Management of coronary artery disease before, during and post TAVI

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Abstract:

Transcatheter aortic valve implantation (TAVI) plays a crucial role in the management of severe Aortic stenosis (AS) regardless of the surgical risk. The burden of coronary artery disease (CAD) in these patients is considerable as CAD and severe AS increase with population aging. In the past, Treatment of severe AS associated with CAD was treated with coronary artery bypass graft (CABG) with surgical aortic valve replacement but nowadays we have another alternative which is TAVI and PCI in those patients. Nowadays, there is an expansion in the indications of TAVI to low-risk and younger patients so coronary complications can occur later in their life so there will be an increase in the need for coronary management after TAVI and there will be some challenges, especially with tall frame transcatheter heart valves (THV). we aimed in our review to discuss the different strategies to protect or to treat the CAD in patients' candidates for TAVI either before or after the procedure and also, we aimed to discuss the tips and tricks for coronary re-access after TAVI.

Keywords:

TAVI: Transcatheter aortic valve implantation, AS: aortic stenosis, CAD: Coronary artery disease

Introduction

In patients with severe aortic stenosis (AS), the burden of coronary artery disease (CAD) is considerable. It could affect the procedural risk as well as the patient's post-procedural prognosis.

Severe AS and CAD increase with population aging which leads to significant association in such patients.

In the past, Treatment of severe AS associated with CAD was treated with coronary artery bypass graft (CABG) with surgical aortic valve replacement but nowadays we have another alternative which is TAVI and PCI in those patients.

we faced some problems in the treatment of CAD in patients' candidates for TAVI especially the guidelines recommendations were based on non-randomized trials and expert opinion. Also, TAVI nowadays is indicated for younger patients with low risk and with longer life span so coronary complications can occur later in their life so there will be an increase in the need for coronary management after TAVI and there will be some challenges, especially with tall frame transcatheter heart valves (THV)

So, we aimed in our review to discuss the optimal management of coronary artery disease in the severe AS population and show the different techniques to preserve coronary access during the TAVI and how to deal with the coronary events before, during, and after TAVI.

Incidence of CAD in patients with severe AS

Large registries and randomized controlled trials have reported that around 50% of patients' candidates for TAVI have CAD. [(1)] In some studies, it was found that

those patients were old age and had multiple diseases as dyslipidemia, diabetes, and hypertension, the prevalence of CAD in those studies was > 70 %.[2, 3] After extension of TAVI indications to low and intermediate-risk patients, the prevalence was estimated in PARTNER 3 and Low-Risk study to be < 30%.[4, 5] It should also be considered that patients with recent percutaneous coronary intervention (PCI), left main disease, syntax score more than 22 were added as an exclusion criterion in intermediate and low-risk TAVI trials.

Also, there are some recent data regarding the incidence of Acute coronary syndrome after TAVI.[6-8] it was shown in several large studies that the incidence of ACS after TAVI was less than 5 %.[6, 9] presentation of ACS was mostly non-ST acute coronary syndromes.[9] Important predictors associated with occurrence of ACS within 6 months after TAVR such as younger patients at TAVI, diabetes mellitus, peripheral arterial disease, history of CAD before TAVI, acute kidney injury after TAVI, and valve-in valve procedures.[9]

A) Management of coronary artery disease pre-TAVI

The latest clinical guidelines recommend the evaluation of CAD in patients scheduled for TAVI as a class I recommendation [10] because there is a high prevalence of CAD and AS, also there is prognostic influence and potential long-term challenges with coronary access especially with self-expanding valves. Heart team discussion is crucial before a decision in patients who have complex CAD and anatomy challenges in the aortic root as it may prefer a combination of aortic valve replacement and CABG over PCI and TAVI.

Invasive Coronary angiography (ICA) is a gold standard test for the evaluation of CAD before TAVI but nowadays you can use Multislice CT coronary angiography instead of ICA notably in low-risk patients as it was shown to be sufficiently accurate to rule out significant CAD in low-risk patients and it avoids the additional radiation and contrast in the invasive coronary angiography.[11]

There was a debate about the prognostic impact of CAD in patients before TAVI, there were many studies that showed there was no impact of pre-existing CAD on major adverse cardiovascular events in patients scheduled for TAVI.

