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A meta-analysis of comparative studies of endovascular versus open repair for blunt thoracic aortic injury

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Several recent comparative studies¹⁻⁵ of endovascular (EVR) versus open repair (OR) for blunt thoracic aortic injury (BTAI) suggest that EVR may be associated with a reduction in mortality. Such comparisons are, however, hampered by the small number of cases, owing to the relative rarity of this condition.⁴ Therefore, the appropriate role of EVR for BTAI remains unclear. We performed a meta-analysis of all comparative studies of EVR versus OR for BTAI to date.

Materials and Methods

All comparative studies of EVR versus OR for BTAI were identified by a 2-level search strategy. First, a public domain database (MEDLINE) was searched using a Web-based search engine (PubMed). Second, relevant studies were identified through a manual search of secondary sources including references of initially identified articles and a search of reviews and commentaries. The MEDLINE database was searched from January 1966 to December 2007. MeSH keywords included "Aortic Rupture," "Aorta," "Wounds and Injuries," "Aortic Aneurysm, Thoracic," "Stents," and "Comparative Study." Studies considered for inclusion met the following criteria: the design was a comparative study of EVR versus OR; the study population was patients with BTAI; and main outcomes included mortality. Data regarding detailed inclusion criteria and mortality were abstracted (as available) from each individual study. For each study, data regarding mortality in both the EVR and OR groups

were used to generate odds ratios and 95% confidence intervals (CIs). Study-specific estimates were combined using inverse variance-weighted averages of logarithmic odds ratios in a random-effects model. Between-study heterogeneity was analyzed by standard χ^2 tests. Sensitivity analyses were performed to assess the contribution of each study to the pooled estimate by excluding individual studies one at a time and recalculating the pooled odds ratio estimates for the remaining studies. Publication bias was assessed graphically by a funnel plot and mathematically by an adjusted rank-correlation test.

Results

Our search identified 17 retrospective nonrandomized comparative studies^{1-5,E1-E12} of EVR versus OR for BTAI. The baseline patient characteristics are summarized in Table 1. In 11^{1-5,E3,E4,E7,E8,E11,E12} of the 17 studies, the EVR and OR groups had similar preoperative variables including the injury severity score. Fifteen of the 17 individual studies demonstrated a statistically nonsignificant benefit of EVR over OR for mortality, whereas only one study^{E10} demonstrated a statistically nonsignificant mortality reduction with OR over EVR. Pooled analysis of all the 17 studies (representing 565 patients) demonstrated a statistically significant 57% reduction in mortality with EVR relative to OR (8.1% in the EVR group vs 20.8% in the OR group; odds ratio, 0.43; 95% CI, 0.25-0.76; $P < .01$) (Figure 1, upper panel). There was neither study heterogeneity of results ($P = .96$) nor evidence of significant publication bias ($P = .32$). To assess the impact of qualitative heterogeneity in study design and patient selection on the pooled effect estimate, we performed several sensitivity analyses. In general, exclusion of any single study from the analysis did not substantively alter the overall result of our analysis. Additionally, when data from the 11 studies^{1-5,E3,E4,E7,E8,E11,E12} with similar preoperative variables in both groups were pooled ($N = 393$), EVR was associated with a 62% reduction in mortality relative to OR that remained statistically significant (7.5% vs 24.1%; odds ratio, 0.38; 95% CI, 0.20-0.73; $P < .01$) (Figure 1, lower panel). There was neither study heterogeneity of results ($P = .91$) nor evidence of significant publication bias ($P = .24$).

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Received for publication Dec 19, 2007; accepted for publication Jan 13, 2008.

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J Thorac Cardiovasc Surg 2008;135:1392-4

0022-5223/\$34.00

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doi:10.1016/j.jtcvs.2008.01.033

