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CASE REPORT

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Current issues on simultaneous TAVR (Transcatheter Aortic Valve Replacement) and EVAR (Endovascular Aneurysm Repair)

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Abstract

Simultaneous EVAR and TAVR is technically feasible and is a reliable option in high-risk patients.

KEYWORDS

abdominal aortic aneurysm, EVAR, severe aortic valve stenosis, simultaneous TAVR and EVAR, TAVR

1 | INTRODUCTION

Single-stage endovascular treatment of cardiac and vascular diseases with combined endovascular techniques has been increasingly reported in the contemporary literature. Although more complex cases are currently being treated with such techniques, there are still crucial issues regarding their safety and efficacy. Among such one-stage treatment options, the simultaneous endovascular treatment of severe symptomatic aortic valve stenosis (SAVS) and abdominal aortic aneurysm (AAA) through Transcatheter Aortic Valve Replacement (TAVR) and Endovascular Aneurysm Repair (EVAR) is not yet a common practice, as few centers have performed such combined procedures. In this case report, we present the management of a 78-year-old woman suffering from SAVS and AAA, who was treated with simultaneous endovascular aortic valve replacement and abdominal aortic aneurysm sac exclusion. Alongside, current issues on simultaneous TAVR and EVAR were analyzed and discussed after integrated review of the recent literature on this field.

Endovascular techniques are commonly used for the treatment of cardiovascular diseases, such as severe aortic valve stenosis (SAVS) and abdominal aortic aneurysm (AAA). Despite the fact that these interventional methods are well described for the treatment of each of these diseases separately, there are still current issues regarding the management of a combined intervention simultaneously. In this article, we present the case of a 78-year-old woman suffering from SAVS and AAA, who was treated with Transcatheter Aortic Valve Replacement (TAVR) and Endovascular Aneurysm Repair (EVAR) simultaneously. A comprehensive review of the literature, highlighting some key points was also performed.

The case has taken place at Evangelismos General Hospital, Athens, Greece

2 | CASE REPORT

A 78-year-old female was admitted to the Department of Cardiology with dyspnea due to pulmonary edema. Her medical background consisted of known severe symptomatic aortic valve stenosis, hypertension, coronary artery disease treated with percutaneous coronary intervention of the right coronary artery 8 years ago, rectal cancer and breast cancer both treated with surgical excision, chemotherapy, and radiotherapy four and 1 year ago, respectively. Moreover, she suffered from peripheral vascular disease and she was treated with stent placement to the left subclavian artery a few years ago.

The findings of the ultrasound revealed that the aortic valve area (AVA) was 0.9 cm^2, the maximal velocity (V_{max}) was 3.8 m/s, the mean gradient was 36 mm Hg and the pulmonary artery systolic pressure (PASP) was calculated at 61 mm Hg, while the ejection fraction was more than 60%. In addition to this, an infrarenal aneurysm of 4.7 cm in size provoked probably repeated episodes of abdominal pain during the last months. The patient was categorized as NYHA class III, the total logistic score Euroscore was calculated 23.85% and the option of open surgery was rejected due to high perioperative risk. The patient was found eligible for Transcatheter Aortic Valve Replacement (TAVR) and simultaneous treatment of the AAA with Endovascular Aneurysm Repair (EVAR). This decision was made based on the urgency of the TAVR due to dyspnea and EVAR due to symptomatic AAA while a dual antiplatelet treatment would be mandatory for at least 6 months postoperatively, based on the protocol used in our department (European Society of Cardiology/European Association of Percutaneous Interventions Guidelines, 2017, Indication IIA, level of evidence C).[1]

The patient was operated under general anesthesia, while a team of cardiologists, cardiac surgeons, and interventional radiologists participated in the planning and the execution of the procedure.

