



A COMPANION TO SPECIALIST SURGICAL PRACTICE

VASCULAR AND ENDOVASCULAR SURGERY

FOURTH EDITION

SAUNDERS
ELSEVIER

Edited by
Jonathan D. Beard
Peter A. Gaines



A Companion to Specialist Surgical Practice

Series Editors

O. James Garden

Simon Paterson-Brown

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FOURTH EDITION

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Series preface

Since the publication of the first edition in 1997, the *Companion to Specialist Surgical Practice* series has aspired to meet the needs of surgeons in higher training and practising consultants who wish contemporary, evidence-based information on the subspecialist areas relevant to their general surgical practice. We have accepted that the series will not necessarily be as comprehensive as some of the larger reference surgical textbooks which, by their very size, may not always be completely up to date at the time of publication. This Fourth Edition aims to bring relevant state-of-the-art specialist information that we and the individual volume editors consider important for the practising subspecialist general surgeon. Where possible, all contributors have attempted to identify evidence-based references to support key recommendations within each chapter.

We remain grateful to the volume editors and all the contributors of this Fourth Edition. Their enthusiasm, commitment and hard work has ensured that a short turnover has been maintained between each of the editions, thereby ensuring as accurate and up-to-

date content as possible. We remain grateful for the support and encouragement of Laurence Hunter and Elisabeth Lawrence at Elsevier Ltd. We trust that our aim of providing up-to-date and affordable surgical texts has been met and that all readers, whether in training or in consultant practice, will find this fourth edition an invaluable resource.

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Editors' preface

Vascular and Endovascular Surgery is designed to be a comprehensive and affordable textbook for all those involved with the management of patients with vascular disease, whether they be trainees, vascular or non-vascular specialists, or other healthcare professionals. A modern vascular service encompasses many disciplines, and success depends upon a team approach. Whilst the vascular surgeon often remains in overall charge of the patient, management may involve clinical nurse specialists, angiologists and interventional radiologists. Other clinicians are frequently involved with the management of many of our patients, including diabetologists, neurologists, rheumatologists and haematologists. Physiotherapists and other rehabilitation specialists are also vital for successful patient outcomes. Our choice of authors for this Fourth Edition reflects this diversity.

Many of the chapters from the Third Edition have been retained, although all of them have been extensively revised and updated in line with recently published evidence, such as the Trans-Atlantic Inter-Society Consensus (TASC) II guidelines. The continued move towards non-invasive imaging, medical therapy and endovascular techniques is reflected in

the content of this book. In response to the reviews of the Third Edition, the technical chapters on grafts and stents have been removed. The space created has allowed us to add a new chapter on the medical treatment of chronic lower limb ischaemia. Vascular surgeons and radiologists are increasingly undertaking access procedures and therefore we have also added a chapter on central and peripheral access. To reflect the problem-orientated nature of the book, the titles of the chapters dealing with venous insufficiency have been focused on the management of the acutely swollen leg and the chronically swollen leg. Another feature of this new edition is the use of colour illustrations throughout the book. The unique use of symbols to denote levels of evidence has been retained.

To reflect the collaborative nature of a modern vascular service, many of the chapters are co-authored by a vascular surgeon and a vascular radiologist. We have continued to expand our authorship to include more experts from Europe and North America, with an emphasis on global practice. We are grateful to all our authors for the hard work that they have put into their respective chapters.

Jonathan D. Beard
Peter A. Gaines
Sheffield

Evidence-based practice in surgery

Critical appraisal for developing evidence-based practice can be obtained from a number of sources, the most reliable being randomised controlled clinical trials, systematic literature reviews, meta-analyses and observational studies. For practical purposes three grades of evidence can be used, analogous to the levels of 'proof' required in a court of law:

1. **Beyond all reasonable doubt.** Such evidence is likely to have arisen from high-quality randomised controlled trials, systematic reviews or high-quality synthesised evidence such as decision analysis, cost-effectiveness analysis or large observational datasets. The studies need to be directly applicable to the population of concern and have clear results. The grade is analogous to burden of proof within a criminal court and may be thought of as corresponding to the usual standard of 'proof' within the medical literature (i.e. $P < 0.05$).
2. **On the balance of probabilities.** In many cases—a high-quality review of literature may fail to reach firm conclusions due to conflicting or inconclusive results, trials of poor methodological quality or the lack of evidence in the population to which the guidelines apply. In such cases it may still be possible to make a statement as to the best treatment on the 'balance of probabilities'. This is analogous to the decision in a civil court where all the available evidence will be weighed up and the verdict will depend upon the balance of probabilities.
3. **Not proven.** Insufficient evidence upon which to base a decision, or contradictory evidence.

