Annals of Surgery and Perioperative Care

Open Access

Austin Publishing Group

Research Article

Systematic Review of Open Versus Endovascular Repair of Thoracoabdominal Aneurysms

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Received: October 19, 2016; **Accepted:** November 14, 2016; **Published:** November 16, 2016

Abstract

Thoracoabdominal aneurysm (TAAA) is an aneurysmal dilatation of the descending thoracic and abdominal aorta. Given the high mortality and morbidity associated with open repair of TAAA a thoracic endovascular aortic aneurysm repair (TEVAR) has been proposed. We performed a systematic review of existing studies on open repair vs TEVAR between 2000-14 with regards to mortality and neurological complications. Eleven studies were reviewed with a total of 1,713 and 317 patients for the open and TEVAR group, respectively. Our results demonstrate (open vs TEVAR): overall 30-day mortality of 7.8% vs 7.0% and spinal cord ischemia (SCI) of 4% vs 10.4%. The TEVAR group included older and unfit patients with more comorbidities. Only one study in the open group reported a stroke rate of 3.2%. Overall stroke rate for the TEVAR group was 1%. Mortality and SCI rates were not different between two groups. While endovascular repair of TAAA has acceptable short-term outcomes, open repair is not obsolete and should be offered to younger, relatively fit patients.

Keywords: Aneurysmal Dilatation; Thoracic Endovascular Aortic Aneurysm Repair; Spinal Cord Ischemia

Introduction

Thoracoabdominal aortic aneurysm (TAAA) is a dilatation of the descending thoracic and abdominal aorta 1.5 times its normal diameter [1]. TAAA are relatively uncommon. TAAA have high mortality and morbidity compared to infrarenal abdominal aortic aneurysms (AAA). The natural history of unrepaired TAAA is progressive with 52% and 17% two- and five-year survival rates, respectively [2]. The most common cause of mortality is cardiopulmonary failure in both unrepaired and surgically corrected patients with TAAA [2]. Mortality varies between 6-48% and is higher after emergency open repair [3]. Spinal cord ischemia (SCI) and stroke rates have been reported between 3-16% and 3-7%, respectively, after open repair of TAAA [4,5]. Given high mortality and morbidity associated with TAAA repair an endovascular approach has been proposed in an attempt to counterbalance complications [6]. In the absence of Level I data comparing outcomes of these two treatment methods we sought to perform a systematic review of existing studies on open and endovascular repair of TAAA with regards to mortality and neurological complications.

Methods and Search Strategy

Extensive search of Medline and EMBASE databases published between 2000-2014 was conducted for studies reporting 30-day mortality, spinal cord ischemia and/or stroke rates in patients who underwent OR and TEVAR. A manual evaluation and extraction of references from primary papers was also performed. Studies published in different journals by the same authors that involved the same study population were carefully evaluated and only one of them was included.

The search was conducted by two independent authors. Additional articles were retrieved by carefully examining references at the end of the articles. All articles published in English between 2000-14 that reported results of endovascular and/or open repair of TAAA were included. Since all studies included patients with both atherosclerotic/degenerative and connective tissue disorder-related aneurysms, both groups were included. Emergency procedures and studies focusing exclusively on redo operations were excluded. Only studies that reported separate outcomes for elective and emergent cases were included. In such cases, patient demographics were accepted for the overall study sample, unless it was reported separately for the elective and emergent groups. If a study included ruptured TAAA, descending thoracic aortic aneurysm (DTAA) or patients with a history of TAAA repair, outcomes were recalculated whenever possible, excluding those patients. Hybrid procedures combining open debranching of renal and mesenteric vessels with endovascular endograft insertion were also excluded from this review. The date of last search was May 30, 2015.

All articles that reported the outcomes of the following research questions were reviewed independently by two authors:

1. What are the 30-day mortality and SCI rates after open TAAA repair?
2. What are the 30-day mortality and SCI rates after TEVAR?

Disagreements about the inclusion/exclusion of a given article were reviewed carefully based on criteria employed for this systematic review and resolved via consensus. Table 1 presents inclusion criteria for this review.

Statistical Analysis

Mortality and SCI rates were calculated using frequencies provided from retrieved studies. Rates were calculated as the number of events divided by a total sample size. If the exact number of events

Citation: Andres RD and Huseynova K. Systematic Review of Open Versus Endovascular Repair of Thoracoabdominal Aneurysms. Ann Surg Perioper Care. 2016; 1(2): 1010.

Table 1: Inclusion criteria for systematic review.

