A STEP-BY-STEP GUIDE FOR ENDOVASCULAR PROCEDURES

Practical Insights into Endovascular Procedures: a Collaborative Portuguese Initiative

---

Writing Committee

Chairs

- Koen Deloose
- José Fernando Teixeira
- João Albuquerque Castro

Members

- Alice Lopes
- Daniel Brandão
- Gabriel Anacleto
- Gonçalo Alves
- João Almeida Pinto
- João Vieira
- Liliana Fidalgo
- Luís Machado
- Marina Neto
- Pedro Amorim
- Sérgio Silva

Content

PURPOSE OF THE DOCUMENT

What this document provides

It is our great pleasure to provide you with a step-by-step guide for endovascular procedures. This guide is the result of the collaborative work of the Writing Committee, developed across multiple sessions of the Vascular Surgery Working Groups held under the auspices of Terumo.

This booklet presents a structured series of material recommendations and procedural options to support intraoperative decision-making during endovascular interventions. It also includes essential advice on radiation protection- an integral aspect of all such procedures.

Disclosures

These recommendations reflect a group of experienced national and international leaders, based on their daily use of practical techniques and expert insights in the endovascular field. The purpose of this guidance is to provide technical instruction and support by creating a practical framework. However, it is not intended to replace the universal guidelines issued by the **ESVS, ESC**, or other scientifically recognized entities, including other medical organizations and societies.

The views presented in this document by the Writing Committee members represent their individual authorship and responsibility. Any data without attribution, as well as recommendations on device selection and procedural approaches, reflect physician preference and are based on personal observations and professional experience, and should be interpreted accordingly.

All visual representations and other images included in this guide are used with permission from the members of the Writing Committee. The information in this guide is intended exclusively for physicians. Please refer to product labels and package inserts for complete warnings, precautions, potential complications, and instructions for use. The products may not be approved by regulatory authorities in all countries.

Document Structure

This document outlines which materials should be available during procedures and the recommended sequence of technical steps. In particular, for Peripheral Arterial Occlusive Disease (PAOD), the procedural flow—or "cadenza"—is divided into the following stages: **access**, **crossing**, **treatment**, and **closure.**

Preliminary Notes

From the disease to the treatment — how to proceed under established consensus.

Procedure

- Access options: puncture site, type of access (ipsilateral or contralateral), and echo guidance.
- Discussion adjusted by procedure.
- Adequate material selection and use (guidewires, catheters, re-entry systems, balloons, and stents).
- Details of intraoperative steps.
- Refer to previous comments on closure system options: when and why, advantages and disadvantages.

Practical techniques and expert insights

Suggestions from the experts — the most frequent and less frequent ones.

References

At the end of the document, the references are grouped by topic or chapter. They provide relational support for the text by highlighting the main conclusions and illustrating the historical evolution of scientific knowledge. Clinical evidence, background experiences, analyses, and statements can be accessed directly through PubMed links for easy consultation.

I. RADIATION PROTECTION ADVICE

by José Fernando Teixeira

Radiation emitted during fluoroscopic procedures constitutes the primary source of radiation dose for medical staff.

In contrast, radiation from diagnostic imaging modalities, such as computed tomography, mammography, and nuclear imaging, contributes minimally to the cumulative radiation dose received by healthcare personnel *(Ref. 1)*.

Formal radiation protection training helps reduce radiation exposure to medical staff and patients.

Any amount of radiation exposure will increase the risk of stochastic effects, including the chances of developing malignancy following radiation exposure. Radiation exposure can produce biological effects such as either a dose-dependent effect or a dose-dependent probability.

There are three basic principles of radiation protection: justification, optimization (precision), and dose limitation, resulting in the golden "ALARA" principle: "As Low As Reasonably Achievable." Key strategies for minimizing radiation exposure include limiting the duration of exposure, maintaining a distance from the radiation source, and using physical shielding.

Advice *(Ref. 2)*

- Plan in advance the required images to avoid unnecessary and redundant exposure.
- All X-ray system settings should be set to use a low dose by default.
- Limit exposure duration whenever possible.
- Use magnification judiciously, as it significantly increases the exposure to the patient and operators.
- Pulsed fluoroscopy captures about five images per second while maintaining image quality; in contrast, standard fluoroscopy machines record around 35 images per second. Continuous or live fluoroscopy can aid anatomical understanding during procedures.
- Use collimation systematically to minimize scatter radiation and focus only on the area of interest.
- Replace digital subtraction angiography with recorded fluoroscopy runs whenever possible.
- Increase the distance between the X-ray beam and the part being imaged to minimize exposure.
- Keep the image intensifier or X-ray plate as close to the patient as possible, with the X-ray tube positioned as far away as possible while maintaining adequate image resolution.
- Decrease scattered radiation (radiation that surgeons, interventionists, and operating room staff commonly encounter during procedures requiring fluoroscopy) exposure levels by a factor of four by doubling their distance from the source.
- Use fusion imaging to facilitate endovascular navigation and allow table and C-arm positioning without fluoroscopy in EVAR and FEVAR *(Ref. 3,4)*.
- Use CO_2 angiography as an alternative or complement to iodinated contrast.
- Use both CO_2 and fusion for FEVAR whenever possible *(Ref. 5)*.
- Consider IVUS use for EVAR and TEVAR procedures *(Ref. 6)*.
- For retrograde puncture of superficial femoral, popliteal, or below-the-knee arteries, use ultrasound guidance (rather than under fluoroscopy).
- If fluoroscopy must be used, consider using lead gloves or a needle extender.
- Wear lead aprons for protection (preferably those that wrap circumferentially around the body).
- Use a thyroid shield.
- Use leaded glasses (which can reduce radiation exposure to the lens by 90%).
- Use dosimeters and confirm regular monitoring.
- Request ceiling-suspended lead acrylic shields, which can reduce doses to the head and neck by a factor of 10.

II. PERIPHERAL ARTERIAL OCCLUSIVE DISEASE (PAOD)

GENERAL GUIDANCE FOR ENDOVASCULAR PROCEDURES

by José Fernando Teixeira

1. **Type of Access**

- Determine puncture type and access (anterior or posterior/anterior wall).
- FemoSeal™: use only when the common femoral artery lumen is ≥ 5 mm.
- Angio-Seal™: suitable for femoral arteries > 4 mm; may also be used in vessels > 5 mm according to IFU conditions.
- Depending on the access, the patient may be discharged the same day.
- Crossover vs. ipsilateral access: request **Eco-Doppler** for echo-guided puncture of the common femoral or superficial femoral artery.
- In case of stenting, use a 6Fr introducer by default and confirm Fr compatibility with stent delivery system.

2. **Guidewire Selection**
   Start with a workhorse guidewire (standard or stiff angled hydrophilic, durable nitinol wire) – *Terumo Radifocus™ Glidewire Advantage™* or *Terumo Radifocus™ Glidewire Advantage™ Track*.

3. **Catheter Selection**

- **Radifocus™ Glidecath™** for tractability in tortuous areas.
- Catheter tip and caliber determined by artery, lesion type, and selected guidewire.
- **Radifocus™ Optitorque™** (offers more support than Radifocus™ Glidecath™) for non-challenging anatomies.
- Common curves: **Berenstein 2** (depending on vessel anatomy) and optionally **Vertebral 1**, **RIM**, **UF**, or **JB2**.

4. **Stent Selection** *(Ref. 1)*

- **Primary or Direct Stenting:** indicated for complex occlusions or stenoses (eccentric, calcified, ulcerated) that risk embolization.
- **Balloon-Expandable Stents:** for short, calcified, eccentric lesions at the ostia of the common or external iliac artery – provide greater radial force.
- **Self-Expanding Stents:** nitinol stents with thermal memory; for tortuous or kinked lesions, minimizing angulation-related distal apposition risk. Best in long, tortuous, less calcified lesions or with abrupt diameter variations.
- **Stent Grafts:** for perforations, fistulae, trauma, or iatrogenic rupture; always have on standby for bailout use, especially for lesions at rupture risk or at the aortic bifurcation.

Kissing Stent:

- Access via ipsilateral Radifocus™ Glidewire Advantage™ and contralateral guidewire with 0.035” × 260 cm PTFE guide.
- Introducer diameter depends on stent type and size, usually 6Fr or 7Fr.
- Ballooning: only post-dilatation and only in self-expanding stents *(Ref. 2)*.

5. **Closure Systems**

- 6–8F: **FemoSeal™ Terumo/Angio-Seal™ Terumo**
- 10–14F: 1 × **Perclose ProGlide™ Abbott/Perclose Prostyle™ Abbott**
- 14F: 2 × **Perclose ProGlide™ Abbott/Perclose Prostyle™ Abbott**

6. **ProGlide™ by Abbott**
   Can be used for 5–21Fr (max. 26Fr OD) arterial sheaths and 5–24Fr (max. 29Fr OD) venous sheaths.

ILIAC ARTERIES ANGIOPLASTY AND STENTING

by Gabriel Anacleto

Technique & Materials

Access

- Ipsilateral or contralateral femoral.
- Preferably ultrasound-guided puncture.
- Puncture in the upper limb—preferably the left side, either humeral/brachial or radial (depending on material availability), due to the shorter distance to the target lesion and less manipulation of the aortic arch.
- The choice depends on puncture type; start with a 5–6F introducer (11 cm). For radial access, use a dedicated radial introducer.
- After crossing the lesion, change the introducer to a larger one adjusted for the device.
- For crossover procedures or complex lesions, use longer introducers to provide better protection and facilitate smoother device advancement.

Crossing

- Heparinization: 5000 units of unfractionated heparin (100 IU/kg) or 50–100 IU/kg.
- Guidewires—contralateral, unilateral, or double puncture—are selected according to preference. Typically, a 0.035" hydrophilic guidewire (e.g., *Radifocus™ Guide Wire M*, 260 cm) is used; for bilateral puncture, two guidewires (exchange guidewire) may be employed.
- For crossover: use **Pigtail**; alternatives include **Cobra**, **Berenstein**, **Internal Mammary**, **JR**, or **Simmons**; then add a **Support Catheter** (e.g., *Navicross™* 0.035"). Use *Radifocus™ Glidecath™ Angiographic Catheter* for tortuous areas requiring better navigability.
- If difficulty crossing, reduce profile to 0.018" or 0.014" guide; dedicated CTO guides may be used.
- For occlusions, consider using a **Straight Terumo Stiff 0.035" (Ex: Terumo Radifocus™ Guide Wire M)**, switching to *Radifocus™ Glidewire Advantage™ TRACK 0.035"* (straight or angled per lesion type).
- After crossing, exchange for a stiffer wire (e.g., *PTFE 260 cm*, **Terumo *Radifocus™ Glidewire Advantage™ Track 0.035"*** *– embolization device*) to provide greater support for stent progression — 180 cm or 260 cm length depending on catheter/device.

Treating

- Choose angioplasty balloons with an 80 cm catheter; prioritize low-profile models for good navigability.
- Pre-dilate in most cases to improve artery diameter and facilitate the passage of balloon-expandable stents.
- For post-dilatation after self-expanding stent placement, use large diameter balloons (8×60 mm × 2; 9×60 mm × 2). Use the same dimensions for non-covered expandable stents.

Take Note:

- Balloon stents: for occlusive or heavily calcified lesions — pre-dilate or cross with a long introducer; remove introducer/sheath after stent placement.
- **External iliac artery:** usually self-expanding stent.
- **Common iliac artery:** usually balloon-expandable stent.
- **Thrombosis or heavy calcification:** consider covered stent (COBEST trial).
- Keep a covered stent available for emergency iliac rupture.

Closing

- **FemoSeal™ Terumo** – preferred for calcified puncture sites; re-access possible after 3 months (vs. *Proglide™ Abbott*, immediate). Up to 7F introducer.
- **ProGlide™ Abbott** avoid in calcified femoral arteries; complications possible in anterograde punctures (not with *FemoSeal™*). One device up to 10–14F; two or more for larger introducers.
- **Angio-Seal™ Terumo** – consider if introducer ≤ 8F.

Practical techniques and expert insights

- Crossing sequence:
    1. Intraluminal (use lower-profile guide if needed).
    2. Crossover/upper limb access (use snare if necessary).
    3. Subintimal + re-entry (use re-entry devices) or retrograde access.

RECONSTRUCTION OF AORTIC BIFURCATION WITH COVERED STENTING (CERAB)

by Gabriel Anacleto, Daniel Brandão

Technique & Materials

Preliminary Notes

- Identify proximal limit of aortic stent implantation.
- Assess risk of embolization to renal arteries; if present, use renal protection.
- Check for visceral stenotic/occlusive lesions and risk of intestinal ischemia (if inferior mesenteric artery occluded by covered stents).
- Consider left upper limb access for antegrade control and imaging.
- When selecting kissing stent diameters, match to aortic bifurcation diameter.

Access

- Bilateral femoral arteries, preferably ultrasound guided.
- Optional upper limb (humeral/brachial/radial) access — preferably left side; for radial, use dedicated introducer.
- Start with 5–6F (11 cm), progress to 7F.
- After crossing, change to larger introducer (11–14F) on side of aortic stent implantation.
- Use long introducers (*Dryseal*, *Sentrant*) for complex lesions to protect devices.

Crossing

- Heparinization: 5000 U unfractionated heparin (100 IU/kg) or 50–100 IU/kg.
- Crossing sequence:
    1. Intraluminal (use low-profile guide if needed).
    2. Crossover/upper limb access (snare if required; treat contralateral side first if disease restricts access).
    3. Subintimal + re-entry. Use re-entry devices or “rendezvous” technique.
- For occlusive or calcified lesions: pre-dilate; prefer long introducer for support.
- Common guidewires:
    - *Terumo Radifocus™ Guidewire M* 180 cm (bilateral access – start)
    - *Terumo Radifocus™ Guidewire M* 260 cm (bilateral access – exchange)
    - *Radifocus™ Guide Wire M (Stiff type)* (for occlusions)
    - *Terumo Radifocus™ Glidewire Advantage™ Track, angled*
    - *PTFE-coated exchange wire, 260 cm – likely Amplatz type.*

- Common catheters: **Berenstein 2**, **Straight**, **Vertebral**, **Pigtail**. Use *Radifocus™ Glidecath™* for tortuous segments.

