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An analysis of early and long-term gender-related outcomes after thoracic endovascular aortic repair

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Abstract

OBJECTIVES: To evaluate gender-related outcomes during endovascular treatment of thoracic and thoraco-abdominal aortic diseases (TEVAR).

METHODS: Multicentre, retrospective, observational cohort study. All TEVARs between January 2005 and April 2023 were identified. Primary outcomes were 30-day mortality and cumulative survival. Secondary outcomes were vascular access complications, and freedom from TEVAR-related reintervention. Interventions performed in male patients were matched to females on the basis of a one-to-one coarsened exact matching.

RESULTS: We identified 151 males who were matched with 151 females. Mortality at 30 days was not statistically different between females and males (11.2% vs 11.2%; $P = 1.0$). At binary logistic regression analysis, duration of intervention ($P = 0.001$) and emergency TEVAR ($P = 0.001$) were associated with mortality at 30 days. Gender did not impact the access vessel complication rate [$n = 6$ (4.0%) vs $n = 5$ (3.3%); $P = 1.0$]. The median follow-up was 46 (interquartile range, 7–84) months with no difference between males and females [median 50 (11–95) vs 37.5 (3.5–71.2); $P = 0.153$]. Estimated survival was not statistically different between females and males [log-rank $\chi^2 = 0.6$, $P = 0.442$; 95% confidence interval (CI) 110.7–207.3]. At Cox's regression analysis, gender did not impact overall survival (hazard ratio 0.8; 95% CI 0.6–1.3; $P = 0.450$). Estimated freedom from TEVAR-related reinterventions was not statistically different between females and males (log-rank $\chi^2 = 0.4$, $P = 0.837$; 95% CI 187.8–219.3).

CONCLUSIONS: Female gender itself was not associated with worse 30-day mortality and late survival than males with similar access vessel complication as well as TEVAR-related reintervention rate.

Keywords: Thoracic endovascular aortic repair • Female gender • Access complication • Freedom from reintervention • Aorta-related mortality

ABBREVIATIONS

95% CI	95% Confidence intervals
EACTS	European Association for Cardio-Thoracic Surgery
EG	Endograft
HR	Hazard ratio
IQR	Interquartile range
n	Number
OR	Odds ratio
SE	Standard error
SVS	Society for Vascular Surgery
TEVAR	Thoracic endovascular aortic repair

INTRODUCTION

Recent studies have brought back to the forefront of clinical attention the pending question of potential gender-based differences between female and male patients undergoing cardiovascular surgery [1–6]. However, there are few series that analysed this topic during thoracic endovascular aortic repair (TEVAR); also, they analysed cohorts predominantly based on elective cases or single clinical scenarios, not always reported long-term results, as well as they are relatively contemporary so improved indication, technical skills and technology may have mitigated potential gender-based differences [7–13]. In addition, there are contradictory results between the very first experiences and the most recent analyses, leaving uncertainty about the

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An analysis of early and long-term gender-related outcomes after thoracic endovascular aortic repair.

Summary

Population

In patients with thoracic aortic diseases

Intervention

Are females prone to worse outcomes

Comparison

In comparison with males

Outcomes

Early mortality and vascular access complication, as well as long-term survival and TEVAR-related reintervention was similar between genders

	Current literature on gender-related outcomes during TEVAR					
	Period (years)	Patients (n)	Female (%)	Mortality (P value)	Access complication (P value)	Reintervention (P value)
Filiberto F, <i>et al.</i>	2005-2020	159	24	0.19	n.s.r.	0.35
Lomazzi C, <i>et al.</i>	2010-2021	805	33.5	0.85	n.s.r.	0.42
Deery S, <i>et al.</i>	2011-2015	2574	40	< 0.01	< 0.01	not reported
Jackson M, <i>et al.</i>	2003-2005	195	41	0.84	< 0.001	< 0.01
Czemny M, <i>et al.</i>	2000-2011	286	29	0.75	n.s.r.	not reported
Amaoutakis G, <i>et al.</i>	2005-2011	649	43	0.03	n.s.r.	0.67
Yousef S, <i>et al.</i>	2010-2018	27118	41	0.75	n.s.r.	not reported
Rastogi V, <i>et al.</i>	2013-2022	1311	27	0.34	0.18	0.02
Romijn ASC, <i>et al.</i>	2016-2019	2022	26	0.93	n.s.r.	not reported
Lareiry F, <i>et al.</i>	2011-2020	7383	25	0.58	n.s.r.	not reported
Present experience	2005-2023	302*	50*	1.0	1.0	0.84

*, matched cohorts out of 655 total patients

TEVAR, thoracic endovascular aortic repair

reliability of gender-related differences as far as major aortic-related outcomes are concerned [14–18].

