


# Aortic Bifurcation Morphology Alone is Not Able to Predict Outcome in Patients Submitted to Elective Endovascular Abdominal Aortic Aneurysm Repair

Pasqualino Sirignano<sup>1</sup>  · Laura Capoccia<sup>1</sup> · Chiara Pranteda<sup>1,2</sup> · Nunzio Montelione<sup>1,3</sup> · Wassim Mansour<sup>1</sup> · Alessandro d'Adamo<sup>1</sup> · Martina Formiconi<sup>1</sup> · Francesco Speziale<sup>1</sup>

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## Abstract

**Purpose** The aim of the present study was to evaluate the impact of the aortic bifurcation (AB) morphological characteristics, analyzed on computed tomography angiography (CTA), on outcomes of patients with abdominal aortic aneurysms (AAAs), treated by endovascular aneurysm repair (EVAR) in a single-center experience.

**Materials and Methods** A retrospective analysis was conducted using a prospectively collected database. Morphological features considered as potentially impacting outcomes were maximum AB diameter ( $AB_{max}$ ), minimum diameter ( $AB_{min}$ ), mean diameter ( $AB_{average}$ ), AB area ( $AB_{area}$ ), and AB calcification ( $AB_{calcification}$ ) and thrombosis ( $AB_{thrombosis}$ ). Outcome measures were perioperative, 30-day, and midterm AAA-related reinterventions and all-cause mortalities.

**Results** Investigators reviewed 306 preoperative CTA scans. Maximum aortic diameter was  $51.4 \pm 12.4$  mm (range 40–110), and mean  $AB_{max}$  was  $24.2 \pm 8.8$  mm (range 10–60),  $AB_{min}$   $17.0 \pm 5.4$  mm (range 4–40),  $AB_{average}$   $20.6 \pm 6.5$  mm (range 9–47.5), and  $AB_{area}$   $35.2 \pm 24.2$  mm<sup>2</sup> (range 6–176).  $AB_{calcification} \geq 50\%$  was present in 63 patients (20.6%), and  $AB_{thrombosis} \geq 50\%$  in

102 patients (33.3%). Technical success was obtained in all cases, without perioperative reintervention or death. At 30-day follow-up, the reintervention rate was 3.3%, and mortality rate was 1.3%. At a mean follow-up period of  $35 \pm 28.6$  (range, 1–72) months, reintervention and mortality rates were 6.5 and 4.9%, respectively. None of the analyzed thresholds were predictive of adverse outcomes. At multivariate analysis, association of a narrowed AB with severe calcification of the distal aorta showed a significant differences in terms of reinterventions ( $p = 0.009$ ). **Conclusions** Our limited experience seems to reveal that a cutoff of  $\leq 20$  mm for AB diameter, as in current guidelines, is ineffective in predicting outcomes after EVAR.

**Keywords** Abdominal aortic aneurysms · EVAR · Aortic bifurcation diameter · Aortic area · AAA preoperative characteristics · Thrombus load · Circumferential calcification · EVAR outcomes

## Introduction

Presently, endovascular aneurysm repair (EVAR) has become universally accepted as the gold standard for patients with infrarenal abdominal aortic aneurysms (AAAs) and suitable aortic anatomies, and several authors proposed the application of this technique even in patients with more complex anatomies [1, 2].

Since its first application, anatomical limitations for EVAR have been postulated and accepted as “challenging neck” [3, 4] and “difficult access” [5, 6]. Definitions of challenging necks and difficult accesses constitute evolving concepts, continuously being modified with advancement of available devices and technology, as well as the improvement of the operators’ experience. In fact, up-to-

✉ Pasqualino Sirignano  
pasqualino.sirignano@uniroma1.it

<sup>1</sup> Vascular and Endovascular Surgery Division, Department of Surgery “Paride Stefanini”, “Sapienza” University of Rome, Policlinico Umberto I, Viale del Policlinico, 155, 00161 Rome, Italy

<sup>2</sup> Vascular and Endovascular Surgery Division, Policlinico Casilino, Rome, Italy

<sup>3</sup> Division of Vascular Surgery, University of Campus Bio-Medico, Rome, Italy

date solutions, cutting edge technology, and additional skills have provided new indications and instructions for use (IFU), as well as novel definitions of challenging anatomies [7].

