A Nurse’s Guide to Caring for Cardiac Intervention Patients

By
EILEEN O’GRADY RN BSc
Interventional Cardiology Unit, Leeds General Infirmary

1807 WILEY
Bicentennial
2007

John Wiley & Sons, Ltd
A Nurse’s Guide to Caring for Cardiac Intervention Patients
A Nurse’s Guide to Caring for Cardiac Intervention Patients

By
EILEEN O’GRADY RN BSc
Interventional Cardiology Unit, Leeds General Infirmary

John Wiley & Sons, Ltd
# Contents

Preface vii

1 Access Sites of Percutaneous Procedures 1

2 Removal of Femoral Sheaths 9

3 Complications Associated with Percutaneous Coronary Procedures 21

4 Cardiac Catheterisation 33

5 Percutaneous Coronary Intervention 53

6 Percutaneous Balloon Mitral Valvuloplasty 81

7 Atrial Septal Defect Closure 99

8 Electrophysiology Studies and Radio-Frequency Ablation 115

9 Cardioversion 137

10 Temporary Pacemakers 155

11 Permanent Pacemakers 177

12 Implantable Cardioverter Defibrillators 201

13 Common Problems Associated with Permanent Pacemakers and Implantable Cardioverter Defibrillators 225

Glossary of Terms 239

List of Abbreviations 259

Index 265
Preface

Since the publication of the National Service Framework for Coronary Heart Disease (NSFCHD), in March 2000, the number of interventional cardiac procedures being performed in England has grown and continues to grow. In order to achieve the NSFCHD targets, more district general hospitals (DGHs) are now performing procedures previously only carried out in tertiary centres, such as electrophysiology and ablation, as well as routine, low-risk percutaneous coronary intervention (PCI) and implantable cardioverter defibrillator (ICD) implantation.

The role of the cardiac nurse in the DGH will evolve to provide efficient and effective care for these patients. As a staff nurse working in Leeds General Infirmary – one of the busiest cardiology interventional centres in England – I found it difficult to find a book explaining various procedures from a nursing perspective. Therefore, using experience gained on the ward, latest research studies and evidence-based practice, this book aims to:

• outline how to care for such patients pre and post procedure;
• provide guidance for when speaking to patients and their families;
• help to recognise and deal with potential complications.

Cardiology is research-driven; therefore protocols vary from hospital to hospital and change in accordance with the latest research findings and cardiologist preference. This book aims to guide nurses through interventional cardiology even though local protocols may differ from what is suggested in the book.

The glossary can be found at the back of the book. This serves not only to explain terms used throughout the book, but can also be used as a quick reference guide and is eminently readable and informative as a stand-alone chapter.

ACKNOWLEDGEMENTS

I would like to thank all of my colleagues at Leeds General Infirmary for their patience and support, especially those who took the time to read a chapter and provided valuable feedback, suggestions and alterations.

All illustrations have been created by Steve Granshaw. I would like to thank Steve for his superb artwork and knowledge on how to use a computer.

DISCLAIMER

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied
upon as recommending or promoting a specific method, diagnosis, or treatment by nurses and healthcare workers for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.
1 Access Sites of Percutaneous Procedures

In 1929, Werner Forssman performed the first human cardiac catheterisation by passing a urethral catheter from his left antecubital vein into the right side of his heart (10). Cardiac catheterisation has evolved since then and nowadays is used in a variety of procedures that vary from investigative tests such as angiograms to interventions such as coronary angioplasty and atrial septal defect repairs, thus reducing the need for cardiac surgery (11).

These can be referred to as percutaneous coronary procedures, as the heart is accessed by inserting a catheter through the skin into an artery and/or vein, and threading it up to the heart. Access to the arterial system may be via the femoral, brachial or radial artery (5).

ADVANTAGES OF PERCUTANEOUS ACCESS

The majority of percutaneous coronary investigations and interventions are performed under local anaesthetic, as patients may be asked to cough, hold their breath or move their position during the procedure. Using a local anaesthetic also has the advantage of avoiding the risks associated with general anaesthesia (11). The other advantages that percutaneous coronary procedures offer over cardiac surgery include:

- Patients are less anxious waiting for a percutaneous procedure than for a surgical procedure (8).
- A cardiopulmonary bypass machine, if required, and its inherent risks are avoided (8).
- The hospital stay is shorter. For example, patients undergoing percutaneous coronary intervention (PCI) normally stay in hospital for 12–24 hours, whereas patients undergoing a coronary artery bypass graft (CABG) require a stay of 3–7 days (8).
- Barring complications, the average cost of percutaneous coronary procedures is substantially lower than that of surgery (8).
- Patients are able to resume their normal life sooner after percutaneous procedures. For example, patients can usually return to work within 7–10 days after a PCI, whereas patients undergoing a CABG return to work within 6 weeks (8).
Brachial artery

Femoral artery

Figure 1.1. Introducing a catheter into the brachial or femoral artery.