Thus, the objective of this multicentre study was to provide a contemporary analysis of the potential gender-related differences in patients who had undergone TEVAR.

MATERIALS AND METHODS

Ethical statement

The Helsinki declaration and its later amendments were respected. The study was approved by the local Ethics Committee (No. 149/24) and registered as an observational study. The data underlying this article are available in the article.

Study cohort

This is a multicentre, observational cohort study that involves 4 academic Italian hospitals [19]. Clinical data were collected in a prospective manner at each centre; all data were merged into a single dedicated database and analysed retrospectively. All patients, between 1 January 2005 and 31 May 2023, treated with TEVAR for any kind of thoracic aortic pathology were identified. Information collected included demographics, comorbidities, morphologic characteristics of the aortic lesion, type of intervention and endograft (EG), as well as postoperative events (complications, death, need of aorta-related reintervention) during hospitalization and follow-up.

Operative details

Operative indications that progressively changed over the course of the years have always been respected on a clinical and technical level and were always consistent and in agreement with the literature and cardiovascular guidelines adjustments for acute and chronic TEVAR [20–22]. Technical strategies, as well as cerebrovascular, spinal cord, and renal protection protocols,

were overlapping and always shared by the participant centres [23]. Institutional indications for reintervention after TEVAR are also aligned with clinical practice guidelines. Triple-phase CT-angiography surveillance was performed as part of the radiological follow-up at 1 and 12 months postoperatively, and annually thereafter.

Definition and primary outcomes

Morphological characteristics and outcomes were defined based on the European Association for Cardio-Thoracic Surgery (EACTS) best practice guidelines for reporting treatment results in the thoracic aorta, and/or the Society for Vascular Surgery (SVS) ad hoc committee on TEVAR reporting standards [24–26]. According to the EuroSCORE classification, the type of intervention was classified as elective, urgent and emergent [27]. TEVAR-related outcomes were defined in agreement with the SVS reporting standards for TEVAR [25]. The follow-up index described follow-up completeness at a given study end date as a ratio between the investigated and the potential follow-up period [28]. Specifically for the purposes of this study, the primary outcomes were 30-day mortality and cumulative long-term survival. Secondary outcomes were vascular access complications at 30 days, and freedom from TEVAR-related reintervention. The following complications were considered access complications: surgical site infection, arterial injury to access vessel (such as pseudaneurysm, avulsion, dissection, arterial bleeding, access vessel thrombosis/occlusion), access site bleeding, seroma and lymphocele. Outcomes were stratified by study period quartiles (2001–2004, 2005–2009, 2010–2014, 2015–2019, 2020–2023).

Statistical analysis

Clinical data were collected in a prospective manner at each centre; thereafter, they were merged in a single database, recorded, tabulated in Microsoft Excel (Microsoft Corp, Redmond, Wash) and analysed retrospectively [29]. To ensure correct data recording

and limit missing records, an audit of the database was conducted, and each centre was queried to provide eventual absent variables. Statistical analysis was performed with SPSS, release 29.0 for Windows (IBM SPSS Inc., Chicago, IL, USA). Interventions performed in male patients were matched to females on the basis of a one-to-one coarsened exact matching (CEM). For its calculation, all the significantly different baseline pretreatment demographic and clinical covariates in the 2 groups were used. A CEM-based matched control group was then generated and compared in terms of 30-day mortality and survival, access-related complication, and TEVAR-related reintervention. Continuous variables were tested for normality using the Shapiro-Wilk's test, and compared between groups with unpaired Student's *t*-test for normally distributed values; otherwise, the Mann-Whitney *U*-test was used. Variables that were normally distributed are presented as mean \pm standard deviation and range; otherwise, they are presented as median and interquartile range (IQR). Categorical variables were presented using frequencies and percentages and analysed with the Pearson's χ^2 test or Fisher's exact test whether the expected cell frequencies were <5 . The Wilcoxon signed-rank test was used to evaluate the difference in covariate measurements before and after intervention. Multivariable analysis was used to adjust the relationship between gender and 30-day mortality and survival, as well as TEVAR-related reintervention. Associations that yielded a *P* value <0.20 on univariate screen were then included in a binary logistic regression analysis using the Wald's forward stepwise model. The strength of the association of variables with each primary outcome was estimated by calculating the odds ratio (OR) and 95% confidence interval (CI); significance criteria 0.20 for entry, 0.05 for removal. Long-term survival and freedom from aorta-related reintervention were estimated according to Kaplan-Meier method and reported with standard error (SE), and associated 95% CI. The log-rank test was used for any possible comparison in the follow-up of the different covariates. Time-dependent coefficients were included in Cox proportional hazards regression and survival. In addition, the estimation of the need for aorta-related reintervention were implemented with a proportional hazards model proposed by Fine & Gray in order to consider the presence of competitive risks [29]. All reported *P* values were 2-sided; *P* value <0.05 was considered significant.

