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Επεμβατικός καρδιολόγος, FSCAI
Κλινική Euromedica-Κυανούς
Σταυρός, Θεσσαλονίκη
Concomitant coronary artery disease (CAD) and valvular heart disease is a common problem in the ageing population.
Currently, rheumatic factors in the etiology of valvular heart diseases have been mostly replaced by degenerative factors, the prevalence of which increase with increasing age.

The prevalence of degenerative aortic valve disease increases with age and it is the leading valvular condition accompanying CAD.

• Among patients presenting with symptomatic aortic stenosis, concurrent CAD occurs in over 50% of those over 70 years of age and over 65% of those over 80 years of age.
Conclusion:
The comparison of MS and AS groups *revealed significantly higher prevalence of CAD in the AS group.*
There was no statistically significant difference between the MR and AR groups in terms of the prevalence of CAD.
The comparison of MS and MR groups revealed significantly higher prevalence of CAD in the MR group.
Evaluation of CAD in Patients Undergoing Valve Surgery

Class I

1. **Coronary angiography** is indicated before valve intervention in patients with symptoms of angina, objective evidence of ischemia, decreased LV systolic function, history of CAD, or coronary risk factors (including men age >40 years and postmenopausal women). *(Level of Evidence: C)*

2. Coronary angiography should be performed as part of the evaluation of patients with chronic severe secondary MR. *(Level of Evidence: C)*
1. **Surgery without coronary angiography** is reasonable for patients having emergency valve surgery for acute valve regurgitation, disease of the aortic sinuses or ascending aorta, or IE. *(Level of Evidence: C)*

2. **CT coronary angiography** is reasonable to exclude the presence of significant obstructive CAD in selected patients with a low/intermediate pretest probability of CAD. A positive coronary CT angiogram (the presence of any epicardial CAD) can be confirmed with invasive coronary angiography.398–404 *(Level of Evidence: B)*
2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary
A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Intervention for CAD

Class IIa

1. CABG or percutaneous coronary intervention is reasonable in patients undergoing valve repair or replacement with significant CAD (≥70% reduction in luminal diameter in major coronary arteries or ≥50% reduction in luminal diameter in the left main coronary artery). (Level of Evidence: C)
## 2014 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostic modalities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary angiography is recommended before valve surgery in patients with severe valvular heart disease and any of the following:</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>• history of CAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• suspected myocardial ischaemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• LV systolic dysfunction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• in men aged over 40 years and in postmenopausal women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• $\geq$1 cardiovascular risk factor for CAD.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary angiography is recommended in the evaluation of secondary mitral regurgitation.</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>CT angiography should be considered before valve surgery in patients with severe valvular heart disease and low probability for CAD or in whom conventional coronary angiography is technically not feasible or of high risk.</td>
<td>IIA</td>
<td>C</td>
</tr>
</tbody>
</table>
Knowledge of coronary anatomy contributes to risk stratification and determines if concomitant coronary revascularization is indicated.

- Coronary angiography can be omitted in young patients with no atherosclerotic risk factors (men <40 years and premenopausal women) and in rare circumstances when its risk outweighs benefit, e.g. in acute aortic dissection, a large aortic vegetation in front of the coronary ostia, or occlusive prosthetic thrombosis leading to an unstable haemodynamic condition.

- The measurement of pressures and cardiac output or the performance of ventricular angiography or aortography *are restricted to situations where non-invasive evaluation is inconclusive or discordant with clinical findings*. Given its potential risks, *cardiac catheterization to assess haemodynamics should not be done routinely with coronary angiography.*

- Due to its high negative predictive value, MSCT may be useful in excluding CAD in patients who are at low risk of atherosclerosis.
# Primary indication for valve interventions

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Primary Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG</td>
<td>Patients with a primary indication for aortic/mitral valve surgery and coronary artery diameter stenosis &gt;70% in a major epicardial vessel.</td>
</tr>
<tr>
<td>CABG</td>
<td>Should be considered in patients with a primary indication for aortic/mitral valve surgery and coronary artery diameter stenosis 50–70% in a major epicardial vessel.</td>
</tr>
<tr>
<td>PCI</td>
<td>Should be considered in patients with a primary indication to undergo TAVI and coronary artery diameter stenosis &gt;70% in proximal segments.</td>
</tr>
<tr>
<td>PCI</td>
<td>Should be considered in patients with a primary indication to undergo transcatheter mitral valve interventions and coronary artery diameter stenosis &gt;70% in proximal segments.</td>
</tr>
</tbody>
</table>
**Primary indication for coronary revascularization**