The most investigated issue is the proximal neck, commonly deemed the Achilles's heel of the endovascular technique; EVAR feasibility was generally related primarily to the presence of a suitable proximal neck [8]. Access vessels are a crucial issue as are proximal aortic necks. Access-related complications are not rare, and unsuitable access is frequently the most common exclusion criteria for EVAR, as well as a frequent root of conversion into open repair [9].

Surprisingly, deficient attention is focused on aortic bifurcation (AB). Currently, the widespread idea is that anatomical constraints in the distal aorta should be preferentially treated by open repair, while a "narrowed" and "calcified" AB has been associated with limb thrombosis and early and long-term EVAR failures [10]. The guidelines of the European Society for Vascular Surgery (ESVS) only recommend avoiding EVAR in the presence of an AB less than 20 mm [11], while a recent paper by the Mayo Group reported its huge experience treating patient with AB < 18 mm [12].

The aim of the present study was to evaluate the impact of mono- and two-dimensional morphological characteristics of AB on EVAR outcomes in a single-center series.

## Materials and Methods

### Study Design and Patient Selection

A retrospective study was conducted on a prospectively compiled, computerized database between January 2010 and December 2015, on consecutively elective surgical patients affected by AAAs. Patients treated in urgent or emergent settings or by aorto-uniliac devices in the same period were excluded from the analysis, as all patients were impacted by mycotic AAAs or aortic pseudoaneurysms. EVAR indications were based on age, comorbidities, operators' experience, and patients' preferences.

Ethical approval was secured by the institutional review board. Informed consent for aneurysm repair and participation in surveillance protocols was obtained from all patients.

AAA morphology was assessed by OsiriX-MD (OsiriX software; PIXMEO, Bernex, Switzerland) on a regular Mac OS computer [13] in one preoperative, contrast-enhanced, computed tomography angiography (CTA). CTA was performed with a biphasic acquisition protocol (unenhanced and contrast-enhanced scanning with a bolus-tracking system) and reconstructions to 1-mm slices. All

measurements (diameter, length, and angles) were performed using a workstation with dedicated reconstruction software and center lumen line (CLL) analysis and multiplanar reconstruction. Two vascular surgeons experienced in EVAR independently evaluated all preoperative examinations for each patient. Disagreements will be discussed and resolved by consensus.

Evaluated parameters were maximum AB diameter ( $AB_{max}$ ), minimum AB diameter ( $AB_{min}$ ), mean AB diameter ( $AB_{average}$ ), and AB area ( $AB_{area}$ ), as well as calcification ( $AB_{calcification}$ ) and thrombosis ( $AB_{thrombosis}$ ).

AB diameters ( $AB_{max}$ ,  $AB_{min}$ , and  $AB_{average}$ ) were assessed in axial projections, perpendicular to the main aortic axis and confirmed by centerline analyses in one single image within 5 mm from the AB, as outer-outer diameter, according to the great majority of the available IFUs.  $AB_{area}$  was calculated semiautomatically with the appropriate tools of the OsiriX software (Fig. 1). Following previously mentioned ESVS guidelines [11], values considered for analysis were:  $AB_{max} \leq 20$ ,  $AB_{min} \leq 18$ ,  $AB_{average} \leq 16$ , and  $AB_{area} \leq 14$  mm, respectively, as potential linear thresholds. As for two-dimensional values,  $AB_{area} \leq 30$  and  $\leq 15$  mm<sup>2</sup> were employed.  $AB_{calcification}$  and  $AB_{thrombosis}$  were classified as circumferential involvement (0, 25, 50, 75, and 100%). For each of those proposed threshold values, study population was split in two groups for univariate analysis of outcomes.

