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Secondary Interventions and Mortality Following Endovascular Aortic Aneurysm Repair: Device-specific Results from the UK EVAR Trials

The EVAR Trial Participants[1]

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Objectives. *To compare secondary intervention rate, aneurysm-related mortality and all-cause mortality for patients receiving elective endovascular aneurysm repair (EVAR) for large abdominal aortic aneurysms with different commercially available endografts.*
Design, materials & methods. *In the EVAR 1 and 2 multi-centre trials, the principal endografts used were Zenith and Talent and these are compared in 505 patients from EVAR 1 and 143 patients from EVAR 2 followed-up for an average of 3.8 years until 31st December 2005. Outcomes were analysed by Cox proportional hazards regression, with adjustments for potential confounding risk factors and centre. Gore/Excluder graft outcomes also are reported.*
Results. *Across the two trials the secondary intervention rates were 7.0 and 9.4 per 100 patient years for Zenith and Talent grafts respectively, adjusted hazard ratio 0.77 [95%CI 0.52–1.12]. Aneurysm-related mortality was 1.2 and 1.4 per 100 patient years for Zenith and Talent grafts respectively, adjusted hazard ratio 0.90 [95%CI 0.37–2.19]. All-cause mortality was 8.5 and 10.3 per 100 patient years for Zenith and Talent grafts respectively, adjusted hazard ratio 0.81 [95%CI 0.58–1.14]. The direction of all results was similar when the two trials were analysed separately.*
Conclusion. *There was no significant difference in the performance of the two endografts but the direction of results was slightly in favour of patients with Zenith (versus Talent) endografts.*

Keywords: Abdominal aortic aneurysm; Endovascular aneurysm repair; EVAR; Graft manufacturer; EVAR Trials.

Introduction

The pioneers of endovascular aortic aneurysm repair used "home-made" endografts.[1,2] The possibilities of this new, minimally invasive approach to repairing abdominal aortic aneurysms (AAAs) soon attracted commercial attention. The early commercial devices encountered a variety of problems and several have been voluntarily withdrawn from the market. Regulatory authorities in Europe and the USA still maintain a close watch on the performance of contemporary endografts and from time to time have issued alerts for specific devices.[3,4] By now the technology for contemporary bifurcated devices is relatively stable. Today there are at least 5 different companies offering bifurcated endografts of different design for infra-renal AAA repair (endovascular aneurysm repair or EVAR), that have been approved by the regulatory authorities in either Europe or the USA.

From the perspective of patient, clinician and regulatory authority there is a need to know whether any of the currently available devices are superior to their competitors. It is clear that randomised trials comparing devices would be challenging given their different anatomical requirements. Some comparative data for contemporary EVAR devices from registries or large volume centre series are becoming available.[5–7] The registries suffer from voluntary participation and incomplete reporting that could make comparative data unreliable. The large volume centre series are retrospective and difficult to adjust for relevant confounders. Two multi-centre randomised trials of open surgical repair versus EVAR have published mid-term results.[8,9] In these trials there has been close scrutiny of endograft performance with regular surveillance by CT scanning and comprehensive reporting of further interventions, complications such as graft migration, graft limb thrombosis and endoleaks: in the EVAR 1 trial, secondary interventions had been performed in 20% of patients undergoing elective EVAR by 4 years of follow-up.[8] This reporting comes from

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the individual trial centres and, for the UK EVAR trials, a programme to evaluate all CT scans in a standard manner at a core laboratory has started, to provide rigorous reporting of graft migration and endoleaks.

From the patient and health economic perspectives the need for further intervention is particularly important. The two principal EVAR devices used in the EVAR 1 trial were Zenith (Cook) and Talent (Medtronic). Excluder (Gore) was used in only about 7% of patients. In this first report to assess device performance, the mid-term secondary intervention rate (including graft ruptures and conversions to open repair) and mortality (all-cause and AAA-related) associated with use of the two principal devices in the EVAR trials 1 and 2[10] are compared and the results for the Excluder device are reported.

Materials and Methods

The detailed methodology for the EVAR trials has been described previously.[11] In brief, patients of either gender who were at least 60 years of age with an AAA measuring 5.5 cm or greater by CT scan were assessed for anatomical suitability for EVAR. Suitable patients were offered entry into EVAR Trial 1 if they were considered fit enough to have open AAA repair and consenting patients were randomised to receive either EVAR or open repair. Patients who were considered unfit for open repair were offered entry into EVAR Trial 2 which randomised patients to either EVAR or no intervention. In both trials, the device used was selected by the participating centre, and centralised National Health Service funding reimbursed the cost of all devices. Planned recruitment closed at the end of December 2003 and mid-term results have been published on these patients.[8,10] However, randomisation into both trials continued until the publication and dissemination of early trial results at the end of August 2004 and during this additional period the number of patients randomised increased to 1252 in EVAR Trial 1 and 404 in EVAR 2. All patients were followed up for death, through the Office for National Statistics (ONS), until 31st December 2005 (minimum follow-up 1.3 years, mean 3.8 years ignoring censoring by death). An endpoints committee reviewed the causes of death, to ascertain aneurysm-related mortality as accurately as possible. The reporting of re-interventions and graft complications was based upon case record form data sent by the trialists at each of the participating EVAR trial centres.

