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Original Research Articel

Morphometric study on papillary muscles of human tricuspid valve-dissection method

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ABSTRACT

Background: Aim of the present study was to observe the measurements of anterior papillary muscles present in tricuspid valve of human heart. Measurements of anterior papillary muscles in tricuspid valve gains utmost importance in cardiac surgeries because they are the causes of myocardial infarction in recent times because of its variations and detection of these causes by advent in modern technologies which will help in treatment of tricuspid valve diseases.

Materials and Methods: This study was carried out on 96 normal formalin fixed human heart specimens. Dissection was performed according to standard techniques. Anterior papillary muscles were observed and length, width and thickness of each muscle were measured and documented.

Results: In the present study, numbers of anterior papillary muscles were present with a frequency of 1-3, with most common appearance of 1 muscle in 66 hearts (68.8%) and least common incidence of 3 muscles in 6 hearts (6.3%). Anterior papillary muscles were present in all 96 hearts. In measurements, anterior papillary muscles mean height was 1.49±0.44 cm; mean width was 0.82±0.21 cm and mean thickness was 0.64±0.15 cm respectively.

Conclusion: We hope this study will serve to understand the morphometry of anterior papillary muscles better and will help in various surgical procedures and cardiac treatment done on tricuspid valve.

1. Introduction

The anatomy of the every part of the human body has its own significance in the surgical field of medicine and detailed information about the structure will always help in the better outcome of the surgery. One such structure which has been given much importance is the anatomy of Tricuspid Valve. The surgery of the tricuspid valve especially involving the its papillary muscle is considered to be one of the most important and fascinating structure. The knowledge of the tricuspid valve will help in the better outcome of the cardiac patients.

The various structure which are present at both the right and left ventricles has its own significance and importance in the valvular movements in the cardiac cycle. At the each AV junction consists of an orifice along with the annulus, the cups, papillary muscle and chordae tendinae which acts as a supporting structure.

The presence of Tricuspid Value at the AV junction has its own importance in the cardiac cycle which has six major parts consists of Annulus, Chordae Tendinae, Papillary Muscle, Right atrial Wall along with the three leaflets of the valve and supported by the free wall of the right ventricle.

The functions of the cardiac cycle is also regulated by the function and action of the tricuspid valve. All the above mentioned parts of the Tricuspid value should work in harmony and together along with the atrial and ventricular masses which further depends upon the conducting tissue and the fibro elastic nature of cardiac muscle which acts as

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mechanical Cohesion.

All these parts regularly and substantially keep changing its position, dimension, shape and angulation in each of the cardiac cycle for complete cardiac cycle.

A small group of muscles called papillary muscles are present in the ventricular wall and are attached to the valve cusps by chordae tendinae. These muscles contract and helps to prevent the invert or prolapse of valve. There are 2 major and 1 Minor papillary Muscle in the right ventricle.

The position of major Papillary muscle is anterior and posterior to each other. The position of the minor papillary muscle is of medical importance because of its position with several smaller and variable muscles which are attached to the ventricular septum.

The anterior papillary muscle is the largest muscle which arises from the right Anterolateral ventricular wall located below the anteroom inferior commissure to the inferior leaflet. Further it also merges with the septomarginal trabeculae on the right side.

The posterior Papillary muscle is usually bifid or trifid and arises from the Myocardium below the inferoseptal commissure and is usually irregular. [1]

2. Materials and Methods

The present study was conducted at Chamarajanagara Institute of Medical Sciences, Chamrajanagara from June 2016 to December 2018. A total of 95 human hearts which were formalin fixed from the patients who died due to non-vascular causes were dissected and studied.

The present study was done on the all the specimen and were not grouped based on the age and gender of the patients.

The dissection of the tricuspid valve was done by scalpel knife passing through right atrium to the apex of the right ventricle along the lateral or acute margin of Ventricle as per the standard dissection protocol. The Interior of the heart was washed to remove the blood clots and second cut was done along the anterior surface of the heart left to intra ventricular groove from the apex of the ventricle to annulus without damaging the papillary muscle and each muscle were measured using Vernier Callipers and documented.

The data was entered in excel and analysed using SPSS V 21. The descriptive Statistics were expressed in the form of Frequency, mean and Standard Deviation.

3. Observations and Results

The number of papillary muscle present in our study was in the range of 3-9. In one of the specimen we saw 9 papillary muscle and minimum of 3 muscle was seen in 3 specimens (3.1%).

The anterior and Posterior Papillary muscle was seen in all the 96 study subjects in our study.

Among the anterior Papillary muscle maximum of 3 muscles were seen in 6 specimens (6.3%) and only one muscle was seen in 66 study specimens (66.8%) which was considered to be normal. In the remaining 24 study specimens two papillary muscle were visible (25%).