- If a patient has a clotting disorder or has recently had thrombolysis, they can be treated in an emergency with PCI (1).

SELECTING THE ARTERIAL PUNCTURE

The access site is selected by the cardiologist prior to the procedure; however, the femoral artery is the preferred access site to the arterial system for the majority of percutaneous procedures (see Figure 1.1). Although the brachial and radial arteries may be preferred by some cardiologists, they are mainly used if the femoral artery is unavailable, due to peripheral vascular disease, for example, or if the patient is unable to lie flat on their back during the procedure, such as patients with severe heart failure, who would normally sleep with three or four pillows (9).

The brachial and radial arteries are smaller than the femoral artery and carry a higher risk of dissection and occlusion. Percutaneous puncture of the brachial artery is more likely to require surgical repair than percutaneous femoral puncture. In addition to this, brachial arteriotomy under direct vision can be technically challenging for the inexperienced operator and is time-consuming (9).

Percutaneous radial artery puncture appears safe, but it results in occlusion of the radial artery in around 5% of cases. Although, in such cases, the blood to the hand would be supplied by the ulnar artery, the occluded radial artery would not be available for a CABG surgery if the patient required one in the future (9).
FEMORAL ACCESS

The most common vascular access site is the femoral artery. It can also be referred to as the Judkin’s approach (7). The selected femoral artery is shaved of groin hair in order to reduce infection risk and then the area is liberally cleaned with antiseptic solution (8). Then, a local anaesthetic such as lignocaine is slowly injected into the inguinal area of the groin, as a slow injection of the local anaesthetic is less painful for the patient and produces better tissue infiltration (2).

Once the femoral area is anaesthetised, the cardiologist punctures the femoral artery percutaneously by inserting a large cannula containing a removable obturator. The presence of blood flow once the obturator is removed confirms that this cannula is within the lumen of the artery. Once proper placement is established, a guidewire is introduced through the cannula into the artery to the level of the diaphragm. The cannula is then removed and replaced by a valved introducer sheath (known as a femoral sheath) (8). The patient may feel some pushing and tugging at this time. This introducer sheath provides haemostasis and support at the puncture site and reduces potential arterial trauma if multiple catheter exchanges are necessary (8).

The femoral vein is accessed in a similar manner if it is required. Venous access is mainly used during electrophysiological studies (EPS) and radio-frequency ablation (RFA). Venous access for temporary pacing is no longer routine during PCI; however, it should be considered for high-risk patients, such as those with acute myocardial infarction (MI) or left bundle branch block needing right coronary artery PCI, or if a rotoblator or thrombus aspiration device is required (6).

REMOVING A FEMORAL SHEATH

There are several methods of obtaining haemostasis in the femoral puncture site post sheath removal. Closure devices, such as AngioSeal, VasoSeal, Duett and Perclose, allow the removal of the femoral sheath at the end of the procedure, no matter what the anticoagulation status is (9). However, the majority of centres still rely on the compression of the femoral artery using either manual or mechanical compression, or a combination (4). This means that the femoral sheath is usually removed 3–4 hours after the procedure if heparin has been used, such as during PCI (8). As femoral sheaths are usually removed on the ward by nursing staff, it is discussed in more detail in Chapter 2.

RADIAL ACCESS

The radial artery approach was developed as an alternative to the percutaneous transbrachial approach in an attempt to limit vascular complications. The inherent advantages of the transradial approach are that the hand has a dual arterial supply
connected via the palmar arches and that there are no nerves or veins at the site of puncture (3). The location of the radial artery enables easy access in most people, and it is easier to control bleeding (see Figure 1.2). In addition, prolonged bed rest is unnecessary after the procedure (6).

Although using the radial approach is associated with fewer severe access site-related bleeding complications than the femoral approach, the sheath sizes are smaller. They are usually limited to size 6 or 7 French, and therefore would not be suitable for cases in which larger catheters are required, such as valvuloplasty or rotablation (7). Unfortunately, the radial artery has a propensity to develop spasm, which may make catheter movement difficult or impossible. This can be overcome by the use of vasodilators and long introducer sheaths when appropriate (6). In addition, radial access is only suitable for left-sided heart catheterisation; another approach would be required if the right side of the heart required catheterisation as well (3).

