TAVR alternative access:
Transapical, transaortic, transsubclavian, suprasternal, transcarotid
For whom and how

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Introduction

- The prevalence of severe calcific aortic stenosis is rising as life expectancy increases and is progressively becoming a greater healthcare burden
- Surgery is the standard of care in patients with acceptable surgical risk
- Transcatheter aortic valve implantation (TAVI) is a less invasive alternative for patients at high or prohibitive risk
- First TAVI 2002 Gribbie (TA)

![Diagram of TAVR versus Surgical AVR in the Patient With Severe Symptomatic AS](image)

AS indicates aortic stenosis; AVR, aortic valve replacement; and TAVR, transcatheter aortic valve replacement.


All the above-mentioned implantation techniques proved their safety and efficiency in trials; available data, however, do not show clearly enough if any of these techniques is more advantageous as compared to the others.
The transfemoral access (TF)

- is the most often used approach in TAVI (66.5–87.8% of all the implantations)
- the least invasive and the only percutaneous way of implantation
- The first transfemoral valve implantations in 2005 required a surgical cut-down of the femoral artery and the usage of 24 and 25 French sheaths.
- Large sizes of the sheath excluded many patients for this approach and led to the frequent vascular and bleeding complications
- The current generation of transcatheter femoral delivery systems, such as CoreValve Evolut R, Sapien 3, and Portico, has a size reduced to 14 and 16 French, according to the valve size.

The transfemoral access (TF)

- The reduction of the size of the delivery system resulted in a decreased rate of the vascular and bleeding complications from 11.9–22.9% (4.7) to 5.9–7.9%
- A smaller profile of instrumentation reduced the requirements for the minimum vessel diameter of the TAVI candidates from the previous 6–7 mm to
- 5 mm in the CoreValve Evolut R valve
- 5.5–6 mm in the Edwards Sapien 3 valve
- 6–6.5 mm in the Lotus valve
The transfemoral access (TF)

- Vascular complications at the femoral access site, however, still belong among the most frequent risks of the procedure.
- The femoral access, as compared to the subclavian, direct aortic and transapical access, is the least invasive, and it is the only approach which allows to perform the implantation truly percutaneously.
- The other above mentioned methods require a surgical cut-down.
- The transfemoral approach, due to the minimal invasion in the patient's body, allows to perform the TAVI just in local anaesthesia or deep sedation.
- There are no convincing data available comparing the local and general anaesthesia and evidence of a superiority of any of these methods.

When should we go **non** TF???

- If the anatomy of the femoral and iliac artery is not suitable for a safe introduction of the catheter and valve.

**General (absolute and relative) contraindications to the TF approach include**

1. Severely calcified or tortuous iliac arteries
2. An iliac artery diameter of < 6 mm to < 9 mm, dependent on the type of device used
3. Previous aortofemoral bypass grafts
4. Severely angulated aorta
5. Severely atherosclerotic aortic arch
6. Transverse ascending arch (for balloon-expandable devices)
7. Aortic aneurysm with extensive mural thrombus
8. Coarctation of the aorta

https://citoday.com/pdfs/cit0912_F5_Bapat.pdf
The transapical access (TA) is the second most widely used approach in TAVI. The transapical access is also used for a valve-in-valve implantation into degenerated mitral bioprosthesis and valve in ring implantation into annuloplasty rings in patients with severe mitral regurgitation. In comparison to the TF access, TA delivery system requires the usage of a larger sheath—24 and 26 French for the Sapien XT system, and 18 and 21 French for the Sapien 3 system.
The transapical access (TA)

- surgical access:
  - the 5th or 6th left intercostal space
  - 4-5cm skin incision
  - after the surgical preparation of the apex
  - puncture is performed with a needle
  - antergrade placement of guidewire is done through the stenotic valve into the descending aorta
  - dedicated sheath is introduced and the bioprosthesis is implanted
Advantages

- very good control of the delivery system
- favorable implantation angle
- no contact of the delivery system with aorta “no touch aorta principle”
Disadvantages

- Direct invasion to the left ventricle myocardium—most invasive
- it is related to a higher complication and mortality rates
- especially true in patients with severely impaired respiratory function, impaired LV function, and frail, elderly patients
- An increased 30-day and one year mortality is explained with patient's higher risk profile and longer learning curve

The transapical access (TA)

