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Anatomy

# CHORDAE TENDINAE OF TRICUSPID VALVE- A STUDY IN HUMANS

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**ABSTRACT** **INTRODUCTION :** Chordae tendinae are endothelial covered fibrous collagenous structures supporting the cusps of atrio ventricular valves. They prevent the cusps from being forced back into the atrium during ventricular systole. The morphology of chordae are important to perform various sub valvular techniques in a valve complex. **MATERIALS AND METHODS :** This is a descriptive observational study to analyse various characteristics of chordae of tricuspid valve of 100 normal adult human hearts obtained from autopsy specimens. The methodology used was the dissection method. The study focus on the site of attachment chordae on leaflets and classify accordingly, the number of chordae attached to each leaflet and to look for any aberrant chordae. **RESULTS :** The different types of chordae observed in Tricuspid valve was classified into rough zone-, free edge-, deep-, basal- and commissural- based on their site of insertion in the leaflets. Of these, the most prominent was rough zone chordae. Aberrant chordae were seen only in 5 % of hearts. **CONCLUSION :** Understanding the morphology of chordae will be useful for cardiothoracic surgeons in performing subvalvular procedures like Chordal Shortening and Plication (for elongated chordae), Chordal Transfer (for chordal rupture) and Chordal Substitution using expanded poly tetra fluoro ethylene sutures (for thickened / shortened chordae). Presence of aberrant chordae will restrict the mobility of the leaflet.

**KEYWORDS :** Chordae tendinae; Tricuspid valve ; Leaflet ; Rough zone

## INTRODUCTION

Chordae tendinae are endothelial covered fibrous collagenous structures supporting the cusps of atrioventricular valves. They were first described by a greek philosopher, Erasistratus of Ceos in an ancient greek treatise 'On the heart'. During ventricular contraction, papillary muscles draw the margins of adjacent cusps together through these cords and prevent them from being forced back into the atrium. These chordae act as protective filter to prevent massive pulmonary embolism.

Patients with congenital valvular dysplasia or functional tricuspid regurgitation are the candidates for various subvalvular techniques like chordal plication, chordal transfer or chordal substitution. So it is important to describe morphological characteristics of chordae which will be helpful for the cardiothoracic surgeons for adjusting and maintaining the height of neochordae.

## AIM

Present study aims to analyse the characteristics of chordae such as the site of attachment on leaflets and classify accordingly, the number of chordae attached to each leaflet and to look for any aberrant chordae.

## MATERIALS AND METHODS

This is a descriptive observational study to analyse morphological characteristics of chordae of tricuspid valve of 100 normal adult human hearts ranging in age from 17 to 80 years obtained from autopsy specimens, Dept of Forensic Medicine, Govt. Medical College, Kozhikode (with permission).

**INCLUSION CRITERIA** :
Adult human hearts obtained with no gross anomalies or nopathological changes were included.

**EXCLUSION CRITERIA** :
Hearts with ventricular wall thickness of more than 15mm were excluded.

**MATERIALS USED**:
Gloves, Dissection box, Brain knife, Camera.

**METHODOLOGY**:
Dissection method[2] - Dissection was performed according to standard autopsy techniques. Using scissors, the initial cut was made between the ostia of both vena cavae to the right atrial appendage. Right atrium was opened and cleaned with water to remove any blood clots so as to visualise the tricuspid orifice from above. Then we opened the right ventricle with a V-shaped cut along its right margin and across the anterior wall of the right ventricle using brain knife. Any residual clots were removed with water so as to inspect the attachment of chordae from the tips of papillary muscles to various zones in leaflets. Photographs were taken to document the important findings. The results obtained were tabulated in groups.