Abdelwahab et al showed in their study that there is no significant impact of CAD on mortality in those patients after adjustment of confounding factors, and also found that there was improvement of functional class in both groups either patients with CAD and underwent TAVI or patients without pre-existing CAD.[12]

Snow TM et al reported in the UK TAVI registry that CAD has no significant impact on short-term or long-term survival in patients who underwent TAVI after 4 years of follow-up.[13]

Also, Matta et al showed that the CAD-TAVI group had no more significant in-hospital major cardiovascular adverse events (MACE) than the TAVI group without CAD.[14]

On the contrary, the TAVI registry from Switzerland reported that there was significant cardiac death in patients presented with CAD who underwent TAVI compared to the other group without CAD (p =0.030)

Sankar Mangalam et al reported in a large meta-analysis with 8013 patients that pre-existing CAD does not impact patients having TAVR, concomitant CAD has no effect on 30-day mortality, but it has a significant effect on 1-year all-cause mortality (p =0.002).[15]

PARTNER 3 trial showed complete data about revascularized patients, illustrating comparable primary endpoints including death from any cause, rehospitalization, or stroke in patients undergoing CABG with SAVR and PCI with TAVI (12.1% vs 9.4%, HR= 0.77). We thought that we were in need of more randomized and prospective trials for studying the correlation between the presence of CAD and TAVI due to the heterogeneous results of the previous studies.

Role of functional assessment of CAD in patients with AS

Functional assessment of coronary lesions can be done either invasive coronary modalities such as fractional flow reserve (FFR) and the instantaneous wave-free ratio (iFR) or non-invasive imaging modalities.

It has been shown that fractional flow reserve (FFR) is a helpful tool for directing the treatment strategy in patients with moderate coronary stenosis with improvement of clinical endpoints.[16] Stanojevic et al studied the safety of intravenous adenosine injection during FFR assessment of intermediate coronary lesions in severe AS cases.[17]it was noticed that all patients tolerated very well adenosine injection without significant adverse events.

However, there is physiological changes in AS such as left ventricular hypertrophy (LVH), diminution of the coronary reserve, change in the anatomy of the coronary vessel, and reduction in stroke volume. these consequences can lead to variability of FFR before and after TAVI.

Wendreick et al [18] studied the effect of FFR and iFR in the assessment of intermediate coronary lesions before and after TAVI and it was proven that TAVI increases hyperemic coronary flow throughout the whole cycle, with continued benefits at longer-term follow-up. Which renders FFR evaluation less appropriate for patients with severe AS. However, in this study, Severe AS does not have a major impact on resting diastolic flow and therefore no significant changes in the iFR values before and after 6 months follow-up of TAVI.

Sabahh et al[19] studied the effect of FFR in 50 coronary intermediate lesions before and after TAVI, it was found that FFR did not differ significantly before and six months after TAVI (p=0.72).

Ahmed et al[20] compared the influence of FFR and iFR in patients who underwent TAVI, and it was concluded that there is no difference in the value of iFR before and after TAVI while the value of FFR was significantly higher before TAVI (p=0.0008).

Scarsini [21] studied the role of iFR in 145 patients who underwent TAVI. It was reported that there is no significant difference of iFR before and after the procedure. (0.89 ± 0.12 before TAVI versus 0.89 ± 0.11 after TAVI, p= 0.66)

There are recent ongoing randomized trials for physiological assessment of CAD in severe AS such as FAITAVI, NOTION-3, TAVI PCI trials. In FAITAVI trial, it will compare in 320 patients with severe AS candidates for TAVI and at least one coronary artery stenosis > 50 % of either physiology-guided treatment of CAD versus angiographically guided treatment. In NOTION-3 trial, it will compare in 452 patients with severe AS candidates for TAVI and at least one coronary stenosis with FFR ≤0.8 or diameter stenosis >90% in a coronary artery ≥ 2.5 mm either conservative treatment of CAD versus FFR-guided complete revascularization. In the TAVI PCI trial, it will compare physiology-guided complete coronary revascularization before (within 1-45 days) or after (within 1-45 days) TAVI using the Edwards SAPIEN Transcatheter Heart Valve. Also, there is a recent ongoing trial called IMPACTavi that will study the role of Near-infrared spectroscopy intravascular ultrasound (NIRS-IVUS) in patients with CAD and severe AS for better assessment of plaque characteristics and burden that can identify patients at risk for future cardiovascular events. It may be a good option instead of a functional assessment of coronary artery lesions (either by FFR or iFR) for better assessment of the severity of CAD in patients with severe AS.[22]

Timing of PCI in patients undergoing TAVI

There is no doubt that PCI should be done before TAVI if the patient presented with acute coronary syndrome. Meanwhile, in chronic coronary syndromes, there is not enough data to determine the timing of PCI either before, during, or after TAVI.

