Eur J Vasc Endovasc Surg (2017) 54, 5–11

Comparison of Renal Complications between Endografts with Suprarenal and Infrarenal Fixation☆

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WHAT THIS PAPER ADDS
This study adds to the understanding of differential outcomes in patients undergoing EVAR with suprarenal versus infrarenal fixation devices.

Objectives: Surgeons have multiple grafts options available for the endovascular treatment of abdominal aortic aneurysm (EVAR), and some hypothesize that suprarenal fixation endografts may result in higher rates of renal complications than infrarenal endografts. This study aimed to compare the outcomes of contemporary suprarenal and infrarenal endografts.
Methods: The Targeted Vascular Module of the National Surgical Quality Improvement Project was utilised to identify patients undergoing EVAR for infrarenal aneurysm from 2011 to 2013. Pre-operative and operative variables and 30 day outcomes were compared among suprarenal (Zenith and Endurant) and infrarenal fixation devices (Excluder). Renal complications included creatinine increase $>$ 2 mg/dL or new dialysis, as defined by NSQIP. Multivariate regression was completed to account for patient demographics, comorbidities, and operative characteristics.
Results: A total of 3587 patients were evaluated including 2273 (63%) with suprarenal grafts and 1314 (37%) with infrarenal grafts. Patients with suprarenal grafts were less commonly white (84% vs. 88%, $p < .01$) and more commonly male (83% vs. 80%, $p = .03$). There were no differences in age or comorbidities. Renal complications (1.1% vs. 0.1%, $p < .01$) and length of stay more than 2 days (34% vs. 25%, $p < .01$) occurred more commonly after suprarenal fixation. After adjustment, suprarenal grafts had significantly higher rates of renal complications (OR, 12.0; 95% CI, 1.6–91) and length of stay more than 2 days (OR, 1.4; 95% CI, 1.2–1.7).
Conclusion: Overall rates of renal complications following EVAR are low. Patients selected for suprarenal stent grafts are at increased risk of renal complications and prolonged length of stay, which may be due to selection bias, deployment techniques, or the presence of a bare stent overlying the renal arteries. Further studies are necessary to evaluate the mechanism and duration of renal dysfunction and important long-term outcomes of interest.

Article history: Received 20 October 2016, Accepted 1 February 2017, Available online 6 March 2017
Keywords: EVAR, Endograft, Fixation, Renal complications, NSQIP

INTRODUCTION

Since it was first described in 1991 by Juan Parodi, endovascular repair of abdominal aortic aneurysms (EVAR) has gained widespread prominence for the treatment of aortic aneurysmal disease.[1,2] As a result, a wide variety of endografts are available for surgeon selection. The safety and efficacy of such devices have been shown in clinical trials as well as Food and Drug Administration (FDA) post-market studies.[3–6]

Despite similar safety profiles, one major difference between endografts is their mechanism of fixation. Today, surgeons have the option of using endografts with suprarenal or infrarenal fixation. Several previous studies have found no differences in most outcomes between grafts with different fixation; however, such research has been limited to small single institution studies and sponsored trials from the early era of EVAR.[7–11] Other studies, bound by similar limitations, have identified increased renal complications among those grafts with suprarenal fixation.[12,13] To date, few studies have evaluated the effect of fixation among patients treated after 2010, and given the dramatic evolution in endovascular technology over the past decade, many

☆ This article was presented at the 44th Annual Society for Clinical Vascular Surgery Annual Meeting, Las Vegas NV, March 12–16, 2016.

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http://dx.doi.org/10.1016/j.ejvs.2017.02.001

of the grafts previously studied are no longer widely utilised, are currently unavailable, or have undergone significant changes in design. Moreover, many of the most commonly used grafts today were not available for inclusion in prior studies. Therefore, this study aims to describe outcomes following EVAR in patients chosen to have a suprarenal versus infrarenal fixation device in the current era.

