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Management of Acute Type B Thoracic Aortic Dissection through Open or Endovascular Repair: A Meta-Analysis Qualitative and Quantitative Analyses

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Abstract

Background: Acute aortic dissection is defined as dissection occurring within 2 weeks of onset of pain. Sub acute and chronic dissections occur between 2 and 6 weeks, and more than 6 weeks from the onset of pain, respectively.

Aim of Study: To compare TEVAR and open surgical repair across a comprehensive range of outcomes reported from studies. The primary outcomes of the studies include early mortality, midterm or long-term survival rate, the secondary outcomes include early and late complications compared in both methods.

Patients and Methods: This systemic review and meta-analysis considered randomized controlled trials and retrospective or prospective observational studies, evaluating endovascular repair, open surgery, and those comparing the 2 techniques for acute type "B" aortic dissection treatment.

Results: The total number of patients included in the analysis was 18339 patients; among them, 11677 patients underwent open repair and 6662 patients had endovascular repair of an acute type B aortic dissection. Patients who underwent open repair were younger than those underwent endovascular repair (60.76±5.77 years vs 65.18±6.16 years, respectively). All the studies reported the percentage of male's attendance over the half of included patients.

Conclusion: In our meta-analysis of over 18,000 patients, TEVAR (n=6662) had higher rates of comorbidities compared to open repair (n=11677) for acute type B aortic dissection. There were no differences in paraplegia, stroke, neurologic or vascular complications. TEVAR had less renal failure but similar cardiovascular complications. Intensive care stay was shorter with TEVAR. In-hospital and 1-year mortality were significantly lower with TEVAR but 5-year mortality was similar between groups. In conclusion, despite sicker patients, TEVAR achieved decreased intensive care duration, early mortality benefit through 1 year, and less renal failure, with similar longer-term survival and neurological, vascular and cardiovascular complications compared to open repair for type B dissection. The early outcomes favor TEVAR while longer-term results are comparable to open surgery.

Key Words: *TEVAR – Open surgical repair.*

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Introduction

ACUTE aortic dissection is defined as dissection occurring within 2 weeks of onset of pain. Sub acute and chronic dissections occur between 2 and 6 weeks, and more than 6 weeks from the onset of pain, respectively **[1].**

The Stanford system is classified into two types "A" and "B" based on involvement of the ascending aorta. Type "A" includes dissection in the ascending aorta regardless of the site of first entry. Type "B" does not include dissection in the ascending aorta [2].

Approximately 25% of patients presenting with acute type "B" aortic dissection are complicated at admission by malperfusion syndrome or hemodynamic instability, resulting in a high risk of early death if untreated. Complicated type "B" aortic dissection refers to malperfusion syndrome involving visceral, renal, or extremity ischemia, rupture or impending rupture, uncontrolled hypertension, persistent abdominal or chest pain, or findings of rapid expansion on computed tomography (CT) imaging [3].

The management of such a condition is outlined in medical therapy, involving heart rate and systolic blood pressure control by intravenous beta-blockers and other agents, which had long been the treatment of choice for uncomplicated type "B" aortic dissection **[4].**

Open surgery (OS) has long been considered as standard treatment for chronic dissection where medical management has failed to prevent disease progression. The anatomical specificities of dissecting aneurysms continue to render open repair challengingly complex **[5]**. This is reflected in the high operative risks incurred, as demonstrated by early series reporting operative mortality as high as 27% with serious neurological complication rates of up to 28% **[6]**.

The application of thoracic endovascular aortic repair (TEVAR) has dramatically changed the treatment paradigm for aortic disease of the thoracic aorta. TEVAR is typically better tolerated by a more elderly and unwell patient cohort due to less invasive nature of stent grafting, which obviates the need for thoracotomy, cardiopulmonary bypass and deep hypothermic circulatory arrest **[7]**.

The goal of endovascular treatment of acute type "B" aortic dissection is the complete elimination of ante grade flow into the FL by closure of the primary intimal tear with a covered stent graft placed into the true lumen (TL). This procedure reduces FL blood flow and allows endograft-assisted TL expansion. TL expansion combined with FL thrombosis and shrinkage has been termed aortic remodeling. Aortic remodeling has been shown to be associated with improved survival in patients with chronic type "B" aortic dissection **[8]**.

Aim of the work:

The aim of the current meta-analysis is to compare TEVAR and open surgical repair across a comprehensive range of outcomes reported from studies. The primary outcomes of the studies include early mortality, midterm or long-term survival rate, the secondary outcomes include early and late complications compared in both methods.

Patients and Methods

Type of Study: Ssystemic review and meta-analysis will consider randomized controlled trials and retrospective or prospective observational studies, evaluating endovascular repair, open surgery, and those comparing the 2 techniques for acute type "B" aortic dissection treatment.

It started from 9-2023 to 3-2024.

Inclusion Criteria for considering studies for this review:

Types of participants: Randomized controled trials and clinical trials all studies reporting at least 15 patients treated for acute type "B" thoracic aortic dissection.

The studies could be retrospective, prospective or cross over studies. Age of patients in the studies between 18 to 80. Period of the study must be between 2001 to 2023.

Types of intervention: Interventions of interest included those related to either endovascular repair, open surgery for acute type "B" thoracic aortic dissection.

Types of outcome measure must be observed in the study reviwed this include: Preoperative variables, operative figures, and perioperative outcomes, survival rates, early complications as paraplegia or paraparesis, renal and respiratory failure, myocardial infarction, ventricular arrhythmias, congestive heart failure and other late outcomes.

Exclusion criteria: Case reports and case series with less than 15 patients. Studies of type A aortic dissection. Studies with chronic type B dissection.

Statistical analysis:

This meta-analysis was performed in line with recommendations from the Cochrane Collaboration and Met-analysis of Observable Studies in Epidemiological guidelines **[9]**. Where appropriate, the effect measures estimated were either risks or odds ratios for dichotomous data and weighted standard mean difference for continuous data, both reported with 95% confidence intervals. The ^{I2} statistic was used to estimate the percentage of total variation across studies, owing to heterogeneity rather than chance, with values of greater than 50% considered as substantial heterogeneity. A *p*-value of less than 0.05 considered as statistically significant outcome. Statistical analysis was performed using RevMan 5.3 Cochrane software (Cochrane UK, Oxford, United Kingdom).

Results

Included studies:

In this analysis, the PRISMA statement flowchart explains the process of the evidence screening (Fig. 1). After application of inclusion and exclusion criterion at different levels of assessment, ten studies were eligible and included in both the qualitative and quantitative meta-analyses.

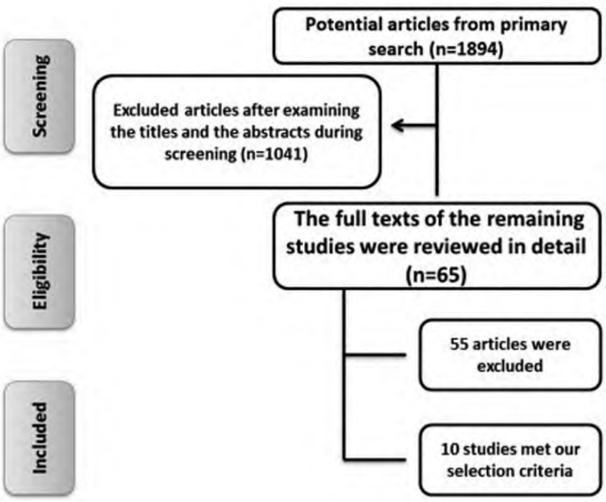


Fig. (1): Flow diagram of the literature search and study selection processes.