Treating

- Angioplasty balloons: ensure proximal over-dilatation of the aortic stent to create a “funnel” or conical flare at the proximal end of the iliac kissing stents.
- Over-dilatation of iliac stents if iliac caliber exceeds stent size.
- Pre-dilatation is typically required to allow passage of balloon-expandable stent.
- For post-dilatation of self-expanding stents, use large-diameter balloons.

BALLOONS FOR OVERDILATATION			
Brand	**Diameters**	**Extension**	**Introducer**
Zelos(Optimed)	12-28mm	20to40mm	**6-12F**
XXL(Boston)	12-18mm	20to60mm	**7-8F**
Maxi LD(Cordis)	14-25mm	40to80mm	**8-12F**
Atlas Gold (BD)	**12-26mm**	**20to60mm**	**7-12F**

Stents

- Choose diameters compatible with angioplasty balloons and vessel size.
- Balloon-expandable covered or uncovered *(Ref. 3)*.
- Consider self-expanding covered stents (GORE Viabahn®) for long lesions, or balloon-expandable covered alternatives *(Ref. 4)*.

BALLOON-EXPANDABLE COVERED STENTS				
Brand/Company	**Diameters (mm)**	**Extension (mm)**	**Introducer (F)**	**Material**
VBX (Gore)	5–11 (expandable to 16)	15–79	7–8 *	Steel + PTFE (coated surface)
V12 (Getinge)	5–10	16–59	6–7	Steel + PTFE
V12 large diameter (Getinge)	12	29–61	9	Steel + PTFE
Lifestream (BD)	5–12	16–58	6–8	Steel + PTFE
Begraft Peripheral (Bentley)	5–10	18–58	6–7	Chromium Cobalt + PTFE
Begraft Peripheral Plus (Bentley)	5–10	27–58	7–8	Chromium Cobalt + PTFE (double layer)
Begraft aortic (Bentley)	12 – 14mm (expandable to 30 mm)	19 to 59 mm	9 – 14 Fr F*	Chromium Cobalt + ePTFE covered

FEMORAL/POPLITEAL ANGIOPLASTY

by Luís Machado

Technique & Materials

Preliminary Notes

Patients with femoropopliteal peripheral arterial disease often have multilevel disease, either in the aorto-iliac or distal segments. Revascularization should begin at the most proximal level. For a satisfactory clinical result, it may be necessary to achieve at least one patent distal artery to the foot.

This guidance applies primarily to **chronic lesions and primary interventions**. For **acute/subacute cases or re-occlusions**, alternative or combined approaches should be considered.

Access

- Always perform ultrasound-guided puncture, typically under local anesthesia.
- Use a **4Fr to 6Fr introducer** (check device compatibility if stenting is planned).
- For contralateral retrograde access: crossover with a **6Fr long sheath** positioned in the external or common femoral artery.

Access Options

1. **Anterograde Puncture:**
    - Choose balloons/stents with shorter stem/catheter.
    - First-line approach whenever possible.
2. **Retrograde Puncture:**
    - Use long-stem/catheter balloons or stents.
    - Ideal for lesions in the first centimeters of the superficial femoral artery (SFA) and in obese patients.
    - Requires crossover at the aortic bifurcation and introduction of a 6Fr or 7Fr sheath (*Destination™ Guiding Sheath Terumo*) as distally as possible.
3. **Alternative Access Options:**
    - Contralateral femoral puncture – for proximal SFA lesions.
    - Contralateral SFA access in obese patients with SFA lesions – contralateral puncture + crossover.
    - Anterograde puncture of the SFA.
    - Upper limb access (humeral or radial).
    - Retrograde puncture of the superficial femoral, popliteal, or distal arteries.

Crossing

- Perform arteriography to characterize the lesion: stenosis/occlusion, extent, calcification, chronic/subacute nature.
- Heparinization: 5000 U unfractionated heparin (100 IU/kg) or 50–100 IU/kg.

A) Intraluminal Approach

Preferred whenever possible — especially in stenoses, short occlusions, and minimally calcified lesions.

Common Materials:

- **Guidewires:** 0.018” or 0.035” (e.g., ***Radifocus™ Guide Wire M*** *(standard type)*, ***Radifocus™ Guide Wire M – Stiff type, 0.035"***, *V18™ – Boston Scientific*, *Command™/Connect™ – Abbott (formerly St. Jude)*, *Radifocus*™ Glidewire Advantage™ TRACK – Terumo).
- **Selective catheter:** *Berenstein* or multipurpose 4–5Fr; low-profile support catheters (*Navicross™ Support Catheters Terumo*), or low-profile angioplasty balloons.

Additional Catheters:

- *Radifocus™ Glidecath™*, *vertebral or straight catheter, 4–5 Fr (any standard brand)*, *support catheter* (Terumo *Navicross™*).

For occlusions: consider CTO 0.018” or 0.014” wires (e.g., *Connect 250T*, *Hi-Torque Winn – Abbott*, *Astat 30 – Asahi*).

B) Subintimal Approach

Used when intraluminal recanalization when not possible, especially for long occlusions.

Common Materials:

- **Guidewires:** 0.018” or 0.035” resistant and angled; straight and rigid wires for secondary attempts (*V18 – Boston*, *Command/Connect – Abbott*, *Radifocus™ Glidewire Advantage™– Terumo*).
- **Catheters:** *Berenstein* 4–5Fr; long low-profile support catheters (Terumo *Navicross™*).

Utilize **re-entry devices** (such as *Outback – Cordis*, *Pioneer – Philips*) in circumstances where antegrade or retrograde re-entry is not possible.

C) Retrograde Approach

Puncture a healthy downstream vessel (distal SFA, popliteal, or tibial artery) using ultrasound or fluoroscopic guidance.

Procedure:

- Attempt intraluminal retrograde recanalization first; if unsuccessful, perform subintimal retrograde recanalization.

Common Materials:

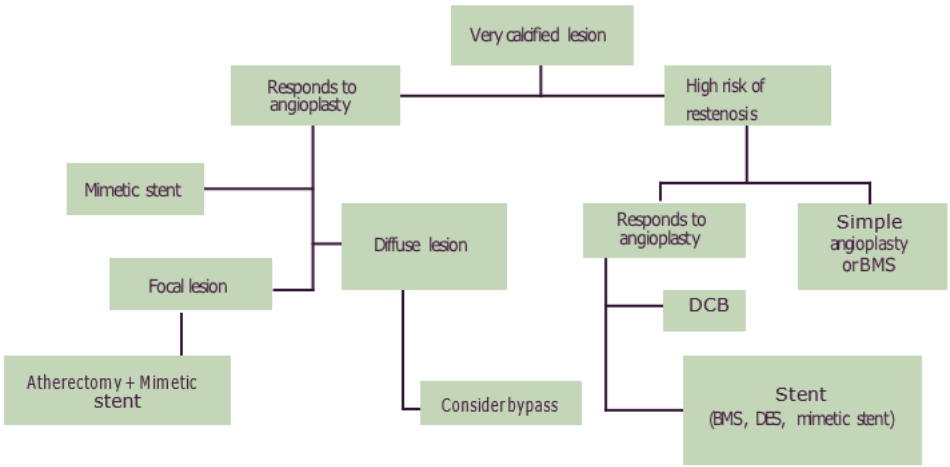
- **Guidewires:** 0.018” (*V18 – Boston*, *Command/Connect – Abbott*).
- Typically, no introducer required – use low-profile support catheters or **3Fr micro puncture kit (Cook)**.

Treating

- **Arterial Dilatation/Pre-dilatation:** use balloons typically 1 mm smaller than the artery diameter (4–5 mm). Typical angioplasty balloons: 4×40 mm, 4×100 mm, 5×40 mm, 5×100 mm, 6×40 mm, 6×100 mm.
- Use long insufflations (3–5 min) to reduce flow-limiting dissections.
- For recoil, persistent stenosis, or flow-limiting dissections: prolong inflation or use different balloon diameters.
- **Stent Indications:** recoil, residual stenosis > 30%, flow-limiting dissection, complex/calcified lesions, or long occlusions.

Treatment proposal according to lesion type:

Figure 1: Treatment proposal according to the type of lesion. (DCB - Drug coated balloon. BMS: bare metal stent. DES - Drug eluting stent)



Based on: Dr. K. Deloose Lesion-Specific SFA Device Selection VOL. 18, NO. 9 SEPTEMBER 2019 ENDOVASCULAR TODAY

Stent Options:

- **Self-expanding stents:** size according to lesion.
- **Primary stenting SFA** *(Ref. 5)*.
- **Covered stent:** *Viabahn® Endoprosthesis by Gore* for long or in-stent lesions.
- **Drug-eluting stent (DES)** *(Ref. 7)*.
- **Drug-coated balloon (DCB)** *(Ref. 8)*.
- **Claudication:** treat only in disabling cases where best medical therapy fails *(Ref. 6)*.

Closing

1. **Manual compression**
2. **Closure systems:**
    - 6–8F: *FemoSeal™ Terumo*/*Angio-Seal™ Terumo*
    - 10–14F: 1 × *Perclose ProGlide™ Abbott*/*Perclose Prostyle™ Abbott*
    - 14F: 2 × *Perclose ProGlide™ Abbott*/*Perclose Prostyle™ Abbott*

DISTAL ANGIOPLASTY

by Daniel Brandão

Technique & Materials

Access

- **Antegrade femoral access** is preferred after excluding (through imaging) relevant upstream lesions, including the initial segment of the superficial femoral artery.
- Perform echo-guided femoral artery puncture and place a **4–6F sheath**.
- For complex cases requiring maximal support, a **45 cm 4–6F sheath** may be advanced up to the third portion of the popliteal artery.

Crossing

- Use a **0.014" or 0.018" guidewire** with a moldable hydrophilic tip and semi-rigid to rigid body as the workhorse wire (Terumo Radifocus™ Glidewire Advantage ™, *Abbott™ Command 14 ES* or *Command 18 ST*; *Boston Scientific™ V18*).
- Vessel selection below the knee can be performed using the wire alone (after tip molding) or with a **Bernstein 4F** catheter.
- Consider the use of a **0.018" support catheter** (*Terumo Navicross™*; *Boston Scientific Rubicon*; *Cook CXI*).

Treatment

- **Angioplasty balloons:**
    - Length and diameter are defined according to the target lesion.
    - The use of a **drug-eluting balloon** should depend on lesion type and clinical evidence.
    - Use **low-profile angioplasty balloons** for heavily calcified lesions that standard balloons cannot cross (*Cook*, *Boston*, *Biotronik*, *Terumo*, *Abbott*).
    - Consider **sequential angioplasty** with progressively larger balloons.
    - Extended inflation times (≥ 2 min) are recommended.
- For **short focal lesions**, consider using a **drug-eluting stent**.

Closing

- Refer to closure recommendations under *Iliac* and *Femoral Angioplasty* sections.

Practical techniques and expert insights – Alternative Techniques

Use when **anterograde crossing** of an occlusion is not possible:

Retrograde Puncture

- Use a **21G needle** (4 cm for foot, 7 cm for leg).
- Perform **X-ray-guided** (with proximal contrast injection) or **echo-guided** puncture.
- Use a **0.018" guidewire** with a moldable hydrophilic tip and rigid body (*Abbott Command 18 ST*; *Boston Scientific V18*; *Radifocus™ Glidewire Advantage™*).
- Consider placement of a **reduced-caliber sheath** (4F OD) for leg-level punctures (*Cook Micropuncture Pedal Introducer Access Set*).
- Advance the guidewire **with or without** a support catheter (preferably without).
- After successful retrograde crossing, **snare the guide** into a **Bernstein 4F** catheter — establishing continuity between antegrade and retrograde subintimal spaces (possible via **rendezvous technique** or equivalent).
- Proceed to **vessel treatment**.
- At completion, achieve hemostasis using **external compression** with or without **low-pressure balloon angioplasty** and **prolonged inflation**.

Pedal-Plantar Loop Technique

- Use a **0.014" guidewire** with a hydrophilic floppy tip and semi-rigid or floppy body (*Abbott Command 14*; *Terumo Runthrough® NS, Floppy*).

III AORTIC ANEURYSMS

AAA

ENDOVASCULAR TREATMENT OF ABDOMINAL AORTIC ANEURYSM

by Gonçalo Alves

Technique & Materials

Access

Two possible approaches:

- **Bilateral access** to the common femoral arteries, potentially with surgical exposure.
- Alternatively, **percutaneous puncture** may be used in selected cases, always echo-guided. In such cases, the closure device should be **pre-positioned or prepared** according to its specific mechanism (*Ref. 1, 2, 3*).

Note 1: In certain situations, a **retroperitoneal approach** may be required by dissecting the common iliac artery and performing an anastomosis with an **8 mm Dacron straight prosthesis**, which will serve as access for endoprosthesis introduction (*Ref. 4*).

Note 2: The patient should be **heparinized** to maintain an **activated clotting time (ACT) ≥ 300 s**, sustained throughout the procedure *(Ref. 5, 6)*.

Procedure

A. Introduction

1. Guided by a **0.035" hydrophilic guidewire** (Terumo Radifocus™ Guide Wire M Standard), advance a **Pigtail catheter** (*Cordis* or *Cook*) above the proximal neck of the aneurysm.
2. Perform anatomic study of the **aorta, iliac arteries, and aneurysm**.
3. Select the **endovascular prosthesis** considering the patient's anatomy and device features. Keep several prostheses available (close size options), along with **iliac extensions** and **proximal cuffs/extensions** *(Ref. 7, 8, 9)*.

B. Catheterization

1. Main Branch

- Insert a **60 cm Pigtail catheter** (various brands) and advance an **extra-rigid guidewire** (*Lunderquist – Cook*, *Amplatz – Boston Scientific*, *Backup Meier – Boston Scientific*, *or Terumo Radifocus™ Glidewire Advantage™*) to the proximal aneurysm neck.
- For a **bifurcated endoprosthesis**, maintain a **second extra-rigid guidewire** in the contralateral limb. The main body's rigid guide stabilizes the device during contralateral limb manipulation.
- Position the **main body** immediately below the **lowest renal artery** and orient it for easy contralateral branch access.

