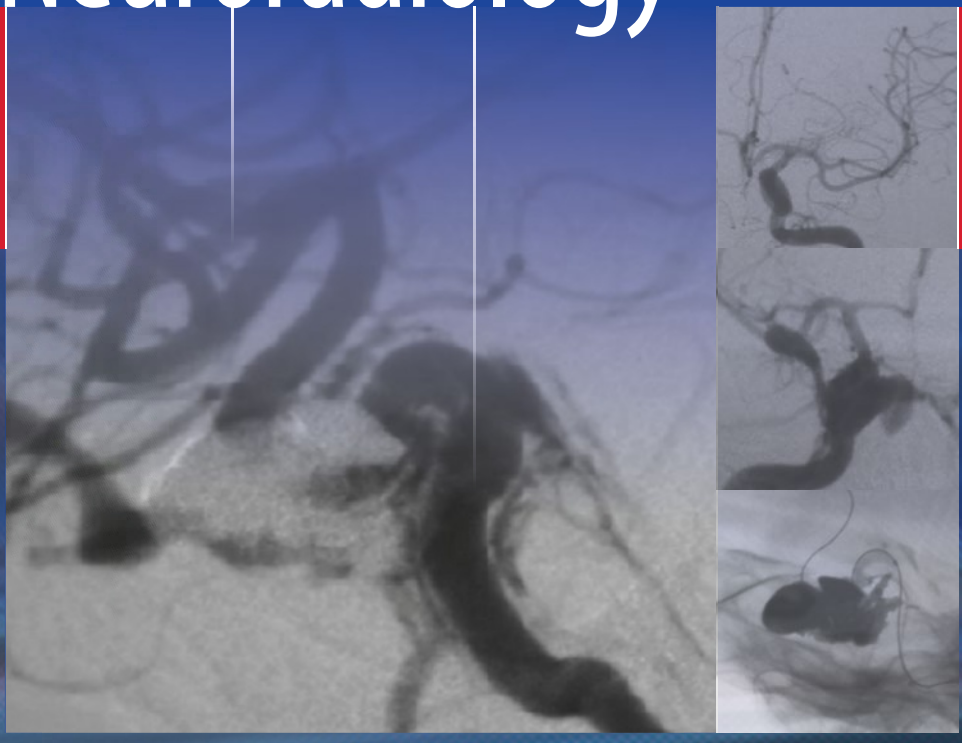
Kieran Murphy · Fergus Robertson *Editors*

Interventional Neuroradiology



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Interventional Neuroradiology

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To Helen, Finley, and Orla – my home team.
Fergus Robertson

To my long suffering family –
Rulan, Ronan, and Anya, the most
interesting people I know – thank you.
Kieran Murphy

Preface from the Book Editors

Interventional neuroradiology is the most rewarding field in medicine today. Where else can a physician change the course of a patient's life in minutes? It is a challenging career that makes demands on the hearts and minds of all of us engaged in it. It requires great self-control and technical virtuosity. It takes confidence but demands humility. Our field today is built on the shoulders of the great practitioners like Terbrugge, Lasjaunias, Rufenacht, and Molyneux, and the inventiveness of Guglielmi, Palmaz, Deramond, and Theron. In this book, you will find your colleagues have taken the time to share with you their best knowledge to save you from the errors and mistakes that they have made and that they will always remember. We thank our colleagues for their significant contributions and hope that you find this a worthwhile addition to the books you keep in your angio suites, to be referred to at times of need.

A final thought, when wondering if you should put in more TPA, or another coil, listen to that little voice in your head that is saying, "You can always do more, you can never do less" and remember that despite your best intentions, bad outcomes happen. If you work in a bomb factory and bombs go off, you were doing your best.

