Duplexsonographie Abschlusskurs
25./26. April 2024
Universitätsspital Basel

Venenmapping vor Bypasschirurgie

Dr. med. Kerstin Kotteck
Allgemeine Innere Medizin FMH und Angiologie FMH
SGUM Tutor Modul Gefässe, Abdomen, Basis-Notfall-Sonographie

Venenmapping vor Bypassoperation

Indikation:

- Kardiochirurgie: aorto-koronare Bypässe
- Gefässchirurgie: beispielsweise Bypässe femoro-popliteal, femoro-crural

Venenmapping vor Bypassoperation

- Femoro-distale Bypässe sollten, wenn möglich, aus autologen Venen (ipsilaterale V. saphana magna) konstruiert werden. *Level of Evidence A*
- Alternativen: V. saphena magna der Gegenseite (jeweils besser als Kunststoffbypass), V. saphena parva, Armvenen
- Keine Stellungnahme zu «Venenmapping», erforderlicher Diameter der Venen etc.!

2016 AHA/ACC Guideline on the Management of Patients With Lower Extremity Peripheral Artery Disease

Recommendations for Surgical Revascularization for Claudication

COR	LOE	Recommendations
I	A	When surgical revascularization is performed, bypass to the popliteal artery with autogenous vein is recommended in preference to prosthetic graft material.[226–234]
IIa	B-NR	Surgical procedures are reasonable as a revascularization option for patients with lifestyle-limiting claudication with inadequate response to GDMT, acceptable perioperative risk, and technical factors suggesting advantages over endovascular procedures.[190,230,235–237]
III: Harm	B-R	Femoral-tibial artery bypasses with prosthetic graft material should not be used for the treatment of claudication.[238–240]
III: Harm	B-NR	Surgical procedures should not be performed in patients with PAD solely to prevent progression to CLI.[186–189,241]

Recommendations for Surgical Revascularization for CLI

COR	LOE	Recommendations
I	A	When surgery is performed for CLI, bypass to the popliteal or infrapopliteal arteries (ie, tibial, pedal) should be constructed with suitable autogenous vein.[228,231,234,265]
I	C-LD	Surgical procedures are recommended to establish in-line blood flow to the foot in patients with nonhealing wounds or gangrene.[266–268]
IIa	B-NR	In patients with CLI for whom endovascular revascularization has failed and a suitable autogenous vein is not available, prosthetic material can be effective for bypass to the below-knee popliteal and tibial arteries.[269–271]
IIa	C-LD	A staged approach to surgical procedures is reasonable in patients with ischemic rest pain.[272–274]

2016 AHA/ACC Guideline on the Management of Patients With Lower Extremity Peripheral Artery Disease

Preoperative duplex venous mapping: A comparison of positional techniques in patients with and without atherosclerosis.

John Blebea, MD, William R. Schomaker, RVT, Giora Hod, MD, Richard J. Fowl, MD, and Richard F. Kempczinski, MD, *Cincinnati, Ohio*

Purpose: Preoperative duplex venous mapping is the preferred modality to measure the diameter of the greater saphenous vein and its suitability as an arterial conduit for infrainguinal bypass. We wanted to determine the optimal mapping technique and maximal venous diameter in patients with and without atherosclerosis.

Methods: Three groups of patients were prospectively studied: younger control subjects (n = 20), preoperative atherosclerotic patients (n = 10), and older control subjects (n = 10). All patients underwent greater saphenous vein duplex mapping in a standardized manner. Maximal internal vein diameters were measured with the subjects in the supine position in bed, in the 20 degree reversed Trendelenburg position, sitting on the edge of the bed, standing, and in the supine position with a high-thigh, low-pressure tourniquet. Measurements were taken just beyond the saphenofemoral junction, in the distal thigh, below the knee, at midcalf, and superior to the medial malleolus.

