Morphometric Study on Anterior Papillary Muscles of Human Tricuspid Valve

Harsha B. R.[1*], Dakshayani K .R.[2#]

[1]Assistant Professor, Department of Anatomy, DM WIMS, Meppadi, Kerala, INDIA.

[2]Professor and Head, Department of Anatomy, MMC and RI, Mysore, Karnataka, INDIA.

[*]Corresponding Addresses:

[*]harsha.charlie@gmail.com, [#]dakshayanikr@gmail.com

Research Article

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.

Keywords: Tricuspid valve, papillary muscle, morphometry

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 morphometry of anterior papillary muscles 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:

1. Right atrial wall
2. Annulus
3. Three leaflets
4. Chordae tendinae
5. Papillary muscles
6. 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 papillary muscles were small muscle groups which were present in ventricular wall and attached to cusps of valve by chordae tendinae. They contract to prevent invert or prolapse of valve. There are 2 major and 1 minor papillary muscle in the right ventricle. The major papillary muscles are located in the anterior and posterior positions. The minor papillary muscles have a medial position along with several smaller and variable muscles attached to the ventricular septum. Anterior papillary muscle is the largest muscle arising from the right anterolateral ventricular wall below the antero-inferior commissure of the inferior leaflet and it also blends with the right end of the septomarginal trabeculae. All the anterior papillary muscles supply the chordae to adjacent components of the leaflets they support. The septomarginal trabeculae (moderator band) is more or less isolated trabeculae of the bridge type, which extends from the interventricular septum to the base of the anterior papillary muscle in the lower part of the ventricle. It contains conducting myofibers from the right limb of the atrioventricular bundle.[1]

Materials and Methods

The study was carried out on 96 formalin fixed human hearts from patients who had died of non-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. Each muscle were measured by using Vernier callipers and documented. The data were summarised using descriptive statistics like frequency (number of papillary muscles), mean, standard deviation, range and 95% confidence interval (measurement of papillary muscles). All the statistical calculations were performed using software SPSS for windows {Statistical Package for Social Service (SPSS) Inc, 2004, New York} version 13.0.

Observations and Results

In the present study, anterior papillary muscles were present in all 96 (100%) hearts with a frequency of 1-3. Maximum numbers of papillary muscles were 3 seen in 66 hearts (68.8%) and minimum numbers of papillary muscle were 1 seen in 6 hearts (6.3%). 2 papillary muscles were seen in remaining 24 hearts (25%). In measurements of papillary muscles, anterior papillary muscle 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.

Discussion

The number, length and shape of papillary muscles and chordae tendinae in the right ventricle are variable. This can be of clinical significance, since the papillary muscles play an important role in right ventricle contraction by drawing the Tricuspid annulus towards the apex, thereby causing shortening of the long axis and the chamber becoming spherical for ejecting blood.[2]

Table 1: Comparison of incidence of anterior papillary muscles

Sl. No.	Studies	No. cases studied	Percentage of Anterior papillary muscles
1	**Present study**	**96**	**100%**
2	Balachandra N[3] *et al.*	96	100%
3	Gerola LR[4]*et al.*	50	100%
4	Nigri GR[5] *et al.*	50	100%
5	Motabagani MAB[6]	10	100%
6	Begum[7] *et al.*	50	92%
7	Wafae N[8] *et al.*	50	100%

Observation regarding the percentage of papillary muscles in the present study was in agreement with the work of all the eminent workers except Begum *et al*. Possible reason for such difference is the number 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.

Comparison of this observation with other studies is as follows:

Table 2: Comparison of measurements of anterior papillary muscles

Sl. No.	Studies	No. cases studied	Measurements of Anterior papillary muscles (cm)		
			Mean height	Mean width	Mean thickness
1	**Present study**	**96**	**1.49±0.4**	**1.05±0.4**	**0.7±0.2**
2	Gerola LR[4] *et al.*	50	0.9±0.2	0.9±0.2	1.1±0.3
3	Nigri GR[5] *et al.*	79	1.9	1.1	0.6

Observations of mean height and mean width was significantly higher in anterior papillary muscles compared to study done by Gerola LR *et al.* Possible reason for such difference is the number of specimens studied. With other worker results are in agreement with slight variations. Possible reason for this may be number of specimen studied. Anatomical variations of papillary muscles would be useful in newer surgical techniques like papillotomy and commissurotomy in rheumatic lesions, leaflet resection in advanced myxomatous lesions, excision of infective vegetation, transfer and rotation of leaflet segments in traumatic conditions and in correction of papillary rupture induced Tricuspid regurgitation. Tricuspid valve in congenital anomalies like Ebstein's malformations, dysplasia, straddling is complicated because the tendinous chords and papillary muscles are often abnormally short and thick. So knowledge of a detailed morphology of anterior papillary muscle is more and more necessary for cardiothoracic surgeries of these conditions.[9]

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. Knowledge regarding high variability of papillary muscles in the valve is helpful in corrective treatment of congenital disease like Ebstein's disease and severe functional Tricuspid regurgitation. Any variation in the attachments of muscle and their number, size and shape or their absence may cause prolapse 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.[10]

References

1. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, et al. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th ed. Philadelphia: Churchill Livingstone Elsevier; 2008. pp. 966-7.
2. Hashimoto K, Oshiumi M, Takakuva H, Sasaki T, Onoguchi K. Congenital mitral regurgitation from absence of the anterolateral papillary muscle. Ann Thorac Surg 2001;72:1386-7.
3. Balachandra N, Rathnam BPP. A Study of the dimensions of the Human Tricuspid valve and attachmentofchordaetendinae. http://www.rguhs.ac.in/digitallibrary/hardbibilo/medical-doc. Accessed on 20-7-2011 at 2.40 pm
4. Gerola LR, Wafae. N, Vieira MC, Juliano Y, Smith R, Prates JC. Anatomic study of the Tricuspid valve in children. Surg Radiol Anat 2001;23:149-53.
5. Negri GR, Didio LJA, Baptista CAC. Papillary muscles and tendinous chords of the right ventricle of the human heart morphological characteristics. Surg Radiol Anat 2001;23:45-9.
6. Motabagani MAB. Comparative, morphometric and histological studies of the Tricuspid valve complex in human and some mammalian hearts. J Anat Soc India 2006;55(1):1-23.
7. Begum JA, Khalil M, Rahman H, Adiluzzaman AA. A morphological and morphometric study of the right ventricular papillary muscles of autopsied heart of Bangladeshi people. Mymensingh Medical Journal 2006;15(2):131-4.
8. Wafae. N, Hayashi. H, Gerola LR, Vieira MC. Anatomical study of the human Tricuspid valve. Surg Radiol Anat 1990;12:37-41.
9. Joudinaud TM, Flecher EM, Duran CMG. Functional terminology for the Tricuspid valve. J Hear Valve Dis 2006 May;15(3):382-8.
10. Ootaki Y, Yamaguchi M, Yoshimuva N, Oka S, Yoshida M, Hasegawa T. Tricuspid valve repair with papillary muscle shortening for severe Tricuspid regurgitation in children. Ann Thorac Surg 2004;78:1486-8.