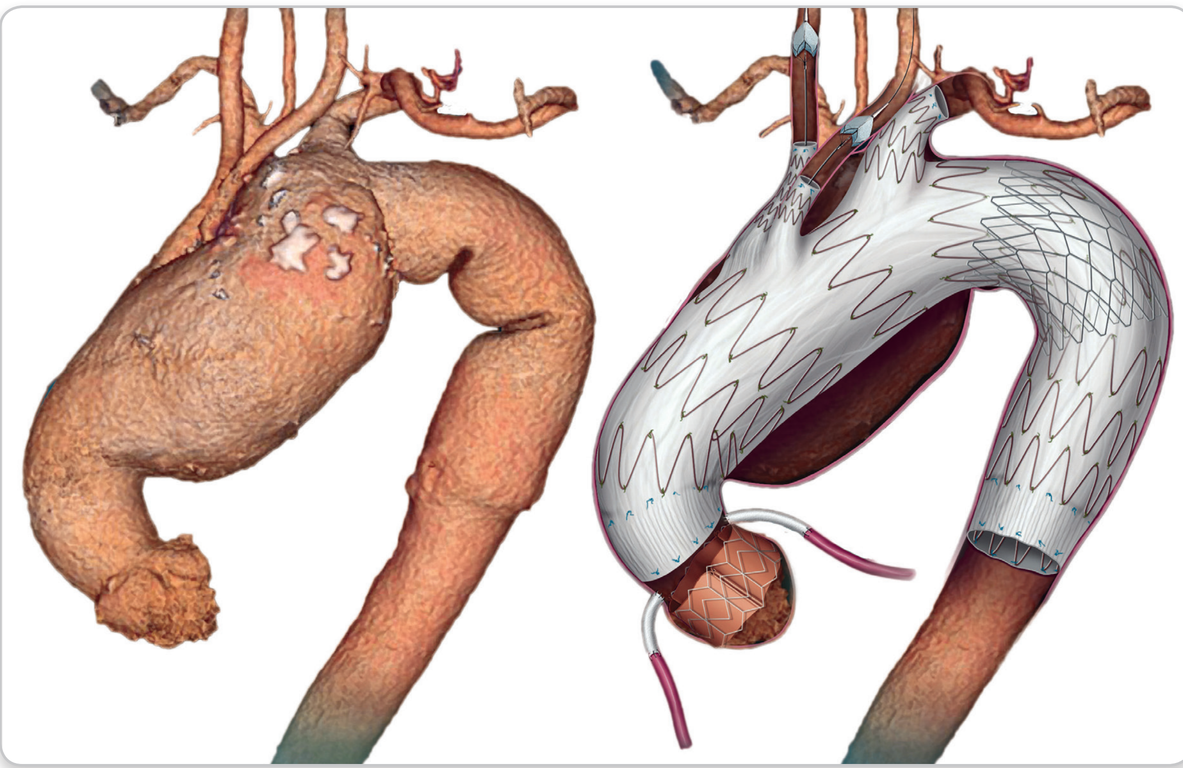
Endovascular and Hybrid Therapies for Structural Heart and Aortic Disease

Edited by Jacques Kpodonu and Raoul Bonan



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The website includes:

- Additional video materials from the book

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Preface

Since the first reports of endovascular repair of abdominal aortic aneurysm (AAA) and transcatheter aortic valve replacement in the early 1990s and 2000s, there has been an explosion in the volume and complexity of endovascular and hybrid procedures for the treatment of aortic diseases and structural heart diseases. Endovascular and hybrid techniques and technologies have evolved from the initial devices and continue to evolve allowing for the treatment of most aortic pathologies and most structural heart pathologies. These new endoaortic surgical procedures and transcatheter valve therapies have proven to shorten hospitalization, reduce morbidity and mortality, speed recovery, and hasten return to normal life. The evolution and conceptual design of the endoaortic grafts and transcatheter valves used to treat these complex pathologies would obviously not be possible without the simultaneous explosion in medical imaging technologies and the development of advanced hybrid surgical rooms and hybrid surgical techniques, which has taken place over a similar time period.

With chapters written in a comprehensive yet concise manner and numerous illustrations, this book aims to engage readers further with additional video materials. We hope that this textbook will be a useful tool for practitioners planning to execute treatment on patients with these various aortic and structural heart pathologies as well as serve as a useful reference as the field of segment continues to evolve.

Jacques Kpodonu, MD
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List of videos

PART I
Aorta

1

CHAPTER 1

Access techniques

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Brachial access techniques used for aortic endografting

Brachial and radial access techniques allow the utilization of angiographic catheters to assist with proximal deployment of thoracic stent-grafts [1]. They allow for easy identification of the left subclavian artery, and angiography can be performed to avoid coverage with the proximal end of a thoracic stent. When coverage of the left subclavian artery is required for an adequate proximal landing zone, subclavian to carotid bypassing may be required. The radial or brachial access can therefore accommodate subclavian artery coil embolization to minimize the risk of type II endoleaks.

The brachial artery has an enveloping fascial sheath, therefore, when a hematoma does occur, brachial plexopathies are more common. In addition, upper extremity vessels tend to spasm more frequently during manipulation, making access more challenging. Brachial access does carry the added risk of distal ischemia and embolization over radial access. Although sheaths up to 6 or 7 Fr (3 Fr ≈ 1 mm) may be percutaneously placed in either vessel, radial access should be preferred over brachial because of a lower complication profile, and open access used for larger sheaths or on smaller patients.

The left brachial artery is preferred over the right so as to avoid the origin of the right common carotid artery. The technique requires that the arm be abducted on an arm board with the arm circumferentially prepped. The artery is palpated just proximal to the antecubital fossa where the biceps muscle thins out to its tendinous insertion. Percutaneous retrograde puncture of the brachial artery with a 21 gauge micropuncture kit is preferred to the 18 gauge due to the smaller size of the vessel (Fig. 1.1a). Catheter-over-wire exchange can then be performed to the desired sheath. Sheaths up to 6 Fr can be placed with relative safety (Fig. 1.1b). Long sheaths can help deal with the inherent vasospasm.