METHODS

Population

The Targeted Vascular Module of the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) was utilised to identify all patients undergoing elective endovascular repair of infrarenal abdominal aortic aneurysm (AAAs) from 2011 to 2013. Patients treated for a rupture ($n = 353$, 7%) and those treated with fenestrated grafts ($n = 112$, 2.2%) were excluded. As a national clinical registry, NSQIP aims to improve surgical care by providing risk adjusted clinical outcomes in the first 30 days following the operative procedure. The targeted module, developed in 2011, greatly expanded the variables collected and allowed for more tailored disease and procedure specific analyses with additional variables such as aortic diameter, operative time, and concomitant procedures, among other pertinent variables. As of the time of analysis, 83 centres contributed to the targeted data. Clinical reviewers prospectively collect demographics, intra-operative details, and 30 day surgical outcomes in a standardised fashion according to NSQIP protocol. NSQIP methodology has been validated for data input accuracy and regular quality assessments are performed through internal and external audits.[20–22] Further information is available at www.facs.org/quality-programs/acs-nsqip.

Grafts were selected for comparison in this study if they had been used more than 100 times (Zenith, Powerlink, Excluder, Endurant). Those grafts not evaluated included AneuRx ($n = 10$, 0.2%), Talent ($n = 19$, 0.4%), Aorfix ($n = 2$, 0%), Ovation ($n = 39$, 0.9%), and other/homemade grafts ($n = 185$, 4.3%). Grafts with suprarenal fixation included Zenith and Endurant. The only infrarenal graft used more than 100 times was Excluder. Because Powerlink can be used in both an infrarenal and suprarenal configuration, it was not included in the comparison between infrarenal and suprarenal endografts, but was assessed in a separate analysis comparing individual grafts.

Variables

Variable definitions for baseline characteristics and outcomes were chosen and clearly delineated by NSQIP and thus not modifiable.[14] Patient demographics, age, and comorbid conditions were compared. Smoking was defined as current tobacco use. Glomerular filtration rate was calculated in accordance with the Modification of Diet in Renal Disease (MDRD) equation, and chronic kidney disease was identified according to the Kidney Disease Improving Global Outcomes (KDIGO) 2012 Clinical Practice Guidelines.[15–17] Among operative variables, distal aneurysm extent was defined as aortic or iliac. Percutaneous access was defined as a bilateral percutaneous approach. Renal revascularisation was defined by the NSQIP as any renal stent, although further granularity, including whether or not angioplasty was performed, was unknown.

All outcomes measured occurred within 30 days of operation. A renal complication was defined by the NSQIP as a post-operative creatinine increase >2 mg/dL from baseline at any point in the first 30 days post-operatively, or new dialysis. This was a binary variable, and there are no data regarding post-operative creatinine. Patients on dialysis preoperatively were excluded from analysis of renal complications. A pulmonary complication was defined as pneumonia, failure to wean from mechanical ventilation within 48 h, reintubation, or pulmonary embolism. Prolonged length of stay was defined as greater than 2 days after intervention.

Statistical analysis

Univariate analysis was performed to compare outcomes between infrarenal and suprarenal grafts, as well as individual graft types. The chi-square and the Fisher exact tests were utilised to compare categorical variables, and the Student *t* test, ANOVA, and Mann–Whitney were utilised to assess continuous variables, as appropriate. When all variables were evaluated, only distal extent exceeded 3% missing data, with 13% missing for both. Stepwise multivariate analysis was completed to account for demographics, comorbidities, and operative characteristics. For comparison of individual graft types, the Excluder was chosen as the reference group because it was the only infrarenal graft. Purposeful selection was utilised to select variables for inclusion into each model.[18] This included all variables with $p < .1$ on univariate screen as well as those variables shown to be predictive of each evaluated endpoint in previous studies. The Hosmer–Lemeshow goodness of fit test was used to evaluate the stability of each model. A p value $< .05$ was considered significant. Statistical analysis was performed using the SPSS statistical package (version 21.0). The institutional review board of Beth Israel Deaconess Medical Centre approved this study and waived consent due to the de-identified nature of the NSQIP database.

