Coronary Obstruction Following Transcatheter Aortic Valve Implantation

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Abstract

Background: **Transcatheter aortic valve implantation (TAVI) was established as an important alternative for high-risk patients with severe aortic stenosis. However, there are few data in the literature regarding coronary obstruction, that although rare, is a potentially fatal complication.**

Objective: **Evaluate this complication in Brazil.**

Methods: **We evaluated all patients presenting coronary obstruction from the Brazilian Registry of TAVI. Main baseline and procedural characteristics, management of the complication, and clinical outcomes were collected from all patients.**

Results: **From 418 consecutive TAVI procedures, coronary obstruction occurred in 3 cases (incidence of 0.72%). All patients were women, without prior coronary artery bypass grafting (CABG), and with mean age of 85 ± 3 years, logistic EuroSCORE of 15 ± 6% and STS-PROM score of 9 ± 4%. All of the cases were performed with balloon-expandable Sapien XT prosthesis. In one patient, with pre-procedural computed tomography data, coronary arteries presented a low height and a narrow sinus of Valsalva. All patients presented with clinically significant severe maintained hypotension, immediately after valve implantation, and even though coronary angioplasty with stent implantation was successfully performed in all cases, patients died during hospitalization, being two periprocedurally.**

Conclusion: **Coronary obstruction following TAVI is a rare but potentially fatal complication, being more frequent in women and with the balloon-expandable prosthesis. Anatomical factors might be related with its increased occurrence, highlighting the importance of a good pre-procedural evaluation of the patients in order to avoid this severe complication. (Arq Bras Cardiol. 2014; 102(1):93-96)**

Keywords: **Aortic Valve Stenosis; Transcatheter Aortic Valve Implantation; Catheters; Coronary Obstruction.**

Introduction

Transcatheter aortic valve implantation (TAVI) has become an important alternative for the treatment of high-risk patients with severe aortic stenosis and those considered inoperable[1]. Regardless of the constant device improvements and growing experience of centers performing the procedure, several complications may occur. Among them, there is coronary obstruction, that although rare, is potentially fatal. Despite case reports and the variable incidence among large registries and randomized studies (0.35-4.0%)[2], there is little information about predictors, clinical presentation and treatment. Thus, we report a series of cases of this complication based on data obtained from the Brazilian Registry of TAVI.

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Methods

We evaluated all cases of coronary obstruction after TAVI for the treatment of severe and symptomatic aortic stenosis in high-risk patients, included in the Brazilian Registry of TAVI. Main baseline and procedural characteristics, management of the complication, and clinical outcomes were collected from all patients. Coronary obstruction was defined as an important decrease in coronary flow documented by selective angiography or aortography.

Results

From January 2008 and January 2013, 418 patients were included in the Brazilian Registry of TAVI at 18 centers, of which 405 (96.9%) showed aortic valve stenosis and 13 (3.1%) dysfunction of surgical bioprosthesis. There were 3 cases (0.72%) of coronary obstruction after TAVI, all in native valves.

Case 1

A 83-year-old female, hypertensive, diabetic, with coronary artery disease and heart failure functional class III (NYHA). In clinical evaluation, it was noted severe aortic stenosis (mean gradient: 77 mmHg; valve area: 0.50 cm^2) of high

risk (logistic EuroSCORE: 9.5%; STS-PROM: 7.9%) being referred to TAVI. On angiotomography it was verified the sinus of Valsalva with mean diameter of 26 mm, valve annulus of 24 mm and height of right coronary artery (RCA) and left main (LM) of 10.4 mm and 9.6 mm, respectively (Figure 1). The procedure was performed by transfemoral approach, with implantation of a 26 mm balloon-expandable Sapien XT prosthesis. Immediately after valve implantation, the patient evolved with severe and maintained hypotension, in addition to ST-segment elevation detected on cardiac monitoring. Transesophageal echocardiogram (TEE) showed appropriate bioprosthesis positioning, with mild perivalvular regurgitation. On aortography it was detected complete obstruction of RCA ostium (Figure 1). A condition of shock and cardiac arrest had quickly begun, so that cardiopulmonary resuscitation and angioplasty with implantation of 2 drug-eluting stent of the RCA were successfully performed (Figure 1). As a further complication, due to resuscitation procedures, there was a perforation on right ventricle by temporary pacemaker and tamponade, and despite the treatment of the complications, there was another cardiac arrest and subsequent death.