The aim of this study was to compare secondary intervention rate, mid-term AAA-related and all-cause mortality of the principal grafts used in each EVAR trial. The data from each trial were analysed separately, but device comparisons also were combined across the trials to increase power.

Analyses were restricted to those patients who received EVAR within their EVAR randomised group. Thus, in the EVAR arm of EVAR Trial 1, there were 598 elective EVAR procedures using the following devices: 318 Zenith (Cook), 187 Talent (Medtronic), 37 Excluder (Gore) and 56 others. For the comparison of Zenith and Talent devices, the 505 patients had a median follow-up of 2.87 years (prior to death or end of follow-up). In the EVAR arm of EVAR Trial 2, 174 EVAR devices were implanted electively: 109 Zenith (Cook), 34 Talent (Medtronic), 10 Excluder (Gore) and 21 others. For the comparison of Zenith and Talent devices the 143 patients had a median follow-up of 2.11 years (prior to death or end of follow-up).

Statistical analysis

The analyses were conducted according to a plan drawn up before inspecting the device-specific data. Patients recruited into the EVAR trials up to August 2004 and followed up to 31 December 2005, randomised to EVAR and electively receiving a Zenith or Talent device, were included in the primary analyses. It was decided that there were too few Excluder devices for formal statistical comparison. Separate analyses of the EVAR 1 and EVAR 2 trials were performed; device differences were then combined in analyses stratified by trial. Baseline characteristics and peri-operative variables in patients receiving different devices were compared using t-tests or chi-squared tests for continuous and categorical variables respectively. All-cause mortality, AAA-related mortality (including all deaths within 30 days of AAA surgery; censoring other causes of death) and secondary intervention (time to first re-intervention, conversion to open surgery, or graft rupture; censoring deaths) were analysed using Cox proportional hazards regression. Adjustments for pre-defined sets of baseline variables in estimating the device differences, expressed as hazard ratios, were made using propensity score analyses.[12] Adjustment was for age, sex, initial AAA diameter, FEV_1, log(creatinine), statin use, of graft (uni-iliac or bifurcated), aneurysm top neck diameter, aneurysm bottom neck diameter, aneurysm neck length, right common iliac diameter, left common iliac diameter and calendar year of operation. These propensity score adjustments correct for imbalances in characteristics between the patient groups receiving different devices, which can be employed

when there are many covariates and only limited numbers of events.[13] Crude and adjusted results are reported with the adjusted results regarded as the primary analysis. Further adjustment for body mass index, smoking status, systolic blood pressure and serum cholesterol made little difference. Additional adjustment for clinical centre as a random effect[14] was always non-significant ($p > 0.2$) and made no material difference to the results. Kaplan-Meier plots stratified by device are based on the adjusted Cox regression estimates.

Results

Outcomes in EVAR 1

Baseline demographic characteristics at randomisation and descriptive peri-operative information for patients receiving Zenith, Talent and Excluder devices in EVAR 1 are shown in Table 1, together with a formal comparison between patients with Zenith and Talent devices. There were too few Excluder devices for useful statistical comparison. Overall, the baseline characteristics of the patients used for this analysis were similar to those

Table 1. Baseline demographic and peri-operative variables for patients in EVAR 1 with elective endovascular repair by device type