- **Contraindications for the TA approach**
  1. poor LV function
  2. left ventricular thrombus
  3. previous surgical patch of the left ventricle (e.g., Dor procedure)
  4. calcified pericardium
  5. and the inability to access the left ventricular apex due to anatomical constraints (e.g., chest deformity)
  6. \((\text{FEV1/FVC})\) ratio < 70% + either the absolute value of FEV1 was < 1 L or FEV1 < 60%

1. Frail patient’s apex (corticosteroids)

TA vs DAA

Table 4. Comparison of 30-Day Outcomes

<table>
<thead>
<tr>
<th>Table 1. Baseline Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Number of patients</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>EuroSCORE I</td>
</tr>
<tr>
<td>LVEF</td>
</tr>
<tr>
<td>Transvalvular gradient</td>
</tr>
<tr>
<td>AVA (cm²)</td>
</tr>
<tr>
<td>NYHA ≥ III (%)</td>
</tr>
<tr>
<td>Edwards SAPIEN</td>
</tr>
<tr>
<td>Medtronic CoreValve</td>
</tr>
</tbody>
</table>

Conclusion

With the limited evidence available, transaortic TAVI appears to be a viable alternative to transapical TAVI. Mortality rates are equivalent with the 2 techniques. Our
The subclavian access (transsubclavian – TS)

- the second least invasive arterial access
- first reported in 2008
- majority of subclavian cases are performed via left subclavian artery
- right subclavian artery is used exceptionally due to its inconvenient implantation angle
- preoperatively, it must be determined that the size of the arteries (≥ 6 mm) is suitable for cannulation and that they are free of stenoses that are not amenable to angioplasty
- The CoreValve and Evolut R are the most frequently implanted valves
- rarely used for the implantation of the Edwards Sapien and Lotus valves due to a complexity of preparation of the Edwards Sapien valve, also a larger size and lower flexibility of the Lotus valve introduction system
The subclavian access (transssubclavian – TS)

- The preparation of the puncture site of the subclavian artery requires surgical cut-down
- Placement of sutures on the vascular wall
- Puncture of the artery
- Introduction of a stiff guide wire to the left ventricle over the pig-tail diagnostic catheter and 8 French sheath

A 5-cm-long skin incision is made below the left clavicle, starting lateral to the sternal margin. The underlying muscle is retracted or divided. The left subclavian artery is isolated, and slings are placed around it. The application of purse strings and the rest of the principles are as described for the TAo approach. More recently, a percutaneous TAx approach has been reported to avoid major bleeding (using balloon occlusion temporarily during closure). Puncture of the axillary artery is performed at a distance of 1 to 1.5 cm lateral to the outer border of the first rib. This has been reported to be a feasible and relatively safe option.
Advantages

- Easy cut-down procedure
- Least post-op pain
- Direct mobilization (no in TF)
- Maybe under local anesthesia and sedation (most prefer GA)
- Placement of the valve is easier (shorter distance)
- Avoid interaction with pathology of iliofemoral vessels, abdominal aorta and descending thoracic aorta
Disadvantages

- Among the patients with the patent LIMA/LAD graft, it is important to consider a risk of a temporary LIMA occlusion with 18 French sheath.
- If the diameter of the subclavian artery at the level of LIMA origin is more than 8 mm, and the angiography with the 18 French sheath shows a sufficient flow in the LIMA graft, the risk of ischaemia is low.
- In case of a limited flow in the LIMA graft, the 18 French sheath can be retracted until the distal tip not exceed the origin of the LIMA.
- A presence of a permanent pacemaker in the left subclavian area is not an absolute contraindication of the subclavian approach.
- The brachial plexus is located proximally and close to the subclavian artery, which increase the risk of neurological complications.
- Possible use of 10mm Dacron graft (end to side) when the distance for AV is unsuitable.
The subclavian access (transsubclavian – TS)

- The subclavian approach is safe
- The short- and mid-term study results are comparable to those of the femoral approach
- Indicated if the femoral access is not feasible or is associated with an increased risk of vascular complications

TS vs TF

Vascular complications

Figure 4. Effect of transfemoral and trans-subclavian/axillary transcatheter aortic valve implantation on incidence of (A) stroke; (B) vascular complications; and (C) permanent pacemaker implantation. Odds ratios (OR) are reported with their 95% confidence intervals (CI). Studies were combined using a random effects model.