Depending on the information available, three grades of recommendation can be used:

- a. Strong recommendation, which should be followed unless there are compelling reasons to act otherwise.
- b. A recommendation based on evidence of effectiveness, but where there may be other factors to take into account in decision-making, for example the user of the guidelines may be expected to take into account patient preferences, local facilities, local audit results or available resources.

- c. A recommendation made where there is no adequate evidence as to the most effective practice, although there may be reasons for making a recommendation in order to minimise cost or reduce the chance of error through a locally agreed protocol.

Strong recommendation



Evidence where a conclusion can be reached '**beyond all reasonable doubt**' and therefore where a **strong recommendation** can be given.

This will normally be based on evidence levels:

- Ia. Meta-analysis of randomised controlled trials
- Ib. Evidence from at least one randomised controlled trial
- IIa. Evidence from at least one controlled study without randomisation
- IIb. Evidence from at least one other type of quasi-experimental study.

Expert opinion



Evidence where a conclusion might be reached '**on the balance of probabilities**' and where there may be other factors involved which influence the recommendation given. This will normally be based on less conclusive evidence than that represented by scalpel icons:

- III. Evidence from non-experimental descriptive studies, such as comparative studies and case-control studies
- IV. Evidence from expert committee reports or opinions or clinical experience of respected authorities, or both.

Evidence in each chapter of this volume which is associated with either a strong recommendation or expert opinion is annotated in the text by either a **scalpel** or **pen-nib** icon as shown above. References associated with **scalpel** evidence will be highlighted in the reference lists, along with a short summary of the paper's conclusions where applicable.

Further reading

The compact format of this book means that it cannot cover every detail of vascular and endovascular surgery, diagnostic imaging and vascular medicine. The books listed below will provide more detail when required.

General

Vascular surgery, 6th edn

Rutherford RB (ed.). WB Saunders, 2005.

The 'bible' of vascular surgery. Encyclopaedic but expensive, with a strong American influence.

Comprehensive vascular and endovascular surgery, 2nd edn

Hallet JW, Mills JL, Earnshaw JJ, Reekers JA, Rooke (eds.). Mosby, 2009.

A more affordable, comprehensive textbook with a transatlantic flavour. Excellent colour illustrations and diagrams.

Pathways of care in vascular surgery

Beard JD, Murray S (eds.). TFM Publishing, 2002.

A useful book produced by the Joint Vascular Research Group. Evidence-based, multidisciplinary approach to the management of common vascular conditions.

ABC of arterial and venous disease

Donnelly R, London NJM (eds.). BMJ Books, 2000.

An inexpensive, well-illustrated, soft-cover book suitable for junior doctors, students and nurses.

Specialist

Abrams' angiography: interventional radiology, 2nd edn

Baum S, Pentecost MJ (eds.). Lippincott, Williams & Wilkins, 2005.

Connective tissue diseases

Belch JJJ, Zurier RB (eds.). Chapman & Hall, 1995.

The vein book

Bergan JJ (ed.). Elsevier, 2007.

The foot in diabetes, 3rd edn

Boulton AJM, Connor H, Cavanagh PRC (eds.). John Wiley, 2000.

Atlas of vascular disease, 2nd edn

Creager MA, Braunwald E (eds.). Philadelphia, PA: Current Medicine, 2003.

Interventional radiology explained

Francis I, Watkinson A (eds.). Remedica Series for Clinicians. Remedica, 2000. ISBN 1-90134602-1.

An introduction to vascular biology, 2nd edn

Halliday AW, Hunt BJ, Poston L, Schachter M (eds.). Cambridge University Press, 2002.

Interventional radiology: a survival guide, 2nd edn

Kessel D, Robertson I. Elsevier, 2005.

Peripheral arterial disease

Mohler E, Jaff M (eds.). ACP, 2008.

Good coverage of epidemiology of peripheral arterial disease.

Amputation surgery and lower limb prosthetics

Murdoch G (ed.). Blackwell, 1988.

Atlas of vascular surgery: operative procedures

Ouriel K, Rutherford RB (eds.). WB Saunders, 1998. Clear line diagrams of vascular surgical techniques and exposures.

CT and MR angiography: comprehensive vascular assessment

Rubin GD, Rofsky NM (eds.). Lippincott, Williams & Wilkins, 2008.