Toronto, ON, Canada — Kieran Murphy
London, UK — Fergus Robertson

Preface from the Series Editors

Interventional radiology treatments now play a major role in many disease processes and continue to mushroom with novel procedures appearing almost on a yearly basis. Indeed, it is becoming more and more difficult to be an expert in all facets of interventional radiology. The interventional trainee and practicing interventional radiologist will have to attend meetings and read extensively to keep up to date. There are many IR textbooks which are disease specific, but incorporate interventional radiology techniques. These books are important to understand the natural history, epidemiology, pathophysiology, and diagnosis of disease processes. However, a detailed handbook that is technique based is a useful addition to have in the cath lab, in the office, or at home where information can be accessed quickly, before or even during a case. With this in mind, we have embarked on a series of books which will provide specific information on IR procedures. Textbooks on Angioplasty and Stenting, Transcatheter Embolization, Biopsy and Drainage, and Tumor Ablative Techniques have already been published. The specialized fields of Neuro and Pediatric Interventional Radiology warrant textbooks in their own right. The final book to complete the series will focus on Emergency Procedures in Interventional Radiology.

We have chosen two editors, who are experts in their fields, for each book. One editor is European and one is from North America so that the knowledge of IR techniques detailed is balanced and representative. We have tried to make the information easy to access using a consistent bullet point format with sections on clinical features, anatomy, tools, patient preparation, technique, aftercare, complications, and key points at the end of each chapter. A short recommended reading list is included.

These technique-specific books will be of benefit to those Residents and Fellows who are training in interventional radiology and who may be taking subspecialty certificate examinations in interventional radiology. In addition, these books will be of help to most practicing interventional radiologists in academic or private practice. We hope that these books will be left in the interventional lab where they should also be of benefit to ancillary staff, such as radiology technicians/radiographers or nurses, who are specializing in the care of patients referred to interventional radiology.

We hope that you will use these books extensively and that they will be of help during your working IR career.

Exeter, UK — Anthony F. Watkinson
Dublin, Ireland — Michael J. Lee

Acknowledgments

We gratefully acknowledge all our coauthors for sharing their experience and knowledge and the staff at Springer for all their work on this book.

Kieran Murphy
Fergus Robertson

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Part I

Basic Skills

Diagnostic Cerebral Angiography and Groin Access and Closure

Kevin Murphy and Gerald Wyse

Abstract

A full clinical history, physical examination, and review of the study indication should be performed prior to every cerebral angiogram. Perform noninvasive imaging initially with magnetic resonance (MR), computed tomography (CT), and/or CT/MR angiography. Closely review all imaging and laboratory data prior to invasive angiography.

Keywords

Diagnostic cerebral angiography • Groin access • Closure • MR • CT • History and physical

Diagnostic Evaluation

A full clinical history, physical examination, and review of the study indication should be performed prior to every cerebral angiogram. Perform noninvasive imaging initially with magnetic resonance (MR), computed tomography (CT), and/or CT/MR angiography. Closely review all imaging and laboratory data prior to invasive angiography.

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Indications for Performing a Diagnostic Cerebral Angiogram

Despite the advances of CT and MR angiography, invasive diagnostic cerebral angiography still has a broad number of indications. Today cerebral angiograms are commonly performed to access dynamic process such as AV shunts or following intracranial interventions such as coil embolization of aneurysms. Cerebral angiography can be performed to further investigate patients with:

- Stenosis or occlusion
- Aneurysm
- Vascular malformations
- Vasculitis
- Vascular tumors
- Previous intracranial intervention

Contraindications

Absolute

- History of anaphylaxis to iodinated contrast
- Patient informed refusal

Relative

- Coagulopathy
- Contrast allergy
- Abnormal renal function
- Uncontrolled hypertension
- Decompensated heart failure
- Pregnancy

Patient Preparation

Nil by mouth for 6–8 h preferable
Peripheral IV access
Correct coagulopathy and other contraindications where possible

Relevant Aberrant Anatomy

Familiarity with common vascular anatomy is essential. Understanding of the common aberrant or variant anatomy is critical to avoid misinterpretation.

Common Arch Variants

- "Normal" (70 %).
- Common left common carotid and innominate origin (termed "bovine" arch) (13 %).
- Left common carotid arises from the innominate (9 %) (also termed "bovine" arch).
- Left vertebral artery directly from arch (5 %).
- Left brachiocephalic trunk (2.7 %).
- Aberrant right subclavian (0.5 %).