Results: In younger control subjects an increasingly more erect position resulted in progressively larger measured vein diameters at all levels along the length of the leg. Both patients with atherosclerosis and older control subjects had no such increase in venous diameter with any positional change from the supine position to standing. Patients with atherosclerosis also had significantly smaller measured veins than either younger or older control subjects. A high-thigh tourniquet significantly increased vein diameters in the atherosclerotic group to the size of vein diameters in the older control group, although the absolute size differences were not large.

Conclusions: The optimal position for venous mapping is with the patient in a supine position. If the internal vein diameter is below an acceptable minimum size, a high-thigh tourniquet will maximally distend the vein in patients with atherosclerosis. Vein diameter decreases with age and is less distended in patients with atherosclerosis compared with older patients without atherosclerosis. (J Vasc Surg 1994;20:226-34.)

Table I. Patient demographics

	Younger control subjects	*Patients with atherosclerosis*	*Older control subjects*	*Significance*
Sex				
Men	12	7	6	
Women	8	3	4	NS
Age (yr.)	37 ± 2	63 ± 3	70 ± 2	$p < 0.0001$ (Younger vs Older) $p < 0.0001$ (Younger vs Athero)
Race				
White	19	4	9	$p < 0.005$ (Younger vs Athero)
Black	0	6	1	
Asian	1	0	0	
Weight	159 ± 8	176 ± 16	172 ± 13	NS
Smoking				
Present	0	7	1	$p < 0.05$ (Younger vs Older)
Past	4	1	5	$p < 0.0001$ (Younger vs Athero)
Never	16	2	4	–
Pack-years	7 ± 3	44 ± 7	29 ± 3	$p < 0.005$ (Younger vs Older) $p < 0.0001$ (Younger vs Athero)

Younger, Younger control subjects; *Older,* older control subjects; *Athero,* patients with atherosclerosis.

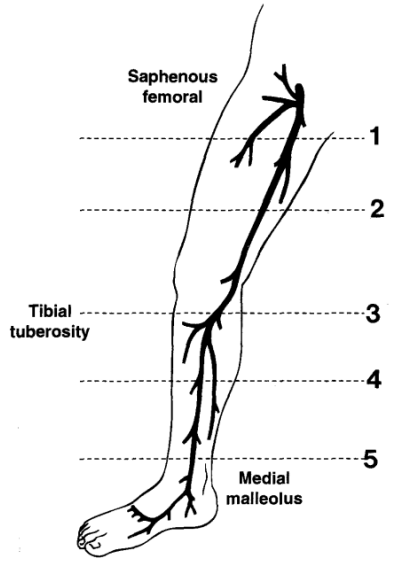


Fig. 1. Sites of greater saphenous vein diameter mapping along leg. *Level 1* is 15 cm distal to saphenofemoral junction; *Level 2* is 20 cm above top of tibial tuberosity; *Level 3* is at top of tibial tuberosity; *Level 4* is 15 cm distal to tibial tuberosity; and *Level 5* is 5 cm above top of medial malleolus.

Position des Patienten bei der Untersuchung:

- 20° reversed Trendelenburg
- sitzend
- stehend
- Tourniquet

Blebea et al. J Vasc Surg 1994

Table II. Vein diameters (in millimeters) in younger control subjects

Position	Location				
	Saphenofemoral junction	*Distal thigh*	*Knee*	*Calf*	*Ankle*
Supine	3.5 ± 0.1	3.3 ± 0.1	2.9 ± 0.1	2.5 ± 0.1	2.8 ± 0.1
20 degrees Trendelenburg	4.1 ± 0.1*	3.6 ± 0.1*	3.1 ± 0.1†	2.7 ± 0.1‡	2.9 ± 0.1
Sitting	4.3 ± 0.1*	3.6 ± 0.1§	3.2 ± 0.1*	2.8 ± 0.1§	3.1 ± 0.1‖
Standing	4.3 ± 0.1*	3.7 ± 0.1*	3.2 ± 0.1*	2.7 ± 0.1‡	3.0 ± 0.1
Tourniquet high-thigh	4.7 ± 0.2§	4.1 ± 0.2§	3.4 ± 0.1†	2.9 ± 0.1‡	3.1 ± 0.1

*p < 0.0001 versus supine position.
†p < 0.001 versus supine position.
‡p < 0.05 versus supine position.
§p < 0.0005 versus supine position.
‖p < 0.005 versus supine position.
Expressed as mm ± SEM. n = 20 in the tourniquet groups; n = 40 in all other groups.