The only randomized trial called the ACTIVATION non-inferiority trial studied 235 patients with severe AS and significant CAD.[23] It was divided into 2 main groups: PCI and non-PCI groups. After 1 year of follow-up, there was a higher incidence of bleeding in the PCI

group but there was no difference between the primary composite endpoint of all-cause death and hospitalizations (44% of the non-PCI group and 41.5 % of the PCI group). The main drawbacks of this trial were 2/3 of patients had single CAD and also 69% of patients were asymptomatic. It does not show benefit in routine revascularization in stable patients.

In the TAVI French registry, after enrolling 4201 patients they found that significant stenosis of the left anterior descending artery (LAD) was associated with increased mortality after 3 years follow-up.[24] they concluded that the deleterious effect of LAD disease on cardiac death or the need for re-vascularization before or at the time of TAVR should be studied better in a randomized control trial(RCT).[24]

There is a recent study published by Tobias et al [25] that compared the different timing strategies of PCI in patients undergoing TAVI and have stable coronary artery disease and it was concluded that composite endpoints of all causes of death, stroke, myocardial infarction, and heart failure at 2 years were significantly lower in patients doing PCI after TAVI with improvement of 2-year outcomes.

we can conclude that routine PCI prior to TAVI should not be the standard of choice in all patients with stable coronary artery disease undergoing TAVI. The patient's symptoms, comorbidities, type of valve prosthesis, and complexity of the coronary anatomy should all be taken into account when determining whether PCI should be performed on TAVI candidates.[26]

PCI before TAVI[1, 27-29]

We thought that PCI before TAVI allows easier coronary access, especially with the self-expanding Evolut valve, it may make the TAVI procedure less risky because it may improve LV function and may reduce the risk of coronary ischemic during LV pacing. However, the main drawback was less accurate iFR/FFR assessment of intermediate coronary lesions and additionally, severe AS increases the risk of hemodynamic instability during PCI, increases the risk of bleeding of subsequent TAVI procedure (due to dual antiplatelet therapy), and involves a second hospital admission with another procedure. we should take into consideration the hazards of injection of nitroglycerine in patients scheduled for PCI through radial access in severe AS.

PCI after TAVI[1, 27-29]

It has various advantages such as allowing assessment of symptoms post TAVI because AS is often the predominate pathology, more accurate FFR/iFR measurement of intermediate coronary lesions, lower risk of hemodynamic decompensation especially during complex PCI such as use of rot ablator in calcified lesions with impaired LV ejection fraction. However, the most important disadvantage is difficult coronary access after TAVI especially the self-expanding supra-annular valve, less support and stability of the coronary catheter for engagement left main coronary artery or right coronary artery. There are important factors that make PCI easier post-TAVI TAVI such as good commissural alignment, depth of the implantation of the valve, operator experience for cannulation of the coronaries

Combined PCI and TAVI[1, 27-29]

There are some benefits for doing combined PCI and TAVI during the same procedure such as utilization of the same arterial access and lower cost. It also allows chimney stenting if required.

But also, there are various disadvantages such as prolonged procedure increase exposure to radiation and use of large amounts of contrast especially in complex CAD, and higher probability of acute kidney injury, and it may be uncertain whether PCI is required

Finally, according to the guidelines, we thought that it is preferable to do PCI before TAVI, especially in proximal coronary lesions with more than 70% stenosis or > 50% LM stenosis, symptoms of typical angina, or ACS presentation with significant CAD.[1, 10, 30]

There are currently no randomized data comparing complete versus incomplete revascularization in subjects with stable CAD undergoing TAVI. Consequently, there were no recommendations for this objective. So, we adopt the Heart Team discussion

before deciding the most appropriate revascularization strategy for TAVI patients, especially in multivessel coronary artery disease, and also to determine the timing of revascularization in all cases.