Case 2

A 82-year-old female, hypertensive and diabetic, in clinical evaluation due to functional class II (NYHA) heart failure, was diagnosed with significant aortic stenosis (mean gradient: 68 mmHg; valve area: 0.60 cm^2). Based on her age and high risk (logistic EuroSCORE: 13.3%; STS-PROM: 14.8%), the patient was referred to transfemoral TAVI, with implantation of a 23 mm Sapien XT prosthesis. Immediately after valve implantation, the patient developed severe and maintained hypotension, without electrocardiographic changes. Control aortography showed complete obstruction of LM ostium (Figure 2). Drug-eluting stent implantation in the LM was performed with restoration of coronary flow and immediate reversal of shock condition (Figure 2). After the procedure, however, a severe stroke was detected, with development of pneumonia and death after 78 days of hospitalization.

Case 3

A 89-year-old female, with history of hypertension, dyslipidemia and ischemic cardiomyopathy with previous percutaneous coronary intervention, was developing heart failure functional class III (NYHA), being diagnosed with significant aortic stenosis (mean gradient: 83 mmHg; valve area: 0.60 cm^2). Based on her age and high risk (logistic EuroSCORE: 23.2%; STS-PROM: 5.4%), the patient was referred to TAVI, that was performed by the transfemoral approach, with implantation of a 23 mm Sapien XT. Due to the presence of moderate periprosthetic aortic regurgitation, post-dilation was carried out. Control aortography and TEE revealed a decrease in aortic regurgiration and the absence of other complications. However, 50 minutes after procedure, the patient suddenly developed severe and maintained hypotension, and aortography showed obstruction of the LM ostium. Despite successful implantation of a bare-metal stent, the patient persisted in refractory cardiogenic shock, leading to death.

Discussion

These cases show that coronary obstruction, although rare, is a severe complication in patients undergoing TAVI. Since the beginning of TAVI procedures, still in the first experimental procedures, coronary obstruction has always been a concern, due to the implantation of biological valve surrounded by a stent frame and due to the proximity of the coronary arteries with the aortic valve. In fact, coronary obstruction was reported in the first experimental studies with percutaneous aortic bioprosthesis[3], being further described in humans in 2006[4]. Despite these initial concerns and variable frequencies in the literature, currently, in the major registries and studies worldwide, its incidence is < 1%[5]. In the Brazilian Registry of TAVI, coronary obstruction incidence was very similar, of 0.72%.

With respect to associated mechanisms, we can observe that, after implantation of bioprosthesis, in all three cases there was a displacement of calcified valve cusp towards coronary ostium, a mechanism also verified in most cases in the literature[2]. Moreover, no case occurred through the endoprosthesis stent frame, nor through its leaflet[2]. Despite the fact that the self-expandable CoreValve prosthesis present increased dimensions of its stent, all cases were documented with balloon-expandable Sapien XT prosthesis. The highest frequency with the latter was also suggested in the literature, however, the exact mechanisms for its occurrence are not defined[2,3]. Factors such as the different material used in prostheses, their implantation mechanisms, as well as recommended criteria for implantation, may have some influence[2].

Although the mechanism is apparently common among coronary obstruction cases, risk factors for their occurrence are very controversial in the literature. However, there is evidence that the low origin of coronary arteries and sinus of Valsalva with reduced dimensions, may be predictors of its occurrence[2]. Regarding the latter anatomical risk factor, it is believed that the smaller space in coronary sinus to accommodate the thick and calcified valve leaflet, may cause its protrusion and, consequently, occlusion of coronary ostia. In the literature, the mean height of the coronary origin in patients with coronary occlusion after TAVI[6], is lower than control patients (mean of 10.3 mm for LM vs. 13-15 mm for control group; $p < 0.01$)[2,6]. This fact can also be observed in aortic sinus (mean of 28 mm vs. 32-36 mm from other studies in the literature; $p < 0,01$)[2,6].