### EVAR Procedure

Endovascular procedures were performed by vascular surgeons in operating rooms equipped with a portable fluoroscopy unit (Euroampli Alien; Eurocolumbus SRL, Milan, Italy), under general or local anesthesia, via surgical femoral artery exposure or percutaneous access and Perclose/Proglide preimplantation (Abbott, Abbott Park, IL-USA). All patients were treated using commercially available, bifurcated aortic devices, and suprarenal fixation was employed in 39.5% of cases (Table 1). Ballooning of the sealing zones, overlapping sites, and entire iliac limbs was routinely performed, prior of the completion angiogram.

### End Points and Definitions

The outcome measures considered for analysis were primary technical success, adjunctive intraoperative procedures (reinforcing stent placement), and perioperative (30-d) and midterm reinterventions, all-cause, and AAA-related mortality rates. Primary technical success was defined as successful implantation of a stent graft in the absence of surgical conversion, intraoperative mortality, type I or III endoleaks, and stent graft migration, or limb occlusion at



**Fig. 1** **A** Preoperative CTA evaluation of  $AB_{max}$ ,  $AB_{min}$ , and  $AB_{area}$  on axial projection, and **B** on multiplanar reconstruction, **C** postoperative CTA control showing good endograft expansion

**Table 1** Endografts used in present series

	306 Patients	%
Excluder and C3 (W.L. Gore & Associates, Flagstaff, AZ, USA)	122	39.9
Endurant I and II (Medtronic Inc, Santa Rosa, CA, USA)	69	22.8
Ovation (Endologix, Irvine, CA, USA)	33	10.9
Zenith (Cook Medical, Bloomington, IN, USA)	28	9.4
Zenith Low Profile (Cook Medical, Bloomington, IN, USA)	20	6.7
AFX (Endologix, Irvine, CA, USA)	20	6.7
Nellix (Endologix, Irvine, CA, USA)	5	1.8
Incraft (Cordis, Fremont, CA, USA)	3	0.9
Treovance (Bolton, Sunrise, FL, USA)	3	0.9

completion angiography. Complications requiring reintervention considered from analysis were type I or III endoleaks, type II endoleaks with sac enlargement > 5 mm, and graft or access vessel occlusions.

### Follow-up

The follow-up protocol included physical examination, duplex ultrasonography (DUS), and CTA at 30 days. DUS was then performed at 3 and 6 months, at 1 year, and yearly thereafter. In the absence of endoleaks, sac enlargement, or graft dislocation, CTA was performed again only at the end of the first year of follow-up.

### Statistical Analysis

The data are reported as mean and standard deviations (SD) or as absolute frequencies and percentages (%). Inter-group comparisons for each variable were performed using the Student's *t* test, Chi-squared, or Fisher's exact test. A *p* value of < 0.05 was considered statistically significant. Multivariate analysis was conducted by logistic regression.

### Results

Investigators reviewed 306 preoperative CT angiography scans, for a mean of  $1237 \pm 419$  images per patient. Mean maximum aortic diameter was  $51.4 \pm 12.4$  mm (range 40–110), mean  $AB_{max}$  was  $24.2 \pm 8.8$  mm (range 10–60) with 106 (34.6%) presenting an  $AB_{max} < 20$  mm, mean  $AB_{min}$   $17.0 \pm 5.4$  mm (range 4–40), mean  $AB_{average}$   $20.6 \pm 6.5$  mm (range 9–47.5), and mean  $AB_{area}$   $35.2 \pm 24.2$  mm<sup>2</sup> (range 6–176).  $AB_{calcification} \geq 50\%$  was present in 63 patients (20.6%) and  $AB_{thrombosis} \geq 50\%$  in 102 patients (33.3%).