<table>
<thead>
<tr>
<th>Primary Indication</th>
<th>Grade</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral valve surgery is indicated in patients with severe mitral regurgitation</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>undergoing CABG, and LVEF &gt;30%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitral valve surgery should be considered in patients with moderate mitral</td>
<td>IIA</td>
<td>B</td>
</tr>
<tr>
<td>regurgitation undergoing CABG to improve symptoms.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair of moderate-to-severe mitral regurgitation should be considered in patients</td>
<td>IIA</td>
<td>B</td>
</tr>
<tr>
<td>with a primary indication for CABG and LVEF ≤ 35%.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress testing should be considered in patients with a primary indication for</td>
<td>IIA</td>
<td>C</td>
</tr>
<tr>
<td>CABG and moderate mitral regurgitation to determine the extent of ischaemia and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>regurgitation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic valve surgery should be considered in patients with a primary indication</td>
<td>IIA</td>
<td>C</td>
</tr>
<tr>
<td>for CABG and moderate aortic stenosis (defined as valve area 1.0–1.5 cm² [0.6 cm²/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m² to 0.9 cm²/m² body surface area] or mean aortic gradient 25–40 mmHg in the</td>
<td></td>
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<tr>
<td>presence of normal flow conditions).</td>
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</tr>
</tbody>
</table>
In patients undergoing aortic valve replacement (AVR) who also have significant CAD, *the combination of CABG and valve surgery reduces the rates of*
- perioperative myocardial infarction,
- perioperative mortality,
- late mortality and morbidity,
when compared with patients not undergoing simultaneous CABG
Coronary Artery Disease and Its Management: Influence on Survival in Patients Undergoing Aortic Valve Replacement

CHARLES J. MULLANY, MB, MS, LILA R. ELVEBACK, PhD, ROBERT L. FRYE, MD, FACC,
JAMES R. PLUTH, MD, FACC, WILLIAM D. EDWARDS, MD, FACC,
THOMAS A. ORSZULAK, MD, LOUIS A. NASSEF, Jr., MD, RONALD E. RINER, MD,
GORDON K. DANIELSON, MD, FACC
Rochester, Minnesota

Group 1A: AS no CAD
Group 1B: AS & CAD, no CABG
Group 1C: AS & CAD + CABG

J Am Coll Cardiol 1987;10: 66-72
The prognostic impact of concomitant coronary artery bypass grafting during aortic valve surgery: Implications for revascularization in the transcatheter era

Nassir M. Thalji, MBChB, Rakesh M. Suri, MD, DPhil, Richard C. Daly, MD, Kevin L. Greason, MD, Joseph A. Dearani, MD, John M. Stulak, MD, Lyle D. Joyce, MD, Harold M. Burkhart, MD, Alberto Pochettino, MD, Zhuo Li, MSc, Robert L. Frye, MD, and Hartzell V. Schaff, MD

50 – 70% Stenosis

<p>
\[
\begin{align*}
\text{Survival (\%)} & \quad \text{Years} \\
\text{CABG} & \quad 161 \quad 104 \quad 36 \\
\text{No CABG} & \quad 137 \quad 60 \quad 16
\end{align*}
\]

\[p = 0.02\]


> 70% Stenosis

<p>
\[
\begin{align*}
\text{Survival (\%)} & \quad \text{Years} \\
\text{CABG} & \quad 882 \quad 518 \quad 155 \\
\text{No CABG} & \quad 128 \quad 64 \quad 18
\end{align*}
\]

\[p = 0.03\]

J Thorac Cardiovasc Surg 2015;149:451-60
However, elderly patients often have more co-morbidities, are more likely to have had a previous cardiac operation, and are less tolerant of complex cardiac surgery.

Furthermore, the addition of coronary artery bypass grafting (CABG) at the time of valve surgery doubles the operative risk of the procedure.

