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PRACTICAL HANDBOOK OF ADVANCED INTERVENTIONAL CARDIOLOGY

FIFTH EDITION

TIPS AND TRICKS

WILEY Blackwell

Practical Handbook of Advanced Interventional Cardiology

Practical Handbook of Advanced Interventional Cardiology: Tips and Tricks

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Preface

ADVANCED INTERVENTIONAL CARDIOLOGY ART AND SCIENCE

At 2020, more than 45 years after its humble beginnings, interventional cardiology is a major player in the management of complex cardiovascular problems. Thanks to the miniaturization of equipment, modern microtechnology, and nano-engineering, interventional cardiology techniques are an effective and user-friendly daily routine. These techniques can be formulated as a sequence of rigorously controled maneuvers which can be taught to fellows or staff, or programmed into robots.

To understand and explain the physical, chemical, biologic, and engineering mechanisms of any of these techniques or maneuvers is a science. To perform a procedure both cost- and time-effectively in a humane manner is an art. In any interventional laboratory, a lesion could be dilated with one guide, wire, balloon, or stent by a senior operator or, *x* (>1) numbers of devices could be operated by a beginner. This is where science and art mix.

Which is the best option to apply to this real-life situation? During a procedure, each operator has the luxury (and the responsibility) to select, change, or modify the direction or position of a device, the drug of use, or the strategy of choice; or, they may be forced to use one when the others are not available. These options are frequently listed and discussed *ad nauseam* elsewhere in the print and electronic media. However, the main question always remains: which is the best option, with the equipment available, in any given real-life situation?

In the fifth edition of this handbook, the authors have tried to answer this very question and to give practical advice derived from their own considerable experience in the cardiac interventional setting.

In the Game Plan boxes, the operator visualizes a global schema of procedural sequences he or she would execute to achieve success. This game plan also includes preventive or corrective measures to deal with crisis situations such as unexpected complications or suboptimal performance of any tactic or strategy.

In the Tactical Move boxes, the authors break up the whole strategy into detailed procedural sequences with limited local goals. At the beginning, it is how to select an appropriate device, e.g. a guide, to achieve success at the first attempt. Then, if a device does not function as expected, there are many simple maneuvers to correct or reverse the situation. In any case, the operator will try to exhaust the full potential of any device first without prematurely and wastefully discarding it.

However, at the same time, while there are many parallel competing tactics or strategies, how does one objectively select the one that is best in any given situation? This is the role of critical thinking: a subjective change of tactics that could save the whole procedure and lead to success or – alternatively, our worst nightmare – failure. In this section, each maneuver is graded according to the time spent, the cost of any extra equipment required, and the risk of complication. For every extra 10 minutes, one more hour can be added to the clock. One dollar sign shown next a procedue in the book means that an extra US$100 are spent. One drop of blood is the symbol for moderate complication; two drops indicate high risk.

In the Warning black boxes, we warn the readers of any deceiving signs or treacherous wrong moves that are the harbinger of impending disaster. This information is combined with operator experience from past personal failures, near-death experiences of the patient, and successful (often almost miraculous) resolution of critical events. Together they constitute a collective memory of how to avoid failure and how to achieve success: that is, what we call experience! If these hard-earned lessons of collective memory were applied in real life, the rate of procedural success would be higher and the incidence of complications much lower.

The rate of complication depends on the operator's skill, the technology available, and patient selection. Rigorous preventive measures learned from that collective memory (i.e. experience) pre-empt the appearance of complications (although one of the best ways to avoid *every* complication is to perform *no* procedures!). With the use of current low-profile balloons and highly torqueable wires, most patients with "simple" stenoses will have good results, even in the hands of a relatively inexperienced operator. However, in patients with complex anatomy or when simple cases become complicated, experienced operators are likely to have superior outcomes. This is why we value experience so much [1].

The authors and editors, who are all your friends and colleagues, labor every day, like you, in the cardiac interventional laboratory, and have done so even during the COVID-19 outbreak. We write from our limited subjective experience and from our hearts. This handbook contains practical advice aimed at you, the reader, and at us, the authors and editors ourselves. We practice what we preach. They are not pronouncements from some ivory tower: they are practiced by those with experience and also by beginners, by the young and old, by men and women, by serious operators and by part timers; so there is no discrimination of class, age, sex, or race.

