Rabih Chaer *Editor*

# Vascular Disease in Older Adults

## A Comprehensive Clinical Guide

Springer

Rabih Chaer
Editor

# Vascular Disease in Older Adults

## A Comprehensive Clinical Guide

Springer

*Editor*
Rabih Chaer
Division of Vascular Surgery
University of Pittsburgh Medical Center
Pittsburgh, PA, USA

ISBN 978-3-319-29283-0 ISBN 978-3-319-29285-4 (eBook)
DOI 10.1007/978-3-319-29285-4

Library of Congress Control Number: 2017937369



Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Dedication

*To my children, the loves of my life, Maria the badass princess, Anthony my big boy with the biggest heart, and Michael the boss, without whom this book would have been completed a year earlier.*

*To all our frail elderly patients with vascular disease who inspired this book. You are the best! This one is for you.*

# Foreword

Vascular disease is one of the most challenging medical problems that we treat. It is not the interventions. The concepts behind these are quite simple. If a blockage is present, bypass around it or use a balloon to push it aside. Or if an artery is too large or aneurysmal, replace it or place a sleeve through its lumen. It is the judgments that make the specialty of vascular medicine and surgery challenging. And why are these judgments so difficult? For the most part, because vascular patients are elderly, frail, and plagued with comorbid conditions. I have often envied those who treat young and or middle-aged patients, for these individuals recover quickly, tolerate misadventure, and rarely have complications. Then, there is the elderly patient with vascular disease…

There have been very few attempts to create a compendium of knowledge regarding vascular disease in the elderly, and there is none that is contemporary. The need is great in that much has been learned in recent years, all essential knowledge for practitioners caring for these individuals. It is not surprising that Rabih Chaer would be the editor. Rabih is one of the nation's leading vascular surgeons with expertise and research penetration in almost every aspect of vascular disease. Rabih's work is characterized by an unparalleled level of comprehensiveness and accuracy. This is readily evident as one reads through *Vascular Disease in Older Adults*. Moreover, Rabih has recruited a superb lineup of experts; the chapters are written by individuals (with expertise in all aspects of vascular disease) who have published the definitive treatises on vascular disease in the elderly.

Over the past 20 years, treatments for vascular disease have evolved significantly. Options include no intervention, medical management, a minimally invasive alternative, or maximally invasive surgery. And not surprisingly, each of these choices is associated with advantages and disadvantages. Increasingly, we have learned that many patients with vascular disease benefit from either no intervention or medical treatment. Statins have stabilized carotid plaque, claudication will often improve on its own or the symptoms are overtaken by generalized arthritis, and small aneurysms rarely rupture. As minimally invasive interventions have evolved, this technology has become more refined, the results are improved, and they have greatly benefited our elderly patients. In terms of durability, traditional surgery for most vascular diseases remains the gold standard and in select patients it is the intervention of choice. The art of treating elderly patients with vascular disease is choosing which option should be used and when? The decisions are not easy, but when well

made, the outcome can be extremely rewarding for the practitioner and the patient alike. These choices need to be individualized: each patient has their own story and particularly in the elderly, each story is different. The patient's social circumstances, morbidity, philosophy on life, and longevity are as important as their symptoms and anatomy. Although I have suggested that treating elderly patients with vascular disease is an art, there is also available a great deal of science accompanied by data, experience, and clinical studies. We now have access to a great deal of information about who to treat, how, and when. And of course all of this science can be found within the chapters of *Vascular Disease in Older Adults*.

If elderly vascular patients compose the majority of your practice, this book is a must read. For the occasional patient with a specific problem, the chapters are concise and advice can easily be found. Dr. Chaer is to be commended for his efforts to create a textbook that, if well used, has the potential to improve the lives and outcomes of thousands of elderly patients afflicted with this devastating disease. I hope you enjoy the read!