In tortuous aorta, the use of the brachio-femoral wire may be required to aid advancement and deployment of an endograft. Deployment of an endoluminal graft in a tortuous aorta may be difficult, requiring the use of a brachio-femoral wire (Fig. 1.2). Use of brachio-femoral access wires can help straighten the most angulated of vessels. The presence of a tortuous aorta requires brachio-femoral access to deploy an endoluminal graft (Fig. 1.3). Brachial access is obtained by a percutaneous retrograde puncture of the right brachial artery with an 18 gauge needle or a micropuncture needle. An extra long 450 cm, 0.035 inch angled glide wire is advanced through the brachial sheath into the tortuous thoracic aorta, snared and pulled out through the groin sheath. The technique requires that a protective guiding catheter be placed over the brachial artery to protect the subclavian artery from injury. It is important to have at least a 260 cm

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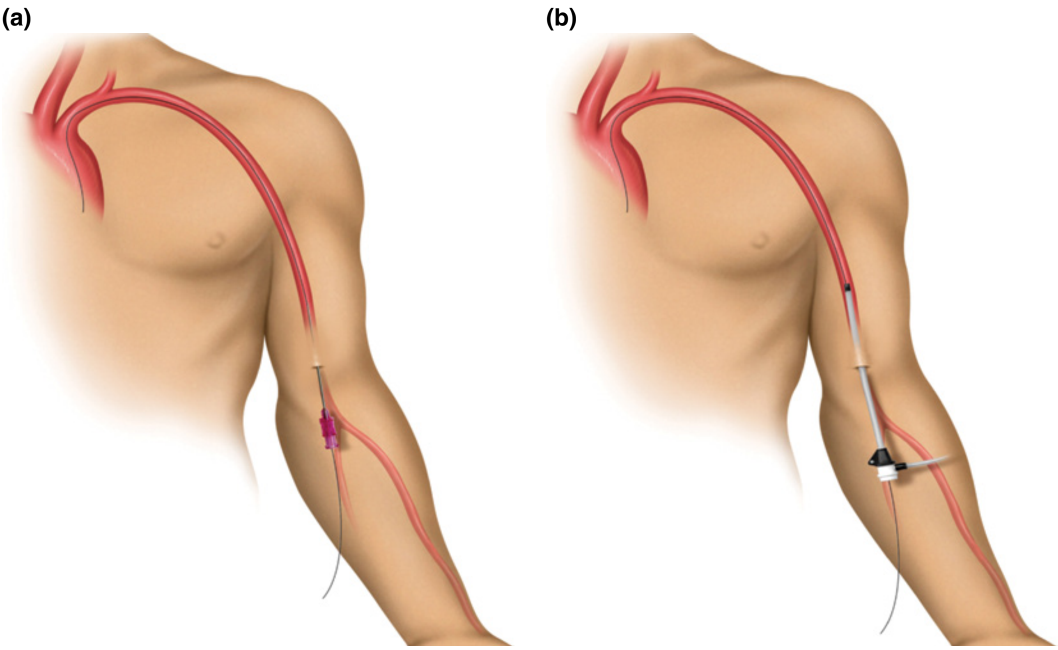

Fig. 1.1 (a) A retrograde percutaneous puncture of the brachial artery with (b) the placement of an introducer sheath.

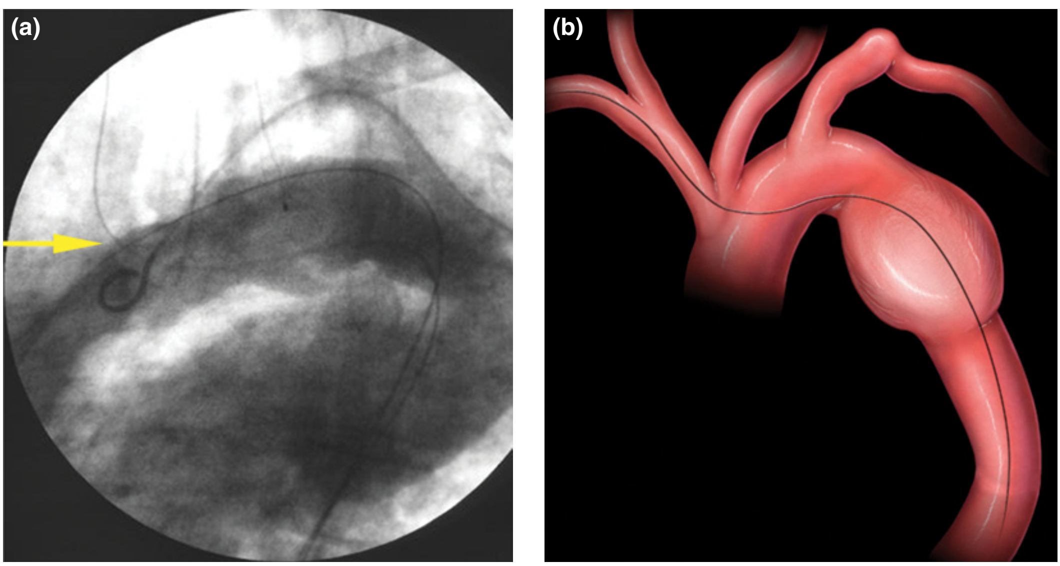

Fig. 1.2 (a) Angiogram and (b) illustration demonstrating advancement of a brachio-femoral wire in a tortuous thoracic aorta.

long wire and constant tension must be placed on both ends of the wire as the delivery sheath is passed into the aorta [2,3]. By pulling on both ends of the wire an endoluminal graft can be advanced up into the tortuous arch aorta with precise deployment of the endoluminal graft.

Techniques for constructing an endoconduit for aortic endografting

An endoconduit is an alternative percutaneous technique that can be used to deliver a thoracic endograft in a patient with a small, calcified, or tortuous

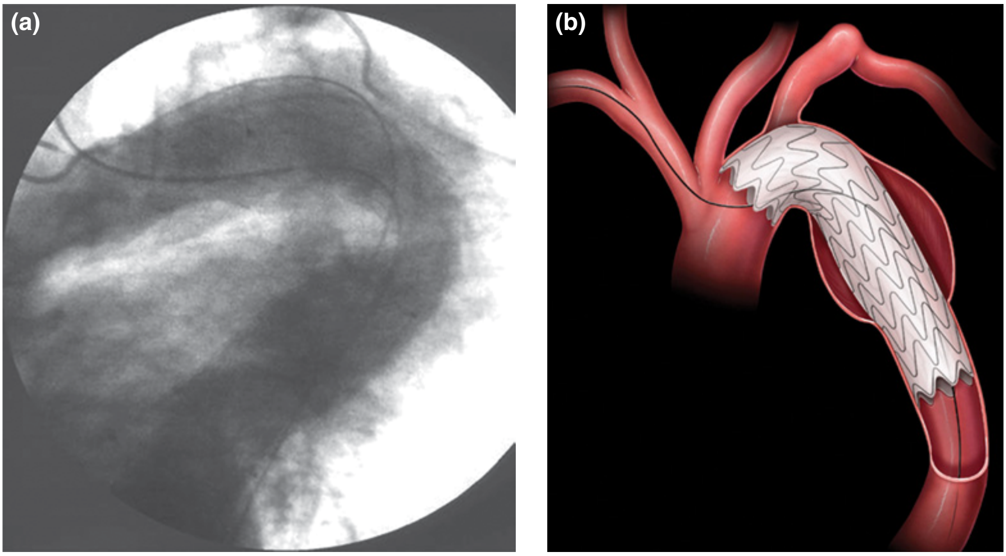

Fig. 1.3 (a) Angiogram and (b) illustration demonstration of deployment of a thoracic endograft using a brachio-femoral wire approach.

vessel instead of the conventional ilio-femoral conduit (Fig. 1.4). This technique can be applied in high-risk patients who have a relative contraindication to conventional open surgical techniques under general anesthesia. The endoluminal conduit technique allows aggressive balloon dilation of long segments of ilio-femoral stenosis without the risk of vessel rupture. The endoluminal graft conduit can be custom-assembled using graft diameters of at least 8 mm and preferably 10 mm, and can be backloaded into a delivery sheath and deployed via a femoral arteriotomy into the common iliac artery covering the origin of the internal iliac artery [2,4].