In this book, we try to highlight these practical suggestions with all of the dramatic ups and downs – reminiscent of an Italian opera – which happen daily in the interventional cardiology laboratory. However, we hope the outcome of these procedures is both happy and beautiful, like the end of any Chinese martial arts movie. The bottom line is that we practice interventional cardiology in a responsible manner, being both cost and time effective without causing more harm (*prima non nocere*). All of us are equal in this quest of striving for the best procedural and clinical success. That is the only goal of this handbook.

REFERENCE

1. Ellis S. Elective coronary angioplasty: Techniques and complications. In Topol EJ, editor. *Textbook of Interventional Cardiology*, 3rd edition. Lippincott-Raven Publishers. pp. 147–62, 1998.

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Foreword

Interventional cardiovascular medicine has evolved from an extremely crude method of opening femoral arteries initiated by Dotter, to a field that has now been recognized as having a sufficient fund of knowledge to require boards sanctioned by the American Board of Internal Medicine. From Andreas Gruentzig's development of the noncompliant balloon method, we have seen an explosion of bio-engineering technology. The discipline of interventional cardiovascular medicine has perhaps initiated more registries and clinical trials than any other discipline in medicine. Indeed, the whole emphasis on evidence-based medicine has evolved during the era of interventional cardiology. Many basic science breakthroughs have been stimulated by the advances produced in interventional cardiology, as well as the problems and complications created by the new technologies.

However, no matter how advanced the science becomes, the success of solving a patient's problem with interventional techniques usually depends on the operator's technical ability. This ability springs from the wealth of experience the operator has acquired to deal with routine situations as well as complex and almost unique problems that may present themselves. Because of the large number of interventional cardiologists and the rapidly expanding number of procedures that can be performed, it is difficult for many cardiologists to experience all of the situations that can be helpful in building this database.

Dr Thach N. Nguyen has prepared a remarkable book, rich with tips and tricks for performing interventional cardiovascular medicine procedures. He has enlisted numerous experts on various aspects of interventional cardiovascular medicine to describe their areas of expertise. Rather than let them recite the evidence from registries and trials that are available elsewhere, he forces the contributors to provide the practical tips that they have learned. It is almost as though Dr Nguyen is trying to simulate the type of scenarios that exist in the catheterization laboratories with new cardiology fellows or less experienced operators. It is the type of advice that he has often given to cardiologists in developing countries who are bringing interventional techniques to help cope with the rapidly expanding new threat in these countries, vascular disease. Since new techniques are constantly appearing, all operators, experienced or not, can benefit from these tips. Whereas every operator will not agree with every approach to a problem or a complication, it is always instructive to understand many potential approaches. In this regard, the book does a masterful job of collecting not only the authors' experiences, but those of many others collected from the published literature, from numerous postgraduate courses, and from one-on-one demonstrations throughout the world.

This book should be a valuable resource to trainees in formal programs that have now evolved in the United States and other countries, as well as the many preceptorships that are the major means of train- ing in other countries. In addition, operators of all levels of experience will find many useful pearls of wisdom. Dr Nguyen and his colleagues are to be congratulated for compiling this most practical guide.

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CHAPTER 1

Vascular Access

Thach N. Nguyen, Nguyen Hong Phat, Phuoc T. Nguyen, and Tri Pham

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*Basic; **Advanced; ***Rare, exotic, or investigational
$, <100.00 $US extra; $$, >100.00 $US extra
⌛, <10 min extra; ⌛⌛, >10 min extra
💧, low risk of complications; 💧💧, high risk of complications

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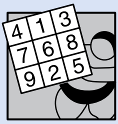
CHALLENGES

Gaining vascular access without early or late bleeding at the access site is a major challenge for every operator carrying out diagnostic or interventional cardiovascular procedures.

FEMORAL APPROACH

GAMEPLAY



Ideal Location of Femoral Access

Usually the femoral artery is palpated below the inguinal ligament that runs from the anterior superior iliac spine to the pubic tubercle. The true position of the inguinal ligament is 1–2 cm below that line. An ideal "landing zone" is defined by vascular entry above the femoral bifurcation and below an upper margin conservatively defined as several centimeters below the inferior excursion of the inferior epigastric artery (IEA). The IEA descends to, but does not cross, distal to the inguinal ligament; thus, entry above the lowest point of the course of this vessel, which typically then turns cranial to supply circulation to the epigastrium, can be used to define an unequivocally high puncture [1] (Figure 1.1).

