

# Morphometric features of Papillary Muscles in Both Ventricles of Heart: A Cadaveric Study from Tamil Nadu

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## Abstract

**Background:** The papillary muscles are crucial to keep the ventricles from overextending because they pull the atrioventricular valve annulus towards its apex. A better understanding of valvular function and diagnosing and treating valve prolapse or regurgitation depends on understanding the anatomical pattern of chordae tendineae and papillary muscles. **Material and Methods:** This study was a cadaveric study conducted in the Department of Anatomy, Government Stanley Medical College, Chennai. The study included 50 hearts collected from embalmed cadavers fixed in 10% formalin. **Results:** The left ventricle typically contains fewer but larger papillary muscles, while the right ventricle tends to have more and comparatively smaller papillary muscles on average. In the present study, we observed that distinct differences in papillary muscle shape, size, and attachment between the ventricles, with the right ventricle showing more cylindrical papillary muscles and a broader distribution of septal muscle attachment sites as compared to the left ventricle. **Conclusion:** In addition to helping cardiothoracic surgeons during corrective cardiac surgeries, a thorough understanding of the normal structure and possible variations of papillary muscles is essential for the timely diagnosis of different cardiac abnormalities. Knowing how to handle conventional and atypical valvular appearances is equally crucial for anatomists, physiologists, and cardiologists.

**Keywords:** Papillary muscle, left ventricle, morphology, right ventricle, variations, chordae tendineae.

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## INTRODUCTION

The papillary muscles are specialized cardiac elements in the valvular complex. They are found in the heart's ventricles. These papillary muscles are cone-shaped muscle projections linked to the ventricle's wall. The papillary muscles start to contract before the ventricles do. This tightens the tendinous cords (Chordae Tendinae) that come from the tops of the papillary muscles and pulls the cusps together. The cords stop the cusps from separating and turning upside down because they are linked to the sides of two neighboring cusps.<sup>[1]</sup>

The papillary muscles are particularly important because they pull the atrioventricular valve annulus toward its apex, which stops the ventricles from getting too long. The right ventricle's anterior papillary muscle (APM) is the biggest, while the posterior or inferior papillary muscle (PPM) is often split into two or three halves. The septal papillary muscle (SPM) is tiny and the smallest among the three papillary muscles. The left ventricle's two papillary muscles that support the mitral valve's cusps may vary in width and length, and may even be split into two. The papillary muscle and its chordae regulate the AV valve's closure during systole.<sup>[2,3]</sup>

The chordae tendineae and papillary muscles vary in length, form, and quantity. Since the papillary muscles are crucial for the contraction of the right ventricle and the closing of the tricuspid valve, which stops ventricular blood from returning to the right atrium, this may be clinically important.

Congenital variations commonly cause mechanical trauma, which leads to tricuspid valve lesions, leading to a significant reduction in the functional capacity of the heart.<sup>[4-6]</sup>

The importance of chordo-papillary alterations in rheumatic heart disease, reparative measures, papillary muscle dysfunction, and mitral valve prolapse is documented in the published literature that is currently available. And replace the mitral/tricuspid valve with mitral valve grafts. Scientists have noted variations in the papillary muscles' quantity, composition, and location in the right ventricle.<sup>[7-12]</sup>

Little information is available on the anatomical differences of the heart's papillary muscles. This knowledge greatly benefits the treatment of papillary muscle dysfunction and valve prolapse or regurgitation. The present research examined the morphometric characteristics of the papillary muscles in both of the heart's ventricles.

