Femoral and Radial Arterial Sheath Learning Package
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Background

For all Coronary Angiograms (C/A) and Percutaneous Coronary Intervention (PCI) procedures an introducer sheath is required to be inserted into either the Right or Left Femoral Artery or Right (and sometimes Left) Radial artery to provide access to the aortic arch and coronary arteries.

Other Cardiac procedures such as Right Heart Studies, temporary pacing wires, Electrophysiological studies (EP) and cardiac valve procedures require a venous sheath to be inserted into a femoral or brachial vein.

For a combination of both left heart and right heart procedures, the insertion of a sheath into both the artery/s and into a large bore vein/s is required.

The various catheters used during both coronary angiography, PCI’s and right heart catheter procedures are inserted into the body via the sheath/s. The sheath is designed to reduce potential damage and possible additional bleeding to the radial or femoral artery and/or vein/venous access sites.

On completion of the cardiac procedure the femoral/radial and/or venous sheath/s must be removed and haemostasis achieved. Depending on the specific patient health issues, including the actual procedure performed, their clotting profile, result of procedure etc., the arterial and/or venous sheath/s may be required to be removed immediately or at a later designated time.

There are several methods to achieve haemostasis post arterial and venous sheath removal including digital pressure, vascular closure devices and FemoStop application. (1)

Note: This document does not cover Arterial Sheath removal following Vascular Surgery. (1)
Target Audience

This learning package is for Registered Division 1 Nurses (RN) and Critical Care trained RNs (CCRN) who provide care to patients undergoing percutaneous cardiac catheterisation and intervention, and associated arterial sheath management. The clinical areas this occurs in are:

- Cardiac Angiography Unit
- ICU
- Westernport Cardiac Unit

Care of, and removal of femoral arterial sheaths and radial artery sheaths after cardiac angiography procedures and/or PCI is a requirement for all staff working in the Cardiac Angiography Unit, all staff caring for these patients post procedure in the Cardiac Care Unit (WPW) and senior RN's of the Intensive Care Unit (ICU). This learning package covers all aspect of care and education, training, and competency of arterial and venous sheath removal.

Aim:

On completion of this learning package, further reading and clinical experience, it is expected the RN will be able to:

- Provide knowledgeable care to a patient with a femoral or radial arterial sheath insitu
- Provide knowledgeable care to a patient with a femoral venous sheath insitu
- Remove a femoral or radial access sheath safely
- Provide continual and follow-up patient care
This learning package is intended to be used in conjunction with the relevant Clinical Practice Guidelines.

**Objectives:**

1. Demonstrate knowledge of arterial and venous anatomy and relevant physiology.
2. Identify the site of the arterial puncture, including difference between a high and low puncture and explain the potential complications associated.
3. Define antegrade and retrograde punctures and explain when each may be used.
4. Identify and explain the possible complications associated with all arterial punctures.
5. Understand the reasoning for accessing coronary anatomy via either femoral or radial artery and the risk associated with both.
6. Understand the risk factors that predispose a patient to developing associated complications.
7. Understand sheath removal, including correct timing, how to assist a medical officer/ RN in sheath removal and possible adverse outcomes of procedure.
8. Understand the concepts of:
   a. Manual digital compression
   b. External compression devices (e.g. FemoStop: Femoral and Trans-radial Band: Radial) and their roles in achieving haemostasis
   c. Mechanical vascular closure devices (VCD) (e.g. Angio-Seal/ Perclose)
9. Demonstrate the correct application of a FemoStop device.
10. Understand the correct application of a Trans-Radial Band.
11. Identify what contributes to a vasovagal episode and when this may occur.
12. Discuss appropriate nursing and medical management of a Vasovagal episode, including appropriate medications and required documentation.
13. Identify signs and symptoms of arterial haemorrhage/haematoma and skin / subcutaneous ooze and the treatment of both.
14. Discuss appropriate nursing and medical management of arterial haemorrhage and required documentation.
15. Identify and manage complications relating to haematoma and arterial dissection.
Accreditation Process:

To achieve competency the RN Div1 should read this learning package and complete:

- ALS competency including life threatening arrhythmia recognition
- BLS
- Complete a minimum of three successful supervised femoral arterial sheath removals and complete competency assessment form.
- Complete FemoStop application assessment and the subsequent single annual satisfactory assessments
- Subsequent annual assessment of three satisfactory sheath removal and competency assessment form completed. (three will depend on previous experience and of the volume of successful sheath removals performed the previous year, speak with your assessor re: amount required to maintain competency)

Assessment tools can be accessed via CEDU e learning portal
Introduction:

Angiography is the study of blood vessel of the organs of the body under fluoroscopy (or X-ray). An artery or vein is accessed by puncturing and cannulating the blood vessel using an introducer sheath. The sheath design is to reduce potential damage and possible additional bleeding to the artery and/or vein access sites. (2)

Percutaneous cannulation of the femoral artery and vein is accomplished predominately using the modified Seldinger’s technique. Percutaneous cannulation of the radial artery may be accomplished by either using the Seldinger’s technique or the modified Seldinger’s technique. This is discussed in further detail on page 11. (2)

For all Coronary Angiograms (C/A) and Percutaneous Coronary Intervention (PCI) procedures, an introducer sheath is required to be inserted into an artery. The chosen artery depends on many factors, with the radial artery recommended, where possible, to be used for STEMI patients; however the physician may have specific reasons to use one side over the other. Both the groin (femoral) and the wrist (radial) may be prepped for the procedure in the event that the access site chosen does not allow catheters to advance to the heart easily. This is especially pertinent in radial artery access and change-over to the femoral artery needs to be performed. (2)

Generally, for cardiac procedures the right radial, right or left femoral artery or sometimes left radial are cannulated to provide access to the aortic arch and coronary arteries. Other cardiac procedures such as Right Heart Studies, temporary pacing wires, Electrophysiological studies (EP) and cardiac valve procedures require a venous sheath to be inserted into a femoral or brachial vein. For a combination of both left heart and right heart procedures the insertion of a sheath into both the artery and into a large bore vein is required. The various catheters used during both coronary angiography, PCI’s and right heart catheter procedures are inserted into the body via these arterial and venous sheath/s. (2)

Prior to the commencement of arterial sheath cannulation, IV access must be obtained for the immediate administration of medication to treat potential complications and to administer analgesia and sedation as ordered by the physician. (2)
Clinical Considerations

On completion of the cardiac procedure, the femoral and/or venous sheath/s must be removed and haemostasis achieved. Depending on the specific patient health issues, including the actual procedure performed, the patient's current clotting profile, the result of procedure etc., the arterial and/or venous sheath/s may be required to be removed immediately. The sheath may be left insitu (occlusive dressing applied with or without suture) to be used longer term by a critical care team, or to be removed at a designated time later the same day. (3)

There are several methods to achieve haemostasis post arterial and venous sheath removal. Provide an explanation of the following methods:

1. Digital pressure
2. Vascular closure device (VCD)
3. Mechanical vascular device

Specialised care, training and competency is required when a sheath is removed from the access site as there are a number of potential access site complications.