Demographic data, risk factors, and anatomical characteristics of all patients are reported in Table 2.

Technical success was attained in all cases, and no adjunctive procedures, i.e., kissing stents, were performed. Neither perioperative type I or III endoleaks, reintervention, stent graft migration, nor AAA-related mortalities were observed.

At 30-day follow-up, reintervention rate was 3.3%, accounting for 10 reinterventions. Mortality rate was 1.3% (4 patients) with no AAA-related deaths: one fatal cerebral hemorrhage, two acute myocardial infarctions, and one gastric neoplasm.

**Table 2** Patients' demographic characteristics and risk factors

	306 Patients	%
Age	73.1 ( $\pm$ 7.6)	
Male gender	277	90.5
Smoking	149	48.7
Hypertension	237	77.5
CAD	74	24.2
PAD	56	18.3
COPD	91	29.7
Diabetes	61	19.9
Renal disease	132	43.1
ASA III/IV	184	60.1
Aortic diameter (mm)	51.4 ( $\pm$ 12.4)	
AB <sub>max</sub> (mm)	24.2 ( $\pm$ 8.8)	
AB <sub>min</sub> (mm)	17.0 ( $\pm$ 5.4)	
AB <sub>average</sub> (mm)	20.6 ( $\pm$ 6.5)	
AB <sub>area</sub> (mm <sup>2</sup> )	35.2 ( $\pm$ 24.2)	
AB <sub>calcification</sub> $\geq$ 50%	63	20.6
AB <sub>thrombosis</sub> $\geq$ 50%	102	33.3

CAD coronary artery disease, PAD peripheral artery disease, COPD chronic obstructive pulmonary disease, AB<sub>max</sub> maximum aortic bifurcation diameter, AB<sub>min</sub> minimum aortic bifurcation diameter, AB<sub>average</sub> average aortic bifurcation diameter, AB<sub>area</sub> aortic bifurcation area, AB<sub>calcification</sub> circumferential involvement of calcification on aortic bifurcation, AB<sub>thrombosis</sub> circumferential involvement of thrombosis on aortic bifurcation

At a mean follow-up period of  $35 \pm 28.6$  (range 1–72) months, reintervention rate was 6.5%, accounting for 20 additional reinterventions in 18 patients. Mortality rate was 4.9% (15 patients), in the absence of AAA-related death: four fatal ischemic strokes, six neoplasms, two myocardial infarctions, and two senectus. Overall reintervention and mortality rates were 9.8% and 6.2%, respectively.

Causes of reintervention were: six type Ia endoleaks (1.9%), three type Ib endoleaks (0.9%), seven type II endoleaks (2.3%) with sac enlargement more than 5 mm, one type III endoleak due to limb disconnection (0.3%), two retrograde type B aortic dissections (0.6%), seven endograft limb thromboses (2.5%), and four iliac or femoral access vessel complications (1.3%). Type Ia endoleaks were treated with endograft ballooning and proximal aortic extension in four cases; in the other two cases, open conversion and graft explantation were required. All patients, except one with type II endoleak, were treated by endovascular procedures: five lumbar embolizations and one inferior mesenteric artery embolization. The remaining patient was handled by partial surgical conversion and graft salvage. Type III endoleaks were treated by endovascular relining. Retrograde aortic dissections were managed by thoracic endograft in one patient and by medical treatment, followed, after 1 year of

follow-up, by open conversion in the other one. Patients were initially treated by Excluder (WL Gore & Ass) in one case and Endurant (Medtronic Inc) in the other one. None of them presented a narrowed or calcified AB at time of index procedure [14].

Among patients with monolateral prosthetic limb thromboses, one patient underwent a femoro-femoral crossover bypass after a failed local fibrinolysis; in the remaining six patients, loco-regional fibrinolyses were performed; and in five cases bare stents were deployed to strengthen prosthetic limbs at the aortic bifurcation levels.

