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Review

An overview of vascular closure devices: What every radiologist should know

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ABSTRACT

Haemostatic devices can be categorised according to their mechanism of action into three main types; namely pressure devices, topical haemostatic pads and vascular closure devices (VCD). Of these three categories, it is the development of VCDs that revolutionised management of endovascular procedures. Currently available VCDs fall into three major classes, those that use a collagen plug, those that use clips and those that perform suture closure at the arteriotomy site. This article provides a comprehensive review of the all three classes with examples of commercially available devices.

Contents

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1. Introduction

It is remarkable that almost half of century since the introduction of Seldinger's technique, manual compression remains the gold standard for achieving haemostasis after gaining vascular access for diagnostic and interventional arterial catheterisation. Increasing time pressure, issues of patient satisfaction and the use of large diameter catheters for endovascular intervention however have recently necessitated alternative ways of establishing post endovascular procedure haemostasis.

From the early 1990s, various devices have been used to achieve haemostasis post arterial puncture. These haemostatic devices can be categorised according to their mechanism of action into three main types; namely pressure devices (Femostop®, RADI medical systems), topical haemostatic pads and vascular closure devices (VCD). Of these three categories, it is the development of VCDs that revolutionised management of endovascular procedures.

1.1. Vascular closure devices

Ideally, a VCD should be user friendly, provide rapid, reliable haemostasis regardless of anticoagulation status and also allow repeated access. The complication rates of such devices should be no greater than that of manual compression. Currently available VCDs fall into three major classes, those that use a collagen plug, those that use clips and those that perform suture closure at the arteriotomy site (Table 1). This article provides a comprehensive review of the all three classes with examples of commercially available devices.

1.2. Collagen plug based devices (Table 2)

Primary vascular haemostasis after arterial puncture is facilitated by blood contact with the exposed arterial wall smooth muscle cells and collagen. This in turn causes platelets adherence, activation and aggregation resulting in clot formation. Bovine collagen used in these devices augment haemostasis by increasing the availability of collagen at the arterial wall defect [1]. Furthermore the swelling of the collagen mass which occurs after deployment completes haemostasis by mechanically sealing the vessel and tissue tract. Bovine collagen is eventually degraded by macrophages and is reabsorbed within 4–6 weeks time.

The main disadvantage of collagen based products is that immediate re-puncture is not advised due to potential increased risk of local infection and the required time period for collagen biodegradation. In addition, localised proliferative reaction resulting in scar formation caused by the bovine collagen hinders future open surgical access [2]. However, in the last few years, this been refuted by a study suggesting that re-accessing is safe in post Angio-Seal® deployment [3].

In general, collagen plug devices are used in patients who are unlikely to require repeated access either immediately or within 90 days after the initial procedure, though in practice if re-access is required, ultrasound can be used to guide re-puncture remote to such devices. Examples of commercially available collagen based vascular devices include: Angio-Seal®, VasoSeal® and Duett Pro® sealing device.

Table 1
Types of vascular closure devices.

Device	Company	Type
Collagen plugs		
Angio-Seal®	St. Jude Medical	Bovine Collagen
VasoSeal®	Datascope	Bovine Collagen
Duett Pro®	Vascular Solutions	Collagen/Thrombin
Sutures		
Perclose®	Abbott Vascular	Suture
X Site®	Datascope	Suture
SuperStitch®	Sutura Inc	Suture
Staples/Clips		
EVS®	Medtronic	Titanium staple
StarClose®	Abbott Vascular	Nitinol clip
Others		
Boomerang®	Cardiva Medical	Arteriotomy tamponade
SoundSeal®	Therus/Boston Scientific Corporation	Ultrasound

Table 2

	Sheath size
Angio-Seal® [9,10]	
Angio-Seal STS ® (self tightening suture)	6–8F for 6F device
Angioseal V-Twist VIP ® (larger coverage with twisting action)	8–10F for 8F device
• Intra and extraluminal component present	
• Deployement success: 92–98.5%	
• Successful haemostasis: 84–98.5%	
• Average 4.4 min (1.0–18) to haemostasis	
• Average 4 h (1.4–9) to ambulation	
• Major complication: 0.8–3.6%	
VasoSeal® [9,10]	
VasoSeal VHD ® (uses needle depth indicator),11.5F	4–5F for low profile
VasoSeal low profile®	One size for 5–8F
Vasoseal ES and Elite® (uses J locator),	One size for 5–8F
• Extraluminal component with temporary intraluminal component	
• Deployment success: 90–100%	
• Successful haemostasis: 87–100%	
• Average 7.2 (4.8–13) to haemostasis	
• Average 6.3 h (2.3–9) to ambulation	
• Major complication: 1.2–13%	
Duett Sealing device® [9,10]	
Duett Pro®	One size fits 5–9F
Diagnostic Duett Pro® (contains less pro coagulant)	One size fits 5–9F
• Extraluminal component with temporary intraluminal balloon	
• Deployment success: 92.6%	
• Successful haemostasis: 93–100%	
• Average 5.9 (4–7.5) to haemostasis	
• Average 3.8 h (2.3–6.4) to ambulation	
• Major complication: 2.5–3.4%	

1.2.1. Angio-Seal® (Fig. 1)

The Angio-Seal® device consists of a rectangular 1 mm × 2 mm × 10 mm co-polymer footplate attached to a 18 mg bovine collagen plug by an absorbable Dexon traction suture. It produces a sandwich closure of the arteriotomy site with a foot-plate that sits against the inner arterial wall intraluminally, and a collagen plug that is tied to lie immediately outside the arteriotomy.

Because of its simple design and easy deployment, the Angio-Seal® makes up more than half of the VCD market in the USA.

The newer versions of Angio-Seal® (Angio-Seal STS Platform®) ensure a smooth transition from sheath tip to dilator, and have repositioned blood inlet holes to facilitate arterial location. Compared with the previous models, this has been shown provide faster and easier deployment along with a similar success rate and incidence of major complication [4]. Angio-Seal® has also been used in other vascular sites such as the aorta and carotid arteries [5,6]. It has also been used to seal inadvertent subclavian artery puncture during central venous catheter placement [7].

This device should not be used in patients due to have a femoral cut down, as there is an inadvertent risk of cutting through the sutures and causing embolisation of the footplate.