1. Bleeding
2. Haematoma
3. Pseudoaneurysm
4. Arteriovenous fistulae
5. Acute arterial occlusions
6. Cholesterol emboli and infections
7. Arterial thrombosis (mostly radial)

Some complications are directly related to inadequate haemostasis to puncture site, while others are related to arterial trauma, which usually occurs during initial access puncture; with both complications needed to be recognised and treated during the sheath removal process. (3)
Major risk factors for complications of angiographic studies include: (4)

- Advanced age
- Repeated angiographic procedures
- Female gender
- Peripheral vascular disease
- Diabetes

There are also a number of minor risk factors for complications such as: (4)

- Level of anticoagulation
- Use of thrombolytic agents
- Elevated creatinine levels
- Low platelet counts
- Procedure sheath size used
- Operator’s technique
Arterial Anatomy

- Arteries carry blood under pressure away from the heart to other organs.
- The arterial wall has three layers: the tunica intima, tunica media and tunica adventitia – also known as the tunica externa.

**Artery Wall**

- The **tunica intima**, the innermost layer consists of an epithelial layer and an elastic tissue layer – the internal elastic lamina. The epithelial layer is a smooth layer of cells that lines the inner surface of the entire cardiovascular system. (3)
- The **tunica media** the thickest layer and consists of elastic and smooth muscle fibres that surround the lumen. These elastic fibres enable the arteries to have high compliance – therefore they easily expand and then contract again without tearing in response to internal pressure changes. (3)
- The **tunica adventitia** is the outer coating of the artery made up of collagen fibres and elastic. (1)
- In the larger arteries of the body, there is an elastic layer known as the external elastic lamina that lies between the tunica media and tunica externa. (3)

Venous Anatomy

Veins are comprised of three layers similar to arteries; however the thickness of each layer is different. The tunica intima is thinner than in arteries and the tunica media is also thinner, containing little smooth muscle or elastic fibres. The tunica adventitia is the thickest layer, consisting of collagen and elastic fibres. Blood pressure in veins is substantially lower than in arteries, so in order to assist the return of blood to the heart, veins contain valves to prevent the backflow of blood. (3)

Haemostasis post venous cannulation occurs at a more rapid rate, as the venous circulation is not a high-pressure system, thus length and strength of pressure required is reduced. (3)

Vein wall

Image from: https://ultrasoundregistryreview.com/vascularTrial17.html

Image from: http://www.biologymad.com/resources/Ch%206%20-The%20Circulatory%20System.pdf
Arterial Cannulation

Modified Seldinger’s Technique

This single anterior arterial wall entry is the preferred technique, especially with femoral arterial access. Local anaesthetic is infiltrated superficially. A hollow access needle (or “Cook” needle) is introduced through the skin and advanced slowly towards the artery at a 30-40 degree angle to the horizontal plan. Puncture of the anterior segment of the artery, (indicated by arterial pulsatile blood flow) confirms the arterial puncture. The soft ‘J’ guidewire is advanced through the access needle and into inner lumen of the vessel; the wire should advance without resistance. Fluoroscopy screening of the guidewire may be used to confirm vessel access. Once confirmed, the access needle is withdrawn back over the wire and the sheath-dilator assembly inserted over the wire and positioned to its full length inside the artery. The access guidewire and introducer is withdrawn and patency of the sheath is confirmed by the aspiration of 2-3 ml of blood from the sidearm of the sheath and the sheath flushed with heparinised saline. The actual technique for access to the femoral artery, radial artery, as well as access to the venous system, if placing a sheath, is relatively the same for all access sites and vessels. (3)

**Seldinger's Technique**

The original Seldinger's double wall puncture technique sometimes is unavoidable, especially with radial artery punctures. This technique may increase the risk of complications especially with patients treated with anticoagulants, anti-platelets, or thrombolytic agents. The type of puncture technique used and if multiple arterial and/or venous punctures occurred or were required should be documented in patient notes.

At the conclusion of the procedure, (or as deemed necessary in relation to the individual patient requirements, actual procedure perform or the ACT), the sheath / s must be removed. In order to reach haemostasis post sheath removal external manual compression is applied or a vascular closure device may be used to achieve immediate haemostasis.(ref)

![Diagram of Seldinger's Technique](http://cardiacathpro.com/VascularAccess.htm)
Radial Artery Anatomy

Image from http://pugliacocina.com/dorsal_forearm_anatomy

Radial Artery Catheterisation

This procedure is performed from either right or left wrist. Prior to the beginning of the procedure, the blood supply to the hand must be assessed. There are two arteries that supply blood to the hand (the radial artery and ulnar artery), and if both are working it is safe to proceed. Hand ischaemia following transradial angiography is extremely rare; however is a known complication of the transradial procedure. (2)
**Advantages of Radial Artery Catheterisation**

Any catheter placement into a blood vessel has an associated risk of bleeding.

After removal of the catheter from the femoral artery, the patient will need to lie flat without bending the leg for 3 to 4 hours (depending on method used to facilitate haemostasis) to allow the artery to heal. In some cases, even with prolonged immobility, internal bleeding can occur. These complications are rare, but they may be less common and more easily recognised with radial catheter insertion. The radial artery is a much smaller artery and located closer to the skin surface. Internal bleeding is significantly reduced and any external bleeding more easily compressed. (2)

After catheter removal from the radial artery, a compression device is placed around the wrist to apply pressure on the artery. The use of the affected arm must be significantly reduced; however, there is no requirement for the patient to remain immobile (sedation and analgesia care must be recognised). In general, patients find radial catheterisation more comfortable than femoral catheterisation because they are able to sit up, walk, and eat immediately. This is a particular advantage for patients with back problems, respiratory issues etc., as there is no lying flat and prolonged immobility. (2)
When a physician is preparing for femoral artery access, recommendation of the following steps (or similar) are in order to ensure optimal puncture: (2)

- Palpation of the inguinal ligament and hip to use as landmarks
- Visualisation of the femoral head of femur via fluoroscopy, using artery forceps externally as a visual location guide
- Palpation of a strong femoral artery pulse
The right femoral artery (RFA) is a commonly used access site for angiographic studies. The left femoral artery (LFA) can also be accessed if the RFA is unable to be used (due to previous surgery or repeated procedures, RFA tortuosity, etc). The size of the common femoral artery can range from 3-8mm in diameter. The systolic pressure in the peripheral artery is slightly higher (about 10mmHg) than the central aortic pressure. \(^{(2)}\)

In select patients, femoral artery puncture may be excluded due to factors such as severe peripheral vascular disease, previous surgery and/or grafting to femoral artery, tortuosity in femoral arteries, scar tissue at site and severe bleeding/haematoma to site after recent angiography. If femoral arterial puncture is contraindicated, other potential sites of arterial access are the right or left radial arteries. \(^{(2)}\)

The femoral artery is located behind the inguinal ligament, midway between the anterior superior spine of the ilium and the symphysis pubis, and is a continuation of the external iliac artery. The distal portion of the femoral artery is between the middle and lower third of the thigh, this becomes the popliteal artery. \(^{(2)}\)

The femoral vein, artery and nerve lie adjacent to each other in a medial to lateral configuration. \textit{Remember: NAVY: Nerve, Artery, Vein and Y front (genital)}. 

Puncture Directions

Two different femoral puncture directions may be utilised in order to access multiple sites for Radiology procedures. When describing puncture direction or approach, it is in relation to the direction of normal blood flow. \( ^{(2)} \)

A **retrograde** ("uphill") approach gives access to the aorta and its branches. For coronary procedures, a retrograde approach is used. Many peripheral vascular procedures, such as renal, cerebral and subclavian procedures will also use this retrograde approach. \( ^{(2)} \)

An **antegrade** ("downhill") approach is used to gain access to peripheral vascular circulation, in order to perform procedures such as femoral, popliteal and tibial angiography/angioplasty. \( ^{(2)} \)

*It is essential to know whether the arterial puncture was retrograde or antegrade (i.e. uphill or downhill) when you receive a post procedure patient.*
It is also important to know (and hand over) if a single arterial puncture access was achieved or if more than one / multiple arterial or venous punctures were required.