Recent advances in thrombosis and haemostasis

Tanaka K, Davie EW (eds.). Springer, 2008.

Atlas of vascular anatomy: an angiographic approach

Uflacker R (ed.). Lippincott, Williams & Wilkins, 2006.

Interventional radiology: a practical guide

Watkinson AF, Adam A (eds.). Radcliffe Medical Press, 1996. ISBN 1-85775031-4.

Endovascular therapies: current evidence

Wyatt MG, Watkinson AF (eds.). TFM Publishing, 2006. ISBN 1-90337846-X.

Introduction to vascular sonography, 5th edn

Zweibel W (ed.). WB Saunders, 2005.

Websites

Books can become outdated, which is why *Vascular and Endovascular Surgery* is published frequently in an affordable format. Websites and journals provide up-to-the-minute information on recent trials and technological developments, as well as news of meetings and courses. A few of the more useful websites are listed below.

American Board of Surgery: <http://home.absurgery.org/default.jsp?index>

American Venous Forum: <http://www.venous-info.com>

British Society of Interventional Radiology: <http://www.bsir.org>

Cardiovascular and Interventional Radiological Society of Europe: <http://www.cirse.org>

European Board of Vascular Surgery: <http://www.uemsvascular.com>

European Journal of Vascular and Endovascular Surgery: <http://www.sciencedirect.com/esvs>

European Society for Vascular Surgery: <http://www.esvs.org>

European Venous Forum: <http://www.european-venousforum.org>

Society for Vascular Surgery (North America): <http://www.vascularweb.org>

Vascular Society of Great Britain and Ireland: <http://www.vascularsociety.org.uk>

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Epidemiology and risk factor management of peripheral arterial disease

Richard Donnelly
Janet T. Powell

Introduction

Atherosclerotic peripheral arterial disease (PAD) involving one or more major vessels of the lower limb is common, especially in older patients, due to complex genetic and environmental interactions which result in structural and functional vascular abnormalities and reduced blood flow. PAD may be asymptomatic in the early stages, but is always associated with shortened survival due to the invariable association with atherosclerosis in other arterial territories, especially the coronary, carotid and cerebral circulation. This is highlighted by observational studies showing that reduced ankle-brachial pressure index (ABPI, a marker of disease severity in PAD) is associated with an increased risk of cardiovascular mortality (Table 1.1).¹ However, calcification and sclerosis lead to incompressible arteries, with false elevation of ABPI even in the presence of major distal atherosclerosis. The Strong Heart Study has identified associations between low (<0.90) and high (>1.40) ABPI and increased risk of all-cause and cardiovascular (CV) disease mortality, reporting a U-shaped relationship between a non-invasive measure of PAD and reduced life expectancy (Fig. 1.1).² For example, adjusted risk estimates for all-cause mortality were 1.69 for low and 1.77 for high ABPI, while the corresponding estimates for CV disease mortality were 2.52 and 2.09.²

This chapter considers the epidemiology of PAD, the observational studies identifying reversible and irreversible risk factors for disease progression, and the evidence from randomised controlled trials which

Table 1.1 • Adjusted relative risk for mortality for levels of ankle-brachial pressure index (ABPI)

ABPI	Relative risk	95% CI	P value
<0.4	3.35	2.16–5.20	<0.001
0.4–0.85	2.02	1.34–3.02	<0.001
>0.85	1.00	Reference	

From McKenna M, Wolfson S, Kuller L. The ratio of ankle and arm arterial pressure as an independent predictor of mortality. *Atherosclerosis* 1991; 87:119–28. With permission from Elsevier.

underpins clinical use of disease-modifying therapies as part of multiple risk factor intervention.

Epidemiology of PAD

Obtaining accurate figures for the prevalence and incidence of PAD has not been straightforward. For example, several epidemiological studies have focused on specific groups, e.g. in the workplace setting or referrals to hospital, which may not be truly representative of the wider population. Thus, workplace screening studies for PAD have excluded those who have retired and those who may be unfit for work. Similarly, epidemiological studies based on inpatient or outpatient referrals tend to underestimate the prevalence of PAD in the community. One of the largest and most reliable sources of information about the overall prevalence of symptomatic and asymptomatic PAD is the Edinburgh Artery Study, which screened large random samples of the

