WHAT CAN THE SURGEON DO TO AVOID PATIENT-PROSTHESIS MISMATCH (PPM)?

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Valve surgery, most of the time, involves replacement of the diseased native valve with a prosthetic valve: Aortic or Mitral.
In AVR, this entails Transverse Aortotomy and Excision of the diseased cusps

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Sizing the aortic annulus
Placing sutures before seating the valve
Mechanical valve: St Jude Regent

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Biologic Valve  St Jude Toronto Stentless Porcine Valve

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Trifecta St Jude Pericardial Stented Supra-annular Valve

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Homograft
What Is Patient–Prosthesis Mismatch (PPM) ?

• PPM is technically present, when the implanted valve has an Effective Orifice Area (EOA) less than that of the normal valve for that Body Surface Area (BSA), thus causing an abnormal residual pressure gradient across the valve with obstruction to ventricular outflow or inflow, or both.

• If The normal area of the aortic valve (EOA) ranges from 2.6 - 3.6cm².

• The effective orifice area index (EOAI) = 2.0cm²/m².

• And Since, Valve prostheses of sizes less than 25, have an EOA of less than 2.5cm².

• Therefore, by definition these valves are inherently stenotic.

• According to the degree of stenosis expressed as EOAI, we can classify PPM into mild, moderate, and severe.
Guidelines used for defining PPM

• The EOAI was used to divide the patients into three groups:
  – Mild PPM : EOAI = / > 0.9 cm²/m² BSA .
  – Moderate PPM : EOAI between 0.6 and 0.9 cm²/m² BSA .
  – Severe PPM : EOAI = / < 0.6 cm²/m² BSA .

Clinical scenario

75-year-old woman with severe aortic stenosis and good EF

- BSA = 1.60 m².
- Aortic annulus diameter = 19 mm.
- The 19mm Bioprosthetic with the largest EOA is the Medtronic Mosaic, its EOA =1.20 cm².
- Thus, IEOA of this patient after implanting the 19mm Medtronic Mosaic valve would be: 1.20 cm²/1.60 m² = 0.75 cm²/m².
- So, this patient would suffer from moderate mismatch
  \[\{\text{IEOA} < 0.85 \text{ cm}²/\text{m}² \quad \text{and} \quad > 0.65 \text{ cm}²/\text{m}².\}\]

- QUESTION ? Should we carry out an annular enlargement in this patient to insert a 21 mm. instead of 19 mm. Bioprosthetic accepting its operative risk to avoid this moderate mismatch ?
ANSWER : NO  MODERATE PPM  +  GOOD EF

• It could be YES If :

1. Mismatch is severe (IEOA < 0.65 cm²/m²) because it is a predictor of overall 30-day or mid-term overall mortality for patients undergoing AVR.

2. Mismatch is Moderate (IEOA 0.85 cm²/m²) + poor EF because moderate PPM is an independent risk factor of early or mid-term overall mortality in the subgroup of patients undergoing AVR with poor ejection fraction.
IF The IEOA is $< 0.65 \, \text{cm}^2/\text{m}^2$ : What are the Surgical Options To Avoid PPM

• **Surgical Maneuvres**
  – Insert the valve Supra-annular & Avoid everting mattress sutures
  – Posterior aortic annular enlargement
    • Nicks’
    • Nicks - Nunez
    • Manougian
  – Anterior aortic annular enlargement : Kono
  – Two-directional aortic annular enlargement (combination of posterior and anterior enlargement)
  – Supra-annular Tilt of prosthesis in the NCS
  – Apico-aortic conduit (to Ascending or Descending Aorta)

• **New Generations of Valve Prostheses**
Supra-annular positioning of Bioprosthesis

[not intra-annular] a gain of 2-3mm orifice area

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Trifecta St Jude : EOA cm²
Trifecta St Jude: Mean Gradient

Mean Gradient

<table>
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<th>Valve Size</th>
<th>n</th>
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<tr>
<td>29 mm</td>
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1. Posterior Aortic Root Enlargement
Nicks’ aortic root enlargement

Aortotomy incision across the aortic annulus into the anterior leaflet of the mitral valve in the center of the anterior leaflet. The defect is closed with autologous or bovine pericardium. The pericardial patch is then used to facilitate closure of the aortotomy.
The Nicks–Nunez posterior enlargement in the small aortic annulus: After the posterior enlargement with synthetic graft, the prosthesis is sewn only under the left and right coronary ostia.
The Nicks–Nunez posterior enlargement in the small aortic annulus: The prosthesis (area of divided non-coronary sinus) is sewn to the appropriate level of the synthetic graft after careful orientation.
2. Anterior Aortic Root Enlargement

Konno and Rastan (through the right coronary sinus extending into the right ventricular outflow tract)
3. Apico-Aortic conduit