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**MATERIALS AND METHODS**

This institution-based cadaveric study was conducted in the Department of Anatomy, Government Stanley Medical College, Chennai, using the conventional dissection method for the past 3 years. The study included 50 human hearts obtained from embalmed cadavers fixed in 10% formalin meant for the first M.B.B.S. students. Ethical committee approval was obtained from the Institutional Ethical Committee, Stanley Medical College, Chennai. The research eliminated specimens with coronary artery disease, cardiomyopathy, valvular abnormalities, enlarged hearts, and deformities that could be seen upon examination. Dissection of the heart was done according to the Cunningham manual of practical anatomy.<sup>[13]</sup> After exposure, the papillary muscles were observed for number and shape. The length and number of the additional heads were measured and recorded. The shape of the papillary muscles was classified as conical or flattened. The attachment of the papillary muscles was categorized as the upper, middle, or lower third. The data was then entered and analyzed using SPSS version.<sup>[14-16]</sup>

**RESULTS**

Fifty adult human hearts were used in the present cadaveric investigation to examine the anatomy of the papillary muscles. Of the hearts examined, 15 came from male cadavers and 35 from female cadavers. [Table 1] The size and quantity of papillary muscles in the left and right ventricles were contrasted. We found that the left ventricle most often contained three papillary muscles (40%), followed by two (30%), five (22%), seven (6%), and six (2%). In contrast, the right ventricle most frequently has four papillary muscles (36%), followed by 3 (24%), 5 (18%), 6 (10%), 7 (8%), and 8 (4%). Regarding the length of the papillary muscles, the mean lengths ( $\pm$  SD) for the right anterior, right posterior, septal, left anterior, and left posterior muscles are  $14.96 \pm 3.2$  mm,  $13.14 \pm 2.37$  mm,  $9.56 \pm 1.86$  mm,  $17.22 \pm 3.46$  mm, and  $17.54 \pm 3.78$  mm, respectively.

The corresponding mean breadths ( $\pm$  SD) are  $6.32 \pm 1.9$  mm,  $5.52 \pm 1.19$  mm,  $3.64 \pm 0.69$  mm,  $8.38 \pm 1.76$  mm, and  $8.06 \pm 1.78$  mm. This data reveals that the left ventricle typically contains fewer but larger papillary muscles, while the right ventricle tends to have more and somewhat smaller papillary muscles on average. [Table 2]

In [Table 3], the anterior papillary muscle in the left ventricle is mostly conical (45%) and wide apexed (5%). In contrast, the posterior papillary muscle is primarily cylindrical (27%), conical (28%), and broad apexed (14%). In every specimen, the right ventricle's anterior papillary muscle was conical. The right ventricle's septal papillary muscle was conical (100%), whereas the posterior papillary muscle was mostly cylindrical (98%), with a small percentage of conical kinds (2%). The average size of the papillary muscles was  $7 \pm 2$  mm for the left anterior,  $12 \pm 2$  mm for the left posterior,  $8 \pm 2$  mm for the right anterior,  $5 \pm 1$  mm for the right posterior, and  $3 \pm 1$  mm for the septal.

[Table 4] shows that attachments of the anterior papillary muscle in the left ventricle primarily occur at the middle third region (74%), with lesser attachments in the upper (16%) and lower thirds (10%) of the septum. The posterior papillary muscle in the left ventricle primarily occurs at the middle third region (80%), with lesser attachments in the upper (12%) and lower thirds (8%) of the septum. In the right ventricle, the anterior papillary muscle primarily occurs at the middle third region (86%), with lesser attachments in the lower (6%) and upper thirds (8%) of the septum. The posterior papillary muscle in the right ventricle primarily occurs at the middle third region (80%), with lesser attachments in the upper (16%) and lower thirds (4%) of the septum. In the right ventricle, the septal papillary muscle attachments were predominantly in the upper thirds (58% followed by the middle and lower thirds in the observed specimens. This data indicates distinct differences in papillary muscle shape, size, and attachment between the ventricles, with the right ventricle showing more cylindrical papillary muscles and a broader distribution of septal muscle attachment sites compared to the left ventricle.

