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Systematic Review and Meta-analysis of 12 Years of Endovascular Abdominal Aortic Aneurysm Repair

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Background. *Endovascular repair (ER) of abdominal aortic aneurysm (AAA) is a new technique, and reported rates of endoleak, conversion to open repair, rupture and mortality vary widely. The aim of this study was to estimate these rates from the published data, and examine how this has changed as more patients have undergone ER.*
Methods. *A systematic review and meta-analysis of publications identified through searches of the electronic databases EMBASE and Medline. All publications quoting endoleak, conversion to open repair, rupture and mortality rates for a series of patients undergoing ER were included.*
Results. *163 studies pertaining to 28,862 patients undergoing ER were identified as relevant for the review and meta-analysis. The pooled estimate for operative mortality was 3.3% (95% confidence interval 2.9 to 3.6%). The pooled estimate for type 1 endoleaks was 10.5% (95% confidence interval 9.0 to 12.1%), with an annual rate of 8.4% (95% confidence interval 5.7% to 12.2%). The pooled estimate of type 2,3 and 4 endoleaks was 13.7% (95% confidence interval 12.3 to15.3%), with an annual rate of 10.2% (95% confidence interval 7.4% to 14.1%). The pooled estimate for primary conversion to open repair was 3.8% (95% confidence interval 3.2 to 4.4%), and for secondary conversion to open repair 3.4% (95% confidence interval 2.8 to 4.2%). The pooled estimate for post-operative rupture was 1.3% (95% confidence interval 1.1 to 1.7%), with an annual rupture rate of 0.6% (95% confidence interval 0.5% to 0.8%). Multivariate meta-regression analysis showed that rates of operative mortality, post-operative rupture and total number of endoleaks all fell significantly* ($p < 0.05$) *over time.*
Conclusions. *This study demonstrates a low mortality and a gradual reduction in vascular morbidity and mortality associated with endovascular repair since it was first introduced.*

Keywords: Abdominal aortic aneurysm (AAA); Endovascular repair; Meta-analysis.

Background

Open surgical repair (OR) is currently the definitive treatment for abdominal aortic aneurysm (AAA). Endoaneurysmorraphy with a prosthetic graft was first described in the literature in 1966,[1] and the basic surgical technique has not changed significantly since then. The mortality rate from elective aneurysm repair is widely reported to be just below 5%,[2] and this has changed little despite advances in critical care. Approximately 2/3rds of these deaths are the result of cardiac morbidity,[3] and the need to reduce the physiological insult caused by clamping the aorta has driven surgeons to find a less dangerous way to repair aortic aneurysms.

Parodi first published his report on minimally invasive aneurysm surgery in 1991.[4] Initial results were encouraging, and endovascular repair (ER) has since been employed by many centres worldwide. This approach is a much less invasive procedure than OR, and can be successfully performed under general, regional or local anaesthesia.[5]

This technique is the first major advance in vascular surgery since 1966. In the UK over 30 centres took part in the EVAR Trials 1 and 2. These were randomised controlled trials which assessed ER compared with OR in patients fit for both types of surgery (EVAR 1) and ER compared to best medical treatment in patients who are unfit for OR (EVAR 2). The EVAR trialists have recently published the results of 4 years of follow-up of ER patients, which have proved that the 3% survival advantage conferred by ER at 30

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days is sustained over 4 years in patients who are fit for OR,[6] but in those who are unfit for OR, ER does not improve survival.[7]

Meanwhile, many centres performing ER have published data from case series or case-control series. The majority of these papers report results from single centre experience of small numbers of patients with asymptomatic infrarenal AAA.

The aim of this study was to estimate the operative mortality, endoleak rate and rate of post-operative AAA rupture, and quantify how these outcome measures have changed over time, in patients undergoing ER. We performed a systematic review, meta-analysis and meta-regression of the relevant literature. This article was prepared according to previously published guidelines for reporting meta-analyses[8] with some necessary modifications relating to the specific nature of synthesis of case series data.

Methods

Search strategy

The lead author (SCF) performed the literature search, using the Ovid search engine (Version 19.2; Ovid Technologies Inc NY USA). Both the Medline (January 1966 to August 2003) and EMBASE databases (January 1980 to August 2003) were searched. The following search strategies were used on both databases:

1. Exp Aortic Aneurysm, Abdominal (textword) *and* exp Stents (textword)
2. Endovascular Surgery (textword) mp *and* exp Aortic Aneurysm, Abdominal (textword)
3. Exp Aortic Aneurysm, Abdominal (textword) *and* Stent Grafts mp
4. Exp Stents *and* Abdominal Aortic Aneurysm (textword) mp
5. Endovascular Surgery (textword) mp *and* Abdominal Aortic Aneurysm (textword) mp
6. Stent Grafts (textword) mp *and* Abdominal Aortic Aneurysm (textword) mp
7. Medline search strategy to identify randomised controlled trials from the guidelines of the NHS centre for reviews and dissemination.[9]

(Where exp indicates a term explosion − i.e. all sub categorisations are included in the search, and mp indicates a multipurpose search).

The search was limited to studies that were in English and human.

The above searches located studies with and without an abstract available on the database queried. At this stage, all available abstracts were searched to establish the relevance of each study and all potentially relevant papers obtained. Those articles remaining that did not have available abstracts were also retrieved in full. Any articles that were not available from the University of Leicester libraries were obtained from the British Library.

Inclusion/Exclusion criteria

All articles included in this study were case series of a minimum of 5 patients who had undergone ER and provided data for either mortality or endoleak rates. Only those studies published in the English language were included. Articles were rejected if they were review articles or letters, if the studies did not include morbidity or mortality data of a case series of patients, if the subjects in the study were not human, or if the subjects did not have degenerative infrarenal AAA. If the subjects of a study were emergency cases only, the study was excluded from the analysis. Some studies reported data on both elective and emergency cases together. Where possible, emergency cases were removed from the analysis, but if the data sets were amalgamated it was felt better to include the data on ruptured AAA as numbers were low and exclusion of these studies would have lead to loss of valuable outcome data to the meta-analysis. Some studies had to be excluded because the subjects did not undergo ER. Studies were excluded if there was a duplication of data. We used the study centre, mid-timepoint of the study and size of the study cohort to identify duplicated results.

Data extraction

The lead author (SCF) extracted all data. For all studies included, the total number of patients and the mid-timepoint of the study were recorded. When the mid-time point of the study was not given, it was derived from the publication date and length of follow-up (when available). When given, data on mortality, morbidity, endoleak and conversion to open repair were also recorded. Where data were given as a percentage, actual numbers were calculated, and the definitions used for mortality (''30-day'', ''in-hospital'' or ''peri-operative'') and endoleaks (''proximal'', ''distal'', ''middle'', ''type I'', ''type II'' or ''type III'') used by each study were also recorded. When given, endoleak rates were also recorded according to the time they were diagnosed during the post-operative period (''immediate'', ''discharge'', ''1 month'' or ''late''). The number of ER patients who underwent primary (at the time of the initial operation) or secondary (at