

ESSENTIAL ANGIOPLASTY

E. von Schmilowski | R. H. Swanton



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Foreword

Coronary angioplasty has become one of the great interventions in modern medicine. Over the last three decades since Gruentzig first introduced this procedure in 1977 the technique has developed to an astonishing degree and its application has spread worldwide. It has avoided the need for coronary bypass surgery in hundreds of thousands of patients with angina, and is increasingly managed as a day case procedure.

The plain old balloon designed by Gruentzig is still used in a design very similar to his original one. To it has been added firstly the bare metal stent, then the drug-eluting stent and now the fully absorbable stent which is entering trials. Remarkable improvements in intracoronary imaging have paralleled these advances.

The result is that almost all cases of coronary disease can be managed wholly or in part by coronary angioplasty. The question becomes not "Can I do this procedure?", but "Should I do it?"

This guide book for the trainee starting coronary angioplasty goes through the procedure in a step by step fashion, and deals with all the modern technology available. It also answers the question fundamental to good practice: "Should I take this case on, or should I refer the patient for surgery?" The answer so often lies in trial data which are included in every section dealing with techniques. We have all struggled with a procedure and got into difficulties because we tried to do too much. The book's motto "keep it simple" will stand the trainee in good stead. Although the technology is increasingly sophisticated this phrase must be in the operator's mind with every case. This very helpful guide book will keep it there!

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Preface

It is hoped this book will be of help to the cardiologist starting out in coronary intervention. Standing at the catheter table for the first time as an assistant operator at a coronary angioplasty case can be a daunting experience however many coronary angiograms you have performed previously. A vast choice of techniques and technology confronts the beginner. This book is designed to guide you through the procedure, avoiding potential pitfalls and complications. It has been written to provide a solid basic background and allow you to develop your own personal approach in interventional cardiology. Our principle was to follow the motto "keep it simple," to provide selected, practical knowledge with a full range of useful tools and tips and to avoid increasing amounts of useless information. The book also deals in detail with more complex intervention, which we hope will help the more experienced interventionist.

It is 35 years since Andreas Grüntzig performed the first balloon coronary angioplasty in man in 1977. Since that time there have been huge advances in pharmacology, technology, and imaging – both X-ray and intracoronary imaging.

This book will help you apply all these advances with each stage of the coronary intervention. A section on angiographic projections will help in the selection of the best view of a lesion in any coronary segment. Radiation doses to patient, operator, and laboratory staff are higher in coronary angioplasty than in diagnostic coronary angiography and the radiation section will help remind the operator how to minimize the radiation dose. There are sections on choice of vascular access and closure devices. Pharmacology is covered in detail. The bewildering choice of guiding catheters, wires, balloons, and stents are dealt with in individual sections. All chapters are illustrated by diagrams, charts, and tables as well as angiographic pictures.

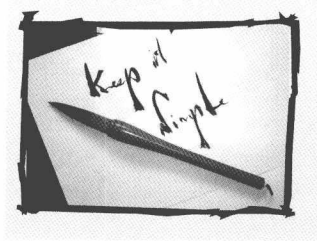
Even with the correct selection of equipment, the story has just started. Every common coronary lesion is dealt with in a step-by-step fashion with caveats listed. Included are sections on primary coronary angioplasty in acute myocardial infarction, the thrombotic lesion, bifurcation lesions, ostial lesions, graft lesions, and left main stem stenosis. There is a section on intracoronary imaging. Complications are covered and include contrast-induced nephropathy.

Cardiology is right at the forefront of medical specialties in its evidence base. We have literally hundreds of trials to guide our practice. The best relevant trials in coronary intervention are included at the end of each chapter with a full list at the back of the book. We would welcome and be very grateful for any suggestions and feedback on gaps in the subject or topics which you feel have been dealt with inadequately.

An integral and very important part of the book is a website, www.wiley.com/go/essentialangioplasty.com. This will provide you with regular updates on topics or content covered in the book, updates on relevant clinical trials, news of new equipment, techniques, and technologies, and reports from key interventional meetings. Additionally, you will benefit from many downloadable color images and illustrations which will cover the most important areas of interventional cardiology. Also included are PowerPoint presentations and clinical cases with video clips which will, we hope, be both entertaining and instructive.

Finally, we encourage you to use this book in the catheter lab on a regular basis. We believe it will help you develop excellent standards in your daily interventional practice.

Good luck!



