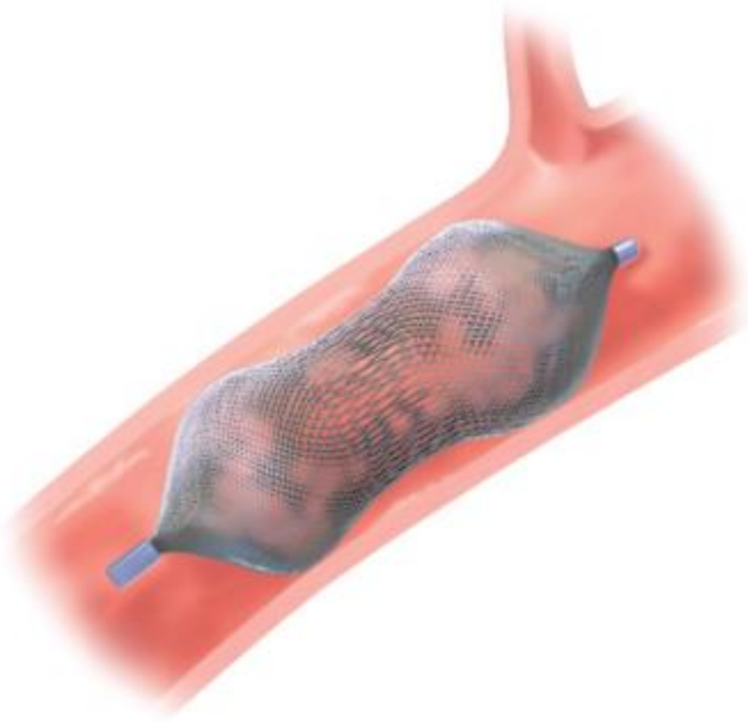


Plugs

in Vascular Surgery

2018

E.DUCASSE

CHU BORDEAUX

INTRODUCTION

- **First approved by the FDA on 2004**
  - for peripheral vascular embolizations
- **First study to report successful use in December 2004[1]**

- **Great technical success[2] : ≃ 95%**

- **IFUs are expanding**

- **NO contraindications have yet been recognized**
  - **« JUST PLUG IT »**

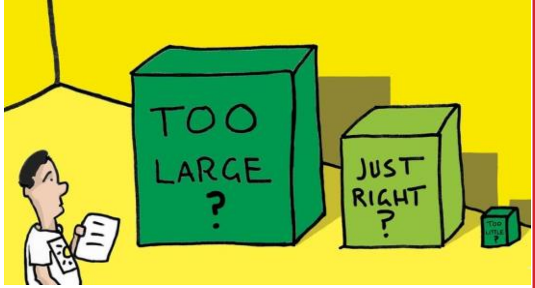
  - **Adequate knowledge of various plugs is essential for the appropriate use of these devices**

1. Hijazi et al. Catheter Cardiovasc Interv 63(4): 482–485
2. Mangini et al. Emerg Radiol 15(3):153–160

COMPOSITION

- **All models of the AVP contain 2 basic components**
    - **a vascular plug**
        - built with nitinol braids
        - self-expanding
        - radiopaque platinum marker bands at both ends
            - high visibility under fluoroscopy
    - **a delivery wire**
        - stainless steel microscrew at the proximal end on the platinum marker band
        - keeps the plug attached to the stainless steel delivery cable

CHOOSING THE CORRECT TYPE AND SIZE OF AVP



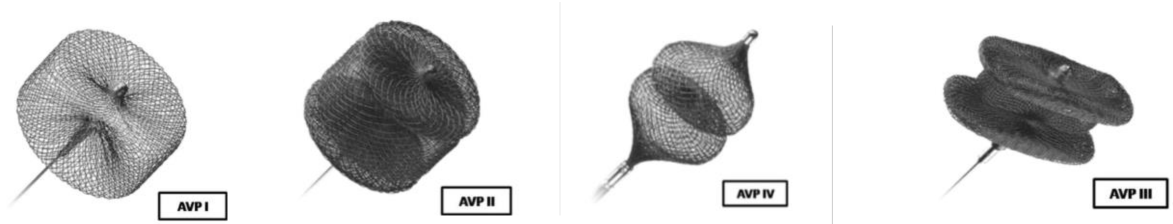
- **Depends on**
  - Vessel type
  - Vessel size
  - Quantum of blood flow
  - Approach to the intended site of occlusion and the available landing zone

