Minimally invasive aortic valve replacement (MIAVR)

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**definitions**

**STS database:** any procedure not performed with a full sternotomy (FS) and cardiopulmonary bypass (CPB).....(TAVI)


A small chest wall incision that not include the conventional FS

Partial Upper Ministernotomy (MS)

Right Anterior Minithoracotomy (RT or RAMT)
Minimally invasive approaches

(A) Upper partial Ministernotomy

(B) right anterior minithoracotomy

(C) right parasternal approach

(D) transverse sternotomy

The minimally invasive incision is marked by the dotted line.
MIAVR was first performed through a 10 cm right parasternal approach in 1996 at the Cleveland Clinic Foundation by Cosgrove and Sabik.


This technique involved removal of the 2nd, 3rd and 4th costal cartilages, sacrificing the right mammary artery.

The major limitation of this technique was a high incidence of lung herniation, which may be physiologically disturbing and cosmetically disfiguring, often requiring a second operation for repair.

This approach was soon abandoned in favour of the MS approach.
conventional surgery vs MIAVR

- faster recovery
- shorter hospital stay
- improved cosmesis
- less wound infection
- Improvement of postoperative respiratory function due to the preservation of sternum
- reduction of postoperative pain
- reduction of blood loss and blood transfusions related to the reduction of surgical dissection
- facilitating reoperation at a later date, as part of pericardium remains closed
- requirement of fewer rehabilitation resources
- costs are reduced
6 to 10 cm midline skin incision, partial J sternotomy (right) third to fifth intercostal space or a V-shaped MS at the level of the second or third intercostal space

In a meta analysis of 4,586 patients, Brown et al (2009) demonstrated that MIAVR by the way of MS was associated with

- shorter ventilation time
- Shorter ICU and hospital stay
- less blood loss within 24 hours compared with conventional surgery

- patients undergoing MS had longer cross-clamp and CPB time

- No difference was found in terms of postoperative AF, stroke and sternal complications.
all patients scheduled for RT should undergo CT scan without contrast enhancement to evaluate the anatomic relationship among the intercostal spaces, ascending aorta, and aortic valve.

**Exclusion criteria for the RT approach:**

- prior cardiac surgery
- history of right-sided pleuritis
- aortic root dilatation
RT criteria

- At the level of main pulmonary artery, the ascending aorta is rightward (more than one half located on the right in respect to the right sternal border)

- The distance from the ascending aorta to the sternum does not exceed 10 cm

- The $\alpha$ angle should be $>45^\circ$ (angle between the midline and the inclination of ascending aorta)
White vertical dotted line is a virtual reference, corresponding to the right margin of the sternal bone, and determines the position of the ascending aorta in relation to the sternum.

(A) Retrosternal position of the ascending aorta (not favorable for RT)

(B) quite dextra-positioned ascending aorta (favorable for RT)

(C) deep thorax (the distance to ascending aorta from anterior chest measures >10 cm)

(D) another example of a deep thorax (the distance to ascending aorta from anterior chest measures 12.1 cm)
unfavourable anatomic conditions for the RT approach

- the retrosternal position of the ascending aorta
- the deep thorax
MIAVR by way of RT

- a **5 to 7 cm** skin incision at the level of the *2nd ICS* without rib resection
- sacrificing the RITA
- A retractor is inserted and **direct aortic cannulation** is performed using flexible cannulas.
- a **percutaneous** cannula is inserted through the **femoral vein** into the right atrium
- TEE guidance and Seldinger’s technique
- LV vent is placed through the RAPV
- the ascending aorta is then clamped
- antegrade cardioplegia: aortic root and selectively into the coronary ostia
cannulation

- Central aortic cannulation vs Femoral
- Percutaneous venous cannulation (TEE)
- Antegrade cardioplegia-ostium
- LV Vent: RSPV
  - Defibrillator
- mortality 1.6%

- rate of intraoperative conversion was 1.6%

- **cross-clamp and CPB time** were longer than that of the standard approach

- the incidence of postoperative **AF** and blood transfusion were 18% and 16%, respectively.