Both femoral arteries were dissected and a 16 French Sheath was placed in the left femoral artery. The contemporary pacemaker's wire was inserted into the left femoral vein. Under controlled pacing, a 25 mm size Portico ^{TM} aortic valve was placed and ballooning was performed in order to eliminate central regurgitation. TAVR was completed uneventfully as the patient was hemodynamically stable and the fluoroscopic control for the aortic valve placement was satisfactory. (Figure 1) Subsequently, we proceeded to the EVAR with the placement of bifurcated stent graft (Incraft Cordis AB2298, IL1012, IL1012). The TAVR and EVAR devices were deployed from the same side while the 16 French Sheath was used for both procedures. More specifically, the 13 F delivery system was positioned after the removal of the 16F Sheath and the bleeding was controlled by torniquet which was placed after the cutdown of both femoral arteries. The completion angiography revealed a satisfactory outcome. (Figures 2,3) The overall procedural time was 125 minutes, and the fluoroscopic time was 42 minutes. The total amount of contrast administrated was 280 mL.

The patient was discharged from the hospital at the 13th postoperative day in a very satisfactory clinical condition. The 3rd postoperative day the patient presented atrial

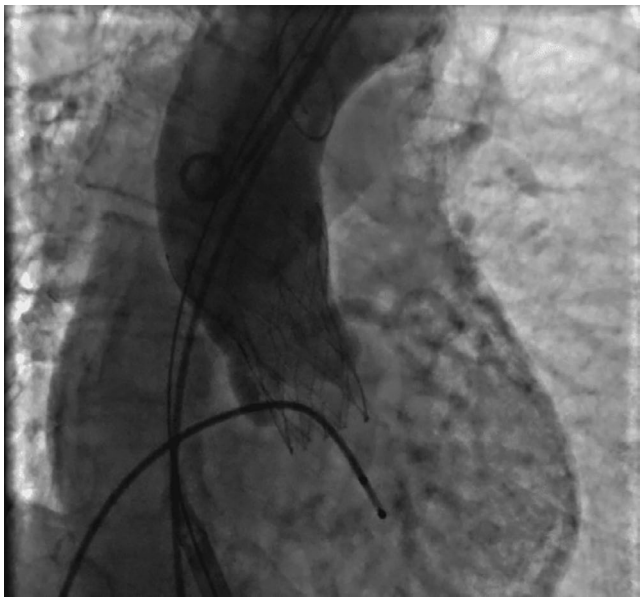

FIGURE 1 The final outcome after the effective aortic prosthesis placement with no sign of regurgitation (angiography)

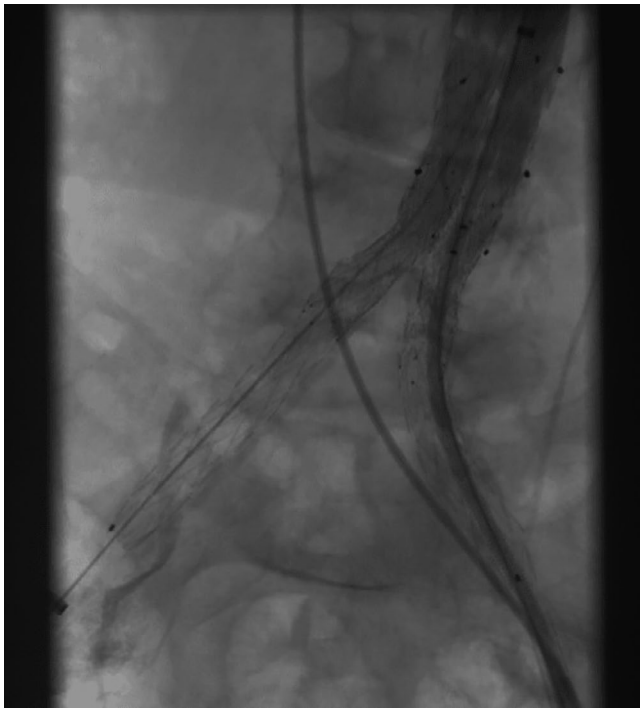

FIGURE 2 The depiction after the completion of EVAR with a satisfactory placement