Table (1): General characteristics of the included studies.

Study	Country	Design	No. of patients	OR No	TEVAR no	Mean age Total (OR/TEVAR)	Percentage of male's attendance Total (OR/TEVAR)	Primary endpoint	Conclusion	NOS score
(Chou et al., 2015)	Taiwan	Retrospective cohort	1661	1542	119	62.6 (62.5/62.6)	83.2 (83.2/83.2)	- All-cause 30-day mortality	- TEVAR showed less perioperative and midterm mortality, shorter length of hospitalization, and less postoperative respiratory and wound complications than open repair.	8
(Conrad et al., 2010)	USA	Retrospective cohort	11,166	6328	4838	70.9 (70.6/71.7)	57.8 (58.0/57.0)	- Perioperative and long-term mortality	- TEVAR provides better perioperative survival rates and similar 5-year survival as open repair.	6
(Garbade et al., 2010)	Germany	Retrospective cohort	51	5	46	64.5 (60.0/65.0)	68.6 (60.0/69.6)	- Perioperative and long-term mortality	- Medical management, TEVAR and open repair all resulted in acceptable survival rates when used for managing acute type B aortic dissection.	6
(Mastroroberto et al., 2010)	Italy	Retrospective cohort	24	11	13	72.4 (70.2/74.3)	62.5 (72.7/53.8)	- In-hospital, 30-day and long-term mortality	- TEVAR showed significantly lower early mortality and similar long-term mortality compared to open repair in repairing acute type B aortic dissection.	5
(Narayan et al., 2011)	UK	Prospective cohort	84	35	49	56.7 (55.5/57.5)	75.0 (81.0/69.0)	- Early and mid-term mortality	- TEVAR showed significantly decreased mortality and morbidity compared to open repair in the short term	7
(Patel et al., 2009)	USA	Prospective cohort	69	34	35	65.9 (60.4/71.3)	59.4 (70.5/48.6)	- Operative and late mortality, and perioperative morbidities	- TEVAR reduces early morbidity, mortality and duration of hospitalization without compromising late outcomes.	6
(Sachs et al., 2010)	Israel	Retrospective population based cohort	5000	3619	1381	60.7	65.6 (65.3/66.4)	- In-hospital mortality	- TEVAR used in high risk surgical patients with lower postoperative morbidity and inhospital mortality when compared to open repair.	7
(Wilkinson et al., 2013)	USA	Retrospective cohort	73	24	49	66.2 (58.3/70.1)	63.0 (75.0/57.1)	- Long term all-cause mortality	- TEVAR showed similar outcomes as open repair despite being used in a high risk group	7
(Zeeshan et al., 2010)	USA	Retrospective cohort	65	20	45	58.1 (56.0/59.1)	73.8 (80.0/71.0)	- 30-day and long term mortality	- TEVAR showed superior early outcome and midterm survival compared to open repair.	6
(Lou et al., 2018)	USA	Retrospective cohort	146	59	87	57.0 (53.4/59.5)	71.2 (76.3/67.8)	- High incidence of surgical intervention and poor long-term survival.	- TEVAR may confer a survival advantage and serve as optimal therapy for complicated and uncomplicated aTBAD patients.	7

Study characteristics:

Study characteristics are summarized in Table (1). The studies included in this analysis were comparative studies between open and endovascular repair for patients presenting with ATBTAD.

The total number of patients included in the analysis was 18.339 patients; among them, 11677 patients underwent open repair and 6662 patients had endovascular repair of an acute type B aortic dissection. Patients who underwent open repair were younger than those underwent endovascular repair (60.76±5.77 years vs 65.18±6.16 years, respectively). All the studies reported the percentage of male's attendance over the half of included patients. The quality of study was assessed by NOS score, 1 study had a score of 8, 4 studies had a score of 7, 4 studies had a score of 6, and the remaining 1 study had a score of 5 (Table 1).

Never the less, those patients who underwent endovascular repair tended to be sicker and have more comorbidities and, therefore, were high-risk candidates for open surgical intervention. The TEVAR group had higher rate of presence of chronic obstructive pulmonary disease (COPD) (24.775% vs 19.7%), CAD (14.62% vs 8.98%), diabetes mellitus (12.45% vs 10.61%). However, hypertension (73.4% vs 75.4%), prior aortic dissection (17.9% vs 24.16%) and aneurysm (49.4% vs 49.58%) rates were lower among TEVAR group than OR group. All of these findings are summarized in Table (2).

Meta analysis

Postoperative outcomes

In-hospital results

Paraplegia:

There was no difference in the incidence of paraplegia rate in those who TEVAR vs OR groups (RR=1.18, 95%CI: 0.53 to 2.65, p=0.68). There was no heterogeneity (I^2=0%), therefore a fixed model was performed (Fig. 2).

The funnel plot analysis of the incidence of paraplegia rate indicator shows that the overall symmetry was still present (Fig. 3). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Stroke:

Seven studies reported the treatment effect of TEVAR versus OR on stroke. There was no significant difference between TEVAR and OR for the risk of stroke (OR: 0.01; 95%CI: -0.02–0.04; p=0.38; Fig. 4), and a significant heterogeneity among included studies was observed as well (I^2=63%; p=0.01).

The funnel plot analysis of the incidence of stroke rate indicator shows that the overall symmetry was still present (Fig. 5). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Neurologic complications:

Eight studies reported the treatment effect of TEVAR versus OR on neurologic complications rate. There was no significant difference between TEVAR and OR for the risk of neurologic complications (OR: 0.02; 95%CI: -0.02–0.06; p=0.26; Fig. 6), and a significant heterogeneity among included studies was observed as well (I^2=52%; p=0.04).

The funnel plot analysis of the incidence of neurologic complications rate indicator shows that the overall symmetry was still present (Fig. 7). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Vascular complications:

Seven studies reported the treatment effect of TEVAR versus OR on vascular complications rate. There was no significant difference between TEVAR and OR for the risk of vascular complications (OR: –0.04; 95%CI: –0.15-0.06; p=0.45; Figure 8), and a significant heterogeneity among included studies was observed as well (I^2=89%; p<0.00001).

The funnel plot analysis of the incidence of vascular complications rate indicator shows that the overall symmetry was still present (Fig. 9). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Renal failure:

Eight studies reported the treatment effect of TEVAR versus OR on renal failure. There was a significant difference between TEVAR and OR for the risk of renal failure (OR: 0.09; 95%CI: 0.02–0.16; p=0.01; Fig. 10), and a significant heterogeneity among included studies was observed as well (I^2=77%; p=0.01).

The funnel plot analysis of the incidence of renal failure indicator shows that the overall symmetry was still present (Fig. 11). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Cardiovascular complications:

Six studies reported the treatment effect of TEVAR versus OR on cardiovascular complications. There was no significant difference between TEVAR and OR for the risk of cardiovascular complications (OR: 0.07; 95%CI: -0.01–0.14; p=0.08; Fig. 12), and a significant heterogeneity among included studies was observed as well (I^2=93%; p<0.00001).

The funnel plot analysis of the incidence of cardiovascular complications indicator shows that the overall symmetry was still present (Fig. 13). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Duration of intensive care stay:

Three studies reported the treatment effect of TEVAR versus OR on duration of intensive care stay. There was a significant difference between TEVAR and OR for the mean difference of duration of intensive care stay (SMD: 0.38; 95%CI: -0.01–0.76; p=0.05; Fig. 14), and a significant heterogeneity among included studies was observed as well (I^2= 92%; p<0.00001).