Retrograde percutaneous access of the common femoral artery is performed with an 18 gauge needle in the usual fashion and a 0.035 inch glide wire is advanced under fluoroscopic guidance into the distal thoracic aorta after heparin is administered. A 9 Fr sheath is then exchanged for the needle. A retrograde angiographic picture of the iliac vessels is performed noting the size, tortuosity, and calcification. The presence of a small, or severely calcific or tortuous, iliac vessel may preclude the introduction of a delivery sheath (Fig. 1.5). An attempt may be made to pass the delivery sheath, and if any resistance is noted the patient would require a retroperitoneal conduit or an endoconduit. Using the existing 9 Fr sheath, balloon angioplasty can be performed to

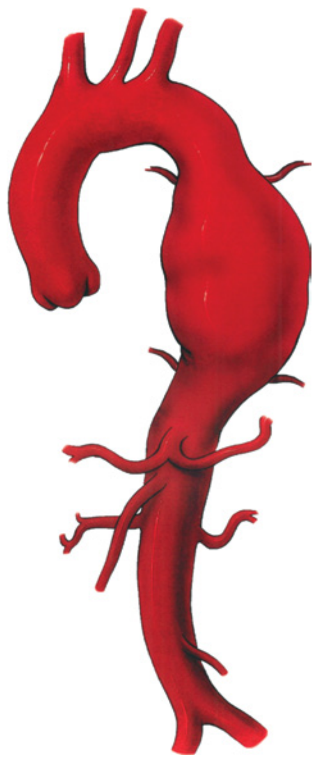

Fig. 1.4 Illustration of thoracic aorta.

gently dilate the vessel; subsequently, an endoluminal graft, most commonly (Viahbahn; W.L. Gore & Associates, Flagstaff, AZ), or an I-Cast stent-graft

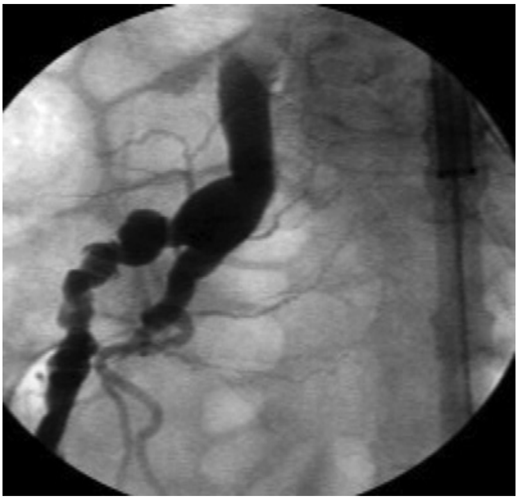

Fig. 1.5 Angiogram demonstrating a small, tortuous left iliac artery.

Table 1.1 Commercially available covered stents used for peripheral indications.

Stent	*Manufacturer*	*Indications*	*Type*
Fluency Plus	Bard	Tracheobronchial	Self-expanding
Jostent	Abbott	Coronary perforation	Balloon-expanded
Viabahn	Gore	Superficial femoral artery	Self-expanding
I-Cast	Atrium	Tracheobronchial	Balloon-expanded

(Atrium Medical, Hudson, NH) (Table 1.1) is deployed across the common iliac and external iliac artery covering the hypogastric vessels (Fig. 1.6). Post-deployment balloon angioplasty is subsequently performed with a balloon to expand the endoluminal graft; this technique has been referred to as cracking and paving. The 9 Fr sheath is subsequently exchanged to a 20–24 Fr delivery sheath that is required to deliver the thoracic endoluminal graft.

Transfemoral access techniques in aortic endografting

Percutaneous retrograde femoral artery access

Most right-handed physicians will prefer the patient's right groin for femoral access, although both groins should be prepped in case of inaccessibility.

Fig. 1.6 Deployment of an endoconduit.

After the pulse is identified, the inguinal ligament is found by tracing a line between the anterior iliac spine and the pubic tubercle. Often, especially in obese individuals, the inguinal crease is inferior to this landmark. Access should be made below the inguinal ligament corresponding to the common femoral artery. One will find that if access is made too high, corresponding with the external iliac artery, hemostasis is difficult to achieve with manual pressure. In this case hemorrhage can occur after removal of devices and a retroperitoneal hematoma can develop. This is often insidious in onset. In addition, the risk of pseudoaneurysm formation is higher in an external iliac stick, again because direct manual pressure cannot be applied this superiorly.

A properly equipped endovascular suite will allow fluoroscopic imaging of the groin to identify all anatomic landmarks. In addition to surface landmarks, most physicians use the medial half of the femoral head to guide femoral artery access; this ensures common femoral artery entry

Fig. 1.7 An 18 gauge 7 cm Cook percutaneous needle.

and avoids the complications of a higher stick. It is also useful in the pulseless femoral artery. Most vascular access kits include an 18 gauge straight angiographic entry needle (Fig. 1.7). This is inserted using the dominant hand at a 45° angle while using the non-dominant hand for guidance using a Seldinger technique. Percutaneous arterial femoral access is usually obtained by the Seldinger technique. A careful palpation of the femoral pulse is performed and a beveled needle (usually 18 gauge) is introduced through the arterial wall. The needle is slowly withdrawn until return of arterial blood is achieved, signifying the intraluminal position of the needle. The presence of poor blood flow signifies that the tip is misplaced or the needle is too close to the arterial wall. A soft-tip angled 0.035 inch guide wire is then introduced through the central lumen of the needle under fluoroscopic guidance (Fig. 1.8). Progress of the guide wire intraluminally should be monitored with fluoroscopy to avoid diversion into branched vessels and dissection of the vessel. The presence of resistance in passing a guide wire signifies possible misdirection or dissection of the vessel wall. In instances where the vessel may be small, calcified, or tortuous, a smaller access needle may be desirable. A micropuncture kit (Cook Medical, Bloomington, IN) exists which includes a 21 gauge needle for initial access.