Previous studies on anatomy and computed tomography have shown that women have coronary height and aortic sinus with reduced dimensions compared to men, and on average, LM shows reduced height in relation to RCA[6]. These studies could partly explain the higher frequency of this complication in women (83% versus ~50% in registries; $p < 0.001$)[2], as in our study, and preferential involvement of LM.

Although coronary angioplasty can be performed with high rate of success, the increased mortality of patients highlights the importance of a proper evaluation and pre-procedural planning. After identifying the risk factors above described, measurements such as less aggressive dimensioning of the bioprosthesis and the selection of a self-expandable prosthesis instead of

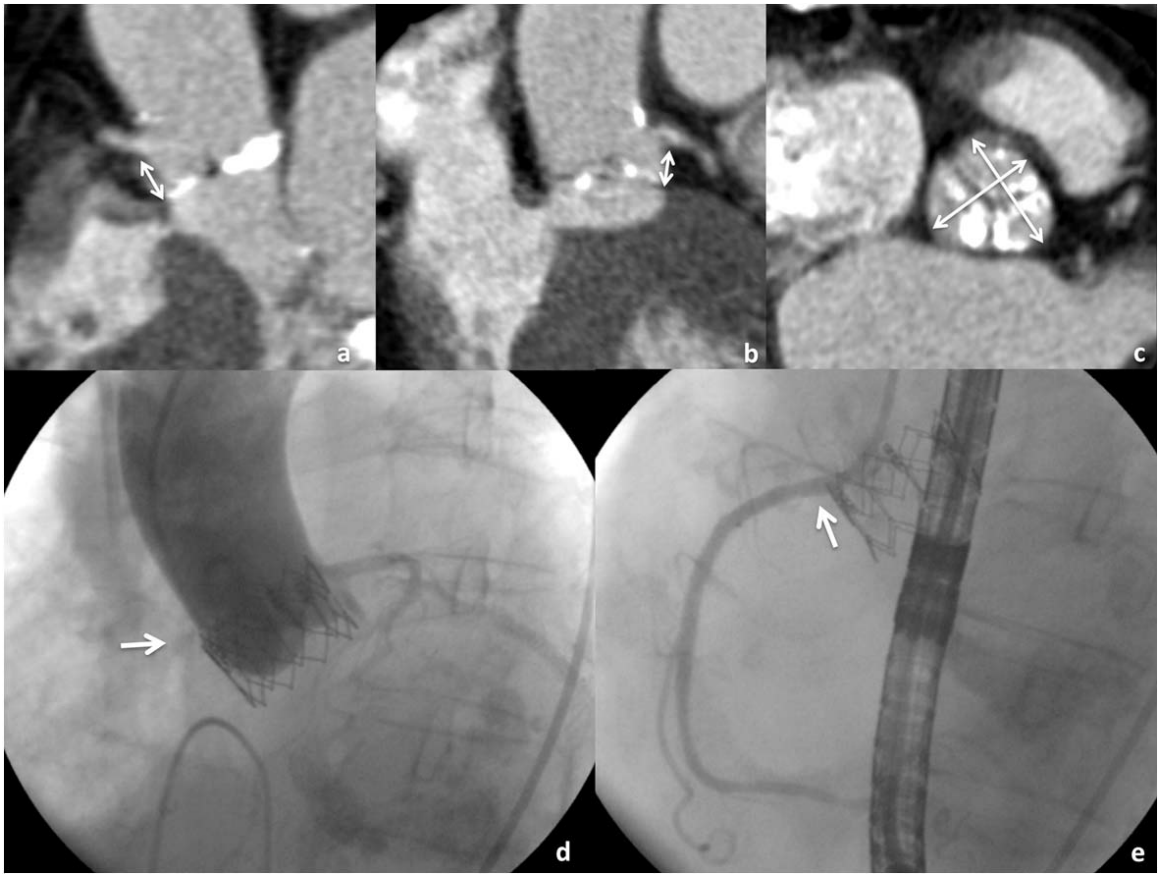

Figure 1 - *Computed tomography with height measurement of coronary arteries in long-axis view, showing right coronary artery (a) and left coronary artery (b). Sinus of Valsalva measurement obtained from the mean between the larger and smallest diameter on short-axis view (c). Aortography showing occlusion of right coronary artery after transcatheter aortic valve implantation (d). Angiography of right coronary artery after successful implantation of two stents (e).*