RESULTS

Study population

Out of 655 (87.4%) patients of the entire registry cohort (Fig. 1), CEM identified 151 males who were matched with 151 females. There were no differences in female enrollment ratio through the quartiles of the experience ($P=0.502$). Demographic data, comorbidities, and risk factors of the 2 cohorts before and after CEM are reported in Table 1. According to the EuroSCORE categories, 262 (86.7%) were elective TEVARs, 56 (18.5%) were urgent, and 40 (13.2%) were emergencies. There was no gender-related difference as far as the acute clinical onset of aortic disease is concerned ($P=0.865$, $P=0.300$, $P=0.865$, respectively).

Surgical details and postoperative course

The common femoral artery was the access vessel in 274 (96.5%) patients; the type of access vessel was not statistically different between males and females ($P=1.0$). A totally percutaneous approach for TEVAR was performed in 228 (80.3%) patients [males,

$n=118$ (83.1%) vs females $n=110$ (77.5%); $P=0.296$]. The proximal landing zone of TEVAR was 'zone 0-2' in 118 (56.5%) patients with no difference between males and females ($P=0.678$). Specifically, 'zone 0' TEVAR was the final indication of a multidisciplinary evaluation comprising multiple diagnostic tests and risk score analysis, and consisted of supra-aortic trunks debranching ($n=15$), in association with different configurations of ascending aorta graft replacement ($n=4$). The left subclavian artery was revascularized in 78 (66.1%) patients with no difference between males and females ($P=1.0$). A total of 48 (35.2%) patients received ≥ 2 EGs with no difference between males and females ($P=0.149$), but the median of aortic coverage was higher in males [mm, 190 (IQR, 150-212.5) vs 150 (IQR, 114.7-200); $P=0.023$]. There was no difference between males and females in terms of median time of intervention ($P=0.971$), mean of contrast agent used during the procedure ($P=0.693$), median blood loss ($P=0.891$), and transfusion ($P=0.113$), as summarized in Table 2. Postoperative stay was not statistically different between males and females, either in intensive care unit [$n=55$, (65.5%) vs $n=45$ (64.3%); $P=1.0$] or overall length of hospitalization [days, 6 (IQR, 5-11) vs 7 (IQR, 4-11.7); $P=0.587$].

Early outcomes (≤ 30 days)

Mortality. Overall, mortality occurred in 34 (11.2%) patients, with no statistical difference across the quartiles of the study period ($P=1.0$). Mortality was not statistically different between females and males (11.2% vs 11.2%; OR 1.0, $P=1.0$), and gender did not impact mortality at 30-day when stratified by acute clinical onset (OR 0.9; $P=1.0$), 'zone 0' proximal landing zone (OR: 0.5; $P=0.534$), and type of aortic disease (OR 0.9; $P=1.0$). At binary logistic regression analysis, duration of intervention (OR 1.005; 95% CI 1.002-1.008; $P=0.001$), and emergency TEVAR (OR 5.5; 95% CI 1.98-15.20; $P=0.001$) were associated with mortality at 30-day, also when adjusted for gender. Acute type B dissections complicated by malperfusion were not a predictor of mortality in the matched cohorts ($P=0.210$).

Access vessel complication. Access complication occurred in 11 (3.6%) patients, with no statistical difference between males and females [$n=6$ (4.0%) vs $n=5$ (3.3%); OR: 0.8, $P=1.0$], as reported in Table 3. Gender did not impact access vessel complication rate when stratified by quartiles of the study period ($P=1.0$), device generation (OR 0.9; $P=1.0$), clinical scenario (OR 1.4; $P=0.644$), or type of aortic disease (OR 1.4; $P=0.478$), even when stratified by access vessel site (femoral vs iliac, OR 0.9; $P=0.331$). Binary logistic regression analysis did not identify covariate associated with access complication at 30 days. In the matched cohorts, there was no instance of intestinal ischaemia, and there was no statistical difference between males and females in terms of acute kidney injury (2.6% vs 0.0%; OR 0.9; $P=0.123$), cerebrovascular accidents (0.7% vs 1.3%; OR 0.7; $P=1.0$), or spinal cord ischaemia (3.3 vs 1.3%; OR 0.4; $P=0.448$).