Ohio State University K. Craig Kent

# Introduction

This textbook is intended to be a valuable resource to all medical and surgical specialties who manage elderly patients with vascular disease. Vascular surgery and vascular interventions have evolved tremendously over the last decade. The ongoing addition and refinement of surgical and minimally invasive endovascular techniques, as well as medical therapy, has made it safer for the elderly patients to get vascular care. As such, we believe it should be seldom the case nowadays to deny vascular care for the elderly patients based on chronological age. In addition, patient-centered interventions that can combine a hybrid approach of surgery, minimally invasive techniques, and medical therapy, can allow the geriatric patient to function and recover optimally even in the setting of multiple medical comorbidities.

Specific attention to the geriatric patients with vascular pathology is a must for multiple reasons. Not only can they present with more advanced vascular disease, but they can also be frail due to multiple other comorbidities. We recognize that optimization of their care starts preoperatively with coordination of care with their geriatrician, and possibly other specialties such as cardiology, pulmonary medicine, and endocrinology. In addition, obtaining a preoperative anesthesia consultation can allow the formulation of a proper anesthetic plan that can minimize side effects and complications. The perioperative care of the geriatric patients with vascular pathology can also be very intricate, as their recovery and quality of life will depend on their hospital stay, rehabilitation process, and eventual return to their social support system. To that effect, difficult ethical decisions have to be sometimes made, starting with the decision to offer care or deny it, and during recovery if the course does not go as planned.

This textbook provides a summary of different pathologies divided by vascular bed: aneurysm disease, cerebrovascular disease, peripheral vascular disease, renal failure, and venous disease. It aims at describing the pathophysiology of the disease process, as well as the decision making that goes into establishing a plan for vascular care, taking into account the extent of the pathology, the patient's frailty, and quality of life. The goals of care can therefore change and can be individualized based on the specific clinical presentation, as well as the patients' and their families' wishes.

We are proud to have rallied experts in the field to address the management of different vascular disease processes, including perioperative care, cutting-edge

state-of-the-art vascular surgical and endovascular interventions, as well as ethical decision making. This book is a collaborative effort and does bring together multiple surgical and medical specialties, which is what is needed for the optimal care of the elderly patient with vascular disease.

# Contributors

**Huiting Chen, MD** Section of Vascular Surgery, University of Michigan, Ann Arbor, MI, USA

**Rafael S. Cires-Drouet, MD** Vascular Medicine, University of Maryland Medical Center, Baltimore, MD, USA

**Anthony J. Comerota, MD, FACS, FACC** Jobst Vascular Institute, Toledo, OH, USA
University of Michigan, Ann Arbor, MI, USA

**Michael S. Conte, MD** Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

**Matthew J. Eagleton, MD** Department of Vascular Surgery, Cleveland Clinic, Cleveland, OH, USA

**Emily V. Finlayson, MD, MS** UCSF Center for Surgery in Older Adults, Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

**Daniel E. Hall, MD, MDiv, MHSc** Division of General Surgery, University of Pittsburgh, Pittsburgh, PA, USA

**Jason M. Johanning, MD, MS** Department of Surgery University of Nebraska Medical Center, Omaha VA Medical Center, The Nebraska Medical Center, Omaha, NE, USA

**Jennifer Kaplan, MD** Department of Surgery, University of California, San Francisco, San Francisco, CA, USA

**Brajesh K. Lal, MD** University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore VA Medical Center, Baltimore, MD, USA

**G. Matthew Longo, MD** Department of Surgery University of Nebraska Medical Center, Omaha VA Medical Center, The Nebraska Medical Center, Omaha, NE, USA

**Alyson Ashleigh Melin, DO** Department of Surgery, University of Nebraska Medical Center, Omaha, NE, USA

**Jon G. Quatromoni, MD** Department of Vascular Surgery, Hospital of the University of Pennsylvania, Philadelphia, PA, USA

**Bradley Reames, MD, MS** Department of Surgery, University of Michigan, Ann Arbor, MI, USA

**Shashank Saxena, MD** Department of Anesthesiology, VA Pittsburgh Health Care Center, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

**Mark L. Unruh, MD** Chair and Professor of Medicine, Department of Internal Medicine, University of New Mexico School of Medicine, Albuquerque, NM, USA