If digital pressure is required, puncture direction needs to be considered:

- Retrograde puncture, pressure should be applied 1.5-2cm above skin entry puncture.
- Antegrade puncture, pressure should be applied 1.5-2cm below skin entry puncture. (2)

Image: Angiography cine of femoral artery with femoral artery sheath insitu.

Radial and Femoral Artery Haemostasis

Femoral Artery Haemostasis

At the completion of angiography and PCI the arterial sheath is removed. Haemostasis is achieved as the result of application of pressure to arterial puncture site either manual / digital pressure or mechanically (i.e., use of FemoStop; recommended as
adjunct therapy post manual pressure). Pressure is applied over the arterial puncture site for a minimum of 5-10 minutes, depending on factors such as sheath diameter size, arterial blood pressure, and level of anticoagulation, bleeding disorders, patient weight, low platelet counts and use of thrombolytic agents. Manual digital pressure method is the gold standard for sheath removal; it is financially cheap but labour and time intensive and requires the patient an average two-six hour rest in bed time after haemostasis is obtained. (2)

Post PCI, when a femoral arterial sheath is required to remain insitu (i.e. high ACT) the patient may raise the back of the bed up to 30-35 degrees. The patient may also lay / roll onto their side, affected side preferred, with affected leg remaining straight. Observation of femoral sheath site must still be observed as per clinical pathway. The aim is to keep the patient comfortable; by reducing their movement and minimising attempts to sit up, will potentially reduce the risk of sheath dislodgement, internal and external bleeding and other sheath site complications. (2)

FemoStop device may be used, as an adjunct therapy, primarily after haemostasis has been achieved using manual digital pressure. In this use, the FemoStop is used to minimise the risk of complications related to bleeding disorders, including high ACT, hypertension and uncooperative patients who are unable to remain resting in bed. The FemoStop device may also be used as a primary haemostasis device when used immediately for high pressure removal of arterial sheath; however this is not recommended routinely in this capacity. (2)

An alternative to digital manual compression is Vascular Closure Device/s (VCD) to achieve immediate haemostasis. These devices are not infallible and are limited in use by factors including arterial lumen size, size of sheath used, location of arteriotomy puncture site, existing disease in the vessel, multiple or difficult arterial punctures and physician technique/ training in use of VCD and the financial cost of the device. VCD’s have a rebate code for patients with private insurance; however, VCD’s are not routinely used at Peninsula Health. (2)
Radial Artery Haemostasis

After the sheath removal, an air-filled band is applied to the wrist to provide patent haemostasis. Patent haemostasis is the amount of pressure applied over the access site to prevent bleeding, whilst maintaining blood flow to the distal extremities. The band we currently use is the TR (Trans Radial) Band by Terumo Interventional Systems. All haemostatic bands (TR Band) are placed over the access site and slow release of pressure over time to provide haemostasis (Refer to Radial Artery Care Trans-radial (TR) band section Page 41).

During the hemostasis period, capillary refill is checked along with pulse oximetry. After all patency checks have been completed, an occlusive applied to prevent risk of infection and protect insertion site.

Avoid blood pressures and blood draws from the procedural arm for 24 hours.

You or the patient may remove the dressing in 24 hours and then wash with mild soap and water. (11)

Image from: https://www.wikidoc.org/index.php/Radial_catheterization_hemostasis
Femoral Arterial Sheath Removal

Manual Digital Compression

Post procedures using vascular access via a sheath, the arterial sheath and/or venous sheath is removed by the proceduralist, Cardiology Fellow, Registrar, Cardiologist, Radiologist, Vascular Surgeon or Registered Nurse who is trained and competent to remove femoral arterial sheaths.

NOTE: Arterial Sheath removal is a two-person procedure performed by Peninsula Health accredited Division 1 Registered Nurses or other Peninsula Health credentialed clinician/s (see above).

One clinician/nurse removes the sheath and the second clinician/nurse must be present (unconsummated by other tasks) to assist immediately with application of additional pressure, medication administration and/or haemodynamic monitoring whilst haemostasis is being achieved.

Apply Firm pressure to the arteriotomy site for a minimum of 5-10 minutes to obtain haemostasis. For the duration of the digital pressure application, 3 minutely observations must be completed. Any changes in haemodynamic state are escalated immediately, treated and reported to medical staff utilising emergency call where necessary. (1)

NOTE: Prior to commencement of femoral sheath removal ALL PATIENTS requiring arterial sheath removal MUST be connected to a Cardiac Monitor that displays heart rate/rhythm and non-invasive blood pressure monitoring on 3 minute cycles prior to the commencement of the procedure and whilst haemostasis is being achieved and IV patency.
Record pre-sheath removal:

- Baseline heart rate, rhythm and blood pressure (non-IVT arm).
- Systolic Blood Pressure between 100 – 170 mmHg
- Determine and record baseline location and strength of dorsalis pedis and posterior tibial pulses (Suggested use of plethmograph on distal aspect (toe) affected limb).
- Pleth trace and waveform should be visualised (if used).
- Confirmation of ACT at or below 170 seconds
- ** French size, length, and direction of sheath insertion must be known and confirmed
- Confirm IV patency and ease of access prior to removing sheath

Sheath removal must not commence until you have obtained and documented the above baseline information and a second clinician is available.

1. Inform patient of procedure, and warn them that they may feel a high level of discomfort. Offer the opportunity to void prior to commencement of sheath removal, as there will be significant pressure near the bladder region.
2. A second RN must stay with patient or in close proximity for duration of sheath removal and haemostasis, un-effectuated with other duties. Both staff should continue to monitor blood pressure and heart rate and symptoms of vasovagal reaction for duration of sheath removal and until haemostasis achieved.
3. Ensure IV access patent and easily accessible.
4. Ensure personal protective equipment (PPE) is worn: eye shield/glasses, gloves (sterile gloves not required), gown/apron (if preferred / required).
5. Ensure patient bed height appropriate for the person performing the manual compression. Ensure patient is close to the edge of the effected leg side of the bed to reduce possible leaning/ stretching of the staff performing procedure.
8. Complete and document 2-3 minutely vital sign observations for duration of haemostasis pressure period. Increase frequency of vital sign observations with vasovagal or bleeding event.
10. Continue to observe site for continual haemostasis post cessation of pressure for minimum of 1-2 minutes. A normal puncture site will be soft, with no ooze. If increased pressure or lump forms under skin, a further 5 minutes (minimum) of digital pressure is required to reduce the risk of further haematoma formation.
11. When haemostasis maintained, and groin remains soft with nil ooze, apply dressing to puncture site. Recommended ‘white dot’ covered by Tegaderm / Opsite dressing.
12. Continued observation of access site and haemodynamics a minimum of 15 minutely for 1 hour, then 30 minutely for second hour then hourly for 4 hours.
13. If persistent bleeding or haematoma formation, see complication section.
14. If FemoStop requested or required, see Femostop section.
15. Continual observation as per clinical pathway or as advised by clinician.
16. Ensure documentation completed:
   a. Time removal of sheath and pressure applied
   b. Time to haemostasis achieved
   c. Description of visual / tactile groin area observation
   d. Time and type of dressing applied
   e. Haemodynamic measurements during sheath removal procedure
   f. Variances or complications documented. Significant complications should have a risk man entry document and medical team notified. (See complications). (1)
Systematic guide to femoral artery sheath removal

Regulating amount of digital pressure required:

- Using a small wad of gauze place two fingers approximately 1 cm above the sheath insertion site. The femoral pulse should be felt (arterial sheath may also be felt especially in thin patients). Whilst two fingers remain in position over the pulse site, using the opposite hand, remove sheath with firm single action. The internal sheath movement is usually able to be felt under fingertips. Initially gentle pressure should be applied to femoral artery and sheath; and firm pressure only applied ONCE the sheath has passed under fingertips or when sheath is outside body.