Late outcomes

The median of follow-up was 46 (IQR 7-84) months with no difference between males and females [median, 50 (11-95) vs 37.5 (3.5-71.2); $P=0.153$], as observed for the median of follow-up index [median, 0.8 (IQR 0.4-1) vs 0.8 (IQR 0.6-1); $P=0.992$].

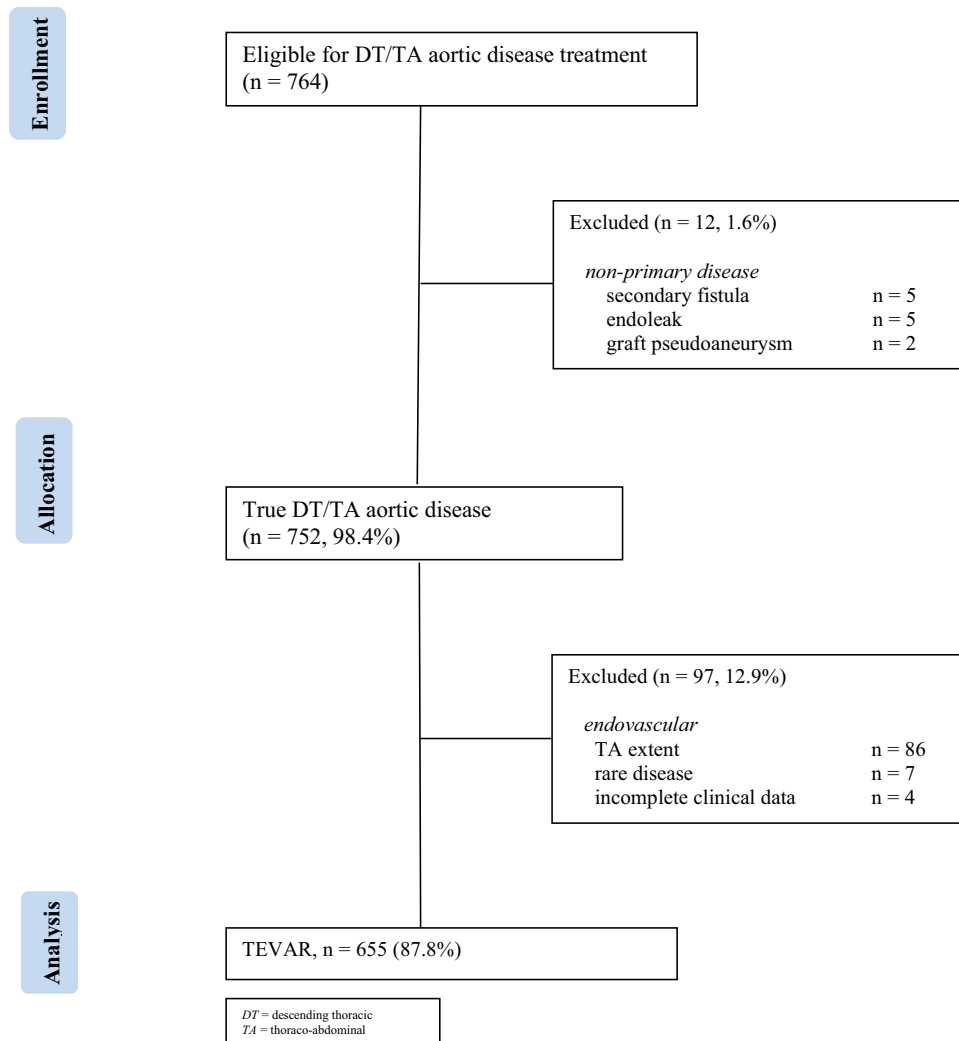


Figure 1: Consort diagram of all thoracic aortic diseases treated with thoracic endovascular aortic repair for descending diseases (2005–2023, n = 655).