The funnel plot analysis of standard mean difference of duration of intensive care stay indicator shows that the overall symmetry was still present (Fig. 15). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Mortality rates:

The mortality rates reported in the articles were analyzed as in-hospital mortality (which is defined as death while in hospital or within 30 days of surgery), at 1, and 5 years.

In-hospital mortality:

Nine studies reported the treatment effect of TEVAR versus OR on in-hospital mortality. There was a significant difference between TEVAR and OR for the in-hospital mortality rate (OR: 0.11; 95%CI: 0.10–0.13; p<0.00001; Figure 16), and a non significant heterogeneity among included studies was observed as well (I^2=18%; p=0.28).

The funnel plot analysis of incidence of in-hospital mortality rate indicator shows that the overall symmetry was still present (Fig. 17). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

One year mortality:

Five studies reported the treatment effect of TEVAR versus OR on one year mortality rate. There was a significant difference between TEVAR and OR for the one year mortality rate (OR: 0.14; 95%CI: 0.09–0.19; p<0.00001; Fig. 18), and a non significant heterogeneity among included studies was observed as well (I^2=38%; p=0.17).

The funnel plot analysis of incidence of one year mortality rate indicator shows that the overall symmetry was still present (Fig. 19). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Five-year mortality rate:

Six studies reported the treatment effect of TEVAR versus OR on five years mortality rate. There was no significant difference between TEVAR and OR for the five years mortality rate (OR: 0.06; 95%CI: -0.07–0.20; p=0.36; Fig. 20), and a significant heterogeneity among included studies was observed as well (I^2=67%; p=0.009).

The funnel plot analysis of incidence of five years mortality rate indicator shows that the overall symmetry was still present (Fig. 21). The results of Egger's test showed that there was no publication bias among the included articles (p>0.05).

Table (2): Perioperative characteristics of patients included in the analysis.

Study	COPD (%) Total (OR/ TEVAR)	Hypertension (%) Total (OR/ TEVAR)	CAD (%) Total (OR/ TEVAR)	Prior aortic dissection (%) Total (OR/ TEVAR)	Diabetes (%) Total (OR/ TEVAR)	Aneurysm (%) Total (OR/ TEVAR)
(Chou et al., 2015)	9.7 (9.7/9.7)	80.5 (79.6/81.4)	3.1 (3.5/2.7)	NA	12.8 (15.0/10.6)	NA
(Conrad et al., 2010)	NA	NA	NA	NA	NA	NA
(Garbade et al., 2010)	19.6 (20.0/19.5)	88.2 (100.0/87.0)	NA	15.7 (40.0/13.0)	19.6 (20.0/19.6)	78.4 (100.0/75.0)
(Mastroroberto et al., 2010)	62.5 (63.6/61.6)	79.2 (81.8/76.9)	8.3 (9.1/7.7)	NA	12.5 (18.2/7.7)	8.3 (9.1/7.7)
(Narayan et al., 2011)	NA	50.0 (53.0/47.0)	8.3 (8.0/8.0)	NA	2.4 (2.0/2.0)	48.8
(Patel et al., 2009)	24.6 (11.7/37.1)	73.9 (70.5/32.6)	26.1 (20.6/31.4)	13.0 (11.7/14.3)	11.6 (11.7/11.4)	31.9 (23.6/40.0)
(Sachs et al., 2010)	18.7 (17.7/21.3)	67.7 (65.5/73.3)	3.7 (2.5/7.0)	NA	7.6 (6.5/10.6)	NA
(Wilkinson et al., 2013)	16.4 (8.3/20.4)	80.8 (75.0/83.7)	26.0 (4.2/36.7)	24.7 (20.8/26.5)	11.0 (8.3/12.2)	100.0
(Zeeshan et al., 2010)	15.4 (15.0/16.0)	76.9 (55.0/87.0)	12.3 (15.0/9.0)	NA	13.8 (5.0/18.0)	18.5 (16.0/25.0)
(Lou et al., 2018)	12.3 (11.9/12.6)	94.5 (98.3/92.0)	NA	NA	12.3 (8.8/20.0)	NA

CAD : Coronary artery disease.

COPD: Chronic obstructive pulmonary disease.

NA : Not available.

	OR		TEVAR			Risk Ratio	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI	Year
Patel 2009	1	34	0	35	4.7%	3.09 [0.13, 73.21]	2009
Mastroroberto 2010	2	11	1	13	8.7%	2.36 [0.25, 22.70]	2010
Zeeshan 2010	2	20	6	45	35.0%	0.75 [0.17, 3.40]	2010
Wilkinson 2013	1	24	3	49	18.7%	0.68 [0.07, 6.20]	2013
Chou 2015	16	1542	1	119	17.6%	1.23 [0.17, 9.23]	2015
Lou 2018	2	59	2	87	15.3%	1.47 [0.21, 10.18]	2018
Total (95% CI)		**1690**		**348**	**100.0%**	**1.18 [0.53, 2.65]**	
Total events	24		13				

Heterogeneity: $Chi^2 = 1.35$, df = 5 (P = 0.93); $I^2 = 0\%$
Test for overall effect: Z = 0.41 (P = 0.68)

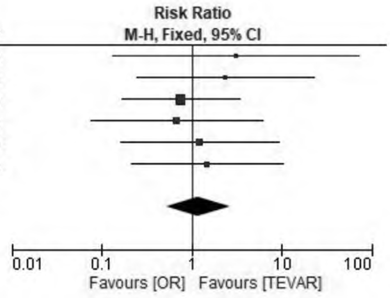


Fig. (2): Forest plot of paraplegia rate.

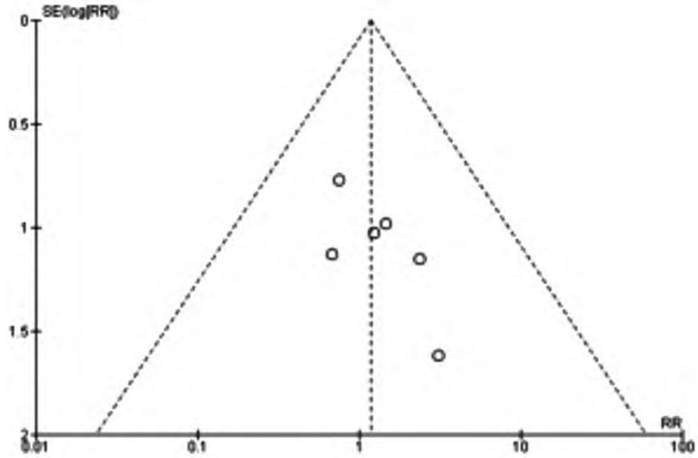


Fig. (3): Funnel plot of paraplegia rate.

	OR		TEVAR			Risk Difference	
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Random, 95% CI	Year
Patel 2009	2	34	0	35	7.5%	0.06 [-0.03, 0.15]	2009
Mastroroberto 2010	1	11	0	13	1.8%	0.09 [-0.12, 0.30]	2010
Zeeshan 2010	0	20	3	45	6.7%	-0.07 [-0.17, 0.03]	2010
Sachs 2010	216	3619	41	1381	32.6%	0.03 [0.02, 0.04]	2010
Wilkinson 2013	3	24	3	49	3.4%	0.06 [-0.08, 0.21]	2013
Chou 2015	4	1542	2	119	28.2%	-0.01 [-0.04, 0.01]	2015
Lou 2018	1	59	0	87	19.8%	0.02 [-0.03, 0.06]	2018
Total (95% CI)		**5309**		**1729**	**100.0%**	**0.01 [-0.02, 0.04]**	
Total events	227		49				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 16.31$, df = 6 (P = 0.01); $I^2 = 63\%$
Test for overall effect: Z = 0.87 (P = 0.38)

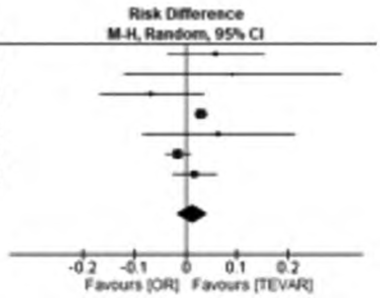


Fig. (4): Forest plot of stroke rate.