Table III. Vein diameters (in millimeters) in patients with atherosclerosis

Position	Location				
	Saphenofemoral junction (n)	*Distal thigh (n)*	*Knee (n)*	*Calf (n)*	*Ankle (n)*
Supine	3.1 ± 0.2 (20)	2.9 ± 0.2 (20)	2.6 ± 0.2 (20)	2.5 ± 0.2 (18)	2.9 ± 0.2 (18)
20 degrees Trendelenburg	3.1 ± 0.2 (20)	3.0 ± 0.2 (20)	2.7 ± 0.2 (20)	2.5 ± 0.2 (18)	3.2 ± 0.2* (18)
Sitting	3.2 ± 0.2† (18)	2.9 ± 0.2 (18)	2.7 ± 0.2 (18)	2.6 ± 0.2† (16)	3.1 ± 0.2‡ (16)
Standing	3.1 ± 0.2 (18)	3.0 ± 0.2 (18)	2.7 ± 0.2 (18)	2.7 ± 0.2† (16)	3.2 ± 0.2* (16)
Tourniquet					
High-thigh	3.5 ± 0.2§ (20)	3.1 ± 0.2§ (20)	2.7 ± 0.2† (20)	2.5 ± 0.2 (18)	3.2 ± 0.2‡ (18)
Low-thigh	–	–	2.9 ± 0.2† (18)	2.6 ± 0.2 (18)	3.2 ± 0.2* (18)

*p < 0.005 versus supine position.
†p < 0.05 versus supine position.
‡p < 0.01 versus supine position.
§p < 0.001 versus supine position.
Expressed as mm ± SEM.

Table IV. Vein diameters (in millimeters) in older control subjects

Position	Location				
	Saphenofemoral junction	*Distal thigh*	*Knee*	*Calf*	*Ankle*
Supine	3.7 ± 0.1	3.3 ± 0.1	2.9 ± 0.1	2.7 ± 0.1	3.0 ± 0.1
20 degrees Trendelenburg	3.7 ± 0.1	3.3 ± 0.1	2.8 ± 0.1	2.6 ± 0.1	3.0 ± 0.1
Sitting	3.8 ± 0.1	3.3 ± 0.1	2.9 ± 0.1	2.5 ± 0.1	3.0 ± 0.1
Standing	3.7 ± 0.1	3.3 ± 0.1	2.8 ± 0.1	2.5 ± 0.1*	3.0 ± 0.1
Tourniquet high-thigh	3.5 ± 0.1	3.3 ± 0.1	2.9 ± 0.1	2.6 ± 0.1	2.8 ± 0.1

*p < 0.05 versus supine position.
Expressed as mm ± SEM. n = 20 in all groups.

Signifikante Steigerung des Durchmessers bei der jungen Kontrollgruppe.

Keine relevante Steigerung des Durchmessers bei Patienten mit Atherosklerose und bei älteren Patienten.

Empfehlung:

- Untersuchung in Rückenlage
- idealer Diameter >3 mm

Blebea et al. J Vasc Surg 1994

INTERACTIVE CARDIOVASCULAR AND THORACIC SURGERY

Interactive CardioVascular and Thoracic Surgery 7 (2008) 188-191

www.icvts.org

Work in progress report - Coronary

Pre-operative long saphenous vein mapping predicts vein anatomy and quality leading to improved post-operative leg morbidity☆

Heyman Luckraz[a,*], Julie Lowe[a], Neil Pugh[b], Ahmed A. Azzu[a]

[a]*Cardiothoracic Unit, Block C5, University Hospital of Wales, Cardiff, CF14 4XW, UK*
[b]*Doppler Ultrasound Department, University Hospital of Wales, Cardiff, CF14 4XW, UK*

Received 4 September 2007; received in revised form 28 November 2007; accepted 26 December 2007