TABLE 1. Characteristics of the included studies

Author	Study	Publication	Period	Patients		Age (y)			Injury severity score		
				EVR	OR	EVR	OR	P	EVR	OR	P
Akowitz ⁴	<i>J Thorac Cardiovasc Surg.</i>	2007;134:897-901	2000–2006	7	8	32 ± 15	28 ± 9	0.4	42 ± 5	44 ± 13	0.3
Amabile ^{E1}	<i>J Vasc Surg.</i>	2004;40:873-9	1998–2004	9	11	30.9 ± 9.6	32.4 ± 9.8	0.74	NR	NR	NR
Andrassy ^{E2}	<i>J Trauma.</i>	2006;60:765-72	NR	15	16	38.7 ± 17.5	39.1 ± 17.5	0.94	NR	NR	NR
Broux ^{E3}	<i>Intensive Care Med.</i>	2006;32:770-4	1995–2005	13	17	46 ± 18	35 ± 15	NR	46 ± 18	35 ± 12	NS
Buz ¹	<i>Eur J Cardiothorac Surg.</i>	doi:10.1016/j.ejcts.2007.10.017	1987–2007	39	35	36 (mean)	36 (mean)	NS	41 (median)	34 (median)	NS
Cook ^{E4}	<i>J Thorac Cardiovasc Surg.</i>	2006;131:594-600	2000–2005	19	24	NR	NR	NR	38.9 ± 10	34.5 ± 9.9	0.1
Doss ^{E5}	<i>Ann Thorac Surg.</i>	2003;76:1465-70	1999–2002	4	12	NR	NR	NR	NR	NR	NR
Kasirajan ^{E6}	<i>Ann Vasc Surg.</i>	2003;17:589-95	1999–2002	5	10	38 ± 19	44 ± 24	NR	42 ± 9	32 ± 11	NR
Kokotsakis ²	<i>Ann Thorac Surg.</i>	2007;84:1965-70	2002–2006	22	10	26.20 ± 2.14	42.45 ± 4.11	0.01	48.8 ± 5.3	48.13 ± 4.54	0.92
Lebl ^{E7}	<i>Arch Surg.</i>	2006;141:177-80	1997–2003	7	10	59 ± 8	39 ± 5	0.10*	35.1 ± 3.7	34.9 ± 3.4	0.48*
Midgley ⁵	<i>J Vasc Surg.</i>	2007;46:662-8	1994–2006	12	16	43.8 ± 19.9	42.9 ± 18.6	0.90	37.9 ± 12.6	45.8 ± 18.2	0.28
Ott ^{E8}	<i>J Trauma.</i>	2004;56:565-70	1991–2002	6	12	43.5 (median)	31.5 (median)	0.18	46 (median)	47.5 (median)	0.33
Pacini ^{E9}	<i>J Thorac Cardiovasc Surg.</i>	2005;129:880-4	1980–2003	15	51	NR	NR	NR	NR	NR	NR
Reed ^{E10}	<i>J Vasc Surg.</i>	2006;43:684-8	2000–2005	13	11	54.8 ± 22.7	NR	NR	40 (mean)	NR	NR
Riesenman ³	<i>J Vasc Surg.</i>	2007;46:934-40	1993–2006	14	48	40.7 (mean)	40.2 (mean)	0.931	38 (mean)	41 (mean)	0.491
Rousseau ^{E11}	<i>J Thorac Cardiovasc Surg.</i>	2005;129:1050-5	1981–2003	29	35	37 ± 19	NR	NR	35.0 ± 2.1	33.0 ± 1.9	NS
Stampfi ^{E12}	<i>Eur J Vasc Endovasc Surg.</i>	2006;31:475-80	1993–2004	5	5	47.2 ± 19.3	30.0 ± 16.0	0.17	53.2 ± 10.8	43.8 ± 8.9	0.17
Total				234	331						

EVR, Endovascular repair; OR, open repair; NR, not reported; NS, not significant. *Comparing endovascular repair, open repair, and medical management.

Discussion

The potential benefits of EVR over OR for BTAI include no thoracotomy, no need for single lung ventilation, decreased use of systemic anticoagulation, avoidance of aortic crossclamping, and less blood loss.⁵ Experience of EVR for BTAI is, however, limited and difficult to study given the low prevalence of patients who survive to presentation.³ Although there is a clear trend toward better results for EVR in comparative studies of EVR versus OR, the relatively low power

of these studies was not able to demonstrate a statistically significant difference in mortality. The present meta-analysis of all comparative studies of EVR over OR for BTAI to date, including several sensitivity analyses, demonstrated a statistically significant benefit of EVR over OR for mortality. The main limitation of our study is to include merely retrospective nonrandomized comparative studies that allow selection and reporting biases for outcomes in favor of EVR. Nevertheless, the results of the present meta-analysis are not the best but are

Review: Repair of Blunt Traumatic Aortic Injury (JTCVS)
 Comparison: 01 Endovascular versus Open Repair
 Outcome: 01 Mortality

Review: Repair of Blunt Traumatic Aortic Injury (JTCVS)
 Comparison: 02 Endovascular versus Open Repair
 Outcome: 01 Mortality

Figure 1. Meta-analysis of mortality of endovascular versus open repair. The upper and lower panels included all 17 studies and the 11 studies with similar preoperative variables in both groups, respectively.

better evidence, because it is difficult to recommend prospective randomized controlled trials that have never been conducted.

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