A Morphological And Morphometric Study Of Right Ventricular Papillary Muscles In North Indian Region

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Abstracts: Background & Objective: Aim of present study was morphological and morphometric observation of papillary muscles of tricuspid valve of human heart. Methodology: This study was carried out in 36 human (24 males and 12 females) heart from adult cadavers, which were dissected according to standard technique. All papillary muscles were observed for their shapes, numbers and dimensions in centimeters. Data were tabulated and statistical comparison were done using "chi square" and "z" test. Results: The average length of anterior, posterior and septal papillary muscle was 1.42 ± 0.29 cm, 0.94 ± 0.23 cm and 0.18 ± 0.08 cm while average breadth of anterior, posterior and septal papillary muscle was 0.41± 0.12 cm, 0.29± 0.09 cm and 0.11± 0.01 cm respectively. The anterior papillary muscles presented 1 head in 27.78% and 2 heads in 25%, while posterior papillary muscles presented 1 head in 27.78% and 2 heads in 25%. All the septal papillary muscles presented with 1 head. Single anterior papillary muscle was found to be 97.22% while posterior papillary muscle was found to be single in 72.28% and double in 27.78. Septal papillary muscle was found to be single in 25% cases and absent in 38.89% cases. Conclusion: Data obtained from this study might be helpful for reparative surgical procedures of tricuspid valve.

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Key Words: anterior papillary muscle, tricuspid valve, posterior papillary muscle, septal papillary muscle, morphometry of papillary muscles.

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Introduction: Papillary muscles are conical projection of the ventricular muscle, the apices which afford the attachment to the chordae tendineae. Papillary muscles play an important role in right ventricular contraction by drawing tricuspid annulus towards the apex. In the right ventricle, three types of papillary muscle are present. These are anterior papillary muscle (APM), posterior papillary muscle (PPM) and septal papillary muscle (SPM). Anterior papillary muscle is largest amongst all, which arises from right antero-lateral ventricular wall. Septal papillary muscle is smallest but typical and arises from the posterior septal limbs of septomarginal trabeculae. Posterior papillary muscle arises from the myocardium below the infero-septal commissure and it is frequently bifid or trifid[1]. Chordopapillary variations of right ventricles have been reported by Silver et al[2], Acar et al[3] and Wafe et al [4] Papillary muscles and chordae of right ventricle show variations in their number, shape and location[5]. These variations have been correlated with age and race and were classified by Setzer et al[6]. Present study includes a detailed morphological and morphometrical examination of papillary muscles of right ventricles in hearts from north Indian region in both sex. These findings provide detailed information of anatomical characteristics of papillary muscles of right ventricle, which can be of clinical, racial and surgical importance like in reparative procedures.

Material and Methods: This study was carried out in the Department of Anatomy in SMIMS, Gangtok; Government Medical College, Jalaun (Orai) and RMCH, Bareilly on 36 human hearts from the adult cadavers of known sex which were died of natural cause. The study population consists of 12 hearts from female cadavers and 24 hearts from male cadavers. Each heart was dissected by giving incision near right atrioventricular sulcus to the apex of the right ventricle along its right lateral margin, followed by its extension in anterior interventricular groove. After opening, each heart was washed under the tap water to remove the blood clots. The morphometric and morphological parameters of the papillary muscle of the right ventricle evaluated were length, breadth, number and shapes (viz. conical/single headed, flat topped and bifurcated/ double headed) of

the anterior, posterior and septal papillary muscle. **(Fig.-1, 2, 3)** Findings were tabulated followed by statistical comparison between two sexes using 'chi-square' test and 'z' test and important inferences were drawn.