2. Contralateral Branch Catheterization

- Advance a **0.035" hydrophilic guidewire** (*Radifocus™ Guidewire, Terumo*).
- Place a **Pigtail catheter** (any brand) above the renal arteries for angiographic control.

C. Main Body and Branches Deployment

1. Perform **angiography** marking the **lowest renal artery** in optimal projection.
2. Deploy the **main body** of the prosthesis in **juxtarenal position**, up to the level of the contralateral branch.
3. **Branch Catheterization:** use **short catheters** (45–60 cm) such as:

    - *Beacon Tip Van Schie – Cook*
    - *Berenstein – Boston Scientific*
    - *Cobra – Terumo (Radifocus™ family)*
    - *Vertebral – Terumo (Radifocus™ family)*
4. Confirm correct catheterization of the contralateral branch using **Pigtail** or **NC inflatable balloon** (any brand).
5. Complete opening of the main body and **bi-iliac extension** under angiographic control, visualizing the hypogastric arteries.
6. Extend both **iliac limbs** to the hypogastric level, confirming patency angiographically.
7. Perform **final biplane angiography** using a **Pigtail catheter** and **hydrophilic guidewire** at the contralateral artery:
    - Injection volume: **10–15 ml**
    - Injection speed: **20 s**
    - Pressure: **600–800 PSI**
8. Conduct **initial and final angiography during apnea** for optimal image clarity.

D. Closing

- Achieve arterial closure either **surgically or percutaneously** using closure systems such as **ProGlide (Abbott)** or **MANTA (Teleflex)** *(Ref. 10, 11)*.

ENDOVASCULAR TREATMENT OF AORTIC ANEURYSM WITH FENESTRATED ENDOPROSTHESIS

by Gonçalo Alves

Technique & Materials

Preliminary Notes

Study the anatomy of the **aorta, iliac arteries, and aneurysm**, considering:

- Aortic wall characteristics (parietal thrombus, angulation, calcification).
- Visceral vessels (caliber, orientation, origin in healthy or aneurysmal aorta).
- Femoral and iliac access routes (diameter, angulation, calcification).

Access

Two possible approaches:

1. **Bilateral access** to the common femoral arteries with surgical exposure.
2. **Percutaneous puncture**, always echo-guided, may be used in selected cases. In these cases, the closure device should be **introduced in advance** according to its specific type.

Note 1: A **retroperitoneal approach** may be required in certain cases by dissecting the common iliac artery and performing an **8 mm straight Dacron prosthesis anastomosis**, which will serve as access for endoprosthesis introduction *(Ref. 4)*.

Note 2: Maintain **heparinization** with **activated clotting time (ACT) ≥ 300 s** throughout the procedure *(Ref. 5, 6)*.

Procedure

- Introduce a **60 cm Pigtail catheter** (any brand) and **extra-rigid guidewire** (*Lunderquist – Cook*; *Backup Meier – Boston Scientific*; *Terumo Radifocus™ Glidewire Advantage™*) to the proximal aneurysm neck.
- Under **0.035" hydrophilic guidewire** guidance (*Terumo Radifocus™ Guide Wire M Standard*), position a **Pigtail catheter** (*Cordis* or *Cook*) above the renal arteries.
- Orient the **fenestrated prosthesis** outside the body, align fenestrae according to renal artery ostia, and insert maintaining the pre-established orientation.

- Perform **angiography** to identify renal arteries; release the endoprosthesis in the cephalocaudal direction, ensuring fenestrae alignment with respective ostia.
- Remove Pigtail catheter and catheterize the fenestrated prosthesis for rigid guide and **18F sheath** placement.
- Adjust C-arm angulation to optimize visualization and catheterization of each fenestra and corresponding visceral vessel using:
    - *Berenstein (Boston Scientific)*
    - *Cobra (Radifocus™ Terumo)*
    - *Shepherd Hook (Cordis)*
    - *Uni-Select (Cordis)*
    - *Vertebral (Radifocus™ Terumo)*
- Replace hydrophilic guide with **rigid guide** (*Rosen*, *Amplatz*) and introduce a **6–7F sheath** in the target vessel.
    - Note: when 3–4 fenestrae exist, only two will receive sheaths; the remaining will have guides only.
- Complete **release of the fenestrated endoprosthesis** and perform **balloon dilatation** as required.
- Deploy **stents in the visceral vessels** and perform **post-dilatation with a 10–12 mm balloon (flare technique)**.
- Release **bifurcated endovascular prosthesis** after aortic bifurcation angiography.
- **Catheterize the contralateral branch using short catheters (45–60 cm):**
  – Beacon Tip Van Schie – Cook Medical
  – Berenstein – Boston Scientific
  – Cobra – Terumo (Radifocus™ family)
  – Vertebral – Terumo (Radifocus™ family**)**
- Confirm catheterization using a **Pigtail** or **NC inflatable balloon** (any brand).
- Complete the opening of the **main body** and **bi-iliac extensions** under angiographic control, visualizing hypogastric arteries.
- Perform **balloon dilatation** of the bifurcated prosthesis and iliac extensions.

Final Biplane Angiography:

- Injection volume: **15–20 ml**
- Injection speed: **20 s**
- Pressure: **600–800 PSI**

Perform **initial and final angiography during apnea**.

Closure Systems

- Arterial closure by **direct suture** or **percutaneous system** (*ProGlide – Abbott*; *MANTA – Teleflex*).

Practical techniques and expert insights (*Ref. 13–16*)

- Maintain accurate pre-operative alignment using 3D imaging and fusion overlay.
- Always confirm renal artery orientation before deployment.
- Ensure guide stability during fenestra catheterization to prevent misalignment.
- Keep additional sheaths and guidewires on standby for visceral stenting.
- Perform completion angiography in apnea to prevent motion artifacts.

ARCH ANEURYSM/PATHOLOGY

TAA

ENDOVASCULAR TREATMENT OF AORTIC ARCH ANEURYSM WITH DOUBLE/TRIPLE BRANCHED DEVICES

by Pedro Amorim

New devices have emerged recently for the arch. Below is a summary description of the technique using COOK and Terumo-Aortic anterograde branched devices according to the author's experience. Radiation emitted during fluoroscopic procedures is responsible for the greatest radiation dose for medical staff.

Preliminary Notes

Study the patient's aorta artery, iliac arteries, and aneurysm anatomy. Select the endovascular prosthesis based on aorta features (thrombus, angulation, calcification), supra-aortic trunk vessel parameters (size, orientation, origin in healthy or aneurysmal aorta), and femoral/iliac access characteristics (diameter, angulation, calcification).

Technique & Materials

Access

1. Bilateral access to the common femoral artery.

When using very large devices, especially if the surgeon opts for percutaneous access, it's crucial to consider the access diameter. Device sizes can reach up to 29 F OD.

We strongly recommend surgical cutdown/exposure of at least one common femoral.

Likewise with TEVAR, a 6F percutaneous access is enough for angiographic control (or bigger to be compatible with the eventual planned retrograde bridge stent for the LSCA, for instance).

Many times, conduct of any kind can be mandatory and can save the whole procedure.

Supra Aortic Vessels – Alternatives

a) Direct exposure of both common carotid arteries – standard fashion.
b) Direct exposure right axillary artery + left common carotid artery (LCCA) – avoids bilateral cervical carotid exposure but needs to have a safe long landing zone at the right brachiocephalic trunk (RBCT) and its tortuosity and angulation should be favorable.
c) In some cases, the left common carotid is not a vessel to be branched (too narrow/diseased/dissected, e.g.) and a left subclavian artery (LSCA) – left common carotid artery (LCCA) bypass or a transposition of the LCCA into the LSCA is needed; cutdown of the left axillary artery may be indicated.
d) Retro/Anterograde approach of the anterograde branches has previously been done successfully with steerable sheaths coming from femoral approach.
e) Normally, if it is a triple branch device, the third one is retrograde and catheterized from below. Nevertheless, if not possible, a 4F introducer/sheath from the left radial/brachial artery is sufficient to go through the branch and can be snared from the femoral access and advanced from below to deploy the bridge stent (a through-and-through wire can be helpful for advancing the stent).
f) Extra venous access can be necessary for rapid pacing.

Note: Once accesses are made systemic heparinization is mandatory for an activated clotting time (ACT) ≥ 300 sec. This level of anticoagulation is maintained throughout the procedure.

Procedure

A 300 cm hydrophilic guidewire (Terumo Radifocus™ Guide Wire M Standard) is introduced through the main femoral access. The aortic valve is crossed using a catheter (e.g., Pigtail, Berenstein, or Amplatz left), allowing entry into the left ventricle. An extra-rigid guidewire (e.g., Lunderquist from Cook, BackupMeier, or Safari from Boston) is then advanced through the catheter to serve as a track for delivery of the endoprosthesis into the ascending aorta. If rapid pacing is planned via this extra-rigid guidewire, it's important to test pacing thresholds at this time.

- From the contralateral femoral guided by a 0.035mm hydrophilic guide (Terumo Radifocus™ Guide Wire M Standard), a pigtail catheter (Cordis or COOK) is positioned into the ascending aorta.
- Orientation of the prosthesis outside the patient and all marks checked.

- Right ventricle accessed via central venous access and electrode tested for the thresholds for rapid pacing.
- Advancement of the main graft into the thoracic descending aorta and oriented as needed.
- Angiography to identify the coronary arteries and RBCT in the best projection possible to see its takeoff. The pigtail can be retrieved distally.
- Final advancement of the graft and deployment under rapid pacing. A small security distance must be kept (+- 1 cm) from the RBCT ostium to facilitate catheterization and smooth the path of the bridging stents. Rapid pacing can be turned off and an extra-rigid guidewire can now exit from the left ventricle.
- Advancement of the pigtail and a new angiography should be done to check the correct positioning of the graft and to detect unexpected complications.
- Perfusion of the limb can be considered if no further use of the main femoral access is predictable (although keeping the wire in place can be useful).
- Retrograde access (e.g., via 6F introducers) of branches with catheterization of the tunnels is normally easy to be done with a 40 cm Berenstein Cordis and with the correct arch projection. Usually, RBCT will be bridged to the posterior tunnel and LCCA to the anterior.
- Once the inner-tunnel is targeted, confirmation is made by withdrawing a pigtail or by inflating a balloon at the proximal edge of the tunnel.
- A centimeter-marked pigtail can be used to measure the ideal length of the chosen covered bridge stent (dedicated limb, Viabahn Gore, iliac extension, Gore standard EVAR, etc.).
- A compatible sheath must be placed, and a bridge stent will go over a 0.035 rigid guidewire (Rose Cook; Amplatz Boston; Terumo Radifocus™ Glidewire Advantage™). Consider doing this step while clamping the carotid artery and restore flow after a good washout.
- Angiography is done to check patency and to confirm extension of the covered vessel. Normally and ideally no ballooning is needed or recommended.
- Same procedure for the other anterograde supra-aortic trunk.
- As stated above, if a third retrograde branch is to be targeted, its catheterization most of the time can be successfully done from femoral access. As the angle of this retrograde branch is predictably close to 90º, a Viabahn Gore or a similar self-expandable covered stent is normally the choice for bridging. The vertebral artery must be preserved and therefore seen while the stent is placed.

Completion angiography through a pigtail catheter in the ascending aorta displays the final result.

ENDOVASCULAR TREATMENT OF THE DISTAL AORTIC ARCH (INVOLVING THE LEFT SUBCLAVIAN ARTERY)

by Marina Neto

Preliminary Notes

Thoracic endovascular aortic repair often requires extending the proximal landing zone into Zone 2, resulting in coverage of the left subclavian artery (LSCA). Managing the LSCA appropriately is essential to minimize risks of posterior circulation stroke, upper extremity ischemia, and spinal cord ischemia.

Custom-made branched devices (Gore™, COOK™, and Terumo™) and physician-modified grafts—whether prepared on the back table or via in-situ fenestration—represent viable options for LSCA revascularization, allowing operators to avoid the complications of LSA bypass or transposition such as phrenic nerve injury, cervical hematoma, lymphatic leak, infection, and vagus nerve injury.

The endovascular prosthesis should be chosen considering the aortic characteristics (parietal thrombus, angulations, calcification), supra-aortic trunk vessels (gauge, orientation, origin in healthy or aneurysmal aorta), and femoral/iliac accesses (diameter, angulations, calcification).

Material

Its main feature is a retrograde side branch that opens into a rectangular window on the outer curvature of the graft, typically accommodating the left subclavian artery (LSA) or, in more proximal configurations, another supra-aortic vessel. The LSA branch is positioned at the 12 o'clock orientation.
The single-branch LSA device designed by Cook Medical™ (William Cook Europe, Bjaeverskov, Denmark) incorporates a retrograde LSA branch with a pre-loaded catheter to facilitate access into the branch, and a triple-wide scallop that allows placement of the stent graft in the mid-segment of the aortic arch while preserving flow into the left common carotid artery (LCCA) and innominate artery (IA) *(Ref. 2)*.

The Terumo Relay™ system also allows the integration of proximal scallops or notches, in addition to the retrograde branch.

When performing back-table modifications, the thoracic stent graft (made of polyester or a double layer of PTFE) is perforated with an electrocautery. The margins are reinforced with a radiopaque material and sutured. The modified graft is ensheathed prior to insertion into the patient.

In-situ fenestration requires the use of a puncture system (such as the Lifetech™ Futhrough™ endovascular needle system) followed by balloon dilatation of the puncture site in the main graft before LSA stent deployment *(Ref. 3)*.

Access

1. Bilateral access to the common femoral arteries
2. Left subclavian artery incorporation (alternatives)
    a) Catheterization of the retrograde branch from below can be performed using a pre-cannulated wire (such as in the Gore™ device) or a pre-loaded catheter (such as in the Cook™ device).
    b) If catheterization from below is not possible or if advancement of the stent is difficult, an introducer/sheath may be inserted through the left radial or brachial artery to access the branch and then snared from the femoral access. Subsequently, deployment of the bridging stent can be performed from the femoral artery over the through-and-through wire.
    c) If in-situ fenestration of a TEVAR intentionally covering the LSA is planned, percutaneous access to the left axillary/left brachial artery (or direct surgical exposure) may be required to introduce the puncture needle.
3. Extra venous access (for example, a common femoral vein) can be necessary for rapid pacing.