In a large series of patients from the New York Cardiac Surgery Reporting System from 2001 to 2003 on approximately 10,000 patients, the mortality for isolated valve surgery was 4.4% versus 9% for valve and concomitant coronary surgery.
Hybrid Procedures
Combination of interventional and surgical techniques in order to reduce invasiveness, improve safety and long term results
Alternative treatments for high-risk patients also include ‘hybrid’ procedures, which involve a combination of scheduled surgery for valve replacement and planned PCI for myocardial revascularization.

**Rationale of Hybrid Valve/PCI**
The rationale behind hybrid valve surgery *is to substitute PCI for CABG* (typically substituting PCI for SVG) to convert a combined valve/CABG procedure requiring sternotomy into an isolated valve procedure, which can be performed using minimally invasive techniques.

➢ With the current excellent performance of drug-eluting coronary stents (DES), restenosis and thrombosis rates of DES may be less than the estimated rate of SVG failure of 20 % at 12 months.
The two most common clinical objectives of hybrid procedures are:

• to facilitate minimally invasive surgery and
• to reduce overall operative morbidity and mortality by transforming a single, high-risk surgery into two less risky procedures.

At present, however, the data on hybrid valve/PCI procedures are very limited, being confined to case reports and small case series. Individual treatment decisions in these complex patients are best formulated by the Heart Team.
Minimally invasive valve surgery refers to a collection of techniques in which several alternative incisions to sternotomy

Median sternotomy (aortic, mitral, or tricuspid valve).
(B) Right thoracotomy (mitral or tricuspid valve).

(C) Upper hemi-sternotomy (aortic valve).
(D) Lower hemi-sternotomy (mitral or tricuspid valve)
**WHY MINIMALLY INVASIVE?**

1. Improves postoperative respiratory function
2. Reduces postoperative pain and recovery
3. Provides a cosmetically superior incision
4. Reduces dissection of other areas (low blood loss)
5. Facilitates a reoperation at a later date, as the lower part of the pericardium remains closed
6. More rapid return to functional activity, less rehab resources
7. *Beneficial effects in elderly*
8. Reduces costs
Limitations of minimally invasive valve surgery are:

• the need for a learning curve;
• operative times can be longer, especially at the beginning;
• it requires the surgeon to work through smaller incisions with sometimes different instruments than usual; and
• the exposure of the valve can be initially difficult.

Moreover, the institution of cardiopulmonary bypass and myocardial protection can be more time consuming and troublesome.

• Satisfactory de-airing may be difficult because of the limited access to the aorta or the apex of the heart. This has raised concern among some investigators of increased risk of neurological adverse events.
Convert high-risk valve/CABG surgery into a lower-risk isolated valve.

The mortality for isolated valve surgery was 4.4% versus 9% for valve and concomitant coronary surgery.

In high-risk patients with multiple comorbidities such as increased age, low ejection fraction, morbid obesity, and pulmonary and renal dysfunction, it may even be higher.

Thus, combining 2 low-risk strategies, PCI (1% mortality in the elective settings) with minimally invasive approaches (0.7% to 2% mortality range) is very appealing to reduce the overall operative risk.
A hybrid procedure that changes a conventional CABG with concurrent valve surgery into a PCI with isolated minimally invasive valve surgery is an appealing way to parse and minimize the risk of complex heart surgery.

**Methods:** We retrospectively evaluated 65 consecutive patients with coronary disease and surgical valvular heart disease who underwent planned PCI followed within 60 days by minimally invasive valve surgery, and we compared them with 52 matched control patients who underwent conventional bypass grafting and valve surgery.

**Death, renal failure, or stroke occurred in 1 (1.5%) in the hybrid group versus 15 (28.8%) in the conventional group**

There were no reoperations for postoperative bleeding in the hybrid group compared with 2 (3.8%) in the conventional group (P ¼ .43).
Emergency coronary artery bypass grafting (CABG) combined with valve surgery as well as some re-operative valve/CABG operations are high-risk procedures with a modern operative mortality for each approaching 20%. The optimal treatment for these patients is not firmly established hybrid valve/PCI.

Hybrid valve surgery is especially suitable for patients with acute coronary syndrome and known valve disease.

In this approach, usually PCI is performed first to the culprit lesion, stabilizing the coronary lesion, and then, during the same hospital stay, the valve lesion is addressed 5 to 7 days after the initial PCI.

This approach converts an emergent/urgent concomitant coronary and valve surgery into a more elective isolated valve surgery.