- **At least 30-50% larger than the size of the native vessel**
- **The mean device to vessel ratio was 1.4-1.5 in most of the published series**
  - Vessel of 4 mm = Plug of 6mm
  - Vessel of 5 mm = Plug of 8 mm

- **Length of the vessel and Available Landing Zone**
  - An oversized AVP tends to lengthen significantly across the vessel
  - Large enough to ensure complete occlusion
    - but not to elongate and protrude into nearby structures

Gandhi et al. Endovasc Today. 2014;4:1–4.

VASCULAR PLUG FAMILY



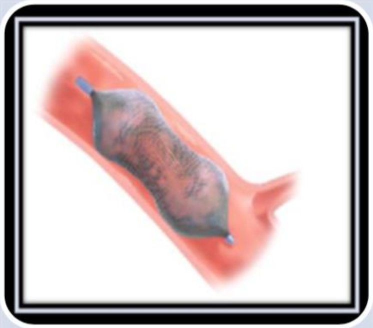
	AVP I	AVP II	AVP III	AVP 4
Structural details	Single lobe	3 lobes plug – one central and 2 peripheral	Oblong plug with extended rims	Two lobes (lower profile)
Available diametric sizes (mm)	4–16	3–22	Long axis, 4–14	4–8
Length of plug (mm)	7–8	6–18	Short axis, 2–5	10–13.5
Guide catheter (Fr)	5–8	5–9	6–9	5F diagnostic

Most common type before the AVPII became available

Available since 2007
Since then, the AVP II is the most commonly used
Better and Rapid occlusive properties
Wide availability of sizes

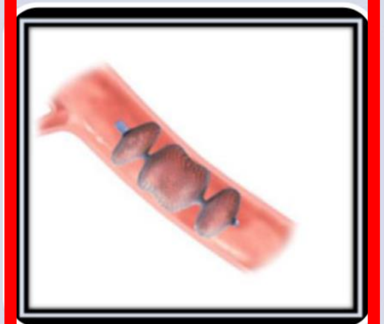
Modified from Wang W, et al 2012.[1]

THE IDEAL INDICATIONS FOR DIFFERENT FORMS OF AVPs



AVP

For short tubular structures with limited landing zone



AVP II

Most versatile of all types

Faster occlusion;

minimizes migration and recanalization

NOT for short landing zone

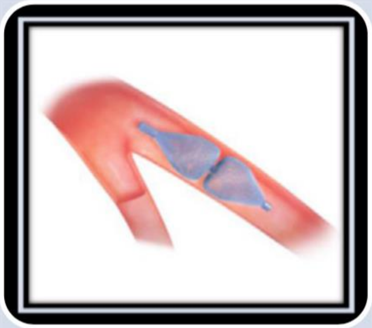
Multilayered
Wide range of sizes (3-22 mm)

AVP III

Fastest occlusion capability and fits elliptical-shaped vascular structures

Paravalvular leak

Medium sized high-flow (faster occlusions)



AVP IV

Best profile (Requires only diagnostic catheter for delivery)

For small & tortuous target vessels

Low profile
For vessles <6mm
Delivered through a 0.038'' microcatheter

PROCEDURAL DETAILS

- **May be done under local anesthesia**

- **Sheaths ranging from 3-8F for plug delivery**
  - Flexor Check-Flo Introducers (Cook Medical, Bloomington, IN)
    - offer both flexibility and support
    - have premade sheath tips to accommodate varied vascular anatomy
- **J tipped Terumo wire (Terumo Medical Corporation, Somerset, NJ, USA)**
- **Catheter to hook the vessel and cross the site of interest using**

- **The delivery cable with the plug attached comes preloaded within an introducer sheath**
- **The device is introduced into the delivery sheath**
  - The plug can be withdrawn and repositioned through the catheter before detachment