Once access is achieved a small nick is made in the skin with a no. 11 blade and a dilator, and an introducer sheath is then advanced over the glide wire with the dilator preceding the introducer sheath by a few inches, again under fluoroscopic visualization (Fig. 1.9). Once the introducer sheath is positioned the dilator is removed. A hemostatic valve at the end of the introducer

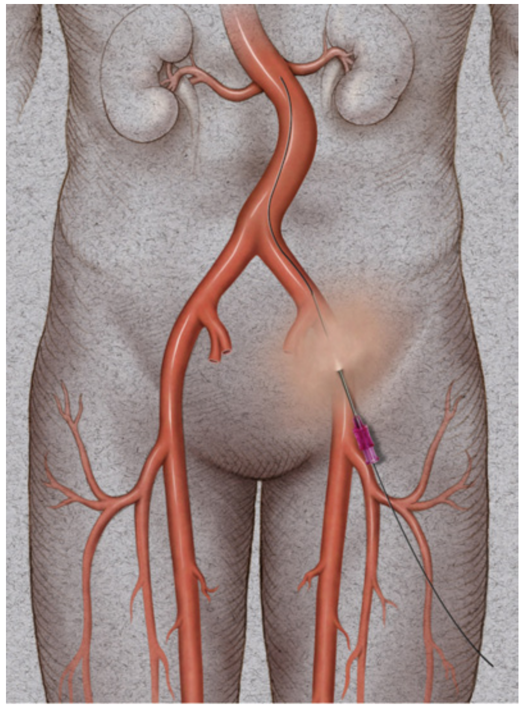

Fig. 1.8 Introduction of an angled glide wire through the 18 gauge needle.

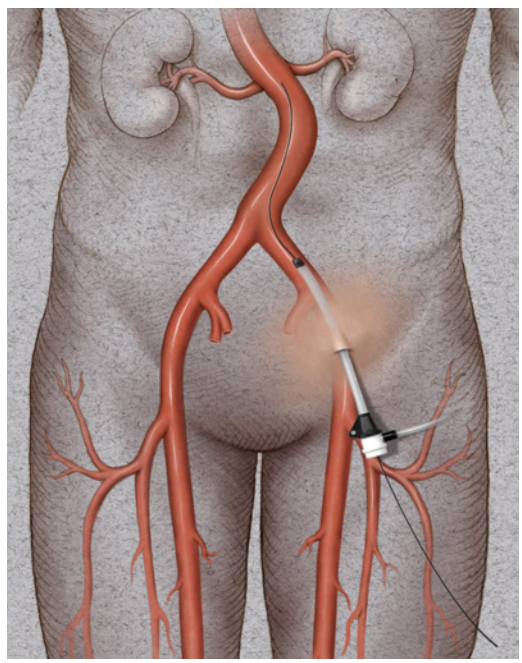

Fig. 1.9 Introduction of a 9 Fr 11 cm sheath in a retrograde percutaneous fashion through the common femoral artery.

sheath prevents leakage of blood. The introducer sheath permits various guide wires, balloons, and stents to be introduced safely within the arterial lumen. The introducer sheath can subsequently be upgraded to a larger delivery sheath for the deployment of an endograft. In patients with a femoral-to-femoral graft, percutaneous access can be performed either through the inflow limb of the femoral–femoral graft or above the inflow limb.

Contraindication to percutaneous femoral access

In patients with significant peripheral vascular disease, imaging studies using an angiogram or a CT scan are necessary for sizing and determination of calcification, as well as tortuosity of vessels which would make the femoral delivery of an endograft hazardous. The introduction of large sheaths in femoral vessels that are calcified, tortuous, small caliber, or a combination are predisposed to rupture.

Open retrograde access

The common femoral artery is usually exposed for retrograde cannulation and the introduction of various large-sized introducer sheaths, balloons, self-expandable and balloon-expandable stents, and endoluminal grafts.

A curvilinear incision is made two finger-breaths above the groin crease and over the palpable femoral pulse. The incision is carried down to the femoral sheath. Retraction is performed with a Gelpe retractor or a Wietlander retractor. The femoral sheath is incised to expose the common femoral artery. Heavy silk sutures are passed circumferentially round the various side branches. Adequate mobilization of the common femoral artery is desired to be able to achieve adequate proximal and distal control of the vessel. A Rummel tourniquet is applied to the common femoral artery to serve as a proximal control.

The fluoroscopic C-arm is then positioned over the exposed femoral artery. Retrograde cannulation of the common femoral artery is performed with a beveled needle (18 gauge) until pulsatile blood flow is visualized. A soft-tip angled guide wire is advanced in the vessels under fluoroscopy. The needle is then exchanged for a selected sized dilator and introducer sheath. The dilator is removed and the sheath flushed with heperanized saline. Open cannulation or retrograde percutaneous access can be similarly performed in the contralateral common femoral artery (Fig. 1.10a).

Once the procedure is completed all wires and sheaths are removed under fluoroscopic guidance to ensure no injury is caused to the vessel wall. The arteriotomy is then closed with a 5-0 prolene suture after proximal and distal control is achieved (Fig. 1.10b).

Complications of femoral access

Rupture

Attempts to introduce a delivery sheath in a small, tortuous, or calcified artery, or a combination, will lead to rupture of the access vessel typically at the junction of the external and internal iliac artery or at the aorto-iliac bifurcation. Rupture of an access vessel should be suspected if there is a drop in the blood pressure during advancement of the delivery sheath or during removal of the delivery sheath. The guide wire should be maintained at all times prior to removal of a delivery sheath and an iliac angiogram performed prior to removal of the introducer sheaths to confirm extravasation of contrast (Fig. 1.11a). Once rupture is confirmed, an appropriate length and diameter of a covered stent-graft should be chosen (Fig. 1.11b) and deployed across the area of rupture (Fig. 1.11c). In most instances coverage of the hypogastric artery is required.

Dissections

The introduction of guide wires, introduction and delivery sheaths may result in dissection of the access vessels. Similarly, balloon angioplasty of calcified access vessels may also result in a dissection flap of the resulting access vessels. Once a dissection is identified on angiogram, gentle balloon angioplasty may be performed to seal the dissecting septum or a covered or uncovered balloon-deployable stent may be used to seal off the dissection. Failure to recognize a dissection may result in thrombosis of the access vessels with resulting ischemia of the involved lower extremity [2].