Note: Once accesses are made, systemic heparinization is mandatory for an activated clotting time (ACT) ≥ 250 sec. This level of anticoagulation is maintained throughout the procedure.

Procedure

Note: The description provides the technique GORE® TAG® Thoracic Branch Endoprosthesis according to the authors' experience *(Ref. 1)*.

- Fusion marks are obtained using the preoperative CT scan to identify the origins of the left subclavian artery (LSA) and the left common carotid artery (LCCA).
- From the main femoral access, an extra-rigid guidewire (e.g., Lunderquist, Cook, or Backup Meier, Boston Scientific) is introduced through a catheter into the proximal ascending aorta.
- The LSA is also cannulated via the main femoral access using a 300 cm hydrophilic guidewire (Radifocus™ Guide Wire Standard, Terumo) and advanced as distally as possible into the arm to provide additional wire support.
- The aortic device may be flushed with CO_2 and subsequently with heparinized saline.
- The primary and branch guidewires are then inserted through the device, which is partially advanced into the access sheath to allow back-bleeding through the endoprosthesis, thereby further flushing the graft and preventing air embolism.
- Advancement and positioning of the endograft are performed based on the fusion marks.

- A pigtail catheter is advanced from the contralateral common femoral artery, and angiography is performed.
- The pacing electrode is tested for rapid pacing thresholds (systolic blood pressure is decreased to approximately 90 mmHg prior to device deployment).
- The graft is then positioned appropriately—taking care not to cover the LCCA—and deployed under rapid pacing.
- The LSA stent is then advanced from the main access.
- If there is difficulty advancing the LSA stent through the gate, a through-and-through access may be created via the brachial artery to provide additional wire support and to allow introduction of a long 6 Fr brachial sheath, adapted to the stent-graft nose cone tip.
- The LSA stent is deployed carefully, ensuring the left vertebral artery is not covered, followed by ballooning of the stent proximally and distally.
- Completion angiography is performed to confirm patency and adequate extension of the covered aortic segment and target vessels.
- Additionally, a cone-beam CT may be performed intraoperatively to rule out any graft compression or technical complications.

Back-table Fenestration Adaptations(Ref. 3)

The aortic stent graft is partially deployed—approximately 4–5 cm—to allow creation of the fenestration.

- An electrocoagulation instrument, tissue scissors, or a sharp scalpel is used to make the fenestration, avoiding damage to sutures that bind the stents to the fabric.
- Using Ankura™ stent graft (Lifetech Co. Ltd., China), there is no need to reinforce the fenestration with a radiopaque material. The fenestration must be made in the membrane distal to the "∞" radiopaque marker. Another radiopaque marker is the "strut," which is kept in the central line of the fenestration.
- The size and distance between the "∞" marker and the proximal border of the fenestration are determined individually for each patient.
- The fenestrated stent graft is then reloaded into the outer sheath and flushed with heparinized saline.
- The stent graft is delivered to the aortic arch over a super-stiff guidewire, ensuring that the "∞" radiopaque marker appears as "e" on fluoroscopy and that the strengthened strut lies along the greater curvature of the aortic arch.
- The stent graft is then fully deployed.
- A digital subtraction angiography (DSA) is performed to evaluate the repair.
- The fenestration is crossed with a catheter and guidewire (from the femoral artery or distal branches).
- A bare-metal stent or covered stent graft is advanced over the wire across the fenestration—approximately 1–1.5 cm within the aorta and the remaining portion within the branch artery. The branch bridging stent is deployed once the position is satisfactory.
- A final angiography is performed to confirm proper positioning of the aortic stent graft and bridging stent, and to assess for endoleaks.

In-situ Fenestration (Ref.3,4)

After regular TEVAR with intentional coverage of the LSA ostium:

- After deployment, the graft is punctured through the left axillary artery using the reversed end of a 0.014" guidewire, puncture needle, reentry catheter, radiofrequency puncture, or laser system.
- A low-profile 4 mm diameter balloon is used to enlarge the fenestration.
- A larger 8 mm high-pressure, non-compliant balloon (Conquest™, Bard Inc.) or a cutting balloon is then introduced.
- The fenestration is then stabilized with a balloon-expandable covered stent.

IV VISCERAL ANEURISMS

by João Vieira, Pedro Amorim

EMBOLIZATION OF VISCERAL ANEURYSMS

Technique & Materials *(Ref. 1,2)*

Access

- Femoral access is usually preferred; consider (left) brachial access depending on the celiac trunk anatomy.

Catheterization and Navigation

- Selective catheterization of the celiac trunk (prefer 4/5F hydrophilic catheters such as Terumo Radifocus™ Glidecath™ with dedicated shape – Simmons 1.2, Cobra 1.2, Yashiro).
- Hydrophilic guidewire with regular body and curved tip 0.035" x 260 cm (Terumo Guidewire).
- A more rigid guidewire for the placement of a sheath (Cook Rosen; Radifocus™ Guide Wire M Stiff Curved Tip or Radifocus™ Glidewire Advantage™ 0.035" x 260 cm).
- Placement of a hydrophilic sheath in the splenic artery (location depending on the segment of the artery to be treated and the anatomy; sheath caliber to be determined by the planned procedure: covered stent placement versus embolization).

Treatment

Covered stent (preferred technique for the proximal third of the splenic artery) *(Ref. 3)*

- Prefer self-expanding covered stents (Viabahn, Gore).
- In some circumstances, a balloon-expandable covered stent can be considered (Viabahn VBX, Gore; Papirus, Biotronik; BeGraft, Bentley).
- In circumstances where a 0.018" platform is chosen, prefer guidewires with a rigid body and flexible hydrophilic tip such as the Radifocus™ Glidewire Advantage™ 0.018" or Abbott Command ST.

Embolization (preferred technique for the middle and distal third of the splenic artery) *(Ref. 4)*

- Place the hydrophilic catheter as distally as possible.
- Navigate with microcatheter (Terumo Progreat™ 2.9F and associated microguide – Radifocus™ Guide Wire GT with gold coil, Terumo).
- Perform distal and proximal release of coils (prefer detachable volume coils – Terumo AZUR™ and AZUR CX).
- If the release of coils in the aneurysmal sac is necessary, start with a framing coil (Terumo AZUR™ Framing Coil); thrombogenic coils can also be considered (Nestor or Tornado, COOK).

Consider alternative techniques such as the stent-assisted coiling technique.

V CAROTID DISEASE

CAROTID ANGIOPLASTY AND STENT PLACEMENT

by Pedro Amorim

Preliminary Notes

Patients receive aspirin at a dose of 80–100 mg/day and clopidogrel at a dose of 75 mg/day, both starting at least six days before the procedure *(Ref. 1)*. As an alternative, a loading dose of clopidogrel 300 mg can be given the night before the procedure. Aspirin should be maintained indefinitely and clopidogrel for at least 3 to 6 months after the intervention.

Technique & Materials

Access

The access decision should be based on imaging, with special focus on the study of the aortic arch. Femoral and radial access should be considered. Femoral access may be contraindicated (formally or relatively) in cases including the presence of vascular prostheses, aneurysms, long occlusive disease, "shaggy" aorta, aortic arch pathology, or unfavorable morphology.

Consider cervical surgical access (Silk Road T-CAR – Trans Carotid Artery Revascularization) as an alternative to avoid manipulation of the aortic arch, with direct approach of the common carotid artery at the base of the neck. The brachial access (useful on the right or also on the left if there is a bovine aortic arch) can also be considered.

A. Introducers: after percutaneous puncture of the femoral artery with a 5F or 6F introducer (Radifocus™ Introducer II, Terumo).
The puncture must always be echo-guided with local anesthesia. Avoid the use of sedatives and other drugs that impair the patient's collaboration and neurological evaluation during the procedure.

B. Guidewire in the aortic arch: hydrophilic 0.035 x 260 mm (Radifocus™ Guidewire, Terumo).
Anticoagulation with 100 U/kg unfractionated heparin should follow.

Crossing

A. Common carotid catheterization is performed with Radifocus™ Glidecath™ vertebral 4F–120, MP, or Headhunter catheter (usually the first options).

Note: Consider using dedicated and steerable catheters (Piton GC, Medtronic; TourGuide, Medtronic).

B. Diagnostic angiography: use utmost caution to avoid gas embolization. All materials must be purged, and the use of 3-way taps is mandatory. Perform projection of the carotid bifurcation.
C. Place a wire in the external carotid artery and exchange it for a rigid wire (Rosen, COOK; Amplatz, COOK or Boston). The use of the Radifocus™ Glidewire Advantage™ should be considered.
D. Stabilize the sheath on the common carotid artery (*Destination™ Guiding Sheath Terumo*; or Flexor, COOK). If the Mo.Ma brain protection system (Medtronic) is used, a sheath is not necessary.
E. Employ road-mapping to pass the stenosis with a Cerebral Protection Filter (FPC) and its positioning in the distal internal carotid artery.

Adopt protection in at-risk patients (symptomatic). In asymptomatic patients, no protection is required.

Protection options:

- Flow inversion – Mo.Ma (Medtronic)
- Filters: Emboshield (Abbott), Spider FX (Medtronic), Filterwire EZ (Boston)

Treatment

Placement of a self-expanding dual-layer stent that advances over the filter and should be positioned at the level of the stenosis.

In cases where the filter cannot be advanced due to severe stenosis, crossing may be achieved with a 0.014 guidewire, and angioplasty can be performed with a 3.0/2.0 mm diameter balloon. However, this maneuver should be avoided.

Stent *(Ref. 6)*
Roadsaver™ Carotid Artery Stent (Terumo) –attention must be paid to the double mesh marks that must be positioned at the stenosis center.

Post-dilatation Balloon
Use short balloons (2 cm) for 0.014 guidewires for post-ballooning of the internal carotid artery intrastent segment only.

Closing *(Ref. 7)*
6–8F FemoSeal™ (Terumo)/Angio-Seal™ (Terumo).

VI VENOUS DISEASE

ENDOVASCULAR TREATMENT OF PELVIC VENOUS CONGESTION SYNDROME

by João Vieira

Technique & materials *(Ref. 1,2)*

Access

Access may be obtained through the **femoral veins** or through the **upper-extremity veins** (basilic or cephalic). Upper-extremity access is typically performed at the cubital fossa.

- Echo-guided puncture of the basilic or cephalic vein in the cubital fold
- Placement of a **4F or 5F introducer** (Radifocus™ Introducer II, Terumo)
- After confirmation of venous dilatation and reflux, **selective catheterization** of the target vessel is performed (Multipurpose, Vertebral, or Internal Mammary 5F Radifocus™ Glidecath™, Terumo)
- Advance the guidewire and catheter to the most distal feasible position

Note: Ovarian and internal iliac vein angiography is often performed with the patient in the **prone position.**

Treatment (Embolization *(Ref. 3,4)***)**

Material: Polidocanol (Etoxisclerol®or lauromacrogol 400) 2%

- **Volume coils** (AZUR™ and AZUR™ CX, Terumo) and other non-thrombogenic coils

Endovascular treatment may be performed using **liquid or solid** embolic agents (coils, plugs), applied either alone or in combination. The choice of embolic materials largely depends on **operator experience and preference**, as both clinical and technical success rates are high across techniques. Treatment is aimed at **ectatic vessels**. There is no consensus in the literature regarding the exact number of vessels that should be treated *(Ref. 5)*.

Coiation

Coil deployment typically begins at the **inferior portion of the ovarian vein**, with care taken to avoid occlusion of the deep pelvic venous plexus. Stainless steel or fibered platinum coils of various diameters may be used.

Glue Embolization

Liquid embolization with **cyanoacrylate glues** (e.g., enbucrilate/n-BCA/NBCA), often combined with coils, is a valid alternative for the treatment of pelvic venous congestion syndrome. NBCA is mixed with **lipiodol** to increase radiopacity and adjust polymerization time.

Mixed Technique

- Embolization of pelvic varices using **2% dense polidocanol foam** (prepared by passing the foam through a syringe at least 40 times)
- Selective catheterization and embolization of affected vessels with **volume coils**
- Placement of the **first coil as distally as possible** with controlled release, followed by foam injection, continuing sequentially to the final point of reflux
- Controlled release of volume coils with **30–40% oversizing**; for internal iliac (hypogastric) branches, the oversizing should be **≥ 50%**
- Always embolize **selected branches**, never the main hypogastric trunk

Laterality

Current evidence suggests **no statistically significant difference** between **unilateral** and **bilateral** embolization with regard to **clinical outcomes**.