RESULTS

A total of 3587 EVARs were evaluated including 1977 (55%) with suprarenal fixation, 1314 (37%) with infrarenal fixation, and 296 (8%) with a Powerlink endograft placed, for which suprarenal or infrarenal fixation could not be identified. When individual grafts were compared, 1314 (37%) Excluder, 1166 (33%) Endurant, 811 (23%) Zenith, and 296 (8%) Powerlink grafts were evaluated.

Demographics and comorbidities

When baseline characteristics were compared, there were no differences in any comorbid conditions, including diabetes, smoking, chronic obstructive pulmonary disease, congestive heart failure, hypertension, and chronic kidney disease (Table 1). Patients with infrarenal grafts were more

Table 1. Baseline demographics among patients treated with suprarenal and infrarenal stent graft fixation in the targeted NSQIP from 2011 to 2013.

Outcomes	Infrarenal grafts (Excluder), $N = 1314$	All suprarenal grafts, $N = 2,273$	Endurant, $N = 1,166$	Zenith, $N = 811$	Powerlink, $N = 296$	p (all)	p (suprarenal vs. infrarenal)
Age, mean (SD)	74 (9)	75 (8)	75 (8)	74.5 (89)	74 (9)	.15	.08
Male gender	1056 (80)	1648 (83)	959 (82)	689 (85)	222 (75)	< .01	.03
White race	1162 (88)	1656 (84)	1015 (87)	641 (79)	265 (90)	< .01	< .01
Diabetes	207 (16)	316 (16)	173 (15)	143 (18)	46 (16)	.41	.86
Smoker (current)	404 (31)	571 (29)	343 (29)	228 (28)	105 (36)	.11	.25
COPD	229 (17)	351 (18)	207 (18)	144 (18)	59 (20)	.71	.81
CHF	22 (1.7)	31 (1.6)	21 (1.8)	10 (1.2)	2 (.7)	.45	.81
Hypertension	1046 (80)	1614 (82)	957 (82)	657 (81)	228 (77)	.18	.15
GFR < 60	446 (35)	713 (37)	421 (37)	292 (37)	99 (34)	.52	.21
Dialysis	17 (1.3)	14 (.7)	6 (.5)	8 (1.0)	3(1)	.26	.09

Note. Values are number (%) unless stated otherwise. CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; GFR = glomerular filtration rate; SD = standard deviation.

commonly white (88% vs. 84%, $p < .01$) and female (20% vs. 17%, $p = .03$) than those with suprarenal grafts. When individual grafts were compared the proportion of patients who were white (Excluder, 88%; Endurant, 87%; Zenith, 79%; Powerlink, 90%, $p < .01$) and female (Excluder, 20%; Endurant, 18%; Zenith, 15%; Powerlink, 25%; $p < .01$) also differed.

Operative characteristics

The median aneurysm diameter was 5.5 cm for all graft types; however, the interquartile range varied ($p < .01$) (Table 2). Infrarenal grafts were more likely to have percutaneous access (27% vs. 23%, $p < .01$) and aneurysm extent involving the iliac vessels (aorta 58% vs. 51%, $p < .01$). Additionally, renal revascularisation was more common among grafts with suprarenal fixation (4% vs. 3%, $p = .02$). There was no difference in median operative time between grafts with infrarenal and suprarenal fixation (infrarenal, 131 min; suprarenal, 129 min, $p = .34$)

When individual grafts were compared, percutaneous access (Excluder, 27%; Endurant, 24%; Zenith, 21%; Powerlink, 32%; $p < .01$), aneurysm extent involving the iliac vessels (Excluder, 58%; Endurant, 53%; Zenith, 51%; Powerlink, 43%; $p < .01$), renal revascularisations (Excluder, 3%; Endurant, 4%; Zenith, 5%; Powerlink, 5%; $p = .04$), and hypogastric embolisation (Excluder, 6%; Endurant, 6%; Zenith, 9%; Powerlink, 5%; $p < .01$) varied. There was a statistically significant difference in median operating time between grafts; however the range was only 15 min (Excluder, 131 min; Endurant, 124 min; Zenith, 137 min; Powerlink, 139 min; $p < .01$).