Prior to a radial procedure, the clinician must complete an Allen’s test to assess the ulnar artery in the arm to be proceeded on. First, the radial and ulnar arteries are occluded simultaneously while the patient makes a fist. Then, when the hand is opened, it appears blanched. The ulnar artery is released and the hand colour should return within 8–10 seconds. Satisfactory ulnar flow can also be documented by pulse oximetry (6).

In order to insert the catheter into the radial artery, the selected arm is abducted at a 70° angle on an arm board, and the wrist hyperextended over a gauze roll. It is cleaned liberally with antiseptic. A topical anaesthetic is applied first, as
it reduces the amount of lignocaine needed for local infiltration over the radial pulse. Large amounts of lignocaine may obscure the pulse and make cannulation more difficult (6). A small incision is made and an 18-gauge needle is introduced at a 45° angle into the radial artery. A guidewire is inserted first and then a valved introducer sheath. Haemostasis is obtained at the end of the procedure after sheath removal using direct pressure. It is recommended that the arterial puncture site be allowed to bleed for several beats before maintaining direct pressure. The radial pulse should be monitored regularly for several hours after the procedure (3).

SHEATH REMOVAL AND POST-PROCEDURE CARE

Before the sheath is removed, 1 mg of verapamil is given through the sheath to minimise spasm of the radial artery (6).

Although haemostasis can be achieved by applying direct manual pressure over the puncture site, there are several radial haemostat devices available on the market, and their guidelines should be followed. The following is a description of one such device. A plastic bracelet with a pressure pad is placed around the wrist. Gauze is wrapped around the plastic strip to prevent skin injury when the bracelet is tightened. Another folded piece of gauze is placed under the pressure pad over the sheath insertion site. While the operator presses the pad over the puncture site, the sheath is withdrawn gently and the bracelet is tightened. The pad is pressed down and locked over the puncture by tightening of the bracelet bracket. The bracelet should be tight enough to ensure haemostasis but not occlude flow to the hand. The patient is checked 1–2 hours later, and the bracelet is loosened. The patient can be discharged 2 hours later and the bracelet removed at home. The patient should be given instructions about puncture site compression with the fingers if later bleeding occurs (6).

BRACHIAL ACCESS

There are two methods of obtaining brachial access, but they should be reserved for patients in whom the radial artery cannot be used (6).

PERCUTANEOUS BRACHIAL ARTERY PUNCTURE

Percutaneous arterial puncture is a safe and effective alternative to brachial artery cut-down, and is normally favoured over the brachial artery cut-down. Although it is similar to femoral arterial puncture, there are several important differences:

1. The brachial artery is smaller (3–5 mm in diameter) than the femoral artery.
2. Because of relatively loose subcutaneous tissues, the course of the brachial artery may change considerably.
3. Spasm can occur easily, with considerable decrease in pulse amplitude, making the puncture more difficult.
4. The artery is more mobile than the femoral artery.
5. The median nerve lies very close to the artery. Accidental touching of the
   median nerve causes a peculiar electrical shock sensation in the hand.
6. Care should be taken to puncture the artery on the first attempt. Because of the
   smaller space in the arm, uncontrolled haematoma formation here can readily
   cause compression syndrome with ischaemia of the forearm and hand (6).

The brachial artery can accommodate up to size 8 French sheath in large men.
However, in most patients, especially smaller men and women, smaller sheaths
(less than or equal to 6 French) are preferred (6). The brachial and radial pulses
should be checked prior to attempting a brachial puncture. They should be strong
and equal in both arms. The patency of the ulnar artery should be checked by
the Allen’s test (6).

The arterial sheath is removed at the end of the procedure and haemostasis is
achieved by applying 15–20 minutes of manual pressure until the bleeding has
stopped. The arm circumference at the site of the puncture should be measured to
facilitate the detection of haematoma formation. The patient should be instructed
to keep the arm in a relaxed position for 4–6 hours. Although the patient is
allowed to sit up in bed, ambulation should be restricted until these 4–6 hours
are completed, to ensure haemostasis (6).

**BRACHIAL CUT-DOWN/SONES PROCEDURE**

The brachial cut-down procedure is also known as the Sones procedure. This
procedure is rarely performed nowadays, as radial access or brachial puncture is
favoured over it. Unlike the other procedures, this is not a percutaneous proce-
dure. Once the brachial area is anaesthetised, the brachial artery is accessed by
making an incision close to the crease in the elbow. The selected artery is brought
to the surface and is used to insert the appropriate catheters for the procedure.
Once the procedure is completed, the artery is sutured to prevent bleeding, and
then the incision is sutured. If non-absorbable sutures are used on the incision,
they will need to be removed in 7–10 days. The wound should be covered with
a firm dressing (2).