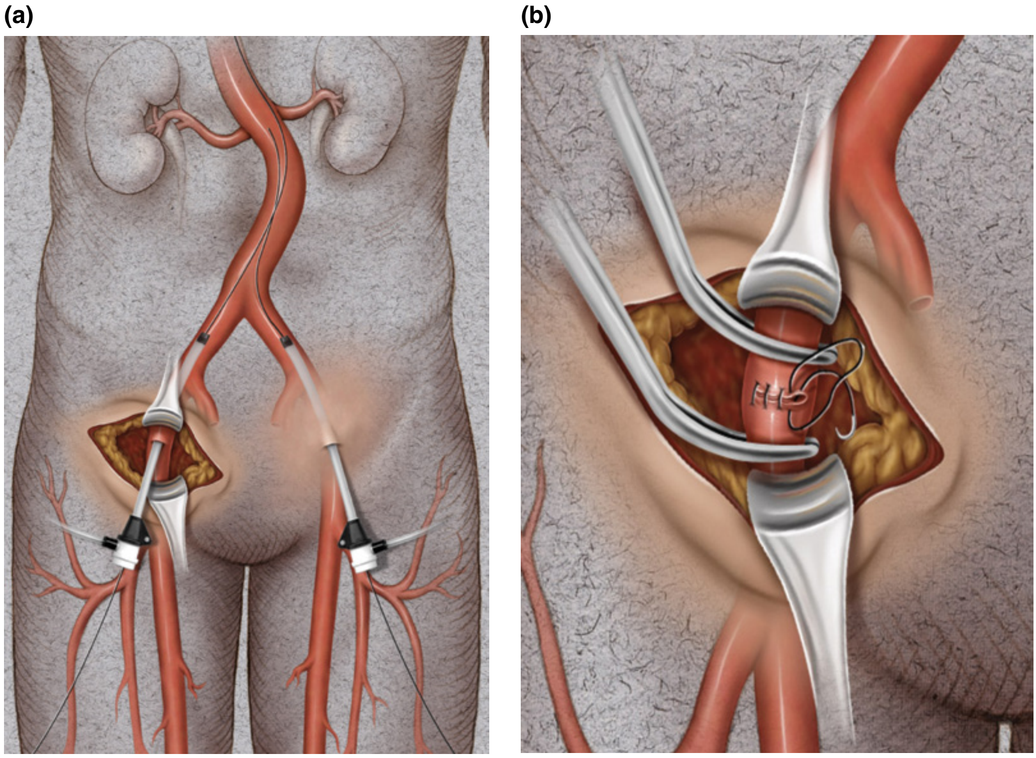

Fig. 1.10 (a) Open retrograde cannulation of the right common femoral artery and percutaneous retrograde cannulation of the left common femoral artery. (b) Closure of the arteriotomy after removal of the guide wire and introduction sheath.

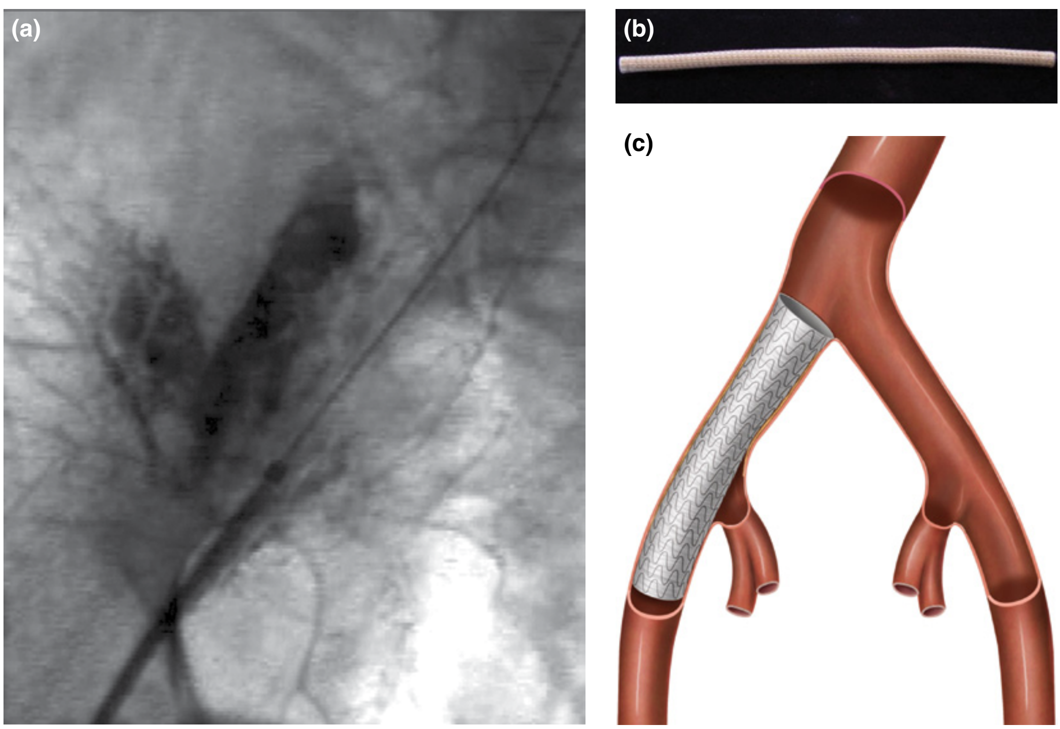

Fig. 1.11 (a) Angiogram demonstrating rupture of the right external iliac artery. (b) A covered stent-graft used to exclude the site of rupture. (c) A covered stent-graft deployed across a ruptured iliac artery.

Retroperitoneal access for aortic endografting

Introduction

Safe performance of thoracic endovascular procedures including thoracic stent-grafting of aneurysms, dissections, retrograde delivery of transcatheter aortic valves, and other complex endovascular procedures for structural heart disease requires zero tolerance for major access-related complications. Thorough preoperative planning, understanding the pathology of aorto-iliac occlusive disease, advanced endovascular skills, and ability to perform an iliac conduit via a retroperitoneal approach are necessary to achieve excellent results. Furthermore, deliverability of complex thoracic endovascular devices through tortuous anatomy or old graft material may be improved by the more proximal access provided by an iliac conduit [5].

Indications and preoperative planning

Patients undergoing thoracic aortic endografting require access with devices ranging between 18 and 25 Fr caliber. The external iliac artery is the size-limiting segment and, depending on the size of sheath required, a minimum diameter of 9 mm may be necessary for safe access via the common femoral arteries. Patients with calcified, tortuous, or small vessel size or a combination (Fig. 1.12) may not be candidates for delivery of these large sheaths through femoral arterial access and any attempts to deliver an introducer sheath or an endoluminal graft may result in an increased risk of iliac artery rupture or the "artery on a stick" phenomenon (Fig. 1.13). Iliac artery diameters of 7.6–9.2 mm are required to deliver most devices through the femoral approach safely without the requirement of a conduit (Tables 1.2 and 1.3). Retroperitoneal exposure with construction of a 10 mm ilio-femoral conduit permits delivery of large sheaths in patients with tortuous, calcified and small iliac vessels or vessels with severe ilio-femoral vascular occlusive disease.