B) Coronary obstruction risk during the procedure[31, 32]

Coronary obstruction during TAVI is the worst complication of TAVI with a higher mortality rate. Nowadays this risk has been declining with the improvement of valve designs, better analysis of CT pre-TAVI, more meticulous patient selection, increased operator's experience, and matching the aortic anatomy to the type of suitable valve.
There are various predisposing factors for coronary obstruction: either anatomical native valve factors or procedural factors or transcatheter heart valve (THV) related factors

A) Anatomical native valve factors:
-long aortic leaflets exceeding the coronary ostial height
-Low-seated coronaries
-low height of Sino tubular junction (STJ)
-shallow sinus of Valsalva
-heavy leaflet calcification
B) Procedural factors:
- Depth of valve deployment
- Valve expansion
- Valve in valve procedure that have a higher risk of coronary obstruction due to displacement of bioprosthetic leaflets
C) Transcatheter heart valve (THV) factors
-valve type and design
-valve skirt
-valve commissural height

Acute obstruction of the Coronary artery during TAVI is very rare < 1% [33] with high mortality rates, it is limited to patients with high anatomical risks. it is the most devastating complication during TAVI. The incidence of obstruction is higher in females and is more common for LM occlusion than the right coronary artery. The incidence of acute obstruction of the Coronary artery increases in cases with valve-in valve procedures up to 2.3%.[33, 34]

Mechanism of coronary artery obstruction may be absent sinus, sinus sequestration, obstruction by mass effect (native leaflets or bioprosthetic leaflet in cases of valve in valve procedures) or TAVR skirt and commissure or calcium embolization (as shown in figure 1) or stent deformation and thrombosis.

The available software now can help us during pre-procedural planning to predict the anatomical risk factors that can lead to coronary obstruction during the index procedure. It was reported that there are several anatomical predictors for coronary obstruction such as the small diameter of the sinus of Valsalva (<30 mm), low coronary height (<10 mm), small virtual transcatheter valve to coronary ostia (VTC <4 cm), the valve in valve procedures especially with externally mounted leaflets, leaflets dimensions and placement, elongated or bulky leaflets.

Treatment of acute coronary obstruction is a therapeutic challenge especially if there is no preparatory coronary protection. Urgent PCI can be performed but crossing a wire and delivering a stent to the coronaries rapidly may be challenging because there are overlying implanted valve struts or displaced native or surgically bioprosthetic valve leaflets.

There are other options for the treatment of acute coronary obstruction including urgent CABG or snaring and removal of the transcatheter valve

Surgical aortic valve replacement can be recommended for patients who are at high risk for coronary obstructions, but we cannot forget patients with prohibitive or very high operative risk that is often indicated for TAVR.

