



ORIGINAL RESEARCH PAPER

Anatomy

CLINICAL SIGNIFICANCE OF MORPHOLOGICAL ANALYSIS OF RIGHT CHORDAE TENDINAE IN HUMAN HEARTS

KEY WORDS: Tricuspid valve, papillary muscle, cusp, Right Atrioventricular orifice

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ABSTRACT

To analysis the morphology and morphometric measurement f right chordae tendinae in human hearts .The chordae tendinae of right ventricle are fibrous, collagenous cords supporting the cusps of the atrio-ventricular valves. The approximate measurements of the chordae have to be known because there is always a possibility of over shortening of the chordae during valve replacement procedures which can result in rupture of papillary muscle. The shape, size and attachments of the chordae differ between individuals. However for the purpose of description it would suffice to express that the chordae are extensions between the papillary muscles and the atrio-ventricular valve.

The study was done among 100 human cadaveric heart specimens which were procured from the Department of Anatomy of VMKV Medical College, Salem. The total numbers of chordae tendinae attached to the anterior papillary muscle were higher compared to posterior and septal chordae in right ventricle the difference between number of chorda tendinae of anterior papillary to posterior and septal were from 5 to 13 with a mean of 9 ± 2 . Position of chordal attachment is classified into apical chordal attachment, lateral chordal, marginal attachment. The length of chordae of posterior papillary muscle was ranged from 5.75 to 17.13 mm with a mean of $11.04 \text{mm} \pm 2.80$. The breadth of chordae of right posterior papillary muscle ranged from 0.10 to 0.61 mm with a mean of 0.29 ± 0.15 .

While fixing of valve during replacement even a minimal difference in the measurements will be crucial for effective post-surgical functioning of the valve. Thus these results may be of great value in endoscopic and conventional tricuspid valve replacements or reconstruction of the chordae tendinae and in tricuspid valve homograft implantation.

INTRODUCTION

The atrioventricular valves of both sides of the heart are attached to wall of ventricles through the chordal attachments. Due to continuous process of contraction over a period the papillary muscle fibers tend to undergo wear and tear and sometimes detach themselves from the ventricular walls. In a study performed by Lopez demonstrated the rupture of papillary muscle is commonly caused by a heart infarct and ventricular dysfunction resulting in ischemia and long term complication such as prolapse of atrioventricular valves [1].

The chordae tendinae of right ventricle are fibrous, collagenous cords supporting the cusps of the atrioventricular valves. Adjacent papillary muscles are connected by the walls of ventricle or by the pseudo-chordae tendinae. These papillary muscles connect directly between point on the ventricular wall including the septum they are morphometrically different in dimensions and number [2].

The true chordae usually arise from small projections on the tips or margins of the apical one third of the papillary muscles, but sometimes arise from the bases of the papillary muscles or directly from the ventricular walls and the septum. They are attached to various parts of the ventricle or the free margins of the cusps. They have been classified into first, second and third order chordae according to the distance of the attachment from the margins of the cusps [3].

The chordae tendinae are divided based on the position of their attachment and their point of origin as i. "Commissural type chordae tendinae are attached in and around the commissures. ii. Rough zone chordae arise from the adjoining part of the ventricular valve and interventricular septum. iii. The cleft free marginal chordae arise from the margins of the interventricular septum. iv. The basal chorda tend tend to arise from the smooth part of ventricular wall and are attached to the basal components of a cusp of ventricle. Deep chorda tendinae arise from the floor of the respective ventricles" [3].

Chordal replacement or augmentation with expanded polytetrafluoroethylene suture is a useful technique in the repair of congenitally dysplastic tricuspid valves with abnormal chordal structures. The approximate measurements of the chordae have to be known because there is always a possibility of over shortening of the chordae during valve replacement procedures which can

result in rupture of papillary muscle [4].

The chordae are extensions between the papillary muscles and the atrioventricular valve. Medical conditions like myocardial infarction, myocardial ischemia, cardiomyopathies result in dysfunction of the papillary muscle which in turn leads to valvular disease. The knowledge of morphology and morphometry of chordae is important for surgical replacement and morphometry of chordae is important for surgical replacement and correction of valve [5].