Construction of a 10 mm retroperitoneal conduit

A 15 cm semi-lunar right flank incision is made four finger-breaths above the groin crease. Division of the external oblique, internal oblique and transversus abdominus muscles is performed in the direction of their fibers. The extraperitoneal fascia and peritoneum are then retracted medially and dissection is carried out in the avascular plane of the retroperitoneum down to the level of the psoas muscle. All of the abdominal contents are then retracted medially with the help of a handheld retractor or an Omni retractor, providing excellent exposure of the lower infrarenal aorta, common iliac artery, and iliac bifurcation. The right common iliac artery along with the hypogastric and the external iliac artery are identified and mobilized (Fig. 1.14a). Care is taken to spare the right urether which crosses the common iliac artery before diving deep into the pelvis. A Rummel tourniquet is applied to control the proximal common iliac artery, the external iliac artery, and origin of the hypogastric artery; alternatively, vascular clamps could be applied for control. Heparin is usually given to the patient prior to clamping the vessels. An arteriotomy is made on the common iliac artery with a no. 11 blade and extended with Pott's scissors close to the bifurcation of the hypogastric artery and the external iliac artery. A 10 mm conduit is then sewn in an end-to-side fashion using 5-0 prolene sutures (Fig. 1.14b). The 10 mm graft is subsequently tunneled through the retroperitoneal space beneath the inguinal ligament and brought out through the groin incision used to expose the common femoral artery. The graft is subsequently flashed and clamped at the groin incision with the Rummel tourniquets released from the common iliac artery, external iliac artery, and hypogastric artery. The 10 mm conduit is subsequently looped with a Rummel tourniquet and ready to be punctured with an 18 gauge needle for access and introduction of a guide wire and an introducer sheath (Fig. 1.14c). The introducer sheath is subsequently exchanged for a device sheath, which is advanced into the distal aorta (Fig. 1.14d). The endoluminal graft is then introduced into the delivery sheath and deployed to the target area. Wires and sheaths are removed from the 10 mm conduit and the conduit is clamped.

The conduit can either be trimmed to the appropriate length and the conduit tied off as a stump (Fig. 1.14e) or the distal end of the conduit can be sewn to the more distal iliac system in an

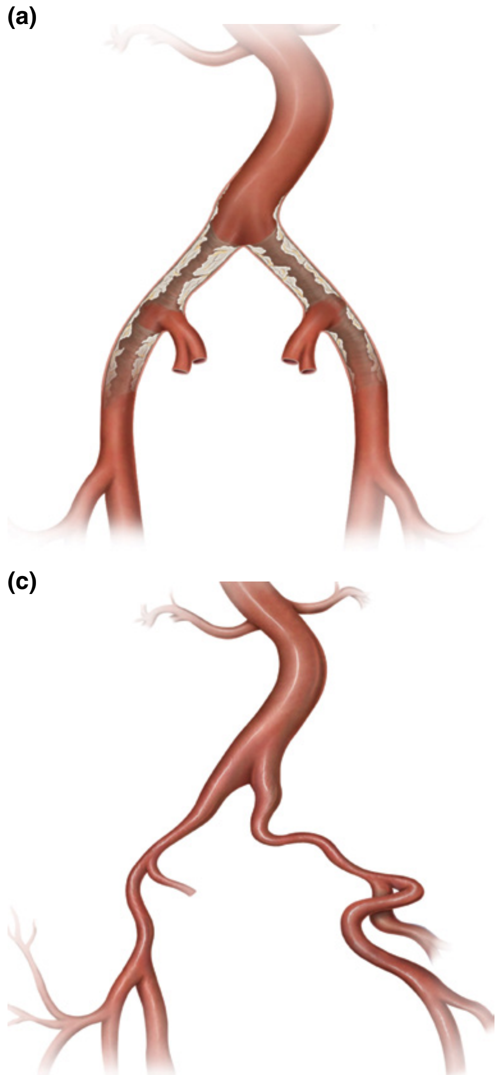

Fig. 1.12 Illustrations demonstrating calcified, tortuous, small tortuous, and small calcified tortuous iliac arteries which are contraindication for femoral access, requiring a retroperitoneal exposure with sewing of an iliac conduit for delivery of the endograft. (a) Calcified iliac artery. (b) Tortuous iliac artery. (c) Small tortuous iliac artery. (d) Small calcified tortuous iliac artery.

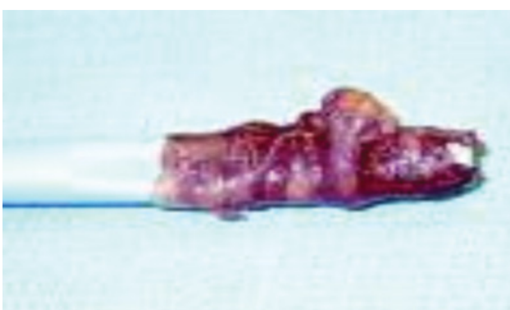

Fig. 1.13 Artery on a stick.

Table 1.2 Graft and delivery sheath sizes for descending thoracic aortic stent-grafts currently available in the United States.

Endograft	*Graft size available (diameter)*	*Sheath size required (diameter)*
Gore TAG	26–40 mm	20–24 Fr (7.6–9.2 mm)
Zenith TX1/TX2	28–42 mm	20–22 Fr (7.6–8.3 mm)
Talent	22–46 mm	22–25 Fr

end-to-end fashion as an interposition graft. Or, more commonly, the conduit can be brought to the groin by tunneling the conduit under the inguinal ligament and performing either an end-to-end anastomosis or an ilio-femoral conduit. The ilio-femoral conduit is performed by making an arteriotomy on the adequately exposed common femoral artery after adequate proximal and distal control is achieved. An end-to-side anastomosis is constructed with a 5-0 prolene suture with adequate flushing maneuvers performed prior to completion of the anastomosis (Fig. 1.14f). The ilio-femoral conduit is best for patients who may require further intervention for diffuse thoracic aneurysmal disease as the conduit may be reused through a simple infrainguinal incision in the future. The groin incision is approximated in layers. The right flank incision is irrigated, a 10 Fr Jackson–Pratt drain is placed in the retroperitoneal space and the incision closed in layers. The same technique can be applied to the infrarenal aorta and thoracic aorta. Similarly, end-to-side grafting of a conduit to the axillary artery, as described elsewhere, to facilitate deep hypothermic circulatory arrest also provides excellent access to the thoracic aorta via the innominate [2].

Table 1.3 Recommended iliac diameters for the introduction of Gore sheaths.

Size (Fr)	*ID (mm)*	*OD (mm)*
20	6.7	7.6
22	7.3	8.3
24	8.1	9.1

ID, inner diameter; OD, outer diameter.