VII COMPRESSION SYNDROMES

ENDOVASCULAR TREATMENT OF MAY-THURNER SYNDROME

by Sérgio Silva

Preliminary Notes

Patient Selection

Indications

1. Symptomatic iliac vein outflow obstruction (leg swelling, pain, venous claudication, skin changes, or non-healing venous ulcers; CEAP C3–C6).
2. Documented >50% stenosis or occlusion of the iliac vein by contrast venography, CTV, MRV, or (preferably) IVUS.
3. Recurrent or extensive DVT despite anticoagulation. *(Ref. 1)*

Contraindications

1. Asymptomatic anatomic compression alone.
2. Active systemic infection.
3. Uncorrected bleeding disorders. *(Ref. 1)*

Preoperative Evaluation

1. Detailed clinical exam with attention to DVT risk factors and comorbidities.
2. Baseline duplex venous ultrasound for initial screening.
3. Cross-sectional imaging (CTV or MRV) to define anatomy and exclude alternative causes.
4. Venography and IVUS as the procedural gold standard for confirming diagnosis, grading stenosis, and guiding intervention. *(Ref. 1,2)*

Procedure Preparation

1. Setting: Interventions should be performed in specialized vascular centers.
2. Anesthesia: Local anesthesia plus sedation for non-thrombotic lesions; general anesthesia may be necessary for severe post-thrombotic cases.
3. Access: Preferably via contralateral common femoral vein (CFV) or ipsilateral popliteal vein (PV) in the prone position for extensive thrombosis. *(Ref. 1)*

Technique & Materials

Access

Vascular Access and Anticoagulation

1. Percutaneous access under ultrasound guidance.
2. Systemic heparinization (UFH 80–100 IU/kg). *(Ref. 2)*

Crossing

1. Diagnostic catheter (e.g., 5F multipurpose, Cobra) advanced toward the iliac vein.
2. Lesion crossed with a 0.035" hydrophilic guidewire (e.g., Terumo), using support catheter if required.
3. Escalate to stiffer wire (e.g., Amplatz Super Stiff) in resistant cases.
4. Valsalva maneuver is helpful for tight stenoses. *(Ref. 1)*

Diagnostic Imaging

1. Initial venogram to delineate lesion.
2. Intravascular ultrasound (IVUS) for:
    - Degree and length of stenosis.
    - Accurate vessel sizing and landing zones.
    - Identification of any venous spurs, webs, or intraluminal synechiae.
3. Perform both before and after intervention. *(Ref. 2)*

Treatment

Acute or Subacute DVT:

1. Catheter-directed thrombolysis (CDT) (alteplase, urokinase, etc.).
2. Mechanical thrombectomy (e.g., AngioJet, Cleaner XT).
3. Pharmacomechanical approaches in selected patients.
4. Proceed with stenting only after clot clearance. *(Ref. 1,2)*

Balloon Angioplasty

1. Predilatation with dedicated venous or high-pressure balloon (typically 12–16 mm diameter, up to 18 mm in large caliber iliac veins).
2. Avoid excessive oversizing to minimize rupture risk. *(Ref. 1,2)*

Stenting

Stent Selection

1. Self-expanding nitinol stents specifically designed for venous anatomy (Cook Zilver Vena, Boston Scientific VICI, Venovo, Abre, etc.).
2. Stent diameter ~20% greater than reference vessel (often 14–18 mm diameter).
3. Sufficient length (typically 60–120 mm) to cover lesion plus 10–20 mm into healthy vein proximally and distally.
4. Avoid placement across the confluence of the IVC unless absolutely necessary ("confluence sparing" if possible).

Deployment

1. Under combined venographic and IVUS guidance.
2. Confirm correct stent expansion and apposition.
3. Post-dilatation with balloon sized 1–2 mm less than stent diameter to optimize luminal gain, especially at both ends. *(Ref. 1)*

Completion and Hemostasis

1. Completion of venography and IVUS to confirm:
    - Resolution of stenosis.
    - Absence of residual thrombus or dissection.
    - Inflow/outflow adequacy (examine distal femoral/CFV inflow; iliac/IVC outflow).
2. Achieve hemostasis (manual compression or closure device as appropriate). *(Ref. 1,2)*

Post-Procedural Care

1. Anticoagulation for at least 3–6 months (LMWH bridging to anticoagulant of choice: warfarin or DOAC).
2. Antiplatelet therapy may be considered for selected patients or stent types.
3. Early ambulation and use of class II–III compression stockings as tolerated.
4. Activity restriction (avoid heavy lifting/straining for 2 weeks).
5. Monitor for access site complications and early thrombosis. *(Ref. 2,3)*

Follow-Up and Surveillance

1. Clinical review and duplex ultrasound at 1, 3, 6, 12 months, then annually.
2. Imaging should assess stent patency, inflow/outflow, and limb symptoms.
3. IVUS may be reconsidered if restenosis symptoms develop. *(Ref. 1)*
4. **Complications:** Recognize and manage promptly:
    - Failure of cross-occlusion: alternative wires/recanalization.
    - Stent migration/embolization: careful sizing and deployment; retrieval if possible.
    - Perforation/rupture: balloon tamponade, covered stent if needed.
    - Early/late reoccurring thrombosis: optimize anticoagulation; consider re-thrombolysis or revision. *(Ref. 2,3)*

Outcomes

1. Primary patency at 2 years: 80–90% in recent series.
2. Complication rates (thrombosis, migration, restenosis): 15–40% depending on center experience and patient selection. *(Ref. 1,4)*
3. Symptomatic improvement (VCSS, Villalta): >90% in properly treated cases. *(Ref. 4)*

ENDOVASCULAR TREATMENT OF NUTCRACKER SYNDROME

by Liliana Fidalgo

Preliminary Notes

Nutcracker syndrome (NCS) refers to the symptomatic compression of the left renal vein (LRV), also known as left renal vein entrapment, and can be divided into three types according to the anatomical site of compression:

1. **Anterior NCS:** the most common type, where the LRV is compressed between the aorta and the superior mesenteric artery.
2. **Posterior NCS:** the LRV is retro-aortic and therefore compressed between the aorta and the spine.
3. **Mixed or Combined NCS:** LRV compression by other causes or vascular configurations leading to similar symptoms.

For the present chapter, we will focus on the endovascular treatment of the Anterior NCS type.

Thorough evaluation of symptoms and imaging is mandatory to ensure the best individualized treatment for each patient. Concurring conditions might coexist, which may require additional measures, such as pelvic congestion syndrome.

Technique & Materials

A) Anesthesia: local anesthesia and moderate sedation or general anesthesia depending on the team and the patient's preferences.

B) Intraoperative Steps *(Ref. 2,3):*

a. Access: percutaneous ultrasound-guided right femoral vein access with 7F short sheath; consider right jugular vein access if anatomical challenges.
b. Systemic heparinization: unfractionated heparin (100 IU/kg).
c. Selective catheterization of the LRV:
- **Wire:** 0.035'' hydrophilic guidewire (Terumo Radifocus™).
- **Catheters:** 5Fr Cobra diagnostic catheter.
- **Practical techniques and expert insights:** to cross over a tight LRV compression, perform under Valsalva maneuver.

d. Confirmation of the diagnosis:
- Selective phlebography done under Valsalva maneuver confirming contrast stagnation and well-developed collaterals.
- Renocaval pressure gradient measurements ≥3 mmHg.
- IVUS: invaluable to confirm the diagnosis in equivocal cases using the pull-back technique, and to obtain accurate LRV measurements for proper stent sizing.

e. Guidewire switch: exchange for a stiff wire directed to the renal vein branches or the left gonadal vein to provide sufficient purchase for sheath delivery.
- **Guidewire:** 0.035'' Amplatz Super Stiff (Boston Scientific, USA).
f. Switch to an 11F sheath.
g. Balloon pre-dilatation:

NON-COMPLIANT BALLOONS			
Brand (Company)	Diameters	Extension	Introducer
Atlas Gold (BD Interventional)	12-26mm	20-60mm	7-12F
XXL Balloon (Boston Scientific)	12-18mm	60-60mm	7-8F

h. Stent implantation:
- **Self-expanding nitinol stent:** currently, there are no dedicated stents for NCS.

SELF-EXPANDABLE STENTS					
Brand (Company)	Design	Material	Diameters	Extension	Introducer
Wallstent (Boston Scientific)	Closed cell	Elgiloy	10-16mm	20-94mm	6-10F
Vici (Boston Scientific)	Closed cell	nitinol	12-16mm	60-120mm	9F

- **Stent diameter:** oversize by ~20% relative to the native LRV at the renal hilum to minimize proximal migration (typically 14–16 mm).
- **Stent length:** 60–80 mm preferred to reduce dislodgment or migration.
- **Practical techniques and expert insights:** stent protrusion into the IVC is generally well tolerated and recommended; distal landing just beyond the first large LRV branch reduces migration risk but could cause long-term renal issues.

i. Post-dilatation: not mandatory; perform only if residual stenosis persists after stent placement.
j. Completion of phlebography and IVUS.
k. Hemostasis: manual compression of access site—no closure device required.

C) In-hospital Observation: monitor for 24 hours post-procedure.

D) Post-operative Therapeutical Regimen:
There is no definitive consensus on the optimal medical therapy following NCS stenting; practice may vary. The following approach is suggested *(Ref. 4)*:
- **First 6 months:** rivaroxaban 20 mg once daily.
- **6–12 months:** salicylic acid 100 mg daily.

E) Recommendations for Patients:
Avoid heavy activities for two weeks post-surgery and prevent unintentional Valsalva maneuvers that could increase stent migration risk.

Follow-Up

A) Clinical and Doppler ultrasound evaluation at 1 month, 3 months, 6 months, 12 months, and annually thereafter. *(Ref. 3)*
B) Stent patency rates *(Ref. 3)*:
- 85.2% primary patency at 2 years, with a 100% primary-assisted patency rate.
- In case of restenosis, reintervention is advised to prevent symptom recurrence or occlusion.

REFERENCES

I RADIATION PROTECTION ADVICE

1. **Radiation Safety and Protection** — Nicholas Frane, Adam Bitterman. *StatPearls [Internet].* Treasure Island (FL): StatPearls Publishing; 2022 Jan. Updated 2021 May 29. https://pubmed.ncbi.nlm.nih.gov/32491431/

2. "There is a large variability observed in the literature regarding radiation exposure and contrast volume injection during endovascular aortic repair (EVAR). Reducing both in order to decrease their respective toxicities must be a priority for the endovascular therapist. Radiation dose reduction requires a strict application of the 'as low as reasonably achievable' principles."

   In: *Techniques to reduce radiation and contrast volume during EVAR* — B. Maurel, A. Hertault, J. Sobocinski, M. Le Roux, T. Martin Gonzalez, R. Azzaoui, M. Saeed Kilani, M. Midulla, S. Haulon. *J Cardiovasc Surg (Torino).* 2014 Apr;55(2 Suppl 1):123–131. PMID: 24796905. https://pubmed.ncbi.nlm.nih.gov/24796905/

3. "When used in simple procedures such as infrarenal aneurysm repair, image-based fusion technology is feasible both in hybrid operating rooms and on mobile systems and leads to an overall 50% reduction in radiation dose. Fusion technology should become standard of care for centers attempting to maximize radiation dose reduction, even if capital investment of a hybrid operating room is not feasible."

   In: *A prospective observational trial of fusion imaging in infrarenal aneurysms* — Blandine Maurel, Teresa Martin-Gonzalez, Debra Chong, Andrew Irwin, Guillaume Guimbretière, Meryl Davis, Tara M. Mastracci. *J Vasc Surg.* 2018 Dec;68(6):1706–1713.e1. doi:10.1016/j.jvs.2018.04.015. PMID: 29804734. https://pubmed.ncbi.nlm.nih.gov/29804734/

4. *Three-dimensional fusion computed tomography decreases radiation exposure,* procedure time, and contrast use during fenestrated endovascular aortic repair — Michael M. McNally, Salvatore T. Scali, Robert J. Feezor, Daniel Neal, Thomas S. Huber, Adam W. Beck. *J Vasc Surg.* 2015 Feb;61(2):309–316. doi:10.1016/j.jvs.2014.07.097. PMID: 25175634. PMCID: PMC4308450. https://pubmed.ncbi.nlm.nih.gov/25175634/

5. "CO_2 angio + Fusion is safe and effective in FEVAR and allows the amount of ICM to be significantly reduced, leading to shorter hospitalization time and better renal function preservation at 30 days."

   In: *The benefit of combined carbon dioxide automated angiography and fusion imaging in preserving perioperative renal function in fenestrated endografting* — Enrico Gallitto, Gianluca Faggioli, Andrea Vacirca, Rodolfo Pini, Chiara Mascoli, Cecilia Fenelli, Antonino Logiacco, Mohammad Abualhin, Mauro Gargiulo. *J Vasc Surg.* 2020 Dec;72(6):1906–1916. doi:10.1016/j.jvs.2020.02.051. PMID: 32276017. https://pubmed.ncbi.nlm.nih.gov/32276017/

6. "Fully ultrasound (IVUS and CEUS)-assisted EVAR is safe, feasible, and reliable, completely eliminating the need for iodine contrast medium and reducing the radiation exposure for both patients and surgeons."

   In: *Fully Ultrasound-Assisted Endovascular Aneurysm Repair: Preliminary Report* — Giulio Illuminati, Priscilla Nardi, Daniele Fresilli, Salvatore Sorrenti, Augusto Lauro, Giulia Pizzardi, Massimo Ruggeri, Salvatore Ulisse, Vito Cantisani, Vito D'Andrea. *Ann Vasc Surg.* 2022 Mar 4;S0890-5096(22)00091-7. doi:10.1016/j.avsg.2022.02.016. PMID: 35257913. https://pubmed.ncbi.nlm.nih.gov/35257913/

II PAOD

1. **Choice of stent in iliac occlusive disease** — Dries Vandeweyer, Jürgen Verbist, Marc Bosiers, Koen Deloose, Patrick Peeters.
   https://www.openaccessjournals.com/articles/choice-of-stent-in-iliac-occlusive-di-sease.pdf

2. "Vessel pre-dilatation using balloon catheter enables an easier stent placement. However, balloon plasty is not binding before stent implantation. There are literature reports regarding better long-term outcomes of stenting without prior pre-dilatation. Pre-dilatation is necessary in case of vessel occlusion or high-grade stenosis. In the remaining cases it is recommended that stent deployment should be performed without prior pre-dilatation as it decreases the rates of restenosis caused by proliferation of intima media caused by high-pressure trauma."

   In: *Assessment of effectiveness of endovascular treatment of common and external iliac artery stenosis/occlusion using self-expanding Jaguar SM stents* — Kazimierz Kordecki, Adam Łukasiewicz, Mirosław Nowicki, Andrzej Lewszuk, Radosław Kowalewski, Bogusław Panek, Michał Zawadzki, Paweł Michalak, Marek Gacko, Urszula Łebkowska. *Pol J Radiol.* 2012 Oct–Dec;77(4):22–29. doi:10.12659/pjr.883625.
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3529708/

3. **Covered/Uncovered Stent Topic (2016)** — "Theoretically, the use of covered stents may increase the patency rate due to decreased restenosis after stent placement. This analysis found that the primary patency was improved with the use of a covered stent in femoropopliteal lesions but not in aortoiliac disease… Long-term results of the comparative efficacy of covered stents over bare metal stents are not currently available."