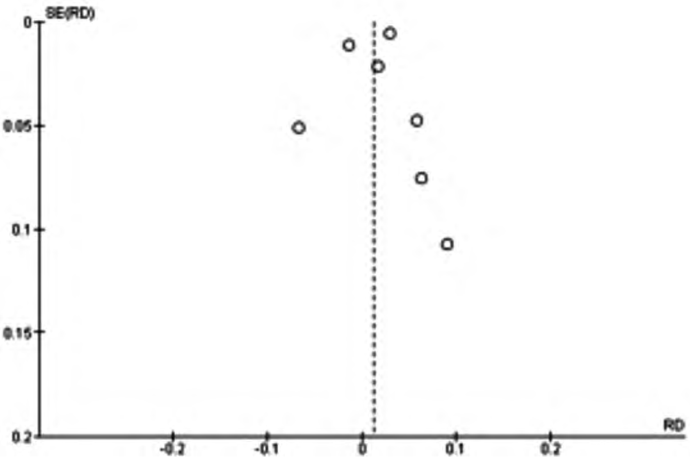


Fig. (5): Funnel plot of stroke rate.

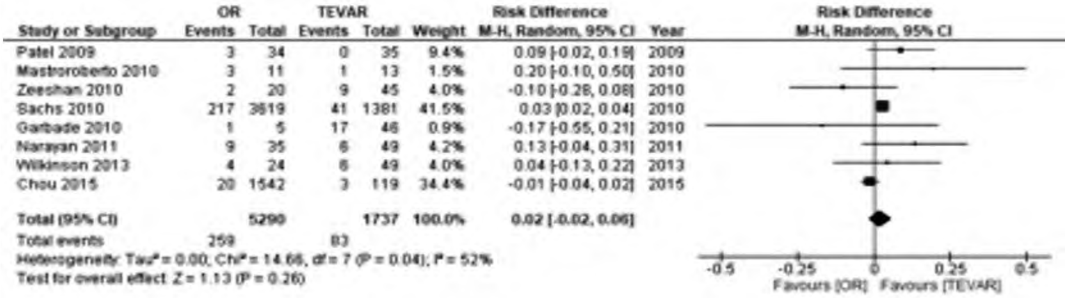


Fig. (6): Forest plot of neurologic complications rate.

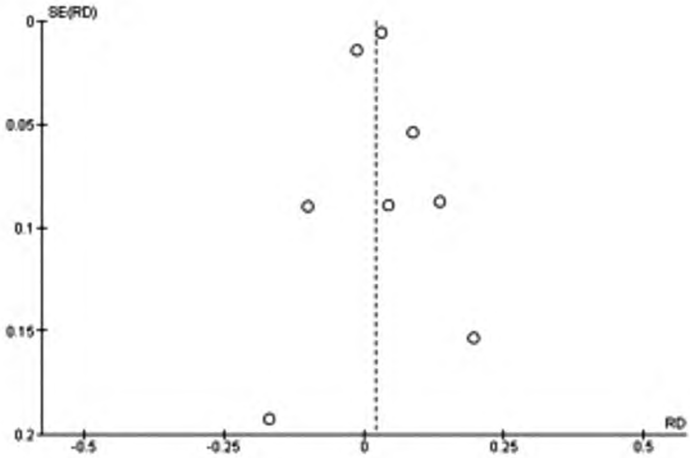


Fig. (7): Funnel plot of neurologic complications rate.

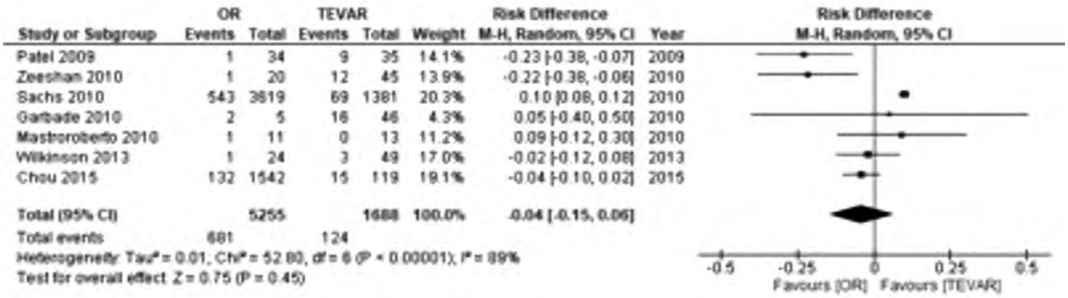


Fig. (8): Forest plot of vascular complications rate.

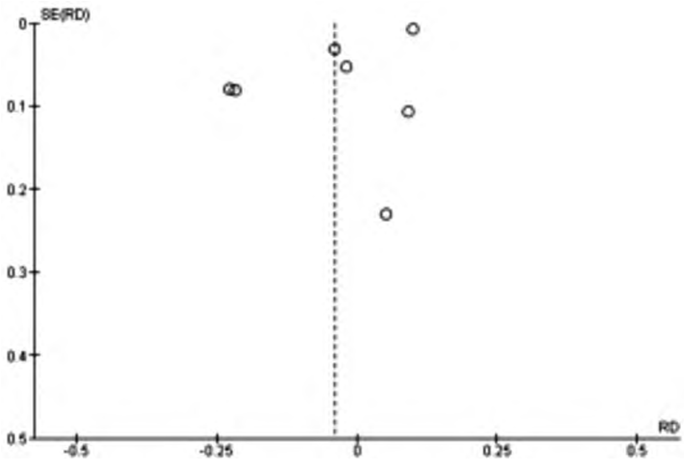


Fig. (9): Funnel plot of vascular complications.

Study or Subgroup	OR Events	OR Total	TEVAR Events	TEVAR Total	Weight	Risk Difference M-H, Random, 95% CI	Year
Zeeshan 2010	4	20	19	45	6.9%	-0.22 [-0.45, 0.00]	2010
Sachs 2010	1158	3619	235	1381	24.4%	0.15 [0.12, 0.17]	2010
Garbade 2010	2	5	14	46	2.2%	0.10 [-0.35, 0.55]	2010
Mastroroberto 2010	3	11	1	13	4.5%	0.20 [-0.10, 0.50]	2010
Narayan 2011	11	35	5	49	9.8%	0.21 [0.04, 0.39]	2011
Wilkinson 2013	4	24	2	49	11.0%	0.13 [-0.03, 0.28]	2013
Chou 2015	155	1542	6	119	23.1%	0.05 [0.01, 0.09]	2015
Lou 2018	6	59	4	87	18.0%	0.06 [-0.03, 0.14]	2018
Total (95% CI)		**5315**		**1789**	**100.0%**	**0.09 [0.02, 0.16]**	
Total events	1343		286				

Heterogeneity: Tau² = 0.01; Chi² = 30.33, df = 7 (P < 0.0001); I² = 77%
Test for overall effect: Z = 2.46 (P = 0.01)

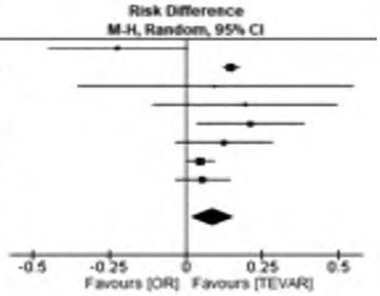


Fig. (10): Forest plot of renal failure.