Systematic Review/Meta-analysis

Transfemoral vs Non-transfemoral Access for Transcatheter Aortic Valve Implantation: A Systematic Review and Meta-analysis

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## TABLE II. In-Hospital Outcome

<table>
<thead>
<tr>
<th></th>
<th>All (202)</th>
<th>TS group (60)</th>
<th>TA group (142)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death (%)</td>
<td>13 (6.4%)</td>
<td>1 (1.7%)</td>
<td>12 (8.5%)</td>
<td>0.06</td>
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<td>MI (%)</td>
<td>7 (3.5%)</td>
<td>2 (3.3%)</td>
<td>5 (3.6%)</td>
<td>0.93</td>
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<td>Stroke (%)</td>
<td>4 (2.0%)</td>
<td>2 (3.4%)</td>
<td>2 (1.4%)</td>
<td>0.34</td>
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<td>Bleeding (%)</td>
<td>83 (41.1%)</td>
<td>7 (11.7%)</td>
<td>76 (53.5%)</td>
<td>&lt;0.001</td>
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<td>Life-threatening bleeding (%)</td>
<td>27 (13.4%)</td>
<td>5 (8.3%)</td>
<td>22 (15.5%)</td>
<td>&lt;0.001</td>
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<tr>
<td>Major bleeding (%)</td>
<td>36 (17.8%)</td>
<td>2 (3.3%)</td>
<td>34 (23.9%)</td>
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<tr>
<td>Minor bleeding (%)</td>
<td>20 (9.9%)</td>
<td>-</td>
<td>20 (14.1%)</td>
<td></td>
</tr>
<tr>
<td>PM implantation (%)</td>
<td>24 (11.9%)</td>
<td>16 (27.1%)</td>
<td>8 (5.6%)</td>
<td>&lt;0.001</td>
</tr>
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<td>Vascular complications (%)</td>
<td>20 (9.9%)</td>
<td>6 (10.0%)</td>
<td>14 (9.9%)</td>
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<tr>
<td>Major</td>
<td>11 (5.4%)</td>
<td>2 (3.3%)</td>
<td>9 (6.3%)</td>
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<tr>
<td>Minor</td>
<td>9 (4.5%)</td>
<td>4 (6.7%)</td>
<td>5 (3.5%)</td>
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<tr>
<td>Sepsis</td>
<td>8 (4.0%)</td>
<td>2 (3.3%)</td>
<td>6 (4.2%)</td>
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<td>Acute kidney injury (AKI) (%)</td>
<td>78 (39.4%)</td>
<td>20 (35.1%)</td>
<td>58 (41.1%)</td>
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<td>AKI Stage 1</td>
<td>55 (27.8%)</td>
<td>11 (18.3%)</td>
<td>44 (31.2%)</td>
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<td>AKI Stage 2</td>
<td>8 (4.0%)</td>
<td>4 (7.0%)</td>
<td>4 (2.8%)</td>
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<tr>
<td>AKI Stage 3</td>
<td>15 (7.6%)</td>
<td>5 (8.8%)</td>
<td>10 (7.1%)</td>
<td></td>
</tr>
<tr>
<td>New AF (%)</td>
<td>24 (11.9%)</td>
<td>6 (10.0%)</td>
<td>18 (12.7%)</td>
<td>0.39</td>
</tr>
<tr>
<td>New permanent LBBB (%)</td>
<td>20 (9.9%)</td>
<td>4 (6.7%)</td>
<td>16 (11.3%)</td>
<td>0.39</td>
</tr>
</tbody>
</table>

**Fig. 1.** In-hospital events in transapical (TA) vs. trans-subclavian (TS) TAVI. AMI = acute myocardial infarction; AKI = acute kidney injury; PM = pace maker; VC = vascular complications.

**Fig. 2.** Kaplan-Meier survival curves in transapical (TA) vs. trans-subclavian (TS) groups. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Direct aortic access (DAA)

- The first description of the direct aortic access was provided by Bauernschmitt in 2009.
- Used in patients in whom neither femoral nor subclavian approaches are possible or a risk of peripheral vascular complication is too high.
- Porcelain aorta or
- Presence of the calcified atherosclerotic plaques on the anterior wall of the ascending aorta is considered a contraindication for DAA.

Direct aortic access (DAA)

- All cases are performed with the patient under general anesthesia in the hybrid operating room or catheter lab under direct fluoroscopy and/or three-dimensional transesophageal echocardiography.
- There are two surgical approaches:
  1. Right anterior mini-thoracotomy (incision in the right 2nd intercostal space)
  2. Upper mini sternotomy

Thoracotomy or Sternotomy?  