Outcomes

Suprarenal grafts had increased renal complications (1.1% vs. 0.1% $p < .01$) and prolonged length of stay (34% vs. 25%, $p < .01$) (Table 3). There were no differences in 30 day mortality (infrarenal 1% vs. suprarenal 2%, $p = .24$). Following multivariate analysis, both renal complication (OR, 12.0; 95% CI, 1.6—91) and prolonged length of stay (OR, 1.4; 95% CI, 1.2—1.7) remained more likely among grafts with suprarenal fixation (Table 4). The increased rate of renal complications was maintained when patients undergoing renal revascularisation were excluded (1.0% vs. 0.1%; $p < .01$; OR, 11; 95% CI, 1.4—83). Following multivariate analysis, those factors predictive of renal complications included suprarenal fixation, pre-operative chronic kidney disease (GFR < 60), female gender, age, and an aneurysm involving the iliac vessels.

When individual grafts were compared, renal complications (Excluder, 0.1%; Endurant, 0.9%; Zenith, 1.4%; Powerlink; 1%; $p < .01$) and prolonged length of stay differed (Excluder, 25%; Endurant, 33%; Zenith, 36%; Powerlink, 35%; $p < .01$) (Table 3). Additionally, myocardial infarction

Table 2. Operative characteristics among patients treated with suprarenal and infrarenal stent graft fixation in the targeted NSQIP from 2011 to 2013.

Outcomes	Infrarenal Grafts (Excluder), $N = 1314$	All Suprarenal grafts, $N = 2273$	Endurant, $N = 1,166$	Zenith, $N = 811$	Powerlink, $N = 296$	p (all)	p (suprarenal vs. infrarenal)
Diameter, cm, median (IQR)	5.5 (5.0—6.0)	5.5 (5.1—6.1)	5.5 (5.1—6.2)	5.5 (5.2—6.1)	5.4 (5.0—5.9)	< .01	< .01
AAA extends into iliac	659 (58)	884 (51)	523 (52)	361 (51)	110 (43)	< .01	< .01
Prior aortic surgery	13 (1)	33 (2)	20 (2)	12 (2)	1 (0)	.54	.25
Percutaneous access	347 (27)	444 (23)	274 (24)	170 (21)	94 (32)	< .01	< .01
Hypogastric embolization	76 (6)	140 (7)	64 (6)	76 (9)	15 (5)	< .01	.14
Renal revascularization	36 (3)	85 (4)	46 (4)	39 (5)	16 (5)	.04	.35
Lower extremity revascularization	33 (3)	63 (4)	31 (3)	32 (4)	9 (4)	.35	.15
Operative time, mins, median (IQR)	131 (101—165)	129 (104—169)	124 (100—160)	137 (109—180)	139 (101—180)	< .01	.34

Note. Values are number (%) unless stated otherwise. IQR = interquartile range; min = minutes.

Table 3. Stent graft fixation in the targeted NSQIP from 2011 to 2013.

