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Original Research Article

A cadaveric study on chordae tendinae of human tricuspid valve

Harsha B R[1], Chandragirish S[1,*], Girish V Patil[1]

[1] *Dept. of Anatomy, Chamarajanagar Institute of Medical Sciences, Chamarajanagara, Karnataka, India*

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ABSTRACT

Background: Aim of the present study was to observe the types of chordae tendinae present in tricuspid valve of human heart. Morphology of chordae tendinae in tricuspid valve gains utmost importance in cardiac surgeries in recent times because advent in modern technologies in treatment of tricuspid valve diseases.

Materials and Methods: This study was carried out on 96 normal formalin fixed human post-mortem heart specimens. Types of chordae tendinae observed on the basis of their attachments.

Results: Chordae tendinae were observed in all specimens. Five types of chordae tendinae were identified namely rough zone, free edge, fan shaped, deep and basal chordae. Anterior papillary muscle was seen providing attachment to 2 to 9; Posterior papillary muscles were seen with 1 to 6 and Septal papillary muscles provided attachment to 1 to 4 chordae tendinae.

Conclusion: We hope this study will serve to understand the tricuspid valve complex and types of different chordae tendinae better and it will help in various surgical procedures done on tricuspid valve.

1. Introduction

The opening of a new field of surgical endeavour often arouses interest in the detailed study of the anatomy of the involved part of the body. As a result of such studies, current notions may be changed and extended so as to understand better. The impetus given to tricuspid valve surgery in the course of the last few years has prompted revision of our knowledge concerning the anatomy of the normal. In present study the number and types of chordae tendinae in tricuspid valve were studied and then compared with the works of many eminent scientists in this field.

The atrioventricular valvular complex in both right and left ventricles consists of the orifice and its annulus, the cusps, the supporting chordae tendinae of various types and the papillary muscles. Tricuspid valve is made up of six major components like Right atrial wall, Annulus, Three leaflets, Chordae tendinae, Papillary muscles, Right ventricular free wall.

Harmonious interplay of all these, together with the atrial and ventricular myocardial masses depends on the conducting tissues and the mechanical cohesion provided by the fibro elastic cardiac skeleton.

All parts change substantially in position, shape, angulation and dimensions during a single cardiac cycle. The tendinous chords are fibrous collagenous structure covered by endothelial lining supporting the valve leaflets.

Chordae tendinae are small thread like structures originated from a papillary muscle either directly from the apex of the muscle or from small nipples, which were usually on their upper third. The chordae were attached to the ventricular end of the valve leaflets and their apices and margins and then, anchored to the muscular ventricular wall. [1]

* *Corresponding author*.
E-mail address: handragirishs@gmail.com (Chandragirish S).

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They were classified by Tandler into I, II and III order chordae but morphologically various types have been described, they are:

1.1. Fan shaped chordae

They have a short stem from which branches radiate to attach to the tip (margin), other zones of apposition between leaflets and to the ends of adjacent leaflets, on their ventricular aspect.

1.2. Rough zone chordae

Arise from a single stem, which usually splits, into three components, which attach to the free margin and to some intermediate point on the leaflet, on the ventricular aspect.

1.3. Free edge chordae

They are single, thread like and often long, passing from either the apex or base of a papillary muscle to a marginal attachment, usually near the midpoint of a leaflet or one of its scallops.

1.4. Deep chordae

Round or flat ribbons, long and slender or short and muscular. They arise from the smooth or trabeculated ventricular wall and attach to the basal component of a leaflet.

1.5. Basal chordae

Small, flat ribbons structure extends from the ventricular wall to the basal zones of the leaflets.

Normal function of tricuspid valve depends on the anatomic and mechanical integrity of the chordae tendinae. This study will be much help for surgical procedures like chordal replacement, tightening of valve leaflets in tricuspid valve prolapse. Ruptured chordae tendinae will be the cause for myocardial infarction and arrhythmia.[2]

2. Materials and Methods

The present cross sectional study was conducted at CIMS Chamarajanagara from January 2017 to December 2018**.** The study was carried out on 96 formalin fixed human hearts from patients who had died of non- to December vascular causes and were autopsied. No gross abnormality of the tricuspid valves was noted. Study was done without any grouping of specimens on the basis of sex and age. Dissection was performed according to standard autopsy techniques. The Tricuspid valve was opened by a scalpel knife cut passing from the right atrium to the apex of the right ventricle through the lateral or acute margin of the ventricle. The interior of the heart was washed and all the blood clots were removed. The second cut was made along the anterior surface of the heart just left to the intra-ventricular groove from apex of the ventricle to annulus; care was taken not to damage the papillary muscles. After opening the valve from ventricular side, blood clots were removed completely, types of chordae tendinae observed according to its morphology and attachments and photographed after the approval from the Ethical Committee.