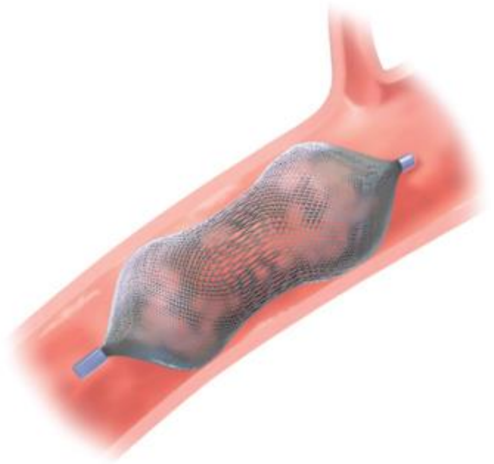
- **Once in place the AVP is detached by rotating the delivery cable in a counterclockwise direction**
  - unscrews the cable from the vascular plug

CHARACTERISTICS OF THE AVP

- **Final angiogram commonly after 10 min of deployment of AVP**
  - when most of the minor residual flow generally disappears

- IMPORTANT : **the AVP can't instantly seal the target vessel to stop the flow**
  - small interstices in the mesh of the device
  - does not have any intrinsic thrombogenic property
  - small holes in the plug reduce the flow and form a clot to seal the device
  - **It will take time to achieve complete occlusion after successful deployment of the AVP**

    = **occlusion time**



ADVANTAGES

- **Versatile**
  - useful in a wide spectrum of clinical situations
  - sizes ranging from 4 to 16 mm in 2 mm increments
- **Easy to use**
  - Released in a controlled fashion
    - precise delivery and secure positioning
  - Very low device embolism risk
- **Few complications**
- **Excellent visibility under fluoroscopy**
  - with limited imaging artifacts

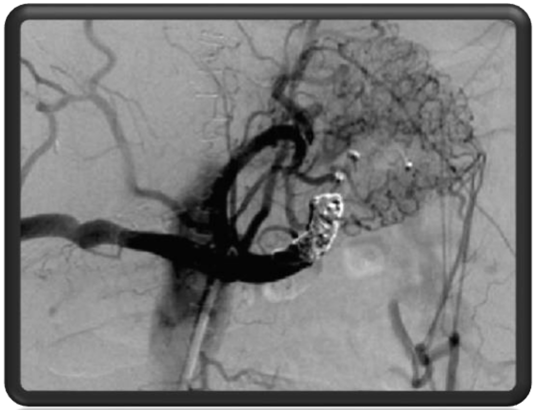
ADVANTAGES

- **Ideal for embolization of medium to large vessels with high flow**
  - reduction in materials used : *single AVP vs many coils* [1,2]
  - reduces procedure times [1,2]
    - average of 13.3 min [3]
  - low radiation exposure [1,2]
    - average of 5.8 min [3]
  - cost-effective alternative
    - 29-79% cost saving *vs coils* [3,4]

1. Bilbao et al. Semin Intervent Radiol. 2006;23:126–42
2. Stromberg et al. US Food and Drug Administration Premarket Notification Rockville, MD. 2003
3. Pech et al. Cardiovasc Intervent Radiol. 2009;32:455–61
4. Pellerin et al. Cardiovasc Intervent Radiol. 2008;31:1088–93

ADVANTAGES

- **“Immobilizer” Function (Anchoring Scaffold)**
  - can facilitate coil occlusion of large vessels
  - focal embolic material immobilizer
    - preventing coil mass migration
    - and leading to improved packing density



- **MRI Compatibility**
  - contains nitinol wire
  - nonmagnetic material
  - safe within a static magnetic field of 3 Tesla[1]

Tabori et al. Catheter Cardiovasc Interv 71(7):940–943

PROCEDURAL ISSUES TO CONSIDER

- **Residual flow**
  - variable depending on the time of final angiogram
  - Adequate oversizing, proper deployment, and better occlusion properties of newer plugs reduces the risk of residual flow

- **Occlusion Time**[1]
  - highly variable
  - prolonged occlusion time in cases of
    - high-flow
    - large vessel diameter
    - underlying coagulopathy

1. Zhu et al. Cardiovasc Intervent Radiol 34(3):522–531

PROCEDURAL ISSUES TO CONSIDER

- **Spontaneous recanalization after successful occlusion**
  - Rare = 0.4%[1]
  - 5 reports of recanalization among more than 1,200 AVP placements in the literature
- **Reconfiguration**
  - An oversized device often lengthens significantly
  - Nearly half of the AVPs reconfigure to the original shape due to nitinol memory[2]

1. Wang et al. Cardiovasc Interv Radiol. 2012;35:725e740.
2. Sheridan et al. Catheter Cardiovasc Interv. 2010;75:857e860.