**NOTE:** It is important not to apply full digital pressure onto the sheath and arteriotomy site prior to and during the actual removing of the sheath from the artery itself, as this can crush the sheath, ‘strip’ clot from the sheath into the femoral artery and damage the artery. Immediately apply firm digital pressure using pressure of fingertips when sheath at skin edge or sheath felt outside the artery insertion point.

- Adjust finger pressure with application of opposite hand on top of the two fingers to occlude pulse oximeter / pleth wave form and to ensure no bleeding is evident. Where possible, the initial two fingers should not be removed from the arteriotomy site until haemostasis achieved.

- With digital pressure applied and maintained, frequent observation of arteriotomy site (without moving fingers) should be assessed to ensure no further bleeding or haematoma develops. Using a second wad of gauze, held in the opposite hand, may be used to assist in the possible cleanup of blood around arteriotomy site.

- The second clinician should continue to assist as required, to assess patient and document haemodynamic profile and relieve staff fatigue if required.

During digital pressure the pedal pulse should feel weaker (indicating reduced flow) but **NOT** absent (indicating no flow); the pleth wave form should also reflect this.
reduced not absent blood flow. If the pedal pulse is absent during compression, the pressure over the artery should be decreased slightly periodically to allow distal circulation. (1)

- Digital pressure must be applied for the duration of haemostasis.
- Recommended approximate pressure application times are:
  - 4F = 4-5 minutes
  - 5F = 5-6 minutes
  - 6F = 8-10 minutes
  - 7F = 10 - 15 minutes
  - 8F onwards = 15 minute plus

The application of pressure times will vary depending on patient ACT, patient anatomy, patient size, weight and shape.

**NOTE:** Vital signs: E.g., heart rate, heart rhythm, oximetry, blood pressure and pedal pulses must be recorded according to the clinical condition of the patient as a variation to the prescribed pathway and should be recorded and reported as such.

Post the recommended pressure time, if no bleeding or haematoma evident, digital pressure may be released.

**NOTE:** If bleeding or haematoma persistent, digital pressure must be re-applied. If active bleeding evident, rearrange position of fingers until bleeding stopped, femoral pulse felt, and/or pleth wave form ceased.
Assistance may be required from the second RN/clinician to ‘take over’ digital pressure. Arterial pressure must remain insitu during ‘take-over’ of compression.

To do this:

- First nurse/clinician is currently placing digital pressure just above femoral arteriotomy site.
- Second nurse/clinician places fingers and gauze directly at same site (just above the skin insertion site). Immediately the first nurse removes fingers, as pressure applied by second nurse/clinician.
- Ascertain pleth waveform and no obvious bleeding immediately after ‘switch’ to ensure haemostasis achieved / maintained.

Repeat above steps as required until no bleeding is observed.

If the bleeding persists; assess if the bleeding is arterial or sub-cutaneous:

- **Arterial bleed** should cease if pleth waveform shows nil arterial blood flow when digital pressure applied above the arteriotomy site.
- **Sub- cutaneous bleeding** may still be present once pleth wave form has been occluded. To treat sub-cutaneous ooze, direct digital pressure should be applied OVER the actual entry site for 2-5 minutes (not above skin entry site as for arterial pressure).

**NOTE:** *C-Clamp must not be used for femoral arterial sheath removal, as this device is a form of patient restraint. The C-clamp physically reduces patient movement as its application actually also clamps the patient to their bed.* (1)

Pressure dressings including sandbags and large taped dressings are ineffective in preventing bleeding, and may obscure the puncture site. These items are not recommended for use. (1)
Continued Care Following femoral artery haemostasis

- A ‘white dot’ compressor dressing should be applied directly at skin puncture site and an adhesive transparent dressing (e.g. Tegaderm™) should be applied over the ‘white dot’. The ‘white dot’ dressing acts as a point of blood site and a visualisation to the patient there is a dressing in-situ. The transparent dressing acts as to maintain the ‘white dot’ in place.\(^1\)

- The patient should be instructed to remove the dressing the next day.

- Vascular observations and puncture site observations are performed as per Clinical Pathway to observe for bleeding, haematoma formation and/or false aneurysm. If abnormality present please report this to the Medical Officer.

- Assess neurological status continuously.

- The patient should be nursed according to the prescribed Clinical Pathway: specifically in relation to the procedure performed, access site, sheath removal technique, time to haemostasis and any possible complications seen. \(^1\)
Angio-Seal (St Jude Medical)

Immediately after procedure, as a sterile technique and part of the angiogram or PCI, the procedure sheath can be removed and replaced with (6F or 8F) Angio-Seal device.

The Angio-Seal is a VCD made up of three components: an intra-arterial anchor, collagen sponge and a suture.

The anchor is deployed intravascular (into the inner lumen of the artery) via the Angio-Seal introducer. The introducer is removed and the collagen sponge deployed. The collagen attaches to the anchor by a suture, which is drawn against the arterial puncture site. This places pressure against the internal arteriotomy puncture site and results in immediate haemostasis following successful deployment.

This device has minimal effects on arterial flow with minor groin ooze post deployment.

(10)

The Angio-Seal Vascular Closure Device uses three bio-absorbable components to actively seal the arteriotomy:

- **Anchor**
  - Absorbable co-polymer anchor placed against the inside of the vessel wall

- **Collagen**
  - Placed on top of the arteriotomy in the tissue tract

- **Suture**
  - Clinches the anchor and collagen together to form a secure seal

All components are fully absorbed within 60-90 days.


Care post VCD: Angio-seal deployment

Vital signs: e.g. heart rate, heart rhythm, oximetry, blood pressure and pedal pulses must be recorded according to the clinical condition of the patient as a variation to the prescribed pathway and should be recorded and reported as such.

Post successful deployment of Angio-seal device immediate haemostasis is achieved.
When haemostasis is maintained, the groin remains soft with nil ooze, apply dressing to puncture site. Recommended ‘white dot’ covered by Tegaderm / Opsite dressing. (7)

Continued observation of access site and haemodynamics:

- Minimum of 15 minutely for 1 hour,
- Then 30 minutely for second hour
- Then hourly for 4 hours.

In some patients the VCD may fail, skin ooze may develop (related to ACT and deployment technique) and/or the device may dislodge (“pop”). This complication may occur immediately post deployment or up to 12 hours post VCD deployment. If any of these complications occur the patient may bleed significantly under the skin as a haematoma or outside the site as an arterial bleed. (7)

**Bleeding / Haematoma post Angio-seal deployment**

Immediately apply digital pressure to arteriotomy site (which should be above the white dot dressing or skin access site if able to be visualised)

Immediately alert staff for emergency assistance.