*E. von Schmilowski
R. H. Swanton*



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*E. von Schmilowski
R. H. Swanton*



List of Abbreviations

AA, arachidonic acid
ACS, acute coronary syndrome
ACT, activated clotting time
AP, anteroposterior
APTT, activated partial thromboplastin time
ARC, Academic Research Consortium
ARU, aspirin reaction unit
BMS, bare metal stents
CAD, coronary artery disease
CART, controlled antegrade and retrograde subintimal tracking
CIN, contrast-induced nephropathy
CMR, cardiac magnetic resonance
CPR, cardiopulmonary resuscitation
CSA, cross-sectional area
CTFC, corrected TIMI frame count
CTO, chronic total occlusion
DAPT, dual antiplatelet therapy
DEB, drug-eluting balloons
DES, drug-eluting stent
DS, digital subtraction (angiography)
EEM, external elastic membrane
FFR, fractional flow reserve
GPI, glycoprotein inhibitor
GTN, glyceryl trinitrate
HPPR, high post-clopidogrel platelet reactivity
IABP, intra-aortic balloon pump
IC, intracoronary
IM, intramuscular(ly)
IMA, internal mammary artery
IMC, internal mammary artery catheter
IRA, infarct-related artery
IV, intravenous(ly)
IVUS, intravascular ultrasound
JVP, jugular venous pulse/pressure
LA, left atrium
LBBB, left bundle branch block

LCB, left coronary bypass
LIMA, left internal mammary artery
LM, left main
LV, left ventricle, left ventricular
LVEDP, left ventricular end-diastolic pressure
MACE, major adverse cardiac events
MBS, myocardial blush score
MLA, minimum luminal cross-sectional area
MLD, minimum luminal diameter
MVD, multivessel disease
NAC, *N*-Acetylcysteine
NSTEMI, non-ST-elevation myocardial infarction
NURD, nonuniform rotational distortion
OMB, obtuse marginal branches
OTW, over the wire
PA, posteroanterior; pulmonary artery
PCI, percutaneous coronary intervention
PEA, pulseless electrical activity
PGA, polyglycolic acid
PLLA, poly-L-lactic acid
PO, per orem
POBA, plain old balloon angioplasty
PTT, partial thromboplastin time
QCA, quantitative coronary angiography
RCB, right coronary bypass
RPFA, rapid platelet function assay
RSV, right sinus of Valsalva
RWMA, regional wall motion abnormalities
SBP, systolic blood pressure
STAR, subintimal tracking and re-entry (technique)
STEMI, ST-elevation myocardial infarction
SVR, systemic vascular resistance
TAVI, transcatheter aortic valve implantation
TIMI, thrombolysis in myocardial infarction
TLD, thermoluminescent dosimeter
TLF, target lesion failure
TLR, target lesion revascularization
TOE, transesophageal echocardiography
TT, thrombin time
TVF, target vessel failure
TVR, target vessel revascularization
UFH, unfractionated heparin
VASP, vasodilator-stimulated phosphoprotein
VASP-P, VASP phosphorylation
VSD, ventricular septal defect

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Companion website

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www.wiley.com/go/essentialangioplasty.com

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Standards of Excellence in Interventional Cardiology

As you are reading this, interventional cardiology has become an important part of your life. After a demanding training and long hours in hospital cardiology practice you have become a member of the interventional community. You undoubtedly have great potential, strong motivation, and a determination to learn and master your profession.

Interventional cardiology is not only about how educated, intelligent, or skilled you are. Good qualifications are indeed important, but being an excellent operator does not necessarily make you an excellent interventional cardiologist. There is much more to it than educational achievements and manual skills.

A skilled angioplasty operator should select patients appropriately and use the best and most up-to-date techniques, equipment, and pharmacotherapy. An interventional cardiologist, on the other hand, should in addition to these skills have a wide knowledge base, common sense, and the ability to cooperate and communicate effectively with both colleagues and patients.

Much of what follows is about being a first-class doctor rather than being a skilled technician. It may be taken for granted by the patient and medical colleagues that the conduct described below is to be expected as part of a first-class service. However, we have all seen how pressure of time and work and the stress of a difficult procedure can erode these standards. It is important that good standards of practice should develop from the very

beginning of training. You will make a positive impact on both patients and the people you work with, and in a few years time your younger colleagues will learn from you.

We hope these few practical thoughts will help you see interventional cardiology from a more human perspective and will make your profession more worthwhile, rewarding, and enjoyable.

Take Care of the Patient

- You are a physician and cardiologist, not just an interventionist. Treat the whole patient, not just the lesion in the coronary artery. Try to imagine what it must be like facing up to a coronary angioplasty.
- Meet the patient and the patient's family before and after the procedure. Explain what will be done and what has been done.
- Be available, kind, and keen to talk. Be honest, quietly confident, and do not hide anything. In getting consent, be realistic about the risks involved. These should be the risks in your hands in your hospital, not national risks.
- During the procedure, mind your language and be careful with comments you make. Don't forget that most patients are awake during a percutaneous coronary intervention (PCI), and sedation does not necessarily stop them hearing or remembering remarks.

