

# Delayed Coronary Ostial Stenosis after Surgical Aortic Valve Replacement and Root Enlargement Treated with Beating Heart On-Pump CABG

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## Abstract

Coronary ostial stenosis after surgical aortic valve replacement (SAVR) is a rare but potentially fatal complication. Surgeons must have a high level of vigilance regarding the presentation of acute myocardial ischemia, arrhythmia, and heart failure after AVR. According to most reports, this event can be time-dependent divided into two groups; early acute phase that mostly happens intraoperative during weaning of CPB or in early ICU stay, and late presentation usually appears 1 - 6 months post surgery. Here, we describe an unusual subacute presentation of right coronary ostial stenosis 12 days after SAVR, which was treated successfully with redo beating heart coronary artery bypass grafting (CABG).

## Keywords

Non-ST Elevation Myocardial Infarction, Iatrogenic Complication, Coronary Artery Disease, Surgical Aortic Valve Replacement

## 1. Introduction

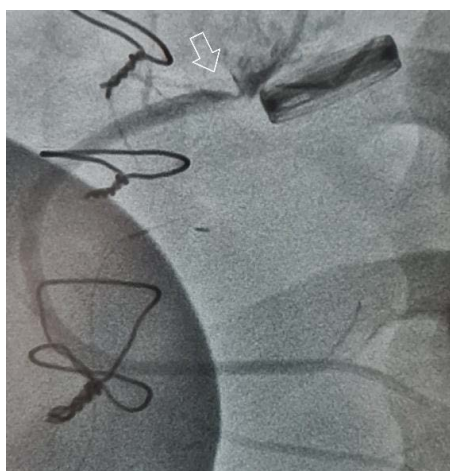
Iatrogenic coronary ostial stenosis (ICOS) following surgical aortic valve replacement (SAVR) is a rare but potentially serious and life-threatening complication. The estimated incidence is about 0.3% - 3.4% [1]. It can occur in one or both coronary Ostia, more commonly affect the left main coronary artery (LM) compared to the right coronary artery (RCA) [2] [3]. Clinical presentation is typical with symptoms of acute myocardial ischemia, ventricular arrhythmia, or heart failure. The exact underlying cause remains undetermined, but various

hypotheses have been proposed. In the acute phase attributed to sudden coronary spasm, calcium plaque embolization, or surgical factors from aortotomy or prostheses suture [4] [5] [6] [7]. A traumatic injury from antegrade cardioplegic cannula or edematous reaction for late presentation [8] [9], which mainly appear 1 - 6 months postoperatively [1]. Although most of case reports highlight the potential ICOS as either acute intraoperative or late postoperative event. Here, we present a case of subacute right coronary ostial stenosis 12 days after SAVR, which was successfully managed with redo beating heart CABG.

## 2. Case Presentation

A 33-year-old female with a body height of 156 cm and a surface area of 1.69 m<sup>2</sup>, known to have a bicuspid aortic valve (type 1, L-N; Sievers classification [10]) was diagnosed with moderate aortic stenosis in 2020. After 2 years of follow-up, she developed symptoms of shortness of breath on exertion (NYHA class III). She did not have angina or syncope. A transthoracic echocardiogram (TTE) demonstrated severe aortic stenosis with a small aortic annular dimension (peak/mean PG 79/41 mmHg, AVA 0.9 cm<sup>2</sup>, LVOT 18 mm). The patient was referred for surgical aortic valve replacement. Her previous medical history included iron deficiency anemia, sleeve gastrectomy, and a history of aspirin allergy. The surgical intervention proceeded via J-Cut hemi sternotomy. After connecting to extra corporal circulation, antegrade blood cardioplegia was given through the aortic root, approximately 1 cm above the Sino-tubular junction. A spiraling-type incision down toward the non-coronary sinus was performed. Inspection of the valve appeared to be bicuspid with raphe between left coronary and non-coronary leaflets. An obvious low lying right coronary ostia was also observed. The annulus size was measured at 19 mm after the excision of both leaflets and annular debridement. The Aortotomy was then extended using the Nicks technique across the non-coronary cusp annulus. A pericardial bovine patch was used to complete the repair using continuous 4-0 Prolene suture. Thereafter, a 21 mm mechanical prosthetic valve (Carbomedics Standard, Liva Nova) using non-everting technique with interrupted pledgeted and non-pledgeted sutures in supra-annular position was implanted. The patient weaned off smoothly from cardiopulmonary bypass (CPB) without complication or any sign of ischemia. Intraoperative TEE showed a well-functioning prosthetic aortic valve with a mean gradient of 8 - 10 mmHg and a normal biventricular function (LVEF 65%). The patient had an uneventful postoperative course and was discharged home on day 11 at a therapeutic dose of Warfarin (INR 2.8) and in good condition. A pre-discharge TTE revealed the same results. Twenty four hours later, she presented to the ER with acute chest pain followed by a syncopal attack. An electrocardiogram (ECG) demonstrated ST segment depression in leads V2 and AVL. Laboratory investigations revealed an elevation of the serum troponin I level up to 6 ng/ml (normal value: less than 0.032 ng/ml), so it was considered a non-ST elevation myocardial infarction (NSTEMI). Repeat TTE revealed decrease left ventricular (LV and right ventricular) RV function (Ejection fraction