	Zenith ($N = 318$)	Talent ($N = 187$)	*P*-value comparing Zenith and Talent	Excluder ($N = 37$)
	Mean (s.d.)	Mean (s.d.)	Student's t-test	Mean (s.d.)
Continuous variables				
Age at randomisation (years)	74.0 (6.0)	74.1 (6.1)	0.80	73.4 (6.0)
AAA diameter (cm)	6.4 (0.9)	6.4 (0.8)	0.80	6.4 (0.7)
FEV_1 (L)	2.2 (0.7)	2.0 (0.7)	0.0002	2.1 (0.7)
Creatinine, median [IQR] (μmol/L) (Median used as data skewed)	102 [91−117]	102 [91−121]	0.07[a]	97 [86−112]
AAA top neck diameter (cm)	2.4 (0.3)	2.4 (0.3)	0.86	2.2 (0.3)
AAA lower neck diameter (cm)	2.5 (0.4)	2.5 (0.4)	0.34	2.3 (0.3)
AAA neck length (cm)	2.8 (1.2)	2.8 (1.1)	0.98	2.7 (1.1)
Right common iliac diameter (cm)	1.6 (0.7)	1.7 (0.7)	0.49	1.4 (0.4)
Left common iliac diameter (cm)	1.6 (0.6)	1.5 (0.4)	0.02	1.4 (0.4)
Body mass index (kg/m^2)	26.8 (4.8)	26.6 (4.6)	0.62	25.0 (3.8)
Systolic blood pressure (mm Hg)	148.3 (22.3)	147.8 (21.2)	0.83	143.0 (21.2)
Serum cholesterol (mmol/L)	5.0 (1.2)	5.2 (1.3)	0.11	5.3 (1.2)
Calendar date of operation (years since 01.01.1998)	4.7 (1.3)	4.4 (1.4)	0.002	4.2 (1.4)
	No. of patients (%)	No. of patients (%)	Chi-squared test	No. of patients (%)
Categorical variables				
Sex				
Number of men	289 (90.9%)	168 (89.8%)	0.70	31 (83.8%)
Statin used	110 (34.9%)	68 (36.4%)	0.74	12 (33.3%)
Smoking				
Current	67 (21.1%)	34 (18.2%)	0.36	12 (32.4%)
Past	216 (67.9%)	129 (69.0%)		24 (64.9%)
Never	35 (11.0%)	24 (12.8%)		1 (2.7%)
	Mean (s.d)	Mean (s.d)	Student's t-test	Mean (s.d)
Peri-operative continuous variables				
Blood loss (mls)	102 (388)	130 (430)	0.46	111 (252)
Contrast agent (mls)	204 (105)	196 (98)	0.48	172 (113)
Length of operation (mins)	194 (70)	170 (49)	0.0001	163 (51)
ITU + HDU usage (days)	1.5 (4.0)	0.9 (3.6)	0.08	0.4 (0.6)
Length hospital stay (days)	8.6 (14.4)	11.3 (20.0)	0.08	9.0 (9.2)
	No. of patients (%)	No. of patients (%)	Chi-squared test	No. of patients (%)
Peri-operative categorical variables				
Graft shape				
Uni-iliac	20 (6.4%)	15 (8.4%)	0.82	0 (0%)
Bi-iliac/bi-fem	291 (93.6%)	163 (91.6%)		36 (100%)
Anaesthesia				
General	241 (77%)	138 (76%)	0.90	30 (81%)
Epidural/local	73 (23%)	43 (24%)		7 (19%)

[a] Student's t-test based upon log-transformed creatinine measurements.
FEV1 = Forced expiratory volume in 1 sec, ITU = Intensive Care Unit, HDU = High Dependency Unit.

reported in previous analyses.[8] Specific devices were selected by the participating centre and therefore there were some differences in baseline characteristics between the patients receiving Zenith and Talent devices, particularly for lung function as assessed by forced expiratory volume in 1 sec (FEV_1). Zenith devices were, on average, implanted at a later time during the course of the trials than the Talent devices and the Excluder devices were implanted the earliest. There were some differences between the devices in terms of peri-operative variables, with Zenith devices requiring more operating time in theatre than the Talent devices. Although there was a shorter hospital stay for the Zenith devices, there appeared to be a greater need for ITU/HDU beds than for the Talent devices.

Secondary interventions per 100 patient-years were non-significantly lower in patients receiving Zenith grafts at 6.4 versus 8.6 for patients with Talent grafts and this non-significant difference remained after adjustment for baseline covariates (Table 2). The underlying reasons for secondary interventions are shown in Table 3. Graft thrombosis appeared to be a more common problem in patients with Zenith grafts whilst migration and type I endoleak were more common in patients with Talent grafts. Overall, fewer secondary interventions were reported for patients with Zenith grafts (17.6%) versus patients with Talent grafts (22.5%). The crude AAA-related and all-cause mortalities appeared lower for Zenith patients than for Talent patients. However, these differences were diminished after adjustment for differences in baseline covariates (Table 2). Adjusted survival curves for secondary interventions and mortality are shown in Figs. 1 and 2 respectively. For patients with Excluder grafts, there were no operative or AAA-related deaths and the all-cause mortality was 3.7 [95% CI 1.2–8.7] per 100 person-years, somewhat lower than for the Zenith and Talent device groups. There were 4 re-interventions for the Excluder group, one for graft rupture, two for type 2 endoleak and one for exploration of a false aneurysm.