There is no need for the patient to be kept flat or motionless following a brachial
cut-down procedure. They may sit up, eat and mobilise to the bathroom. If the
patient has a strong radial pulse, they can be discharged home after 4–6 hours’
observation (2).

**REFERENCES**

   London, Mosby.
2. Baim, D. S. (2006) *Grossman’s Cardiac Catheterisation: Angiography and Inter-
   vention*, 7th edn, Philadelphia, Lippincott Williams & Wilkins.


2 Removal of Femoral Sheaths

There are three arterial access approaches commonly used for cardiac catheterisation procedures and interventions: radial, brachial and femoral. Although the radial and the brachial artery allow the majority of patients to mobilise immediately after the procedure, the femoral artery is easier to access and allows larger introducer sheaths to be used (10). Therefore, the majority of patients undergoing cardiac catheterisation procedures and interventions will have an introducer sheath percutaneously introduced into either their left or right femoral artery (11). This is commonly referred to as a femoral sheath. Occasionally, an introducer sheath may be inserted into the femoral vein during the procedure if a temporary pacing wire is required or peripheral venous access was a problem (8).

A large proportion of complications associated with cardiac catheterisation procedures and interventions are associated with the arterial access puncture site (2). These complications include: bleeding at the arterial site; haematoma formation; arterial pseudoaneurysm; arteriovenous fistulae; arterial occlusion; distal ischaemia or necrosis; vasovagal response resulting in hypotension and bradycardia. Therefore, in order to minimise these complications, femoral sheaths should be removed by trained personnel (12).

REMOVING SHEATHS USING ARTERIAL CLOSURE DEVICES

Anticoagulants such as heparin or bivalirudin may be required during cardiac interventions and they are usually allowed to dissipate before the femoral sheath is removed (12). Therefore, the femoral sheath may be removed several hours after the procedure on the ward. Then, the traditional approach is to apply manual pressure to the femoral artery for 10–20 minutes, until haemostasis is achieved. The disadvantages of manual compression are that it is time-consuming and uncomfortable for the operator, as a reasonable degree of force is required (12).

Several devices have been developed so that femoral sheaths can be removed immediately at the end of the procedure, no matter what the anticoagulation status is. There are four arterial closure devices currently available: two collagen plug devices (AngioSeal, VasoSeal), a liquid plug (Duett) and a percutaneous suture closure device (Perclose) (12). Using these devices has not reduced the risks associated with puncture site complications; therefore, the patients should continue to be closely monitored (12). These devices are more comfortable for the patient as pressing on the femoral artery, either manually or with a compression
device, can be an uncomfortable experience; these devices reduce the risk of a vasovagal reaction induced by such pressure. As haemostasis is immediate, based on the manufacturers’ guidelines, the patients will be able to sit up and mobilise earlier, and therefore could be discharged or transferred earlier (or on the same day) if the patient is stable from a cardiac point of view (2; 17). These devices should be used with caution in patients with peripheral vascular disease or low arterial puncture (8). A downside to the closure devices is the added expense (6).

VASOSEAL

The VasoSeal acts by deploying a collagen plug on the external surface of the artery. The collagen interacts with platelets to create a haemostatic seal directly over the puncture site (2; 12; 17).

ANGIOSEAL

The AngioSeal, like the VasoSeal, uses bovine collagen to seal the arterial puncture site. A flat rectangular plate is deployed inside the artery wall. This acts as an anchor to which a suture carrying a small collagen plug is attached, thus forming a mechanical sandwich around the hole in the artery. The anchor, the suture and the collagen sponge are all fully bio-absorbable (2; 12; 17).

DUETT SEALING DEVICE

A pro-coagulant liquid (a mixture of collagen and fibrin) is placed on the external surface of the artery, thus promoting the body’s natural clotting plug at the puncture site. The potential advantages of this device are that no foreign material is left inside the artery and the artery can be re-punctured immediately, if this proves necessary (12).

PERCLOSE DEVICE

Perclose devices enable the cardiologist to suture the arterial puncture hole without direct vision of the artery. Unless some arterial wall damage is present, usually only one or two pairs of sutures around the puncture site are required to close the hole effectively (12; 17).

HINT

Personal experience has found that if the puncture site continues to ooze after using an arterial closure device, manual compression applied for 10–20 minutes may stop the oozing. If this does not work, applying a haemostatic dressing such as Kaltostat over the puncture site and then applying a compression device such as a FemoStop with low pressure for 1–2 hours are usually helpful adjuncts.
Despite the advantages of these devices, many centres rely on compressing the arterial puncture site until the bleeding has stopped, using either manual or mechanical compression, or a combination (6). No matter which type of compression is to be applied, in order to reduce potential complications, the person removing the femoral sheath(s) should address the following problems first.