   In: *Covered vs. Uncovered Stents for Aortoiliac and Femoropopliteal Arterial Disease: A Systematic Review and Meta-analysis* — Shahab Hajibandeh, Shahin Hajibandeh, Stavros A. Antoniou, Francesco Torella, George A. Antoniou. *J Endovasc Ther.* 2016 Jun;23(3):442–452. doi:10.1177/1526602816643834.
   https://pubmed.ncbi.nlm.nih.gov/27099281/

2017 (indications) — "This is the first study comparing the outcomes of self-expanding covered stents (CS) with bare metal stents (BMS) in the primary treatment of iliac artery occlusions (IAOs)… These specific parameters may be useful to the operator in the decision making during endovascular iliac revascularisation planning."
In: *Outcomes of Self-Expanding PTFE Covered Stent Versus Bare Metal Stent for Chronic Iliac Artery Occlusion in Matched Cohorts Using Propensity Score Modelling* — M. Piazza, F. Squizzato, A. Dall'Antonia, S. Lepidi, M. Menegolo, F. Grego, M. Antonello. *Eur J Vasc Endovasc Surg.* 2017 Aug;54(2):177–185. doi:10.1016/j.ejvs.2017.03.019.
https://pubmed.ncbi.nlm.nih.gov/28487112/

2018 — "High-quality evidence supporting the use of covered stents for aortoiliac occlusive arterial disease is limited. The use of covered stents in TASC C and D lesions may improve patency rates… more research is necessary to identify which lesion characteristics might benefit most from covered stent placement."
In: *The use of covered stents in aortoiliac obstructions: a systematic review and meta-analysis* — Joost A. Bekken, Hidde Jongsma, Bram Fioole. *J Cardiovasc Surg (Torino).* 2018 Feb;59(1):14–25. doi:10.23736/S0021-9509.17.10213-2.
https://pubmed.ncbi.nlm.nih.gov/28933521/

4. **V12 & Viabhan V12** — "CBE (Covered Balloon Expanded) stents are a viable treatment option for patients with complex aortoiliac lesions because of their high rates of technical success and favorable patency across all devices at 12 months. However, long-term data are only available for a single device, the iCast/Advanta V12."

   In: *A systematic review of covered balloon-expandable stents for treating aortoiliac occlusive disease* — Patrice Mwipatayi, Kenneth Ouriel, Tahmina Anwari, Jackie Wong, Eric Ducasse, Jean M. Panneton, Jean-

Paul P. M. de Vries, Raje. *J Vasc Surg*. 2020 Oct;72(4):1473–1486.e2. doi:10.1016/j.jvs.2020.01.084.
https://pubmed.ncbi.nlm.nih.gov/32360678/

Viabhan/VBX — "This preliminary experience shows that the VBX stent may allow an effective reconstruction of the aortic bifurcation; the conformability and flaring capability may allow to overcome the diameter incompatibility between the aorta and the iliac arteries."
In: *The Viabahn balloon expandable stent for endovascular reconstruction of the infrarenal aorta and its bifurcation in cases of severe obstructive disease* — Michele Antonello, Francesco Squizzato, Michele Piazza. *Vascular*. 2021 Feb;29(1):40–44. doi:10.1177/1708538120927847.
https://pubmed.ncbi.nlm.nih.gov/32522137/

5. **Primary Stenting SFA/Claudication** — *Primary Stenting of the Superficial Femoral Artery in Patients with Intermittent Claudication has Durable Effects on Health-Related Quality of Life at 24 Months: Results of a Randomized Controlled Trial* — Hans I. V. Lindgren, Peter Qvarfordt, Stefan Bergman, Anders Gottsäter. *Cardiovasc Intervent Radiol*. 2018 Jun;41(6):872–881. doi:10.1007/s00270-018-1925-0.
https://pubmed.ncbi.nlm.nih.gov/29520431/

6. **Claudication** — "Based on these guiding principles, treatment goals for claudicant patients should focus on reducing cardiovascular risk through secondary prevention, improving symptoms and functional status, and using revascularization primarily for quality of life improvement rather than limb salvation."
In: *Treatment Strategies for the Claudicant Patients* — Keith Pereira. *Semin Intervent Radiol*. 2018 Dec;35(5):435–442. doi:10.1055/s-0038-1676322.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6363545/

7. **DES (Drug-Eluting Stents)** — "According to this analysis, drug-coated balloons (DCB) and drug-eluting stents (DES) provide the greatest clinical and economic benefits in the endovascular treatment of suprapopliteal lesions compared to PTA with uncoated balloons and/or BMS."
In: *Results of the PSI register study in 74 German vascular centers* — C.-A. Behrendt, F. Heidemann, K. Haustein, R. T. Grundmann, E. S. Debus. *Gefasschirurgie*. 2017;22(Suppl 1):17–27. doi:10.1007/s00772-016-0202-2.
https://pubmed.ncbi.nlm.nih.gov/28715513/

8. **DEB (Drug-Eluting Balloons)** — "DCB significantly reduces the risk of TLR (Target Lesion Revascularization) compared with PB without affecting all-cause death. Evidence exists for differential efficacy according to device type."
In: *Drug-Coated Balloon Versus Plain Balloon Angioplasty for the Treatment of Femoropopliteal Artery Disease: An Updated Systematic Review and Meta-Analysis of Randomized Clinical Trials* — Daniele Giacoppo, Salvatore Cassese, Yukinori Harada, Roisin Colleran, Jonathan Michel, Massimiliano Fusaro, Adnan Kastrati, Robert A. Byrne. *JACC Cardiovasc Interv*. 2016 Aug 22;9(16):1731–1742. doi:10.1016/j.jcin.2016.06.008.
https://pubmed.ncbi.nlm.nih.gov/27539695/

2018 — "All-cause death up to 5 years increased further in the case of paclitaxel (14.7% vs. 8.1%; risk ratio 1.93). There is increased risk of death following application of paclitaxel-coated balloons and stents in the femoropopliteal artery of the lower limbs. Further investigations are warranted."

In: *Risk of Death Following Application of Paclitaxel-Coated Balloons and Stents in the Femoropopliteal Artery of the Leg: A Systematic Review and Meta-Analysis* — Konstantinos Katsanos, Stavros Spiliopoulos, Panagiotis Kitrou, Miltiadis Krokidis, Dimitrios Karnabatidis. *J Am Heart Assoc*. 2018 Dec 18;7(24):e011245. doi:10.1161/JAHA.118.011245.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6405619/

2019 — "Analyses of patient-level data identified no mortality differences between DCB angioplasty and PTA… The lack of dose-response relationships argues against a causal relationship between paclitaxel and

mortality."

In: *Safety of Paclitaxel-Coated Balloon Angioplasty for Femoropopliteal Peripheral Artery Disease* — Kenneth Ouriel, Mark A. Adelman, Kenneth Rosenfield, Dierk Scheinert, Marianne Brodmann, Constantino Peña, Patrick Geraghty, Arthur Lee, Roseann White, Daniel G. Clair. *JACC Cardiovasc Interv*. 2019 Dec 23;12(24):2515–2524. doi:10.1016/j.jcin.2019.08.025.
https://pubmed.ncbi.nlm.nih.gov/31575518/

2019 continued — "This independent patient-level meta-analysis demonstrates that this paclitaxel DCB is safe. Within DCB patients, there was no correlation between level of paclitaxel exposure and mortality."

In: *Mortality Not Correlated With Paclitaxel Exposure: An Independent Patient-Level Meta-Analysis of a Drug-Coated Balloon* — Peter A. Schneider, John R. Laird, Gheorghe Doros, Qi Gao, Gary Ansel, Marianne Brodmann, Antonio Micari, Mehdi H. Shishehbor, Gunnar Tepe, Thomas Zeller. *J Am Coll Cardiol*. 2019 May 28;73(20):2550–2563. doi:10.1016/j.jacc.2019.01.013.
https://pubmed.ncbi.nlm.nih.gov/30690141/

2019 continued — "The mortality rates for patients treated with the DCB and uncoated PTA were indistinguishable over 3-year follow-up."

In: *Mortality Assessment of Paclitaxel-Coated Balloons: Patient-Level Meta-Analysis of the ILLUMENATE Clinical Program at 3 Years* — William A. Gray, Michael R. Jaff, Sahil A. Parikh, Gary M. Ansel, Marianne Brodmann, Prakash Krishnan, Mahmood K. Razavi, Frank Vermassen, Thomas Zeller, Roseann White, Kenneth Ouriel, Mark A. Adelman, Sean P. Lyden. *Circulation*. 2019 Oct;140(14):1145–1155. doi:10.1161/CIRCULATIONAHA.119.040518.
https://pubmed.ncbi.nlm.nih.gov/31567024/

2020 — "No sign of increased all-cause mortality following use of paclitaxel-coated devices was found in this large cohort, emphasizing differences between population-based evidence and randomized trials."

In: *Long Term Survival after Femoropopliteal Artery Revascularisation with Paclitaxel-Coated Devices: A Propensity Score Matched Cohort Analysis* — Christian-Alexander Behrendt, Art Sedrakyan, Frederik Peters, Thea Kreutzburg, Marc Schermerhorn, Daniel J. Bertges, Axel Larena-Avellaneda, Helmut L'Hoest, Tilo Kölbel, Eike S. Debus. *Eur J Vasc Endovasc Surg*. 2020 Apr;59(4):587–596. doi:10.1016/j.ejvs.2019.12.034.
https://pubmed.ncbi.nlm.nih.gov/31926836/

2020 continued — "When relevant risk factors were taken into account, there were no associations between PTX and mid-term mortality in patients with PAOD."
In: *Paclitaxel and Mortality Following Peripheral Angioplasty: An Adjusted and Case Matched Multicentre Analysis* — Athanasios Saratzis, Talia Lea, Trixie Yap, Andrew Batchelder, Benedict Thomson, Prakash Saha, Athanasios Diamantopoulos, Nikos Saratzis, Robert Davies, Hany Zayed. *Eur J Vasc Endovasc Surg*. 2020 Aug;60(2):220–229. doi:10.1016/j.ejvs.2020.04.008.
https://pubmed.ncbi.nlm.nih.gov/32370918/

9. **DEB BTK (Infrapopliteal)** — "DCB is safe and effective for recurring infrapopliteal disease. It outperforms the objective performance goals for CLI patients with clinical and anatomical high-risk features."

   In: *Drug-coated balloon angioplasty for the management of recurring infrapopliteal disease in diabetic patients with critical limb ischemia* — Luis M. Palena, Larry J. Diaz-Sandoval, Efren Gomez-Jaballera, Olga Peypoch-Perez, Enrico Sultato, Cesare Brigato, Enrico Brocco, Marco Manzi. *Cardiovasc Revasc Med*.

2018;19(1 Pt B):83–87. doi:10.1016/j.carrev.2017.06.006.
https://pubmed.ncbi.nlm.nih.gov/28648324/

But: "Based on this systematic review and meta-analysis, no significant differences in limb salvation, survival, restenosis, TLR, and AFS rates were found when DCB angioplasty was compared with standard PTA."

In: *Drug Coated Balloon Angioplasty vs. Standard Percutaneous Transluminal Angioplasty in Below the Knee Peripheral Arterial Disease: A Systematic Review and Meta-Analysis* — Jetty Ipema, Eline Huizing, Michiel A. Schreve, Jean-Paul P. M. de Vries, Çağdaş Ünlü. *Eur J Vasc Endovasc Surg.* 2020 Feb;59(2):265–275. doi:10.1016/j.ejvs.2019.10.002.
https://pubmed.ncbi.nlm.nih.gov/31926836/

2021: "Different angles of interpretation of the data, important missing data, and pertinent biases have been noted to allow a more educated appraisal of available evidence to date. In the meantime, most individual patient data from large, randomized studies remain inaccessible."

In: *The Rollercoaster of Paclitaxel in the Lower Limbs and Skeletons in the Closet: An Opinion Review* — Konstantinos Katsanos, Panagiotis Kitrou, Stavros Spiliopoulos. *J Vasc Interv Radiol.* 2021 Jun;32(6):785–791. doi:10.1016/j.jvir.2021.03.537.
[https://doi.org/10.1016/j.j

III AORTIC ANEURYSMS AAA/TAAA/TAA

Percutaneous access versus cutdown access

1. "PEVAR is a safe and efficacious approach with a similar technical success rate and a lower incidence of complications compared to OFA. Due to shorter procedure times, PEVAR should be the preferential approach."

   In: *Safety and Efficacy of Totally Percutaneous Access Compared With Open Femoral Exposure for Endovascular Aneurysm Repair: A Meta-analysis*. — Cao Z, Wu W, Zhao K, Zhao J, Yang Y, Jiang C, Zhu R. *J Endovasc Ther.* 2017 Apr;24(2):246–253. doi:10.1177/1526602816689679.
   https://pubmed.ncbi.nlm.nih.gov/28164730/

2. "A trend towards fewer complications was seen in the arteriotomy closure devices group (i.e., seroma, dehiscence, femoral neuropathy, and SSIs). (…) but more pseudoaneurysms are found when compared with surgical cutdown."

   In: *Editor's Choice - Arteriotomy Closure Devices in EVAR, TEVAR, and TAVR: A Systematic Review and Meta-analysis of Randomised Clinical Trials and Cohort Studies. Eur J Vasc Endovasc Surg.* 2017 Jul;54(1):104–115. doi:10.1016/j.ejvs.2017.03.015.
   https://pubmed.ncbi.nlm.nih.gov/28164730/

3. "Percutaneous EVAR appears to be safe and effective having comparable clinical outcomes with conventional EVAR performed by surgical exposure of the femoral arteries. The duration of the procedure is shorter than cutdown EVAR, and it can be considered in patients in whom local anaesthesia is deemed a better anaesthetic option. Furthermore, a percutaneous approach may be a suitable option for patients undergoing ambulatory EVAR, who have reduced requirements for analgesia and monitoring of surgical sites for seroma or infection."