Abstract

Long saphenous vein harvesting for coronary bypass surgery is associated with significant morbidity. Furthermore, vein quality is often variable sometimes requiring incisions in both legs. This prospective randomised control study assessed the usefulness of pre-operative long saphenous vein mapping in terms of conduit quality and location, incision lengths and post-operative morbidity. The long saphenous vein was assessed and mapped pre-operatively ($n=31$) by venous Doppler ultrasound or not ($n=30$). The size and anatomical distribution of the long saphenous vein was well predicted by the ultrasound study (correlation coefficient=0.87). Intra-operatively, the mean length of leg wound incision per vein graft performed was significantly less in the mapped group [16.8 (4.0) vs. 24.1 (10.4) cm, $P=0.005$]. This translated in a shorter operative time for vein harvesting per length of vein graft needed [36 (13) vs. 47 (17) min, $P=0.04$]. Post-operatively there was a tendency to less leg wound complications in the mapped group ($P=0.08$) and earlier hospital discharge (median length of stay 6.5 days vs. 8.0 days, $P=0.05$). Thus, long saphenous vein mapping pre-operatively predicted the size and anatomy of the vein appropriately. This led to a selective leg wound incision and reduced operative time with the benefit of reduced leg complication post-operatively.

Luckraz et al. ICVTS 2008

- Mapping vs. ohne Mapping
- prospektive, randomisierte, kontrollierte Studie
- n = 31 vs. n = 30 (koronarer Bypass)

- weniger Inzisionen für Venenentnahme (p=0.005)
- kürzerer Operationszeit für Venenentnahme (p=0.04)
- Tendenz zu weniger Wundinfekten (p=0.08)
- frühere Entlassung aus dem Spital (p=0.05)

Luckraz et al. ICVTS 2008

Interact Cardiovasc Thorac Surg. 2013 Jun;16(6):886-7. doi: 10.1093/icvts/ivt090. Epub 2013 Mar 7.

Ultrasound mapping of the long saphenous vein in coronary artery bypass graft surgery

Alan Soo [1], Dennis Noel, Simon MacGowan

Affiliations + expand

PMID: 23470614 PMCID: PMC3653490 DOI: 10.1093/icvts/ivt090

Free PMC article

Abstract

Long saphenous vein is the most common conduit utilized for surgical coronary revascularization. Ultrasound-assisted vein assessment is superior to traditional clinical examination of the long saphenous vein in discerning path and suitability for use as a conduit. Preoperative ultrasound mapping of the long saphenous vein is easy and rapidly accomplished allowing optimal surgical site selection, avoiding unnecessary surgical dissection and potential wound complications. We describe the technique of ultrasound mapping of the long saphenous vein and its application to conduit harvest in coronary artery bypass graft (CABG) surgery.

Keywords: Coronary artery bypass graft surgery; Long saphenous vein; Saphenous vein harvest; Vein mapping.

Supplementary Video 1:

Surface mapping of the long saphenous vein.

Figure 1:

Saphenous vein mapping using the ultrasonic probe.

Supplementary Video 2:

Ultrasonic images of the long saphenous vein.

Figure 2:

Location of great saphenous vein identified and marked.

Mapping unmittelbar präoperativ

Technik: Patient in Rückenlage, Beine reverse Trendelenburg, Bein leicht gebeugt und nach aussen rotiert
VSM-Verlauf markiert und Durchmesser bestimmt
Seitenäste, variköse Veränderungen, Duplikaturen markiert
beide Beine untersuchen, auch nach Venenoperationen (residuelle kurze Segmente?)

JSLS. Apr-Jun 2017;21(2):e2016.00083. doi: 10.4293/JSLS.2016.00083.