Outcomes	Infrarenal grafts (Excluder), $N = 1314$	All suprarenal grafts, $N = 2,273$	Endurant $N = 1,166$	Zenith, $N = 811$	Powerlink, N = 296	p (all)	p (suprarenal vs. infrarenal)
30-day mortality	13 (1)	33 (2)	20 (2)	12 (2)	1 (0)	.18	.24
Renal complications	1 (0.1)	21 (1.1)	10 (.9)	11 (1.4)	3 (1.0)	$< .01$	$< .01$
Pulmonary complication	34 (3)	44 (2)	24 (2)	14 (2)	6 (2)	.59	.20
Reoperation	53 (4)	68 (3)	43 (4)	25 (3)	15 (5)	.44	.38
Wound infection	23 (2)	35 (2)	19 (2)	11 (1)	5 (2)	.92	.63
Myocardial infarction	12 (1)	34 (2)	10 (1)	15 (2)	9 (3)	$< .01$	.14
Ischemic colitis	3 (0.2)	13 (0.6)	8 (0.7)	4 (.5)	1 (0.3)	.39	.19
Lower extremity ischemia	16 (1)	28 (1)	16 (1)	9 (1)	3 (1)	.94	.97
Length of stay > 2 days	334 (25)	775 (34)	380 (33)	292 (36)	103 (35)	$< .01$	$< .01$

Note. Values are number (%) unless stated otherwise.

(Excluder, 0.9%; Endurant, 0.9%; Zenith, 1.8%; Powerlink, 3%; $p < .01$) also differed between endografts. Mortality rates were similar (Excluder, 1%; Endurant, 2%; Zenith, 2%; Powerlink, 0%; $p = .18$). Following multivariate analysis, renal complications were least likely with the Excluder (Endurant: OR, 11.6; 95% CI, 1.5—91; Zenith: OR, 19; 95% CI, 2.4—147; Powerlink: OR, 13; 95% CI, 1.4—131). Prolonged length of stay was also least likely with the Excluder (Endurant: OR, 1.4; 95% CI, 1.2—1.7; Zenith: OR, 1.6; 95% CI, 1.3—2.0; Powerlink: OR, 1.6; 95% CI, 1.2—2.1) (Table 5). Myocardial infarction was more likely with Powerlink grafts (OR, 3.4; 95% CI, 1.4—8.2) than with Excluder, but did not differ among other grafts. Again, there were no differences in 30 day mortality.

DISCUSSION

This study found that patients treated with infrarenal grafts have fewer renal complications and a shorter length of stay than patients with grafts with suprarenal fixation. These findings were maintained when the Excluder was compared with individual suprarenal grafts. The reasons for these differences are not clear, and while they could be a result of the suprarenal fixation itself or deployment techniques, it could also be due to selection bias, as anatomical differences could not be accounted for.

The study found very low rates of renal complications following EVAR (suprarenal, 1.1%; infrarenal, 0.1). These rates are similar to those reported in other analyses; however, they are significantly lower than those documented in previous studies, that examined graft fixation specifically, that were from the early endovascular era. These include rates reported by Pisimisis (infrarenal 15% vs. suprarenal 19%), Alsac (infrarenal 30% vs. suprarenal 26%), and Miller (infrarenal 12.1% vs. suprarenal 12.3%).[7—10,19,20] Notably, however, several of these studies reported outcomes from different time points, including mid-term as well as 30 day outcomes. Additionally, overall improvements in patient outcomes following EVAR have probably occurred over the last decade, related to surgeon experience and device evolution.[21] Lower rates of renal complications may also be explained in part by a lower threshold for defining renal dysfunction in previous studies (creatinine increase of > 1.5 mg/dL or $< 20\%$ decrease in GFR), compared with the current work (creatinine increase of > 2 mg/dL, as defined by NSQIP).