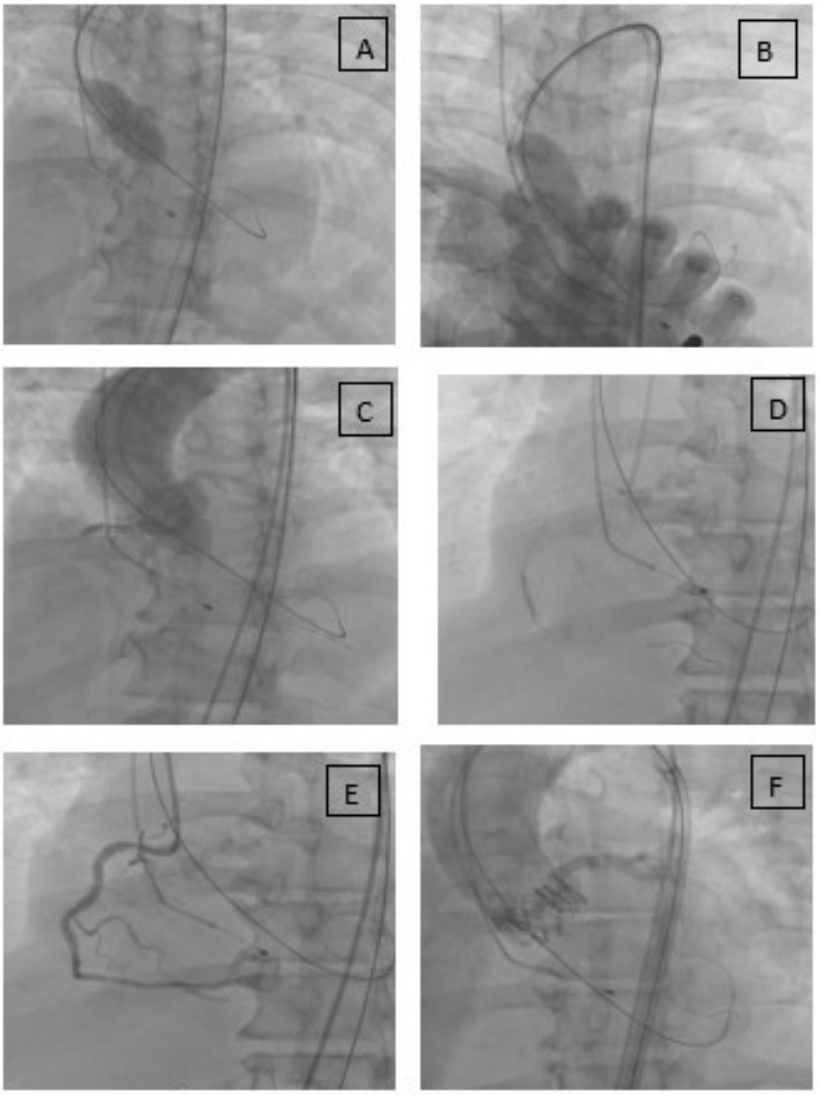

Figure (1)

Figure (1): Case with coronary artery obstruction by calcium embolization after valve pre-dilation by balloon valvuloplasty A= Pre-dilation by balloon valvuloplasty due to heavy valve calcification, B= patient was arrested after valve pre-dilation due to VF and CPR was done for 2 minutes, C=injection through pigtail showed occlusion of RCA, D=engagement of RCA and passage of guidewire and balloon pre-dilation, E=restoration of the flow in RCA, F= balloon-expandable valve was deployed, and injection through pigtail showed patency of both coronaries

VF: ventricular fibrillation, CPR: cardiac pulmonary resuscitation, RCA: right coronary artery

Delayed coronary obstruction is a rare complication after TAVI and is associated with a higher death rate.[35]it is more common with self-expanding valves. It can occur early (within hours to a few days after TAVI) or late and occurs after several months or years after TAVI. Jabbour et al, showed that valve in valve procedures, low coronary height, and shallow sinus of Valsalva can lead to early coronary obstruction after TAVI, while thrombus formation on the valve or endothelization of the implanted valve can be responsible for late coronary obstruction after TAVI.[35]

Commissural Alignment and optimizing the Coronary Access During the Index procedure [1, 32, 36]

Trans catheter valve neo commissures should be aligned with the native aortic valve commissures and it is crucial to facilitate coronary access in the future by preventing the overlap with the coronary ostia. Commissural alignment should be considered when implanting a tall-frame self-expanding valve. It improves the easier cannulation of the coronaries after TAVI, in addition to decreasing the procedural duration and contrast volume.[37] However, we sometimes faced some difficulty in engaging the coronaries post-TAVI in spite of good commissural alignment, especially with the transcatheter valve with a supra-annular leaflet position.

Tang et al [36]studied the effect of different valve types orientation and the overlap of the coronaries in his famous study (ALIGN TAVR) and it was concluded that optimization of commissural alignment will be crucial for re-accessing the coronaries and for redo-TAVI in the future.

Self-expanding Evolut valves: For improving the commissural alignment, there are some specific considerations: put the flush port at 3 o'clock while using the cusp overlap view, position the Hat marker in the outer curve of aorta, ensure that the C-paddle at the right on the screen in the cusp overlap view.

To avoid acute coronary obstruction, it is better to avoid high implantation of the self-expanding valve, especially with low-seated coronaries.

Self-expanding Accurate-Neo valves: it is better to put the flush port at 6 o'clock while using the cusp overlap view, isolate one of the commissural posts to the right of the cusp overlap view

Balloon expandable Sapien valve: Commissural alignment is unaffected when the valve is crimped in a predefined direction.