Bedside Vein Mapping for Conduit Size in Coronary Artery Bypass Surgery

Frank Manetta [1], Pey-Jen Yu [1], Allan Mattia [1], John C Karaptis [1], Alan R Hartman [1]

Affiliations + expand

PMID: 28439192 PMCID: PMC5385143 DOI: 10.4293/JSLS.2016.00083

Free PMC article

Abstract

Background and objectives: The greater saphenous vein has been used in coronary artery bypass grafting (CABG) for more than 50 years. Endoscopic vein harvesting has greatly reduced the morbidity associated with obtaining the vein, but the quality of the vein could not be assessed before its was exposed surgically or after the endoscopic procedure had been performed. This study was conducted to evaluate the accuracy of preoperative mapping of the greater saphenous vein at the bedside in assessing suitable conduit size for use in CABG.

Methods: Seventy-two consecutive patients undergoing saphenous vein harvesting for use as a conduit during CABG underwent preoperative ultrasonographic vein mapping on the operating table after the leg was positioned for vein harvesting. Vein diameters at 3 distinct locations were measured by ultrasonography after vein harvesting and preparation. Similar linear regression was used to determine the correlation between measurements by ultrasonography and the true vein size after harvesting. Standard methods of computing 95% lower and upper confidence limits for single predicted values were also used.

Results: Two hundred twenty measurements were obtained from 72 patients. Mean vein diameters were 3.4 ± 0.9 and 4.6 ± 0.9 mm as measured by ultrasonography and after vein harvest, respectively. True vein size was an average of 1.2 ± 0.4 mm larger than that measured by ultrasonography. Ultrasonographic determination of vein diameters closely correlated with the true vein diameter (correlation coefficient, 0.91; $P < .001$), and the measurement obtained predicted the true measurement within 1.6 mm with 95% confidence.

Conclusion: Bedside ultrasonographic vein mapping provides an accurate noninvasive method for preoperative assessment to determine the suitability of the greater saphenous vein for use as a bypass conduit. It is therefore an important component of preoperative planning before CABG.

Keywords: Coronary artery bypass; Preoperative care; Saphenous vein.

220 Messungen mit einem mittleren Durchmesser von 3.4 +/- 0.9 mm im Ultraschall und 4.6 +/- 0.9 mm nach Entnahme
VSM durchschnittlich 1.2 +/- 0.4 mm grösser

Table 1.

Measurements with 95% Confidence Limits

Ultrasound Measurement (mm)	Predicted True Measurement (mm)	95% Confidence Limit	
		Lower Limit (mm)	Upper Limit (mm)
1.5	2.8	2.0	3.6
2.0	3.3	2.5	4.1
2.5	3.8	2.9	4.5
3.0	4.2	3.4	5.0
3.5	4.7	3.9	5.5
4.0	5.1	4.3	5.9
4.5	5.6	4.8	6.4
5.0	6.1	5.3	6.9
5.5	6.5	5.7	7.3
6.0	7.0	6.2	7.8
6.5	7.5	6.6	8.3
7.0	7.9	7.1	8.8
7.5	8.4	7.6	9.2

n = 72. Consecutive patients who underwent pre-operative measurements and surgeon measurements.

This is a regressional analysis of predicted vein measurements based on ultrasound measured size. True measurements ranged from 1.8–5.5 cm.

Soo et al. ICVTS 2012

Observational Study > Interact Cardiovasc Thorac Surg. 2020 Jul 1;31(1):16-19.
doi: 10.1093/icvts/ivaa063.

Predictive value of great saphenous vein mapping prior to endoscopic harvesting in coronary artery bypass surgery

Ferdi Akca [1], Ka Yan Lam [1], Niels Verberkmoes [1], Ignace de Lathauwer [1], Mohamed Soliman-Hamad [1], Bart van Straten [1]

Affiliations + expand

PMID: 32359067 DOI: 10.1093/icvts/ivaa063

Abstract

Objectives: The use of endoscopic vein harvesting in patients undergoing coronary artery bypass grafting is increasing, often using bedside mapping. However, data on the predictive value of great saphenous vein (GSV) mapping are scarce. This study assessed whether preoperative mapping could predict final conduit diameter.