PROCEDURAL ISSUES TO CONSIDER

- **Device migration and embolization[1,2]**
  - Self expanding with a good radial force
    - prevents migration even in a high flowing structure
  - Very rare in experienced hands
    - *Only one study described migration of an AVP into the abdominal aorta, for which conservative management was elected[3]*
  - The embolized device may be retrieved percutaneously
    - while precise control of the location of embolization of the majority of traditional embolic agents is difficult and they cannot be retrieved
      - *Coils, detachable balloons, liquid embolic agents, particulate embolic agents, and sclerosing agents*

1. Wang et al. Cardiovasc Intervent Radiol. 2012;35:725–40
2. Tuite et al. Cardiovasc Intervent Radiol. 2007;30:650–4
3. Maleux et al. J Vasc Interv Radiol. 2011;22:569–70

OVERALL RESULTS

@ 2 months
AVP vs coil embolization

- **Low recanalization rates**
- **Shorter occlusion times**
- **Improved deployment precision without device migration**
- **Significantly decreased recanalization rate**

1. Stromberg et al. US Food and Drug Administration Premarket Notification Rockville, MD. 2003

COMMON CLINICAL APPLICATIONS

- **Arterial Embolization**
  - Internal Iliac Artery
  - Carotid Artery
  - Splenic Artery
  - Renal Artery
  - Gastroduodenal Artery
  - Aneurysm / pseudoaneurysm
- **Venous Occlusion**
- **Abnormal Vascular Connection**
  - arteriovenous fistula

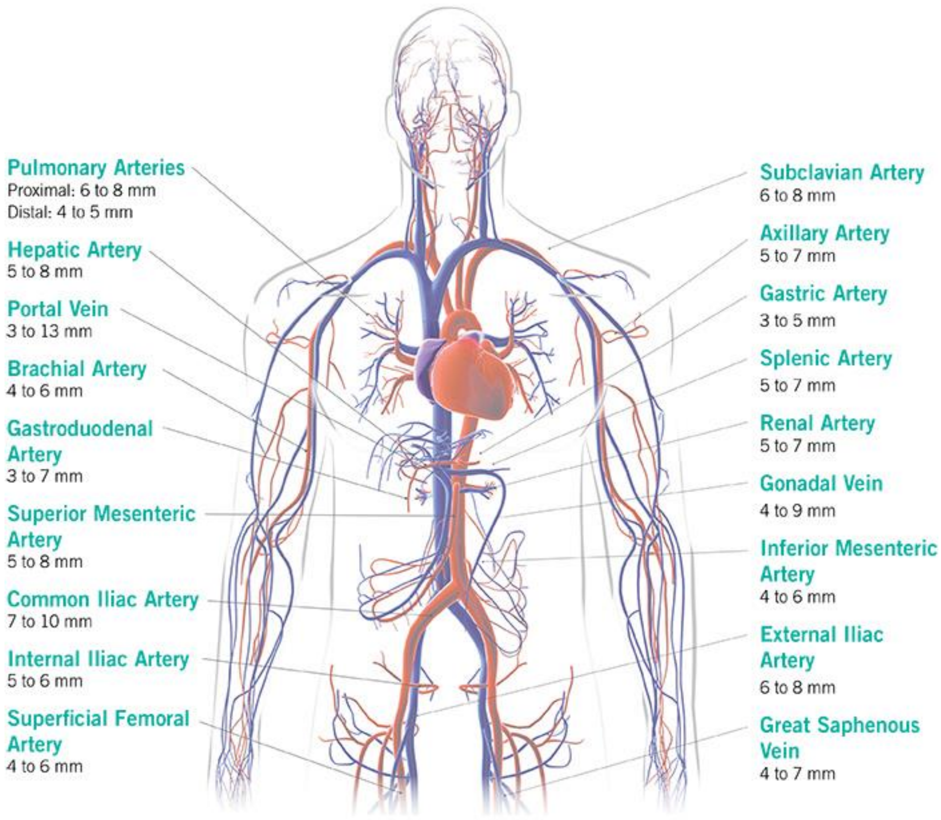


Fig. 2 A, B. A large right internal iliac artery aneurysm (arrow) approached from the contralateral side. The aneurysm has a single outflow vessel. Two AVPs were deployed in both the inflow and outflow limbs causing thrombosis of the aneurysm

