Artificial heart valves

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Overview

- Introduction
- Classification
- History
- Fabrication
- Problems
- Comparison
- Conclusion
There are four valves in the human heart for guiding the blood flow.

- 2 atrioventricular valves
- 2 semilunar valves
Indications for heart valve repair/replacement:

- Congenital deformation
- Valve stenosis
- Valve insufficiency/regurgitation

~ 95,000 heart valve surgeries/year worldwide
### Classification

<table>
<thead>
<tr>
<th>Mechanical Heart Valves (MHV)</th>
<th>Biological Heart Valves (BHV)</th>
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<tbody>
<tr>
<td>Caged-ball valve</td>
<td>Tissue / leaflet-based Xeno- / Allograft</td>
</tr>
<tr>
<td>Tilting-disk valve</td>
<td>Stent-framed</td>
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<tr>
<td>Bileaflet valve</td>
<td>Stentless</td>
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<tr>
<td>Trileaflet valve</td>
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First successful operation of a mitral valve stenosis

1923
First successful implant of an artificial heart-valve (MHV)
First successful open heart operation using a heart-lung-machine
History

1960

Starr-Edwards caged-ball valve (MHV)
Discovery of pyrolytic carbon

1963
First pulmonary allograft transplant (BHV)
First pyrolytic carbon valve (MHV)
History

Bjork-Shiley tilting-disk valve (MHV)

1969
History

1979

St. Jude Medical bileaflet valve (MHV)
History

First pericardial valve (BHV)

1981
First stentless pericardial valve (BHV)
First percutaneous valve replacement (BHV)
Fabrication

- No standard procedure
- Difficult biological processes
- No in-vitro testing

Selection

- Fixation
- Decellularization
- Neutralization
- Material improvement
- Assembly
Fabrication

- Selection
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- Assembly

Pericardium sheet

Glutaraldehyde (GA)
Fabrication

Selection

Fixation

Decellularization

Neutralization

Material improvement

Assembly

Fixated sheet

Washing

SDS

Triton X-100

Tween 80

Altered tissue
Fabrication: decellularization

Native porcine pericardium with hematoxylin and eosin stain (mag. 300x)

Bovine pericardium with hematoxylin and eosin stain (mag. 300x)
Fabrication

Selection

Fixation

Decellularization

Neutralization

Material improvement

Assembly

GA-fixated sheet

Uncombined aldehydes

Amino oleic acid (AOA)

Alternative: heating
Fabrication

Selection
Fixation
Decellularization
Neutralization
Material improvement

Assembly

Pericardium sheet
Fibre orientation
Thickness
Cutting & sewing
### Problems

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![Caged-ball valve]

Blood vessel
## Problems

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![Caged-ball valve](image)

- Blood vessel
- Caged-ball valve
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![Tilting-disk valve](image)

**Blood vessel**

![Blood vessel](image)
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**Tilting-disk valve**
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![Blood vessel](image)

**Bileaflet valve**
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Trileaflet valve

Blood vessel
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![Trileaflet valve](image)

![Blood vessel](image)
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<td>Calcified leaflets removal</td>
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<td>Percutaneous implantation</td>
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## Mechanical heart valves

- **Advantages**
  - Long-term stability / durability
  - Good biocompatibility
  - No anticoagulation needed
  - Better opening / closing behavior
  - Unobstructed blood flow
  - Allow minimally invasive procedure

## Biological heart valves

- **Disadvantages**
  - Lifelong anticoagulation therapy
  - No guaranteed longterm stability
  - Unnatural opening / closing behavior
  - Prone to inflammation
  - Obstructed blood flow
  - Prone to calcification
  - Clicking noises
  - Involvement in biological processes

### Comparison

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Conclusion

Future topics:

- Increasing long-term stability of biological valves
- Understanding calcification processes
- Focus on percutaneous implantation

Biological heart valves will replace mechanical valves eventually.
Thank you for your attention!