**HAS THE ANTICOAGULANT ADMINISTERED DURING THE PROCEDURE DISSIPATED?**

It is recommended practice to administer an anticoagulant during cardiac catheterisation or intervention when the procedure is expected to be longer than 20 minutes or when prior clinical indications for the use of an anticoagulant exist (8). Traditionally, heparin is the anticoagulant used. However, as each patient responds differently to a dose of heparin, it is impossible to determine the timing of the peak effect of heparin, or when the plasma levels of heparin are diminished and the drug has ‘worn off’. This problem is overcome by measuring the patient’s blood’s ability to clot – a test referred to as anticoagulant time (ACT) (6). Ideally, the arterial and venous sheaths should not be removed until the ACT level falls below 160 seconds (2; 11). Unfortunately, the ACT test loses its reliability below 225 seconds and many centres do not have easy access to an ACT monitor (6). Consequently, in many centres, heparin is allowed to dissipate naturally over 3–4 hours before the femoral sheaths are removed (11; 12).

Direct thrombin inhibitors such as bivalirudin are a new class of anticoagulant (10). Unlike heparin, the half-life of bivalirudin (25 minutes) is predictable in patients with a normal renal function. Although the half-life is longer in patients with renal failure, it takes approximately two half-lives for the drug levels to fall to a non-therapeutic level. Thus, sheaths can be safely removed in most patients 2 hours after bivalirudin has been discontinued (6). However, for patients on dialysis, it may take up to 8 hours before bivalirudin has reached a non-therapeutic level (2).

**IS A HAEMATOMA PRESENT?**

Poor insertion technique, vessel laceration or excessive anticoagulation may lead to problems such as haematoma formation prior to sheath removal. Large haematomas can cause considerable discomfort to the patient and have the potential to develop into false aneurysms (2). Haematomas in the soft tissue surrounding the site of the femoral sheath will feel firm and will have defined boundaries. If you are unsure whether one is present, compare it with the other thigh (8). If the haematoma is growing larger or there is a lot of oozing around the sheath, it should be removed earlier than planned (15).
WHAT IS THE PATIENT’S BLOOD PRESSURE?

If a patient is hypertensive (i.e. has a systolic blood pressure greater than 150 mmHg), the pressure within the arteries is high. This means that greater pressure is exerted at the arterial puncture site, impeding the clot’s ability to adhere and seal off the puncture wound (13; 15). In addition to this, it increases the patient’s risk of developing a haematoma (1). The patient’s medication should be reviewed and if they are on anti-hypertensive drugs, these should be administered if the time is appropriate, to help reduce the patient’s blood pressure before removing the femoral sheath (13). The doctor should be consulted, as the administration of glycerine trinitrate (GTN) either intravenously or orally will help to reduce the patient’s blood pressure. As prolonged compression (greater than 30 minutes) will probably be required, the application of a compression device such as a FemoStop should be considered (2).

If a patient is hypotensive (i.e. with a systolic pressure of less than 100 mmHg), the patient is at risk of acute cerebral or myocardial ischaemia (12). The drugs used during the procedure can dilate the arteries, leading to a drop in blood pressure (2). In addition, the patient may be hypovolaemic, as they may have fasted prior to the procedure and the contrast agent encourages diuresis (8). The skin in such hypotensive patients usually feels normal or warm. They normally respond to the elevation of the lower extremities (more than 30°), as this increases venous return, and the administration of intravenous fluids (2; 8).

If the hypotension is drug-induced, the offending medication should be reversed or discontinued. This may mean stopping or decreasing the intravenous vasodilators, such as nitroglycerine, or administering naloxone if narcotics are found to be the cause of the drop in blood pressure (8).

WHAT IS THE PATIENT’S HEART RATE?

Iodinated contrast medium and/or a vasovagal response contribute to slowing of the heart rate (8). Therefore, in order to avoid a life-threatening bradyarrhythmia, it may be necessary to pre-medicate a symptomatic patient (one whose pulse is less than 50 beats per minute and whose systolic blood pressure is less than 100 mmHg) with 600 micrograms of atropine prior to removing the femoral sheaths (15). If a patient is asymptomatic but they have a heart rate of less than 50 beats per minute, their drug regime should be assessed, as drugs such as betablockers, calcium channel blockers, digoxin, amiodarone, methyldopa and clonidine may cause bradycardia (9).