What is behind the sternum?
Right anterior mini-thoracotomy

- skin incision is usually 5 cm, starting lateral to the sternal margin
- intercostal muscles are divided
- pleura is opened
- pericardium is incised over the lateral portion of the ascending aorta
- The site of the purse-string suture is chosen as through the mini sternotomy approach, and the procedure is carried out
Right anterior mini-thoracotomy

- If the ascending aorta is horizontal and/or shifted to the right side in relation to the sternum
- Approach through the 2nd or 3rd right intercostal space is preferred
- This is used to avoid retraction of the rib cage and/or excision of costal cartilage for exposure
- In cases of previous CABG in which the LIMA graft is in the mid-line and/or the innominate vein or aorta is stuck to the sternum
- Unsuitable when RIMA in situ is patent
- Open pleural space (unsuitable when FEV1 and/or FEV1/FVC are low)
- Possible endoscopically (port access)
Right anterior mini-thoracotomy

1. is less invasive
2. gives the operator the opportunity to achieve the optimal implantation angle
3. a shortage of space for the sheath in the aorta is a disadvantage of this method
Mini-sternotomy

- A limited skin incision (5 cm) is made starting just below the sternal notch.
- A partial upper sternotomy (J-shape) is performed through the 2nd or 3rd right intercostal space.
- The aim is to expose the upper portion of the ascending aorta for cannulation.
- Preferred in obese patients,
- Patients with an ascending aorta in the mid-line/to the left.
- A short ascending aorta.
- In patients with poor respiratory reserve because the pleura remains intact, and it has less effect on the respiratory dynamics.
- In patients with previous CABG and a patent LIMA graft provided that the LIMA graft is not in the mid-line and the innominate vein and aorta are not in close proximity to the sternum;
- This can be easily confirmed from the preoperative angiogram and CT scan.
- Proximal saphenous vein graft anastomoses are usually performed on the proximal two-thirds of the ascending aorta, and hence, they are away from the cannulation site for the procedure, which is in the distal third.
Mini-sternotomy

1. enables a sufficient space for the sheath introduction into the aorta
2. more invasive and less favourable in terms of the achievement an optimal implantation angle
   • Possible modification 10mm Dacron graft end/side

Choosing the correct purse-string/aortic puncture site is of paramount importance.

- Combination of preoperative CT, on-table aortography, and digital palpation.
- Non-contrast CT imaging permits evaluation of the suitability of the ascending aorta for cannulation.
- Even in the so-called porcelain aorta, the portion of the ascending aorta chosen for cannulation is usually free from calcification.
- On-table aortography identifies the site of the purse strings, which should (1) be free of calcification, (2) allow the sheath to be directed in a straight line to the aortic valve, and (3) provide enough space between the tip of the sheath and the aortic valve to allow the balloon to fully expand during deployment of the device (depending on the type and size of the device used).
- This area should be at least 5 cm (3 cm for the balloon and 2 cm for the sheath) above the aortic valve annulus.
- It is usually on the greater ascending aortic curvature 1 to 2 cm below the origin of the innominate artery (TAo zone) and is confirmed with digital palpation.
- Two purse-string pledgeted or nonpledgeted sutures are placed with 2–0 or 3–0 prolene.
- Rapid ventricular pacing is required for balloon-expandable devices but not for self-expandable system.
Advantages

- highly accurate transfer of the operator’s maneuvers to the delivery system
- the valve can be easily and accurately placed
- Less invasive than TA
- less movement of the aorta compared to TA
- Less bleeding episodes
- Probably earlier mobilization than TF
Disadvantages

- General anesthesia?
- More invasive than TF, TS/Ax, suprasternal
Direct aortic access (DAA)

- Procedural success is achieved in 90.8–98.0% cases
- 30-day mortality is 6.1–8.0%
- A rather increased invasiveness of this method represents a disadvantage in comparison to the other vascular approaches.

Suprasternal Access

In a manner similar to an extended mediastinoscopy, the Suprasternal Aortic Access (SuprAA) TAVR provides excellent visualization of the ascending aorta and innominate artery for the placement of a transcatheter valve.