Outcomes in EVAR 2

The baseline characteristics and peri-operative variables for patients receiving Zenith and Talent grafts only are shown in Table 4 and there appeared to be little difference between this cohort and that reported in the mid-term EVAR 2 analyses[10] although the use of statins has increased slightly. Too few patients received Excluder grafts ($n = 10$) to justify reporting of either baseline characteristics or outcomes. There were few clear differences but a greater proportion of the Talent devices were aorto-uni-iliac, and this may be explained by the slightly larger mean right common iliac diameter in the Talent group. There was some evidence to suggest that the Zenith group were slightly older than the Talent group and that fewer patients were being treated with statins in the Zenith group than the Talent group. There were also more current smokers in the Zenith group. There was little difference in peri-operative variables between the devices.

Secondary interventions per 100 person-years appeared lower for the Zenith grafts at 9.6 versus 15.1 for patients with Talent grafts, although this difference was non-significant even after adjustment for baseline covariates (Table 2). The underlying reasons for secondary intervention are shown in Table 3; again

Table 2. Cox regression analysis for secondary intervention, AAA-related mortality and all-cause mortality for patients with Zenith versus Talent devices in EVAR 1 and EVAR 2 separately

EVAR trial 1				EVAR trial 2			
No. events/No. patients (Events per 100 person-years)		Hazard ratio (95% CI) [*p*-value]		No. events/No. patients (Events per 100 person-years)		Hazard ratio (95% CI) [*p*-value]	
Zenith ($N = 318$)	Talent ($N = 187$)	Crude	Adjusted[a]	Zenith ($N = 109$)	Talent ($N = 34$)	Crude	Adjusted[a]
Secondary intervention							
56/318 (6.4)	42/187 (8.6)	0.77 (0.52–1.15) [0.205]	0.79 (0.51–1.21) [0.273]	21/109 (9.6)	10/34 (15.1)	0.68 (0.31–1.47) [0.325]	0.69 (0.29–1.62) [0.391]
AAA-related mortality							
8/318 (0.8)	6/187 (1.0)	0.77 (0.27–2.23) [0.636]	0.88 (0.29–2.65) [0.817]	7/109 (2.8)	3/34 (4.0)	0.69 (0.18–2.66) [0.589]	0.94 (0.21–4.27) [0.939]
All-cause mortality							
58/318 (5.9)	50/187 (8.6)	0.70 (0.48–1.02) [0.062]	0.79 (0.53–1.19) [0.263]	46/109 (18.5)	18/34 (23.9)	0.83 (0.47–1.46) [0.524]	0.85 (0.45–1.60) [0.616]
No. of cases dropped due to missing values		0	30	No. of cases dropped due to missing values		0	11

[a] Adjustment using propensity score for age, sex, initial AAA diameter, FEV_1, log(creatinine), statin use, shape of graft, aneurysm top neck diameter, aneurysm bottom neck diameter, aneurysm neck length, right common iliac diameter, left common iliac diameter and calendar year of operation.

Table 3. Reasons for secondary intervention in the EVAR trials

Complication	EVAR trial 1			EVAR trial 2		
	Zenith $N = 318$ (% of 318)	Talent $N = 187$ (% of 187)	Total $N = 505$	Zenith $N = 109$ (% of 109)	Talent $N = 34$ (% of 34)	Total $N = 143$
Graft rupture	5 (1.6%)	2 (1.1%)	7	0	0	0
Graft infection	1 (0.3%)	0	1	0	0	0
Migration	2 (0.6%)	5 (2.7%)	7	0	0	0
Type 1 endoleak (proximal or distal)	8 (2.5%)	9 (4.8%)	17	5 (4.6%)	1 (2.9%)	6
Type 3 endoleak	5 (1.6%)	0	5	3 (2.8%)	1 (2.9%)	4
Graft kinking	0	1 (0.5%)	1	1 (0.9%)	0	1
Endotension	0	0	0	0	1 (2.9%)	1
Type 2 endoleak	8 (2.5%)	7 (3.7%)	15	4 (3.7%)	0	4
Technical deployment problems	7 (2.2%)	2 (1.1%)	9	0	0	0
Unspecified endoleak	2 (0.6%)	3 (1.6%)	5	0	2 (5.9%)	2
Graft thrombosis	11 (3.5%)	2 (1.1%)	13	1 (0.9%)	1 (2.9%)	2
Graft stenosis	1 (0.3%)	0	1	0	0	0
Distal embolisation from graft	1 (0.3%)	0	1	0	0	0
Anastomotic aneurysm	0	1 (0.5%)	1	0	0	0
Iliac expansion	0	1 (0.5%)	1	0	0	0
Other surgery during primary admission (cardiac/abdominal or vascular)	5 (1.6%)	7 (3.7%)	12	5 (4.6%)	2 (5.9%)	7
Other and unknown	0	2 (1.1%)	2	2 (1.8%)	2 (5.9%)	4
Total	56 (17.6%)	42 (22.5%)	98	21 (19.3%)	10 (29.4%)	31