Figure 1: Measurement of Papillary Muscle Using Vernier caliper

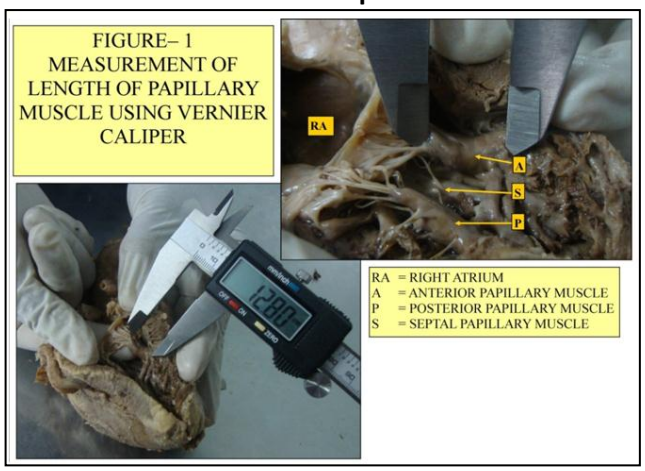


Figure 2: Shapes Of Papillary Muscles- Conical and Flat Topped Papillary Muscles

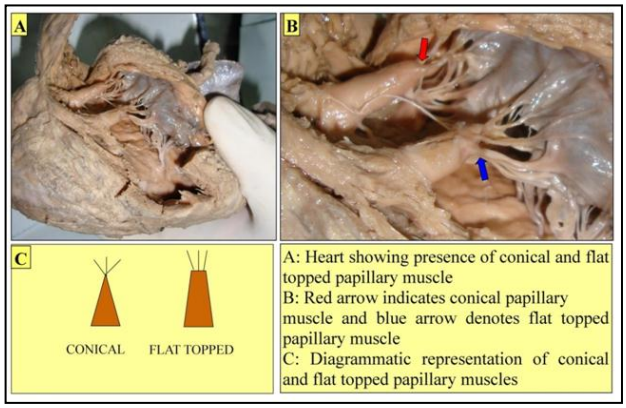
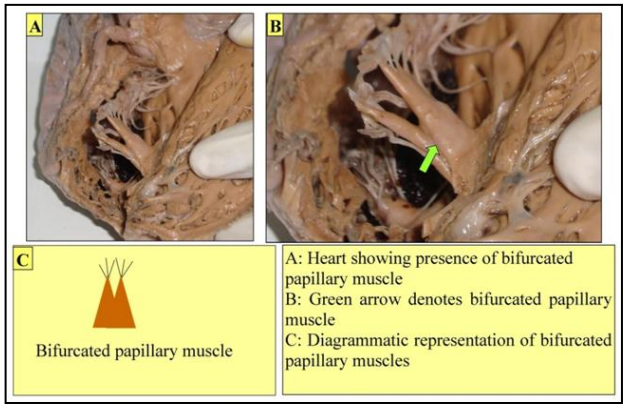


Figure 3: Shapes of Papillary Muscles- Bifurcated Papillary Muscle



Results: Regarding the morphometry of papillary muscles, significant differences were found between length of anterior and septal papillary muscles between males and females. **(Table-1)**

Regarding the shape of papillary muscles, flat topped papillary muscles of right ventricle were commonest amongst anterior and posterior papillary muscles in both sexes. Conical (single headed) papillary muscles of right ventricle were found to be commonest amongst septal papillary muscles in both sexes. **(Table-2)**

Bifurcated (double headed) papillary muscles were least common type of papillary muscles in right ventricle in males, while conical (single headed) papillary muscles were least common type of papillary muscles in right ventricle in females. **(Table-2)**

In most of the instances, anterior as well as posterior papillary muscles of right ventricle were single in both sexes. Septal papillary muscles were found to be absent in most of the males, while in case of females, single septal papillary muscles were quite common in right ventricle. **(Table-3)**

Table 1: Morphometry of papillary muscles and comparison between genders

	Anterior papillary muscle		posterior papillary muscle		Septal papillary muscle	
	Length in cm.	Breadth in cm.	Length in cm.	Breadth in cm.	Length in cm.	Breadth in cm.
Males mean ± SD)	1.54 ± 0.27	0.42 ± 0.11	0.97 ± 0.25	0.30 ± 0.09	0.21 ± 0.1	0.11 ± 0.01
Range	1.10 - 2.00	0.20 - 0.60	0.60 - 1.50	0.20 - 0.60	0.15 - 0.30	0.1 - 0.13
Females mean ± SD)	1.17 ± 0.13	0.35 ± 0.14	0.88 ± 0.17	0.26 ± 0.08	0.15 ± 0.032	0.11 ± 0.013
Range	0.90 - 1.30	0.20 - 0.60	0.60 - 1.20	0.20 - 0.40	0.10 - 0.20	0.1 - 0.13
Statistical result	Z = 5.55 S	Z = 1.514 NS	Z= 1.271 NS	Z= 1.355 NS	Z= 1.961 S	Z= 0 NS

(S = Significant, NS= Not significant)

Table 2: Distribution of shape in three muscle groups

Shapes	Anterior papillary muscle		Posterior papillary muscle		Septal papillary muscle[#]	
	M	F	M	F	M	F
Conical/ single headed	8	2	8	2	12	10
Flat topped	10	7	10	7	0	0
Bifurcated/ double headed	6	3	6	3	0	0
	X^2=1.26 p>0.05 NS		X^2=1.26 p>0.05 NS		X^2=0 p>0.05 NS	

([#]Septal papillary muscle was absent in 14 hearts, M = Male, F = Female, NS= Not significant)