As soon as possible assess if this is an arterial bleed or sub-cutaneous bleed.

Arterial bleeding should cease when digital pressure applied to the pulse site. Application of a pleth waveform to a distal limb should show no arterial blood flow/waveform when digital pressure applied above the arteriotomy site. If bleeding remains when artery site has no blood flow, it probably is subcutaneous ooze / bleeding. (see below). If bleeding ceased, continue with sheath removal protocol of 5-10 minutes digital pressure, until haemostasis achieved. (7)

**Haematoma** formation is assumed to be arterial bleeding post Angio-seal leak or dislodgment. Immediate digital pressure should be applied to haematoma. Call for immediate assistance. Continue with sheath removal protocol of 5-10 minutes digital pressure, until haemostasis achieved. (7)
Sub-cutaneous bleeding may still be present when the pleth wave form has been occluded. To treat sub-cutaneous ooze, immediately apply digital pressure directly OVER the actual entry site for 2-5 minutes. (Do not apply pressure above skin entry site as for arterial pressure). This pressure should not restrict arterial blood flow or pleth waveform. (7)

If persistent bleeding or haematoma formation, see complication section.

1. If FemoStop requested or required, see FemoStop section.
2. Continual observation as per clinical pathway or as advised by clinician.
3. Ensure documentation completed
4. Document time digital pressure applied
5. Document time to haemostasis achieved
6. Description of visual / tactile groin area observation
7. Time and type of dressing applied
8. Haemodynamic measurements during bleeding event
9. Variances or complications documented. Significant complications should have a risk man entry document and medical team notified. (See complications). (7)

Other Vascular Closure Devices

Alternative Vascular Closure devices (VCD) are available and can be used depending on the Cardiac Interventionist requirements and / or preference and patient suitability. A VCD is often a piece of collagen, metallic clip or suture designed to elicit immediate sealing of a puncture site made in an artery after an angiogram. (7)

Vascular closure devices provide an alternative to manual compression. These devices provide immediate sealing of the femoral artery access site, so there is no need for prolonged compression. (7)
Risks with Vascular Closure Devices (VCD)

The main complications are rare, though can include:

- **Device failure (<6%).** This requires immediate firm digital pressure on the bleeding site. If device failure occurs, blood loss can be greater than if closure device had not been used, increased risk of increased blood loss should be considered in patients on anticoagulation medications.

- **Pseudoaneurysm (2.5-5%).** If a small bleed goes unrecognised at the time of inserting the closure device, a collection of blood can form immediately outside the artery, causing a pseudoaneurysm. This can clot spontaneously and resolve itself or continue and risk rupture and further bleeding.

- **Obstruction (<1%).** The closure device can cause an obstruction in the artery, thus limiting blood flow down the leg, leading to acute limb ischaemia.

- **Infection (< 1%).** Vascular closure devices are foreign bodies in the artery and/or surrounding soft tissue. These foreign bodies increase infection risk, symptoms occur approximately 1 week after the procedure. (7)

Benefits of Vascular Closure Device (VCD)

VCD’s reduce the amount of time required to lie flat after angiographic procedures, thus the patient may be discharged sooner. The immediate risk of bleeding from the groin puncture site is reduced when a VCD is in-situ.

VCD’s can reduce the risk of bleeding in patients requiring anticoagulation medications. (7)

Certain angiographic procedures require larger punctures in your femoral artery for adequate access. Applying manual compression to stop the bleeding after these procedures can be difficult. VCD’s are useful following the use of large bore catheters. (7)
VCD’s are useful for bariatric patients, where digital pressure is difficult to obtain and maintain. Elderly and/or unstable patients may benefit from these devices, as they reduce time for lying flat and reduce risk of agitation and pain with prolonged bed rest. (7)
External Haemostatic Devices - FemoStop

The FemoStop pressure system is a device consisting of an inflatable dome, held in place by positioning a belt under the patient and plastic bar over the patient. The dome is inflated to a determined amount, which places controlled pressure on the arteriotomy site to reduce the risk of on-going bleeding and/or haematoma formation. (8)

A plastic arch bar (either disposable of non-disposable) is placed on top of the patient’s abdomen / pelvic area, at level of the patient’s hips. This bar is held in position by positioning a disposable belt placed underneath the patient and around the patient’s hip and back. One side of the plastic bar is an inflatable soft dome that exerts pressure over the arterial puncture site and assists in haemostasis. The plastic dome is clear, enabling full visualisation of the skin entry puncture site at all times. The amount of pressure exerted on site is controlled and measured using a manometer attached to the dome not by tightening the belt. (8)

The FemoStop device can be used to achieve primary haemostasis at the commencement of the sheath removal. However, this device is most commonly used in this facility to provide ongoing pressure to the arteriotomy site at the completion of initial haemostasis post 5-10 minutes of digital pressure. (1)
For support post haemostasis

FemoStop is positioned for up to an hour at low pressure (20-60mmHg), and then may remain in positioned without additional dome pressure for up to 1-2 hours, before removal of the device – and according to medical orders, adjusted application time to suit each patient haemostasis and haemodynamic status. [8]

Correct application of the FemoStop is vital, as use of this device by unskilled practitioners and in unsuitable patients may result in higher complication rates. Therefore, it is important to assess the patient for suitability before use. Literature has demonstrated the device to be ineffective in obese patients or in warm room / environmental conditions – as these factors can make effective application difficult. [8]

Contraindications for FemoStop

Contraindications include critical limb ischaemia, localised skin site necrosis or infection, severe peripheral vascular disease, previous femoral arterial or venous grafting – as use of the device in the presence of these conditions may exacerbate them. [8]

Application of FemoStop:

- Application of FemoStop is a two-person procedure.

- Follow femoral artery sheath removal manual compression instructions (as above) for patient preparation.

- Explain procedure to patient. Ensure they understand the requirements for the FemoStop and time of duration. Anxiety in a patient may increase length of compression required and exacerbate risk of vasovagal reaction.

- If possible, ensure patient able to void/ empty bladder prior to the application of FemoStop as pressure will be applied near the bladder. However, patients can still use bed pan / urinary bottle with FemoStop insitu.
• Examine puncture site for pre-existing bleeding. Document: haematoma present, mark haematoma borders so that any further change is noticeable.

• If major bleeding or large haematoma noted, seek assistance and follow procedure for Treatment of Major Bleeding/Haematoma below.

• Document baseline set of haemodynamic vital signs and peripheral vascular observations.

• Slide/position the FemoStop paper-belt under the patient's hips, ensuring it is not twisted or folded and is pulled through equally on each side, with the bottom third in line with the puncture site (see below). This will help the dome sit in the correct position. If patient unable to lift hips off from the bed / trolley to place the paper-belt, log-roll patient from each side to position belt correctly.

• Attach the FemoStop dome to the plastic arch and twist into place, peel back the plastic cover of the dome, avoid touching dome (promote aseptic / sterile) until placed over arterial puncture site (with or without dressing insitu).

• Attach the arch to the belt, by fully depressing lever on the arch and inserting a corner of the belt, pulling it through. Repeat on the other side, pulling belt

Image from: https://www.cathlabdigest.com/articles/Mechanical-External-Compression-FemoStop%C2%AE-plus
through so that the dome is sitting snug over the femoral artery puncture site. Do not pull belt and device tight.