fibrillation with increased cardiac palms which was treated with administration of amiodarone iv initially followed by per os treatment. The arrhythmia resolved and sinus rhythm was observed again the 9th day after the operation. Moreover, the patient's renal function was affected (with creatinine values at 2.1 and mg/dL and urea levels 108 mg/dL) at the 8th day, probably due to dehydration as a consequence of the diuretic treatment in combination to the low fluid intake from the patient. These two factors extended the hospitalization of the patient more than expected. The cardiac ultrasound confirmed a successful aortic valve replacement without the presence of regurgitation. The abdominal CT angiography showed that the stent graft was well-positioned, with no endoleak apparent.

3 | DISCUSSION

A comprehensive review of the literature on simultaneous TAVR and EVAR revealed 14 published articles from 9 different countries worldwide, in which the data of 16 patients was presented. (Table 1). The majority of the patients were older than 80 years (ages range between 67 and 93 years), with a male predominance and they suffered from symptomatic SAVS suggesting the need for urgent intervention. Furthermore, EVAR was performed due to AAA, except for one case of endoleak type II. Serious comorbidities were present in most of the cases (Table 1). In addition to this, we have to highlight that in all cases reported the general anesthesia was chosen, as in our case, despite the fact that sedation is used in the majority of the EVAR procedures and is commonly used for TAVR, when performed separately. This fact reveals that anesthesiologists and the rest of the medical team are not familiar with these combined procedures and general anesthesia is chosen as the safest option.

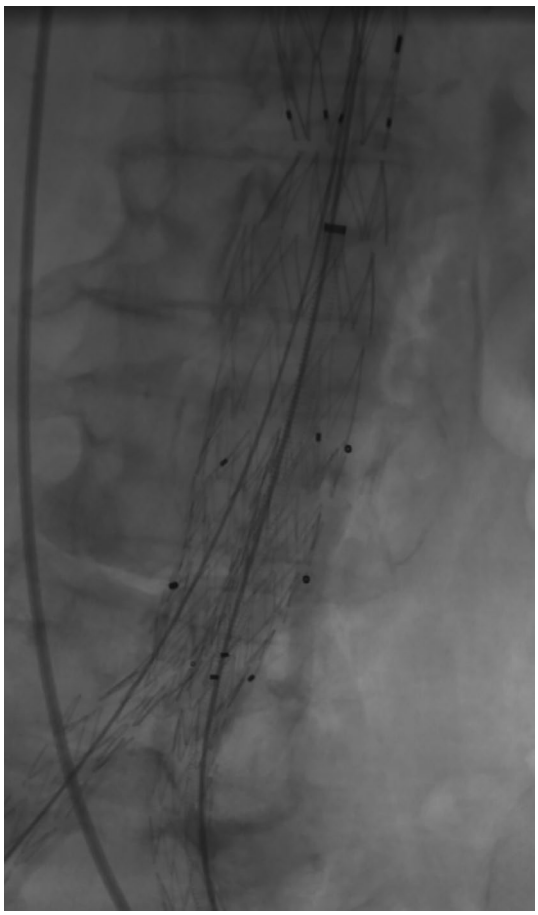

FIGURE 3 Final outcome after the EVAR completion ensuring a satisfying proximal sealing

As in our case, the review data indicated that an urgent intervention was mandatory. Interestingly, what is currently debatable is whether these interventions should be performed simultaneously. Firstly, the replacement of the stenotic aortic valve is associated with hemodynamic changes and more specifically with the increase of systolic arterial pressure. In a study of 105 patients who were submitted to TAVR, the systolic arterial pressure increased on average 15 ± 31 mm Hg postoperative.[2] Subsequently, the elevation of the systolic arterial pressure provokes enhanced strain at the AAA wall and the risk of rupture is higher.[3-6] Secondly, another crucial parameter is the fact that the bioprosthesis implantation through TAVR requires the administration of dual antiplatelet treatment for at least 6 months after the procedure. Taking under consideration the increased risk deriving from elevated systolic pressure, a delay of more than 6 months would augment significantly the risk for acute events such as aortic rupture.[7] Moreover, the surgical risk for a second surgical procedure may be higher than the risk of a one-stage intervention especially for patients with serious comorbidities receiving general anesthesia.[7]