Suprasternal

- Skin incision 3-4cm transverse or smile incision over the manubrium
- Division of platysma and retraction of strap muscles laterally beyond the isthmus of thyroid gland
- Dissection of soft tissues across the pretracheal fascia
- Mobilization and anterior traction of innominate vein
- Preparation of the “entry point” (usually innominate artery or proximal arch
- Double felted purse strings
- Puncture.....etc

Suprasternal

2 devices available

1. AEGIS

Figure 2: The SuprAA-TAVR system: (A) Diagram of the SuprAA system, identifying the superior extension designed to lift the innominate vein off the aorta, creating a working lumen, filled in the diagram by the green obturator. (B) An illustration of the size of the device. (C) The visualization provided within the working lumen.

Figure 3: ‘Box-in-diamond’ dual purse-string sutures. The inner ‘box’ suture (green) is a horizontal mattress suture passing through the incision side of the two pledgets. The outer ‘diamond’ suture (blue) is a diamond purse-string suture passing through the outer sides of the same two pledgets.
2. CoreVista Transcervical Access System

Advantages

1. Same as DAA
2. No PAIN
3. Less invasive than DAA
4. Feasible hemorrhage control
Disadvantages

- REDO—possible difficult mobilization of innominate vein
- Problem in Goiter (especially if intrathoracic)
- CONTRAINDICATION: tracheostomy, previous mediastinoscopy
Table 3. Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Suprasternal¹ (n = 11)</th>
<th>Transaortic² (n = 11)</th>
<th>Transapical¹ (n = 11)</th>
<th>Subclavian¹ (n = 11)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device success</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>1.00</td>
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<tr>
<td>Postdilation balloon</td>
<td>4 (36)</td>
<td>4 (36)</td>
<td>4 (36)</td>
<td>1 (9)</td>
<td>0.39</td>
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<tr>
<td>NIHLE acute kidney injury class 0</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>11 (100)</td>
<td>0.31</td>
</tr>
<tr>
<td>More than mild paravalvular leak</td>
<td>1 (9)</td>
<td>1 (9)</td>
<td>0 (0)</td>
<td>1 (9)</td>
<td>0.05</td>
</tr>
<tr>
<td>Inhospital stroke</td>
<td>0 (0)</td>
<td>1 (9)</td>
<td>1 (9)</td>
<td>0 (0)</td>
<td>1.00</td>
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<tr>
<td>Death in hospital</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (9)</td>
<td>0 (0)</td>
<td>0.60</td>
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<td>Need for permanent pacemaker</td>
<td>2 (18)</td>
<td>1 (9)</td>
<td>1 (9)</td>
<td>2 (18)</td>
<td>0.30</td>
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<tr>
<td>Blood transfusion</td>
<td>2 (18)</td>
<td>4 (36)</td>
<td>3 (27)</td>
<td>2 (18)</td>
<td>0.53</td>
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<tr>
<td>Thirty-day all-cause mortality</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (9)</td>
<td>1 (9)</td>
<td>0.68</td>
</tr>
<tr>
<td>Discharge to rehabilitation</td>
<td>1 (9)</td>
<td>7 (63)</td>
<td>7 (63)</td>
<td>3 (30)</td>
<td>0.046</td>
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<td>Procedure time, minutes</td>
<td>90.2 (86–112)³, ⁴, ⁵</td>
<td>131 (127–153)³, ⁴, ⁵</td>
<td>154 (148–186)³, ⁴, ⁵</td>
<td>91 (86–116)³, ⁴, ⁵</td>
<td>0.04</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>91.5 ± 28</td>
<td>142.3 ± 34</td>
<td>169.6 ± 30</td>
<td>94.6 ± 36</td>
<td></td>
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<tr>
<td>Hemoglobin drop, g/dL</td>
<td>2.9 (2.1–4.1)</td>
<td>1.1 (0.1–3.7)</td>
<td>1.9 (0.7–2.5)</td>
<td>2.1 (1.4–3.0)</td>
<td>0.25</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.4 ± 1.0</td>
<td>2.1 ± 2.2</td>
<td>1.7 ± 1.4</td>
<td>2.1 ± 0.9</td>
<td></td>
</tr>
<tr>
<td>Length of intensive care unit stay, days</td>
<td>1.8 (1.0–2.2)</td>
<td>3.3 (2.7–5.3)</td>
<td>4.3 (3.2–6.2)</td>
<td>3.4 (3.0–5.1)</td>
<td>0.22</td>
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<tr>
<td>Mean ± SD</td>
<td>1.7 ± 0.8</td>
<td>4.8 ± 4.7</td>
<td>5.0 ± 4.3</td>
<td>3.6 ± 3.1</td>
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<tr>
<td>Length of hospitalization, days</td>
<td>4 (3–8)², ⁵, ⁶</td>
<td>8 (6–14)², ⁶</td>
<td>8 (6–11)¹</td>
<td>4 (4–8)², ⁵, ⁶</td>
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<tr>
<td>Mean ± SD</td>
<td>5.1 ± 2.3</td>
<td>9.1 ± 5.1</td>
<td>9.4 ± 4.4</td>
<td>7.2 ± 3.8</td>
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<tr>
<td>Time to get out of bed, days</td>
<td>0.9 (0.6–1.6)</td>
<td>2.2 (1.9–4.1)</td>
<td>1.9 (1.6–2.7)</td>
<td>0.9 (0.8–1.7)</td>
<td>0.07</td>
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<tr>
<td>Mean ± SD</td>
<td>1.0 ± 0.6</td>
<td>2.4 ± 1.3</td>
<td>2.2 ± 0.9</td>
<td>1.2 ± 0.7</td>
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<tr>
<td>Time to ambulation, days</td>
<td>1.6 (0.9–1.8)²</td>
<td>3.9 (1.9–4.5)²</td>
<td>2.9 (1.9–3.6)</td>
<td>1.6 (0.9–2.7)²</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>1.4 ± 0.6</td>
<td>3.7 ± 1.6</td>
<td>2.7 ± 1.2</td>
<td>1.9 ± 1.3</td>
<td></td>
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<tr>
<td>Morphine per hospitalization day, mg</td>
<td>8.0 (2.0–13.6)¹</td>
<td>15.0 (0.0–195.4)</td>
<td>33 (12.0–68.3)⁴</td>
<td>10 (0.0–14.3)³</td>
<td>0.03</td>
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</tbody>
</table>