Table 3: Number of papillary muscles

Number	Anterior papillary muscle		Posterior papillary muscle		Septal papillary muscle	
	M	F	M	F	M	F
	(n =24)	(n =12)	(n =24)	(n =12)	(n =24)	(n =12)
0	0	0	0	0	12*	2*
1	23	12	19	7	2	7
2	0	0	5	5	2	2
3	1	0	0	0	7	1
4	0	0	0	0	1	0
5	0	0	0	0	0	0
	X^2=0.50 p>0.05 NS		X^2=0.51 p>0.05 NS		X^2=12.85 p<0.01 Significant	

(* = absent, NS= not significant, n= number of specimen, M = Male, F = Female)

Discussion: The average length of anterior papillary muscle was found to be 1.42± 0.29 cm, ranging from 0.9 cm to 2.0 cm **(Table-1)**. Harsha BR et al[7]noted average length of anterior papillary muscle was 1.49± 0.4 cm, ranging from 0.6 cm to 2.9 cm. The average breadth of anterior papillary muscle was 0.41± 0.12 cm, ranging from 0.2 cm to 0.6 cm **(Table-1)**. Harsha BR et al[7] noted average breadth of anterior papillary muscle was 1.05± 0.4 cm, ranging from 0.3 cm to 1.4 cm. Average length and breadth of anterior papillary muscle was found to be 1.9 cm and 1.1 cm respectively by Nigri et al[5].

The average length of posterior papillary muscle was found to be 0.94± 0.23 cm, ranging from 0.6 cm to 1.5 cm **(Table-1)**. Average length of posterior papillary muscle was found to be 1.15 cm by Nigri et al[5]. The average breadth of posterior papillary muscle was 0.29± 0.09 cm, ranging from 0.2 cm to 0.6 cm **(Table-1)**.

The average length of septal papillary muscle was found to be 0.18± 0.08 cm, ranging from 0.1 cm to 0.3 cm **(Table-1)**. Harsha BR et al[8] noted average length of septal papillary muscle was 0.7± 0.2 cm, ranging from 0.3 cm to 1.3 cm. The average breadth of septal papillary muscle was 0.11± 0.01 cm, ranging from 0.1 cm to 0.13 cm **(Table-1)**. Harsha BR et al[8] noted average breadth of septal papillary muscle was 0.5± 0.2 cm, ranging from 0.2 cm to 0.8 cm. Average length of septal papillary muscle was found to be 0.6 cm by Nigri et al[5].

In the present study anterior and posterior papillary muscles were present in all the cases **(Table-2, 3)** similar to the finding of Nigri et al[5]. Anterior papillary muscles were found to be present in all cases in the study of Wafae et al[4],Harsha BR et al[7], Priya P et al[9], Gerola et al[10] and Motabagani MAB et al[11], while Begum et al[12]found that anterior papillary muscles were absent in 8% cases.

Septal papillary muscles were found to be absent in 38.8% cases (33.3% males, 5.5% females). **(Table-2, 3)** In the study of Nigri et al[5], they found that septal papillary muscles were absent in 21.5% cases, while Begum et al[12]found that septal papillary muscles were absent in 24% cases. Harsha BR et al[8] found that 4.2% heart showed absence of septal papillary muscles. Septal papillary muscles were found to be present in all cases in the study of Wafae et al[4], Gerola et al[10] and MotabaganiMAB et al[11].

The anterior papillary muscles presented 1 head (conical shape) in 27.78% and 2 heads (bifurcated shape) in 25% **(Table-2)**, while Nigri et al[5]found 1 head in 81% and 2 heads in 19% of anterior papillary muscles. The posterior papillary muscles presented 1 head (conical shape) in 27.78% and 2 heads (bifurcated shape)

in 25% **(Table-2)**, while Nigri et al[5]found 1 head in 25.4% and 2 heads in 46.8% of posterior papillary muscles. In this study there was no anterior or posterior papillary muscle which showed ≥3 heads **(Table-2)**. Nigri et al[5]even found 3 heads in 21.5% and 4 heads in 6.3% of posterior papillary muscles.

All the septal papillary muscles presented with 1 head **(Table-2)**, while Nigri et al[5]found 1 head in 41.7%, 2 heads in 16.5%, 3 head in 12.7% and 4 head in 7.6% of septal papillary muscles.

In the present study, single anterior papillary muscle was found to be 97.22% **(Table-3)**, while Begum et al[12] found single anterior papillary muscle in 92% cases in right ventricle. The posterior papillary muscle was found to be single in 72.28% and double in 27.78% **(Table-3)**, while in study of Begum et al[12]posterior papillary muscle was single in 28% and double in 32% cases. Septal papillary muscle was found to be single in 25% cases and absent in 38.89% cases **(Table-3)**, while in study of Begum et al[12] septal papillary muscle was single in 46% cases and absent in 30% cases.

Conclusion: These findings provide detailed information of anatomical characteristics of papillary muscles of right ventricle from North Indian region and compares the same with the data of different global regions, which can be of clinical, racial and surgical importance like in reparative procedures.

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