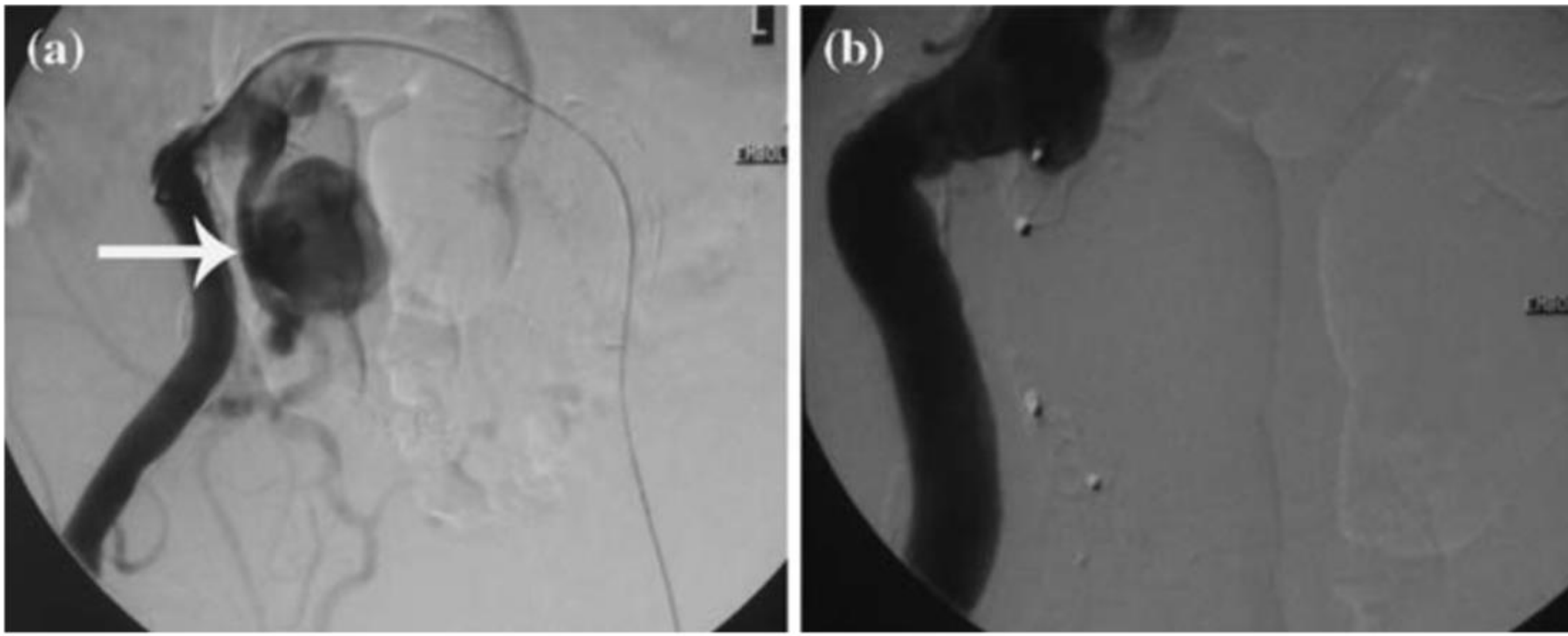
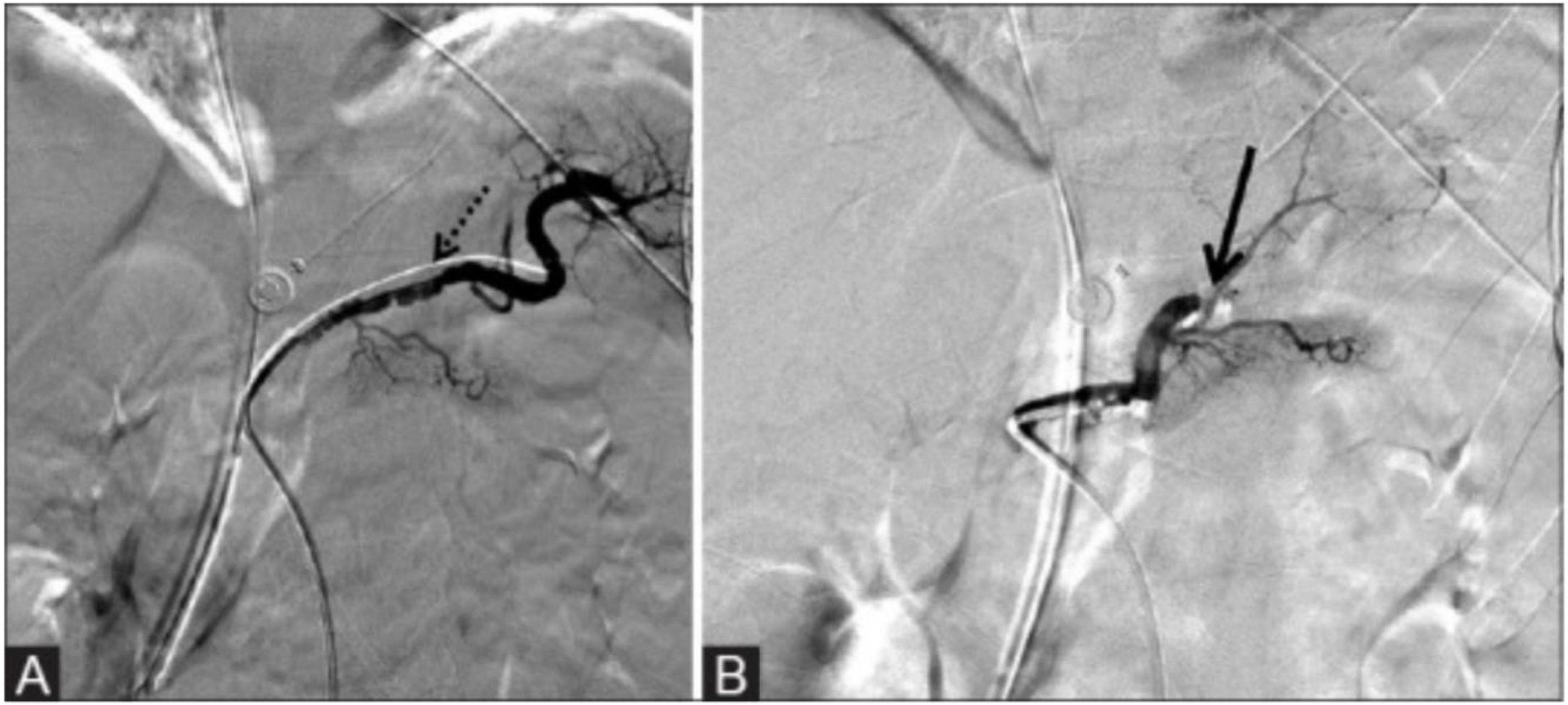