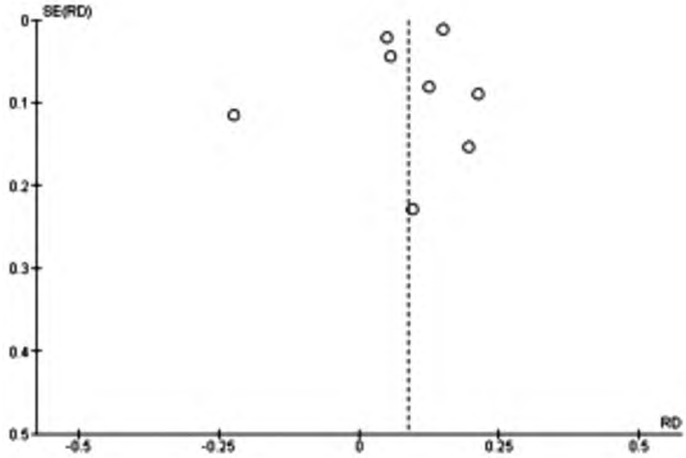


Fig. (11): Funnel plot of renal failure.

Study or Subgroup	OR Events	OR Total	TEVAR Events	TEVAR Total	Weight	Risk Difference M-H, Random, 95% CI	Year
Zeeshan 2010	4	20	4	45	9.6%	0.11 [-0.08, 0.31]	2010
Sachs 2010	434	3619	69	1381	31.7%	0.07 [0.05, 0.09]	2010
Garbade 2010	0	5	6	46	6.9%	-0.13 [-0.37, 0.11]	2010
Mastroroberto 2010	1	11	1	13	7.9%	0.01 [-0.21, 0.24]	2010
Narayan 2011	12	35	1	49	12.2%	0.32 [0.16, 0.48]	2011
Chou 2015	17	1542	1	119	31.6%	0.00 [-0.01, 0.02]	2015
Total (95% CI)		**5232**		**1653**	**100.0%**	**0.07 [-0.01, 0.14]**	
Total events	468		82				

Heterogeneity: Tau² = 0.00; Chi² = 67.02, df = 5 (P < 0.00001); I² = 93%
Test for overall effect: Z = 1.78 (P = 0.08)

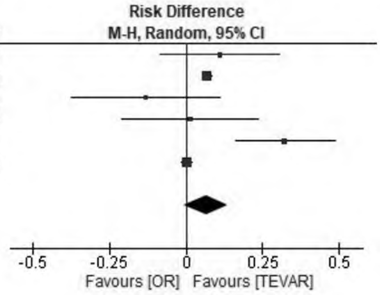


Fig. (12): Forest plot of cardiovascular complications.

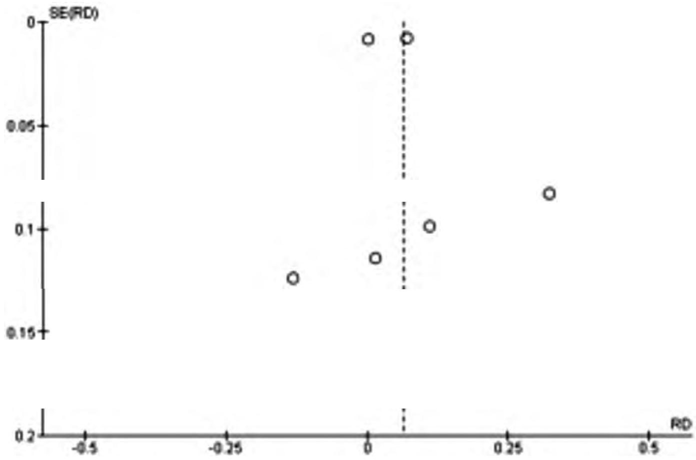
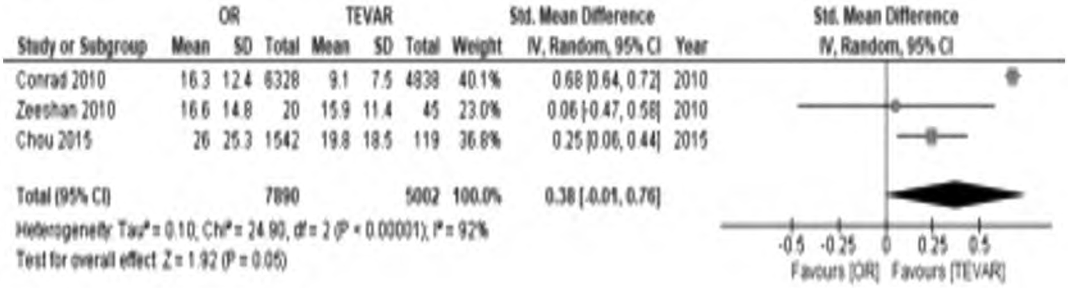


Fig. (13): Funnel plot of cardiovascular complications.



Study or Subgroup	OR Mean	OR SD	OR Total	TEVAR Mean	TEVAR SD	TEVAR Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year
Conrad 2010	16.3	12.4	6328	9.1	7.5	4838	40.1%	0.68 [0.64, 0.72]	2010
Zeeshan 2010	16.6	14.8	20	15.9	11.4	45	23.0%	0.06 [-0.47, 0.58]	2010
Chou 2015	26	25.3	1542	19.8	18.5	119	36.8%	0.25 [0.06, 0.44]	2015
Total (95% CI)			7890			5002	100.0%	0.38 [-0.01, 0.76]	

Heterogeneity: Tau² = 0.10; Chi² = 24.90, df = 2 (P < 0.00001); I² = 92%
Test for overall effect: Z = 1.92 (P = 0.05)

Fig. (14): Forest plot of standard mean difference of duration of intensive care stay.

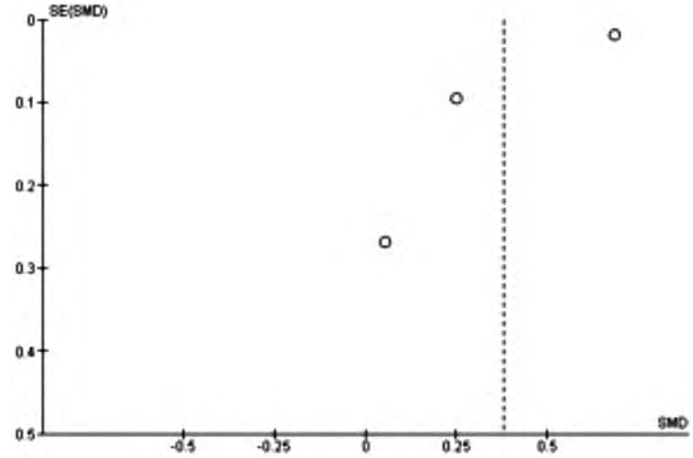
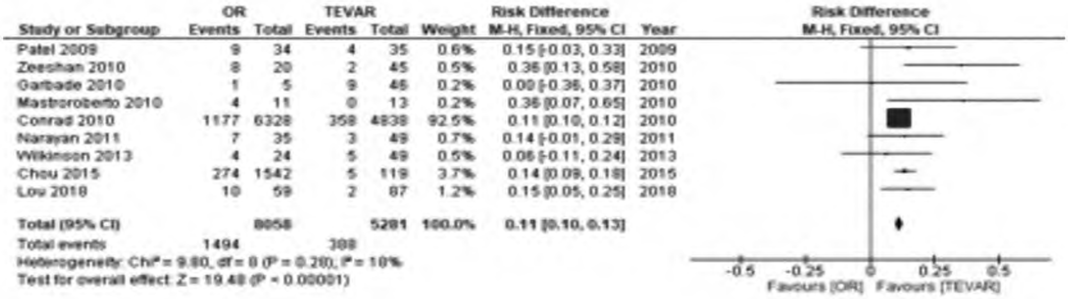


Fig. (15): Funnel plot of standard mean difference of duration of intensive care stay.