POTENTIAL VASOVAGAL REACTIONS

Pressure on a large artery and pain can stimulate the vagus nerve, which will respond by slowing the heart rate and lowering blood pressure (8). Anxiety and
tissue injury can also result in a vasovagal reaction (7). Early signs include pallor, nausea and/or yawning, vomiting, feeling hot or cold and shivering (7; 8). Vasovagal reactions may lead to irreversible shock if untreated. However, they respond dramatically to intravenous atropine (usual dose 0.6–1.0 mg). Elevation of the legs, infusion of gelatin (Gelofusine) and administering oxygen are helpful adjuncts (2; 8).

As vasovagal reactions may occur while pressing on the groin during sheath removal, it is advisable to have another person present who can administer treatment while pressure on the site is maintained (13).

CAN THE PATIENT LIE STILL?

If a patient has difficulty remaining immobile, the time to haemostasis may need to be lengthened (3; 13). Activity may dislodge the forming clot from the arterial puncture site and cause bleeding (3; 13).

IS THE PATIENT COMFORTABLE?

If the femoral sheaths are being removed several hours after the procedure, the local anaesthetic administered during the procedure will have worn off and removing the sheaths may be painful (15). Therefore, further lignocaine should be administered where the pressure is going to be applied. Hint: the lignocaine should be given early and while the anaesthetic is taking effect, other preparations can be completed (8). Systemic analgesia should be administered early if a patient develops a headache or backache due to prolonged bed rest. A bedpan or urinal should be offered to the patient before sheath removal, to promote the patient’s comfort and reduce their movement immediately after sheath removal (13).

DOES THE PATIENT HAVE A VENOUS SHEATH IN SITU?

Occasionally, during cardiac intervention, an additional sheath will be inserted into the femoral vein to allow for a temporary pacing wire or venous access if peripheral venous access is a problem (8). When this does occur, the sheaths should be removed and haemostasis achieved separately in order to reduce the risk of atrioventricular fistula, haematoma formation and blood loss (8). If manual pressure is being used, the arterial sheath is usually removed first, then the venous sheath (2; 8).

ACHIEVING HAEMOSTASIS USING MANUAL PRESSURE

Manual pressure is also referred to as digital compression, as the operator presses on the puncture site with their fingers until haemostasis has been achieved (16).
The femoral sheath normally is inserted at a slight angle so that the arterial puncture site is not directly beneath the skin. Therefore, the operator should place their fingers over the femoral pulse, and not directly over the puncture site itself. Then, gentle pressure should be applied whilst removing the sheath. Care should be taken not to crush the sheath or to ‘strip’ clots into the distal artery. A small spurt of blood purges the arterial site of retained thrombi (8).

Firm downward pressure should then be applied. Five to ten minutes of pressure is usually suitable following cardiac catheterisation procedures such as coronary angiogram (12). However, the use of larger arterial sheaths, anticoagulants, glycoprotein (GP) IIb/IIIa inhibitors and antiplatelet agents in cardiac intervention procedures increases the risk of bleeding complications (2). Therefore, 15–20 minutes of firm pressure should be applied following these procedures. After the first 10 minutes of firm compression, the pressure should be gradually released until the haemostasis is achieved. During the pressure application, the pedal pulses should be checked every 2–3 minutes, to ensure that the distal pulses are not obliterated completely (8; 12). In addition to this, the operator should be feeling for haematoma formation, as this indicates that it is bleeding under the skin and they may need to readjust the position of where they are applying the pressure.

The venous sheath is removed in a similar fashion but 5–10 minutes of pressure is usually sufficient (8).

Once haemostasis has been achieved, the patient must remain on bed rest. The typical recommendation is to lie flat for 1 hour and sit up for 1 hour when a size 5 French catheter has been used. The patient should lie flat for 2 hours and sit up for 1–2 hours if a size 6 French sheath or larger catheter has been used (4; 16).

MECHANICAL COMPRESSION

The disadvantages of manual compression are that it is time-consuming and uncomfortable for the operator, since a reasonable degree of force is required. As a result, a number of mechanical devices have been tried. These include sandbags, mechanical C-Clamps, stasis buttons and pneumatic devices. It has been found that sandbags do not reduce vascular complications and may even increase patient discomfort. The mechanical clamps and pneumatic devices have been shown to be as effective as manual pressure in preventing complications; however, compression time may be longer (12).

To prevent complications, these devices should be applied by trained individuals following the manufacturer’s instructions. The patient should be monitored frequently, as misalignment of the device and puncture site may result in bleeding or haematoma. Excessive pressure on the femoral artery may deprive the leg of oxygenated blood, resulting in limb ischaemia (8).
FEMOSTOP PRESSURE SYSTEM

The FemoStop is an example of a pneumatic compression device. It consists of an air-filled, clear plastic compression bubble that moulds to the skin contours. It is held in place by a strap passed around the hips. The clear plastic dome allows the operator to see the puncture site. The amount of pressure applied by the FemoStop depends on the patient’s own blood pressure and is controlled using a sphygmomanometer gauge. A FemoStop can be applied prior to removing the femoral sheaths, or when bleeding persists despite prolonged manual pressure (8; 14).