**Thomas W. Wakefield, MD** Section of Vascular Surgery, Samuel and Jean Frankel Cardiovascular Center, University of Michigan, Ann Arbor, MI, USA

**Grace J. Wang, MD** Department of Vascular Surgery, Hospital of the University of Pennsylvania, Philadelphia, PA, USA

**Max Wohlauer, MD** Division of Vascular Surgery, Froedtert & the Medical College of Wisconsin, Milwaukee, WI, USA

**Jun Xu, MD** Division of Vascular Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA, USA

**Theodore H. Yuo, MD** Assistant Professor of Surgery, Division of Vascular Surgery, Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

# Contents

# Screening for Vascular Pathology: Current Guidelines and Recommendations

1

Jon G. Quatromoni and Grace J. Wang

## 1.1 Abdominal Aortic Aneurysm

Abdominal Aortic Aneurysms (AAAs) represent a significant vascular health problem. In the United States alone, an estimated 1.5 million people have AAAs, with 200,000 more diagnosed each year, and associated with at least 15,000 annual deaths [1, 2]. AAAs account for 4–5% of sudden deaths and represent the 13th most common cause of death overall [3]. An aneurysm is defined as an abnormal focal dilation of a blood vessel where the minimum diameter exceeds 3.0 cm in any perpendicular plane; this generally accepted threshold equates to 1.5 times the normal juxta-renal diameter [4]. As aneurysms grow, the vessel wall weakens, increasing the risk of rupture. AAA rupture is a life-threatening event with a high mortality rate due to the rapidity with which exsanguination occurs, often prior to the patient arriving at a medical facility for treatment. Thus, there is a rationale for screening to diagnose AAA and institute measures to reduce the growth of the aneurysm, as well as to stratify those who may need surgical treatment.

The benefit of treating AAAs electively is significant. An 80% improvement in mortality has been ascribed to elective AAA repair compared to emergent repair of a ruptured AAA (<5% vs. 80–90%, respectively) [5]; thus, the most effective method of reducing AAA-related mortality at the present time is early identification and elective repair. However, identifying only those patients who would most benefit from elective repair while at the same time limiting over-diagnosis and over-treatment is challenging, as any systematic program would uncover many previously undiagnosed AAAs that are unlikely to rupture. Thus, clear criteria for the population eligible for screening and the clinical handling of AAAs of all sizes need to be established and rigorously maintained. Unfortunately, there is no universal set of

J.G. Quatromoni • G.J. Wang (✉)
Department of Vascular Surgery, Hospital of the University of Pennsylvania, Philadelphia, PA, USA
e-mail: Grace.Wang@uphs.upenn.edu



R. Chaer (ed.), *Vascular Disease in Older Adults*,
DOI 10.1007/978-3-319-29285-4_1

guidelines set forth by which all practitioners abide; rather, multiple partially conflicting recommendations exist which confuse what should be a unified societal approach. This section of the chapter investigates the different published screening guidelines and the evidence upon which their recommendations are made.

### 1.1.1 Overview of Screening Guidelines

Multiple societies and governmental agencies have published AAA screening guidelines (Table 1.1). The major societies', and others', guidelines have been systematically reviewed elsewhere [6]. The most significant domestic sources include the United States Preventive Services Task Force (USPSTF), the American College of Cardiology/American Heart Association (ACC/AHA), the American College of Preventive Medicine (ACPM), and the Society for Vascular Surgery (SVS). Internationally, prominent groups include the Canadian and European Societies for Vascular Surgery (CSVS and ESVS, respectively) and the UK's National Health Service (NHS). While the NHS also serves as the main health insurance payer for eligible patients in the UK, Medicare covers most of the eligible patients in the United States under a recent piece of legislation entitled the Screening Abdominal Aortic Aneurysms Very Efficiently (SAAAVE) Act, reviewed later in the chapter.