Overall, estimated survival (Fig. 2) was not statistically different between females and males (Log-rank $\chi^2 = 0.6$, $P = 0.442$; 95% CI 110.7–207.3), even when stratified across the quartiles of the study period (Log-rank $\chi^2 = 0.5$, $P = 0.459$). At Cox's regression analysis, gender did not impact overall survival [hazard ratio (HR) 0.8; 95% CI 0.6–1.3; $P = 0.450$]. Survival during the follow-up was associated with preoperative ischaemic heart disease (HR 1.74; 95% CI 1.004–3.008; $P = 0.048$), preoperative chronic kidney disease (HR 2.02; 95% CI 1.25–3.3; $P = 0.004$), and emergency TEVAR (HR 2.3; 95% CI 1.2–4.4; $P = 0.012$). We recorded 21 (7.0%) TEVAR-related reinterventions with no difference between males and females [$n = 12$ (8.1%) vs 9 (6.0%); OR 0.7; $P = 0.503$; Table 4]. Three patients (males, $n = 2$) died postoperatively after TEVAR-related reintervention (aorto-oesophageal fistula, $n = 2$, and aortic arch rupture, $n = 1$) for an overall estimated freedom from TEVAR-related reintervention-free survival of 99.6% (SE 0.004) at 1 year, 98.9% (SE 0.008) at 3 years, and 97.8% (SE 0.1) at 5 years. The estimated freedom from TEVAR-related reinterventions was not statistically different between females and males (Log-rank $\chi^2 = 0.4$, $P = 0.837$; 95% CI 187.8–219.3), even when stratified across the quartiles of the study period (Log-rank $\chi^2 = 0.04$, $P = 0.949$). This was confirmed at competing risk analysis when the only covariate to be

associated with lower freedom from TEVAR-related reintervention was dissection-related aortic disease (sub-HRs 3.3; 95% CI 1.34–8.24; $P = 0.009$).

DISCUSSION

The main findings of our analysis were that females had no different mortality rate after TEVAR neither at 30 days nor during the course of the follow-up, and that access vessel complication and TEVAR-related reintervention were not impaired by female gender.

Clinical studies infrequently analysed the role of female gender on TEVAR outcomes, potentially because they represented the smallest fraction within these study cohorts covering a percentage in the range of 24–43% [30]. Similarly, in our experience, females represented 27% of the overall cohort; this data, together with the similar distribution of aortic diseases as well as their clinical acute onset, confirm the reliability of the results extrapolated from this recent real-world analysis of TEVAR.

Most of the previous studies that investigated TEVAR-related outcomes in genders, underlined the importance of female gender on 2 major outcomes: early (≤ 30 days) mortality, and access vessel complications, which were analysed also in our cohort [7–18, 30, 31]. At a first glance, literature data are contradictory as

Table 1: Demographic data, comorbidities, and risk factors of the 2 cohorts

Covariate	Before matching			After matching		
	Males (n = 475)	Females (n = 180)	P	Males (n = 151)	Females (n = 151)	P
Demographics						
Age, median (IQR)	71 (64–78)	74 (68–79)	0.001	72 (66–78)	73 (66–78.2)	0.418
Comorbidity, n (%)						
Hypertension	401 (84.4)	157 (87.2)	0.432	111 (82.8)	115 (85.8)	0.615
Dyslipidaemia	236 (49.7)	85 (47.2)	0.642	69 (51.5)	58 (43.3)	0.221
Chronic obstructive pulmonary disease	179 (37.7)	55 (30.5)	0.119	42 (31.8)	43 (31.8)	1.0
Obesity	129 (27.1)	41 (22.8)	0.400	27 (25.5)	26 (24.5)	1.0
Chronic kidney disease	111 (23.4)	48 (26.7)	0.389	35 (25.4)	29 (21.5)	0.477
Coronary artery disease	88 (18.5)	29 (16.1)	0.541	23 (17.2)	19 (14.4)	0.615
Diabetes	69 (14.5)	17 (9.4)	0.174	9 (8.0)	9 (8.0)	1.0
Cerebrovascular accidents	56 (11.8)	21 (11.7)	1.0	13 (9.7)	15 (11.5)	0.692
Atrial fibrillation	28 (5.9)	11 (6.1)	1.0	11 (7.3)	8 (5.3)	0.637
Valve disease	6 (1.2)	3 (1.7)	0.712	3 (2.0)	3 (2.0)	1.0
Left heart insufficiency	3 (0.6)	0 (0.0)	0.565	0 (0.0)	0 (0.0)	
Risk factor, n (%)						
Previous cardiac surgery	46 (9.7)	31 (17.2)	0.023	17 (13.9)	17 (13.9)	1.0
Previous aortic surgery	98 (20.6)	17 (9.4)	0.001	12 (8.3)	12 (8.3)	1.0
Rupture	97 (20.4)	38 (21.1)	0.830	19 (12.6)	21 (13.9)	0.865
Aortic disease, n (%)						
Degenerative atherosclerotic						
Aneurysm/ulcer	282 (59.4)	131 (72.8)	0.001	100 (68.0)	100 (68.0)	1.0
Dissection-related type B						
Acute uncomplicated	68 (14.3)	18 (10.0)	0.146	10 (6.6)	10 (6.6)	1.0
Acute complicated	10 (2.1)	1 (0.5)	0.200	5 (3.3)	6 (4.0)	1.0
Chronic	33 (6.9)	9 (5.0)	0.366	8 (5.4)	8 (5.4)	1.0
Blunt traumatic aortic injury	58 (12.2)	24 (13.3)	0.698	14 (9.5)	13 (8.8)	1.0
Intramural haematoma type B	21 (4.4)	10 (5.5)	0.542	10 (6.8)	10 (6.8)	1.0