In: *Percutaneous Access Does Not Confer Superior Clinical Outcomes Over Cutdown Access for Endovascular Aneurysm Repair: Meta-Analysis and Trial Sequential Analysis of Randomised Controlled Trials*. — George A. Antoniou, Stavros A. Antoniou. *Eur J Vasc Endovasc Surg*. 2021 Mar;61(3):383–394. doi:10.1016/j.ejvs.2020.11.008.
https://pubmed.ncbi.nlm.nih.gov/33309488/

Retroperitoneal approach/Iliac conduit

4. "Iliac conduits are a safe and viable option for high-risk patients with challenging iliac artery access for EVVAR. ICs are best performed in a planned fashion or in a staged manner, when feasible."

In: *Iliac conduits remain safe in complex endovascular aortic repair*. — Jarrad W. Rowse, Katherine Morrow, James F. Bena, Matthew J. Eagleton, Federico E. Parodi, Christopher J. Smolock. *J Vasc Surg*. 2019 Aug;70(2):424–431. doi:10.1016/j.jvs.2018.10.099.
https://pubmed.ncbi.nlm.nih.gov/30598354/

Use of heparin

5. "The use of heparin is a general vascular surgery principle. Accepted doses range between 50 and 100 IU/kg, and heparin efficacy may be tested using an activated clotting time (ACT) test to ensure adequate anticoagulation."

In: *Prophylactic perioperative antithrombotics in open and endovascular abdominal aortic aneurysm (AAA) surgery: a systematic review*. — Wiersema A.M., Jongkind V., Bruijninckx C.M., Reijnen M.M., Vos J.A., van Delden O.M., et al. *Eur J Vasc Endovasc Surg*. 2012 Oct;44(4):359–367. doi:10.1016/j.ejvs.2012.06.008.
https://pubmed.ncbi.nlm.nih.gov/22831869/

6. "Pro: activated clotting time should be monitored during heparinization for vascular surgery."

In: *J Cardiothorac Vasc Anesth*. — Jordan E. Goldhammer, Darin Zimmerman. 2018 Jun;32(3):1494–1496. doi:10.1053/j.jvca.2017.04.047.
https://pubmed.ncbi.nlm.nih.gov/28943189/

Choice of stent-graft

7. "There are no data that convincingly favour any of the above features or one particular EVAR device over another… Pending further evidence, local preference and experience should therefore guide device selection."

In: *Editor's Choice - European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms*. — Wanhainen A., Verzini F., Van Herzeele I., Allaire E., Bown M., Cohnert T., Dick F. et al. *Eur J Vasc Endovasc Surg*. 2019 Jan;57(1):8–93. doi:10.1016/j.ejvs.2018.09.020.
https://pubmed.ncbi.nlm.nih.gov/30528142/

8. "In cases of hostile infra-renal neck morphology, active suprarenal fixation appears to be used more frequently… Further research is needed to evaluate more optimal treatment options such as fenestrated or branched EVAR and endovascular adjuncts."

In: *Outcomes of using endovascular aneurysm repair with active fixation in complex aneurysm morphology*. — Rami O. Tadros, Alex Sher, Windsor Ting, Michael Marin, Peter Faries. *J Vasc Surg*. 2018 Sep;68(3):683–692. doi:10.1016/j.jvs.2017.12.039.
https://pubmed.ncbi.nlm.nih.gov/29548813/

9. “This is the first report to show a significant increase in operative mortality in patients undergoing EVAR with severely angulated suprarenal neck… These findings suggest that EVAR should be used with caution in patients with severe angulation.”

   In: *Impact of suprarenal neck angulation on endovascular aneurysm repair outcomes.* — Asma Mathlouthi, Satinderjit Locham, Hanaa Dakour-Aridi, Mahmoud B. Malas, James H. Black. *J Vasc Surg.* 2020 Jun;71(6):1900–1906. doi:10.1016/j.jvs.2019.08.250.
   https://pubmed.ncbi.nlm.nih.gov/31708299/

Closure devices

10. “In patients undergoing transfemoral TAVI, the MANTA VCD showed a similar risk of vascular and bleeding complications compared to the ProGlide (Abbott) VCD, but it reduced significantly the need for additional vascular closure devices for completion of hemostasis.”

    In: *MANTA versus ProGlide (Abbott) vascular closure devices in transfemoral transcatheter aortic valve implantation.* — Biancari F., Romppanen H., Savontaus M., Siljander A., Mäkikallio T., Piira O.P., Piuhola J., Vilkki V., Ylitalo A., Vasankari T., Airaksinen J.K.E., Niemelä M. *Int J Cardiol.* 2018 Jul 15;263:29–31. doi:10.1016/j.ijcard.2018.04.065.
    https://pubmed.ncbi.nlm.nih.gov/29681408/

11. “The MANTA device demonstrated a short time to hemostasis and low complication rates compared with other closure devices. The MANTA device provides reliable closure with a single percutaneous device for PEVAR/TEVAR procedures.”

    In: *Pivotal Clinical Study to Evaluate the Safety and Effectiveness of the MANTA Vascular Closure Device During Percutaneous EVAR and TEVAR Procedures.* — Krajcer Z., Wood D.A., Strickman N., Bernardo N., Metzger C., Aziz M., Bacharach J.M., Nanjundappa A., Campbell J., Lee J.T., Dake M.D., Lumsden A., Nardone S. *J Endovasc Ther.* 2020 Jun;27(3):414–420. doi:10.1177/1526602820912224.
    https://pubmed.ncbi.nlm.nih.gov/32193971/

Overview TAAA

12. “Based on the results reported in the literature, regardless of its complexity and costs, fEVAR for jrAAA has been accepted in substantial number of hospitals worldwide.”

    In: *The role of fEVAR, chEVAR and open repair in treatment of juxtarenal aneurysms: a systematic review.* — Igor B. Končar, Aleksa L. Jovanović, Stefan M. Dučič. *J Cardiovasc Surg (Torino).* 2020 Feb;61(1):24–36. doi:10.23736/S0021-9509.19.11187-1.
    https://pubmed.ncbi.nlm.nih.gov/32079378/

13. “In the reported case, the use of coronary stents was a safe and long-lasting solution to rescue an iatrogenic renal artery dissection during F/B-EVAR.”

    In: *An Original Bailout Solution for Renal Artery Dissection after Fenestrated/Branched EVAR.* — Alice Lopes, Miguel Lemos Gomes, Ryan Melo, Pedro Amorim, Gonçalo Sobrinho, Luís Mendes Pedro. *Ann Vasc Surg.* 2020 May;65:286.e1–286.e4. doi:10.1016/j.avsg.2019.11.006.
    https://pubmed.ncbi.nlm.nih.gov/31712189/

14. “This article summarizes the basic concepts of device design, case planning, techniques of implantation, and some of the bail-out maneuvers that may be required during endovascular repair using the Zenith fenestrated stent-graft system.”

In: *Technique of implantation and bail-out maneuvers for endovascular fenestrated repair of juxtarenal aortic aneurysms*. — Gustavo S. Oderich, Bernardo C. Mendes, Karina S. Kanamori. *Perspect Vasc Surg Endovasc Ther.* 2013 Jun;25(1–2):28–37. doi:10.1177/1531003513512372. https://pubmed.ncbi.nlm.nih.gov/24317632/

15. "FEVAR after previous FEVAR is a feasible and efficient treatment option. The modified 'snare-ride' technique can be used to catheterize target vessels in the absence of an Indy snare."

    In: *Technique for Fenestrated Stent-Graft Implantation as a Proximal Extension to a Previous Fenestrated Endovascular Repair for Abdominal Aortic Aneurysm*. — Konstantinos Spanos, Nikolaos Tsilimparis, Franziska Heidemann, Fiona Rohlffs, Christian-Alexander Behrendt, Eike Sebastian Debus, Tilo Kölbel. *J Endovasc Ther.* 2018 Feb;25(1):16–20. doi:10.1177/1526602817745779. https://pubmed.ncbi.nlm.nih.gov/29235384/

16. "FEVAR TIPS & TRICKS FROM SIZING TO CBCT ASSESSMENT." — Gustavo Oderich, Presentation. https://linc2017.cncptdlx.com/media/1405_Gustavo_Oderich_25_01_2017_Room_2_-_Main_Arena_2.pdf

TAA

ENDOVASCULAR TREATMENT OF AORTIC ARCH ANEURYSM WITH DOUBLE/TRIPLE DEVICES

1. Current Options and Recommendations for the Treatment of Thoracic Aortic Pathologies Involving the Aortic Arch: *An Expert Consensus Document of the European Association for Cardio-Thoracic Surgery (EACTS) and the European Society for Vascular Surgery (ESVS)*.

   In: Czerny M, Schmidli J, Adler S, Van Den Berg JC, Bertoglio L, Carrel T, et al. Editor's Choice European Journal of Vascular and Endovascular Surgery. 2018; 57(2):165–98.

   PMID: 30665842

   DOI: 10.1016/j.ejvs.2018.12.011

   https://pubmed.ncbi.nlm.nih.gov/30665842/

2. "Our preliminary study confirms the feasibility and safety of the endovascular repair of arch aneurysms in selected patients who may not have other conventional options."

   In: Global experience with an inner branched arch endograft. — Haulon S, Greenberg RK, Spear R, Eagleton M, Abraham C, Lioupis C, et al. Journal of Thoracic and Cardiovascular Surgery 2014;148(4):1709–16.

   PMID: 24685375.

   DOI: 10.1016/j.jtcvs.2014.02.072

   https://pubmed.ncbi.nlm.nih.gov/24685375/

3. "Extensive endovascular coverage of the aorta for aortic disease seems to be a feasible procedure in experienced centers, with acceptable perioperative morbidity and mortality. Spinal cord ischemia appears acceptable despite extensive aortic coverage."

   In: Combined fenestrated-branched endovascular repair of the aortic arch and the thoracoabdominal aorta. — Tsilimparis N, Haulon S, Spanos K, Rohlffs F, Heidemann F, Resch T, et al. Journal of Vascular Surgery 2020;71(6):1825–33.

PMID: 32081476.

DOI: 10.1016/j.jvs.2019.08.261

https://pubmed.ncbi.nlm.nih.gov/32081476/

4. In: “A retrospective analysis was conducted of prospectively collected data from a single center of all consecutive patients treated with b-TEVAR.” Single-center experience with an inner branched arch endograft. —Tsilimparis N, Detter C, Law Y, Rohlffs F, Heidemann F, Brickwedel J, et al. Journal of Vascular Surgery. 2018; 69(4):977-985.e1.

   PMID: 30477941

   DOI: 10.1016/j.jvs.2018.07.076

   https://pubmed.ncbi.nlm.nih.gov/30477941/

5. “Total endovascular aortic arch repair (TEAAR) represents an emerging alternative for the treatment of aortic arch disease in patients at prohibitive risk for open surgery. A systematic review of TEAAR was performed to delineate early outcomes with this new technology.”

   In: A Systematic Review of Total Endovascular Aortic Arch Repair: A Promising Technology. — Basha AM, Moore RD, Rommens KL, Herget EJ, McClure RS. Can J Cardiol. 2023 Jan;39(1):49-56. doi: 10.1016/j.cjca.2022.11.003. Epub 2022 Nov 14.

   PMID: 36395997

   DOI: 10.1016/j.cjca.2022.11.003

   https://pubmed.ncbi.nlm.nih.gov/36395997/

6. Total endovascular aortic arch repair using the Terumo Aortic triple-branch arch endograft. — Negmadjanov U, Motta JC, Lee WA. Ann Vasc Surg. 2021 Nov;77:351.e7-351.e14. doi: 10.1016/j.avsg.2021.05.044. Epub 2021 Aug 23.

   PMID: 34437959

   DOI: 10.1016/j.avsg.2021.05.044
   https://pubmed.ncbi.nlm.nih.gov/34437959/

7. Technical tips and clinical experience with the Cook Triple inner arch branch stent-graft. —Tenorio ER, Vacirca A, Mesnard T, Sulzer T, Baghbani-Oskouei A, Mirza AK, Huang Y, Oderich GS. J Cardiovasc Surg (Torino). 2023 Feb;64(1):9-17. doi: 10.23736/S0021-9509.22.12569-3. Epub 2023 Jan 4.

   PMID: 36598743

   DOI: 10.23736/S0021-9509.22.12569-3

   https://pubmed.ncbi.nlm.nih.gov/36598743/

ENDOVASCULAR TREATMENT OF THE DISTAL AORTIC ARCH (INVOLVING THE LEFT SUBCLAVIAN ARTERY)

1. Gore Tag Thoracic Branch Endoprosthesis in Acute Aortic Syndromes: A Case Series.

   Spertino A, Marrocco S, Zavatta M, Squizzato F, Piazza M, Antonello M.

   J Endovasc Ther. 2025 Feb 23:15266028251318957.

   Doi: 10.1177/15266028251318957.

   Epub ahead of print.

   PMID: 39988992.

   Doi: 10.1177/15266028251318957

   https://pubmed.ncbi.nlm.nih.gov/39988992/

2. Early Feasibility of Endovascular Repair of Distal Aortic Arch Aneurysms Using Patient-Specific Single Retrograde Left Subclavian Artery Branch Stent Graft.

   Wong J, Tenorio ER, Lima G, Dias-Neto M, Baghbani-Oskouei A, Mendes B, Kratzberg J, Ocasio L, Macedo TA, Oderich GS.

   Cardiovasc Intervent Radiol. 2023 Feb;46(2):249-254.

   Doi: 10.1007/s00270-022-03304-x.

   Epub 2022 Nov 1.

   Erratum in: Cardiovasc Intervent Radiol. 2023 Jan;46(1):170.

   Doi: 10.1007/s00270-022-03318-5.

   PMID: 36319711; PMCID: PMC9628377.

   https://pubmed.ncbi.nlm.nih.gov/36319711/

3. "*The SF-TEVAR technique, which utilizes the radiopaque marker in stent-graft as an indication for PMF in TEVAR, seems a likely safe, effective, and efficient procedure that brings acceptable survival rate and branch artery patency rate. SF-TEVAR serves as a progressive alternative method to keep the branch artery patent in aortic arch endovascular reconstruction.*"

   In: *Self-Radiopaque Markers Guiding Physician-Modified Fenestration (S-Fenestration) in Aortic Arch Endovascular Repair*.