**Transcatheter Aortic Valve Replacement by a Novel Suprasternal Approach**

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The transcarotid access (common carotid access – CCA)

- the least used approach
- For the first time, the access through the left carotid artery was described by French authors in 2012
- The transcarotid approach should be considered when all other avenues are exhausted and none of the established access sites are suitable
- The decision to use this method requires a truly dedicated TAVR team approach, establishing a unique access for TAVR patients without regular access options
- limited data of the French Transcarotid TAVI Registry do not support such concerns.
CCA

- Transverse incision 3cm over the manubrium or incision along the anterior border of sternocleidomastoid muscle
- Division of platysma
- Preparation of common carotid artery
- GA or LA
- Proximal and distant control with slings or clumps
- Possible use of femoral/carotid shunt (may improve cerebral perfusion)
- Puncture, soft guide wire, small sheath (6-8Fr), stiff wire, sheath 14-18 Fr, delivery system
CCA

**Advantages:**
1. easy vascular access
2. good control over the delivery system
3. a short distance from the puncture site to the aortic annulus
4. Avoid pathology of descending, abdominal aorta and iliofemoral vessels

**Disadvantages:**
1. A contact of the sheath and the delivery system with the carotid artery wall
2. demands Brain MRI angiography
3. Demands transcranial Doppler
4. Cerebral oximetry maybe useful during the procedure
5. In case of atherosclerotic (especially soft or ulcerated plaques), problematic
6. **Contraindication:** occlusion or severe stenosis of contralateral ICA and/or vertebral artery
Which access is the most advantageous?

- no prospective randomised data comparing the different approaches
- available results usually compare incomparable groups of patients
- current medical practice:
  - the femoral access is usually the first option
  1. It is the least invasive
  2. the only purely transcatheter approach
  3. does not require any surgical preparation
  4. it enables to perform the complete procedure under local anaesthesia

For this reasons, it is the most widely used access for TAVI procedures
Which access is the most advantageous?

- lower short- and mid-term mortality when the femoral access is applied as compared to the transapical access (Partner, SOURCE, GARY, France 2, NANCY)
- A rather strong invasiveness and a higher pre-implantation morbidity of patients, expressed by means of EUROScore, may be the cause of less favourable mortality rates of the transapical access
- The Canadian registry shows a certain non-consistency of data, as it does not show any differences between the 30-day mortality of the transfemoral and transapical approaches
The similar results have been achieved in the Cardiocenter Hospital Podlesi.

Ciucca et al. made a comparison of the safety of the transapical and subclavian TAVI approaches in 262 patients included in a prospective registry.