Few reports have assessed the impact of graft fixation on outcomes, and those that do are limited by small sample size. In a collaborative study of 225 patients treated at two tertiary institutions, Saratzis et al.[12] found significant decline in renal function among patients treated with suprarenal fixation. However, other studies evaluating endografts used from 1994—2011 have found no differences.[7,9]

In an effort to address these challenges, Miller et al.[10] and Walsh et al.[22] conducted meta-analyses evaluating the effect of suprarenal fixation on endografts placed from 1994—2011. Walsh et al. included 11 studies between 1998 and 2006 and found increased renal impairment following suprarenal fixation. However, this effect was eliminated after adjustment for the significant heterogeneity of studies, and the authors concluded that given limitations of current reports, the data were insufficient to determine the precise effect of suprarenal fixation on renal function.[22] In 2015, Miller et al.[10] published a similar meta-analysis of 21 studies including endografts from 1994 to 2011 and concluded that type of fixation did not impact renal complications, despite higher rates of renal infarction among suprarenal grafts (6.4% vs. 2.5%, $p = .09$). Importantly, however, the authors appropriately note the challenges to this work including the fact that only one study included results from more than two centres, and no studies included patients beyond 2011.[23] Perhaps most importantly, however, neither meta-analysis was able to evaluate the specific endografts, and a wide variety of

Table 4. Multivariable outcomes among patients treated with suprarenal and infrarenal stent graft fixation in the targeted NSQIP from 2011 to 2013.

Outcome	Suprarenal (Zenith, Endurant) OR (95% CI)
30-day mortality	1.4 (0.7—2.8)
Renal complications [b]	12.4 (1.6—94) [a]
Pulmonary complication	0.8 (0.5—1.3)
Reoperation	0.8 (0.5—1.2)
Any wound infection	0.8 (0.5—1.5)
Myocardial infarction	1.4 (0.7—2.7)
Lower extremity ischemia	1.1 (0.5—2.2)
Length of Stay > 2 days	1.4 (1.2—1.7)[a]

CI = confidence interval; OR = odds ratio.

[a] Statistically significant.

[b] Also adjusts for gender, preoperative GFR, chronic obstructive pulmonary disease, aortic extent, and renal revascularization.

Table 5. Multivariable outcomes by graft type.

Outcome	Excluder OR (CI)	Endurant OR (CI)	Zenith OR (CI)	Powerlink OR (CI)
30-day mortality	Ref	1.6 (0.8–3.5)	1.2 (0.5–2.9)	0.3 (0.4–2.4)
Renal complications [b]	Ref	8.3 (1.01–68)[a]	14 (1.7–114)[a]	4.4 (0.3–74)
Pulmonary complication	Ref	0.5 (0.1–1.6)	0.7 (0.4–1.4)	0.8 (0.4–1.4)
Reoperation	Ref	0.9 (0.6–1.4)	0.7 (0.4–1.2)	1.2 (0.7–2.2)
Any wound infection	Ref	0.9 (0.5–1.7)	0.7 (0.3–1.5)	0.9 (0.3–2.4)
Myocardial infarction	Ref	0.9 (0.4–2.1)	2.0 (0.9–4.3)	3.4 (1.4–8.2)[a]
Lower extremity ischemia	Ref	1.1 (0.6–2.3)	.9 (0.4–2.0)	0.7 (0.2–2.6)
Length of stay > 2 days	Ref	1.4 (1.2–1.7)[a]	1.6 (1.3–2.0)[a]	1.6 (1.2–2.1)[a]

CI = 95% confidence interval; Ref = referent Group; OR = odds ratio.

[a] Statistically significant.

[b] Also adjusts for gender, preoperative GFR, chronic obstructive pulmonary disease, aortic extent, and renal revascularization.

grafts were studied including many not available today, including surgeon-made endografts.

The current study found increased renal complications among suprarenal grafts. There are several explanations for why recent results differed from those historically presented. As noted in previous studies, renal complications following EVAR occur in approximately 1% of elective cases, requiring a large sample size to achieve sufficient power to accurately evaluate the effect of graft fixation.[20] Nearly all previous studies included fewer than 300 patients and were significantly underpowered to adequately evaluate this rare complication. In one of the largest series to date, Bockler et al.[13] identified increased rates of renal infarction among patients with suprarenal fixation; however, this study was limited to grafts used between 1994 and 2001 and may not be generalisable to today's devices. Finally, it should be noted that the current study is one of the only studies to assess Excluder in the infrarenal graft cohort. Previous work was largely driven by the comparison of AneuRx to suprarenal endografts on the market at the time of each study and found no differences in renal complications.[7,9]