Treat the patient, not the lesion.

Quality and Respect Are Essential

- Be humble and respect the people you work with. You are not the master of the universe. Don't act in a superior way.
- Be professional. Build your reputation as a professional physician and a decent human being, not a pop star.
- Dress properly. Have clean hands and fingernails.
- Be available and well organized. Keep your desk clean, keep your files in order, manage your time effectively by planning ahead.
- Be reliable, honest, and truthful. We all want to work with people whom we can trust and rely on.
- Be effective, but not arrogant.
- Be decisive. Don't dwell on problems, solve them. A good decision made quickly is ideal, but when you are stuck, any decision is better than no decision.
- Be strong and determined. Do not give up because things are getting difficult.
- Be adaptable as well as decisive. Be prepared to change strategy if your initial plan is not working out.
- Be a good speaker. Express your opinions in sentences rather than in paragraphs.
- Don't argue with anyone. Accept constructive criticism.
- Be calm and peaceful. Control your emotions when things go wrong. Do not raise your voice.

- Be well balanced. Keep your mind and body in healthy shape. Your mind is like a parachute. It only works when open.

Any decision is better than no decision.

Communicate Effectively

- Cooperate with your medical colleagues and catheter lab staff.
- Present results of the procedure to your referring doctor.
- Be careful when you present your opinions about PCI performed by others and avoid disparaging or disdainful remarks.
- Consider and respect others' views. If you disagree, disagree gracefully.
- A healthy and friendly atmosphere in the catheter lab is very important.
- Maintain a good relationship with catheter lab staff. Help them and teach them, but do not patronize them. Many of them will be highly experienced. Discuss cases with them, particularly when things go wrong.
- Remember each nurse and technician by name and thank them at the end of the procedure.
- Do not make people feel intimidated by your knowledge, experience, skills, achievements, etc. The greatest people will never make you feel intimidated.

Build bridges, not walls.

Don't Overestimate Your Skills

- Courage is important. However, there is a thin line between courage and stupidity. The only hero in a heroic procedure is the patient. Be very cautious, particularly in the first few months of your training.
- If in doubt, ask your more experienced colleagues for their opinion. Discuss the problem with others.
- In complex cases, ask one of your colleagues to scrub in with you, even if you think you don't need help.
- There is no failure. Only feedback. When complications occur, stay calm, manage the patient appropriately, and do not leave the bedside until the situation is under control. Once the patient is stable, immediately contact your more experienced colleague to explain the case and review the patient in detail. Always tell the truth.
- Being told you are competitive may be a compliment or an insult. PCI is not a rugby game and it is not about winning, beating others, or proving you are the best.
- Avoid "Let me show you..." situations. Compete when it is yourself you are competing against.

Skill is successfully walking a tightrope over Niagara Falls.

Intelligence is not trying.

Learn, Learn, Learn

- Learn every day. Enjoy it and share your knowledge. Learn before you start practicing. Manual skills are extremely important, but without a solid theoretical background you can only be good, never great.

- Attend and participate in interventional meetings at least once a year. Euro PCR in Europe, ACI in the UK, and TCT in the USA are invaluable meetings and will broaden your horizons and inspire you. You will learn from the greatest and most experienced interventionists in the world.
- Keep up to date with interventional technology, new equipment, and new trials.

*Good judgment comes from experience and
experience comes from bad judgment.*

Above all keep it simple. Simplicity is the ultimate sophistication.

Introduction to Interventional Procedures

- **Coronary Angioplasty, 4**
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Coronary Angioplasty

When Andreas Grüntzig introduced coronary angioplasty in man in 1977, he introduced a technique which proved to be one of the great advances in modern medicine. Major advances in technology coupled with great improvements in both X-ray and intracoronary imaging have enabled cardiologists to tackle more and more complex coronary lesions. This has saved hundreds of thousands of patients a year worldwide from the need for coronary artery bypass surgery (CABG). Coronary angioplasty has been of value in the management of patients who develop angina years after CABG and has extended treatment options in elderly or frail patients who are considered unsuitable for coronary surgery.

Coronary angioplasty has revolutionized the treatment of acute myocardial infarction (MI), replacing thrombolysis in many areas reducing hospital mortality and mortality in cardiogenic shock. It has proved its superiority over thrombolysis in acute MI, preventing postinfarct angina and recurrent infarction.