In patients treated for access vessel complications, one patient required stenting for iliac artery dissection, another patient, in which a dysfunction of the Perclose/Proglide system occurred, a surgical approach to the femoral artery was required, and the remaining two patients were treated by endarterectomies of the femoral arteries.

At univariate analysis, none of the morphological features considered as potential predictors of outcome was found to be statistically significant (Table 3). In details, neither linear or two-dimensional thresholds, nor thrombosis or calcifications were found to be related to reinterventions and mortalities during the follow-up.

After excluding from the analysis 20 patients (6.7%) treated by AFX endograft (Endologix), all presenting an AB<sub>average</sub>, and in which no reintervention was performed, no significant association was encountered with AB parameters as previously reported.

Multivariate analysis was also performed combining different anatomical thresholds for AB diameter, area, calcification, and thrombosis. Only the association of a narrowed bifurcation (defined as  $AB_{max} \leq 20$  mm or  $AB_{area} < 30$  mm<sup>2</sup>) with severe calcification of the distal aorta ( $AB_{calcification} > 50\%$ ) showed a differences in terms of reintervention rate during follow-up. The presence of  $AB_{max} \leq 20$  mm associated with  $AB_{calcification} > 50\%$  lightly missed the significance level ( $p = 0.078$ , OR 3.8, 95% CI 0.85–12.16), as well as  $AB_{area} < 30$  mm<sup>2</sup> plus  $AB_{calcification} \geq 50\%$  ( $p = 0.055$ , OR 4.2, 95% CI 1.01–13.75), while a significant difference was evident adopting  $AB_{calcification} 100\%$  as threshold ( $p = 0.009$ , OR 14.4, 95% CI 1.37–150.81, and  $p = 0.009$ , OR 15.7, 95% CI 1.45–153.92).

Results were also analyzed as potentially affected by short ( $< 10$  mm) proximal aortic neck length, and narrowed or severely tortuous iliac axes as previously defined [15]. Among the six patients submitted to reintervention for type Ia endoleak, only three presented a short proximal neck; at multivariate analysis, no significant association was found with AB parameters.

Even considering only the 11 reinterventions related to limb thrombosis or iliac/femoral access vessels complications that occurred in four patients presenting severe