**Do not place external force over puncture site using FemoStop clamp; the dome inflation will provide the pressure, not the belt and device placement.**

- The arch should be level and sit squarely across the groin area. Position centre of dome superior and medial to skin puncture (approximately 1-2cm) so that it sits over arterial puncture. (Remember, in retrograde approaches, skin puncture is usually slightly below arterial puncture site. See diagram below).
- Tighten belt only enough that the dome sits snugly against site
- Attach hand pump and manometer. Inflate to desired pressure (as medically ordered – usually 10-20mmHg more than the patient’s blood pressure) and close tap on dome. Pleth waveform placed on the affected leg extremity on the may assist to ensure appropriate amount of dome pressure is applied to femoral artery. (8)

**Document:**

- Time of FemoStop application,
- First set of baseline observations with FemoStop application
- Initial FemoStop pressure amount
- Orders for deflation time and amount
- Continue to document reduction in dome pressures, haemodynamic observations, changes in patients’ status and changes made to FemoStop device until FemoStop removed.

**NOTE:** FemoStop device must be removed after three hours. Clinical observations completed as per regime in relevant Clinical Pathway.
Radial Artery Care Trans-radial (TR) band

TR Band Post Procedure Monitoring

- Instruct patient to keep wrist straight and refrain from lifting or pushing with the affected arm.

- Monitor access site and extremity distal to puncture wound every 15 minutes until TR Band removed then follow diagnostic/interventional orders.

- Assess for absence of ulnar pulse, capillary refill > 3 seconds, cyanosis, numbness and/or pain in affected extremity, if present notify MD.

- If bleeding or hematoma occurs, immediately apply adequate pressure to achieve haemostasis and notify Doctor and T/L & NIC.

- Limit movement in the affected arm for 6 hours post procedure. If needed place wrist on arm board to restrict movement.

- If sterile pressure dressing is used remove 6 hours after application.

- Pt may ambulate 30 minutes after arrival in recovery area.

Post Diagnostic Cath Procedure (Angiogram)

1 Hour after TR Band is applied deflate 3ml of air from cuff. If no bleeding occurs from the site deflate 3ml of air from the TR Band every 15 minutes until all 15ml of air has been removed.

No blood pressure readings, lab draws, or IV access in the ___ Rt Arm; ___ Lt Arm; x 24 hours.
If bleeding occurs when 3ml of air is removed re-inflate with 3ml of air. Wait 15 minutes then restart releasing 2ml of air every 10 minutes until all 15ml of air has been removed.

If site free of bleeding or hematoma after 5 minutes, remove TR Band and apply sterile dressing to site.

- After TR Band removal evaluate access site for bleeding every 15 minutes x for 1 hour.

Limit movement in the affected arm for 6 hours post procedure. If needed place wrist on arm board to restrict movement.

- If sterile pressure dressing is used remove dressing 6 hours after application.

**Post Intervention Cath Procedure (PCI + Stent)**

- **Two hours after TR Band is applied** deflate 3ml of air from cuff. If no bleeding occurs from the site deflate 3ml of air from the TR Band every 15 minutes until all 15ml of air has been removed. If site free of bleeding or hematoma after 60 minutes remove TR Band and apply sterile dressing to site.

- If bleeding occurs when 3ml of air is removed re-inflate with 3ml of air. Wait 60 minutes then restart releasing 2ml of air every 10 minutes until all 15ml of air has been removed.

- After TR Band removal evaluate access site for bleeding as follows: every 15 minutes x for 1 hour; every 30 minutes x 2 hours and every hour x 2 hours.

- Limit movement in the affected arm for 6 hours post procedure. If needed place wrist on arm board to restrict movement.

- If sterile pressure dressing is used remove 6 hours after application.
**Discharge Advice**

- Instruct patient no lifting with affected arm for 24 hours.

- Instruct patient to apply manual pressure and call physician immediately if bleeding or hematoma occurs at the site.

- Instruct patient to remove dressing the next day and keep site clean, dry and covered with a new band aid daily until healed.

- Instruct patient to avoid submersion of site in water for 3 days.

Instruct patient to report any symptoms other than slight tenderness at the site or tingling of the fingers and hand for up to 3 days. (5)
Access Site Complications and Management:

The rate of vascular access site complications has been reported from anywhere to 0.1% to 61%, depending on definition of complications.

**Bleeding and haematoma**

Bleeding or blood loss from puncture site may range from minor superficial ooze to major haemorrhage presenting as pulsatile flow. Bleeding may also be accompanied by haematoma. Bleeding is a major indicator of in-hospital mortality, with increased rate of mortality evident in post-bleed patients up to one year after the event. *(2)*

Haematoma is caused by bleeding into soft tissue around the access site and requires immediate attention. Patients may suffer significant blood loss or femoral nerve compression if left untreated. Haematoma can be confirmed via ultrasound, which is also useful in excluding the presence of pseudoaneurysm or arteriovenous fistula. *(4)*

Signs and symptoms of haemorrhage/haematoma include hypotension, tachycardia (may not occur in a patient with a permanent pacemaker), pallor, palpable haematoma around site, visible external blood loss, altered conscious state. *(4)*
Retroperitoneal haemorrhage/haematoma

High femoral artery puncture is a strong predictor for retroperitoneal bleeding and a common cause is perforation of a suprainguinal artery.

Signs and symptoms include hypotension, tachycardia, pallor, flank/lower abdominal or back pain, restlessness, nerve pain down leg on puncture site. Pooling and bruising may be evident in the patient’s back and buttocks, therefore log-rolling and visually inspecting the patient with a suspected retroperitoneal haemorrhage is a useful assessment. (4)
Ultrasound and CT may be required to diagnose, assess and success of treatment techniques. Surgical repair and evacuation of collection may be required as an emergency procedure or as an in-hours procedure. (4)

Treatment of haemorrhage/haematoma is aimed at preventing any further blood loss from arterial puncture site, compressing and removing any collection of blood and treating blood loss. Applying pressure to the femoral artery may induce a vasovagal episode; therefore it is important to seek assistance immediately and to closely monitor the patient’s vital signs. (4)

**Treatment of Superficial Bleeding**

Minor superficial ooze is common post VCD, particularly Starclose or Angio-Seal deployment and/or may occur when patient first sits up or first mobilises.

Once haematoma and/or arterial haemorrhage are excluded, maintain pressure directly over the bleeding site for 5 minutes. When bleeding ceased, apply a new dressing so that any further bleeding is immediately visible.

Document changes and action required. Continue to assess and monitor closely for further change in access site. Repeat above as required. Occasionally superficial bleeding may be evident for a significant length of time. (4)
**Treatment of Major Bleeding**

Summon immediate help. Reassure patient. Lie patient flat. With gloved hands, eye protection and gauze apply firm pressure above the puncture site (at arteriotomy site) for at least 15 minutes.

Placing a pulse oximeter on a toe of the leg that you are compressing may ensure effective occlusive pressure (a poor trace = poor perfusion caused by occlusive arterial pressure).

Pressure must not be released before initial 15 minute period. After this time, and if appropriate, slowly release pressure and assess bleeding site. Additional pressure may be required depending on factors patient’s clotting profile and haemodynamic status. Use second assistant for fatigue relief if required. (2)

Before applying pressure, it is important to ascertain whether the arterial puncture was retrograde or antegrade (i.e. uphill or downhill). (2)

Retrograde puncture *pressure should be applied 1.5-2 cm above skin puncture.*

Antegrade puncture *pressure should be applied 1.5-2 cm below skin puncture.*

- Palpate area and ascertain whether a haematoma is present, if so follow *treatment of haematoma* below.