Except bleeding (11.7% TS vs. 53.5% TA, \( P \leq 0.001 \))

no statistically significant difference was found between both methods; in 30-day follow up

a trend towards a lower mortality rate was observed in the subclavian approach (1.7% TS vs. 8.4% TA, \( P = 0.06 \))

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**Table 2 – 30-Day outcome according to approach (in-hospital complications included) TAVI patients implanted in Cardiocenter Hospital Podlesi Trinec (July 2009 – December 2013).**

<table>
<thead>
<tr>
<th></th>
<th>Total(^a)</th>
<th>Femoral(^a)</th>
<th>Transaortic(^a)</th>
<th>Subclavian(^a)</th>
<th>( p )^(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>6 (2.6%)</td>
<td>4 (2.5%)</td>
<td>2 (5.1%)</td>
<td>0 (0.0%)</td>
<td>0.293</td>
</tr>
<tr>
<td>Stroke/transient ischaemic attack</td>
<td>7 (3.1%)</td>
<td>5 (3.2%)</td>
<td>0 (0.0%)</td>
<td>2 (6.3%)</td>
<td>0.194</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>–</td>
</tr>
<tr>
<td>Bleeding</td>
<td>8 (3.5%)</td>
<td>6 (3.8%)</td>
<td>2 (5.1%)</td>
<td>0 (0.0%)</td>
<td>0.273</td>
</tr>
<tr>
<td>NACE</td>
<td>20 (8.8%)</td>
<td>14 (8.9%)</td>
<td>4 (10.3%)</td>
<td>2 (6.3%)</td>
<td>0.824</td>
</tr>
<tr>
<td>MACE</td>
<td>12 (5.3%)</td>
<td>8 (5.1%)</td>
<td>2 (5.1%)</td>
<td>2 (6.3%)</td>
<td>0.966</td>
</tr>
</tbody>
</table>
A recent meta-analysis of Irish authors made a comparison of outcomes in 193 patients with the direct aortic access and 1543 patients with the transapical access.

During 30-day follow up it was found no significant difference

1. procedural success rate
2. mortality
3. bleeding
4. stroke
5. permanent pacemaker implantation rate
## Table 2
### Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subclavian (n=188)</th>
<th>Transapical (n=761)</th>
<th>Direct aortic (n=185)</th>
<th>Femoral (n=2928)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-hospital death</td>
<td>8 (4.3%)</td>
<td>72 (9.5%)</td>
<td>14 (7.6%)</td>
<td>105 (3.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>5 (2.9%)</td>
<td>80 (11.0%)</td>
<td>15 (8.4%)</td>
<td>121 (4.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>12-months mortality</td>
<td>33 (20%)</td>
<td>187 (27%)</td>
<td>42 (29%)</td>
<td>388 (18%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Stroke in hospital</td>
<td>6 (3.0%)</td>
<td>23 (3.0%)</td>
<td>1 (1.0%)</td>
<td>58 (2.1%)</td>
<td>0.12</td>
</tr>
<tr>
<td>TIA in hospital</td>
<td>3 (2.0%)</td>
<td>4 (1.0%)</td>
<td>0</td>
<td>16 (0.6%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Tamponade</td>
<td>4 (2.0%)</td>
<td>4 (1.0%)</td>
<td>1 (1.0%)</td>
<td>22 (0.8%)</td>
<td>0.07</td>
</tr>
<tr>
<td>Major vascular complication</td>
<td>4 (2.0%)</td>
<td>3 (0.4%)</td>
<td>6 (3.0%)</td>
<td>98 (3.5%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Need for vascular surgery</td>
<td>3 (2.0%)</td>
<td>7 (1.0%)</td>
<td>3 (2.0%)</td>
<td>63 (2.2%)</td>
<td>0.59</td>
</tr>
<tr>
<td>Emergency valve in valve procedure</td>
<td>7 (4.0%)</td>
<td>7 (1.0%)</td>
<td>2 (1.0%)</td>
<td>77 (2.7%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Need for haemofiltration</td>
<td>7 (4.0%)</td>
<td>54 (7.0%)</td>
<td>19 (10%)</td>
<td>71 (2.5%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>GI bleeding</td>
<td>2 (1.0%)</td>
<td>15 (2.0%)</td>
<td>0</td>
<td>21 (0.8%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Pacemaker implantation post TAVI</td>
<td>43 (2.3%)</td>
<td>37 (5.0%)</td>
<td>13 (7.0%)</td>
<td>363 (13%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>7.0 (5.0-10.0)</td>
<td>8.0 (5.0-15.0)</td>
<td>8.0 (5.0-16.0)</td>
<td>5.5 (4.0-8.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Follow-up (days)</td>
<td>609 (312-994)</td>
<td>567 (225-1056)</td>
<td>421 (202-680)</td>
<td>544 (283-929)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

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**Figure 1.** Kaplan-Meier curve (unadjusted) to compare survival with femoral versus nonfemoral access routes (p <0.001).