26 patients with known combined coronary artery disease and valve disease

Of these patients, 92% had acute coronary syndrome, 50% had unstable angina, 42% had acute myocardial infarction, and 15% were in cardiogenic shock.

Observed versus predicted operative mortality
Convert reoperative valve/CABG into reoperative isolated valve surgery

**hybrid valve/PCI**

Two broad scenarios for this strategy include:
1. the need for reoperative valve re-replacement for structural valve degenerations after biological valve replacement in the setting of known coronary disease and
2. the need for primary native valve surgery late after CABG.

**Typical scenarios for the latter include**
1. late native aortic valve stenosis after CABG in which the gradient at the time of original CABG was thought to not warrant concomitant aortic valve replacement or
2. late ischemic mitral regurgitation after CABG in which avoiding sternotomy is particularly appealing.
Convert reoperative valve/CABG into reoperative isolated valve surgery

Reoperative coronary bypass grafting in a patient with valvular disease poses a **particular challenge in cardiac surgery**

- The technical difficulty of accessing lateral wall targets, safely dissecting patent bypass grafts and obtaining exposure often precludes safe surgery, and these risks are not reflected in traditional scoring systems.

Hybrid valve/PCI may be particularly useful in this regard and **can dramatically simplify a challenging open valve and CABG surgery**

It just makes no sense to dissect the entire heart, placing patent grafts at risk, to place an SVG on an obtuse marginal target.

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Poor or limited vein graft quality combined with poor target vessel quality is one of the reasons SVG failure at 1 year is as high as 30%.

*In the presence of such conditions, a PCI with DES may be a better option.*
Several questions remain unresolved, such as

✓ the order in which surgery and PCI should be performed,
✓ the duration of the staging of the 2 procedures,
✓ antiplatelet strategies,
✓ the costs, and
✓ the logistics.
The optimal relative timing of the staged hybrid valve/PCI procedures remains unknown.

A one-stop, or single-stage procedure may be appealing with respect to convenience, patient safety and resource utilisation.

However, the ability to perform a single-stage procedure may be limited by the availability of appropriate staff and facilities.

The single-stage approach requires a hybrid suite that can accommodate the equipment to perform the PCI as well as full cardiopulmonary bypass-based cardiac surgery.
✓ The risk-benefit profile of a single-stage procedure may also become unfavourable in the setting of significant renal dysfunction and certain other clinical circumstances.

✓ Finally, the management of required antiplatelet and anticoagulation therapies may be challenging based on the relative timing of the hybrid procedures.
**Anticoagulation Management**
Regardless of the hybrid strategy employed, concern remains over the impact of clopidogrel, or other antiplatelet therapies on bleeding at the time of cardiac surgery.

- The early hybrid experience was associated with increased blood loss and higher transfusion rates, which was attributed to the use of clopidogrel at the time of the valve operation.
- However, more contemporary data suggests the risk of surgical bleeding while on clopidogrel may be overestimated.

The subsequent strategy of shortening the duration between stages offered the potential to circumvent the increased risk of bleeding based on the pharmacokinetics of clopidogrel.

- Another way to decrease the risk of bleeding is to shorten the staging of PCI and surgery within 6 h, so that clopidogrel effects are just beginning to take effect once the surgery is completed. This approach, however, requires a specially designed suite, the hybrid operating room.
Decision making for hybrid procedures is complex, should be individualized and take into account not only the short-term risk but also the long-term benefit.
CORONARY ARTERY DISEASE AND TAVI: PCI BEFORE, DURING OR NEVER?
- 82 y/o female
  - NYHA IV, ACS
- Severe low-flow, low-gradient AS
  - AVA 0.7 cm²
  - Mean gradient 31 mmHg
  - LVEF 40%
- Risk Scores
  - Logistic EuroSCORE: 33.7
  - Standard ES: 13
  - Chron. kidney disease (eGFR43)
Options for treatment

- **Optimal medical treatment**
  - “Ignoring” CAD and focusing upon TAVI

- **Coronary revascularization**
  - Prior to the TAVI procedure.
  - Concomitant to the TAVI procedure.
  - Following TAVI and pending on CAD symptoms
CORONARY ARTERY DISEASE AND TAVI: PCI BEFORE, DURING OR NEVER