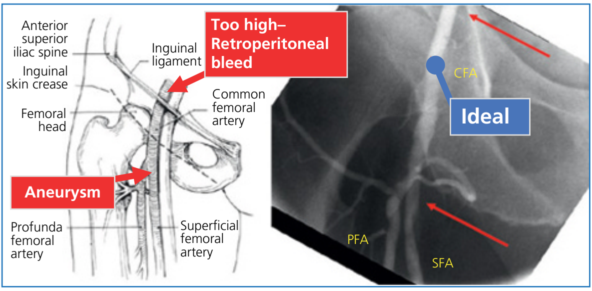


Figure 1.1 Ideal location for puncture of the femoral artery. Reproduced with permission of Wiley.

BEST PLAYERS

aka Standard of Technical Excellence in Femoral Approach

The technique employs visualization of the femoral head under fluoroscopy in a posterior–anterior projection. The skin puncture starts at the level of the lower border of the head of femur with the eventual goal of arterial cannulation at the mid-third of the head of femur. However, even with this technique, punctures below the bifurcation of the common femoral artery (CFA) cannot be completely avoided. This is due to variability in the site of the femoral artery bifurcation in reference to the femoral head. Although in a majority of cases (approximately 77%) the bifurcation is below the level of the femoral head, in approximately 23% of cases the femoral artery bifurcation site is higher. Ninety-seven percent of patients have the femoral artery lying on the medial third of the femoral head. Only 3% have the artery totally medial to the femoral head. Therefore the best way to perform a near-perfect femoral puncture is to use ultrasound guidance [1].

Real-time Actions

Ultrasound-guided puncture In this technique, a needle is initially positioned under fluoroscopy to locate on the skin the best location for puncture, the lower two-thirds of the femoral head (Figure 1.2a).

The equipment used is the Fujifilm SonoSite™, with the goal of locating the segment of the common femoral artery (CFA) proximal to the bifurcation. The femoral artery is recognized as a minimally pulsatile round structure next to another round structure, which is the femoral vein (Figure 1.2b). If the operator presses the vascular probe down, the size of the femoral artery stays the same, while the femoral vein is compressed (Figure 1.2c). The operator then tilts the probe up and down in order to locate the bifurcation with the superficial femoral artery (SFA) and the profunda femoral artery (PFA) (Figure 1.2d). Once the SFA and PFA are located, the puncture site would be proximal to the bifurcation (Figure 1.2b). The needle is positioned right at the middle of the probe and pointed tangentially towards the artery. The metal shadow of the needle can be traced and the tip of the needle makes a dent on the anterior wall of the CFA. Push forward and the tip is inside the lumen with strong blood flow back.

Tricks and Tips

*****Selection of the area for puncture under ultrasound** With ultrasound, the operator can recognize many areas with calcification on the anterior wall of the CFA. These are the areas to be avoided for puncture. The reason is that the needle could enter the wall of the artery but the following wire could not. At that time, manipulation of the needle could end up with vascular access. Another problem is that the wire could enter the