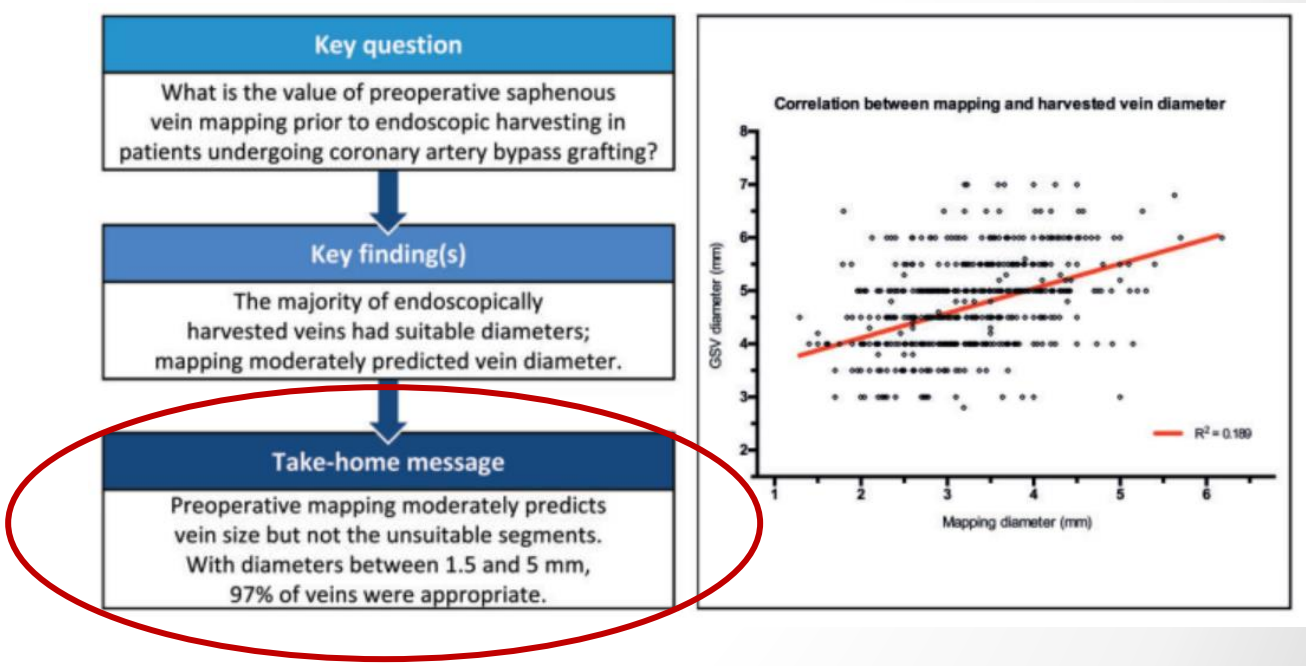
Methods: A prospective registry was created that included 251 patients. Saphenous vein mapping was performed prior to endoscopic vein harvesting at 3 predetermined sites. After harvesting and preparing the GSV, the outer diameters were measured. Appropriate graft size was defined as an outer diameter between 3 and 6 mm.

Results: A total of 753 GSV segments were analysed. The average mapping diameter was 3.2 ± 0.7 mm. The harvested GSV had a mean diameter of 4.7 ± 0.8 mm. Mapping diameters were significantly positively correlated with actual GSV diameters (correlation coefficient, 0.47; P < 0.001). If the preoperative mapping diameters were between 1.5 and 5 mm, 96.6% of the GSVs had suitable dimensions after endoscopic vein harvesting.

Conclusions: Preoperative bedside mapping moderately predicts final GSV size after endoscopic harvesting but could not detect unsuitable vein segments. However, the majority of endoscopically harvested GSVs had diameters suitable to be used as coronary bypass grafts.

Keywords: Coronary artery bypass grafting; Endoscopic harvesting; Minimally invasive; Preoperative mapping; Saphenous vein.

