lower limit of the flap and not deeper into the fascia. Pulling is very dangerous.

GROIN FLAP– PROS & CONS

PROS

Well-hidd**en scar**
Consistent anatomy
Abundant surrounding **soft tissue**

CONS

Lower limb lymphedema → Vignes et al, 2013 (38%)
Reverse lymphatic mapping is imperative!

GROIN FLAP – OUTCOMES

Vascularized groin lymph node flap transfer for postmastectomy upper limb lymphedema: flap anatomy, recipient sites, and outcomes (Cheng, 2013)

Significantly greater decrease in limb circumference in patients undergoing groin VLNT versus those receiving physical therapy (40.4% versus 8.3%, respectively).

Comprehensive review of vascularized lymph node transfers for lymphedema: Outcomes and complications (Scaglioni, 2018)

70.4% of the 138 patients undergoing groin VLNT reported that the procedure benefited their lymphedema treatment.

18.Cheng MH, Chen SC, Henry SL, Tan BK, Lin MC, Huang JJ. Vascularized groin lymph node flap transfer for postmastectomy upper limb lymphedema: flap anatomy, recipient sites, and out- comes. Plast Reconstr Surg 2013;131(06):1286–1298
19.Scaglioni MF, Arvanitakis M, Chen Y-C, Giovanoli P, Chia-Shen Yang J, Chang EI. Comprehensive review of vascularized lymph node transfers for lymphedema: outcomes and complications. Microsurgery 2016

CONCLUSION

- **oncologic surgery** is the #1 cause of secondary lower limb lymphedema in the western world (affecting 50 million individuals)
- Lower limb swelling → **differential diagnosis** is paramount!
- Resistance to conservative treatment, Recurrent lymphangitis, Advanced disease, TI > 30, (stardust or diffuse pattern on ICG
- VLNT → **primary or secondary** lymphedema; **alone or combined treatments**
- Donor sites → **hypo/anesthesia, nerve injury, iatrogenic lymphedema**

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THANK YOU FOR YOUR ATTENTION!