A STEP-BY-STEP GUIDE TO REMOVING A FEMORAL SHEATH USING A FEMOSTOP

1. Examine the puncture site carefully.
2. Note and mark the edges of any haematoma.
3. Record the patient’s current blood pressure.
4. Identify the arterial puncture site by feeling for the femoral pulse. Some operators like to mark it in ink.
5. Place the belt under the patient’s hips. The belt should be in line with the puncture site and equally aligned either side of the patient.
6. Attach the dome to the FemoStop arch and peel back the lid. Keep the dome sterile.
7. Connect the dome to the pressure pump and close the valve.
8. Align the centre of the star on the FemoStop pressure dome over the arterial puncture site. Attach the belt to the arch and tighten slowly to ensure the arch remains level and square and the dome remains perpendicular to the arterial puncture.
9. The belt should fit snugly, but not be too tight.
10. If present, the venous sheath is usually removed first when a FemoStop system is used for compression.
11. To remove a venous sheath, inflate the dome to 20–30 mmHg and remove the sheath.
12. If bleeding persists, slowly increase the pressure until haemostasis is achieved. Achieving haemostasis in the venous puncture site before removing the arterial sheath minimises the formation of arteriovenous fistula.
13. For the arterial sheath, inflate the dome to 60–80 mmHg and remove the sheath. Increase the pressure in the dome to 10–20 mmHg above the systolic blood pressure.
14. Maintain full compression for 3 minutes.
15. Reduce pressure in the dome to medium blood pressure. After appropriate duration, per hospital protocol, lower the pressure by 10–20 mmHg every
few minutes until the pressure is zero. During this time, it is important to monitor the pedal pulse to ensure that the leg is not being deprived of oxygenated blood.

16. The FemoStop can be left in place at low pressure, if appropriate.
17. If there is no sign of bleeding or haematoma formation, release the air from the FemoStop dome.
18. Roll the FemoStop dome off the puncture site.
19. The patient can sit up 10–15 minutes after this if there is no sign of bleeding or haematoma (8; 14).

The preparations for removing a femoral sheath using a FemoStop are the same as those for using manual compression. Therefore, the following care plan could be followed up to step 14.

**CARE PLANS**

The aim is to remove the femoral sheath(s) using manual compression, obtain haemostasis at the puncture site and prevent complications.