**CAD & TAVI: PREVALENCE - 3**

Significant CAD is present in 40% to 75% of patients undergoing TAVR
The following considerations arise when evaluating patients with severe AS and CAD for TAVR:
1. hemodynamic alterations during TAVR in presence of unrevascularized CAD
2. Need for revascularization
3. mode of revascularization: PCI or surgical;
4. safety of performing PCI in patients with severe AS;
5. timing of PCI in relation to TAVR; and
6. type of stent and management of antiplatelet regimen.
IMPACT OF CAD ON TAVI

Presence of CAD per se does not appear to lead to adverse clinical outcomes following TAVI

30-DAY MORTALITY

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IMPACT OF CAD ON TAVI

Presence of CAD per se does not appear to lead to adverse clinical outcomes following TAVI

**1-YEAR MORTALITY**

<table>
<thead>
<tr>
<th>Study</th>
<th>CAD</th>
<th>No CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewey et al</td>
<td>35.7</td>
<td>18.4</td>
</tr>
<tr>
<td>Mason et al</td>
<td>26.3</td>
<td>18.8</td>
</tr>
<tr>
<td>Gautier et al</td>
<td>24</td>
<td>18.5</td>
</tr>
<tr>
<td>Khawaja et al</td>
<td>31.5</td>
<td>14.4</td>
</tr>
<tr>
<td>Stefanini et al</td>
<td>16.9</td>
<td>14.5</td>
</tr>
<tr>
<td>Ussia et al</td>
<td>15.9</td>
<td>15.9</td>
</tr>
</tbody>
</table>

*p = 0.006, p = ns, p = 0.01, p = ns, p = ns*
Presence of CAD per se does not appear to lead to adverse clinical outcomes following TAVI

**Prognostic Value of Coronary Artery Disease Among Patients Undergoing TAVI**

N = 2,472
Prevalence of CAD 52% (42-63)

*Median follow-up 452 days (357-585)*

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>log(Odds Ratio)</th>
<th>SE</th>
<th>Weight</th>
<th>Odds Ratio IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dewey, 10</td>
<td>1.3</td>
<td>2.8</td>
<td>0.5%</td>
<td>3.67 [0.02, 887.08]</td>
</tr>
<tr>
<td>Gasparetto, 11</td>
<td>0.08</td>
<td>0.79</td>
<td>6.8%</td>
<td>1.06 [0.23, 5.10]</td>
</tr>
<tr>
<td>Moual, 11</td>
<td>0.09</td>
<td>0.37</td>
<td>31.0%</td>
<td>1.09 [0.53, 2.29]</td>
</tr>
<tr>
<td>Presbitero, 12</td>
<td>0.08</td>
<td>0.98</td>
<td>5.5%</td>
<td>1.06 [0.10, 6.00]</td>
</tr>
<tr>
<td>Schnabel, 12</td>
<td>-0.02</td>
<td>0.53</td>
<td>15.1%</td>
<td>0.99 [0.35, 2.77]</td>
</tr>
<tr>
<td>Torino, 12</td>
<td>0.08</td>
<td>0.97</td>
<td>4.5%</td>
<td>1.08 [0.16, 7.22]</td>
</tr>
<tr>
<td>Ussla, 12</td>
<td>-0.11</td>
<td>0.34</td>
<td>36.7%</td>
<td>0.90 [0.46, 1.74]</td>
</tr>
</tbody>
</table>

Total (95% CI)

Heterogeneity: $\tau^2 = 0.00; \chi^2 = 0.41, df = 6 (P = 1.00); I^2 = 0$
Test for overall effect: $Z = 0.02 (P = 0.98)$

D’ASCENZOF ET AL INT J CARDIOL 2013; 168: 2528-2532

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Are all AS+CAD patients the same?

What happens when we stratify AS+CAD patients according to anatomic severity (based on the SYNTAX Score)?

*The severity of CAD appears to be more important*

$P = 0.016$

$P = 0.029$

Stefanini GG et al EHJ 2014 & O’sullivan CJ et al JACC Interventions 2015
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

There are 2 key questions in the management of high-risk patients with severe AS and concomitant significant CAD.

• First, is the CAD significant enough to warrant an intervention?
• Second, if a PCI is deemed necessary, what is the best timing for PCI?