**Table 1: Gender distribution of the observed specimens (n=50)**

Gender	Frequency (n=50)	Percentage (%)
Male	35	70
Female	15	30

**Table 2: Papillary muscle characteristics among the observed specimens (n=50)**

Parameters	Left Ventricle n (%)	Right Ventricle n (%)
Number of Papillary Muscles		
2	15 (30)	0 (0)
3	20 (40)	12 (24)
4	0 (0)	18 (36)
5	11 (22)	9 (18)
6	1 (2)	5 (10)
7	3 (6)	4 (8)
8	0 (0)	2 (4)
Papillary Muscle	Length (Mean $\pm$ SD) (mm)	Breadth (Mean $\pm$ SD) (mm)
Right Anterior	$14.96 \pm 3.20$	$6.32 \pm 1.90$
Right Posterior	$13.14 \pm 2.37$	$5.52 \pm 1.19$
Septal	$9.56 \pm 1.86$	$3.64 \pm 0.69$
Left Anterior	$17.22 \pm 3.46$	$8.38 \pm 1.76$
Left Posterior	$17.54 \pm 3.78$	$8.06 \pm 1.78$

**Table 3: Papillary muscle characteristics (Shape and Chordal Attachments) among the observed specimens (n=50)**

Parameters	Left Ventricle n (%)		Right Ventricle n (%)		Septal Papillary Muscle
	Anterior Papillary Muscle	Posterior Papillary Muscle	Anterior Papillary Muscle	Posterior Papillary Muscle	
Shape of Papillary Muscle					
Conical	45 (90)	14 (28)	50 (100)	1 (2)	50 (100)
Cylindrical	0 (0)	29 (58)	0 (0)	46 (98)	0 (0)
Broad Apexed	5 (10)	7 (14)	0 (0)	0 (0)	0 (0)
Number of Chordal Attachments (Mean ± SD)	7 ± 2	12 ± 2	8 ± 2	5 ± 1	3 ± 1

**Table 4: Papillary muscle attachments of septal papillary muscle among the observed specimens (n=50)**

Parameters	Left Ventricle n (%)			Right Ventricle n (%)		
	Upper third	Middle third	Lower third	Upper third	Middle third	Lower third
Anterior papillary muscle	8 (16)	37 (74)	5 (10)	3(6)	43 (86)	4 (8)
Posterior papillary muscle	6 (12)	40 (80)	4 (8)	8 (16)	40 (80)	2 (4)
Septal papillary muscle	0 (0)	0 (0)	0 (0)	29 (58)	12 (24)	9 (18)

## DISCUSSION

This cadaveric research aimed to examine the papillary muscles' morphometric characteristics in the heart's two ventricles. Fifty cadaveric heart specimens were used in the current investigation, which was conducted at the Government Stanley Medical College's Department of Anatomy in Chennai. Our observations have been categorised under the following topics.

**Number of Papillary Muscles in Both Ventricles of the Heart:** Kirklin et al,<sup>[14]</sup> Romanes et al,<sup>[15]</sup> have documented that the left ventricle has two papillary muscles. In comparison, in the right ventricle, there are three papillary muscles: anterior, posterior, and a small septal papillary muscle. Similar observations have also been documented by Varghese et al.<sup>[16]</sup> The findings from our study showed that in the left ventricle of the heart, two papillary muscles, namely anterior and posterior, were present in 15 out of 50 specimens (30%). According to the authors mentioned above, 12 out of 50 specimens (24%) had the anterior, posterior, and septal papillary muscles in the heart's right ventricle.

Saha et al,<sup>[17]</sup> reported that the classical picture of two papillary muscles in the left ventricle was found only in 25% of specimens. In the present study, the classical picture of two papillary muscles in the heart's left ventricle was present in 15 out of 50 specimens (30%), which is higher than their findings. In the right ventricle, we observed that the classical picture of three papillary muscles in the heart's right ventricle was present in 12 out of 50 specimens (24%), similar to the findings of Saha et al. in their study.

Aktas et al,<sup>[18]</sup> showed that the right ventricle has a minimum of two and a maximum of nine papillary muscles. The current investigation found a minimum of three and a maximum of eight papillary muscles in the heart's right ventricle.