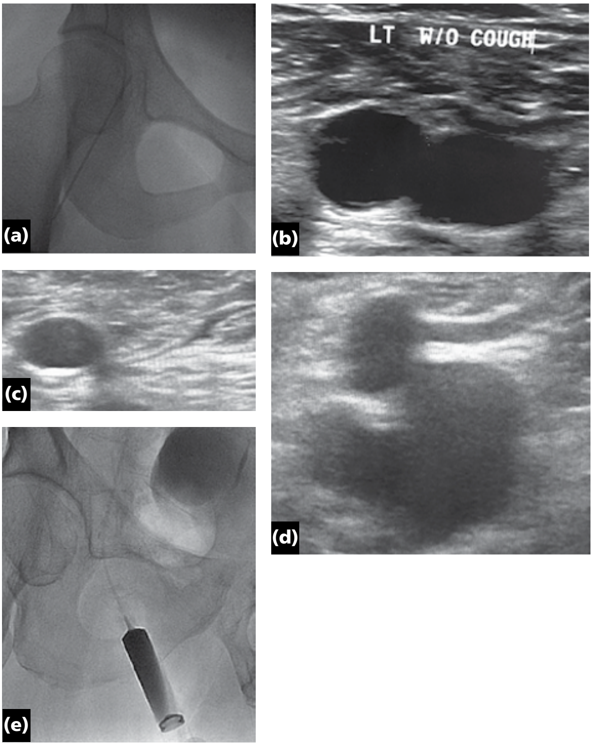


Figure 1.2 (a) A needle is positioned in the right groin area under fluoroscopy looking for the ideal location for puncture. The tip should be at the lower two-thirds of the femoral head. The reason for this is to locate the upper limit of the area of puncture so the tip of the needle does not end up too high as guided by ultrasound in a patient with a high bifurcation of the deep femoral artery. (b) The femoral artery is recognized as a minimally pulsatile round structure. Next to it should be an oblong structure, which is the femoral vein. (c) Press the vascular probe down: the femoral artery stays the same, while the femoral vein disappears because it is compressed. (d) The superficial femoral artery, profunda femoris artery and femoral vein at the bifurcation. (e) Before upsizing the micropuncture sheath, perform angiography of the arteriotomy site, in the ipsilateral 30–40° angle. Note vessel morphology. If the location is not "ideal", pull the sheath out, compress the groin area and re-access the artery.

artery but in a subintimal fashion and dissect the artery. It is advisable to avoid all areas with calcification. Try to find an area without calcification and enter the vessel there.

****Difficulty in cannulating the arterial sheath** Sometimes there is slight difficulty in inserting a sheath into the artery. The reason for this is kinking of the wire at the entry site. Push the wire a little deeper and insert the sheath pointing downwards to get into the lumen, then slide the sheath up along the artery. This may need to be done under fluoroscopy to be sure that the dilator does not bend the wire (creating a pointed tip) and perforate the artery.

Real-time Actions

Fluoroscopically guided micropuncture access The micropuncture vascular access technique involves the use of needles and wires typically in the 21-gauge and 0.018-inch range. For femoral access, these needles are usually 7 cm in length. The outer diameter of this needle is 0.8 mm; in contrast, the 18-gauge needle used by most operators is 56% larger, resulting in as much as six times the blood flow rate through an inadvertent back wall puncture or from an arterial entry with failed sheath placement [2].

The CFA is punctured under fluoroscopic guidance using the mid-third of the femoral head to guide the needle to the anticipated puncture site, although restricting puncture to a point below the centerline of the femoral head may be the most prudent approach. After the initial localization of the bottom of the femoral head, repeat fluoroscopy is performed after the needle has been placed deep in the tissue track, but not yet into the femoral artery, to achieve an ideal location of puncture. The path of the needle can be adjusted several times, if necessary, as it traverses deep into the subcutaneous tissue [2]. Once the needle is in the vessel and there is blood return, some operators perform a limited femoral angiogram via the micropuncture needle using a 3-mL syringe (Figure 1,2e).

If an acceptable CFA access location is confirmed, a 0.018-inch wire is advanced through the needle. A 4-Fr micropuncture sheath is advanced over the wire and exchanged for a 0.035-inch wire to support passage of a larger sheath size. There are also larger, highly tapered sheaths designed to go directly over the micropuncture wire. This technique allows relatively safe removal of the micropuncture needle or sheath after unfavorable location entry, with manual pressure applied for 3–5 min before attempting a new puncture based on the angiogram [2].

Large sheath Newly developed inflatable vascular sheaths designed to minimize frictional forces caused by large-bore devices have been evaluated, and recent studies suggest that these sheaths may increase the availability of femoral access in patients with access-limiting peripheral artery disease (PAD). One of the large sheaths is the 19-Fr SoloPath™ balloon-expandable transfemoral access [3].

DEDICATED EQUIPMENT

E

The 19-Fr SoloPath Transfemoral Introducer (STFI) is a vascular access device that permits large-bore access with technology that enables entry into the femoral artery at a low insertion profile (13 Fr) and then radially expands to a larger profile (19 Fr). The STFI sheath is inserted in a folded state over an expansion balloon dilator. The SoloPath transfemoral system is advanced under fluoroscopic guidance over a stiff