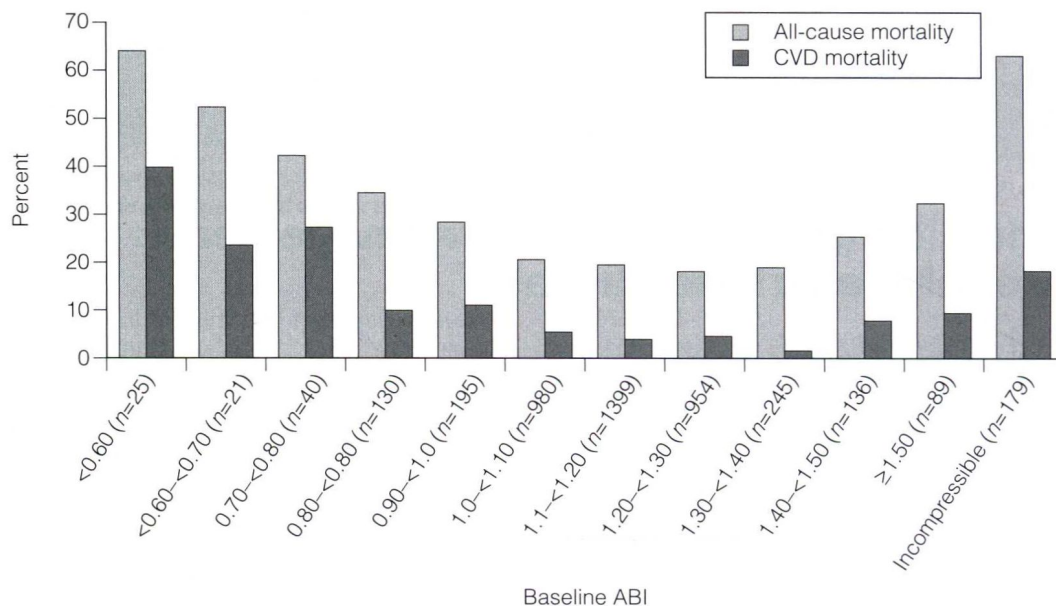


Figure 1.1 • Relationship between ABPI (ankle-brachial pressure index) and survival in patients in the Strong Heart Study.² There is a U-shaped relationship such that both low (<0.9) and high (>1.4) ABPI is associated with increased risk of CV and all-cause mortality.

general population using age/sex registers from general practices.^{3,4}

Investigative techniques for epidemiological screening

Clearly, the technique used to establish the presence or absence of PAD will also affect the results of epidemiological surveys. Questionnaires have often been used to establish the nature and severity of symptomatic PAD, e.g. the WHO/Rose questionnaire designed in 1962. The original questionnaire developed by Rose was shown to be highly sensitive but only moderately specific, and therefore in 1985 the tool was modified in a way that increased the specificity, albeit at the expense of a small decrease in sensitivity.⁵ The Edinburgh Artery Questionnaire is designed to be self-administered and has a sensitivity of 91% and a specificity of 99% for symptoms of PAD.⁶ In general, all questionnaires appear to underestimate the true prevalence of intermittent claudication and the Transatlantic Inter-Society Consensus (TASC) group recommend great caution in interpreting epidemiological studies of symptomatic PAD based solely on questionnaires.

Physical examination to establish the presence or absence of peripheral pulses has also been used in epidemiological surveys to confirm a history of intermittent claudication. However, the absence of a peripheral pulse is not necessarily due to PAD, and at least one pulse may be undetectable in up to 10%

of the adult population even though only 3% have symptomatic arterial disease.⁷

Establishing the prevalence of asymptomatic PAD in the general population is equally important. The most useful non-invasive test for this purpose is the ABPI, which is quick and painless and has excellent sensitivity and specificity. An ABPI <0.9 is 95% sensitive and 100% specific for detecting angiogram-positive disease.⁸ At the more severe end of the spectrum, most of the data on the prevalence of critical limb ischaemia has been obtained from inpatient records, and only rarely from population-based studies or using ABPI criteria.

Prevalence and incidence of PAD

Evidence from epidemiological studies using ABPI suggests that the prevalence of asymptomatic PAD in the middle-aged and elderly population is around 7–15%.^{3,9} However, in the British Regional Heart Study, direct assessment of the femoral artery with ultrasound found that 64% of people aged 56–77 years had significant femoral atherosclerosis and only 10% of these were symptomatic.¹⁰ Autopsy studies have found similar results suggesting that the true incidence of asymptomatic PAD may be much higher than previously recognised.