40%) and new hypokinesia of the proximal to mid inferior and inferolateral segments, the mechanical valve was seated well, although no paravalvular leakage or gradient was found. The patient was stabilized allowing safe transfer to the Cath-Lab. An urgent coronary angiogram demonstrated a significant isolated severe ostial stenosis (90%) of the right coronary artery (RCA) (**Figure 1**). After taking the consensus in the conjoint heart team, we decided to go with surgical revascularization. So the patient was taken back to the theater and a beating heart On-Pump coronary artery bypass grafting was performed with the in-situ right internal mammary artery (RIMA) grafted to the middle portion of the RCA, the flow over the graft was 65 ml/minute. This resulted in prompt resolution of the ischemic changes and instant improvement of LV and RV contractility. The patient was shifted to ICU in stable condition with minimal cardiac support. Cardiac CT showed patent RIMA to RCA (**Figure 2**). Her post-operative convalescence went smoothly and she was discharged after 12 days.



**Figure 1.** Diagnostic coronary angiogram shows severe ostial stenosis of the right coronary artery (arrow).



**Figure 2.** Postoperative computer tomography (CT) shows successful revascularization of the right coronary artery with RIMA.

### 3. Discussion

ICOS as a lethal complication following SAVR was initially described by Roberts and Morrow in 1967 [11]. Historically, the incidence rate of 1% to 5% with Starr-Edward ball prosthesis was first reported [12]. Afterward, Chavanon *et al.* estimated a lower rate of 0.3% to 3.4% in all SAVR procedures [1]. Farid *et al.* reported a mortality of 3.4% due to ICOS in postmortem analyses [6].

Clinical presentation includes symptoms of stable angina, acute coronary syndrome, ventricular arrhythmia, congestive heart failure, and sudden cardiac death, which typically appear either 1 to 6 months postoperatively or immediate perioperative. It has rarely have been identified within the first 4 weeks or beyond 1 year after surgery [1] [3].

The exact pathophysiologic mechanism remains undetermined. Various hypotheses have been proposed to explain the development of this disease entity. Faulty surgical technique appears to be the main reason for ICOS occurring intraoperatively after weaning from CPB or in the early ICU stay. This includes prosthesis oversizing especially in a small anulus, improper positioning of the sewing ring, and excessive aortic traction causing turbulence front the disc occlude moving in front of the ostium [13].

Over-tightening the aortotomy suture or high-level valve stitch specifically in the bicuspid valve with a low ostial level [14] could entrap or even occlude the Ostia. All these factors can lead to sudden intraoperative hemodynamic collapse, RV dysfunction and dilatation, and fatal outcomes [6] [7]. Furthermore, embolism from calcium debris or floating plaque can obstruct the coronary ostium during decalcification [5].

Coronary artery spasm has been also recognized as a possible cause in the acute stage with features of hemodynamic and arrhythmic instability. Pragliola *et al.* reported a case of ST segment depression and repeated ventricular fibrillation after discontinuation of CPB post SAVR, although in absence of apparent surgical causes an urgent coronary angiography showed diffuse vasospasm of the entire coronary tree which promptly resolved with the intracoronary infusion of nitrate and verapamil [4].