Monitor and document frequent vital signs and neurovascular observations. A second nurse should be present at all times and acting as “scribe” to document vital signs and sequence of events, and to provide assistance if required.

- Report to medical staff. IVT Fluid volume replacement (i.e. Normal Saline, Gelofusine, Packed Cells) or drugs such as Aramine (IV, usually titrated doses of 0.5mg-1mg each) and/or Atropine 300 – 600 mg, may be ordered if patient showing signs of haemodynamic compromise.
1. Document episode and cause of event if known (i.e. ambulation, sitting up in bed) in nursing /procedure notes. Include approximate amount of blood loss, treatment provided, and any medical orders. Further investigation: ultrasound, ABG’s, check Hb, CT or other investigations as required or as medically ordered.

2. Document event in VHIMS (1)

**Treatment of Haematoma**

Summon immediate assistance.

Warn patient that significant pressure is required to stop the internal bleeding. Reassure patient.

Ensure patient is lying flat, 20 -25 degrees is acceptable. With gloved hands, eye protection and gauze apply firm pressure above the puncture site and hematoma for at least 15 minutes. This pressure is usually extremely painful for the patients and a vasovagal event is highly likely to occur. Analgesia may be required.

With a second hand, or with the assistance of a second operator, continue to maintain pressure over site, then use firm pressure to the haematoma external edges to attempt to push haematoma out via the skin entry site.

The aim is to try to push the haematoma mass out. Pressure over the arteriotomy site must not be released before this initial 15 minute period. After this time, slowly release pressure and assess site. Additional pressure may be required depending on factors patient’s clotting profile and haemodynamic status. Use second assistant for fatigue relief if required.

Take frequent vital signs (2-3 minutely) and neurovascular observations. A second nurse should be present at all times and acting as an assistant for medication administration, patient care assistant, and “scribe” to document vital signs and
sequence of events. If possible, ask colleague to trace an outline of initial haematoma’s palpable borders with black pen. (1)

Report to medical staff as soon as possible.

Medical assistance and medication orders may be required early in the sequence of events when treating arterial bleeding and haematoma. Fluid volume replacement (i.e. Normal Saline, Gelofusine, Packed Cells) or drugs such as Aramine/Atropine may be ordered if patient showing signs of haemodynamic compromise.

**Documentation**

- Document episode in nursing/procedure notes. Include location (i.e. retroperitoneal or groin) of haematoma, size after compression, treatment provided and any medical orders.

- Assess if ultrasound, check Hb, CT or any other investigations are required (as medically ordered).

- Complete VHIMS (1)

**Femoral artery dissection**

Femoral artery dissection is a tear in one, two or three layers of the wall of an artery. This may be superficial and not require treatment or result in extensive blood loss, retroperitoneal haematoma and/or the development of a pseudoaneurysm. Dissection extent is confirmed via femoral angiogram or ultrasound. Percutaneous femoral artery stent insertion or surgical repairs are among possible treatment options. (4)

Dissections may also be managed conservatively, with symptom management, +/- manual or FemoStop pressure, and / or allowed to heal themselves. (4)

First line treatment is manual pressure, additional manual pressure and / or FemoStop device placement. (4)
**Pseudoaneurysms**

A cavity/pouch formed between two layers of the arterial wall, which usually occurs as a result of arterial trauma (or dissection) during arterial puncture. The artery bleeds into the outpouching, forming a collection of blood that is at risk of rupture. Large pseudoaneurysms are palpable masses that may only become symptomatic when they begin to compress on the adjacent nerve. This condition is diagnosed via ultrasound. Small, asymptomatic pseudoaneurysms may spontaneously resolve after cessation of anticoagulant therapy. Large pseudoaneurysms may become thrombotic and be a source of infection if left untreated. Treatment involves compression of the mass under ultrasound guidance, with or without thrombin injection as an adjunct. Compression causes extreme discomfort to the patient, therefore close vital signs observation is important and intravenous sedation often required. Occasionally ultrasound-guided compression may be contraindicated, in which case surgical repair is sought. (4)

The incidence of pseudoaneurysm is estimated at approximately 1% and 3%. Pseudoaneurysm occur when the blood flows, intermittently, during systole and diastole into the hematoma sac overlaying from artery. The risk factors for pseudoaneurysm are: low femoral puncture (puncture of the superficial femoral artery), large sheath size, ineffective manual compression, anticoagulant and antifibrinolytic therapy, older age, and arterial hypertension. (4)

**Clinical evaluation:** Patients present with pain and swelling at the access site or may be asymptomatic. Physical exam reveals a pulsatile swelling with a bruit.

**Diagnosis:** Duplex ultrasound. Arteriography (CT or angiography) is rarely required.

**Treatment:** Small (≤2 cm)—observation and serial ultrasonography. Large—ultrasound guided compression (30 to 300 min)/thrombin or collagen injection, or surgical repair.
Vasovagal Syncope

A vasovagal is a syncopal episode marked by a slowing of the heart rate and hypotension, caused by vagus nerve stimulation. (3)

The vagus nerve is mediated by receptors located in the carotid arteries, the aortic arch and the heart. When stimulated it results in decreased parasympathetic nervous stimulation and increased sympathetic nervous system tone. (3)

A vagal response may also be induced when a patient experiences extreme pain, for example on intravenous cannulation, during initial arterial puncture, VCD/Angio-Seal deployment or as manual compression is being applied to femoral access site. (3)

Signs and symptoms of a vasovagal include bradycardia, hypotension, nausea, vomiting, pallor, diaphoresis, dizziness, and decreased alertness/conscious state.

In elderly patients with decreased vagal tone, the heart rate may not slow – the only manifestation of a vasovagal may be hypotension. Therefore it is important to know your patient and monitor closely for any change in vital signs and their sequale.

Treatment includes Atropine (0.6mg – 1.2mg) IV and Normal Saline bolus if necessary. The Valsalva manoeuvre (e.g. asking patient to cough) may also be effective in increasing heart rate and restoring blood pressure.

Management of Vasovagal Syncope

- Summon immediate assistance. Reassure patient.
- Obtain vital signs 2-3minutely.
- Ask patient to cough if able to.
- Lie patient flat, however Do NOT tilt head of bed down. Elevate legs. If patient sitting in chair or lying on the floor, do not attempt to move them – elevate legs as much as possible.
- Ensure patient large bore IV access.
- Administer IV Atropine and/or Aramine and IV Normal Saline bolus as medically ordered. ALS guides lines as appropriate.
- Document episode.
- Ensure medical review conducted, obtain ongoing treatment orders.
Arteriovenous (AV) fistulae

AV fistulae result from puncture and subsequent placement of sheath through anterior and posterior wall of the femoral artery then into the femoral vein. Artificial communication between the vessels results when the sheath is removed. Occurrence of AV fistulae is rare. Similarly to pseudoaneurysms, treatment with ultrasound-guided compression is effective however if contraindicated, surgical repair may be required. (4)

Acute arterial occlusion

Most commonly occurs due to thromboembolism. May rarely also occur due to dislodgement of vascular closure device, i.e., AngioSeal. Symptoms include pain, paralysis, paresthesia, pulslessness and pallor (the 5 P's).

Neurovascular observations are routine pre and post angiogram/angioplasty in order to detect possible changes to distal limb perfusion, which may be signs of arterial occlusion.