It has been hypothesized that the adverse renal outcomes associated with suprarenal fixation are the result of disruption and embolisation of thrombus into the renal arteries, a claim that was supported in two studies by an increased incidence of renal infarctions among grafts with suprarenal fixation.[13,24] An additional source of embolisation may be due to the initial partial graft fabric deployment above the renal arteries, after which the graft fabric is pulled down into its final position below the renal arteries. This deployment technique can be utilised for grafts with suprarenal fixation as well as some grafts with infrarenal fixation (Powerlink, AneuRx). Finally, the bare stent sitting across the renal arteries may be a nidus for future thrombi or may stimulate future hyperplasia narrowing the orifice; however, a difference in renal patency at 12 months has not been identified.[11]

Despite these potential explanations, it is also likely that at least some of the difference in renal deterioration was the result of patient selection. Specifically, shorter neck lengths, increased angulation, and larger diameter may be more common in those patients treated with suprarenal grafts, thereby predisposing patients to higher risks of renal complications because of hostile anatomy. In an analysis of the Talent stent graft with suprarenal fixation, Fairman et al.[25] identified an increased rate of renal complications because of infarction among patients with complicated necks (28% vs. 14%). Increased rates of re-intervention and endoleaks have also been reported in several studies evaluating EVAR patients with hostile anatomy.[26–29] Alternatively, other studies have suggested complicated necks do not result in adverse outcomes.[29–31] Hager et al.[30] evaluated this hypothesis in a more recent study of 1379 EVARs, including both Zenith and Excluder, and found no differences in proximal neck length, aneurysm size, re-interventions, or migration between those grafts with suprarenal and those with infrarenal fixation among patients with short necks (defined as < 1.5 cm). Interestingly, however, more patients with short necks in that study underwent infrarenal fixation ($n = 60$) than suprarenal fixation ($n = 24$). Despite the results of Hager's work, additional study is necessary to better account for differences in anatomical characteristics and patient selection before it can be concluded that suprarenal fixation itself results in increased renal complications.

This study is bound by the limitations of all NSQIP analyses, which include coding errors and variable specificity. However, NSQIP is not an administrative database, but instead a clinical registry that uses trained clinical reviewers to evaluate operative and progress notes and also gather complete 30 day outcome data through outpatient chart review and telephone follow-up. Additionally, with NSQIP 30 day outcomes, long-term differences between graft types could not be evaluated, including graft migration, re-interventions, the duration of peri-operative renal dysfunction, and the development of renal dysfunction over time. An additional limitation of this study is that renal complications were defined as a creatinine > 2 mg/dL increase from baseline. This represents a substantial increase in creatinine, and as such, more subtle renal complications cannot be accounted for. This study was also unable to address certain anatomical characteristics including neck length, diameter, and angulation, which likely impact surgeons' graft choice. As centre and surgeon identification are also not included, selection bias cannot be accounted for by limiting to only routine users of certain devices. Also, the volume of contrast media used cannot be accounted for, and higher use of contrast has previously been associated with renal insufficiency.[12] Those patients with suprarenal fixation could have higher use of contrast volume, which

could then be confounding the relationship between fixation and renal complications; therefore, this also merits further study. It is believed the data from this study are useful to improve surgeon awareness of potential complications and to guide areas for future study. It also calls to attention the need for vascular registries such as the targeted module of the NSQIP, the Vascular Quality Initiative, and the International Consortium of Vascular Registries to include more granular clinical and anatomical data, such as neck anatomy, to enhance and encourage future comparative effectiveness studies.