Protecting the coronaries during the index procedure

There are different ways to protect coronaries during TAVI either chimney technique or leaflet modification therapies either electrical or device based but we thought the most important step is a careful patient selection and meticulous CT analysis pre-TAVI

A) Chimney technique[38]

Coronary artery obstruction can be avoided by placing a coronary guidewire, balloon, undeployed stent, or guide extension in the coronary artery at risk before deployment of the transcatheter heart valve.[38-40] If there is a reduction in coronary blood flow during or after valve deployment, the stent is pulled back proximally to be parallel to the deployed THV then the stent will be deployed to make a channel between the aortic wall and displaced native valve leaflets for better coronary perfusion. The aim of Successful chimney stenting is to resolve coronary obstruction with the establishment of good TIMI (Thrombolysis in Myocardial Infarction) flow with patent stent grade 3 flow.

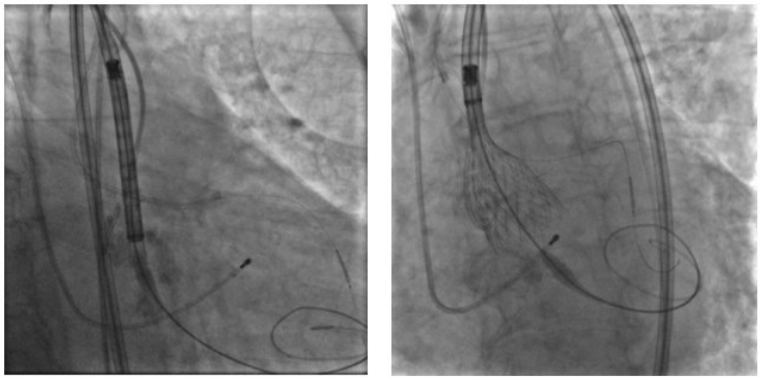

Figure (2)

Figure (2) Chimney technique showed the placement of the guide wire and undeployed stent in a left anterior descending artery (LAD) as a protection strategy for the low seated left main coronary artery (less than 10mm) before deployment of self-expanding Evolut valve.

In the international chimney registry, it showed that the chimney technique was used in 0.5% of all cases that were recruited in this study (12800 patients). it was concluded that the chimney technique is an acceptable feasible technique for bailout coronary artery obstruction during deployment of the valve.

They found that 93 % of patients have one or more anatomical risk factors for coronary obstruction. prophylactic coronary protection reduces the risk of Myocardial infarction (MI), and cardiogenic shock and reduce also mortality rates[38]. It also facilitates easy restoration of blood flow.[38]

The length and diameter of the stent should be considered very carefully before the chimney procedure. The main drawback of this technique is late stent failure which was 3.5% after 1 year of follow-up.

Stenting strategies to avoid coronary obstruction may be suboptimal in different settings because there is a risk for stent deformation and thrombosis with turbulent blood flow given that their locations are in the compressed space between the deployed valve and coronary ostia. Also, future coronary access may be affected and patients are asked to take dual antiplatelet therapy (DAPT) which increases the risk of bleeding. Meanwhile, DAPT duration for 3 to 6 months post-TAVI may not be sufficient for patients who have proximal stents protruding in the ascending aorta that will be poorly reendothelized.[41]

B) BASILICA (bioprosthetic or native aortic scallop intentional laceration to prevent iatrogenic coronary artery obstruction)

This method utilizes electrocauterization to transverse and lacerate a natural heart or bioprosthetic leaflet that may lead to coronary obstruction after displacement by TAVR maintaining the coronary blood flow.[42]

Despite the fact that BASILICA is an effective method of preventing coronary occlusion, it calls for highly qualified and experienced operators using this unusual technique.

It utilizes an electrified guidewire to split the aortic leaflet either right or left to facilitate the blood flow going toward the coronary ostia. it may need the exchange of catheters, various sheath accesses, and manipulation with severely calcified leaflets therefore it may increase the risk of stroke, vascular complications, injury of non-target structures, and aortic regurgitation (AR) that can lead to hemodynamic instability.