**Table 3** Univariate analysis on morphological features considered as potential predictors of outcome

		Patients (n)	Reinterventions (%)	<i>p</i> (OR; 95 % CI)	Reinterventions and deaths (%)	<i>p</i> (OR; 95 % CI)
$AB_{max}$	< 20 mm	106	7.5	0.33 (0.66; 0.28–1.53)	12.3	0.19 (0.63; 0.32–1.26)
	> 20 mm	200	11.0		18.0	
$AB_{average}$	< 20 mm	142	7.8	0.26 (0.64; 0.29–1.39)	13.0	0.13 (0.62; 0.33–1.17)
	> 20 mm	164	11.6		19.1	
$AB_{min}$	< 20 mm	223	9.4	0.70 (0.85; 0.37–1.95)	15.7	0.80 (0.91; 0.46–1.80)
	> 20 mm	83	10.8		16.9	
$AB_{max}$	< 18 mm	79	8.8	0.74 (0.86; 0.35–2.09)	15.2	0.81 (0.92; 0.45–1.86)
	> 18 mm	227	10.1		16.3	
$AB_{average}$	< 18 mm	116	8.6	0.58 (0.80; 0.36–1.77)	11.2	0.07 (0.54; 0.27–1.06)
	> 18 mm	190	10.5		18.9	
$AB_{min}$	< 18 mm	198	9	0.57 (0.8; 0.36–1.73)	14.6	0.37 (0.75; 0.40–1.41)
	> 18 mm	108	11.1		18.5	
$AB_{max}$	< 16 mm	37	10.8	0.82 (1.13; 0.37–3.45)	13.5	0.65 (0.79; 0.29–2.16)
	> 16 mm	269	9.6		16.3	
$AB_{average}$	< 16 mm	69	7.2	0.41 (0.66; 0.24–1.8)	10.1	0.13 (0.52; 0.22–1.22)
	> 16 mm	237	10.5		17.7	
$AB_{min}$	< 16 mm	145	8.9	0.63 (0.83; 0.39–1.78)	11.7	0.06 (0.53; 0.28–1.01)
	> 16 mm	161	10.5		17.2	
$AB_{max}$	< 14 mm	20	5	0.45 (0.46; 0.06–3.61)	5	0.16 (0.26; 0.03–1.99)
	> 14 mm	286	10.1		17.1	
$AB_{average}$	< 14 mm	43	11.4	0.66 (1.25; 0.45–3.47)	14.2	0.69 (0.82; 0.32–2.08)
	> 14 mm	263	9.6		16.2	
$AB_{min}$	< 14 mm	96	8.5	0.55 (0.77; 0.33–1.81)	12.8	0.25 (0.66; 0.33–1.34)
	> 14 mm	210	10.1		16.9	
$AB_{area}$	< 30 mm	156	9.0	0.61 (0.82; 0.38–1.75)	15.4	0.75 (0.90; 0.49–1.67)
	> 30 mm	150	10.6		16.7	
$AB_{area}$	< 15 mm	34	11.7	0.68 (1.26; 0.41–3.86)	11.7	0.47 (0.67; 0.22–2.00)
	> 15 mm	272	9.5		16.5	
$AB_{calcification}$	> 50%	66	9.5	0.93 (1.04; 0.40–2.69)	14.3	0.55 (0.79; 0.36–1.72)
	< 50%	240	9.9		16.5	
$AB_{thrombosis}$	> 50%	84	9.8	0.91 (0.95; 0.40–2.24)	15.7	0.87 (0.94; 0.47–1.88)
	< 50%	222	9.8		16.2	

$AB_{max}$  maximum aortic bifurcation diameter,  $AB_{min}$  minimum aortic bifurcation diameter,  $AB_{average}$  average aortic bifurcation diameter,  $AB_{area}$  aortic bifurcation area,  $AB_{calcification}$  circumferential involvement of calcification on aortic bifurcation,  $AB_{thrombosis}$  circumferential involvement of thrombosis on aortic bifurcation

narrowed iliac arteries, and in seven with severely tortuous iliac axis, none of the above reported parameters were found to be statistically significant.

## Discussion

AB and access vessels represent a not-negligible cause of concern in EVAR. Although in past years the proximal neck has driven the most part of the attention, access vessels and AB complications have been recorded in few cases, unsuitable access is frequently the most common

exclusion criteria for EVAR, and a common root of conversion into open repair [9], thus underlining the need for a proper definition of challenging conditions preventing EVAR. Surprisingly, there are only vague and ambiguous indications regarding the AB in available guidelines; ESVS and Society for Vascular Surgery/American Association for Vascular Surgery (SVS/AAVS) provide generic, and perhaps dated, indications and IFU merely indicate the common iliac artery lengths and diameters [1, 11, 13, 14, 16].

Regarding AB diameter, although it is recognized that a “narrowed” aortic bifurcation may be a frequent cause of



limb occlusion, for anatomical (narrowed AB and iliac arteries, calcifications, thromboses, and severe angulations) [17–20], and technical causes (low radial force devices, excessive or insufficient endografts' oversizing) [21–24], there is still no consensus for defining what is meant by “narrowed” (i.e., what should be considered the linear threshold) and what roles calcified and/or thrombosed ABs might have [25, 26].

Indeed, it has to be acknowledged that iliac limb thrombosis has an estimated incidence between 2.6 and 7.4% [21, 27–30], and it has to be considered a potentially fatal complication [31]. AB diameter or area has surely a major role in those complications development.