**Length of Papillary Muscles in Both Ventricles:** Negri et al,<sup>[12]</sup> found that the average length was 19.16 mm for the right anterior papillary muscle, 11.53 mm for the right posterior papillary muscle, and 5.59 mm for the septal papillary muscle. Gerola et al,<sup>[19]</sup> revealed that, on average, the right anterior papillary muscle measured 9 ± 2 (mm) in length. Harsha et al,<sup>[20]</sup> had noted that the right anterior

papillary muscle was 14.9 ± 4 (mm) in length on average. In the present study, the right anterior papillary muscle length ranged from 11 to 28 mm, with a mean of 14.96 ± 3.2 (mm), which is higher than the observations made by Gerola et al.<sup>[19]</sup> At the same time, it is lower than the observations of Negri et al. Still, it is similar to the findings of Harsha et al.<sup>[20]</sup> The right posterior papillary muscle length ranged from 9 to 19 mm with a mean of 13.14 ± 2.37 (mm) and the right septal papillary muscle ranged from 5 to 14 mm with a mean of 9.56 ± 1.86 (mm) which is more than the observations of Negri et al.<sup>[12]</sup> In the present study the mean length of left anterior papillary muscle was 17.22 (mm). It is slightly less than Kavitha et al,<sup>[21]</sup> but greater than Hosapatna.2 In the present study, the mean length of the left posterior papillary muscle was 17.54 (mm). It is lower than Hosapatna et al.'s two but similar to the observations of Kavitha et al.<sup>[21]</sup> We observed that the mean length of the right anterior papillary muscle was 14.96 (mm), identical to Kavitha et al. At the same time, it was greater than Hosapatna et al.<sup>[2]</sup> In the present study the mean length of right posterior papillary muscle was 13.14 (mm) which is higher than the findings of Hosapatna et al two and more or less equal to Kavitha et al.<sup>[21]</sup> We noted that the mean length of septal papillary muscle was 9.56 (mm) higher than the observations made by Hosapatna et al. At the same time, it coincides with the findings of Kavitha et al.<sup>[21]</sup> This can be attributed to the various racial and geographic variations of the study population.

### Breadth of Papillary Muscles in Both Ventricles

The mean width of the left anterior papillary muscle in this investigation was 8.38 mm, greater than the observation made by Kavitha et al.<sup>[21]</sup> Still, our findings were consistent with the conclusions Saha et al,<sup>[17]</sup> made in their study. We observed that the mean breadth of the left posterior papillary muscle was 8.06 (mm), which is greater than the findings of Kavitha et al,<sup>[21]</sup> but similar to the observations made by Saha et al.<sup>[17]</sup>

Our findings showed that the mean breadth of the right anterior papillary muscle was 6.32 (mm), which is higher when compared to the observations of Kavitha et al,<sup>[21]</sup> but was slightly less than the findings of Saha et al,<sup>[17]</sup> in their study. The mean breadth of the right posterior papillary muscle was 5.52 (mm), and the mean breadth of the right septal papillary muscle was 3.64 (mm) in our study. These findings were similar to the observations made by Kavitha et al,<sup>[21]</sup> but were less than the measurement reported by

Saha et al.<sup>[17]</sup>

Variation in the shape of the papillary muscles in the left and right ventricles of the heart.

Gunnal et al.<sup>[22]</sup> reported that most papillary muscles in the left ventricle had a conical form (45.51%), whereas other types were pyramidal. (26.73%), broad apexed (14.83%) and fan-shaped (12.93%). Hosapatna et al.<sup>[2]</sup> reported that all the left ventricle's papillary muscles had a cone-like form. According to Kavitha et al.<sup>[21]</sup> 100% of the specimens had conical left anterior papillary muscles.