IQR: interquartile range; n: number; OR: odds ratio.

Table 2: Procedural details during the index thoracic endovascular aortic repair

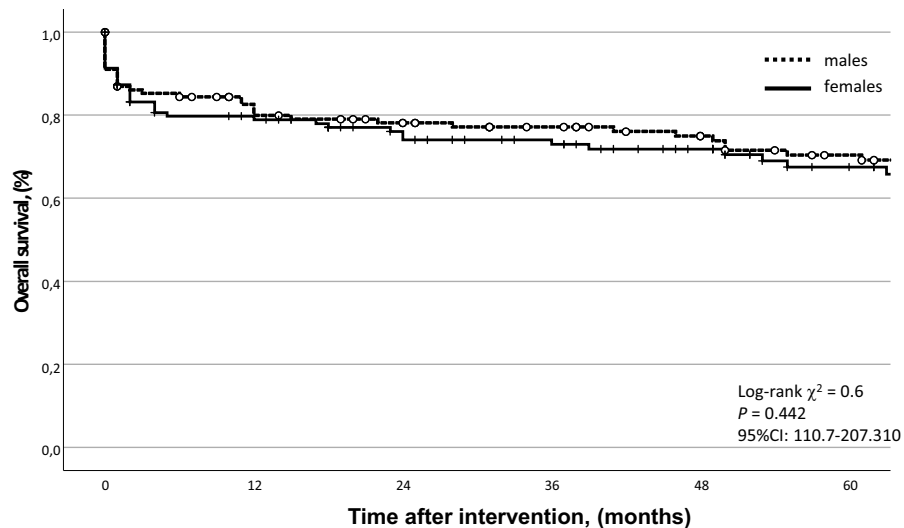
Covariate	Before matching				After matching			
	Males (n = 475)	Females (n = 180)	OR	P	Males (n = 151)	Females (n = 151)	OR	P
Access vessel								
Femoral	458 (96.2)	167 (93.0)	2.0	0.084	137 (96.5)	137 (96.5)	1.0	1.0
Aorto/iliac	17 (3.8)	13 (7.0)			5 (3.5)	5 (3.5)		
Totally percutaneous	391 (82.3)	135 (75.0)	0.7	0.069	118 (83.1)	110 (77.5)	0.7	0.296
Device								
Diameter, median (mm: IQR)	36 (34–40)	34 (31–37)		0.001	37 (34–40)	34 (31–37)		<0.001
EG, median (number: IQR)	1 (1–2)	1 (1–2)		0.703	1 (1–2)	1 (1–2)		0.112
>1 EG	197 (41.5)	70 (38.9)	0.9	0.574	64 (45.4)	48 (35.3)	0.6	0.111
Manufacturer [®]			1.1	0.362			0.7	0.128
W.L. Gore	201 (42.3)	85 (47.2)			42 (37.8)	56 (49.6)		
Terumo Aortic	101 (21.3)	32 (17.6)			28 (25.2)	20 (17.1)		
Cook	85 (17.9)	29 (16.2)			24 (21.6)	19 (16.8)		
Medtronic	77 (16.2)	28 (15.4)			15 (13.5)	14 (12.4)		
Artivion	4 (0.9)	4 (2.1)			0 (0.0)	3 (2.7)		
Lifetech	5 (1.1)	1 (0.7)			2 (1.8)	0 (0.0)		
Kawasumi	2 (0.6)	1 (0.7)			0 (0.0)	0 (0.0)		
Microport	0 (0.0)	1 (0.7)			0 (0.0)	1 (0.4)		
Procedure								
Aortic coverage, median (cm: IQR)	155 (135–200)	150 (127–226)		0.012	190 (150–212.5)	150 (114.7–200)		0.023
CSFD, n (%)	141 (29.6)	65 (36.1)	1.3	0.267	28 (29.8)	32 (34.4)	1.2	0.533
Duration, median (min: QR)	120 (75–180)	120 (60–240)		0.879	120 (65–198.7)	120 (70–227.5)		0.971
Proximal landing zone, n (%)			1.3	0.538			1.1	0.570
Zone 0	46 (9.8)	21 (11.7)			7 (6.4)	12 (11.9)		
Zone 1	26 (5.4)	13 (7.5)			5 (4.5)	5 (5.0)		
Zone 2	175 (36.8)	72 (40.0)			48 (43.6)	41 (40.6)		
Zone 3–4	228 (47.9)	74 (40.8)			50 (45.5)	43 (42.6)		
Contrast agent, median (ml: IQR)	105 (80–150)	90 (60–125)		0.342	110 (80–150)	90 (60–137.5)		0.693
Estimated blood loss, median (ml: IQR)	110 (50–300)	100 (50–475)		0.721	100 (50–337.5)	100 (50–487.5)		0.891
PRBC, median (units: IQR)	0 (0–2)	2 (0–2)		0.029	0 (0–2)	1.5 (0–2)		0.113