**Table 1.1** Summary of AAA screening recommendations by organization

| | Men <65 | Men 65–75 | | Women 65–75 | |
|---|---|---|---|---|---|
| | Positive risk factors | Ever-smoker | Never-smoker | Ever-smoker | Never-smoker |
| USPSTF | Not addressed | Screen once | Selectively screen based on RFs | No recommendation | Do not screen |
| ACC/AHA | Screen once after *age 60* if (+) FHx in 1° relative | Screen once | Screen once if (+) FHx in 1° relative | Do not screen | Do not screen |
| SVS | Screen once after *age 55* if (+) FHx | Screen once | Screen once | Screen once | Screen once if (+) FHx |
| ACPM | Not addressed | Screen once | Not addressed | Do not screen | Do not screen |
| NHS | Not addressed | Screen once | Screen once | Do not screen | Do not screen |
| CSVS | Do not screen | Screen once | Screen once | Screen once | Screen once if (+) multiple RFs, i.e., CardioVascular Disease (CVD) or (+) FHx |
| ESVS | Consider screening if (+) RFs | Screen once | Screen once | No recommendation | Maybe screen with a (+) FHx |

*FHx* family history, *N/A* not available, *RFs* risk factors

While differences in self-interests and audience exist between these bodies, the recommendations are generally concordant regarding populations for which strong supporting data exists [6]. The guidelines with the most influence in the United States are those of the USPSTF [7], which recommend one-time screening for AAA by ultrasonography in men aged 65–75 years who have ever smoked. It makes no definitive recommendation for or against screening in men aged 65–75 years who have never smoked, but endorses selective screening based on individual patient risk factors including their past medical and family history. It recommends against the routine screening for AAA in women who have never smoked and repeat screening in men who have had a negative ultrasound. Lastly, it makes no definitive statement regarding routine screening in women aged 65–75 years who have ever smoked because of "insufficient evidence" [7]. This current USPSTF recommendation on screening in the female population is an update from the 2005 guidelines, in which the USPSTF recommended against screening in all women regardless of smoking history [7]. The ACPM and the ACC/AHA agree with the USPSTF's screening recommendation for men aged 65–75 who have ever smoked [4, 8]. However, the ACC/AHA deviate from the USPSTF guidelines by including a recommendation for screening in men over the age of 60 who have a family history of AAA in a first-degree relative [4]. Furthermore, neither group recommends screening in never-smoker men without a family history and in women altogether.

The original ACC/AHA guidelines were published in conjunction with the SVS; however, the SVS issued updated guidelines in 2009 that increased the pool of eligible recipients [9]. First, it recommended screening for all men older than 65, regardless of smoking history. Second, it recommended earlier screening at age 55 with a positive family history. Lastly, it definitively addressed the issue of screening in the female population with a recommendation in direct opposition to the USPSTF and ACC/AHA. While data from numerous sources suggests that the prevalence of AAAs in women is lower [10, 11], the SVS recommended screening for women older than 65 who have ever smoked or have a positive family history, with the rationale that women have both higher rates of rupture and longer expected lifespans [9, 11–15].

Internationally, the NHS recommends a screening ultrasound for all men at the age of 65, regardless of smoking history [16]. In fact, the NHS recently launched a screening program with the goal of reducing deaths from ruptured AAAs in men over 65 by 50%. It recommends against the screening of women, stating that "screening is inefficient" for this population. The CSVS and the ESVS largely agree with the SVS's recommendations [17, 18]. Both these organizations support screening in all men aged 65–75, but they both have slightly different recommendations regarding women and men aged 55–65. The CSVS, in individualized cases, recommends screening for women over the age of 65 who have multiple risk factors; furthermore, it recommends against screening in men under the age of 65 regardless of risk factors. The ESVS agrees with the SVS on screening in the slightly younger male population with risk factors; however, it does not make a definitive statement about screening in women, stating that "screening in women who smoke may require further investigation" and screening of older women having a family history of AAA "might be recommended".