Population studies have varied widely in reporting the incidence of intermittent claudication. Most of these are based on questionnaire surveys and therefore prone to some degree of over-reporting. Nevertheless, it is clear that the incidence of

intermittent claudication increases steeply with age. The Scottish Heart Study, for example, found a prevalence of 1.1% in subjects aged 40–59 years;¹ in the Limburg study (subjects aged 40–79 years) the reported prevalence varied between 1.4% and 6.1%¹² depending on the criteria used and the Edinburgh Artery Study indicated a higher prevalence of 4.5%, but in a group (55–74 years) with older mean age.³

Information about the prevalence of PAD in the USA has emerged from the National Health and Nutrition Examination Survey (NHANES, 1999–2000).¹³ By analysing data from 2174 participants, Selvin and Erlinger found that, among adults aged 40 years and over, the prevalence of PAD was 4.3% (PAD was defined as ABPI <0.90 in either leg). This equates to approximately 5 million people in the USA with PAD. Among those over 70 years old, the prevalence was 14.5%¹³ (Fig. 1.2).

The incidence of critical limb ischaemia has been estimated to be around 400 cases per million population per year, which equates to a prevalence of 1 in 2500 of the population annually.¹⁴ For every 100 patients with intermittent claudication, approximately one new patient per year will develop critical ischaemia.⁸

Natural history of PAD: cardiovascular and lower limb outcomes

It is important in discussing the natural history of PAD to consider both the progression of the disease in the legs and the fate of the patient as a whole in terms of systemic cardiovascular complications.

Asymptomatic disease

The Edinburgh Artery Study is one of the few studies to have examined the pattern of progression among asymptomatic patients with abnormal

ABPIs and the rate of development of symptoms; 7–15% of subjects with asymptomatic PAD developed intermittent claudication over a 5-year period, depending on the initial severity of the disease.⁴ A more recent study from the Netherlands reported similar conversion rates, with 27 of 177 asymptomatic patients (15%) developing lower limb symptoms during a 7-year follow-up period.¹⁵

Information about longitudinal changes in ABPI, and risk factors for declining ABPI, has emerged from the Cardiovascular Health Study.¹⁶ Among 5000 patients with normal ABPI at baseline, 9.5% had a significant decrease in ABPI during 6-year follow-up. Independent predictors of ABPI decline included age (odds ratio (OR) 1.96 for the 75–84 age group and 3.79 for those >85 years), current cigarette use (OR 1.74), hypertension (OR 1.64), diabetes (OR 1.77) and raised low-density lipoprotein (LDL) cholesterol.¹⁶ Reduced ABPI has also been associated with rising serum creatinine,¹⁷ indicating that even asymptomatic PAD may affect renal outcomes.

There is good evidence that subjects with asymptomatic PAD have a much higher risk of systemic CV complications. The risk of death or disability from cardiac or cerebral events may be much higher than the risk of lower limb symptoms (claudication or acute limb ischaemia). The Edinburgh Artery Study showed that asymptomatic PAD patients have an increased risk of acute myocardial infarction and stroke; in fact, they have almost the same increased risk of CV events and death as that reported among patients with claudication.³ The reverse also applies, e.g. in men with asymptomatic carotid stenosis ABPI was the strongest predictor of stroke risk.¹⁸

Intermittent claudication

Large population follow-up studies suggest that up to 50% of patients with intermittent claudication will remain relatively stable (i.e. no deterioration in walking distance) or experience some spontaneous improvement in symptoms during a 5-year period; only 25% of claudicants will develop significant deterioration in walking distance.^{19,20} The Basle study²⁰ is typical of several observational follow-ups in showing that, although two-thirds of patients surviving at 5 years reported no limiting intermittent claudication (i.e. their symptoms had resolved), 63% actually had angiographic progression of the disease. This suggests that although PAD is pathologically progressive, other factors contribute to symptomatology, e.g. collateral vessel formation or physiological and psychological adaptation. Although one-quarter of patients with intermittent claudication have symptoms that worsen over time, only 5% deteriorate sufficiently

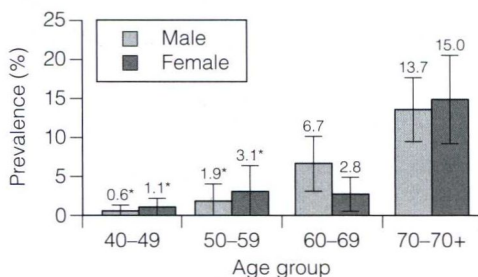


Figure 1.2 • Recent information about the prevalence of PAD from the US National Health and Nutrition Survey, confirming a steep age-related prevalence.¹³