Inclusion criteria	*Exclusion criteria*
Demographics (age, gender, comorbidities) are clearly described	Concomitant ascending aortic or arch surgery
30-daymortality reported after elective TAAA repair	N<10
At least one of the two clinical complications of interest is reported (SCI, stroke)	Hybrid repair
Thoracoabdominal aneurysms (degenerative, connective tissue disorders-related)	Ruptured/symptomatic aneurysms requiring emergent/urgent surgery, the results of which are combined with elective repair results
English language	
Publication year 2000-2014	

Table 2: Baseline demographic characteristics of patients in studies included in the systematic review.

First author	Study period	Number of patients with elective TAAA repair	Study design	Inclusion criteria	Comorbidities	CSF drain	Anesthesia	Mean follow up in months
OPEN REPAIR								
Lombardi	1993-2003	279	Retrospective	With and without prior TAAA/ AAA repair	COPD Smoking MI CRF	Selective	General	NR
Rectenwald	1993-1999	58	Retrospective	NR	HTN Smoking CAD Prior vascular surgery	All	General	12
Coselli	1986-1998	1,108	Retrospective	NR	HTN CAD COPD RAOD	Selective	General	NR
Sundt	2001-2010	32	Retrospective	Elective and urgent DTAA and TAAA	HTN COPD CAD Prior cardiovascular surgery	NR	General	NR
Greenberg (open repair results)	2001-2006	236	Retrospective cohort	Elective DTAA and TAAA with/ without ascending aortic/arch involvement	Smoking CAD COPD CRF	Selective	NR	NR
TEVAR/ f(b)EVAR								
Ferreira	2006-2008	11	Prospective	Unfit for open repair	COPD CAD HTN	All	General	8
Verhoeven	2009	30	Retrospective	Unfit for open repair	Smoking HTN	Selective	Mostly general	12
Greenberg (TEVAR results)	2001-2006	189	Retrospective cohort	Elective DTAA and TAAA with/ without ascending aortic/arch involvement; Older or unfit patients	Smoking CAD COPD CRF	Selective	NR	NR
Clough	2008-2011	31	Retrospective cohort	Elective, high risk for open surgery	HTN CAD Arrhythmias COPD CRF DM	All	General Epidural Local	12
Jamieson	2009-2012	10	Retrospective cohort	Elective	NR	Selective (1patient)	General	14
Bisdas	2010-2013	46	Retrospective cohort	Elective	HTN Smoking CAD COPD DM	Selective	General	6

DTAA: Descending Thoracic Aortic Aneurysm; TAAA: Thoracoabdominal Aortic Aneurysm; NR: Not Reported; CAD: Coronary Artery Disease; COPD: Chronic Obstructive Pulmonary Disease; CRF: Chronic Renal Failure; HTN: Hypertension; MI: Myocardial Infarction; RAOD: Renal Artery Occlusive Disease; DM: Diabetes; f(b) EVAR: Fenestrated or Branched Graft Endovascular Aneurysm Repair.

was not given, the numbers were obtained through back calculation using the provided percentage (or rate) and the total sample size. A t test was used to obtain pooled comparisons between groups for continuous variables. SAS 9.3 package was used for statistical analysis (SAS Institute Inc. Carry, NC).

Results

Our systematic search of literature revealed a total of 328 study titles. After deduplication, 120 titles remained. Of these, 40 abstracts reported mortality rates (of which, 24 abstracts met inclusion criteria); 16 abstracts reported stroke rates (6 of which met inclusion criteria); and 25 abstracts reported SCI rates, 17 met inclusion criteria. After retrieving full texts of abstracts and checking them against our inclusion/exclusion criteria, 10 studies were included in the current review. Table 2 outlines studies included in the current review. All studies used different design and methodology. In addition, there was significant heterogeneity within the OR and TEVAR groups.

Open Repair

Tables 2 and 3 provide information about patient characteristics, intraoperative details and perioperative complications for both groups.

There were a total of 1,713 patients in the OR group across 5 retrospective studies [7-11]. The most common type of TAAA was Crawford type I (29%). Fifty percent of the overall patients had prior aortic surgery. The mean age was 65 (median: 66). Sixty percent of patients were male. The most common indication for repair was presence of a TAAA in a relatively fit patient.

No study reported postoperative mesenteric ischemia, sac enlargement or visceral branch occlusion rates. Re-intervention rate was between 6-9% [7,10,11]. The overall mortality rate was 7.8%. The overall SCI rate was 4%. Only one study reported a stroke rate of 3.2% [10].

TEVAR

There were a total of 317 patients in the TEVAR group (Table 3) [11-16]. The most common type of TAAA was Crawford type III (53%). Overall, 35.7% patients had prior aortic surgery. The mean age was 72 (median 72). Seventy one percent of patients were male. The most common reason for repair was a prohibitively high risk for open surgery.

All studies used custom-made branched grafts. The number of treated branches varied between 1-4 [12,14,15]. Preoperative paraplegia rate was not available. Re-intervention rate was between 0-7%.Overall stroke rate was 1%. Overall mortality rate was 7% and the SCI rate was 10.4%.