### 1.1.2 Risk Factors for AAA

The most widely accepted risk factors that have been cited for AAA include male sex, older age, and smoking [19]. Population-based studies in adults older than 50 have consistently reported a higher prevalence of AAAs in men versus women. A recent study reported prevalence of 3.9–7.2% in men and 1.0–1.3% in women [19]. Most AAAs found in the population occurred in individuals over the age of 60, with a total prevalence of 4–9% [20, 21]. One cohort study demonstrated a 4.5-fold increase in the relative risk of AAA for males over 65 compared to those under 55 [22]. However, the majority of these aneurysms were small, with diameters less than 3.5 cm, and likely not clinically important during the patients' lifetime. More clinically important aneurysms over 4.0 cm exist in 1% of men between 55 and 64 years old, with incremental increases by 2–4% per decade thereafter [23]. Smoking is the most important risk factor , estimated to cause 75% of all AAAs over 4.0 cm and increasing risk of AAA by a factor of six [20, 24]. Other risk factors include positive family history, prior AAA, Caucasian or Native American ethnicity, cardiovascular disease, Hypertension (HTN), obesity, and aneurysms of the femoral or popliteal arteries [20, 22, 25, 26].

### 1.1.3 Natural History and Rationale for Screening for AAA

The natural history of AAAs is important to consider when establishing screening guidelines, as the risk for rupture and the expansion help determine surgical and surveillance planning. By projecting AAA growth curves, it is possible to estimate when the rupture risk is high and to intervene beforehand, as the case-fatality rate is 50% when surgery is performed emergently on the 40% of patients who even make it to the hospital [5, 27]. In contrast, the perioperative mortality from elective repair is reported to be 1–5%, and is largely dependent on patient comorbidities and the type of repair [3]. Fortunately, men without AAA by age 65 are unlikely (only about ~1%) to develop a new aneurysm over the course of the subsequent 5 years [28]. When aneurysms develop, however, larger aneurysms tend to grow faster than smaller aneurysms due to the increase in wall tension according to LaPlace's law. According to one systematic review, for each 0.5 cm increase in AAA diameter, growth rates increased on average by 0.59 mm per year and rupture rates by a factor of 1.91 [29]. Aneurysms less than 4.0 cm in transverse diameter have a very low (~0%) annual risk of rupture, with an exponential increase in risk thereafter: 4.0–4.9 cm (0.5–5%), 5–5.9 cm (3–15%), 6–6.9 cm (10–20%), 7–7.9 cm (20–40%), and greater than 8 cm (30–50%) [30]. Extending this risk out to 5 years, the overall cumulative rupture rate of incidentally diagnosed aneurysms in population-based samples is 25–40% for aneurysms larger than 5.0 cm compared to 1–7% for aneurysms 4–5 cm [31–33].

### 1.1.4 Screening Imaging Modalities

Before imaging tests were developed, AAA screening was based on physical exam. However, accuracy of physical exam is limited by patient factors such as obesity and smaller aneurysm size [34]. Clinical studies have confirmed the poor reproducibility of physical exam, with sensitivity and specificity estimated at 39–68% and 75–91% [7, 19]. Aside from exposing patients to ionizing radiation, computed tomography (CT) can over-estimate aneurysm size by 2 mm or more because the cross sectional diameter of the aorta obtained in axial CT imaging is often not in the transverse plane [9]. While CT is more reproducible and remains the primary modality for operative planning, ultrasound has become the primary method for AAA screening because of its high sensitivity and specificity, portability, ease-of-use, safety (i.e., lack of radiation), and relative low cost [7]. While somewhat user-dependent, the sensitivity and specificity of ultrasound both approach 100%. Thus, given these advantages, ultrasound remains the primary method for AAA screening.

### 1.1.5 Clinical Trials and Longitudinal Studies on Screening for AAA

Four large randomized controlled trials (RCTs) have been conducted to evaluate the effectiveness of population-based screening for AAAs using ultrasound: the Multicentre Aneurysm Screening Study (MASS), the Chichester, UK screening trial, the Viborg County, Denmark screening trial, and the Western Australia screening trial [35–38]. Multiple summative attempts have been made to combine these data sets, including a meta-analysis and two systematic reviews [19, 39, 40]. As these trials represent the highest-quality evidence in the literature, their cumulative data serves as the basis for all the major societal guidelines presented above. Overall, these trials showed that invitation to one-time screening for AAA is associated with a reduction in AAA-specific mortality in 65–75-year-old men. Follow-up reports for these trials have shown that this effect is both persistent, lasting up to 15 years [7, 41–44], and significant, with estimated relative reductions of 42% and 66% at 13 years in the two highest-quality trials [41, 44]. Other beneficial effects, including reductions in risk for AAA rupture and emergency surgery, persisted up to 13 years out from screening as well [7]. While these trials did not collect specific data about participants' smoking histories or other risk factors, given the increased AAA prevalence in men who have ever smoked (6–7% of this population [24, 45]), the presence of this risk factor increases the benefit of screening in this population. The data for screening in other populations, including women, is less definitive [7].