there were fewer secondary interventions in patients with Zenith grafts (19.3%) versus patients with Talent grafts (29.4%). The secondary intervention rate for the Zenith and Talent groups combined in EVAR 2 (10.9 per 100 person years) was higher than that for the patients in EVAR 1 (7.2 per 100 person years), but this did not achieve statistical significance, hazard ratio 1.33 [95% CI 0.89−2.00] and there are many differences in baseline characteristics of patients between the two trials that could contribute to this observation. The crude all-cause mortality was much higher than in EVAR 1, but there were no significant differences between the Talent and Zenith patients in terms of either AAA-related or all-cause mortality (Table 2). Adjusted survival curves for secondary interventions and mortality are shown in Figs. 3 and 4 respectively.

Combining EVAR 1 and EVAR 2

The number of secondary interventions and AAA-related deaths in each group was small. So to improve the power of the analysis, despite the very different

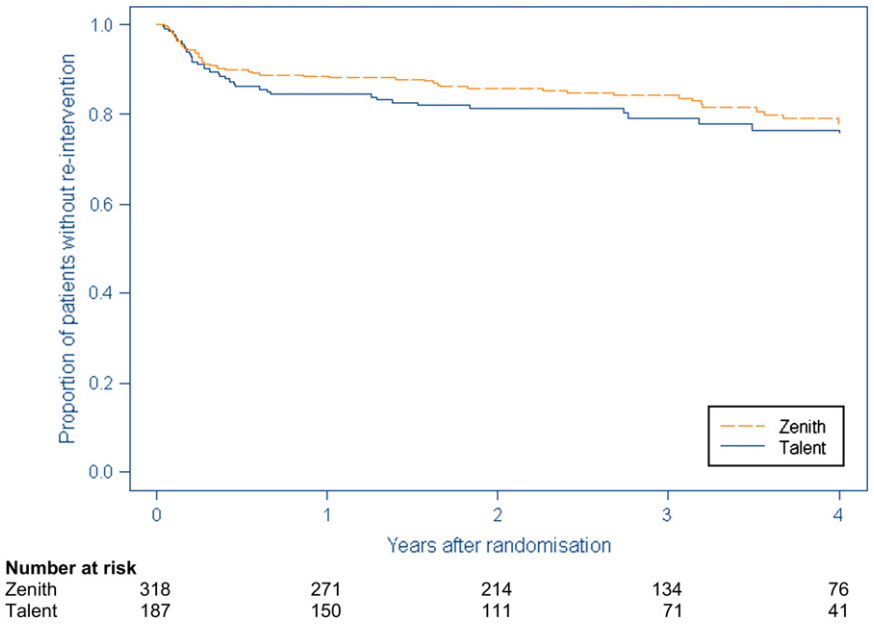

Fig. 1. EVAR 1 adjusted Cox regression estimates of time to secondary intervention by device graft used with numbers at risk.

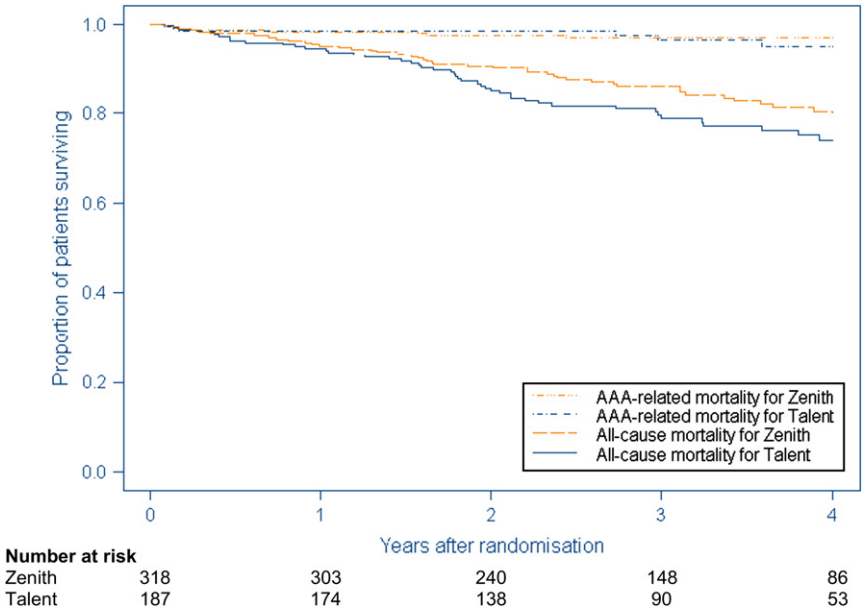

Fig. 2. EVAR 1 adjusted Cox regression survival estimates by device graft used with numbers at risk.

co-morbidities of patients in the two trials, the device differences were combined across trials (Table 5). There were no significant differences in secondary intervention rate, AAA-related mortality or all-cause mortality although the direction of results tended to favour the patients with Zenith devices.