The data were summarised using descriptive statistics like frequency (number of chordae tendinae) and discrete variable (types of chordae tendinae) were measured by proportions. All the statistical calculations were performed using software SPSS for windows {Statistical Package for Social Service (SPSS) Inc, 2004, New York} version 13.0.

3. Observations and Results

In present study number of chordae tendinae in a tricuspid valve ranges from 4 to 19. Most commonly observed were 11 chordae tendinae in 16 hearts. Maximum number is 19 chordae tendinae observed in 2 hearts and minimum number is 4 chords in 1 heart specimen. Average number of chordae tendinae attached to each papillary muscle was as follows: 1-9 chordae tendinae originated from the anterior papillary muscle, 1-6 from the posterior papillary muscle and 1-4 from septal papillary muscle.

5 types of chordae tendinae were observed namely fan shaped, free edge, rough zone, basal and deep.

In 130 anterior papillary muscle observed, fan shaped chordae present in 20 muscles with range of 1 to 3 per muscle, free edge chordae present in 105 muscles with range of 1 to 4 per muscle, rough zone chordae present in 83 muscles with range of 1 to 3 per muscle, basal chordae present in 69 muscles with range of 1 to 2 per muscle and deep chordae present in 53 muscles with range of 1 to 3 per muscle.

Table 1: Types of anterior papillary muscle seen in the present study

Shape of Anterior Papillary Muscle	Frequency
Fan Shaped	20
Free Edge Shaped	105
Rough Zone Shaped	83
Basal Chordae	69
Deep Chordae	53

In 211 posterior papillary muscle observed, fan shaped chordae present in 22 muscles with range of 1 to 3 per muscle, free edge chordae present in 152 muscles with range of 1 to 3 per muscle, rough zone chordae present in 67 muscles with range of 1 to 3 per muscle, basal chordae present in 46 muscles with range of 1 to 3 per muscle and deep chordae present in 58 muscles with range of 1 to 2 per muscle.

Table 2: Types of anterior papillary muscle seen in the present study

Shape of Posterior Papillary Muscle	Frequency
Fan Shaped	22
Free Edge Shaped	152
Rough Zone Shaped	67
Basal Chordae	46
Deep Chordae	58

In 77 septal papillary muscle observed, fan shaped chordae present in 48 muscles with range of 1 to 2 per muscle, free edge chordae present in 40 muscles with range of 1 to 2 per muscle, rough zone chordae present in 10 muscles with 1 per muscle, basal chordae present in 12 muscles with range of 1 to 2 per muscle and deep chordae present in 17 muscles with range of 1 to 2 per muscle.

Table 3: Types of anterior papillary muscleseen in the present study

Shape of Septal Papillary Muscle	Frequency
Fan Shaped	48
Free Edge Shaped	40
Rough Zone Shaped	10
Basal Chordae	12
Deep Chordae	17

4. Discussion

In the present study range of Chordae Tendinae in papillary Muscle was seen in the range of 2-9 in APM, 1-6 in PPM and 1-4 IN SPM. The Chordae Tendinae seen in other studies done by Balachandra N[3] et al. (1-8 APM, 1-6 PPM and 1-9 SPM), Gerola L R et al[4] (3-8 APM, 2-6 PPM and 5-8 SPM), Nigri GR[5] et al.(1-11 APM, 1-8 PPM and 1-5 SPM), Motabagani MBM[6] (11-13 APM, 5-7 PPM and 6-11 SPM), Kocak A[7] et al (2-7 APM, 1-6 PPM and 1-4 SPM), Skwarek M[8] et al (8-18 APM, 5-16 PPM and 9-11 SPM), Skwarek M[2] et al (3-4 APM, 3-4 PPM and 2-4 SPM), Silver MD[9] et al (2-7 APM, 2-6 PPM and 2-9 SPM).

Observation regarding the number of chordae tendinae in Tricuspid valve in the present study was not in agreement with the any of the work, every work has its own value. Possible reason for these differences would be number of specimens studied and geographical place of the specimens. This shows high variability of number in chordae tendinae arrangement.