CSFD: cerebrospinal fluid drainage; EG: endograft; IQR: interquartile range; n: number; OR: odds ratio; PRBC: packed red blood cells.

Table 3: Type of complication after the index thoracic endovascular aortic repair

Access-related complications	Before matching				After matching			
	Males (n = 475)	Females (n = 180)	OR	P	Males (n = 151)	Females (n = 151)	OR	P
Overall, n (%)	18 (3.8)	6 (3.3)	1.1	0.781	6 (4.0)	5 (3.3)	0.8	1.0
Surgical approach, n (%)								
Wound infection	6	1			0	1		
Brachial artery occlusion	3	1			1	0		
Femoral artery occlusion	3	1			0	1		
Femoral artery pseudoaneurysm	0	1			1	0		
Percutaneous approach, n (%)								
Wound infection	6	1			2	0		
Lymphatic leakage	2				1	0		
Brachial artery occlusion	3	1			1	1		
Femoral artery occlusion	3	1			0	0		
Femoral haematoma	2	0			0	1		
Femoral artery pseudoaneurysm	0	1			0	1		

n, number; OR, odds ratio.



Time window	12m	24m	36m	48m	60m
Estimate, % males females	82.6 78.9	78.1 76.1	77.1 73.0	75.0 71.8	70.4 67.5
SE males females	0.03 0.04	0.04 0.04	0.04 0.04	0.04 0.04	0.04 0.05
@ risk males females	92 90	83 75	75 67	67 57	59 45
95%CI males females	74.7-84.5 70.8-85.2	69.8-84.6 68.2-82.6	68.7-83.7 64.3-80.2	66.5-82.0 63.0-79.2	61.2-78.2 58.0-75.8

Figure 2: Kaplan-Meier estimate of freedom from TEVAR-related reintervention stratified by the underlying aortic disease. TEVAR: thoracic endovascular aortic repair.

far as mortality is concerned. Overall, our 11% mortality rate at 30 days seems to be higher than previously reported, but we should underline that the incidence of emergent interventions due to rupture or complicated type B dissection is higher than the cohorts reported so far [10, 12, 16]. In particular, early

mortality was reported to be increased in females compared with males but this is evident only in the first wave of papers reporting on this topic, while the most recent did not [8, 12, 13]. Our 'real-world' data confirm that female gender did not impact early mortality: while acute clinical onset (e.g. emergency)

Table 4: Types of reinterventions during the follow-up

Reintervention (n = 26)	After matching		OR	P
	Males (n = 151)	Females (n = 151)		
			0.7	0.503
Distal TEVAR	3	2		
T1b endoleak	2	2		
T1b endoleak rupture	1	0		
TEVAR relining	1	1		
Intragraft thrombosis	1	0		
Endotension	0	1		
FEVAR/BEVAR	3	3		
Thoraco-abdominal extent	3	3		
Embolization	3	0		
LSA-related T2 endoleak	3	0		
Ascending replacement	1	2		
T1a endoleak	1	1		
Retrograde type A dissection	0	1		
Oesophageal stent	1	1		
Fistulization	1	1		

BEVAR: branched thoracic endovascular aortic repair; FEVAR: fenestrated thoracic endovascular aortic repair; LSA: left subclavian artery; n: number; OR: odds ratio; T1: type 1; T2: type 2.

negatively influenced 30-day mortality in both females and males, female gender itself was not a predictive factor of 30-day mortality.