## RESULTS

**The following types of chordae are observed in Tricuspid valve :**

(1) Rough zone chordae : Inserted into the ventricular aspect of the distal rough portion of the leaflets.
(2) Free edge chordae: Inserted to the leaflet's free edge or into one of its scallops.
(3) Deep chordae: Inserted to the leaflet's ventricular surface either in the upper part of the rough zone or in the clear zone.
(4) Basal chordae : Inserted into the basal zone of the leaflet. Fan shaped chordae : Inserted to the commissural region of the leaflet

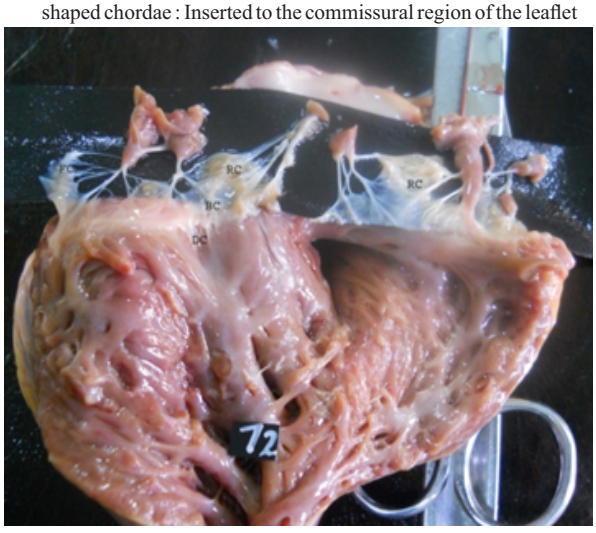



**Fig 1: Various types of chordae on Tricuspid valve**

RC – Rough zone Chordae
DC – Deep Chordae
FC – Free edge Chordae
BC – Basal Chordae

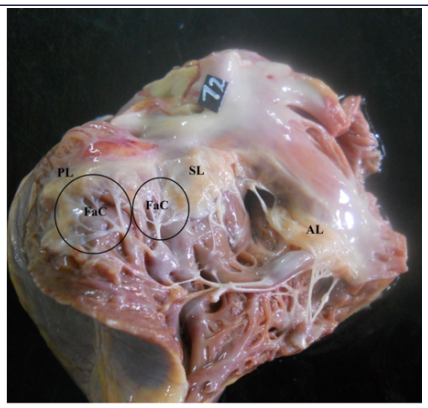
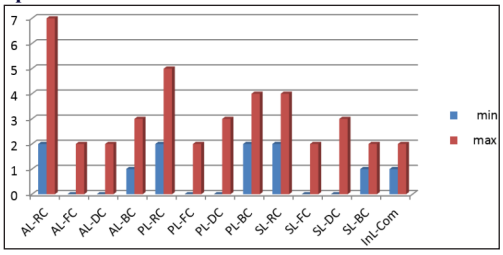



**Fig 2 : Fan shaped Chordae (FaC) or Commissural chordae on Posterior Leaflet and Posteroseptal commissure of Tricuspid valve (AL–Anterior Leaflet, PL– Posterior Leaflet , SL- Septal Leaflet)**

**Number and distribution of chordae**:
For counting the number of chordae tendinae in a valve complex, the true chordae are considered. In the present study, we found that the rough zone chordae ranged from 2-7 in the anterior leaflet, 2-5 in the posterior leaflet and 2-4 in the septal leaflet. The free edge chordae varied from 0-2 in all the leaflets. The deep chordae ranged from 0-2 in the anterior leaflet and 0-3 in the posterior and septal leaflets. The basal chordae ranged from 1-3 in the anterior leaflet, 2-4 in the posterior leaflet and 1-2 in the septal leaflet and commissural chordae varied from 1-2.

Regarding the distribution, the rough zone and commissural chordae originated from all the three groups of papillary muscles. In majority of hearts, the stem of rough zone chordae were divided into 3-4 branches before inserting into the leaflets. The free edge chordae were attached to the leaflets' free margin whereas the deep chordae were attached beyond the rough zone of the leaflets. Most of the basal chordae were attached to the ventricular wall and the commissural chordae to the free margin of the commissures.

**Chart 1: Bar diagram showing the number and distribution of Tricuspid valve chordae.**




(**AL**- Anterior Leaflet; **PL**- Posterior Leaflet; **SL**- Septal Leaflet; **InL**- InterLeaflet; **RC**- Rough zone Chordae; **FC**-Free edge Chordae; **DC**- Deep Chordae; **BC**-Basal Chordae; **Com-**Commissural)

**Aberrant chordae :**
In the present study, we noticed aberrant chordae in the right ventricle in 5 hearts (Fig 3). Of these, the 3 hearts showed aberrant chordae as a thin cord passing from the ventricular wall near the annulus to the clear zone of the septal leaflet. In the remaining 2 hearts, the aberrant chordae was thick and flattened, connecting the ventricular wall to the annulus and extending to the clear zone of the septal leaflet.