Recently the first multicenter study in Europe named EURO-BASILICA studied the safety and feasibility of the BASILICA technique. [43]It was shown that this technique was effective in preventing coronary artery obstruction caused by deployed THV. Seventy-six patients were recruited across multiple different centers in Europe. Most of the patients had bioprosthetic valves (92.1%), other patients had native aortic valves (5.3%) and 2.6% of patients had a history of transcatheter valve implantation.

Only 11.8 % of the study population was indicated for double BASILICA for both coronary cusps. This technique was successful in 97.7% of cases but 2.4 % of patients experiencing complete coronary occlusion. It was reported in this study that only 2 patients had complications with leaflet-induced total occlusion and it was treated by urgent stenting with the aid of mechanical circulatory support.

There are new modalities for preventing coronary obstruction especially for TAV-in TAV such as shortcut devices. It is the first specialized transcatheter leaflet-splitting device to prevent coronary artery obstruction after TAVI, especially in cases with failed bioprosthetic valves.[44]

C) Coronary access after TAVR

As we mentioned before nowadays there is an extension of the indication of TAVI to low-risk and younger patients, so it is important to re-access the coronaries due to the possibility of ACS or chronic coronary syndrome in the future. Acute coronary syndromes were estimated around 10 % after TAVI and the predicted all-cause mortality was 40-50% after 21 months of follow-up.[31, 45] Also, retrospective studies indicate that 3.5%-5.7% of patients who underwent TAVI required PCI post-TAVI, with a time range from 1 to 72 months.[46]

Faroux et al[47] showed in his study that there were some difficulties regarding the cannulation of coronaries in ST-elevation myocardial infarction following TAVI. It was recognized that 33% of PCI post-TAVI had a longer door-to-balloon time than non-TAVR procedure and there was a 4 times higher failure rate of PCI in the PCI post-TAVR group with excess mortality rates.

We previously discussed that there are multiple factors not only one factor that hinder coronary access after TAVI, there are either anatomical factors such as coronary height, width and height of sinuses of Valsalva, leaflet length and thickness, or another device or procedural factors such as the commissural alignment, the depth of implantation of the valve, and the height of sealing skirt.

Barbanti et al [48] reported in the RE-ACCESS study (Reobtain Coronary Ostia Cannulation Beyond Transcatheter Aortic Valve Stent) to search for the predictors for failure of cannulation of the coronaries post TAVI, it was found that the failure rate of coronary engagement was seen in 23 patients (7.7% of the study population) and it was more common with Evolut transcatheter valve (22 patients). From this famous study, we concluded that there are 3 factors mostly predicting the failure of coronary engagement including the relation between transcatheter aortic valve and sinuses of Valsalva (SOV), higher depth of implantation of THV, and Evolut Medtronic valve.

While Stefanini et al concluded in the REVIVAL study that the most common indication of PCI post-TAVI was ACS with a higher success rate (96.6% of the whole study population), it was reported also that there is no significant difference between the balloon-expandable valve and self-expanding valve for accessing the coronaries post TAVI [49].There are several studies that compare the feasibility of coronary angiography (CA) after implantation of self-expanding and balloon-expandable valves. It was found that in both groups success rate was very high, selective angiography of the right coronary artery was reported that it was easier than the left coronary artery.

Ochiai et al[50] made also a virtual assessment of the cannulation of coronaries by utilization of Computed tomography (CT) post-TAVI. From this study, we learned that skirt position and length, commissural alignment of the implanted device, THV frame height,

and the sinus of Valsalva space between the THV frame and coronary ostia are multiple factors that affect selective coronary engagement. it was reported that CT characteristics of difficult coronary access were found more in the supra-annular self-expanding Evolut platform in comparison to the short-frame intra-annular balloon-expandable Sapien 3 valve. We concluded from this study that CT assessment before elective CA might be helpful in better evaluation of the feasibility for cannulation of the coronaries before CA.

Tips and tricks for better coronary cannulation post-TAVI

First, balloon-expandable valves have no difficulty in recannulation of the coronaries especially if it was implanted properly as the valve is a short frame and leaflet position is intra-annular, so usual diagnostic catheters can be utilized for CA and PCI without change in the size of the catheters.

