Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

Author Year Country	Study type	Study groups; Intervention and control	Method	Anatomy	Comments
Presence and dimensions of the SIEV					
Ayhan, 2009, Turkey [1]	Case series (prospective and retrospective)	P2: 50 women (100 hemiabdomens)	Colour Doppler ultrasound	SIEV diameters ranged from 0.50 to 4.06 mm. There was a slightly inverse correlation between the size of the SIEV and the DIEV. The diameter increases with an increasing BMI. The larger the artery, the larger the vein. The largest arteries and veins were not always located on the same perforator bundle.	
Bast, 2016 [2]	Case series (retrospective)	P2: 50 women (100 hemiabdomens)	CTA	Mean SIEV diameter: 2.06±0.81 mm (range 0–4 mm) SIEV calibre was bimodally distributed and peaked at 15 mm and 27 mm. Mean total fat pad thickness: 24.8±16.9 mm (range 4.37–84.7 mm).	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				Correlation between the suprascarpal fat thickness and SIEV-calibre ($p<0.0001$). A suprascarpal fat layer thicker than 23 mm predicted a larger SIEV calibre ($p<0.0001$). Mean SIEV diameter in patients with a suprascarpal thickness > 23 mm: 2.69 ±0.51 mm >23 mm: 1.80±0.76 mm	
Figus, 2012, UK [3]	Case series (prospective)	P2: 140 women (280 hemiabdomens)	Pre-operative Duplex ultrasonography	Presence of SIEV: 78% (109/140) (163 SIEVs) Mean SIEV diameter Right: 2.48±0.52 Left: 2.47±0.67, p=0.48 Correlation between right and left SIEV: r = −0.347, p = 0.295 SIEV diameter was not correlated with any other vessel diameter, albeit a non-significant inverse correlation with the DIEV existed.	
Gusenoff, 2008 [4]	Case series (prospective)	P2: 32 pats (64 hemiabdomens)	In vivo dissection	Presence of SIEV Left 32 (100%)	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				Right 31 (97%) Bilateral 31 (97%) SIEV diameter ≥1.5 mm Left 29 (91%) Right 29 (91%) Bilateral 28 (88%) The SIEV size was correlated to current body mass index ($p < 0.001$; $r = 0.61$) maximum body mass index ($p < 0.001$; $r = 0.54$) pannus specimen weight ($p < 0.001$; $r = 0.58$) but not to change in body mass index ($p = 0.3$).	
Kita, 2020, Japan [5] *(also presented under branching patterns)*	Case series (Prospective and retrospective)	P2: 72 women (144 hemiabdomens)	Pre-operative multidetector-row computed tomography angiography (MDCTA)	Presence of: SIEV 99% (143/144) SCIV 91% (131/144) VC of SIEV 77% (111/144) Absent VC 23% (33/144)	
Reardon, 2004, Ireland [6]	Cadaveric study	P3: 22 cadavers (3 men)	Dissection	SIEV was identified as an individual vein in 12 cases, as a pair of *vv. comitantes* in 8 cases and as both in one case. SIEV drained into the saphenous bulb in all but one case, in which it passed deep to the common femoral artery and drained into the	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				femoral vein. The mean calibre was 2.1 mm and the mean pedicle length was 6.4 cm.	
Rozen, 2010, Australia [7]	Case series (retrospective)	P2: 145 DIEPs	CTA	Variant where SIEV arises from the DIEV itself and perforates the rectus abdominis muscle as a musculocutaneous perforator at a more proximal origin instead of entering the abdominal wall integument below the inguinal ligament detected in 5/145 pats (3.4%)	
Rozen, 2010, Australia [8]	Case series (retrospective)	P2: 250 women (500 hemiabdomens)	CTA	Presence of SIEV: 100% Mean distance between SIEA and ipsilateral SIEV, at level of inguinal ligament: 4 cm (range 0.3-8.5) (16%< 3cm, 72% 3-6 cm, 12% >6 cm)	
Rozen, 2011, Australia [9] *(also presented under branching patterns)*	Case series (retrospective)	P2: 100 women (200 hemiabdomens)	CTA	Presence of SIEV: 100% Presence of medial SIEV trunk draining into second branch of the SIEV: 88% Arising from common SIEV trunk: 48% Arising from a separate SIEV trunk, without common trunk: 40%	
Vijayasekaran, 2017, USA [10]	Non-randomised study (retrospective) with controls	P1: 60 DIEPs		Concept of medial branch of the SIEV (MSIEV) (cf. Rozen 2011 [9])	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