Common Intracranial Variants

- Complete circle of Willis (20–25 %)
- Hypoplasia of one or both posterior communicating arteries (PComs) (34 %)
- Hypoplastic/absent A1 segment of the anterior cerebral artery (ACA)
- Origin of posterior cerebral artery (PCA) from the internal carotid artery (ICA) with and absent or hypoplastic P1 segment (17 %) (fetal PCom or fetal circulation)
- Infundibular dilatation of the PCom origin (10 %)

Preprocedure Medications

Sedation of the patient is not routinely required. An oversedated patient can be difficult to neurologically assess, and an acute complication may be missed. In addition noncompliance from a sedated patient may lead to a poor quality or even nondiagnostic study.

Procedure

Access

A common femoral artery (CFA) groin approach, the right groin in particular, is favored for access. The femoral artery is easily compressed post procedure and is associated with a low puncture site complication rate even in the setting of antiplatelet agents.

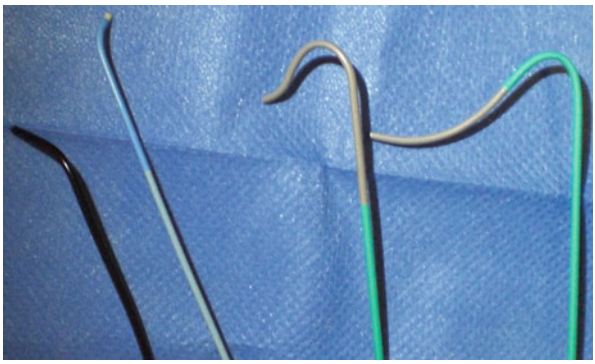

Fig. 1 JB-1, Berenstein, Sim1, and SIM 2 catheters

Radial access continues to grow in popularity for coronary procedures. Compression with a wrist brace negates the need for prolonged supine bed rest post procedure. Although useful for ipsilateral vertebral artery access, this approach is not ideal to access all four vessels during a cerebral angiogram. Brachial and axillary access may be used but are associated with higher puncture site complication rates.

The authors recommend the use of a "micro" access set (21-gauge access needle with a short 0.018″ wire and a 4-French sheath). Alternatively, a standard 18-gauge needle with 0.035″ wire can be used.

- Routine fluoroscopy to accurately locate the center of the femoral head is recommended.
- Infiltration of local anesthetic (1–2 % lignocaine).
- A subsequent single-wall puncture with a 21-gauge needle is performed with a small skin insertion to aid sheath insertion.
- Ultrasound guidance should be readily available and is a valuable adjunct.
- Long sheaths 25 cm or more are useful in the setting of diseased or tortuous iliac vessels.

Immediately after sheath insertion a femoral angiogram should be performed. This leads to early discovery of arterial injury or dissection. It also ensures that the puncture site is appropriate for insertion of a closure device.

After gaining access to the (right) common femoral artery, the following are routinely used:

- Short 4-French sheath
- 4-French 100-cm Berenstein catheter (Fig. 1)
- 0.035″ hydrophilic angled glide wire
- Closed system pressurized saline flush (Fig. 2)

A 5-French system can also be used.

A wide variety of different selective end-hole catheters may be utilized. An unfolded aorta or tortuous anatomy may require two different catheters. Operator preference varies from basic hockey-stick-style catheters to more complex tip shapes. Commonly used