   Li X, Shu C, Li Q, He H, Li M, Wang L, Li J, Liu D, Du M.

   Front Cardiovasc Med. 2021 Aug 20;8:713301.

   Doi: 10.3389/fcvm.2021.713301.

   PMID: 34490376; PMCID: PMC8417741.

   Doi: 10.3389/fcvm.2021.713301. eCollection 2021

   https://pubmed.ncbi.nlm.nih.gov/34490376/

4. Comprehensive Review of In Situ Fenestration of Aortic Endografts.

   Glorion M, Coscas R, McWilliams RG, Javerliat I, Goëau-Brissonniere O, Coggia M. A

   Eur J Vasc Endovasc Surg. 2016 Dec;52(6):787-800.

   doi: 10.1016/j.ejvs.2016.10.001.

Epub 2016 Nov 11.

PMID: 27843111.

Doi: 10.1016/j.ejvs.2016.10.001. Epub 2016 Nov 11.

https://pubmed.ncbi.nlm.nih.gov/27843111/

IV VISCERAL ANEURYSMS

Overview

1. "Interventional procedures are normally performed under local anaesthesia, with high technical success rates, low complication rates, and shorter hospital stays. (...) Our data analysis yielded a technical success rate of 93.3%"

   In: *Visceral artery aneurysms: Incidence, management, and outcome analysis in a tertiary care center over one decade*.

   Pitton MB, Dappa E, Jungmann F, Kloeckner R, Schotten S, Wirth GM et al.

   Eur Radiol. 2015 Jul;25(7):2004-14.

   Doi: 10.1007/s00330-015-3599-1.

   Epub 2015 Feb 19

   https://pubmed.ncbi.nlm.nih.gov/25693662/

2. "There are several endovascular methods that an operator may choose to treat visceral artery aneurysms, and selection of the appropriate technique depends on the type and size of aneurysm and the anatomy of the affected artery."

   In: *Endovascular management of visceral arterial aneurysms*

   Hemp JH, Sabri SS. Tech Vasc

   Interv Radiol. 2015 Mar;18(1):14-23.

   Doi: 10.1053/j.tvir.2014.12.003. Epub 2014 Dec 29.

   https://pubmed.ncbi.nlm.nih.gov/25814199/

Vessel preservation

3. "In the present single-center series with stent-grafts, the parent visceral artery patency rate was 81.8% and the sac thrombosis rate was 100% (...) Irrespective of their etiology and acuteness, VAAs can be treated with stent-grafts, with an excellent clinical long-term outcome and a high patency rate."

   In: *Stent-graft repairs of visceral and renal artery aneurysms are effective and result in long-term patency*.

   Künzle S, Glenck M, Puippe G, Schadde E, Mayer D, Pfammatter T.

   J Vasc Interv Radiol. 2013 Jul;24(7):989-96.

   Doi: 10.1016/j.jvir.2013.03.025. Epub 2013 May 30.

   https://pubmed.ncbi.nlm.nih.gov/23727420/

Embolization

4. “Embolization has recently gained popularity and is an alternative to open and laparoscopic repair. An 85% success rate with embolization has been reported.”

   In: *Splenic artery aneurysms: two decades experience at Mayo clinic*.

   Abbas MA, Stone WM, Fowl RJ, Gloviczki P, Oldenburg WA, Pairolero PC et al.

   Ann Vasc Surg. 2002 Jul;16(4):442-9.

   Doi: 10.1007/s10016-001-0207-4. Epub 2002 Jul 1.

   https://pubmed.ncbi.nlm.nih.gov/12089631/

V CAROTID DISEASE

Combined Anti-platelet Treatment in Carotid Artery Stenting

1. “The dual anti-platelet regime has a significant impact on reducing adverse neurological outcomes without an additional increase in bleeding complications.”

   In: *The benefits of combined anti-platelet treatment in carotid artery stenting*.

   McKevitt FM, Randall MS, Cleveland TJ, Gaines PA, Tan KT, Venables GS.

   Eur J Vasc Endovasc Surg. 2005 May;29(5):522-7.

   Doi: 10.1016/j.ejvs.2005.01.012.

   https://pubmed.ncbi.nlm.nih.gov/15966092/

Cerebral protection devices

2. “The use of cerebral protection systems [after CAS] was associated with a lower risk of stroke or death”

   In: *Systematic review of the perioperative risks of stroke or death after carotid angioplasty and stenting*.

   Touzé E, Trinquart L, Chatellier G, Mas JL.

   Stroke. 2009 Dec;40(12):e683-93.

   Doi: 10.1161/STROKEAHA.109.562041.

   https://pubmed.ncbi.nlm.nih.gov/19892997/

3. “No significant difference was found between carotid endarterectomy and stenting with embolic protection for the treatment of atherosclerotic carotid bifurcation stenosis with regard to the composite end point of stroke, death, or myocardial infarction.”

   In: *Stenting versus endarterectomy for treatment of carotid-artery stenosis*.

   Brott TG, Hobson RW 2nd, Howard G, Roubin GS, Clark WM, Brooks W et al; CREST Investigators.

   N Engl J Med. 2010 Jul 1;363(1):11-23.

   Doi: 10.1056/NEJMoa0912321. Epub 2010 May 26.

   https://pubmed.ncbi.nlm.nih.gov/20505173/

4. “Carotid-artery stenting with a device to capture and remove emboli is an effective alternative to carotid endarterectomy in patients at average or high risk for surgical complications.”

   In: *Randomized Trial of Stent versus Surgery for Asymptomatic Carotid Stenosis*.

   Rosenfield K, Matsumura JS, Chaturvedi S, Riles T, Ansel GM, Metzger DC et al; ACT I Investigators.

   Randomized Trial of Stent versus Surgery for Asymptomatic Carotid Stenosis.

   N Engl J Med. 2016 Mar 17;374(11):1011-20.

   Doi: 10.1056/NEJMoa1515706. Epub 2016 Feb 17.

   https://pubmed.ncbi.nlm.nih.gov/26886419/

Proximal versus distal protection devices

5. “The number of new ischemic lesions per patient and the incidence of ischemic lesions were significantly greater in the distal protection devices group than in the proximal group. No difference was found between clinical periprocedural or 30-day adverse event rates.”

   In: *Comparison of Embolic Protection with Proximal and Distal Protection Devices: Periprocedural Complications, Clinical Outcomes, and Cerebral Embolic Lesions on Diffusion-Weighted Magnetic Resonance Imaging*

   Kim MS, Rho MH, Hong HP, Park HJ, Chung PW, Won YS.

   World Neurosurg. 2020 Mar;135:e731-e737.

   Doi: 10.1016/j.wneu.2019.12.121. Epub 2019 Dec 30.

   https://pubmed.ncbi.nlm.nih.gov/31899400/

Double-layered stents (meta analysis)

6. “This study suggests that DLS use for CAS is associated with a low 1-year death and stroke rate, and the specific DLS stent used could affect the restenosis rate

   In: *Use of Dual-Layered Stents for Carotid Artery Angioplasty: 1-Year Results of a Patient-Based Meta-Analysis*

   Stabile E, de Donato G, Musialek P, De Loose K, Nerla R, Sirignano P, et al.

   JACC Cardiovasc Interv 2020 Jul 27;13(14):1709-1715.

   Doi: 10.1016/j.jcin.2020.03.048

   https://pubmed.ncbi.nlm.nih.gov/32703595/

Closure devices

“VCDs have shown marked improvement in patients’ comfort and satisfaction as well as in time to hemostasis and ambulation after percutaneous vascular procedures.”

In: *A systematic review of vascular closure devices for femoral artery puncture sites*. Vincent J Noori, Jens Eldrup-Jørgensen.

J Vasc Surg. 2018 Sep;68(3):887-899.

Doi: 10.1016/j.jvs.2018.05.019. Epub 2018 Jun 29.

https://pubmed.ncbi.nlm.nih.gov/30146036/

VI VENOUS DISEASE

ENDOVASCULAR TREATMENT OF PELVIC VENOUS CONGESTION SYNDROME

Diagnostic imaging

1. "Reflux was present in more than one pelvic vein in over half the patients… complex anatomy makes it difficult to identify and treat all points of reflux."

   In: *Pelvic venous incompetence: reflux patterns and treatment results*

   Asciutto G, Asciutto KC, Mumme A, Geier B.

   Eur J Vasc Endovasc Surg. 2009 Sep;38(3):381-6.

   doi: 10.1016/j.ejvs.2009.05.023. Epub 2009 Jul 1

   https://pubmed.ncbi.nlm.nih.gov/19574069/

2. "How should we evaluate the pelvic veins… and what are the currently established criteria for imaging?"

   In: *Diagnostic imaging of pelvic congestive syndrome*

   Arnoldussen CW, de Wolf MA, Wittens CH.

   Phlebology. 2015 Mar;30(1 Suppl):67-72.

   doi: 10.1177/0268355514568063

   https://pubmed.ncbi.nlm.nih.gov/25729070/

Treatment

3. "Clinical success… ranges from 83 to 100% (median 94.9%) in 196 patients."

   In: *Pelvic Congestion Syndrome: Systematic Review of Treatment Success*

   Brown CL, Rizer M, Alexander R, Sharpe EE 3rd, Rochon PJ.

   Semin Intervent Radiol. 2018 Mar;35(1):35-40.

   doi: 10.1055/s-0038-1636519. Epub 2018 Apr 5.

   https://pubmed.ncbi.nlm.nih.gov/29628614/

4. "Embolization using pushable coils and 3% polidocanol foam… PCS improved in 91%."

   In: *Embolization is essential in the treatment of leg varicosities due to pelvic venous insufficiency*

   Hartung O.

   Phlebology. 2015 Mar;30(1 Suppl):81-5.

   doi: 10.1177/0268355515569129.

   https://pubmed.ncbi.nlm.nih.gov/25729072/

5. *Liquid and Solid Embolic Agents in Gonadal Veins.*

   Tiralongo F, Distefano G, Palermo M, Granata A, Giurazza F, Vacirca F, Palmucci S, Venturini M, Basile A.

J Clin Med. 2021 Apr;10(8):1596.

doi: 10.3390/jcm10081596

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8069975/

VII COMPRESSION SYNDROMES

ENDOVASCULAR TREATMENT OF MAY–THURNER SYNDROME

1. *ESVS Clinical Practice Guidelines on Chronic Venous Disease of the Lower Limbs*.

   Eur J Vasc Endovasc Surg. 2022;63(2):184-267.

   doi: 10.1016/j.ejvs.2021.12.024. Epub 2022 Jan 11.

   https://pubmed.ncbi.nlm.nih.gov/35027279/

2. "May-Thurner syndrome should be considered in recurrent DVT."

   In: *Endovascular stenting for May-Thurner syndrome: a case report*.

   Cureus. 2023;15(7).

   doi: 10.7759/cureus.42525. eCollection 2023 Jul.

   https://pubmed.ncbi.nlm.nih.gov/37637667/

3. *Treatment of May-Thurner's Syndrome and Associated Complications: a Multicenter Experience*.

   Sigua-Arce P et al. Int J Gen Med. 2021;14:7137-7147.

   doi: 10.2147/IJGM.S325231. eCollection 2021.

   https://pubmed.ncbi.nlm.nih.gov/34447265/

4. "Endovascular treatment and stenting is safe and effective treatment of CVI with good technical success and improved clinical outcome. IVUS is essential part of management and MTS is common underlying cause"

   In: *Endovascular treatment of chronic venous insufficiency with May-Thurner Syndrome: challenges and outcome*.

   Acta Phlebologica. 2023 Aug;24(2):62-7. minervamedica.

NUTCRACKER SYNDROME VENOUS STENTING

1. *Nutcracker Phenomenon and Nutcracker Syndrome*

   Kurklinsky AK, Rooke TW.

   Mayo Clin Proc. 2010;85(6):552–559.

   doi:10.4065/mcp.2009.0586.

   https://pubmed.ncbi.nlm.nih.gov/20511485/

2. **"**Angioplasty alone, although there was no residual mark on the balloon when inflated, always failed to relieve the stenosis."

In : *Endovascular stenting in pelvic vein congestion due to nutcracker syndrome*

Hartung O, Grisoli D, Boufi M, Marani I, Hakam Z, Barthelemy P, et al.

J Vasc Surg. 2005;42(2):275–280.

doi: 10.1016/j.jvs.2005.03.052.

https://pubmed.ncbi.nlm.nih.gov/16102626/

3. “Coexisting pelvic congestion was treated simultaneously or as a firststage procedure, and on symptom persistence, LRV stenting followed. As a general rule, with predominantly pelvic congestion syndrome (PCS) symptoms, PCS is treated first; with predominantly NCS symptoms, NCS is treated first. We typically wait, and if there is no improvement within 6 to 12 months, further intervention is considered”

In : *Outcomes of left renal vein stenting in nutcracker syndrome*

Avgerinos ED, Saadeddin Z, Humar R, Salem K, Singh M, Hager E, et al.

C J Vasc Surg Venous Lymphat Disord. 2019;7(6):853–859.

doi:10.1016/j.jvsv.2019.06.016.

https://pubmed.ncbi.nlm.nih.gov/31471277/

4. “The use of an arterial bare metal stent for the LRV angioplasty allows us to use a lower profile vascular access in the internal jugular vein (6 Fr) with a better navigability and conformability to the curve and angle of the LRV and the IVC. This arterial stent had the most ideal diameters and lengths to adapt in the LRV that is 10–12 mm and 40 mm. The other plus to use an arterial stent is the higher radial force to avoid stent migration or dislodgement.”

In : *Endovascular approach using an arterial stent: first Latin-American experience*

Garcia LF, Arroyo F, Vallejo C, Del Castillo J, Moreno N, Forero N, et al.

Cirugía Cardiovascular. 2023;30(6):322–326.

https://doi.org/10.1016/j.circv.2023.06.002
https://www.sciencedirect.com/science/article/pii/S1134009623001043?via%3Dihub