Ultrasound and angiogram are used to image and diagnose the source of occlusion.

Treatment may involve percutaneous thromboembolectomy and thrombolysis with a thrombolytic drug such as Urokinase. Rare cases may require surgical evacuation of emboli. (4)

Cholesterol emboli

A rare complication in which cholesterol from within the arterial wall embolises, causing distal, mesenteric or central nervous system ischaemia. Signs and symptoms include abdominal pain, headache, skin mottling, decreased renal function and lung haemorrhage. (5)

Infection

Risk of infection increases with repeat punctures, long complicated interventions, and if a femoral arterial sheath is left insitu for extended periods. Signs and symptoms include fever, redness/tenderness to site, wound drainage. The patient should be educated to monitor for signs of infection post discharge as the signs of
infection may not appear during hospitalisation, but become evident in the days and weeks post procedure and discharge. (5)

**Dissection**

Retrograde dissection of the femoral artery occurs as a result of the needle or the guidewire entering the dissection plane at the time of femoral artery cannulation. In addition, dissection can occur during femoral angiography if the sheath is up against the wall of the femoral artery (angiography with the guidewire in place will reduce the chance of this occurrence as described above). (4)

Most dissections are discovered on femoral angiography and are usually asymptomatic. The dissection flap is held open by the antegrade flow of blood and rarely results in complete occlusion of the femoral artery.

**Diagnosis:** Most dissections are discovered on femoral angiography. Dissections resulting in femoral artery occlusion will result in ipsilateral lower leg pain with signs of arterial insufficiency (5 Ps described below).

**Treatment:** Most dissections without occlusion are usually asymptomatic and no definitive treatment is needed. However, if the dissection is discovered on femoral angiography, it may be prudent to withdraw the sheath back and repeat femoral angiography using hand injection of contrast to ensure that the artery will not completely occlude upon sheath removal. In patients with femoral artery occlusion, contralateral access with attempted percutaneous or surgical approaches to femoral artery recanalization will be required. Acute ischemic limb is a surgical emergency and is described below. (4)

**Acute Limb Ischemia**

Rare with an Incidence of less than 1.0%. Acute limb ischemia may be due to a thrombus at the site or due to femoral artery dissection (antegrade). It may be due to complication of VCD use. Risk factors include a small caliber artery, using larger size sheaths, those most at risk are females, diabetics, longer catheter dwell time, or superficial femoral cannulation where the artery lumen is smaller. (4)
Signs and symptoms include: 5 Ps—Pain, Pallor, Paresthesia, Pulselessness, Power (loss), compartment syndrome.

- Treatment is an emergency. Immediate alternative access should be considered, angiography and possible thrombectomy/angioplasty and stenting may be required, fibrinolytics or surgery may also need consideration.\(^\text{(4)}\)

**Retroperitoneal Haemorrhage**

Retroperitoneal hemorrhage is a rare but serious complication of femoral arterial access with an incidence of less than 3%. Risk factors include: high puncture, use of glycoprotein IIb-IIIa inhibitors, and posterior wall puncture.

Clinical evaluation shows signs of flank/back pain, hypotension with associated bradycardia unresponsive to Atropine. On assessment signs and symptoms of hypotension, tachycardia, Cullen’s sign, Turner’s sign are evident.

*Image from: http://dwormink.info/gray-turners-sig.htm*
Cullen’s sign is evidenced by bruising around the periumbilical area.

Turner’s sign, otherwise known as Gray Turner’s sign, is where there is bruising on bilateral aspects of the torso between the ribs and hips. (9)

A computed tomography (CT) image of the pelvis (without contrast) is required for accurate diagnosis. Alternatively, angiography can identify the site of perforation.

Fluid resuscitation with crystalloids and blood transfusion are used to treat these bleeding anomalies. In severe cases, surgery may be required. (4)
Risk Factors for Access Site Complications

A number of factors lead to increased risk of access site complications. Keep in mind that the following factors are common in most of the patients where angiography/PCI is indicated. Risk factors include: advanced age, diabetes, being female, hematocrit, patient height and weight, peripheral vascular disease, hypertension, type and length of procedure, history of previous procedures, anticoagulation, presence of a venous sheath and a history of renal failure. (5)

Advanced age

Increased age is associated with an increased risk of vascular access complications. Studies have demonstrated increased risk of bleeding complications in patients over 70 years of age. (5)

Diabetes

Patients with diabetes usually have small, tortuous circulation due to peripheral vascular disease. Diabetes also contributes to increased infection risk. (5)

Sex

It has been demonstrated that females are at an increased risk of bleeding than males, although literature has been unable to find an explanation behind this. (5)

Hematocrit

Hematocrit is the volume of packed Red Blood Cells in 100ml of blood, measured as a percentage the normal; range is 45% - 52% for men and 37% - 48% in women. Patients with low haematocrit pre-procedure should be monitored carefully for complications because bleeding or development of a haematoma will lead to a further drop in haematocrit, causing patient to become symptomatic. (5)

Height and weight

Excess adipose tissue in obese patients can lead to difficulty in locating artery for accurate puncture. Excess tissue may also make it more difficult to obtain
haemostasis via manual compression. Thin patients are also at increased risk of bleeding complications – although the reason behind this is unknown. (5)

Peripheral Vascular Disease (PVD)

PVD patients tend to have calcified, brittle vessels that are difficult to access, tortuous and patients are at an increased risk of distal cholesterol embolisation. (5)

**High blood pressure**

Hypertension may increase length of time taken to achieve haemostasis. Consider administration of an antihypertensive in these patients prior to sheath removal, as medically ordered. (5)

**Type and time length of procedure performed**

Longer procedures often require use of higher amounts of anticoagulants. The length of that sheath is left insitu also correlates with risk of complications – longer than four hours is associated with increased bleeding and infection risk. (5)

Pre-existing closure device and previous groin access attempts

Repeated previous procedures can lead to development of scar tissue and bruising around site. These can make it difficult for the practitioner to palpate underlying artery and locate appropriate puncture site. Scar tissue and bruising may also increase level of discomfort to patient on arterial puncture, increasing risk of vasovagal reaction. When a patient has had Angioseal vessel closure, repeat puncture should be performed 2cm above the site. (5)

**Anticoagulation**

Anticoagulated patients take longer to achieve haemostasis therefore are at an increased risk of bleeding. (5)
Congratulations

Congratulations on completing this learning package you now have the clinical knowledge (with some further reading) to put into practice. You are now able to complete your supervised Sheath removal competency.
Peninsula Health Femoral Arterial Sheath removal – using digital pressure CPG 2017

Peninsula Health Clinical Pathway: Cardiac Angiography/ Percutaneous Coronary Intervention Version 6. 2014


St Vincents & Mercy Private Hospital Clinical Pathway: CORONARY ANGIOGRAM per diem

St Vincents & Mercy Private Hospital Clinical Pathway: PTCA/ STENT/ ROTABLATOR per diem

St Vincents & Mercy Private Hospital CCC 01 040 Percutaneous Coronary Intervention (PCI) + - Stent Insertion Policy

St Vincents & Mercy Private Hospital GEN 7.8 Incident Reporting Policy

St Vincents & Mercy Private Hospital NUR 09 020 Arterial Lines Policy
References


8. Mechanical External Compression with FemoStop® plus. [Internet] [Cited 2018 November]. 2003 Available from: https://www.cathlabdigest.com/articles/Mechanical-External-Compression-FemoStop%C2%AE-plus