	Routine venous augmentation - two consecutive cohorts				
Venous branching patterns					
Carramenha e Costa, 1987, USA [11]	Cadaveric study	P3: 12 cadavers	I4: Methylene blue and/or Methyl methacrylate injected in the SIEV. TRAM was performed in 3 cadavers.	Venous drainage in the anterior abdominal wall is mainly from the superficial to the deep system. The orientation of the valves is in accordance with this flow pattern. In the TRAM them the flow is through the superficial system and across the midline. The superficial system gains access to the deep system mainly through paraumbilical perforators. Scarpa's fascia should be conserved when the flap is thinned, so that the superficial system is preserved. The SIEV lies superficial to Scarpa's fascia. Superiorly, the SIEV join the lateral thoracic vein and eventually drain into the axillary vein. Inferiorly, the SIEV lies approximately 9 cm from the anterosuperior iliac spine. It crosses the inguinal ligament, flows into *fossa ovalis* and joins the saphenous or the femoral vein.	
Davis, 2018, UK [12]	Non-randomised study	I1+2: 13 C: 227	CTA	Type I: 77% (normal connection) Type II: 12% (absent connection) Type III: 11% (atypical connection)	Connections between the deep

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

	(prospective) with controls				and superficial venous system Type I: normal connection, that is ≥1 connection, present on every CT slice Type II: absent connection Type III: Atypical communication present in terms of (1) calibre, (2) tortuosity, or (3) superficial path.
Blondeel, 2000, Belgium [13]	Case series (prospective)	P3: 15 cadavers and 3 abdominoplasty specimens	Microfil injections of the superficial venous system in cadavers and dissection	Direct lateral branches crossing the midline: 18% Indirect connection through deeper network of smaller veins: 45% No crossing branches: 36%	
Frank, 2022, Germany [14]	Case series (retrospective)	P2: 300 women (600 hemiabdomens)	Pre-operative CTA	Direct connection 47% Indirect connection 45% (drained only the superficial fat compartment) No connection: 7.7%	SIEV connection was classified as direct, indirect, or no connection

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				There was a correlation between the perforator diameter and SIEV connection as a larger perforator diameter was more likely to have a connection to the SIEV or superficial fat compartment. The perforator exits of the rectus sheath influenced SIEV connectivity ($p < 0.01$) as an exit close to the umbilicus was more likely connected to the SIEV. The medial perforators more often had a direct connection to SIEV. The lateral perforators mainly drained the superficial compartment ($p<0.001$).	to upper fat compartment
Imanishi, 2003, Japan [15]	Case series (prospective)	P3: 8 cadavers	Dissection, Whole-body injection of lead-oxide-gelatin mixture into the arterial system in 8 cadavers and venous system in 5 cadavers Stereoscopic radiography	In the paraumbilical region, the SIEV formed a polygonal venous network in the superficial layer. It was not accompanied by an artery. The network was connected to the *vena comitans* of the large paraumbilical arterial perforator by large and small communicating veins the venous territory of the SIEV is larger than that of the *venae comitantes* of the large paraumbilical arterial perforator.	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				Valves were confirmed as small diverticular projections at the sites where the small veins arose.	
Katz, 2010, USA [16]	Katz, 2010, USA [16]	P2: 172 hemiabdomens (86 pats)	CTA	Type I Traditional anatomy - 150/172 (87%), 95% CI: 81%–91% – the deep vessels are in continuity with the source vessels and the perforator. Some intramuscular course. One dominant perforator. Type II Highly favorable – 11/172 (6.4%), 95% CI: 3.5-11%- paramuscular perforator. Type III altered- superiorly translocated – 9/172 (5.2%), 95% CI: 2.6-9.8% - the dominant perforator is located higher than expected, in tissue that would normally not be included in the flap, which necessitates a higher scar placement. Type IV Superficial dominant - 26/172 (15%), 95% CI: 10-21% – there are CT signs that the SIEV that is 'seemingly adequate to support transferred abdominal tissue'.	The total is more than 100% as some flaps fit into two patterns, e.g. high and altered.