In previous studies, access vessel for TEVAR has been identified as a concerning issue in female patients [13, 32]. This was not the case in our series: the site of access vessel as well as the need to expose the iliac artery through a retroperitoneal approach for EG insertion was not statistically different in our matched cohorts. Moreover, despite the use of iliac conduit has been recognized as a predictive factor for the development of major postoperative complications, the incidence of access-related complication has not been significantly different in our cohorts [33]. Of note, this observation held true throughout the different quartiles of our experience. Currently, it is impossible to advocate an unquestionable explanation for our results partially differing from the published literature. We can hypothesize that various factors may have had a positive influence on that. Previous published data homogeneously demonstrated that TEVAR did not demonstrate a volume-outcome effect, either in elective scenarios or in acute aortic syndromes [34, 35]. Nevertheless, the improving experience in TEVAR procedures at each centre may not be uniquely correlated with case volume. Potentially, technological improvements of the different generation devices over the years may partially explain our satisfactory data [31, 36–38]. The decrease in the device sheath size along with the improved quality of the materials, and the growing expertise of the operators in the careful selection of the access vessel, may have contributed to balance the differences in terms of access vessel complications.

A major limitation of the experiences that analysed gender-related outcomes during TEVAR was that focused on short-term results, primarily [30]. It would be more interesting to analyse the long-term results to appreciate the weight of the female gender on the TEVAR results. Although rarely evaluated in gender-related literature, TEVAR-related reintervention may have posed a considerable challenge to achieving long-term treatment success [9–11, 14–18, 30, 31]. While our data find consistent support within the most recent literature demonstrating that TEVAR-

related reintervention rate seems not to be impaired by gender, our experience has highlighted a different trend as far as the underlying aortic disease is concerned. Definitely, our finding needs to be confirmed in larger series compared to the scant data in the literature; however, in our cohort, the competing risk analysis showed that a dissection-related lesion was associated with a worse freedom from TEVAR-related reintervention survival [31, 39].

Limitation

This study has several limitations. First, the analysis is essentially retrospective in nature. Large databases rely solely on accurate site reporting, but they have potential high value due to sample size. Since each institutional database relies solely on the accuracy and completeness of data collection, it is possible that in such a context, investigators might have not identified all patients and all variables. However, missing data were not defaulted to negative, and denominators reflect only reported cases [40]. Moreover, multiple review auditing was performed by the senior authors (G.Pi., R.P., G.Pr., D.A.) at each centre to limit major inconsistencies. Second, the results may be influenced by selection bias, given the observational nature of the study; however, treatment criteria were homogeneous among the different centres, as well as guideline-based, and changes in indications and treatment did not occur significantly over time. Third, while we attempted to correct for potential confounders using multivariate analyses, the number of patients and events is relatively small, and the eventual absence of statistically significant differences could reflect a type II error. Notwithstanding all these limitations that may not allow for generalizability of our findings, our data compares well with the available literature owing to the very recent nature of the cohort and homogeneity protocol and follow-up among centres, as well as data validation by official health documents.

CONCLUSION

Our findings showed that the female gender itself was not associated with worse 30-day mortality and late survival than males with similar access vessel complication even when stratified by quartiles of the study period, device generation, acute clinical onset as well as type of aortic disease. Also, TEVAR-related reintervention rate was similar between females and males. Emergency TEVAR emerged as the most important predictor for survival independently of gender.

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DATA AVAILABILITY

The data underlying this article will be shared on reasonable request to the corresponding author.

Author contributions

Gabriele Piffaretti: Conceptualization; Data curation; Formal analysis; Methodology; Resources; Software; Supervision; Validation; Writing—original draft; Writing—review & editing. **Francesca Mauri:** Data curation; Resources; Writing—review & editing. **Gaddiel Mozzetta:** Data curation; Resources; Software; Writing—review & editing. **Sergio Zaca:** Data curation; Resources; Writing—review & editing. **Raffaele Pulli:** Conceptualization; Writing—review & editing. **Giovanni Pratesi:** Conceptualization; Writing—review & editing. **Aaron Thomas Fargion:** Data curation; Validation; Writing—review & editing. **Domenico Angiletta:** Conceptualization; Writing—review & editing.

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