On the other side, the self-expandable valve has longer valve frames with small cell sizes and the leaflet position is supra-annular. these challenges can hinder coronary access and make it difficult for coronary engagement in the future. There are some technical modifications for better coronary access post-TAVI. For balloon-expandable valves, coronary engagement can be done easily from the upper edge of the valve design. However, in cases with self-expanding valves, access of the coronaries can be done through the closest open cell

to the Ostia and then engage the coronary ostia co-axially.

In long-frame self-expanding valves, to engage the left coronary artery it is better to use smaller catheters [Judkins left (JL)3.5 instead of JL 4], if it is failed you can use other catheters such as right Judkins (JR) 4 or Ikarr right 1.5/1.0 catheters. Use J-shaped wire for better catheter manipulation. For PCI you can use extra backup (EBU) guiding catheters 3.0 instead of EBU 3.5. while engagement of the right coronary artery (RCA), can be done by JR 4 diagnostic catheter or Amplatz right or multipurpose catheter, or in case of failure of coronary engagement we can cannulate indirectly the coronaries by guidewires or guide extensions such as Guidelines, Telescope, Guidezilla. we believe that a baseline aortogram can be helpful for better understanding the position of the implanted valve in regard to the coronaries.

After finishing the baseline angiogram or PCI, we should carefully disengage the coronary catheter from the ostia using J shaped wire to prevent catheter entrapment or valve cell deformation. We thought that interventional cardiologists should have complete training for access post-TAVI.

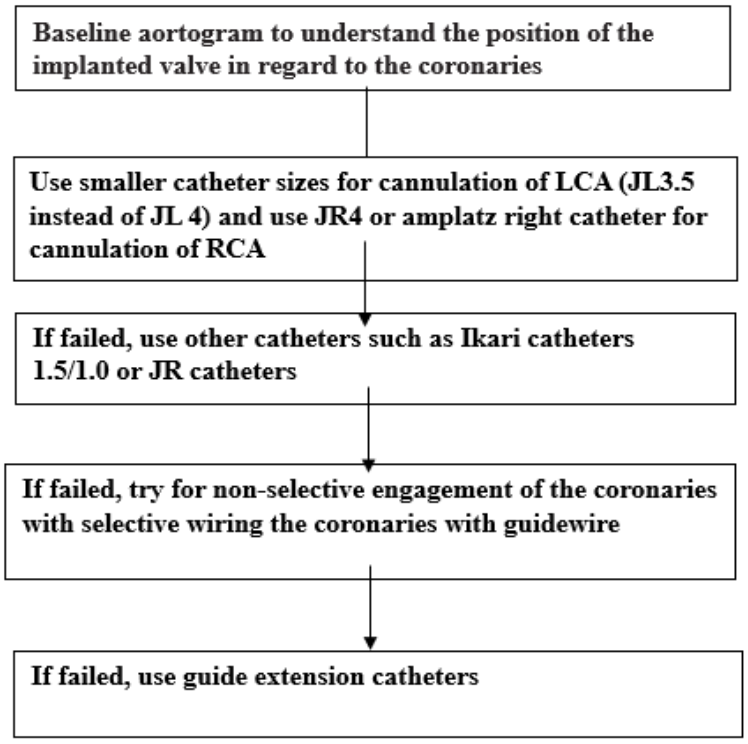

Figure (3)

Figure (3) tips and tricks for coronary access after TAVI

Abbreviations: LCA: left coronary artery, RCA: right coronary artery

Future predictions:

As the previous studies included TAVI patients with high surgical risk, the future perspective concerning the relationship between the younger population and planned PCI in the TAVI population has to be studied with more randomized trials in another clinical interest. There is a recent ongoing trial called the COMPLETE TAVR trial (NCT04634240) that compares complete revascularization versus medical therapy in patients undergoing TAVI. Also, there is an ongoing trial called the TAVI-PCI (NCT04310046) that discusses the ideal timing for physiology-guided revascularization strategy relative to the TAVI procedure.

Conclusion:

Treatment strategies for CAD in patients planned for TAVI are very important after the expansion of the indication of TAVI to lower-risk patients. Routine PCI before TAVI should not be the standard of choice for the treatment of stable CAD in all patients' candidates for TAVI. Careful patient selection, meticulous analysis of CT before TAVI, commissural alignment, good choice, and position of THV are key points for avoiding coronary artery complications during or after TAVI.

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