Discussion

The two principal endografts used in the EVAR trials have different design features. Talent is a modular polyester graft with interspersed self-expanding stents. It is available in aortic diameters ranging from 24–36 mm and employs a non barbed suprarenal bare metal fixation. Zenith is a self-expanding modular Dacron graft supported by Z stents. It also uses suprarenal bare metal fixation, but unlike with the the Talent device, proximal fixation is assisted by barbs which can be driven into the aortic wall using a balloon moulding technique. This is marketed as producing a very low rate of proximal graft migration. Likewise, it is available in a variety of diameters ranging between 22 and 36 mm, although the larger diameters have only been available latterly. Both devices have iliac limb diameters varying from 8–24 mm and both have additional components, such as proximal cuffs and extension limbs, which are used as required to generate an adequate seal at the time of or following initial deployment. In addition, the Zenith device can now be obtained in scalloped or fenestrated modalities, although these devices were not available for inclusion in either the EVAR 1 or 2 trials.

The term Talent or Zenith graft is used overall, even though there have been design modifications during the recruitment period to the EVAR trials (1999–2004). The criteria for secondary interventions were not pre-specified and indeed may have altered during the trials, with fewer secondary interventions for type II endoleak in the latter part of the trial. The non-randomised comparison of these two devices for AAA repair is subject to potential bias and therefore comparative data have been adjusted for multiple confounders, including calendar year of operation to allow for device modification. Only mid-term results are available. For all these reasons the results must be interpreted with caution.

Although the crude AAA-related and all-cause mortalities were higher for patients with Talent grafts, this could be explained by the Talent patients being less fit than Zenith patients, especially with respect to lung function in EVAR Trial 1; in particular there is a suspicion that the shorter operating time for Talent devices could be a contributory factor to the increased use of these devices in patients with poor lung function. After adjustment for co-morbidities there was no clear difference in all-cause mortality between patients with Talent and Zenith devices. A small amount of missing data resulted in loss of up to 41 patients in the adjusted analyses. There were not a disproportionate number of secondary

Table 4. Baseline demographic and peri-operative variables for patients in EVAR 2 with elective endovascular repair by device type

	Zenith ($N = 109$)	Talent ($N = 34$)	P-value
	Mean (s.d.)	Mean (s.d.)	Student's t-test
Continuous variables			
Age at randomisation (years)	77.3 (6.8)	75.4 (6.1)	0.15
AAA diameter (cm)	6.8 (1.1)	6.8 (1.1)	0.84
FEV_1 (L)	1.6 (0.6)	1.6 (0.6)	0.49
Creatinine, median [IQR] (μmol/L) (Median used as data skewed)	105 [87−123]	111 [88−134]	0.86[a]
AAA top neck diameter (cm)	2.4 (0.3)	2.4 (0.4)	0.28
AAA lower neck diameter (cm)	2.6 (0.3)	2.5 (0.5)	0.37
AAA neck length (cm)	2.8 (1.5)	2.8 (1.0)	0.88
Right common iliac diameter (cm)	1.7 (0.6)	2.1 (1.5)	0.09
Left common iliac diameter (cm)	1.6 (0.6)	1.6 (0.7)	0.52
Body mass index (kg/m^2)	26.9 (5.0)	26.8 (4.6)	0.99
Systolic blood pressure (mm Hg)	139.5 (21.1)	140.5 (17.5)	0.81
Serum cholesterol (mmol/L)	4.7 (1.0)	4.8 (1.7)	0.71
Calendar date of operation (years since 01.01.1998)	5.0 (1.3)	4.8 (1.4)	0.27
	No. of patients (%)	No. of patients (%)	Chi-squared test
Categorical variables			
Sex			
Number of men	98 (89.9%)	28 (82.4%)	0.24
Statin used	46 (42.2%)	20 (58.8%)	0.09
Smoking status			
Current	25 (22.9%)	2 (5.9%)	0.19
Past	76 (69.7%)	31 (91.2%)	
Never	8 (7.3%)	1 (2.9%)	
	Mean (s.d)	Mean (s.d)	Student's t-test
Peri-operative continuous variables			
Blood loss (mls)	171 (643)	277 (461)	0.38
Contrast agent (mls)	203 (110)	174 (101)	0.21
Length of operation (mins)	194 (58)	192 (72)	0.82
ITU + HDU usage (days)	1.7 (3.3)	1.7 (3.2)	0.92
Length hospital stay (days)	11.4 (19.2)	14.8 (11.2)	0.33
	No. of patients (%)	No. of patients (%)	Chi-squared test
Peri-operative categorical variables			
Shape of the graft			
Uni-iliac	7 (6.4%)	7 (21.9%)	0.01
Bi-iliac/bi-fem	102 (93.6%)	25 (78.1%)	
Anaesthesia			
General	59 (55%)	14 (45%)	0.35
Epidural/local	49 (45%)	17 (55%)	