It is still unclear which patients should undergo PCI before TAVR.
Is the CAD significant enough to warrant an intervention?

Interventions should be performed only on lesions that were deemed clinically relevant after consideration of symptoms, the extent of myocardium at risk, proven ischaemia by invasive or non-invasive testing, and technical feasibility of PCI.
Are there advantages to achieving complete / “reasonable” incomplete revascularization?

O’sullivan CJ et al. JACC Interventions 2015
Are there advantages to achieving complete / “reasonable” incomplete revascularization?

More complete revascularization (\(\rightarrow rSS < 8 \text{ or } 14\)) probably attenuates the effect of severe CAD.

Are there advantages to achieving complete / “reasonable” incomplete revascularization?

More data required on impact of complete vs incomplete revascularization on clinical outcomes after TAVI

In an elderly patient population undergoing TAVI for severe AS, a judicious revascularization strategy selection by a dedicated heart team can generate favorable mid-term outcome obviating the need for complete coronary revascularization.

Revascularization should be considered for severe coronary stenoses in proximal epicardial coronary vessels that subtend a large area of myocardium at risk.
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

There are three options

1. PCI before TAVR.
2. PCI with TAVR as combined procedure.
3. PCI after TAVR.
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

There are pros and cons to consider with each approach.

<table>
<thead>
<tr>
<th>PCI Prior to TAVI</th>
<th>PCI Combined with TAVI</th>
<th>PCI After TAVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro</td>
<td>Con</td>
<td>Pro</td>
</tr>
<tr>
<td>Simplified coronary access with no prosthetic valve in place</td>
<td>DAPT required after PCI may impact post-TAVI bleeding</td>
<td>Decreases the risk of mortality while waiting for TAVR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased dye load (contrast nephropathy), longer procedure time</td>
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<tr>
<td></td>
<td></td>
<td>Treating severe AS first may improve myocardial perfusion, decreasing need for PCI</td>
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<tr>
<td></td>
<td></td>
<td>Potential access issues, valve struts interfering with coronary cannulation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pro</th>
<th>Con</th>
<th>Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less risk of hemodynamic instability and ischemia during TAVI</td>
<td>Risks of performing PCI in the presence of severe AS</td>
<td>Reduction of vascular complications by needing one access site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Catheter manipulation could move the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher risk of hemodynamic instability and ischemia during TAVI</td>
</tr>
</tbody>
</table>

Minimize contrast load by giving it at 2 separate times. Less risk of hemodynamic instability and ischemia during TAVI.
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

Before transcatheter aortic valve replacement

The potential advantages of this approach are:
1) simplified access to the coronaries before TAVR;
2) less risk of ischemia and hemodynamic instability during rapid pacing and balloon inflation during subsequent TAVR; and
3) minimizing the contrast load by giving it at 2 separate points in time, thus minimizing the risk of contrast nephropathy.

There are 2 potential issues with this approach:
1) dual antiplatelet therapy after PCI and its impact on bleeding outcomes after subsequent TAVR, especially via non-transfemoral approach; and
2) the safety of performing PCI in the presence of severe AS.
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

Before transcatheter aortic valve replacement

• How safe is it to perform PCI in patients with AS?

• What type of stents?

• How long interval between PCI and TAVR and how to manage DAP?
How safe is it to perform PCI in patients with AS?

**30 day Survival**

PCI can be performed in patients with severe symptomatic AS and CAD without an increased risk of short-term mortality compared with propensity-matched patients without AS.

Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

What type of stents?

In the absence of large-scale studies evaluating the outcomes of drug-eluting stent (DES) versus bare-metal stent in patients undergoing TAVR, this decision should be made on an individual basis by the heart team, depending upon the perceived risk of bleeding and restenosis of the patient.

• In patients with atrial fibrillation, the risk of bleeding with warfarin and long-term dual antiplatelet therapy should be weighed against the risk of restenosis with bare-metal stent.

• For other patients, DES might be suitable.
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

How long interval between PCI and TAVR and How to manage DAP?

The ideal interval remains undefined and again should be individualized by the heart team on the basis of the specific clinical situation.