We observed that the left anterior papillary muscle was conical in 90% which is more than the findings of Gunnal et al.<sup>[22]</sup> but similar to the observations by Hosapatna et al two and is less than Kavitha et al.<sup>[21]</sup> The percentage of broad apexed muscle was 10% which is less than the observations by Gunnal et al.<sup>[22]</sup> We observed that the posterior papillary muscle was conical in 27% which is more than Kavitha et al.<sup>[21]</sup> cylindrical in 58% which is similar to Kavitha et al.<sup>[21]</sup> and broad apexed in 15% which coincides with the findings of Kavitha et al.<sup>[21]</sup>

Kavitha et al.<sup>[21]</sup> reported that in the right ventricle, all the anterior papillary muscles were conical in shape. They also noted that the posterior papillary muscles were conical in 2% and cylindrical in 98% of the specimens, similar to our observations from our study. They also reported that the septal papillary muscles were conical in all the observed specimens; these findings coincide with our observations in the current study.

Attachment of base of papillary muscles to the ventricular wall.

#### Left Ventricle

Victor et al.<sup>[23]</sup> found that the anterior papillary muscle was attached predominantly to the middle third (79.5%), followed by the upper third of the ventricular wall (19%). Radhakrishnan et al.<sup>[24]</sup> had also reported similar observations. The findings from our study are also identical to the studies mentioned above Victor et al.<sup>[23]</sup> reported that in the posterior muscle, the corresponding figures are 6%, 92.5% and 1.5% respectively. Radhakrishnan et al.<sup>[24]</sup> reported that the posterior papillary muscle of the left ventricle had its base attached to the upper third in 13% to the middle third in 81% and to the lower third in 6%. In the present study the posterior papillary muscle base was attached to upper third in 12% which is more than Victor et al.<sup>[23]</sup> but is slightly less than Radhakrishnan et al.<sup>[24]</sup> middle third in 80% which is less than Victor et al.<sup>[23]</sup> but similar to Radhakrishnan et al.<sup>[24]</sup> and lower third in 8% which is more than Victor et al.<sup>[23]</sup> and Radhakrishnan et al.<sup>[24]</sup>

#### Right Ventricle

Radhakrishnan et al.<sup>[24]</sup> reported that in the right ventricle, the anterior papillary muscle was attached to the upper third in 7%, the middle third in 86%, and the lower third in 7% of the specimens. In the present study, we have also made similar observations.

Radhakrishnan et al.<sup>[24]</sup> reported that the posterior papillary muscle was attached to the upper third in 9%, middle third in 88%, and lower third in 3%. In the present study the corresponding figures for posterior papillary muscle are 16% (upper third) which is more than Radhakrishnan et al.<sup>[24]</sup> 80%

(middle third) which is less than Radhakrishnan et al.<sup>[24]</sup> and 4% (lower third) which is slightly more than the observations of Radhakrishnan et al. In the present study the corresponding figures for septal papillary muscle were similar to Radhakrishnan et al and 18% (lower third) which is slightly less than Radhakrishnan et al.<sup>[24]</sup>