753 VSM-Segmente mit einem mittleren Durchmesser von 3.2 +/- 0.7 mm im Ultraschall und 4.7 +/- 0.8 mm nach Entnahme



Optimaler Venendurchmesser

- Innerer Durchmesser < 2.0 mm
  Vene nicht geeignet[1-3]

- Aussendurchmesser < 3.0 mm
  1-year patency rate 31 %
  vs. 62 % als > 3.0 mm[4]

- Innerer Durchmesser > 4.0 mm
  besser als < 4.0 mm[5,6]

[1]Towne et al. J Cardiovasc Surg 1991
[2]Scott et al. Br J Surg 1988
[3]Shah et al. J Vasc Surg 1986
[4]Wengerter et al J Cardiovasc Surg 1987
[5]Buxton et al Surgery 1980
[6]Taylor et al. Am J Surg 1987

Empfehlungen: Venenmapping vor Bypassoperation

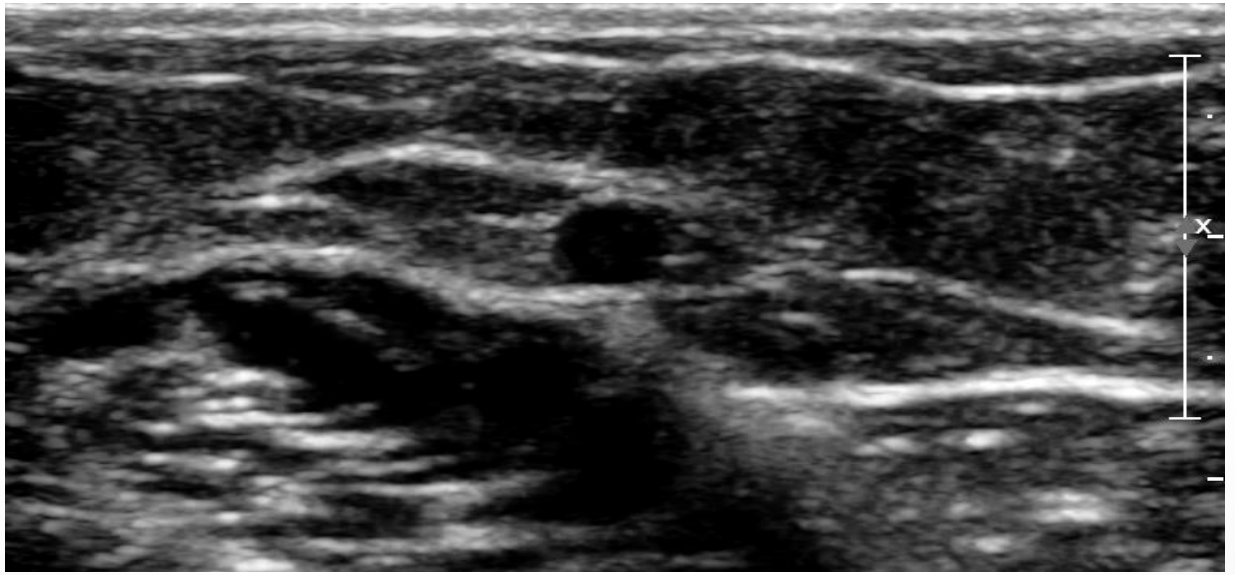
- liegender Patient
- keine Stauung
- angenehme Raumtemperatur

Empfehlungen: Venenmapping vor Bypassoperation

- Untersuchung im Querschnitt – innerer Durchmesser (optimal >3 mm)
- postphlebitische Veränderungen ?
- Varikose ?
- Abstand zur Oberfläche
- Seitenäste
- Duplikaturen
- Untersuchung des tiefen Venensystems (Okklusion, postthrombotische Veränderungen, Anomalien, etc.)

Empfehlungen: Venenmapping vor Bypassoperation

- ipsilaterale V. saphena magna
- kontralaterale V. saphena magna
- V. cephalica beidseits
- *ggf. V. saphena parva oder V. basilica in Rücksprache mit Operateur*



Take home …

- optimaler Venendurchmesser 3 - 5 mm
- standardisierte Bedingungen für die Untersuchung
- möglichst detaillierte Angaben in den Befund
- Rücksprache mit dem Herz-/Gefässchirurgen

Vielen Dank für die Aufmerksamkeit!