Srajina and co-workers reviewed the clinical data of 1070 patients who underwent EVAR between 2000 and 2011, including 112 patients with an AB diameter < 18 mm and, among those, 34 with a AB < 14 mm. At 1- and 5-year follow-ups, freedom from reintervention was 91 and 84%, respectively, for bifurcated stent grafts. They concluded that EVAR with bifurcated stent grafts is safe and effective in patients with a narrowed, distal aortic diameter, even when the AB was < 14 mm [12].

Reviewing the data of patients treated with Endurant (Medtronic Inc, Santa Rosa, CA, USA) from three Dutch tertiary vascular centers, van Zeggeren et al. [32] reported a 4% graft occlusion rate. Estimated freedom from occlusion was 98.4% at 30-day, 95.7% at 1-year, and 95.3% at 3-year follow-ups. Only in one case, a “narrowed” AB (measure not reported) was found to be a determining factor for occlusion. Recently, Troisi et al. published an experience on 87 Endurant devices implanted in cases of AB < 20 mm. They reported no differences at 3-year follow-ups between patients with normal and narrowed AB. The only difference was a higher rate of adjunctive procedures, i.e., kissing stenting, in patients with narrowed aortas (47.1 vs 23.3%,  $p < 0.001$ ) [33].

Even Bianchini Massoni et al. in a recent paper showed iliac limb thrombosis is a relatively common event after EVAR with bifurcated endografts. However, in their work, the predictive value was a ratio endograft limb diameter/AB diameter > 1.4, whereas AB < 20 mm and calcification > 50% failed to be correlated with adverse events during follow-up [34].

Our data, in accordance with those experiences [12, 32–35], seem to buttress the hypothesis that a linear threshold  $\leq 20$  mm AB, as defined by ESVS guidelines [11], is ineffective in predicting outcomes after EVAR, regardless of considered diameter  $AB_{max}$ ,  $AB_{average}$ , and  $AB_{min}$ . Even the adoption of smaller threshold, fixed at  $\leq 18$ ,  $\leq 16$ , and  $\leq 14$  mm, could not influence outcomes after EVAR. Unfortunately, we also failed to identify a single two-dimensional threshold such as  $AB_{area}$ , even considering two distinct, and very restrictive, bi-

dimensional thresholds.  $AB_{calcification}$  and  $AB_{thrombosis}$ , according to previously reported papers, were not recognized as contraindications for EVAR [34].

The major finding of the present study was a significant difference in terms of reintervention occurrences during the entire follow-up period in patients presenting a narrowed bifurcation ( $AB_{max} \leq 20$  mm or  $AB_{area} \leq 30$  mm<sup>2</sup>) with circumferential calcification ( $p = 0.009$ ).

Potentially, these results could represent a first step toward further analysis aimed at identifying reliable anatomical features predicting outcomes after EVAR and for updating of guidelines.

This study has constraints as it is a retrospective one conducted on a relatively small cohort of patients, the size of which was owing primarily to the unavailability of the CTAs for patients treated in the earlier phases of the study period. Furthermore, procedures included in this cohort were performed by operators in advanced phases of their learning curves, which could partially account for the small number of reinterventions recorded, as well as the fact that most complex cases were likely addressed by open surgical repairs. Furthermore, we have to admit that 47/58 unconventional endografts (Ovation, Nellix, and AFX), and all the Incraft devices implanted in this series were implanted in patients with  $AB_{max} \leq 20$  mm. This could constitute a sort of selection bias and explains, at least in part, the reported good results.

## Conclusions

Our experience, even if limited by a small number of patients, seems to reveal that a cutoff of  $\leq 20$  mm for AB is ineffective by itself in predicting outcomes after EVAR and, from a speculative point of view, available guidelines need to be updated.

Moreover, our data showed no correlation between AB diameter by itself, even considering different, and smaller, threshold (18, 16, and 14 mm).

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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