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				Type V Hostile anatomy 4/172 (2.3%), 95% CI: 0.7-6.0% – the vessels are not in continuity due to previous injury or surgery. The authors recommend that a SIEV is anastomosed in patients with type IV anatomy (superficial dominant) on CTA	
Kita, 2020, Japan *(also presented under presence and dimensions)*	Case series (Prospective and retrospective)	P2: 72 women (144 hemiabdomens)	Pre-operative multidetector-row computed tomography angiography (MDCTA)	Branching pattern of the veins VC drains to the SCIV 47% (68/144) VC drains to the SIEV 21% (30/144) VC drains to the common femoral vein 9% (13/144)	
Kurlander, 2016, USA [17]	Case series (retrospective)	P2: 53 patients (106 hemiabdomens)	MRA with gadolinium-based contrast	Superficial vessels were identified in 85% of the hemiabdomens. Branching patterns: Simple 80 (76%) Complex 10 (9.4%) Absent 16 (15%) Symmetric branching pattern between the two sides: 85% Prescence of at least one superficial to deep communication: 84% of hemiabdomens and 91% of patients Communication between the left and right superficial systems: 26%	Classification of branching patterns: "Simple: a single superficial vessel with branches from that vessel. Complex: multiple main vessels or branches that re-anastomose and form a vascular mesh-like network. "

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				The article presents diagrams of branching and communication places.	
Kwon, 2009, Korea [18]	Case series (retrospective)	P3: 11 hemi-TRAMs (zones II and IV)	SIEV cannulation and injection of barium sulphate-gelatine mixture. Venous angiogram.	Medial 2/3 included SIEV territory and lateral 1/3 included SCIV territory in 11 specimens. The SIEV had ascending, descending, medial and lateral branches. The medial branches were more developed in the 9 cases who had a lower abdominal vertical scar. The SIEV was connected to the DIEV through communicating veins (DIEV perforators) close to the umbilicus in 10 specimens.	
Lie, 2014, Australia [19]	Case series (prospective)	P3: 21 cadavers (41 sides)	Venous cannulation and pulse injection of 6% hydrogen peroxide, which makes the valves incompetent, and contrast injection of 100 g of lead oxide and 15 g of milk powder in 500 ml of water	There are two main types of connections between the superficial and the deep system: • large-calibre *venae communicantes* (direct branches or continuations of the main branches of the SIEV crosses the midline) • small-caliber venae comitantes (<0.5 mm, occurs laterally and have implications in case of zone IV venous congestion)	
Park, 2020, Korea, Japan [20]	Case series (prospective)	P3: 9 cadavers (4 men)	Venous cannulation and serial injection of an angiographic agent in various condition.	Supraumbilicaly: 1-2 short polygonal venous networks connect the two SIEVs	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

			Injection of a silicone rubber compound (Microfil) in the main perforator artery or its vena comitantes. Radiography with a soft X-ray system Preoperative CTA	Infraumbilicaly: Long and multiple polygonal venous networks connect the two SIEVs. The supraumbilical midline crossover is more favourable in venous flow, due to the configuration of the SIEV (inverted-V shape), valves, angulation and major flow.	
Rozen, 2011, Australia [9] (*also presented under presence and dimensions*)	Case series (retrospective)	P2: 100 women (200 hemiabdomens)	CTA	Destination of SIEV drainage: Superficial femoral vein 42% Long saphenous vein 7% Saphenous bulb 23% Deep inferior epigastric vein 6% Superficial circumflex iliac vein 21% Superficial external pudendal vein 1%	
Schaverien, 2008 [21]	Case series (prospective)	P3: 10 cadavers and 2 abdominoplasty specimens	Dissection, CTA, and venography	The superficial inferior venous system is the main drainage of the lower abdomen. The superficial and the deep system were connected across the midline though direct communicating veins between the two SIEVs and through *veane comitantes* of the perforators of the DIEA. Direct connections are more likely to be found in the medial than in the lateral row of perforators.	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				Vessels cross the midline at the level of the subdermal plexus. Different variants of venous morphologic patters were seen.	
Sowa, 2021, Japan [22]	Case series (retrospective)	P1: 52 DIEPs (52 pats)	CTA	If connecting vessels between the superficial and the deep system and across the midline in the superficial system are missing on CTA there is significantly increased risk for complications such as fat necrosis.	”Fat induration was defined as palpation of a nodule or hard mass based on an optimal cut-off value of fat tissue of 60 kPa for significant fat induration using SWE at 6 months after the operation”
The macrovascular arteriovenous (MAS) shunt					
Grinsell, 2020, [23]	Case series (prospective)	P2: 300 women (600 hemiabdomens)	Pre-operative CTA In vivo dissection Histopathological analysis	Size of SIEV with shunt at origin (mm): median 2.64 (1.27-4.91), mean 2.8 MAS shunt size (mm): median 1.28 (range 0.72-2.81), mean 1.33. MAS is a macrovascular structure. Number of shunts per hemiabdomen median 2 (range 1-11), mean: 2.84	