The flexibility of particular leaflets of the Tricuspid valve varies, as does the tension of the blood stream in particular cusps. The study of the distribution of tendinous chords of the Tricuspid valves is helpful in aspects of progress in cardio surgical techniques, including Tricuspid valve repair with chordal replacement after traumatic regurgitation, surgical repair of the mitral and Tricuspid valve simultaneously using the De Vega method and invasive procedure with balloon valvuloplasty in cases of stenosis.[2]

The ramification of chords attaching septal leaflets was higher than for the anterior and posterior leaflets. This, as well as the morphology of the septal papillay muscles, may be related to the lower mobility of the septal cusp than others. In the present study five types of chordae are identified which are similar to the studies by Silver MD et al., Kocak A et al. and Balachandra N et al.

Comparison of this observation with studies of above mentioned authors as follows:

Observation regarding the range of fan shaped chordae tendinae in papillary muscles in the present study was in agreement with the work of Balachandra N et al.[3] (0-7 APM, 0-5 PPM, 0-4 SPM) Observations are showing much difference between present study and work done by Kocak A et al.[7] (0-2 PPM) and Silver MD et al.[9] (0-2 PPM)Possible reason for such difference is the number of specimens studied.

Observation regarding the range of free edge chordae tendinae in papillary muscles in the present.

study was in agreement with the work of Balachandra N et al.[3] (0-5 APM, 0-5 PPM, 0-4 SPM).

But, number of chordae tendinae from APM in the present study was ranged from 0-5.

Observations are showing much difference between present study and work done by Kocak A et al.[7] (0-2 APM, 0-4 PPM, 0-4 SPM) and Silver MD et al.[9] (0-2 APM, 0-4 PPM, 0-4 SPM).

Possible reason for such difference is the number of specimens studied.

Observation regarding the range of rough zone chordae tendinae in papillary muscles in the present study was in agreement with the work of Balachandra N et al.[3] (0-4 APM, 0-3 PPM, 0-5 SPM). But, number of chordae tendinae from SPM in the present study was ranged from 0-5. Observations are showing much difference between present study and work done by Kocak A et al.[7] (2-6 APM, 0-4 PPM, 2-7 SPM) and Silver MD et al.[9] (2-6 APM, 0-5 PPM, 2-6 SPM). Possible reason for such difference is the number of specimens studied.

Observation regarding the range of basal chordae tendinae in papillary muscles in the present study was in agreement with the work of Balachandra N et al.[3] (0-3 APM, 0-2 PPM, 0-2 SPM). Observations are showing much difference between present study and work done by Kocak A et al.[7] (0-3 APM, 0-5 PPM, 1-6 SPM).and Silver MD et al.[9] (0-3 APM, 0-5 PPM, 0-6 SPM). Possible reason for such difference is the number of specimens studied.

Observation regarding the range of deep chordae tendinae in papillary muscles in the present study was in agreement with the work of Balachandra N et al[3] (0-3 APM, 0-2 PPM, 0-3 SPM). Observations are showing much difference between present study and work done by Kocak

Table 4: Comparison of number of free edge chordaetendinae in papillary muscles

S. No.	Studies	No. cases studied	Range of FE chordae tendinae in papillary muscles		
			APM	PPM	SPM
1	Present study	96	0-4	0-3	0-2
2	Balachandra N[3] et al.	96	0-5	0-5	0-4
3	Kocak A[7] et al.	400	0-2	0-4	0-4
4	Silver MD[9] et al.	50	0-2	0-4	0-4

A et al[7] (0-5 APM, 0-5 PPM, 0-5 SPM) and Silver MD et al.[9] (0-5 APM, 0-5 PPM, 0-4 SPM). Possible reason for such difference is the number of specimens studied.

5. Conclusion

The present study to understand the anatomy of the constituent parts of the tricuspid valve complex not only helped examination of these parts in cross sectional interrogation but also enhanced appreciation of valvular anomalies. Free edge and deep chordae are unique to the Tricuspid valve. The deep chordae seem to provide a second arcade of leaflet attachment which is not found in the mitral valve. Possibly this is needed because of the larger valve annulus and the larger veil of leaflet tissue that descends into the ventricular cavity. Regurgitation is a consequence of deformity, shortening and retraction of one or more leaflets of the Tricuspid valve as well as shortening and fusion of the chordae tendinae and papillary muscles.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

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Author biography

Harsha B R, Assistant Professor

Chandragirish S, Assistant Professor

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