MATERIALS AND METHODS

The descriptive study which was carried out in human cadaveric heart specimens obtained from the Department of Anatomy, VMKV Medical College Salem, Tamilnadu and India. The study was performed after obtaining ethical clearance from the Institutional Review Board and Ethical Committee. The sample size was determined as 100 by using Z test. The equipments utilized for the study were digital vernier calipers hand lens, measuring scale and digital photographic equipment.

The chordal length was measured from the point of origin from the papillary muscle to the point of attachment to the leaflet (fig.1A). The breadth of the chordae was taken at the midpoint of the chordae after measuring the length. The number of chordae was enumerated for anterior, posterior and septal papillary muscles (fig.1B)

Figure: 1 A&B



Figure 1. A. Measurement of length of chordae tendinae
B. Breadth of chordae tendinae
PM- Papillary Muscle

Statistical Analysis

The chordal measurements were subjected to statistical analysis using SPSS software version 16. The standard deviation and mean were calculated. Paired t' test was done to compare the variables.

RESULTS

In the present study the number of chordae tendinae attached to the anterior papillary muscle of the right ventricle ranged from 5 to 13 with a mean of 9±2 .The number of chordal attachment in right posterior papillary muscle ranged from 5 to 8 with a mean of 6±1. The number of chordal attachment to the septal papillary muscle ranged from 2 to 7 with a mean number of 4±1 (table.1).

N=100	Right ventricle papillary muscles		
	Anterior	Posterior	Septal
Mean± SD	09±2	06±1	04±1
Range	05- 13	05- 8	02- 7

POSITION OF CHORDAL ATTACHMENT:

In the present study the position of chordal attachment to the papillary muscles of the right ventricle is as follows: Apical chordal attachment: The position of chordal attachment of right anterior papillary muscle was 21.54 %, posterior papillary was 74.67% and septal papillary muscle was 80.23 %. Lateral chordal attachment: The right anterior papillary muscle was 70.86 %, posterior papillary muscle was 20.34 % and septal papillary muscle was 15.76 %. Marginal chordal attachment: The right anterior papillary muscle was 21.54%, posterior papillary muscle was 4.99% and septal papillary muscle was 4.01% (table 2).

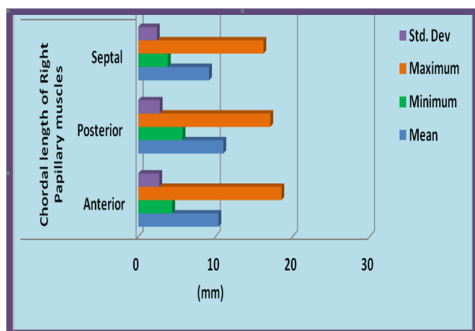
N=100	Right ventricle papillary muscles (%)		
	Anterior	Posterior	Septal
Apical	21.54	74.67	80.23
Lateral	70.86	20.34	15.76
Marginal	7.06	4.99	4.01

LENGTH OF CHORDAE TENDINAE:

In the present study the length of chordae tendinae of right anterior papillary muscle ranged from 4.41 to 18.57 mm with a mean of 10.40 mm ±2.73 and posterior papillary muscle ranged from 5.75 to 17.13 mm with a mean of 11.04mm ±2.80 and septal papillary muscle ranged from 3.85 to 16.24 mm with a mean of 9.19mm ± 2.43 (table .3) & fig.2

N=100 Hearts	Anterior	Posterior	Septal
Mean ± SD	10.40±2.73	11.04±2.80	9.19±2.43
Range	4.41-18.57	5.75-17.13	3.85-16.24

Figure 2. Graph Showing Length of chordae in Right Ventricle



CHORDAL BREADTH

The breadth of chordae of right anterior papillary muscle ranged from 0.06 to 0.89mm with a mean of 0.26 ± 0.15. The breadth of right posterior papillary muscle ranged from 0.10 to 0.61 mm with a mean of 0.29 ± 0.15 and septal papillary muscle ranged from 0.05 to 0.86 mm with a mean of 0.24 ± 0.19.