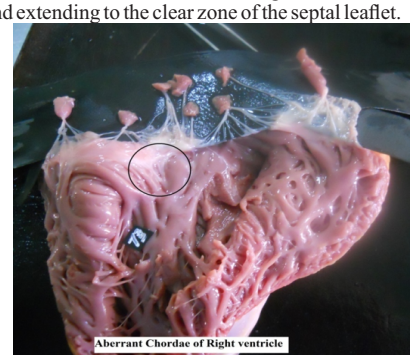



**Fig 3 : Aberrant Chordae in Right ventricle**

## DISCUSSION

It is essential to understand various zones in the leaflet before classifying the chordae of atrioventricular valves. They are as follows : [3]

(1) Rough zone (the area between the cusp's free edge and its line of closure) : This zone is relatively thick, opaque and uneven on its ventricular aspect where most of the chordae are attached.
(2) Clear zone (proximal thin translucent area between the rough zone and the cusp base) : This zone is smooth and translucent and receive only a few chordae.
(3) Basal zone (from the annulus of the posterior cusp to the clear zone) : This zone is thick, extending 2-3 mm from the circumferential attachment of the cusps and receive only a few chordae.
(4) Commissural zone : Interleaflet zone to which fan shaped chordae are attached.

**Description of each type of chordae :**
Rough zone chordae arise from a single stem which usually splits into three components attaching to the free margin and the ventricular aspect of rough zone (which extends 0.8 to 1 cm from the free margin to the line of closure).

Free edge chordae are single, thread like chordae passing from either the apex or base of a papillary muscle into the leaflet's margin, usually near to its midpoint or one of its scallops.

Deep chordae are long that pass beyond the leaflet's margin and branch to various extent, reach the more peripheral rough zone or even the clear zone.

Basal chordae often arise from the smooth or trabaculated ventricular wall and attach to the basal component of the leaflet (which is approximately 2 mm wide from the tricuspid valve annulus) These chordae are usually single and completely separated from the wall of the ventricle.

Fan shaped chordae (Commissural chordae) arise as a main stem that branch radially like the struts of a fan to insert into the free margin of the commissural region of the leaflet.

**Aberrant chordae :**
Another type of chordae which could not be included under any of these were named as aberrant chordae. They inserted into the clear zone of the leaflet, but not arising from the papillary muscles. These type of chordae will limit the mobility of the leaflet [4].

Mc Elhinney DB et al [5] in 1999, evaluated congenital TR in 3 chidren and found that the abnormally short and thick tendinous cords tethered the septal leaflet of tricuspid valve causing significant regurgitation. They emphasised the importance of recognising this lesion as it was readily amenable to surgical repair.

**True chordae and False chordae:**
True chordae are those chordae that are inserted into the leaflets. But there are chordae that are inserting elsewhere other than into the leaflet. They are called false chordae, which are
(i)Chordae connecting one papillary muscle to the other (ii) Chordae connecting the papillary muscle to ventricular wall (iii) Chordae connecting one portion of ventricular wall with another. They are excluded while counting the number.

Silver et al [6] in 1971 noted the average number of each type of chordae in 50 normal human tricuspid valves. According to them, the rough zone chordae ranged from 2-6 in the anterior leaflet, 0-5 in the posterior leaflet and 2-6 in the septal leaflet. In case of free edge chordae, the number ranged from 0-2 in the anterior leaflet, 0-4 in the posterior as well as in the septal leaflets. The deep chordae ranged from 0-5 in the anterior leaflet,0-5 in the posterior leaflet and 0-4 in the septal leaflet whereas the basal chordae ranged from 0-3 in the anterior leaflet, 0-5 in the posterior leaflet and 0-6 in the septal leaflet. They also calculated the number of commissural chordae and found that their number ranged from 0-1.

In 2004, Kocak A et al[7] conducted an autopsy study on valvochordal anatomy of Tricuspid valve in sudden death cases with no apparent cause and found that thickened and shortened chordae will negatively affect its feeding which could precipitate sudden ischemic attack.