CONCLUSIONS

Patients undergoing EVAR for infrarenal AAA have very low rates of renal complications regardless of device fixation mechanism. Despite likely selection bias, those patients currently selected for suprarenal stent grafts are at slightly higher risk of renal complications and prolonged length of stay, either due to the fixation itself, deployment technique, or the underlying anatomy that led to the choice of a suprarenal device. Further studies are necessary to evaluate the mechanism and duration of renal dysfunction and important long-term outcomes of interest including endoleak, migration, re-intervention, and rupture.

CONFLICT OF INTEREST

None.

FUNDING

Supported by the NIH T32 Harvard-Longwood Research Training in Vascular Surgery Grant 5T32HL007734-22.

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COUP D'OEIL

Surgical Treatment of Splenic Artery Aneurysm

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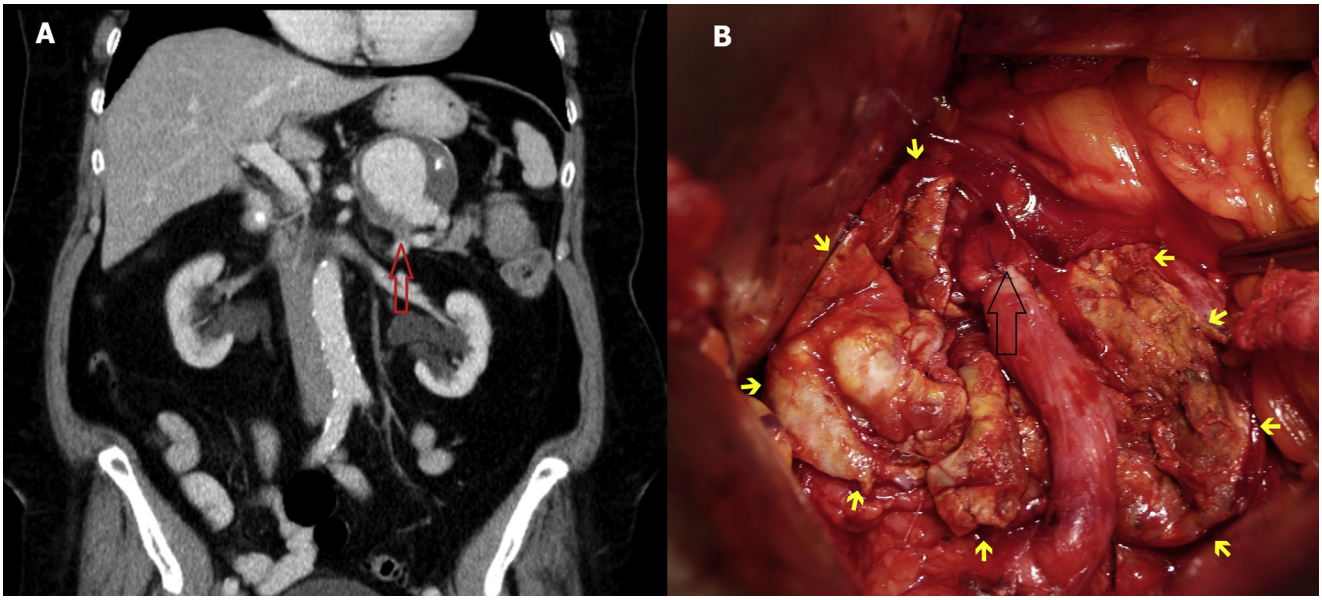

A 73 year old patient was admitted with back pain in the thoracic and lumbar area; CT angiography revealed a 60×70 mm saccular splenic artery aneurysm (SAA) (panel A). The symptomatic SAA was repaired via a left subcostal incision, with end to end splenic artery reconstruction precluding the need for great saphenous vein or prosthetic graft interposition (panel B, hollow black arrow = anastomosis, yellow arrows = margins of the open SAA sac). The patient was discharged home 8 days after the operation in a clinically stable condition and with relief of his back pain.

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http://dx.doi.org/10.1016/j.ejvs.2017.02.019