Another advantage of simultaneous TAVR and EVAR is that both procedures can be performed from the same access site while any combination of devices between TAVR and EVAR is feasible. According to Matsumura et al, the complication rate regarding the vascular access site reaches 8% for EVAR.[8] In addition to this, the reoperation for femoral artery could be troublesome and the quality of the access point may be affected from the previous surgery. Another very important issue is the fact that some endovascular catheters can be used in both procedures, thus contributing to the cost reduction, while the total length of stay can be also reduced when both procedures are performed at the same time.[9-11] Although the one-stage procedure is associated with obvious advantages, there are some caveats that have to be underlined, such as the longer duration of the simultaneous procedure and the need for higher amounts of intravenous heparin.[9] As a result, it seems that the simultaneous

TABLE 1 Demographics, cardiac parameters, abdominal aneurysm parameters and comorbidities gathered from all the published cases of simultaneous TAVR – EVAR throughout the literature

						Cardiac parameters						Abdominal Aneurysm parameters				
Author	**Country**	**Year**	**No patients**	**Age**	**Sex**	**MG**	**AVA**	**Vmax**	**NYHA**	**EF (%)**	**Symptoms**	**Location**	**Diameter (mm)**	**Length (mm)**	**Comorbidities**	**Logistic Euroscore (%)**
Koutsias et al[11]	Greece	2020	2	78	M	50	0.8	4.6	III	50	Yes	Infrarenal	60	58	CAD (CABG, recent PCI), HTN, COPD	N
				88	M	63	NM	5.1	III	65	Yes	Infrarenal	66	62	CAD (PCI)	NM
Natour et al[10]	Israel	2018	2	86	M	34	0.6	NM	NM	NM	Yes	Infrarenal	60	NM	NM	NM
				93	M	30	0.4	NM	NM	NM	Yes	Infrarenal	>10 increase in 6 mo	NM	NM	NM
Sato et al[9]	Japan	2017	1	83	M	105	NM	5.5	III	NM	Yes	Infrarenal	57	NM	NM	NM
Horiuchi et al[6]	Japan	2016	1	81	M	42	0.7	4.2	NM	NM	Yes	Endoleak II (previous EVAR)	76	NM	NM	NM
Orejola et al[2]	USA	2016	1	83	M	49	0.8	3.1	III	35	YES	Infrarenal	55	NM	CAD (CABG), MVR, HTN, CRF	18.4
Weber et al[17]	Germany	2016	1	75	M	11	0.8	2.3	NM	20	Yes	Infrarenal	100	95	Multiple procedures for aneursyms	NM
Rashid et al[12]	Australia	2016	1	79	M	46	0.7	NM	III	60	Yes	Infrarenal	60	123	COPD	NM
Kawashima et al[5]	Japan	2016	1	91	W	36	0.4	NM	NM	64	Yes	Infrarenal	45	NM	HTN, CAD, CRF, COPD	25.6
Koudoumas et al[14]	USA	2015	1	74	M	43	0.48	NM	NM	30-35	Yes	Infrarenal	5	NM	COPD, DM, CD, NSCLC	NM
Binder et al[15]	Switzerland	2015	1	67	M	NM	NM	NM	NM	NM	Yes	Infrarenal	NM	NM	CRF, Alchooholic, ST-elevation at the time of admission	NM
Aluko et al[8]	USA	2014	1	75	M	48	0.6	5.3	III	NM	Yes	Infrarenal	5.1	NM	COPD	NM
Ayhan et al[4]	Turkey	2014	1	83	M	27	0.5	NM	III	35	Yes	Infrarenal	NM	NM	NM	52.8
Drury-Smith et al[3]	United Kingdom	2012	1	85	M	88	0.8	NM	NM	NM	Yes	Infrarenal	71.4	147	NM	NM
Drury-Smith et al[16]	United Kingdom	2011	1	80	M	46	0.9	NM	NM	55	Yes	Infrarenal	68	70	CAD (CABG), CRF	NM

TAVR and EVAR is an option with significant benefits in comparison to the two-stage confrontation.