On the other hand, the late phase of presentation as delayed ostial stenosis has been often reported and well studied. In most of these cases, the mechanism has been attributed to the use of ostial cannulae for antegrade cardioplegia, which can cause a micro-injuries to the media and intima distal to the ostium orifice resulting a local hyperplastic reaction related to the excessive infusion pressure of the cardioplegic solution and overdilation of the vessel by the tip of the cardioplegic catheters [8] [9]. Recently, the use of basket tip cannula has been popularized which minimizes contact area in ostium and deliver a dispersed flow.

A different mechanism has been earlier suggested to explain the occurrence with the use of Starr Edwards caged ball valve is the turbulent blood flow in the aortic root, presumably over time, can cause intimal thickening and fibrous proliferation [15].

Less common mechanisms such as secondary fibrosis in the suture area, the use of surgical glue with extrinsic compression around the ostium during hemostasis, and immunological reaction to the bioprosthetic valve have been described [16] [17] [18]. In addition, late coronary artery embolism was hypothesized but mostly related to subtherapeutic anticoagulation leading to coronary embolic events.

Intraoperative TEE is a quick useful implement to evaluate the prosthetic valve as well as a diagnostic tool in acute complications to identify the mechanisms of urgent hemodynamic instability after valve surgery. Such detailed findings can be provided, including prosthetic leaflet motion, paravalvular leakage, wall motion abnormality, and the new relationship between the coronary ostium and the prosthetic valve.

In case of a suspicion of ICOS, coronary angiography is the gold diagnostic tool and should be performed promptly. Considering IVUS is not bad for better understanding the possible underlying mechanism. MDCT can be considered as an alternative in stable late presenter patients or who decline cath.

Our patient developed symptoms of myocardial ischemia and heart failure 2 weeks after surgery in the subacute phase. This clinical sequelae besides the angiography and CT results may strongly lead us to attribute the cause to some surgical factors of high prosthetic valve level plus low RCA ostium, as is commonly known in the bicuspid aortic valve [14], and slightly tilted sewing ring causing compression to proximal RCA, beside a likely suture impingement on the ostium without complete occlusion. This kind of issue can be explicitly faced in small LVOT diameter, which mainly needs root augmentation.

Such patients need prompt attention and a heart team meeting should discuss the strategy of intervention, either percutaneous coronary intervention or CABG.

In the era of LM stenting, several case reports of successful ICOS treatment with PCI (thrombus aspiration or angioplasty/drug-eluting stents) have been published with excellent short and midterm outcomes [3]. The major advantages are immediate availability and lower procedural risk but it is not suitable for all.

CABG is still considered to be the preferred treatment in the acute intraoperative phase and stable high-risk patients with good early and long-term outcomes [19]. If ICOS occurs within 6 postoperative months when pericardial adhesions are most dense and residual inflammation of tissues, [1], it is associated with high morbidity and mortality rate.

In our patient, we decided after a heart team discussion to prefer the surgery over PCI based on the age of the patient and aspirin allergy. Moreover, CABG with beating heart on-pump technique was performed. We chose to use arterial conduit as it is guideline recommended.

#### 4. Conclusion

Coronary ostial stenosis after SAVR is very rare but should be considered in the differential diagnosis when patients postoperatively present with anginal pain, heart failure, or arrhythmia mostly occurring intraoperatively or late within 1 - 6

months after surgery. It can manifest even in the subacute phase, as in our case, or later after a year as has been reported. Surgeons must have a high level of vigilance regarding this complication and must be ready to perform properly. Due to its rarity, urgent heart team meeting include surgeon, interventionist, anesthesiologist, and echocardiographer to discuss the etiology first, especially if a spasm is suspected which is usually treated medically, and to select the proper type of intervention either PCI or CABG.

### Author Contributions

M. Tolah: This author wrote the original draft. M. Sadek: This author helped with the writing, review and editing. M. Tamim: This author helped with the supervision. Y. Elkady: This author helped with the conceptualization. All authors read and approved the final manuscript.

### Ethics Approval and Consent to Participate

The study was approved by the Research Ethics Committee of the General Directorate of Health Affairs in Madinah National Registration Number (ID: IRB23-047), confidentiality of the participants' data was ensured by keeping the data sheets anonymous after assigning a code number specific to each patient, which is known only by the investigators.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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