The access route might also have an influence on the type of stent

- Dual antiplatelet therapy in patients with DES is not an issue in case of transfemoral TAVR
  • Currently 1 month for BMS and 6 month for DES (?)
Concomitant with transcatheter aortic valve replacement

Some groups have proposed performing PCI on the most significant coronary lesions at the time of TAVR as a single staged procedure

**The potential advantages of this combined approach are:**

1) Providing a comprehensive cardiac solution similar to SAVR+CABG
2) *treatment of both pathologies at the same time* with elimination of potential morbidity and mortality after PCI while awaiting definitive management (i.e., TAVR for severe AS);
3) *1 arterial access for PCI and TAVR on the same day*, with potential reduction in the risk of vascular access site complications and bleeding; and
4) possible reduction in the risk of inducing ischemia and hemodynamic instability while performing TAVR this might be true if PCI is performed just before TAVR.

**On the other hand, one may argue that the risk of myocardial infarction, stroke and renal failure is increased for patients undergoing concomitant PCI during TAVI, as the procedure time is prolonged and the amount of contrast is larger**
Timing of revascularization of severe CAD in patients with severe AS undergoing TAVR.

After transcatheter aortic valve replacement

Investigators have also explored the possibility of performing PCI immediately after TAVR. There are a few case reports on PCI after TAVR.

This strategy poses certain, unique procedural risks. These include

- the possibility that the prosthetic valve struts may interfere with cannulation of the coronary arteries and

- that catheter manipulation may potentially dislodge the prosthetic valve.
Treating the right patient at the right time

The CAD in these patients may evolve and present as effort angina or may lead to complications in the form of acute coronary syndrome, and require a new PCI once the valve has been implanted.
In the future, the need for performing PCI through a CoreValveR prosthesis will increase given the generalisation of this treatment in SAS and the longer follow-up time for these patients. We believe that this is a feasible and safe technique if proper precautions are taken.

As the TAVR experience continues to grow, ongoing studies will shed more light on whether PCI after TAVR might be a safe and feasible option in cases where the need for coronary revascularization arises post-TAVR.
Patients with CAD that requires revascularization are randomized to undergo TAVR and PCI or SAVR and CABG with the exact timing of the PCI left to operator discretion.

If there is significant CAD with intended revascularization, the patient is then randomized and will undergo either TAVR + PCI or SAVR + CABG.

Until then, a case by case approach should be used by the heart team to guide selection of patients for percutaneous revascularization prior to TAVR.

ACTIVATION trial
The percutAneous Coronary inTervention prior to transcathe ter aortic valve replacement trial will be conducted in selected centres and will randomize 310 patients with severe AS and at least one proximal coronary stenosis of ≥70% to undergo PCI and TAVR vs. TAVR alone. Important endpoints will include 30-day and 1-year mortality and re-hospitalization.

PARTNER 2A trial
The PARTNER 2A trial is a prospective, multicentre, randomized trial that will test whether PCI and TAVR prior to SAVR leads to better outcomes than TAVR alone in patients with severe AS and ≥70% proximal coronary stenosis. Patients will be randomized to receive PCI and TAVR prior to SAVR or TAVR alone. Important endpoints will include 30-day and 1-year mortality and re-hospitalization.

SURTAVI trial
The Medtronic CoreValve® Surgical Replacement And Transcathe ter Aortic Valve Replacement trial will randomize 310 patients with severe AS and at least one proximal coronary stenosis of ≥70% to undergo PCI and TAVR vs. TAVR alone. Important endpoints will include 30-day and 1-year mortality and re-hospitalization.

Hopefully, from these studies, a clearer understanding of the best PCI strategy in various clinical scenarios will emerge.
TAVI and PCI Left Main in one Procedure
Most...not all coronaries with significant stenosis can be addressed by PCI

**Hybrid CABG / TAVR**

**Opportunities**
- Revascularize patients not amendable to PCI
- No contrast use
- Can use DAPT
- Not affected by Renal insufficiency

**Challenges**
- Redo-CABG suboptimal
- More invasive
- Longer procedural times
- May not tolerate manipulation of the heart with AS

Hybrid procedures with OPCAB and TAVR are an option if the lesions are not amendable to PCI
Failed PCI of CTO of the LAD and severe PVD
MidCAB and TA- TAVR
Letter to the Editor

Off-pump coronary artery bypass grafting in combination with transaortic transcatheter aortic valve implantation: A possible approach for patients with associated diseases