There was no statistically significant difference in mortality (p=0.13) and SCI rates (p=0.32) between open repair and TEVAR groups.

Discussion

The TEVAR group included older and unfit patients. The incidence of SCI was high in the TEVAR group but the difference was not statistically significant. 30-day mortality rates were similar after TEVAR and OR. This could be related to centralization of TAAA cases in high-volume centers with better infrastructure for treating such patients and improved reperfusion techniques to prevent SCI. Studies published by these centers demonstrate it as well [17]. In addition, only elective cases were included in this review.

Several studies have shown that Type II TAAA extending from the left subclavian artery to the aortic bifurcation is associated with higher rates of SCI [17,18]. In our systematic review Type II TAAA

Table 3: Reported mortality and spinal cord ischemia (SCI) rates for open repair and TEVAR.

Study	Study period	Number of patients with elective TAAA repair	Deaths N (%)	SCI N (%)	Stroke N (%)
OPEN REPAIR					
Lombardi	1993-2003	279	31 (11)	8 (3.0)	NR
Rectenwald	1993-1999	58	6 (10.0)	6 (10.0)	NR
Coselli	1986-1998	1,108	70 (6.3)	40 (3.6)	NR
Sundt	2001-2010	32	3 (9.4)	0	1 (3.2)
Greenberg (open repair results)	2001-2006	236	23 (9.7)	14 (11.4)	NR
Total		***1,713***	***133 (7.8)***	***68 (4.0)***	*****
TEVAR/f(b)EVAR					
Ferreira	2006-2008	11	2 (18.2)	3 (27.3)	1(9.0)
Verhoeven	2009	30	2 (6.7)	5 (16.7)	0
Greenberg (TEVAR results)	2001-2006	189	12 (6.0)	14 (7.4)	NR
Clough	2008-2011	31	3 (9.7)	3 (9.7)	1 (3.2)
Jamieson	2009-2012	10	1 (10.0)	3 (30.0)	1 (10.0)
Bisdas	2010-2013	46	2 (4.3)	5 (10.9)	NR
Total		***317***	***22 (7.0)***	***33 (10.4)***	***3 (1.0)***

NR: Not Reported
SCI: Spinal Cord Ischemia
f(b) EVAR: Fenestrated or Branched Graft Endovascular Aneurysm Repair
*Overall stroke rate not calculated due to too many missing values.

comprised 32% and 25% of TAAA in open repair and TEVAR groups, respectively. Studies included in our review did not stratify outcomes based on Crawford types.

Cerebrospinal fluid drain has been shown to significantly reduce paraplegia/paraparesis rates related to repair of extensive TAAA in some studies, especially in Type II TAAA [19]. Interestingly, a recent Cochrane review did not show any significant benefit of CSF drainage among patients undergoing Types I and II TAAA repair compared to a control group [20]. Of note, this study included 3 randomized trials, and one trial used a combination of CSF drain and intrathecal papaverine administration. Our review demonstrates that CSF drains have been and continue to be heavily utilized. The majority of studies report at least selective placement of CSF drain.

Several facts became evident in our current literature review. First, it became apparent that the emphasis in most published studies was on description of certain techniques and not necessarily outcomes. For example, in studies included in this review, several important outcomes such as endoleak, sac enlargement, and mesenteric ischemia rates were not reported. In addition, there is significant heterogeneity in patient selection, outcome definitions, and techniques used and reporting of results. Most studies combine results of emergency and elective repair and report overall mortality and morbidity rates, which are subject to high variations given the inherent differences in baseline hemodynamic and other characteristics of patients in these two respective groups. Our review demonstrated that although certain centers achieve acceptable results with either type of repair, there is a need for some standardizing criteria for patient selection, outcome definitions and report of results. There is also significant heterogeneity in endovascular options for the treatment of TAAA, as well as surgeon preference and training, graft availability at each institution and the branch structure. Several reports combine various grafts and techniques. Standardization of techniques and grafts and outcome definitions would allow for more robust and head-to-head comparison of open and endovascular repair of thoracoabdominal aneurysms.

Conclusion

In summary, there is an indication for both open and endovascular repair of thoracoabdominal aneurysms. While evidence for endovascular repair of TAAA is progressively growing, open repair should still be offered to younger and relatively fit patients. Our review highlights the importance of establishing more homogeneous ways for reporting TAAA repair in literature. More specifically, every attempt should be made to separate emergency and elective cases given different outcomes associated, and important complications such as stroke, renal failure and mesenteric ischemia related to TAAA repair, branch occlusion, sac enlargement and reintervention rates should be reported. In case of TEVAR, indicating the number of branches treated, whether a fenestrated or branched endograft was used, and conversion to open repair should be reported. Only by standardizing the reported outcomes can we make head to head comparisons to improve complication rates.

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