Fig. 1 A, B. Flush aortogram demonstrating the left renal artery target vessel (arrow). This measured 6 mm. An 8 mm AVP was deployed. After 15 min there is complete thrombosis of the artery

Tuite et al. Cardiovasc Intervent Radiol (2007) 30:650–654

6 mm × 6 mm AVP used to successfully occlude the splenic artery in a trauma patient while preserving collateral blood supply to the spleen, avoiding splenectomy. (A) Pre-deployment reveals no active extravasation and vasospasm of the splenic artery (dotted arrow) which resolved after slow instillation of 500 mcg nitroglycerine and (B) post-deployment of the AVP (arrow) with lack of flow in the splenic artery and preservation of collateral perfusion



TAKE HOME MESSAGE

- **The AVP has demonstrated its value in managing a wide variety of disease processes**
  - *Newer models have improved occlusion properties and offered a smaller profile*

- **The device is**
  - **easy to use**
  - **can be precisely deployed**
  - **with high resistance to migration**
  - **and a low recanalization rate**
  - **Associated with cost benefit and reduced procedure time and radiation dose**

- **The anatomic and clinical scenario of each case must be considered**

- **Variable occlusion time remains a major shortcoming**
  - *The addition of coils or multiple AVPs can expedite the occlusion process*

THANK YOU FOR YOUR ATTENTION