DISCUSSION

Even though various studies have elaborated on the situation and attachment of chordae, enumerates the length and breadth of chordae from the tilt of papillary muscle to the septal leaflet. These dimensions will give a definitive significance for preserving the chordae in tricuspid valvuloplasty performed for tricuspid valve deficiency. Post surgical competence of the right ventricular function improved after conservation of chordae in patients who underwent tricuspid valvuloplasty [4].

So in the present study number of chordal attachment for anterior papillary muscle was ranging from 5 to 13 with a mean of 9±2.

In a study conducted by Nigri, et al. the mean numbers of five chordae was found attached to the right anterior papillary muscle. In case of the right posterior papillary muscle the mean was three chordae and septal papillary muscle mean number of attachments of chordae was two. In present study the mean is higher when compared with the other two papillary muscles of the right ventricle [6].

In another study which was performed by Skwarek et al., found that the chordae of right posterior papillary muscle, 52.63% of apical chordae were mostly connected directly with the tricuspid valve. There was 38.59% of direct connection of chordae tendinae which was originated from the anterior papillary muscles [7].

In the present study apical attachment of position of chorda tendinae were more in septal papillary muscle 80.23 %. Position of the laterally attached chordae were more in right anterior papillary muscle was 70.86 %, and marginal attached chordae were more in anterior papillary muscle was 21.54%. The percentages of lateral and marginal chordae were more in anterior papillary muscles.

Adam Kosinski et al., have studied the fibrous chordae and measured them with respect to their position and attachments. They also advocated the retention of chordae tendinae in valve replacement surgeries. They also observed that cadaveric measurements is a must for surgeries is involving chordal preservation. When natural chordae is used, it improves the function post surgically. [2]

In the present study apical attachment of position of chorda tendinae were more in septal papillary muscle 80.23 %. Position of the laterally attached chordae were more in right anterior papillary muscle was 70.86 %, and marginal attached chordae were more in anterior papillary muscle was 21.54%. The percentages of lateral and marginal chordae were more in anterior papillary muscles.

The length of the chordae tendinae determined whether the person would be affected by prolapse or not. While affixing an artificial heart valve, optimum fixing of the chordae tendinae should be done to have an effective heart function. Laxity of right chordae tendinae will result in tricuspid valve prolapse syndrome [8].

Many acquired valvular abnormalities can be corrected surgically. If the cusps of a stenosed valve are not unduly deformed, the fused commissures may be divided (commissurotomy). Most cases of valvular incompetence however can be corrected only by replacing the defective valve with an artificial prosthetic valve [9].

In the present study when comparing the breadth of chordae in right posterior papillary muscle chordal breadth was significantly higher (p>0.1) than the right anterior chordal breadth (table.4).

Table: 4 Comparison between the length and breadth of right anterior chordae and posterior chordae Paired Samples 't' Test

	Paired Differences				T	Sig. (2-tailed)	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower			Upper
Breadth of chordae anterior-posterior	-.03150	.19213	.01921	-.06962	.00662	-1.640	.104
Length of chordae anterior-posterior	-.64430	3.64759	.36476	-1.36806	.07946	-1.766	.080

Dissection studies and model reconstructions should be performed prior to any surgical procedures to understand the role of biomechanics and surgical techniques involved in surgical reconstruction of chordae tendineae [10].

CONCLUSION

So the subvalvular apparatus plays an important role in heart valve replacement surgeries of the modern era. While fixing of valve during replacement even a minimal difference in the measurements will be crucial for effective postsurgical functioning of the valve. There is a marginal difference in the measurements between the attachments of the chordae from the papillary muscle to the valve.

In the present study the dimensions of the right posterior papillary muscle chordal breadth was marginally higher than that of right anterior and septal papillary muscle chordae. The length of the chordae of right posterior papillary muscle was slightly higher than that of the rest of the chordae.

Thus these results may be of great value in endoscopic and conventional tricuspid valve replacements or reconstruction of the chordae tendinae and in tricuspid valve homograft implantation.

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