Functional Anatomy of the Tricuspid Valve and Right Ventricle

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Tricuspid valve

- TV is the inflow valve of the RV

- In contrast with MV, the TV has a direct relationship with the septum, but not in the continuity with the pulmonary valve as the mitral valve is with the aortic valve
Tricuspid valve anatomy

- Annulus
- Leaflets
- Commissures
- Chords
- Papillary muscles
- RV wall

Tricuspid valve anatomy and pathology is much more complex as it appears to be.
Tricuspid valve annulus

- The annulus is only partially fibrous at the level of the membranous septum and has a strict relationship with the aortic annulus.
- The most part of the annulus is muscular.
Tricuspid valve annulus

- The annulus is not planar, but shows a complex 3D shape, with the highest point being located anteroposteriorly and the lowest point mediolaterally.
- The high-low distance is about 7.2
Tricuspid Leaflets

There are 3 leaflets: the septal, anterior and posterior one.
Papillary muscles

- The septal PM is the furthest from the centroid and the closest to the annular plane.
- The anterior PM was the most apical
The shape of the RV

RV shape is also dependent on the position and function of the interventricular septum.
The RV in normal human heart

• The right ventricle volume is large than the LV, the septum is concave towards the LV in both systole and diastole.

• The normal range of RV end-diastolic volume is 49-101 ml/m², whereas the normal range of LV is 44-89 ml/m²

• The RV mass is approximately a third that of LV mass: 26 g/m² versus 87 g/m²
Right ventricle walls

- The RV has 3 walls: anterior, inferior and septal, with the last in common with the LV.

- There are 3 RV components: the inlet portion (between the TV and the base of PPMs), the apical trabecular portion shows coarser trabeculations than the LV, and the outlet corresponds to the outflow tract.
Muscle layers

• **Superficial muscle layer:**
  fibers are arranged more or less circumferentially in a direction that is parallel to the atrioventricular groove. These fibers turn obliquely toward the cardiac apex and continue into the superficial LV myofibers.

• **Deep muscle layer:**
  fibers are arranged longitudinally from base to apex.
• In contrast to the RV, the LV contains obliquely oriented myofibers superficially, longitudinally oriented fibers in subendocardium, and predominantlly circular fibers in between.

• This arrangement contribute to more complex movement of the LV, which includes torsion, translation, rotation and thickening.
The ventricular interdependence

- The continuity between the muscle fibers
- Interventricular septum and pericardium
The pressure-volume relationship

- The RV is an energetically efficient pump, almost entirely dependent on the low pulmonary hydraulic impedance.

- This is a dynamic phenomenon.

The Hangout period

- The RV contraction is dependent on its loading condition.
- The RV contract in a peristaltic manner.

RV & LV

The impact of the LV contractility on RV function is well known.

1. Whereas the RV contribution to develop pressure in the LV was minimal, the LV caused pronounced pressure generation in the RV.

2. Approximately 30% of the contractile energy of the RV was generated by the LV.

RV & LV

Impact of LV unload on RV function

- LV volume reduction
- RV volume expansion
- Load-independent RV dysfunction
- RV heart failure

This is caused by chronic septal displacement into the LV that lead to septum fibrosis, reducing thickening and dysfucntion

Effects of the LV contraction on the RV
Role of interventricular septum

• Septum twists and shortens
• Reduction in ventricular volume
• Forceful ejection of blood out of both ventricle
• When the septum is damaged, the contraction of the RV depend only by the circumferential constriction caused by the basal wall that contains transverse fibers.
• Such construction does not ensure adequate cardiac output specifically when PAP is increased.
RV & LV

Normal heart

Dilated RV
RV & the lungs

RV is not capable of sustaining long-term pressure overload:

- Cardiac contractile decrease, due to functional or structural (apoptosis) changes in cardiomyocytes
- RV dilate, due to increased wall tension
- Myocardial oxygen demand increase
- RV perfusion decrease
Pathophysiology of functional TR

- Annular dilatation
- RV enlargement
- Papillary muscle displacement
- Leaflets thetering
Annular Enlargement

Papillary muscle displacement
Papillary muscle displacement in dilated RV
Surgical Consideration

The TV is not only annulus, but also leaflets, chords and PMs, the position of which depends on the RV size and function.
Conclusions

• TV function is strictly correlated to the RV geometry, which depends on preload, afterload, and LV geometry.

• The RV reverse remodelling is unpredictable.

• As the mechanism of functional TR does not found only in annular dilatation, the surgical technique applied mainly to annular reduction, have fluctuating results.

• In selected patients leaflets techniques will be used to improve results.
Conclusions

The increasing attention toward the right side of the heart will lead to the diffusion of more standarized diagnostic and surgical techniques, to clarify better the anatomical changes and the reversibility of the RV dysfunction, and to improve surgical repair outcomes.

Thanks
Surgical Techniques

De Vega’s technique

Annuloplastic ring

Kay’s technique
Surgical Techniques addressed to the leaflets

Edge-to-edge

Leaflet augmentation

![Diagram of surgical techniques](image-url)