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**Comparative Survival After Transapical, Direct Aortic, and Subclavian Transcatheter Aortic Valve Implantation (Data from the UK TAVI Registry)**

Georg M. Fröhlich, MD**, Paul D. Baxter, PhD**, Christopher J. Malkin, MD**, D. Julian A. Scott, MD**, Neil E. Moat, MD**, David Hildick-Smith, MD**, David Cunningham, MD**, Philip A. MacCarthy, PhD**, Uday Trivedi, BSc**, Mark A. de Belder, MD**, Peter F. Ludman, MD**, and Daniel J. Blackman, MD**,**

on behalf of the National Institute for Cardiovascular Outcomes Research
<table>
<thead>
<tr>
<th>TRANSFEMORAL</th>
<th>ILIOFEMORAL COMPLICATIONS</th>
<th>AORTIC COMPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dissection</td>
<td>Stenosis/Thrombosis/Occlusion</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>Artery avulsion</td>
</tr>
<tr>
<td></td>
<td>Access site infection</td>
<td>Pseudoaneurysms</td>
</tr>
<tr>
<td></td>
<td>Access site bleeding</td>
<td>Failed percutaneous closure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aortic aneurysm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aortic rupture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aortic dissection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Retroperitoneal hemorrahage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TRANSAPICAL</th>
<th>TRANSAXILLARY</th>
<th>TRANSAOARTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Apical puncture bleeding</td>
<td>Subclavian artery thrombosis</td>
</tr>
<tr>
<td></td>
<td>Myocardial tears</td>
<td>Subclavian artery dissection</td>
</tr>
<tr>
<td></td>
<td>Apical scarring</td>
<td>Subclavian artery stenosis</td>
</tr>
<tr>
<td></td>
<td>Blood flow obstruction (LAD)</td>
<td>Tearing of the aorta</td>
</tr>
<tr>
<td></td>
<td>Aneurysm formation</td>
<td>Deep wound infection</td>
</tr>
<tr>
<td></td>
<td>Chronic pain</td>
<td>Mediastinitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RIMA graft injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right ventricle laceration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IC artery pseudoaneurysm</td>
</tr>
</tbody>
</table>

Figure 1 TAVI-related major vascular complications according to access routes. TAVI, transcatheter aortic valve implantation; LAD, left anterior descendent; RIMA, right internal mammary artery; IC, intercostals.
HEART TEAM on the road to... BEST TAVR ACCESS SITE

× For every patient suitable for TAVR a 3D CT Angiography of his whole vascular tree should be made

1. Least diameter of the aorta
2. Calcification burden + peripheral allocation
3. tortuous aorta
4. Angle between AV and horizontal level
5. Distance of AV and “entry point”
6. Distance of access site and “entry point”
7. Topographic relation ascending aorta/ mid-sternum and spine
8. Anatomic deformities
Conclusions

- The selection of the approach should be highly individual
- Capability and experience of the Heart Team
- Availability of different valve types
- Anatomy and pathology of the patient’s vessels

Duke Heart Center

Vessel Analysis

- CTA chest/abdomen/pelvis
  - ≥64 slice w/1 mm thin-cut reconstructions
- CTA diameter measurements obtained perpendicular to centerline of flow lumen
  - 3D workstation: TeraRecon, M2S
- Considerations
  - Artery diameter
  - Lesions
  - Tortuosity
  - Calcification
- You need to learn to do this yourself!!!

Figure 2. Options for direct aortic access.
Cases-Examples

- A patient with tortuous, calcified and narrow ileofemoral arteries. If the anatomy of the subclavian artery is favourable, subclavian access would be preferred.
- Another patient with a tortuous abdominal and thoracic aorta and calcified bicuspid aortic stenosis will be a suitable candidate for the direct aortic access and a self-expanding valve.
- A patient with strongly angulated aortic root and small calcific valve will be indicated for the transfemoral implantation of a balloon-expandable valve.
The selection of the access route and the type of valve tailor-made to the specific patient needs is, and will remain, the only correct way towards further improvement of the outcomes of the transcatheater aortic valve implantation.
Thank You