Concerning the endovascular materials that are necessary for the simultaneous operation (Table 2). The main manufacturers were equally represented in the published cases, while almost half of the physicians preferred the 18French sheath during TAVR.

A controversial topic among experts is which procedure should be performed first. Our literature review showed that, in the majority of the cases, the TAVR preceded in 13 of the 16 cases, while 3 patients were submitted initially to EVAR. (Table 3). The supporters of the notion that TAVR should be first, highlighted that hemodynamic stability is the major concern in these critically ill patients. In addition to this, the TAVR-first strategy reduces the risk of local thrombosis, as the larger catheters remain less time in place, and other intraoperative complications such as migration of the stent graft that was placed through EVAR or aneurysm rupture due to TAVR manipulations.[12]In our case, this strategy was chosen after evaluating the patient's clinical status and estimating the risk of hemodynamic collapse.

On the other hand, those who prefer the EVAR-first strategy signify that the risk of AAA rupture, aortic dissection, and peripheral embolism is higher when the aortic valve replacement is preceded.[10] According to this point of view, the possibility of vascular injury is lower when EVAR is deployed first as the abdominal stent graft acts like a inner coverage of the aorta eliminating the possibilities of damages due to TAVR device manipulations.[12] Currently, the decision is based mainly on the preference of the members of the team.

Another point that should be highlighted is the contrast-induced renal failure. The incidence of this clinical condition ranges from 3% to 19% in different studies after EVAR and 8.3%–37.5%, respectively, after TAVR, while this deviation is related to significant differences of the criteria imposed for the diagnosis of Acute Kidney Injury (AKI).[13] Despite the fact that there are different factors based on the patient's medical background related to renal insufficiency, the administration of high doses of contrast is the main predisposing factor. In Table 3, we presented the data concerning the amount of contrast administered; however, only 3 studies recorded this information, with the amount of contrast ranging from 182 to 385 mL. In our case, 280 mL of contrast was used. The clinical question is whether the combined interventional approach is beneficial, with lesser usage of contrast in comparison with sequential procedures, or is aggravating, with large dosages that increase the possibilities of AKI. Future recording of data on this field would be very important. Similarly,

TABLE 2 Presentation of the materials and their characteristics that have been used for simultaneous TAVR-EVAR in published cases

	TAVR parameters			EVAR parameters		
Author	Type	Size (mm)	Sheath Diameter	Type	Size (mm)	Length (mm)
Koutsias et al[11]	CoreValve Evolut R	29	14 Fr	bifurcated Endurant endoprosthesis	28 × 16	166
	CoreValve Evolut R	34	16 Fr	W. L. Gore & Associates	28 × 14	140
Natour et al[10]	NM	NM	NM	NM	NM	NM
	NM	NM	NM	NM	NM	NM
Sato et al[9]	CoreValve Evolut R	26	18 Fr	W. L. Gore & Associates	26 × 14.5	180
Horiuchi et al[6]	Sapien XT valve	26	NM	W. L. Gore & Associates	NM	NM
Orejola et al[2]	Sapien XT valve	26	NM	W. L. Gore & Associates	31 × 23	NM
Weber et al[17]	SAPIEN 3	26	14 Fr	NM	NM	NM
Rashid et al[12]	LotusTM valve	27 [a]	NM	Cook Zenith	28	111
Kawashima et al[5]	Sapien XT valve	23	NM	Cook Zenith	NM	NM
Koudoumas et al[14]	CoreValve Evolut R	31	18Fr	Ovation PrimeAbdominal	20	NM
Binder et al[15]	LotusTM valve	27	NM	NM	NM	NM
Aluko et al[8]	Sapien XT valve	26	NM	Endurantbifurcated EVAR stent	32 × 16	145
Ayhan et al[4]	Sapien XT valve	26	18	Cook Zenith	36	130
Drury-Smith et al	CoreValve Evolut R	29	18	Cook Zenith	NM	NM
Drury-Smith et al[16]	CoreValve Evolut R	29	18	Cook Zenith	NM	NM