Study or Subgroup	OR Events	OR Total	TEVAR Events	TEVAR Total	Weight	Risk Difference M-H, Fixed, 95% CI	Year
Patel 2009	9	34	4	35	0.6%	0.15 [-0.03, 0.33]	2009
Zeeshan 2010	8	20	2	45	0.5%	0.36 [0.13, 0.58]	2010
Garbade 2010	1	5	9	46	0.2%	0.00 [-0.36, 0.37]	2010
Mastroroberto 2010	4	11	0	13	0.2%	0.36 [0.07, 0.65]	2010
Conrad 2010	1177	6328	358	4838	92.5%	0.11 [0.10, 0.12]	2010
Narayan 2011	7	35	3	49	0.7%	0.14 [-0.01, 0.29]	2011
Wilkinson 2013	4	24	5	49	0.5%	0.06 [-0.11, 0.24]	2013
Chou 2015	274	1542	5	119	3.7%	0.14 [0.09, 0.18]	2015
Lou 2018	10	59	2	87	1.2%	0.15 [0.05, 0.25]	2018
Total (95% CI)		8058		5281	100.0%	0.11 [0.10, 0.13]	
Total events	1494		388				

Heterogeneity: Chi² = 9.80, df = 8 (P = 0.28); I² = 18%
Test for overall effect: Z = 19.48 (P < 0.00001)

Fig. (16): Forest plot of in-hospital mortality.

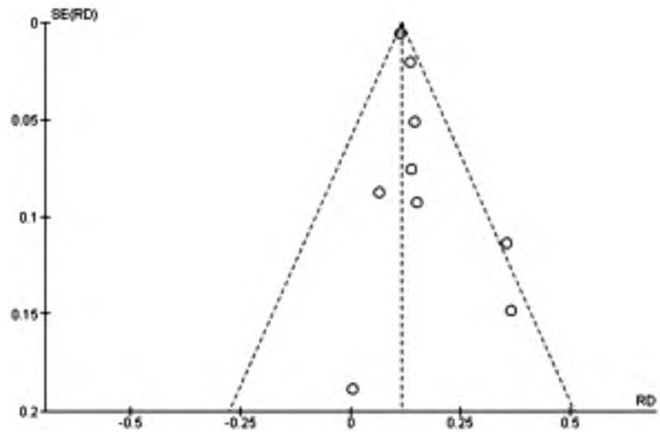


Fig. (17): Funnel plot of in-hospital mortality.

Study or Subgroup	OR Events	OR Total	TEVAR Events	TEVAR Total	Weight	Risk Difference M-H, Fixed, 95% CI	Year
Garbade 2010	1	5	13	46	2.7%	-0.08 [-0.46, 0.29]	2010
Mastroroberto 2010	5	11	1	13	3.5%	0.38 [0.05, 0.71]	2010
Zeeshan 2010	8	20	8	45	8.1%	0.22 [-0.02, 0.46]	2010
Chou 2015	370	1542	10	119	65.0%	0.16 [0.10, 0.21]	2015
Lou 2018	13	59	16	87	20.7%	0.04 [-0.10, 0.17]	2018
Total (95% CI)		**1637**		**310**	**100.0%**	**0.14 [0.09, 0.19]**	
Total events	397		48				

Heterogeneity: $Chi^2 = 6.50$, df = 4 (P = 0.17); $I^2 = 38\%$
Test for overall effect: Z = 5.28 (P < 0.00001)

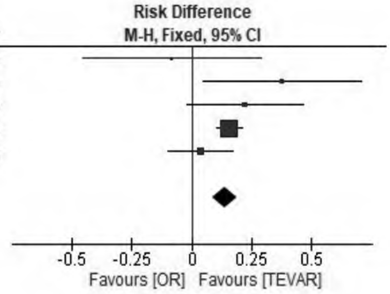


Fig. (18): Forest plot of one year mortality.

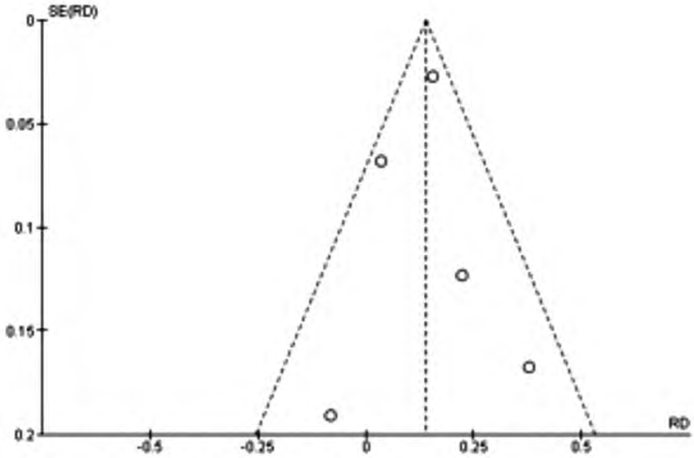


Fig. (19): Funnel plot of incidence of one year mortality rate

Study or Subgroup	OR Events	OR Total	TEVAR Events	TEVAR Total	Weight	Risk Difference M-H, Random, 95% CI	Year
Garbade 2010	1	5	20	46	8.9%	-0.23 [-0.61, 0.14]	2010
Mastroroberto 2010	6	11	2	13	9.8%	0.39 [0.04, 0.75]	2010
Zeeshan 2010	11	20	9	45	14.9%	0.35 [0.10, 0.60]	2010
Conrad 2010	2955	6328	2255	4838	29.9%	0.00 [-0.02, 0.02]	2010
Wilkinson 2013	9	24	15	49	15.8%	0.07 [-0.16, 0.30]	2013
Lou 2018	28	59	49	87	20.7%	-0.09 [-0.25, 0.08]	2018
Total (95% CI)		**6447**		**5078**	**100.0%**	**0.06 [-0.07, 0.20]**	
Total events	3010		2350				

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 15.26$, df = 5 (P = 0.009); $I^2 = 67\%$
Test for overall effect: Z = 0.91 (P = 0.36)

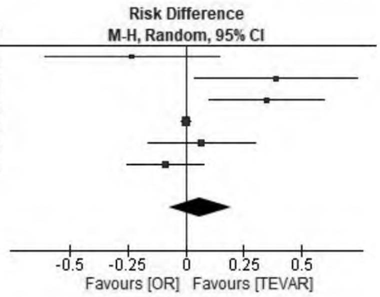


Fig. (20): Forest plot of five years mortality rate.