Together, the four large population-based screening RCTs accumulated 137,214 participants with mean (or median) ages ranging from 67.7 to 72.7 years [7]. In each trial, participants were selected from population registries or regional health directories and randomized to either invitation for one-time ultrasound screening or usual care. The MASS trial, the largest of the four, randomized 67,800 men aged 65–74.

This was the only trial that excluded participants based on health status; men that were too high risk to be screened by their primary care physicians, terminally ill, or had other serious health problems were excluded. Men with 3–4.4 cm aneurysms were followed with annual ultrasounds while those with 4.5–5.4 cm aneurysms were rescanned every 3 months. Surgery was offered to men with aneurysms greater than 5.5 cm, growth greater than 1 cm per year, or development of symptoms. Mean follow-up was 4.1 years in the original study but long-term data out to 13 years continues to be published [41, 42]. The Viborg trial included 12,658 men aged 65–73 years old. Participants with aneurysms above 3.0 cm were offered annual rescreening while those with aneurysms greater than 5.0 cm were offered surgery. While mean follow-up in the original study was 5.1 years, a subsequent report detailing results out to 10 years was published thereafter [44]. The Chichester trial was the only trial to include women, with a total of 15,775 randomized participants (6433 men, 9342 women), aged 65–80 years. Subjects with 3–4.4 cm aneurysms were followed with annual ultrasound, while those with 4.5–5.9 cm aneurysms were rescanned every 3 months. Surgery was offered to participants with aneurysms greater than 5.9 cm, growth greater than 1 cm per year, or development of symptoms. Lastly, the Western Australia trial involved 41,000 men aged 65–83 years. The structure of this study was unique in that it did not specify its post-screening ultrasound surveillance protocol. Men were provided with two copies of a letter detailing the outcome of their ultrasound: one for them and one for their primary care doctor. Follow-up care, whether rescreening or surgical referral, was left up to the discretion of the primary care doctor as they deemed appropriate. Median follow-up was 43 months.

In general, the statistical analysis plans and outcome variables among the trials were similar. All four trials were conducted via intention-to-treat analysis. Adherence to screening varied from 62.5% in the Western Australia trial, to 80.2% in the MASS trial. Less than 1% of the control groups crossed over in any trial to receive elective surgery, even at the longest follow-up of 13–15 years [19]. The primary outcome variable was AAA-specific mortality (all deaths related to AAAs and all deaths within 30 days of AAA surgical repair), but AAA rupture and all-cause mortality were also reported. In a recent systematic review that evaluated each trial according to USPSTF design-specific criteria [46], the MASS and Viborg trials were rated as "good-quality", while the Chichester and Western Australia studies were labeled as "fair-quality" [19].

The prevalence of AAAs across the four trials ranged from 4.0% to 7.6%, with the majority (70–82%) less than 4.0–4.5 cm, and only a small proportion (0.4–0.6%) greater than 5.5 cm. The two "good-quality" trials, MASS and Viborg, demonstrated statistically significant reductions in AAA-related mortality in the groups invited to screening compared with the control groups, up to 13 years after screening (13-year hazard ratio [HR], 0.58 [CI, 0.49–0.69] and 0.34 [CI, 0.20–0.57], respectively) [35, 36, 41, 42, 44, 47]. For the MASS trial, this was associated with an absolute risk reduction of 0.14%, or 1.4 fewer AAA-related deaths per 1000 men screened [7, 41]. Not surprisingly, these two trials also found that an invitation to screening was associated with both lower AAA rupture rates at the 13-year