[a]During the procedure the initial prosthesis (Lotus 25 mm) was displaced and therefore was replaced by a larger (Lotus 27 mm).

TABLE 3 Data regarding procedural parameters and the outcomes of simultaneous TAVR-EVAR

Author	Sex	General Anesthesia	Access site	First procedure	Fluoroscopic time	Procedural time	Amount of contrast	Length of stay	Follow up/ Complications
Koutsias et al[11]	M	YES	Femoral Bilateral	TAVR	37	NM	385	10	2 y/None
	M	YES	Femoral Bilateral	TAVR	40	138	350	8	1 y/None
Natour et al[10]	M	YES	Femoral Bilateral	EVAR	NM	NM	NM	NM	3 mo/None
	M	YES	Femoral Bilateral	EVAR	NM	NM	NM	NM	NM
Sato et al[9]	M	YES	Femoral Bilateral	TAVR	52	138	182	8	NM
Horiuchi et al[6]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	7	NM
Orejola et al[2]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	13	1 y/None
Weber et al[17]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	NM	NM
Rashid et al[12]	M	YES (Laryngeal)	Femoral Bilateral	TAVR	NM	NM	NM	NM	6 mo/None
Kawashima et al[5]	W	YES	Femoral Bilateral	EVAR	NM	NM	NM	22	NM
Koudomas et al[14]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	3	3 mo/None
Binder et al[15]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	NM	NM
Aluko et al[8]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	3	1 y/None
Ayhan et al[4]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	7	1 mo/none
Drury-Smith et al[2]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	NM	6 mo/None
Drury-Smith et al[16]	M	YES	Femoral Bilateral	TAVR	NM	NM	NM	5	NM

although the fluoroscopic time was lesser for the combined TAVR-EVAR, scarce data were also presented. However, it seems that simultaneous intervention is related to lower exposure to radiation.

Although only minor complications were reported in the published articles, a selection bias cannot be ruled out. Serious complications, including major adverse cerebrovascular events, are commonly met after the implementation of such techniques. Rashid et al were the only researchers that have reported an intraoperative complication. More specifically, the bioprosthesis, which was undersized, migrated after its placement, and therefore had to be removed and replaced by a larger one.[14] Moreover, these operations are challenging even for experienced staff as anatomic factors can cause serious problems. Koudoumas et al have reported the case of a narrowed neck of aneurysm that required enhanced care and exceptional technique in order to be successful.[15]Additionally, such procedures can become even more complex as for example in one case that was described by Binder et al They reported the case of a man 67-year-old man who was submitted to TAVR, EVAR, permanent pacemaker placement, and ablation.[16] In any case, according to Drury-Smith et al, who were the first that reported a simultaneous TAVR – EVAR, "the combination of careful assessment, improved trans-catheter techniques and a true multi-disciplinary team, can together enable the simultaneous treatment of some complex cardiovascular, previously treated surgically."[17]

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CONFLICT OF INTEREST

All authors have no conflict of interest.

AUTHOR CONTRIBUTIONS

NS: designed initially the manuscript, gathered the data from literature, and wrote the article. CA: designed the manuscript, supervised during the whole process. VP: analyzed the data, collected the images for the manuscript and partially contributed to the writing. KL: provided critical feedback and helped shape the final manuscript. TK: conceived the idea, involved in planning and supervision of the work. MA: designed and directed the project, had the central role in supervision of the manuscript.

ETHICAL APPROVAL

"All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study."

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