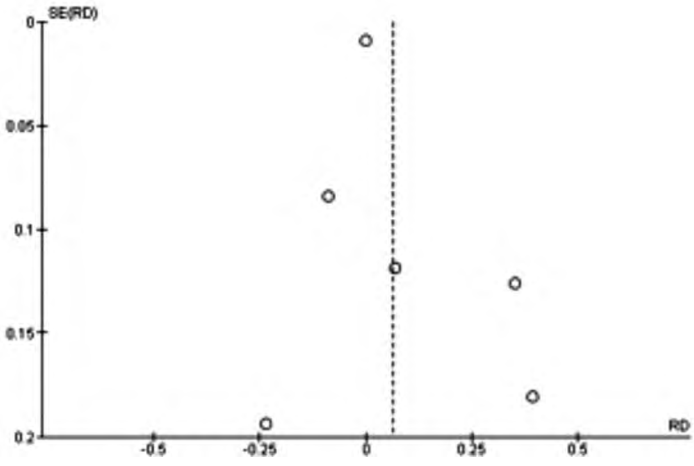


Fig. (21): Funnel plot of incidence of five years mortality rate.

Discussion

Acute Stanford type B or DeBakey type III aortic dissection (TBAD) originating distal to the left subclavian artery is a medical condition that is typically treated with anti-impulse therapy. However, as many as 30% of patients with this type of dissection will develop complications, including persistent symptoms, malperfusion, enlarging aneurysms and impending rupture. In these cases, TBAD becomes a surgical emergency that requires endovascular intervention to complement the medical therapy. Thoracic endovascular aortic repair (TEVAR) is an approach that can immediately reestablish flow to the true lumen, stabilize the aneurysm and prevent rupture, while lowering the mortality rate to approximately 14%. Long-term benefits of TEVAR include the remodeling of the descending thoracic aorta and elimination of subsequent procedures in the thoracoabdominal aorta *[10,11]*.

TEVAR has long been considered a viable therapeutic option for complicated TBAD; however, its ability to promote thrombosis of the false lumen and to prevent progression of the aneurysm indicate that it is also appropriate for uncomplicated scenarios. As a result, there has been a subtle paradigm shift in the considerations for TEVAR use *[12]*. Originally used to treat descending thoracic aortic aneurysm disease, TEVAR grafts are now approved by the US Food and Drug Administration for the treatment of acute TBAD, which has increased interest in endovascular technology and widened the spectrum of patients for which it is applicable *[13]*.

The aim of the current meta-analysis was to compare TEVAR and open surgical repair across a comprehensive range of outcomes reported from studies. The primary outcomes of the studies include early mortality, midterm or long-term survival rate, the secondary outcomes include early and late complications compared in both methods.

This systemic review and meta-analysis considered randomized controlled trials and retrospective or prospective observational studies, evaluating endovascular repair, open surgery, and those comparing the 2 techniques for acute type "B" aortic dissection treatment.

In a nationwide population-based study by Chou et al. *[14]* from 2003-2009 comparing outcomes of TEVAR versus open surgery for type B aortic dissection, the TEVAR group (n=119) had older patients with more comorbidities than the open repair group (n=1542). Nevertheless, 30-day mortality was significantly lower with TEVAR (4.2% vs 17.8%). Midterm survival at 1, 2, 3 and 4 years also favored TEVAR (92%, 86%, 82%, 79% vs 76%, 73%, 71%, 68%). Length of stay was shorter with TEVAR. TEVAR had less respiratory failure and fewer wound complications. Thus, despite older and sicker patients in the TEVAR group, outcomes including 30-day mortality, midterm survival, length of stay, and complications were superior with TEVAR compared to open repair for type B aortic dissection.

A study by Conrad et al. *[15]* using the Medicare database from 2004-2007 identified 11,166 patients undergoing repair of descending thoracic aortic pathology, with an increase in TEVAR (n=4,838) versus open repair (n=6,328) over time. Perioperative mortality was significantly lower with TEVAR for the overall cohort (7.4% vs 18.5%) and for thoracic aortic aneurysms (5% vs 12%), dissections (9% vs 21%), and ruptures (24% vs 45%). Kaplan-Meier analysis showed early survival benefit for TEVAR but similar 5-year survival except for improved survival with TEVAR for dissections (58.2% vs 50.6%).

Garbade et al. *[16]* compared outcomes of 135 patients with acute TBAD treated with medical management (n=84), TEVAR (n=46), or open surgery (n=5). There were no differences in baseline characteristics, but the open surgery group had larger aortic diameters. 30-day mortality was 8.5% for medical management, 20% for TEVAR and 20% for open surgery. 5-year mortality was higher for TEVAR than medical management (43.7% vs 27.9%, p=0.018). Reintervention rate was lower with TEVAR than medical management (17.4% vs 26.2%, p=0.049). Major complication rates were similar among groups.

A study of 398 patients with acute TBAD compared outcomes of complicated patients undergoing acute TEVAR (aTEVAR, n=80) versus uncomplicated patients treated with initial medical therapy (n=318), of whom 45.9% later underwent chronic TEVAR (cTEVAR, n=87) or open repair (n=59). Inhospital mortality was equivalent at 5% for complicated and uncomplicated groups. With later intervention, open repair had higher mortality and renal failure rates while stroke rate was highest with aTEVAR. Despite greater initial risk, complicated patients trended towards improved long-term survival compared to uncomplicated patients (84.1% vs 58.9% at 5 years, p=0.17). Intervention-free survival at 5 and 10 years was 50.4% and 32.9% for uncomplicated medically managed patients *[17]*.

Mastroroberto et al. *[18]* compared outcomes of open surgery (OS) versus endovascular repair (TEVAR) for acute type B aortic dissection in 51 patients (OS n=11, TEVAR n=13). Early mortality was significantly lower with TEVAR (0%) versus OS (36.4%, p<0.05). TEVAR also had significantly less paraplegia (7.7% vs 28.6%), renal failure (7.7% vs 42.8%), respiratory failure (7.7% vs 28.6%), and stroke (0% vs 14.3%) compared to OS. Late mortality was 42.8% for OS and 30.8% for TEVAR (p=NS). Cumulative 1, 3, and 8-year survival trended better with TEVAR (93%, 84%, 69%) versus OS (86%, 71%, 57%). Thus, for acute type B dissection, TEVAR achieved superior early outcomes and trend for improved longer-term survival compared to open surgery, with endoleaks in 15.4% of TEVAR patients.

A retrospective study of 84 patients undergoing intervention for descending thoracic aortic disease compared outcomes and costs of TEVAR (n=45) versus open repair (n=39). Despite TEVAR patients having more acute dissections, morbidity was lower with TEVAR, including less renal dysfunction (10% vs 31%, p=0.025), lower in-hospital mortality (6% vs 20%, p=0.03), and shorter ICU stay (median 1 vs 6 days, p<0.0001). Procedural costs were higher with TEVAR (£2468 vs £9581, $p \leq 0.0001$) due to stent costs, but overall hospitalization costs were similar. However, freedom from death or reoperation was lower with TEVAR (p=0.048) [19].

Patel et al. [20] compared outcomes of TEVAR (n=35) versus open repair (n=34) for ruptured thoracic aortic aneurysms. TEVAR was performed in nonoperative candidates with extensive comorbidities (88.6%) or favorable anatomy. In-hospital/30-day mortality was lower for TEVAR (11.4%) than open repair (26.5%), as was length of stay (8 vs 15 days, p=0.02), but mean long-term survival was similar (67.4 vs 65 months). Independent predictors of early mortality or major morbidity were hemodynamic instability on presentation (p<0.001) and open repair (p=0.02).