[a] Student's t-test based upon log-transformed creatinine measurements.
FEV1 = Forced expiratory volume in 1 sec, ITU = Intensive Care Unit, HDU = High Dependency Unit.

interventions or deaths in the patients excluded with missing data and hence missing data are not likely to be an important source of bias. In addition there did not appear to be any significant centre effect on any of the outcome measures. As expected, both AAA-related and all-cause mortality were higher in EVAR 2 patients.

There was a non-significant trend for patients with Zenith endografts to have a lower secondary intervention rate than patients with Talent endografts; 6.4 versus 8.6 per 100 patient-years respectively for EVAR 1 patients. It must be stated however that this study was not powered to detect small differences in secondary intervention rates. Nevertheless, the direction of benefit in favour of Zenith is in accord with other studies, although usually secondary interventions are reported as crude percentages, which tend to underestimate the secondary intervention rate. For instance, in the EUROSTAR registry 91/1147 (7.9%) patients with Zenith grafts had secondary interventions compared with 77/791 (9.7%) patients with Talent grafts.[7] In a much smaller Spanish study, the secondary intervention rate for patients with Zenith and Talent grafts were 1.7% and 11.1% respectively.[15] In contrast to these observations, it has been suggested that patients with Talent grafts might

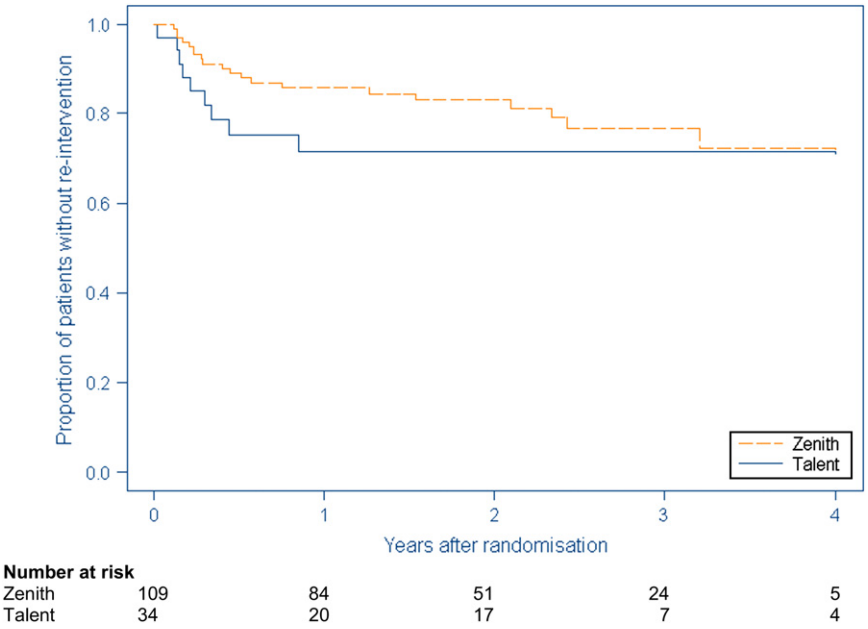

Fig. 3. EVAR 2 adjusted Cox regression estimates of time to secondary intervention by device graft used with numbers at risk.

have the lowest rate of type II endoleaks.[6] However, there was no evidence of fewer interventions for type II endoleaks in patients with Talent grafts in the EVAR trials. Previously, the range of Talent grafts available made them applicable to wider necked aneurysms than the Zenith graft, but again there was no clear evidence that Talent grafts were used in cases with wider aneurysm necks in the EVAR trials. The softer Talent graft may have been preferred to treat patients with significant angulation of their infrarenal necks. In this group, deployment of the stiffer Zenith device with the rigid suprarenal uncovered stent could result in proximal type 1 endoleak. Likewise, the Zenith graft with its long suprarenal barbs may have been used preferentially by several centres for the treatment of patients with ''short'' infrarenal aortic necks (0.5–1.5 mm), in an attempt to minimise the risk of proximal graft migration. Again, there is no