## CONCLUSION

Based on our results and a review of previous research, we conclude that differences in morphometric values may be caused by differences in the number of specimens studied, racial predilection, and geographic regions. In addition to helping cardiothoracic surgeons during corrective cardiac surgeries, a thorough understanding of the normal structure and possible variations of papillary muscles is essential for the timely diagnosis of different cardiac abnormalities. Knowing how to handle conventional and atypical valvular appearances is equally crucial for anatomists, physiologists, and cardiologists.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Peter L Williams: Gray's Anatomy, 39th edition, Churchill Living stone. 2005; 967-72.
- Hosapatna M, DSouza A, Ankolekar VH, D Souza AS. Morphology of Papillary Muscles in Human Adults: A Cadaveric Study. *Ibnosina J Med BS.* 2014;6(4):168-172
- Hashimoto K, Oshiumi M, Takakura H, Sasaki T, Onoguchi K. Congenital mitral regurgitation from absence of the anterolateral papillary muscle. *Ann Thorac Surg* 2001; 72:1386-87.
- McElhinney DB, Silverman NH, Brook MM, Hanley FL, Stanger P. Asymmetrically short tendinous cords causing congenital tricuspid regurgitation: improved understanding of tricuspid valvar dysplasia in era of color flow echocardiography. *Cardiol Young* 1999; 9: 300-4.
- Chares M, Lamm P, Leischik R, Lenz G, Steinmann EH, Polonius MJ. Highly acute course of ruptured papillary muscle of the tricuspid valve in a case of blunt chest trauma. *Thorac Cardiovasc Surg* 1993; 41:325-27.
- Hachiro Y, Sugimoto S, Takagi N, Osawa H, Morishita K, Abe T. Native valve salvage for post traumatic tricuspid regurgitation. *J Heart Valve Dis* 2001; 10:276-78.
- Xanthos T, Dalivigkas I, Ekmektzoglou KA. Anatomic variations of the cardiac valves and papillary muscles of the right heart. *Ital J Anat Embryol* 2011;116(2):111-26.
- Hetzer R, Drews T, Siniawski H, Komoda T, Hofmeister J, Wenig Y. Preservation of papillary muscles and chordae during mitral valve replacement: possibilities and limitations. *J Heart Valve Dis* 1995;4(Suppl 2):115-23.
- Lang P, Oberhoffler R, Cook A. Pathologic spectrum of malformations of the tricuspid valve in prenatal and neonatal life. *J Am Coll Cardiol* 1991;17:1161-67.
- Spherling ID. Papillary-chordal insufficiency of the cardiac atrioventricular valves. *Arkh Patol* 1980;42:23-6.
- Bardy GH, Talano JV, Meyers S, Lesch M. Acquired cyanotic heart disease secondary to traumatic tricuspid regurgitation: Case report with a review of the literature. *Am J Cardiol* 1979;44:1401-06.

12. Nigri GR, Di Dio LJA, Baptista CAC. Papillary muscles and tendinous cords of the right ventricle of the human heart: morphological characteristics. *Surg Radiol Anat* 2001;23:45-9.
13. Koshi R. *Cunningham's Manual of Practical Anatomy VOL 2 Thorax and Abdomen*. Oxford University Press; 2017.
14. Kirklin JK, Blackstone EH. *Kirklin/Barratt-Boyes Cardiac Surgery E-Book: Expert Consult-Online and Print (2-Volume Set)*. Elsevier Health Sciences; 2012 Oct 26.
15. Romanes GJ (Eds). *Text book of Cunningham's Manual of Practical Anatomy*. 15th edition. Oxford University Press, New York. 1986;(2):51-54
16. Varghese G, Setiya M. Morphological and Morphometric Study of Papillary Muscles in Adult Cadaveric Hearts: A Cross-sectional Study from Central India. *Journal of Clinical & Diagnostic Research*. 2025 Jul 1;19(7).
17. Saha A, Roy S. Papillary muscles of right ventricle-morphological variations and its clinical relevance. *Cardiovasc Pathol*. 2018; 34:22-27. Doi: 10.1016/j. carpath.2018.01.007.
18. Aktas EO, Govsa F, Kocak A, Boydak B, Yavuz IC. Variations in the papillary muscles of normal tricuspid valve and their clinical relevance in medicolegal autopsies. *Saudi Med J* 2004; 25 (9):1176-85
19. 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(3):149-53. Doi: 10.1007/s00276-001-0149-0
20. Harsha BR, Dakshayani KR, Morphometric study on septal papillary muscles of human tricuspid valve. *Global Journal of Medical Research*. 2014;14(11):05-07.
21. Kavitha S, Selvam V. The clinical significance of morphological study of variations of papillary muscles in adult human hearts. *International Journal of Scientific Research*. 2018;7(5):93-98
22. Gunnal SA, Wabale RN, Farooqui MS. Morphological variations of papillary muscles in the mitral valve complex in human cadaveric hearts. *Singapore Med J*. 2013;54(1):44-48. Doi: 10.11622/smedj.2013011
23. Victor S, Nayak VM. Variations in the papillary muscles of the normal mitral valve and their surgical relevance. *J Card Surg* 1995;10(5):597- 607
24. Radhakrishnan NS. Variations in the number and attachment of papillary muscles (Doctoral dissertation, Stanley Medical College, Chennai).2009.