A study of the Nationwide Inpatient Sample database from 2005-2007 by Sachs et al. [21] identified over 10,000 repairs for thoracic or thoracoabdominal aortic dissections. After excluding type A and aneurysmal dissections, 5000 repairs were for type B dissection, of which 3619 underwent open repair and 1381 TEVAR. TEVAR patients were older with more comorbidities. In-hospital mortality was significantly lower for TEVAR (10.6%) than open repair (19%) (OR 2.24). Mortality was lower for TEVAR with both elective and emergent admissions, though not significantly for elective. Cardiac, respiratory, genitourinary and hemorrhagic complications as well as acute renal failure were more common in the open repair group. Median length of stay was also longer for open repair (10.7 vs 8.3 days).

Wilkinson et al. [22] compared outcomes of open repair (n=24) versus TEVAR (n=49) for 73 patients with type B aortic dissection treated in the acute or subacute period. TEVAR patients were older with more comorbidities. 30-day mortality was 12% with no difference between groups. Morbidity was also similar, while presentation with rupture or limb ischemia predicted worse composite outcomes. 10-year survival was equivalent at 57.5% between groups. Predictors of late mortality were perioperative stroke and presenting with rupture. 5-year freedom from reintervention or rupture was similar for TEVAR (80%) and open repair (82.8%).

A retrospective study by Zeeshan et al. [23] compared TEVAR (n=45) versus open surgery (n=20) or medical therapy (n=12) for acute complicated type B aortic dissection in 77 patients. In-hospital/30-day mortality was significantly lower with TEVAR (4%) than open surgery (40%) or medical therapy (33%) (p=0.006). Survival remained significantly higher with TEVAR at 1, 3 and 5 years (82%, 79%, 79%) compared to open surgery/medical therapy (58%, 52%, 44%) (p=0.008).

The total number of patients included in the analysis was 18.339 patients; among them, 11677 patients underwent open repair and 6662 patients had endovascular repair of an acute type B aortic dissection. Patients who underwent open repair were younger than those underwent endovascular repair (60.76±5.77 years vs 65.18±6.16 years, respectively). All the studies reported the percentage of male's attendance over the half of included patients.

In our study, those patients who underwent endovascular repair tended to be sicker and have more comorbidities and, therefore, were high-risk candidates for open surgical intervention. The TEVAR group had higher rate of presence of chronic obstructive pulmonary disease (COPD) (24.775% vs 19.7%), CAD (14.62% vs 8.98%), diabetes mellitus (12.45% vs 10.61%). However, hypertension (73.4% vs 75.4%), prior aortic dissection (17.9% vs 24.16%) and aneurysm (49.4% vs 49.58%) rates were lower among TEVAR group than OR group.

In our study, there was no difference in the incidence of paraplegia rate in those who TEVAR vs OR groups (RR=1.18, 95%CI: 0.53 to 2.65, p=0.68).

In our study, there was no significant difference between TEVAR and OR for the risk of stroke (OR: 0.01; 95%CI: -0.02–0.04; p=0.38).

In our study, there was no significant difference between TEVAR and OR for the risk of neurologic complications (OR: 0.02; 95%CI: -0.02–0.06; p=0.26).

In our study, there was no significant difference between TEVAR and OR for the risk of vascular complications (OR: -0.04; 95%CI: -0.15–0.06; p=0.45).

In our study, there was a significant difference between TEVAR and OR for the risk of renal failure (OR: 0.09; 95%CI: 0.02–0.16; p=0.01).

In our study, there was no significant difference between TEVAR and OR for the risk of cardiovascular complications (OR: 0.07; 95%CI: -0.01–0.14; p=0.08).

In our study, there was a significant difference between TEVAR and OR for the mean difference of duration of intensive care stay (SMD: 0.38; 95%CI: -0.01–0.76; *p*=0.05).

In our study, there was a significant difference between TEVAR and OR for the in-hospital mortality rate (OR: 0.11; 95%CI: 0.10–0.13; *p*<0.00001).

In our study, there was a significant difference between TEVAR and OR for the one year mortality rate (OR: 0.14; 95%CI: 0.09–0.19; *p*<0.00001).

In our study, there was no significant difference between TEVAR and OR for the five years mortality rate (OR: 0.06; 95%CI: -0.07–0.20; *p*=0.36).

Conclusion:

In our meta-analysis of over 18,000 patients, TEVAR (n=6662) had higher rates of comorbidities compared to open repair (n=11677) for acute type B aortic dissection. There were no differences in paraplegia, stroke, neurologic or vascular complications. TEVAR had less renal failure but similar cardiovascular complications. Intensive care stay was shorter with TEVAR. In-hospital and 1-year mortality were significantly lower with TEVAR but 5-year mortality was similar between groups. In conclusion, despite sicker patients, TEVAR achieved decreased intensive care duration, early mortality benefit through 1 year, and less renal failure, with similar longer-term survival and neurological, vascular and cardiovascular complications compared to open repair for type B dissection. The early outcomes favor TEVAR while longer-term results are comparable to open surgery.

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التحليل البعدى لعلاج النوع الحاد
من انسلاخ الشريان الأورطى الصدرى نوع «ب»
عن طريق الإصلاح المفتوح أو من داخل الأوعية الدموية

الهدف من التحليل التلوى الحالى هو مقارنة TEVAR والإصلاح الجراحى المفتوح عبر مجموعة شاملة من النتائج المبلغ عنها من الدراسات. تشمل النتائج الأولية للدراسات الوفيات المبكرة، ومعدل البقاء على قيد الحياة فى منتصف المدة أو على المدى الطويل، وتشمل النتائج الثانوية المضاعفات المبكرة والمتأخرة مقارنة فى كلا الطريقتين.

نظرت هذه المراجعة المنهجية والتحليل التلوى فى التجارب المعشاة ذات الشواهد والدراسات الرصدية بأثر رجعي أو مستقبلى، وتقييم إصلاح الأوعية الدموية، والجراحة المفتوحة، وتلك التي تقارن بين الطريقتين لعلاج تسلخ الأبهر من النوع «ب» الحاد.

فى تحليلنا التلوى لأكثر من ١٨٠٠٠ مريض، كان لدى TEVAR (ن = ٦٦٦٢) معدلات أعلى من الأمراض المصاحبة مقارنة بالإصلاح المفتوح (ن = ١١٦٧٧) لتشريح الأبهر الحاد من النوع ب. لم تكن هناك اختلافات في الشلل النصفى، والسكتة الدماغية، والمضاعفات العصبية أو الأوعية الدموية. كان لدى TEVAR فشل كلوى أقل ولكن مضاعفات القلب والأوعية الدموية مماثلة. كانت الإقامة فى العناية المركزة أقصر مع TEVAR. كانت الوفيات داخل المستشفى والوفيات لمدة سنة واحدة أقل بشكل ملحوظ مع TEVAR ولكن الوفيات لمدة ٥ سنوات كانت مماثلة بين المجموعات. فى الختام، على الرغم من المرضى الأكثر مرضًا، حقق TEVAR انخفاضًا فى مدة العناية المركزة، واستفادة من الوفيات المبكرة خلال عام واحد، وفشلًا كلويًا أقل، مع بقاء مماثل على المدى الطويل ومضاعفات عصبية وعائية وقلبية وعائية مقارنة بالإصلاح المفتوح لتشريح النوع B. النتائج المبكرة تفضل TEVAR بينما النتائج طويلة المدى قابلة للمقارنة بالجراحة المفتوحة.