With these extraordinary advances has come an understanding of the indications for PCI. It is primarily a technique for the relief of anginal symptoms which have not responded to medical treatment. Not all patients with refractory angina should be advised to have a PCI as CABG may still be an alternative treatment option in certain groups of patients: particularly those with complex, diffuse three-vessel disease and diabetes. PCI can be of value as part of a hybrid procedure: e.g., stenting of a coronary lesion before a transcatheter aortic valve implantation (TAVI). The points below indicate some common clinical situations where PCI should be considered:

- Stable angina resistant to medical treatment
- Symptomatic one-, two-, or three-vessel disease (based on the result of the stress test and suitable coronary anatomy)

- Angina with a poor exercise test result: e.g., ST depression at low workload with symptoms, or inadequate BP response
- ST elevation MI (STEMI)
- Unstable angina / non Q wave MI / NSTEMI
- Angina in patients with severe LV dysfunction and heart failure if ischemia has been demonstrated
- Recurrent angina after coronary bypass surgery

Coronary Angiography

Coronary angiography is a diagnostic procedure for assessing the severity of coronary lesions. The result determines the choice of treatment. The majority of patients undergoing angiography are symptomatic with confirmed angina, and they often require prompt further interventional treatment. Angiography is also performed in patients with congenital heart disease, aortic dissection, a large area of ischemia, and new onset of left ventricular dysfunction or heart failure, as well as in those who require valve surgery. Finally, in some patients the diagnosis of coronary disease is uncertain and cannot be excluded by noninvasive testing. In this situation angiography is needed to decide treatment strategy. Patients with acute coronary syndrome (ACS) require urgent angiography (see pp. 133–162). Coronary angiography is contraindicated in the following situations:

- *No consent*: The patient refuses consent
- *Active*: Bleeding, infection
- *Acute*: Stroke, renal failure, endocarditis
- *Severe*: Anemia, coagulopathy, electrolyte disturbances
- *Heart failure*: If decompensated
- *Hypertension*: If uncontrolled

Interventional Tools

The standard diagnostic table contains the following equipment:

- Sterile cups
- Sterile syringes
- Sterile introducing needle
- 1% lidocaine (lignocaine)
- Intracoronary glyceryl trinitrate (GTN), adenosine, nitroprusside, verapamil, atropine
- Coronary manifold
- Sheath for vascular access
- Diagnostic coronary catheter
- Guide wire 0.035"

In addition if proceeding to angioplasty:

- Inflation device
- Contrast media (50% contrast/50% saline)
- Hemostatic valve (e.g., Ketch or Touhy–Borst)

- Coronary guiding catheter
- Coronary guide wire 0.014"

Basic Principles

In a procedure probably proceeding to PCI, limit the use of contrast as much as possible. Use only selected projections, focusing on stenotic segments and potential involvement of side branches. This will help you choose the best working projection. In the patient who has had coronary bypass surgery, angiography is usually only a diagnostic procedure and there is less restriction on contrast use. As well as the native vessels, focus on the state and number of bypass grafts and their proximal and distal anastomoses. Distal runoff into the native vessel is important. The angiogram must be reviewed with a cardiothoracic surgeon to decide on the best treatment strategy.

There is no such thing as routine angiography. Every individual procedure requires care and attention:

- Proceed gently; never force wires, sheaths, or catheters.
- Start angiography with an initial injection of 100–200 μ g intracoronary GTN.
- Assess coronary anatomy: significant narrowing, vessel dominance, coronary anomalies, coronary collaterals, coronary blood flow.
- Are there any missing areas, or absent vessels? If so, consider the possibility of a severe lesion, complete total occlusion (CTO) lesion, or thrombus.
- Standard projections usually provide complete information about major vessels. Sometimes, however, these do not fully display coronary arteries, and multiple projections with steeper angles are needed to avoid overlaps.
- Do not finish before you are sure all vessels including side branches have been identified and shown properly.
- Think about a treatment strategy: medical therapy, angioplasty, or bypass surgery. Review the patient with a more experienced colleague or with a cardiothoracic surgeon for a final decision.

Pitfalls in the Interpretation

Misinterpretation or underestimation of severe stenoses, e.g., due to diffuse disease, tortuosities, etc., may have serious clinical implications. A few points may help in the assessment of the angiogram:

- *Adequate contrast injection* is important for good opacification of the coronary arteries. This can be improved by use of a larger-size catheter or a power injector.
- *Poor opacification* is a common problem. This results in streaming and may be misinterpreted as an ostial lesion, a missing side branch, or thrombus. An adequate-sized diagnostic catheter may help overcome it.
- *Subselective injection*. If the left main is short or double-barreled, a standard contrast injection may selectively opacify only one vessel – either the left anterior descending artery or the left circumflex artery. If the left circumflex artery is opacified clearly, the left anterior descending artery may be misinterpreted as totally occluded, and vice versa. Sometimes a rapid contrast