In 2006, Mohamed A B Motabagani [8] studied 200 autopsy cases and observed that the rough zone chordae of tricuspid valve ranged from 5-

7 in the anterior leaflet, 3-5 in the posterior leaflet and 3-5 in the septal leaflet. The number of free edge chordae varied from 0-2 in the anterior and posterior leaflets whereas in case of septal leaflet the number ranged from 0-1. They did not mention about deep chordae in their study. In case of basal chordae, their number ranged from 1-3 in the anterior leaflet, 2-4 in the posterior leaflet and 1-2 in the septal leaflet. And finally, the number of commissural chordae varied from 1-2 in his study.

In our study, the rough zone chordae ranged from 2-7 in the anterior leaflet, 2-5 in the posterior leaflet and 2-4 in the septal leaflet. The free edge chordae varied from 0-2 in all the leaflets. The deep chordae ranged from 0-2 in the anterior leaflet, whereas it varied from 0-3 in the posterior as well as in the septal leaflets. In case of basal chordae, their number ranged from 1-3 in the anterior leaflet, 2-4 in the posterior leaflet and 1-2 in the septal leaflet and the commissural chordae varied from 1-2.

Regarding the distribution, the stem of rough zone chordae was divided into three branches before inserting into the ventricular aspect of distal rough portion of the leaflets whereas the free edge chordae were attached to the leaflets' free margin. The deep chordae were attached beyond the rough zone of the leaflets and the basal chordae were inserted into the basal portion of the leaflet after their origin from the ventricular wall. The commissural chordae were seen attached to the free margin of the commissures (interleaflet areas).

**Limitation of the study :**
Study was not related to Biomechanics in living individuals

## CONCLUSION

Present study has classified chordae into rough zone-, free edge-, deep-, basal- and commissural- chordae. Of these, the rough zone chordae are the most prominent which are inserted into the distal rough zone of the anterior and posterior leaflets. Understanding the morphology of chordae will be useful for cardiothoracic surgeons in performing subvalvular procedures like Chordal Shortening and Plication (for elongated chordae), Chordal Transfer (for chordal rupture) and Chordal Substitution using expanded poly tetra fluoro ethylene sutures (for thickened / shortened chordae). Presence of aberrant chordae will restrict the mobility of the leaflet.

**Conflicts of Interests**: None

## REFERENCES


1. Hurlbutt, Frank.R.Hurlbutt, Peri Kardies.1939. A treatise 'On the heart' from the Hippocratic Corpus. Bull.Hist.Med. Vol VII Page : 1104-1113.
2. Ludwig J. 2002. Autopsy manual Cardiovascular System. Handbook of Autopsy Practice, 3 rdEdition. pg 45-48.
3. Susan Standring, Elsivier 2008. Heart and great vessels, *Gray's Anatomy. The Anatomical Basis of Clinical Practice, 40th Edition*, Chapter 56, Page 1775.
4. Theodoros Xanthos, Ioannis Dalivigkas, Konstantinos A. Ekmektzoglou. 2011 .Anatomic variations of the cardiac valves and papillary muscles of the right heart. Italian Journal of Anatomy and Embryology, Vol .116, no.2 : 111-126.
5. Mc Elhinney D B, Silverman N H, Brook M M, Hanley F L,Stanger P.1999 May. Asymmetrically short tendinous cords causing congenital tricuspid regurgitation: Improved understanding of tricuspid valve dysplasia in the era of colour flow echocardiography. Cardiol. Young. 9 (3):300-304.
6. M.D.Silver MBBS PH D, J H C Lam BSc, N Ranganathan MBBS and E D Wigix MD. March 1971. Morphology of the Human Tricuspid Valve. Circulation, Volume XLIII, , Page 333-348.
7. Aytac Kocak, Figen Govsa, Ekin O Aktas, Bahar Boydak, Ismail C Yavuz. 2004 August. Structure of the human tricuspid valve leaflets and its chordae tendineae in unexpected death. A forensic autopsy study of 400 cases. Saudi Med J. 25(8):1051-9.
8. Mohamed A.B. Motabagani 2006. Comparative Anatomical, Morphometric and Histological Studies of theTricuspid Valve-Complex in Human and Some Mammalian Hearts. J. Anat.Soc.India ; 55(1) page :1-23.