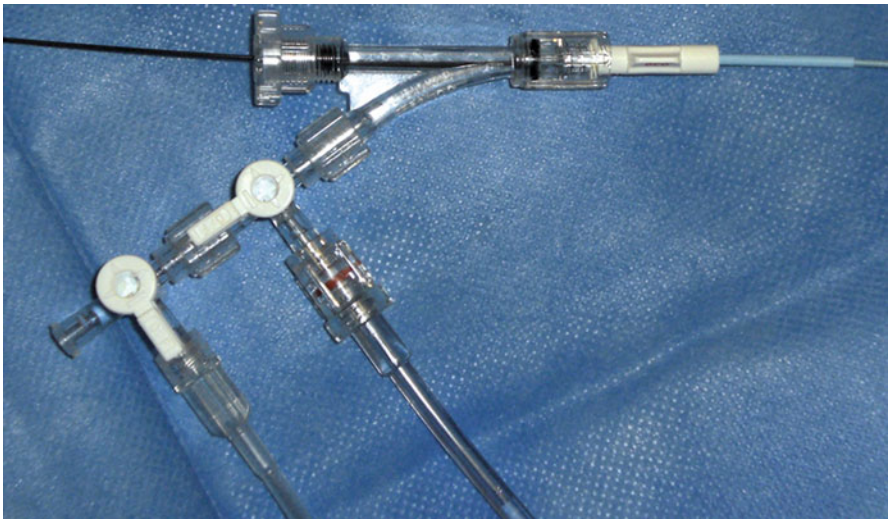

Fig. 2 Closed system with adaptor, contrast pump connection, and saline flush

catheters for cerebral angiography include Bernstein, Headhunter, Sim 1, Sim 2, JB-1, and Vert catheters or equivalent (Fig. 1).

Regular flushing of the catheter is essential during cerebral angiography to prevent clot formation and a possible embolic complication. Always use a double-flush and meniscus-to-meniscus technique. Closed continuous flush systems enable a single operator to perform a cerebral angiogram without an assistant. Continuous saline flushing prevents clot formation in the catheter. Meticulous examination of these closed flush systems is required to ensure the system is free of air. Operator inexperience or unfamiliarity with such systems can lead to devastating air embolism. Opinions and practices regarding these closed flush systems vary widely.

Angiography

A complete cerebral angiogram includes angiograms in at least two views of both carotid bifurcations, the intracranial circulation from both common carotid arteries, the vertebral arteries, and the posterior circulation. 3D DSA assessment of the artery of interest is usually performed. Additional angiograms relating to the clinical indication can be performed as well as relevant magnified branch assessments.

Intraprocedural Medications

Routine heparin use for cerebral angiography is optional. Heparin should be used in patients at high risk of thrombosis.

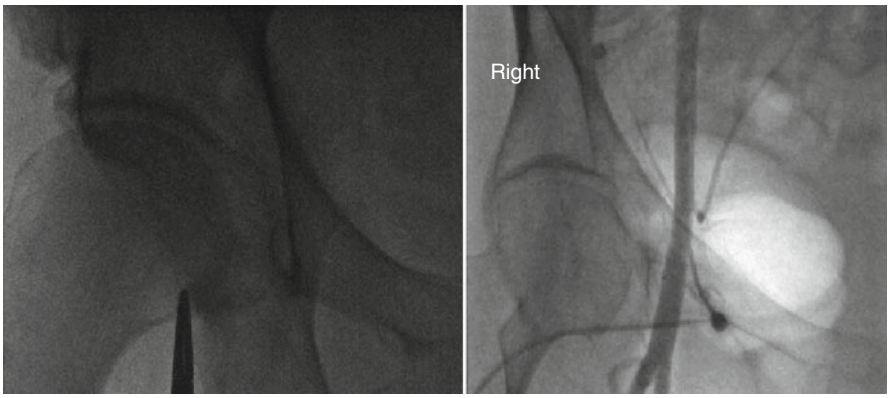

Fig. 3 Accurate pre-puncture localization as well as low-dose angiogram (fluoroscopy loop) of the right CFA is advised to ensure safe puncture and sheath placement

