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REVIEW

Systematic Review of the Growth Rates and Influencing Factors in Thoracic Aortic Aneurysms

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WHAT THIS PAPER ADDS

Growth rates of thoracic aortic aneurysms are poorly understood. This review identifies an overall mean growth rate of 0.2—4.2 mm/year. Large presenting diameter, distal aneurysm location, and history of bicuspid aortic valve or Marfan's syndrome were also identified as risk factors for accelerated aneurysm growth. Most importantly, the review confirms a dearth of research on the expansion of thoracic aortic aneurysms and highlights the need for high-quality studies to guide clinical decision-making.

Objective/Background: The growth rates of thoracic aortic aneurysms (TAAs) and factors influencing their expansion are poorly understood. This study aimed to review systematically published literature describing TAA expansion and examine factors that may be associated with this.
Methods: A comprehensive search of MEDLINE and Embase databases was performed until 30 April 2015. Studies describing rates of TAA growth were identified and systematically reviewed. Outcomes of interest were TAA growth rates and associated factors. Study quality was assessed using Scottish Intercollegiate Guidelines Network quality checklists for cohort studies.
Results: Eleven publications, involving 1383 patients, met the eligibility criteria and were included in the review. Included studies were generally low in quality. Aneurysm measurement and growth-rate estimation techniques were inconsistently reported. Mean growth rates for all TAAs ranged from 0.2 to 4.2 mm/year. Mean growth rates for ascending and aortic arch aneurysms ranged from 0.2 to 2.8 mm/year, while those for descending and thoracoabdominal aneurysms ranged from 1.9 to 3.4 mm/year in studies reporting according to anatomical location. Large aneurysm size, distal aneurysm locations, presence of Marfan's syndrome, and bicuspid aortic valve were consistently associated with accelerated TAA growth. Presence of chronic dissection and chronic obstructive pulmonary disorder were also implicated as risk factors for faster TAA growth. Associations between medical comorbidity and aneurysm expansion were conflicting. Previous aortic surgery and anticoagulants were reported to have a protective effect on aneurysm growth in two studies.
Conclusion: There is a shortfall in the understanding of TAA expansion rates. Existing studies are heterogeneous in methodology and reported outcomes. Identified unifying themes suggest that TAAs grow at a slow rate with large presenting diameter, distal aneurysm, and history of bicuspid aortic valve or Marfan's syndrome serving as main risk factors for accelerated aneurysm growth. High-quality studies with a standardised approach to TAA growth assessment are required.

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INTRODUCTION

Thoracic aortic aneurysms (TAAs) are one of the most dangerous pathologies of the aorta, and, if left without treatment, rupture can ensue, which may be fatal. An estimated incidence of 10.4 per 100,000 patient years has been reported in an American population study,[1] while a

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TAA hospital admission rate of 9.0 per 100,000 was reported in a similar British study.[2] Although the incidence of TAA is apparently increasing, the majority of TAAs remain unidentified or misdiagnosed owing to the silent nature of the disease and the lack of a screening programme.[3]

Untreated, the rate of serious aneurysm-related complications increases from approximately 10% at 60 mm maximum diameter to 43% at 70 mm.[4–7] Decision-making regarding management and timing of intervention therefore relies on adequate understanding of the growth rate of TAAs balanced against the risk posed by operative repair.[8] While open surgical repair remains the mainstay of TAA management in many centres, minimally invasive endovascular techniques have reduced surgical morbidity and mortality rates and expanded the population that can be offered repair.[9,10] Conservative management may be favoured in some patients who are at high risk of surgical complications, especially if they are considered to be at low risk of rupture.

Uncertainties regarding the natural evolution of TAAs mean decisions regarding the timing of surveillance and subsequent intervention do not have a strong evidential basis. This review aims to identify systematically and analyse existing studies investigating the growth rates of TAAs. Where available, factors influencing aneurysm growth rates are also reviewed.

MATERIALS AND METHODS

Study selection

Selection of studies was performed in conformity with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards.[11] A comprehensive search of the MEDLINE and Embase (1974—April 2015) databases was performed using various combinations of medical subject headings terms “thoracic”, “thoracoabdominal”, “growth”, “dilation”, “expansion”, “aorta”, and “aneurysm”, with Boolean operators “AND” or “OR” without filters. A search of clinicaltrials.gov and controlled-trials.com was also performed until end of April 2015. The references of identified studies were searched and further eligible studies were retrieved for inclusion. Studies were included if they investigated the growth rate of nonoperated TAAs. Other aneurysm-related studies that recorded the growth rates of TAAs within their outcomes were also included. All studies investigating acute aortic dissections or abdominal aortic aneurysms (AAAs) and those that did not report TAA growth rates data were excluded. In cases where patient data were duplicated, the most recent or most comprehensive publications were selected for inclusion. Abstracts of potential studies were reviewed by two independent authors (D.O. and B.O.P.) to determine eligibility for inclusion.

Definitions

For the purpose of this review, TAA was defined as dilatation of the thoracic or thoracoabdominal aorta to $\geq$3.5 cm, or thoracic/thoracoabdominal aorta diameter double that of adjacent normal aorta. This definition was also adopted in included studies. Statistical significance was defined as $p < .05$.

Data collection and analyses

Data collection was performed using a predesigned proforma. Data relating to patient demographics, study design, imaging techniques, scanning intervals, follow-up period, aneurysm sizes, growth rates, growth-rate estimation, risk factor for aneurysm growth, and overall TAA management were extracted and analysed for the purpose of the systematic review. All studies were read and assessed for quality by two independent authors (D.O. and B.O.P.). Quality assessment was performed using the Scottish Intercollegiate Guidelines Network tool for assessment of methodological quality (checklist for cohort studies).[12] Discrepancies were resolved through discussion and achievement of consensus.

RESULTS

Search results and study characteristics

In total, 1881 studies were retrieved via the literature search. This were reduced to 670 following elimination of review articles or duplicates, and to 52 after abstract screening. Eleven studies met the inclusion criteria and were included in the systematic review.[5,13–22] Fig. 1 shows the PRISMA diagram for the review. All included publications were observational studies. There were three prospective[17,19,22] and eight retrospective analyses studies,[5,13–16,18,20,21] involving a total of 1383 patients with TAAs followed up with serial imaging.[5,13–22] Owing to retrospective and single cohort study designs, the majority of the included studies were of low quality (Table 1).

Approximately 28% of all patients studied were female, although three studies did not report sex for the patient subgroups included in their analyses. The median age of studied patients was 65 years (range 48—72 years) and the median follow-up period was 34 months (range 17.5—47.0 years). The types of TAA studied by the included publications were highly varied. Three publications studied all cases of dilating thoracic aortopathies, including chronic dissections,[13,15,22] while the remaining eight excluded aortic dissections. Three publications focused on TAAs of specific anatomical origins, that is, ascending aorta only,[17] thoracoabdominal aneurysms only,[14] and descending/thoracoabdominal aortic aneurysms.[19] All other studies included TAAs of all anatomical origin.

Aneurysm measurement techniques

Eight studies utilised computed tomography (CT) scans only for aneurysm surveillance,[14,15,17–22] one used CT and magnetic resonance imaging (MRI),[13] while another used a combination of MRI, CT, and echocardiograms (ECGs).[5] One study utilised ECGs alone for aneurysm assessment, but this study was limited to the investigation of ascending aortic aneurysms only.[16]

The majority of included studies made two-dimensional measurements of maximal aortic diameter in either anteroposterior or transverse dimensions via a calliper method. Three studies utilised aneurysm outline tracing