MIAVR via RT was associated with:

- lower incidence of postoperative AF (18.1% vs. 29.7%)
- blood transfusions (18.8% vs. 34.1%) compared to FS
- patients in the RT group had a shorter mechanical ventilation time (6 vs. 8 hours)
- postoperative length of stay (5 vs. 6 days)
- No difference was found in terms of late mortality at median follow-up of 30 months (range, 17-54 months)
- patients receiving a RT approach had better outcomes than those receiving MS in terms of lower postoperative atrial fibrillation (19.5 % vs. 34.2%),
- shorter ventilation time (median 7 vs. 8 hours) and
- hospital stay (median 5 vs. 6 days)

Minimally invasive aortic valve replacement using right minithoracotomy is associated with better outcomes than ministernotomy.
CRITICISMS

- Central-peripheral cannulation
- Cost: HeartPort instruments etc
- Not "surgeon friendly" technique
- Longer CPB-cross clump time
- Sutureless valves

- **Enable™** Valve System (Medtronic, Minneapolis, MN, USA)

- **Perceval S™** Valve System (Sorin Biomedica Cardio Srl, Sallugia, Italy)

- **Edwards Intuility™** Valve System (Edwards Lifesciences, Irvine, CA, USA)
• Over **10,000** implants worldwide
• Up to **5 years** of published results
• The broadest follow-up published in sutureless solutions
The combination of MIAVR using sutureless/fast deployment valves has improved postoperative mortality.

**Black line:** in-hospital mortality reduction from 3.4% in 1997 to 2.6% in 2006 for isolated AVR according to STS data (2).

**Red line:** the introduction of sutureless valves associated with MIAVR has decreased the in-hospital mortality from 1.6% in 2005 to **0.7% in 2013**.
This European multicentre experience, with the largest cohort of patients with Perceval S valves to date, shows excellent clinical and haemodynamic results that remain stable even up to the 5-year follow-up.

Even in this elderly patient cohort with 40% octogenarians, both early and late mortality rates were very low.

There were no valve migrations, structural valve degeneration or valve thrombosis in the follow-up.

The sutureless technique is a promising alternative to biological aortic valve replacement.
From April 2007 to August 2012, 731 consecutive patients (mean age: 78.5 years; 68.1% females; mean logistic EuroSCORE 10.9%) underwent AVR with the Perceval valve in 25 European centres.

Isolated AVR was performed in 498 (68.1%) patients.

A minimally invasive approach was performed in 189 (25.9%) cases.

The cumulative follow-up was 729 patients-years.
mean cross-clamp and CPB times were 30.8 and 50.8 min in FS
37.6 and 64.4 min in the MIAVR, respectively
Early cardiac-related deaths occurred in 1.9%
Overall survival rates at 1 and 5 years were 92.1 and 74.7%, respectively
Major paravalvular leak occurred in 1.4% and 1% at early and late follow-up, respectively
Significant improvement in clinical status was observed postoperatively in the majority of patients
Mean and peak gradients decreased from 42.9 and 74.0 mmHg preoperatively, to 7.8 and 16 mmHg at the 3-year follow-up
LV mass decreased from 254.5 to 177.4 g at 3 years
Sutureless Percival Aortic Valve Replacement in Aortic Homograft
Thierry A. Folliguet, MD, and François Laborde, MD
Institut Lorrain du Coeur & des Vaisseaux Louis Mathieu, Centre Hospitalier Universitaire, Vandoeuvre les Nancy and Institut Mutualiste Montsouris, Paris, France
Incisions for Minimally Invasive Surgery
Perceval S in porcelain aorta

The use of the Perceval S aortic valve in patients with porcelain aorta; is this ideal option?

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Perceval S aortic valve implantation in an achondroplastic Dwarf.

Aortic valve replacement in elderly with small aortic root and low body surface area; the Perceval S valve and its impact in effective orifice area

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Aortic valve replacement with Perceval aortic valves in geriatric patients with comorbidities and small aortic annulus seems to be an alternative, safe and "fast" intervention with excellent short and mid-term results which provides a better effective orifice area.
Sutureless valve vs TAVI

Santarpino et al 2014; J Thorac Cardiovasc Surg
- High risk pt
- No difference in:
  - In-hospital mortality
  - Permanent pacemaker
  - Neurological events
- Higher paravalvular leak in TAVI (13.5% vs 0% p=0.027)
- At 19 months follow up: highrt survival (97.3% vs 86.5%)
- Conclusion: sutureless valves may be the ideal treatment for pt in ”gray zone” between conventional AVR and TAVI

D’Onofrio et al 2013; J Thorac Cardiovasc Surg
- Multicenter analysis
- 349 conventional
- 38 sutureless
- 566 TAVI
- Similar results between sutureless and TAVI

Muneretto et al 2015; Interact Cardiovasc and Thorac Surg
- TAVI: Higher pacemaker (25.5% vs 2%)
- Peripheral vascular complications (14.5 vs 0%)
- 24 months survival: 91.6% vs 70.5%)
Thank you
"Don't tell me the sky's the limit when there are footprints on the moon."

~Paul Brandt