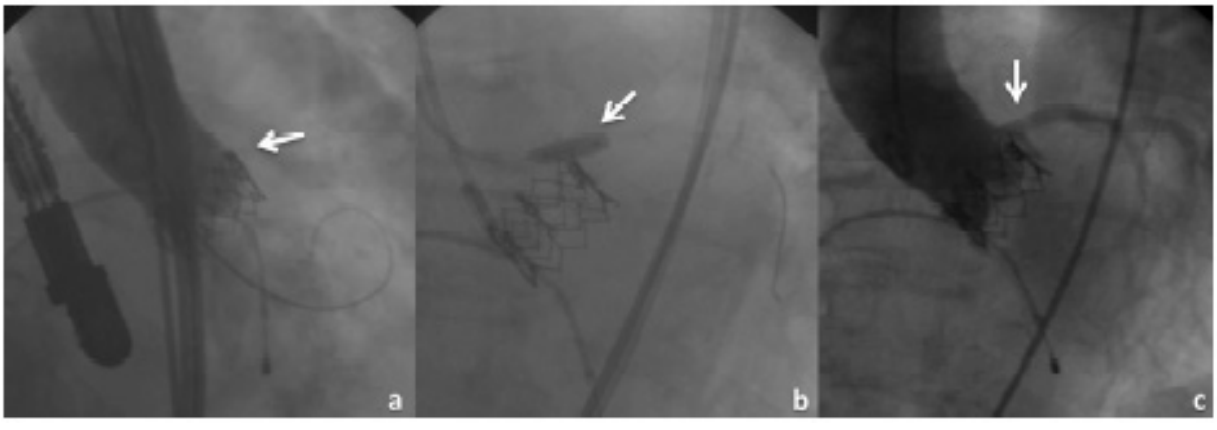

Figure 2 - *Aortography showing obstruction of the left main after transcatheter aortic valve implantation (a), and angioplasty with stent implantation (b) showing good final angiographic result (c).*

balloon-expandable, could prevent the occurrence of this severe complication. Additionally, other preventive measures such as the a coronary guidewire protection, could speed up the treatment of a possible coronary obstruction. Future studies including a larger number of cases may confirm the predictors as well as a more proper management of this significant TAVI complication.

In conclusion, coronary obstruction following TAVI is a rare but potentially fatal complication, being more frequent in women. Low lying coronary ostia and small sinus of Valsalva may be anatomical risk factors, emphasizing the importance of a proper pre-procedural evaluation in order to avoid this complication.

Author contributions

Conception and design of the research: Ribeiro HB, Sarmento-Leite R, Rodés-Cabau J, Brito Jr. FS. Acquisition of data: Ribeiro HB, Sarmento-Leite R, Siqueira DAA, Carvalho LA, Mangione JA, Perin MA, Brito Jr. FS. Analysis and interpretation of the data: Ribeiro HB, Sarmento-Leite R, Siqueira DAA, Carvalho LA, Mangione JA, Rodés-Cabau, Perin MA, Brito Jr. FS. Writing of the manuscript: Ribeiro HB, Sarmento-Leite R, Brito Jr. FS. Critical revision of the manuscript for intellectual content: Ribeiro HB, Sarmento-Leite R, Siqueira DAA, Carvalho LA, Mangione JA, Rodés-Cabau, Perin MA, Brito Jr. FS.

Potential Conflict of Interest

The authors Drs. Fabio Sandoli de Brito Junior, José Armando Mangione, Josep Rodés-Cabau, Luiz Antonio de Carvalho, Marco A. Perin and Rogério Sarmento-Leite received honoraria from industry (Medtronic) on consulting and lectures. The author Dr. Josep Rodés-Cabau received honoraria from industry (Edwards Lifesciences and St. Jude Medical) on consulting and research projects. The author Dr. Dimytri A. Siqueira received honoraria from industry (Edwards Lifesciences and Medtronic) on consulting and lecture.

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Study Association

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