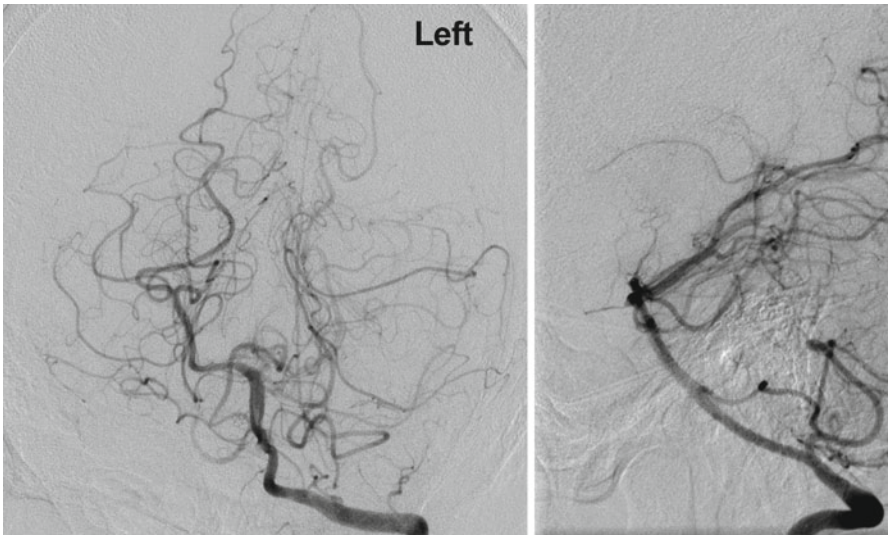

Fig. 4 Normal two plane vertebral angiogram

Performing the Procedure

Accurate pre-puncture localization as well as low-dose angiogram (fluoroscopy loop) of the right CFA is advised to ensure safe puncture and sheath placement (Fig. 3).

Angle the tube with 20–30° of LAO may assist in cannulation of the carotids and the left vertebral arteries from the arch. Fluoroscopy techniques such as roadmap or fluoro fade can be of assistance.

An occipitofrontal-type frontal plane view in conjunction with a true lateral view is advisable for ICA analysis (Fig. 4). Vertebral analysis is best assessed with a true lateral in association with a fronto-occipital/Towne's frontal plane projection (Fig. 5). Always review the clinical indication and the angiograms obtained before removing the sheath

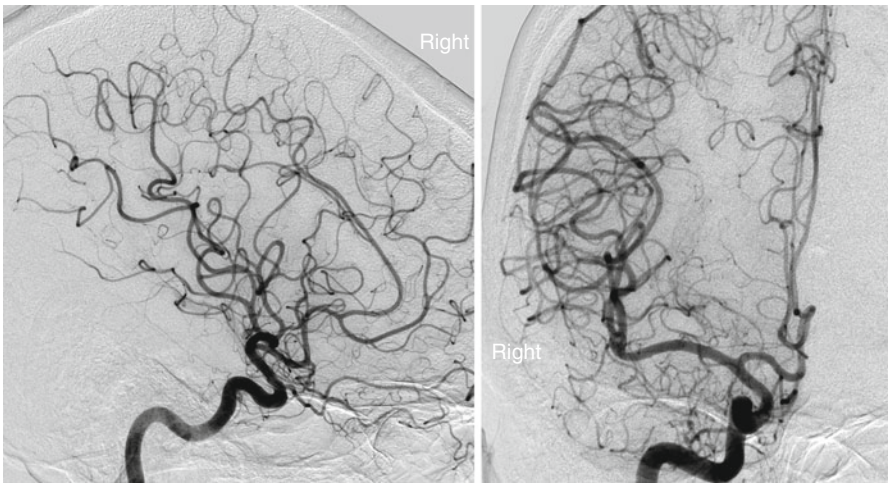

Fig. 5 Normal two plane ICA angiogram

Groin Closure

The two broad alternatives to close a CFA arteriotomy are the employment of manual compression or the use of a vascular closure device (VCD). When manual compression is utilized, nonocclusive pressure should be applied to the arteriotomy puncture site for at least 10 min post procedure. When a large caliber sheath has been used or when the patient is anticoagulated, this length of time is insufficient and a longer duration of pressure and observation is needed. It is advised that the patient lies supine for 4 h if closure is with manual compression. The patient should be examined for the presence of distal pulses, hematoma, and pseudoaneurysm formation at the site of puncture. A wide choice of VCDs is available and broadly fit into the following categories of device:

- Passive external pad or patch which enhances manual compression
- Suture devices which close the arteriotomy
- External extravascular collagen plug or nitinol clip

Vascular closure devices are utilized in 30–50 % of all angiograms worldwide. The complications associated with the use of VCDs are comparable to manual compression (3–5). Closure devices have the advantage of earlier hemostasis and earlier mobilization. Both of these are advantageous when the patient is anticoagulated or coming out of a general anesthetic. The risk of groin infection and possibly the need for puncture site surgery are marginally greater with VCDs. However, overall, the differences between VCDs and manual compression are not statistically significant. The cost of these devices should also be considered. The most popular closure devices on the market are shown in Table 1. A statistically significant difference in efficacy and complication rate does not exist between these commonly used closure devices.

Angio-Seal™, ProGlide/Perclose™, and StarClose™ dominate the market at present. Device deployment for these three closure methods is shown in Figs. 6, 7 and 8.