Direct iliac artery access via a retroperitoneal approach

A 15 cm semi-lunar right flank incision is made four finger-breaths above the groin crease. Division of the external oblique, internal oblique,

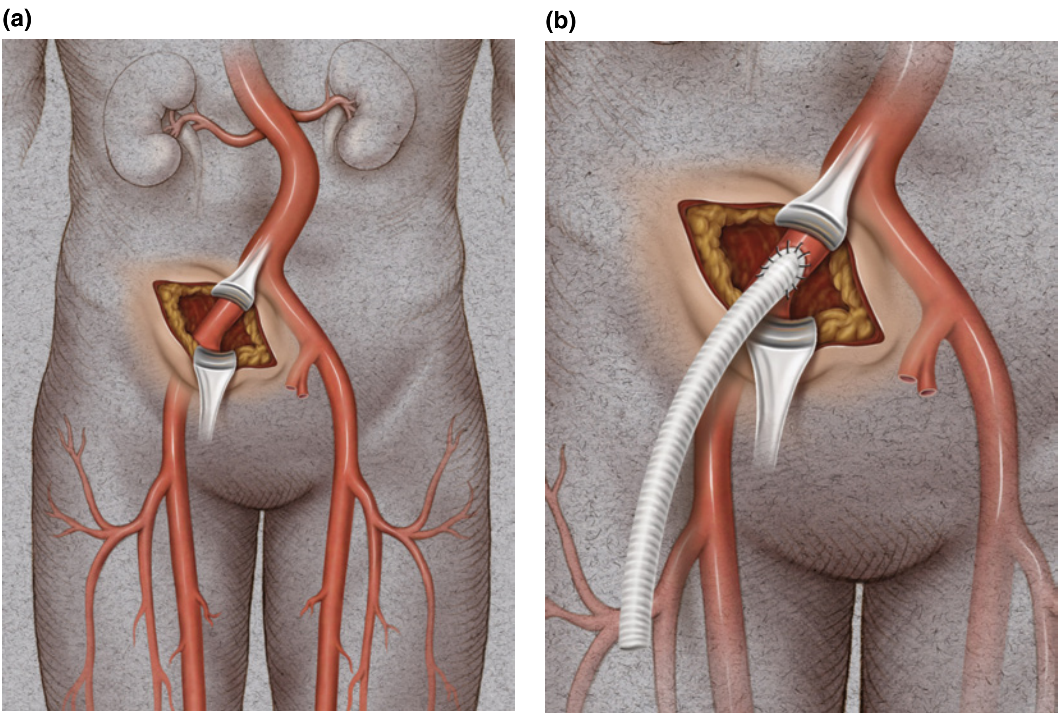

Fig. 1.14 (a) Retroperitoneal exposure. (b) A 10 mm conduit sewn to the iliac artery. (c) Conduit brought out of the incision with cannulation of the conduit with an introducer sheath. (d) Introducer sheath exchanged for a device sheath and advanced through the 10 mm conduit to the distal abdominal aorta. (e) Ligation of a 10 mm conduit. (f) Conduit tunneled and sewn to the femoral artery as an ilio-femoral conduit.

(c) (d) (e) (f)

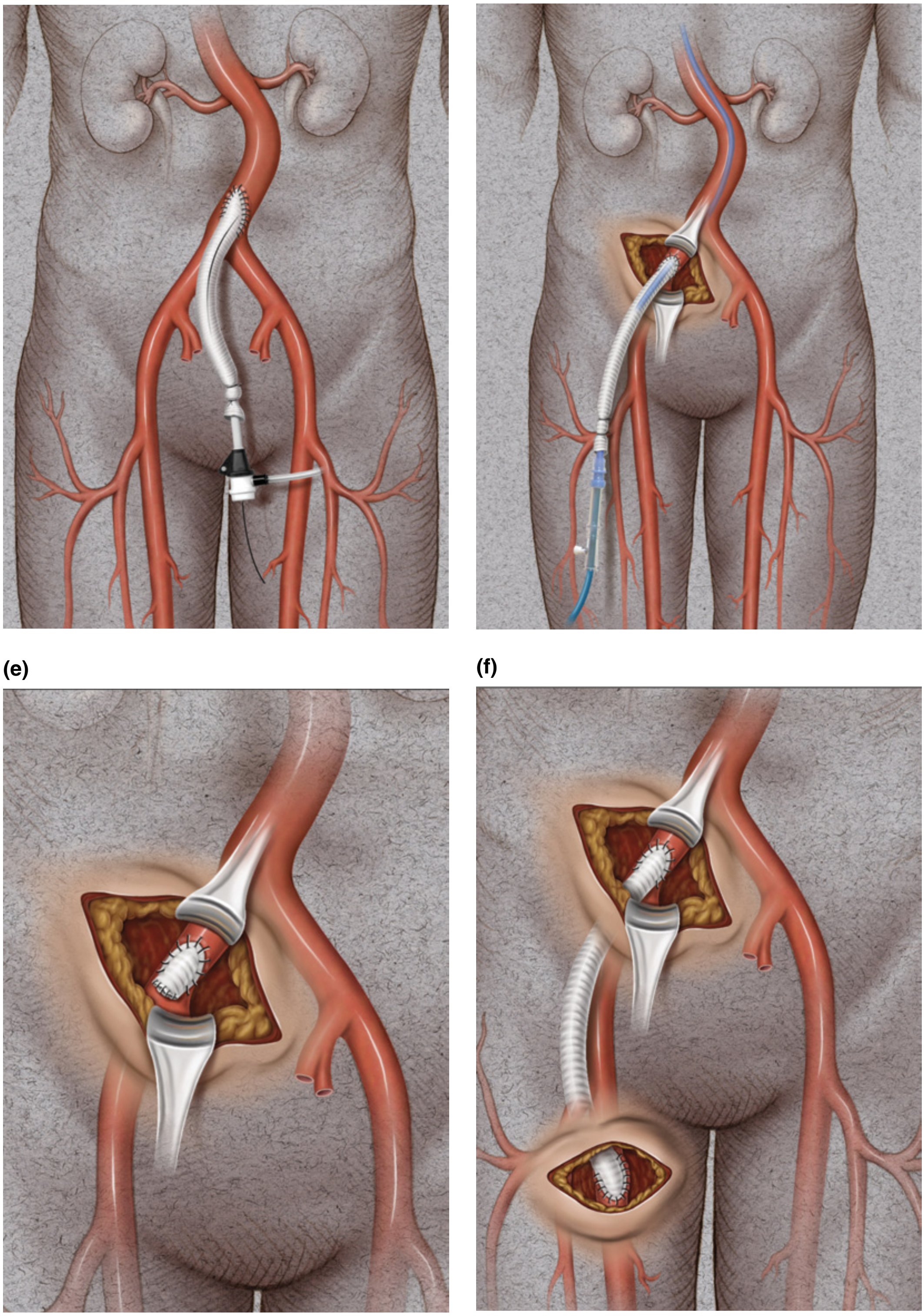

Fig. 1.14 *(Continued).*

and transversus abdominus muscle is performed. The peritoneum is identified and gently retracted medially with the help of a handheld retractor. The common iliac artery along with the hypogastric and external iliac artery are identified and mobilized. Care is taken to spare the right urether which crosses the common iliac artery before diving deep into the pelvis. A Rummel tourniquet is applied to control the proximal common iliac artery, the external iliac artery, and origin of the hypogastric artery; alternatively, vascular clamps could be applied for control. Heparin is usually given to the patient prior to clamping the vessels. An 18 gauge needle is used to access the common iliac artery close to the hypogastric artery bifurcation and a guide wire and an introducer sheath are advanced. The introducer sheath is subsequently exchanged for a device sheath, which is advanced into the distal aorta (Fig. 1.15). The endoluminal graft is then introduced into the delivery sheath and deployed to the target area. Wires and sheaths are removed and the arteriotomy repaired in a standard fashion (Fig. 1.16). The flank incision is irrigated, a 10 Fr Jackson–Pratt drain is placed in the retroperitoneal space, and the incision closed in layers.