<table>
<thead>
<tr>
<th>Nursing action</th>
<th>Rationale and key points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Using an aseptic technique, prepare a trolley with the required equipment (see Box 1)</td>
<td>Reduces risk of cross-infection. Easily available equipment saves time (5)</td>
</tr>
<tr>
<td>2 Explain and discuss the procedure with the patient</td>
<td>Ensures that the patient understands the procedure and gives his or her consent (5)</td>
</tr>
<tr>
<td>3 Place the patient in a supine position and with the head of the bed elevated less than 10°</td>
<td>Allows better access to the site and the location of landmarks (8)</td>
</tr>
<tr>
<td>4 Check the colour, movement, sensation and pulses in both legs. Mark the location of the pulses</td>
<td>To obtain a baseline for comparison after the sheath is removed (11)</td>
</tr>
<tr>
<td>5 Ensure that the patient has intravenous access</td>
<td>Allows emergency intravenous medication to be administered (8)</td>
</tr>
<tr>
<td>6 Check that cardiac monitoring is properly attached</td>
<td>To observe heart rhythm and rate during sheath removal (11)</td>
</tr>
<tr>
<td>7 Set the non-invasive automatic blood-pressure cuff to check blood pressure every 3 minutes</td>
<td>Pressure on a large artery and pain may stimulate the vagus nerve to slow heart rate and lower blood pressure (8; 13)</td>
</tr>
<tr>
<td>Nursing action</td>
<td>Rationale and key points</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>8 Clean hands with a bactericidal skin-cleanser solution</td>
<td>Contamination may result from handling outer packets (5)</td>
</tr>
<tr>
<td>9 Apply protective equipment, as in hospital protocol, such as apron, gloves, goggles, mask</td>
<td>To reduce the risk of being contaminated by the accidental spurting of the patient’s blood and cross-infection (5; 8)</td>
</tr>
<tr>
<td>10 Remove semi-occlusive dressing and tape from sheath site. If a haematoma is noted, mark the border outline</td>
<td>To enable easy removal of the sheath(s) and assess any increase in size of the haematoma (5; 13)</td>
</tr>
<tr>
<td>11 Clean sheath site with sterile gauze</td>
<td>Achieves clean field of vision of suture and sheath site (13)</td>
</tr>
<tr>
<td>12 Locate femoral pulse proximal to insertion site. Position three fingers of left hand sequentially up artery, starting from puncture site, until arterial pulse can be palpated</td>
<td>The femoral sheath is inserted at an angle; therefore, the actual puncture in the artery is 1–2 cm above the puncture site towards the head (8)</td>
</tr>
<tr>
<td>13 Infiltrate 5 ml prescribed 1 or 2% lignocaine on either side of the femoral artery, maximum dose 10 ml, to the area in which pressure will be applied</td>
<td>Lignocaine is a topical anaesthetic that renders the area in which it was administered insensitive to pain by blocking the nerve impulses that transmit pain (9)</td>
</tr>
<tr>
<td>14 Cut the retaining suture</td>
<td>The suture is used to secure the sheath to the patient (2)</td>
</tr>
<tr>
<td>15 If there is both an arterial and venous sheath, you should prepare to remove the arterial sheath first</td>
<td>Reduces peripheral vascular complications (8)</td>
</tr>
<tr>
<td>16 As previously, locate femoral pulse; place fingers on pressure position; while pressing firmly, gently remove the sheath from the artery; do not crush the sheath</td>
<td>Crushing the sheath may ‘strip’ a clot into the distal artery (8)</td>
</tr>
<tr>
<td>17 Relax pressure enough to allow a small spurt of blood</td>
<td>This action purges any retained thrombi (8)</td>
</tr>
<tr>
<td>18 Manual pressure is held firmly for 15–20 minutes: 5 minutes’ full pressure; 5 minutes’ 75% pressure; 5 minutes’ 50% pressure; 5 minutes’ 25% pressure</td>
<td>Pressure controls bleeding and promotes haemostasis. Up to a further 10 minutes of pressure may be required when the patient is on antiplatelet therapy (8)</td>
</tr>
</tbody>
</table>
During compression, check pedal pulse every 3–5 minutes

The pedal pulse may decrease during application of full pressure, but should not disappear. If pulse is absent, pressure over the femoral artery should be lowered to allow distal circulation (8).

While applying reduced pressure with one hand, palpate the surrounding area with the other to detect haematoma formation. Skin should be soft and pliable.

A haematoma will feel firm and have a defined boundary (8).

If a haematoma begins to form, check to be sure your hand is positioned properly.

Appropriate compression can disperse and reduce a haematoma (2).

After holding for 20 minutes, slowly release pressure and observe for bleeding or haematoma formation.

Ensures that haemostasis has been achieved (13).

<table>
<thead>
<tr>
<th>Nursing action</th>
<th>Rationale and key points</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>During compression, check pedal pulse every 3–5 minutes</td>
</tr>
<tr>
<td>20</td>
<td>While applying reduced pressure with one hand, palpate the surrounding area with the other to detect haematoma formation. Skin should be soft and pliable.</td>
</tr>
<tr>
<td>21</td>
<td>If a haematoma begins to form, check to be sure your hand is positioned properly.</td>
</tr>
<tr>
<td>22</td>
<td>After holding for 20 minutes, slowly release pressure and observe for bleeding or haematoma formation.</td>
</tr>
</tbody>
</table>

Box 1. Equipment needed for femoral sheath removal

- 5–10 ml lignocaine
- Stitch cutter
- Gauze
- Sterile gloves
- Ink marker
- 10 ml saline flush
- 600 micrograms atropine
- 1 litre Gelofusine and blood-giving set
- Oxygen mask attached to oxygen administration set
- FemoStop equipment (13)

**NURSING CARE FOLLOWING FEMORAL SHEATH REMOVAL**

While the patient is on bed rest, the nurse should maintain half-hourly observations on the patient, checking the following:

- the pulse and blood pressure for signs of hypovolaemic shock;
- the affected groin to ensure no recurrence of bleeding or haematoma formation;
- pedal pulses, skin colour and warmth on the affected leg’s foot to ensure that no distal ischaemia has occurred (3).
In addition to this, patients are advised to:

- Keep the affected leg straight for the first 2 hours if manual pressure was used.
- Press on the groin site when coughing or sneezing.
- Call for nurse’s assistance if there is a recurrence of bleeding.
- Inform the nurse if they experience chest pain.
- Drink plenty of fluids in order to prevent hypotension (11).

REFERENCES