Sewing-ring implantation

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In Severely Stenotic Aortic Annulus : Apico-Aortic Conduit
Three-dimensional reconstruction; anterior view showing the correct position of the conduit
Prosthetic Valve Replacement

- The impact of PPM after aortic valve replacement (AVR) remains **controversial**.
- Some authors reported that PPM in patients with **mechanical** valves has a negative impact on survival for:
  - young patients
  - average and large-size patients.
- The important fact is that **bioprostheses** have a higher incidence of PPM and more negative impact with respect to mechanical prostheses.
- Among bioprosthetic devices, the use of **stentless** prostheses and completely supraannular prostheses might be beneficial to reduce the incidence of PPM.
The other side of the coin Patient prosthesis mismatch is rare after aortic valve replacement: valve size may be irrelevant.

**NO Effect on LVMI and **Mid-term **Survival**

- Abnormal postoperative gradients were defined as those patients with mean gradient 21 or peak gradient 38 mm Hg.
- PPM was defined as those patients with indexed effective orifice area < 0.60 cm²/m².
- **Conclusions:**

  Severe PPM is rare after aortic valve replacement. PPM, abnormal gradient, and the size of valve implanted do not influence left ventricular mass index or intermediate-term survival.


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Again **PPM has NO Effect** on **Late Survival** in Patients With Aortic Stenosis Undergoing Isolated Aortic Valve Replacement.

- Prospectively collected data on 801 patients undergoing isolated AVR for aortic stenosis between 1997 and 2007 were analyzed. PPM was defined as **moderate** for EOAI of 0.85 cm²/m² and **severe** if 0.6 cm²/m².
- PPM was severe in (6.0%), moderate in (57.8%), and nonexistent in (36.4%).
- Mismatch was associated with increasing age and female gender.

**Conclusions:**
- Moderate PPM is common in patients undergoing AVR for aortic stenosis, but severe mismatch is rare.
- Patients with PPM have similar early and late postoperative survival rate.

New designs of prosthesis such as the St. Jude HP valve improved the hemodynamic results in patients with small aortic roots. The hemodynamic performance of the 21-mm St. Jude HP valve corresponded closely to that of the standard 23-mm St. Jude valve, thus reducing the need for aortic annulus enlargement.

St. Jude Standard 23-mm = St. Jude Master HP 21-mm
St Jude Aortic Regent Mechanical Valve 17-mm

- Recent studies reported good results when using a 17-mm valve in patients with a mean BSA of 1.59 cm/m² and an EOAI of 0.67 cm/m², and reported LV mass regression and good 5-year survival.
- Using dobutamine stress echocardiography, patients with a mean BSA of 1.68 cm/m² and an EOAI of 0.7 cm/m², had satisfactory performance of the valve.
  - Thus, a 17-mm valve is a satisfactory choice for selected patients (small, older, female patients) with a small aortic root.
  - Implantation of this prosthesis allowed regression of left ventricular mass index and improved the perceived quality of life.


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Aortic root enlargement: What are the complications?

- Persisting left ventricular dysfunction or hypertrophy
- Hemolysis
- Thrombosis
- Mitral regurgitation

+ Complications related to surgery (bleeding) and longer CPB time

*J Thorac Cardiovasc Surg 2007;134:916-924*
Mitral Valve PPM

- IEOA of 1.25 cm$^2$/m$^2$ or less is a cutoff point to define MVPPM.
- Below this value, the insertion of a smaller valve has a negative impact.

However, contrary to aortic valve PPM, there are limited operative solutions to alleviate the problem of MVPPM.

- **Possible solutions:**
  - Stentless mitral prostheses and homografts (requires expertise and experience).
  - Selection of the largest available EOA valve for annulus size, irrespective of valve type or brand.
  - Mitral valve repair as the preferred therapeutic option whenever possible.
The impact of PPM on late outcomes after mitral valve replacement:
Heart failure, PH and affects Late Survival

- Between 1985 and 2005, 884 patients, with a mean age 63 ± 12 years, underwent mitral valve replacement (657 mechanical, 227 bioprosthesis).
- The incidence of PPM was 32%.
- PPM after mitral valve replacement is not uncommon.
- It is associated with recurrence of congestive heart failure and postoperative pulmonary hypertension.
- It affects late survival.


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CONCLUSION

• Severe PPM should be always avoided.
• The presence of moderate mismatch could be tolerated in patients with normal ejection fraction without any impact on overall survival.
• In the presence of a narrowed annulus, decision making is based on careful evaluation of several factors: patient’s age and lifestyle, the familiarity of the surgeon with the different surgical techniques, and the type of prostheses available.
• At present, several modern small-sized prostheses allow for clinically acceptable hemodynamics in annuli that may have traditionally called for annulus enlargement.
Thank you