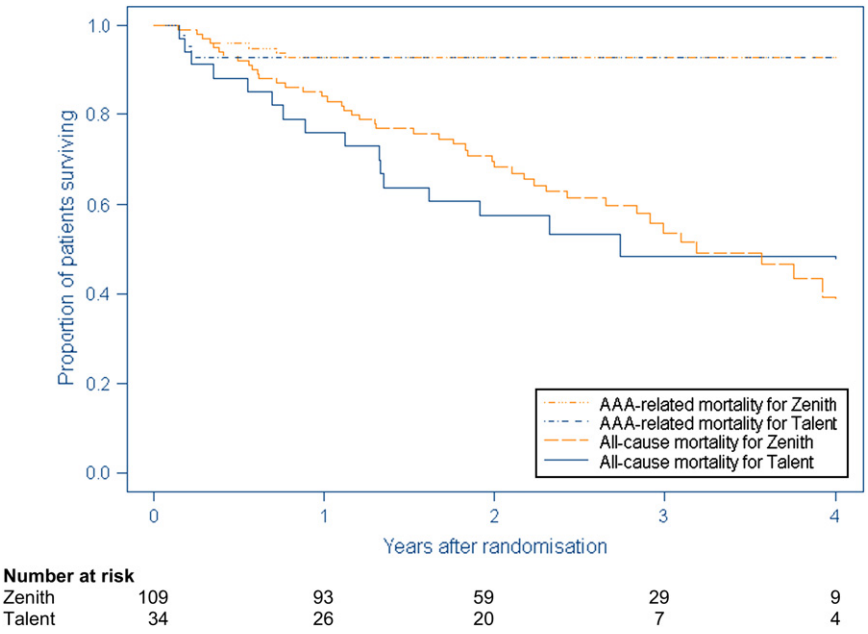

Fig. 4. EVAR 2 adjusted Cox regression survival estimates by device graft used with numbers at risk.

Table 5. Cox regression analysis for secondary intervention, AAA-related mortality, and all-cause mortality for patients with Zenith versus Talent devices in EVAR 1 and 2 combined

No. events/No. patients (Events per 100 person-years)		Hazard ratio[a] (95% CI) [*p*-value]	
Zenith ($N = 427$)	Talent ($N = 221$)	Crude	Adjusted[b]
Secondary intervention			
77/427 (7.0)	52/221 (9.4)	0.75 (0.53−1.07) [0.116]	0.77 (0.52−1.12) [0.174]
AAA-related mortality			
15/427 (1.2)	9/221 (1.4)	0.74 (0.32−1.71) [0.480]	0.90 (0.37−2.19) [0.816]
All-cause mortality			
104/427 (8.5)	68/221 (10.3)	0.74 (0.54−1.01) [0.056]	0.81 (0.58−1.14) [0.224]
No. of cases dropped due to missing value		0	41

[a] Hazard ratio stratified by trial.
[b] Adjustment using propensity score for age, sex, initial AAA diameter, FEV_1, log(creatinine), statin use, shape of graft, aneurysm top neck diameter, aneurysm bottom neck diameter, aneurysm neck length, right common iliac diameter, left common iliac diameter and calendar year of operation.

evidence to support this practice and Zenith now advise the use of scalloped or fenestrated grafts for these patients. Another factor favouring the use of the Zenith device was the superiority of its delivery system. Whereas the Zenith consisted of a low profile rigid delivery system and utilised a long tapered nose cone, the Talent delivery system was designed with a shorter, stubbier nose cone and a softer outer sheath, which often deformed like a concertina during more difficult deployments. This has been corrected with current devices and the two delivery systems are now very similar. Despite these differences, the major determinant of graft usage is likely to have been 'centre directed', with individual endovascular specialists preferring a single favourite device for their patients. In fact, many centres used a single device type during the course of the trials, hence the importance of adjusting for centre.

The results presented here are the first device-specific analyses based upon the EVAR Trials and the outcomes analysed were selected because they are relatively robust endpoints that do not require further validation. Although no statistically significant differences have been noted in the performance of each graft, the follow-up period is relatively short (mean 3.8 years, not accounting for deaths) and it is possible that the performance of these devices may not demonstrate such equivalence with continued follow-up. Equally it is possible that any difference in secondary intervention rate would be revealed early, during the time period with the highest rate of secondary intervention. It is also worth noting that although the Excluder device results appear encouraging, they are based on very small numbers and should be interpreted with caution. For this reason, it is imperative that comparisons between devices in terms of both AAA and all-cause mortality, in addition to specific complications such as graft rupture, migration and endoleak, continue. Recently, the EVAR Trials Management Committee have secured further funding for the instigation of a central CT scan core laboratory which will be used to validate all the CT scan measurements as well as any reports of device related complications. As the reporting of these events is subject to individual interpretation, the data will need to be validated before a reliable comparison can be made. This will become a useful tool for monitoring and investigating the performance of these devices further.

In summary, the current data suggests that both Zenith and Talent endografts performed well within the context of the EVAR 1 and 2 trials, as depicted by a low AAA-related and all-cause mortality. Although no significant difference was detected in the performance of these devices, there remains the possibility that the secondary intervention rate may be higher for patients with Talent grafts.

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