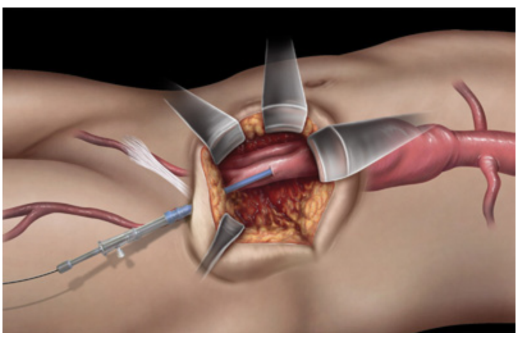

Fig. 1.15 Direct introduction of the device sheath through the common iliac artery through a retroperitoneal exposure.

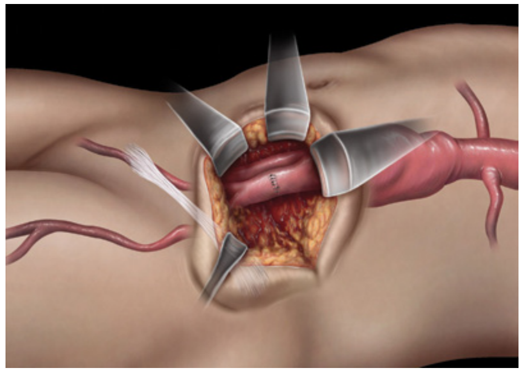

Fig. 1.16 Direct repair of the iliac artery.

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2

CHAPTER 2

Equipment required for aortic endografting

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Equipment lists

Main equipment

- Fluoroscope with digital angiography capabilities (C-arm or fixed unit):
  - non-obstructive table for imaging of chest and abdomen
  - power injector for fluoroscopic contrast studies
  - connecting tubing for power injector
  - digital subtraction angiography
  - road mapping
  - multiplane image system.
- High-resolution fluoroscopic imaging and the ability to record and recall at imaging.
- Surgical suite standby in the event that emergency surgery is necessary.
- Cell saver and/or autotransfuser (optional).
- Inflation device with pressure gauge.
- Needles.
- Radiopaque ruler with centimeter increments.
- Heparinized solution.
- Puncture needles 18 or 19 gauge.
- Assorted guide wires of at least 260 cm in length, including a stiff 0.035 inch wire to support the Xcelerant delivery system (Medtronic, Minneapolis, MN).
- Assorted angiographic, angioplasty, and graduated pigtail catheters.
- 12 Fr introducer system to be used with the Reliant stent-graft balloon catheter (Medtronic).
- Sterile introducer sheaths of 5 or 10 Fr for vascular access to femoral arteries and to perform diagnostic imaging.
- Radiopaque contrast media.
- Sterile silicone lubricant or mineral oil.

Supplementary equipment

- Nitinol goose neck snare (10–15 mm).
- Angioplasty catheters 8–40 mm (depending on case).
- Intravascular ultrasound unit with catheters.
- Sterile marker.
- 25–30 mm valvuloplasty balloons.
- Dilators.

Further equipment information

Percutaneous entry needle/devices

Endovascular procedures require the use of a percutaneous needle. Needles come in a variety of lengths and gauges. Each needle contains two parts: the hub used when attaching the needle to the syringe and the cannula, which is the hollow shaft of the needle. The most common gauge used is the 18 gauge needle (Fig. 2.1). The 18 gauge needle will accommodate a .035 inch guide wire. The length of

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Fig. 2.1 18 gauge 7 cm Cook percutaneous needle.

needles varies between 2 and 3.5 inches. Other accessories include micropuncture sets and smart needles.

Vessel dilators

These devices dilate the tract the needle has created, allowing large devices such as catheters and sheaths to be introduced into the vessel. They are placed over the guide wire that was introduced through the original puncture needle. Vessel dilators are measured in French sizes (1 Fr ≈ 0.33 mm) and are most commonly 15–20 cm in length. "Serial dilation" can be necessary when attempting to introduce large diameter sheaths, particularly with patients that have scar tissue build up in the common femoral artery (CFA) area. It is important not to overdilate the tract. Overdilating can allow blood to leak around your catheter or sheath, not allowing you to gain hemostatic control of the vessel. Dilator sets may vary from 4 to 22 Fr × 20 cm (Fig. 2.2).

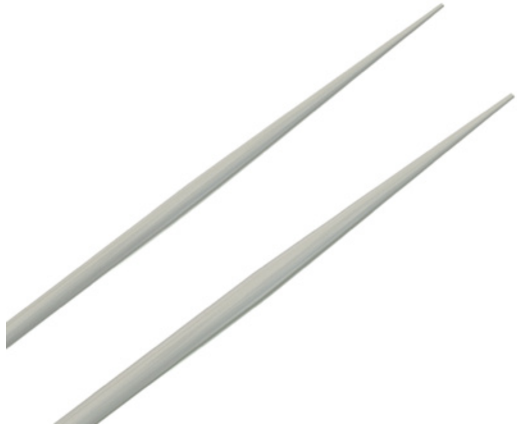

Fig. 2.2 Dilator sets.

Guide wires

Guide wires are used to access the vessel through the percutaneous needle [1]. In addition, they are used to help steer catheters and devices through the vascular anatomy. Guide wires are manufactured in several different ways: they are either solid steel core wires, or the steel core can be wrapped in a thin steel coil. The core can also be encased in a polymer-type jacket. Recently they have started using nitinol metal for the inner core material. Guide wires usually have a floppy tip with a stiff body. The tip configuration usually includes angled tips, straight tips, J-tips, and shapeable tips. The diameters of the wires are measured in thousandths of an inch, ranging from 0.014 to 0.038 inches. Lengths are measured in centimeters and can range from 80 to 300 cm. However, some specialty wires can come in lengths up to 450 cm.

Fig. 2.3 Ultrastiff guide wires used in thoracic endografting.

Some guide wires may have a hydrophilic coating, making them slippery when wet. Hoag Hospital's primary workhorse guide wire is the 0.035 inch Terumo angled glide wire. This wire has a hydrophilic coating. It is constructed with a center core of superelastic metal alloy that tapers to a soft flexible tip. The kink-resistant core is coated with a polyurethane jacket. This jacket is bonded with a hydrophilic polymer that becomes slick when saline has been applied. There are many guide wire manufacturers, with hundreds, possibly thousands, of wires to choose from (Fig. 2.3). The wire selection is dependent on the location of the lesion, the tortuousity of the vessel, and the physician's preference.

Introducer sheaths

Sheaths are hemostatic conduits inserted into the vessel (Fig. 2.4). They allow the passage of guide wires, catheters, and interventional devices. The