Among the posterior papillary muscle Seven papillary muscles were observed in only 1 (1%) heart and only 1 papillary muscle was seen in 27 (28.1%) hearts. Septal papillary muscles were present in 73 hearts (76.1%). Maximum numbers of papillary muscles were 2 seen in 6 (6.3%) hearts and minimum number of muscles was only 1 seen in 67 (69.8%) hearts. In 29 hearts (30.2%) four papillary muscles were observed with a combination of 1 anterior, 2 posteriors and 1 septal papillary muscle.

The mean height of the anterior papillary muscle was 1.49+0.44 cm and mean width was 0.82+0.21 cm and the thickness was 0.64 +0.15 cm respectively.

In septal papillary muscle mean height was 0.7±0.22 cm, mean width was 0.48±0.16 cm and mean thickness was 0.34±0.12 cm respectively and posterior papillary muscle mean height was 1.05±0.37 cm, mean width was 0.63±0.17 cm and mean thickness was 0.5±0.11 cm respectively.

4. Discussion

The papillary muscle and the chordae tendinae present in the right ventricle varies in the size, shape and length which is of very much significant clinical importance since the papillary muscle in the right ventricle plays an important role by helping in contraction of the right ventricle by drawing the tricuspid valve towards the apex and causing the shortening of the long axis and the chamber becomes spherical which helps in ejecting the blood. [2]

Observation regarding the percentage of papillary muscles in the present study was in agreement with the work of Nigiri GR et al. Other works by Balachandra N et al., Wafae N et al. and Motabagani MAB are also in agreement with the present study but, percentage of septal papillary muscles noted in present study was 95.8% which was different in above mentioned studies. Possible reason for such difference is the number of specimens studied.

Significant difference was observed between the present study and the study done by Begum et al. possible reason for such difference is the number of specimens studied.

There was minimal difference noted in the present study and work done by Gerola LR et al., regarding incidence of percentage of both posterior papillary muscles and septal muscles. Possible reason for such difference is the number of specimens, geography and race of specimens studied.

In the present study all the papillary muscles were measured for height, width and thickness. Mean height of APM was 1.49 cm ranged between 0.6 cm to 2.9 cm, mean width was 0.8 cm ranged between 0.3 cm to 1.4 cm and mean thickness was 0.64 cm ranged between 0.2 cm and 1 cm. Mean height of PPM was 1.05 cm ranged between

Table 1: Comparison of incidence of papillary muscles

S. No.	Studies	Number of Specimens	Percentage of papillary muscles		
			APM	PPM	SPM
1	Present study	96	100%	100%	95.8%
2	Balachandra N[3] et al.	96	100%	100%	100%
3	Gerola LR[4] et al.	50	100%	84%	100%
4	Nigri GR[5] et al.	50	100%	100%	78.5%
5	Motabagani MAB[6]	10	100%	100%	100%
6	Begum[7] et al.	50	92%	60%	76%
7	Wafae N[8] et al.	50	100%	100%	100%

Table 2: Comparison of measurements of papillary muscles

S. No.	Studies	No. cases studied	Measurements of papillary muscles (cm)								
			Mean height			Mean width			Mean thickness		
			APM	PPM	SPM	APM	PPM	SPM	APM	PPM	SPM
1	Present study	96	1.49±0.4	1.05±0.4	0.7±0.2	0.8±0.2	0.6±0.2	0.5±0.2	0.6±0.2	0.5±0.1	0.3±0.2
2	Gerola LR[4] et al.	50	0.9±0.2	0.9±0.2	1.1±0.3	1.2±0.3	0.7±0.2	1.2±0.3	-	-	-
3	Nigri GR[5] et al.	79	1.9	1.1	0.6	-	-	-	-	-	-

0.3 cm to 3.3 cm, mean width was 0.6 cm ranged between 0.2 cm to 1.2 cm and mean thickness was 0.5 cm ranged between 0.2 cm and 0.8 cm. Mean height of SPM was 0.7 cm ranged between 0.3 cm to 1.3 cm, mean width was 0.5 cm ranged between 0.2 cm to 0.8 cm and mean thickness was 0.3 cm ranged between 0.2 cm and 0.7 cm. So, anterior papillary muscle is the largest muscle followed by posterior and septal muscles. Comparison of this observation with other studies is as follows (Table 2).

Observations of mean height was significantly higher in anterior and posterior papillary muscles and minimally lower significant in septal papillary muscles, same way observations of mean width was significantly lower in anterior and septal papillary muscles compared to study done by Gerola LR et al. Possible reason for such difference is the number of specimens studied.

The observations of mean height of papillary muscles were in agreement with work done by Nigri GR et al. But none of the above mentioned authors commented about thickness of the papillary muscles.

5. Conclusion

From the present study we were able to analyse and understand the anatomy of the tricuspid valve complex and improved the knowledge of valvular anomalies. In few of the Congenital anomalies like ebsteins disease and Severe Tricuspid Regurgitation the prior knowledge about the anatomy and structure of the papillary muscle helps in planning the corrective treatment.

The prolapse of the leaflets occurs due to variation in the number, size and shape of the leaflets. 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 papillary muscles.[9,10]

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

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