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				For all women, there was a MAS present on *both* sides of the abdomen The intraoperative shunt dissection correlated exactly with the CTA findings. Histological features of the MAS: • Thick-walled vessel with smooth muscle • <Less media organisation than an artery • Elastin fibres in media less organised • No internal or external elastic lamina • Wall thickness: lumen > arterial feeding vessel	
Effect of scars					
Kim, 2017, South Korea [24]	Non-randomised study (prospective) with controls	P2: 100 women (50 with Pfannenstiel scar and 50 without)	Preoperative CTA	No of direct communications, scar group: median 2, (IQR 1-3), no scar group 1, (0-2) (p<0.001) No of indirect communications, scar group: 3 (1-4), no scar group 2 (1.75-3), p=0.25 Total no of communications, scar group: 5 (3-6.25), no scar group: 3 (2-4.25)	More DIEP fat necrosis in scar group (10 vs. 3 cases, p=0.03), more donor-site complications in the study group (13 vs. 5 cases, p=0.06), more seroma in the study group (7 vs. 0 cases,

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

				The Pfannenstiel scar increased more direct and total communications between the SIEV and the *venae comitantes* of the perforator.	p=0.01). No difference in would healing delay and fat necrosis abdomen.
Rozen, 2009, Australia [25]	Case series (retrospective)	P2: 168	CTA	Open appendicectomy scar: Disruption of SIEV in all cases Pfannenstiel scar: disruption of the medial branches of the SIEA and SIEV in 30/35 and dilatation of the lateral branches of the SIEA and SIEV in all the 30 cases	

*Type I DIEA branching pattern: short intramuscular course, Type II: bifurcating, Type III: trifurcating [26]

Abbreviations

BGMI blood glucose measurement index
BMI body mass index
BV basilic vein
C comparison
CI confidence interval
CLBS combined laser Doppler spectrophotometry system
CSV circumflex scapular vein
CT computer tomography
CTA computer tomography angiography

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

CV cephalic vein
DIEA deep inferior epigastric artery
DIEP Deep Inferior Epigastric Perforator flap
DIEV deep inferior epigastric vein
DIEVc *vena comitantis* of the DIEV
EJV external jugular vein
GRADE Grading of Recommendations, Assessment, Development and Evaluations
I Intervention
ICG indocyanine green
IMV internal mammary vein / internal thoracic vein
IQR interquartile range
LMV lateral mammary vein
LOS length of hospital stay
LTV lateral thoracic vein
MAS macrovascular arteriovenous shunt
MDCTA multidetector-row computed tomography angiography
MRA magnetic resonance angiography
ms muscle sparing
MSIEV the medial branch of the SIEV
NA not applicable
NR not reported
NS non-significant
O outcome
P population
PICO Population, Intervention, Comparison, and Outcome
RR relative risk
SA serratus anterior muscle branch of thoracodorsal vein
SCIV superficial circumflex iliac *vein*
SCIVc vena comitantis of the SCIV
SIEV superficial epigastric vein
SOS superficial outside-flap shunt

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

TAV thoracoacromial vein
TDV thoracodorsal vein
TRAM Transverse Rectus Abdominus Muscle flap
VG venous graft

Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

References Electronic supplement 1

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Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

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Electronic supplement 1: Anatomy

Emma Hansson and Jonas Löfstrand. Atlas of recipient vessels for the superficial venous system of DIEP-flaps: a systematic review and clinical practice review

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