Giuseppe Santarpino *, Steffen Pfeiffer, Theodor Fischlein

- 88 yr old Female
- EuroScore 45%
- MID-RCA Stenosis not amendable to PCI
  - SYNTAXscore: 18
- Operation
  - OPCAB SVG to RCA
  - TAo TAVR with 23 Sapien XT
Transapical Aortic Valve Implantation and ‘Off-Pump’ Arterial Coronary Bypass in a Patient with a Porcelain Aorta

Miralem Pasic, Axel Unbehaun, Semih Buz, Thorsten Drews, Roland Hetzer

Deutsches Herzzentrum Berlin, Berlin, Germany

Procedure: OPCAB Lima to LAD / TA TAVR with 23 Sapien Valve
Hybrid therapy for severe aortic stenosis and calcified coronary artery disease induced by radiation: Combination of CABG via lateral thoracotomy and trans-femoral TAVI
Biolimus-eluting stent (BES) was deployed with LMT-LAD crossover stenting (Fig.A). At 6-month follow-up, we performed POBA for ISR (Fig.B). Unfortunately, he came back to our hospital due to recurrent angina 3-month latter. CAG showed recurrent ISR within the BES.
Hybrid therapy including CABG via lateral thoracotomy and TF-TAVI may be one of the options for treatment in patients with radiation-induced heart disease.
Management of patients with CAD and TAVI: Risk-based Algorithm

CAD
- ACS
  - Left main
  - Ischemia > 10%
- Single vessel

AS
- Severe 0.7-1 cm²
- Critical < 0.5 cm²

CAD
- Two staged procedure
  1. PCI
  2. TAVR

AS
- One staged procedure
  Consider circulatory support
  1. PCI
  2. BAV

AS
- Two staged procedure
  1. PCI
  2. Re-evaluation CAD

Hellenic Institute of Cardiovascular Diseases

www.e-Cardio.gr
A case by case approach should be used by the heart team to guide selection of patients for percutaneous revascularization prior to TAVR.
A selective revascularization strategy upon careful heart team decision might lead to favorable outcome
NEVER FORCE TOO MUCH...
EITHER INDICATIONS, DEVICES, TECHNIQUES,
OR
Limitations of Hybrid Valve/PCI

As for coronary hybrid CABG/PCI, there is concern regarding the impact of antiplatelet agents on bleeding after surgery.

- In the literature, one hybrid valve series (45) reports increased chest tube output, blood requirements (85% of patients received a blood transfusion), and reoperation for bleeding (8%), whereas another series (57) reports low chest tube output, low incidence of reoperation for bleeding (0%), and lower blood utilization (44% of patients). Both series are retrospective studies with small numbers of patients.

The main difference between these series is the timing of the surgery, in the first within 5 to 7 days after PCI and in the second within 24 h. It may be hypothesized that the different timing of loading of clopidogrel has an impact on the different incidence of bleeding.

Another way to decrease the risk of bleeding is to shorten the staging of PCI and surgery within 6 h, so that clopidogrel effects are just beginning to take effect once the surgery is completed. This approach, however, requires a specially designed suite, the hybrid operating room.
Management of coronary artery disease in patients with valvular heart disease

<table>
<thead>
<tr>
<th>Diagnosis of coronary artery disease</th>
<th>Class&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Level&lt;sup&gt;b&lt;/sup&gt;</th>
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</thead>
</table>
| Coronary angiography<sup>c</sup> is recommended before valve surgery in patients with severe valvular heart disease and any of the following:  
  • history of coronary artery disease  
  • suspected myocardial ischaemia<sup>d</sup>  
  • left ventricular systolic dysfunction  
  • in men aged over 40 years and postmenopausal women  
  • ≥1 cardiovascular risk factor. | I | C |
| Coronary angiography is recommended in the evaluation of secondary mitral regurgitation. | I | C |
### Indications for myocardial revascularization

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<tr>
<th>Indications</th>
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<td>CABG is recommended in patients with a primary indication for aortic/mitral valve surgery and coronary artery diameter stenosis $\geq 70%$.</td>
<td>I</td>
<td>C</td>
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<tr>
<td>CABG should be considered in patients with a primary indication for aortic/mitral valve surgery and coronary artery diameter stenosis $\geq 50$–$70%$.</td>
<td>IIa</td>
<td>C</td>
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