

## Study of Numbers of Papillary Muscles in Left Ventricle of Fetal Hearts of Gestational Age from 14 to 40 Weeks

Ashish E Khokhariya<sup>1</sup>, Kuldeep N Suthar<sup>2</sup>

### Abstract

**Introduction:** Normal mitral valve function depends on pillars of the trabeculae carnea represented by the papillary muscles. Knowledge of numbers of papillary muscles in anterior and posterior groups of papillary muscles is important because it is one of the components of mitral valvar complex and also for the restoration of normal physiological function of mitral valve which required resenctioned and stitching of papillary muscle, in case of injury and dysfunction of papillary muscle which lead to mitral regurgitation. **Materials and Methods:** Thirty formalin preserved fetal hearts at gestational age from 14 to 40 weeks were dissected through midline thoracotomy and cutting open the pericardial sac. The numbers of papillary muscles in anterior and posterior groups of papillary muscles in left ventricle were observed and recorded after an incision from the apex of heart along the left border and extending up to the left atrium. **Result:** The single papillary muscle in the anterior group of papillary muscles was in 21 (70%) fetuses, 2 anterior papillary muscles in 8 (26.7%) fetuses and 3 anterior papillary muscles in 1 (3.3%) fetus. The single papillary muscle in posterior group of papillary muscles was seen in 25 (83.3%) fetuses, 2 posterior papillary muscles in 4 (13.3%) fetuses, 3 posterior papillary muscles in 1 (3.3%) fetus. **Conclusion:** This study helps to understand the importance of papillary muscle in mitral valve complex and also to cardiothoracic surgeons for the surgery on mitral valve in case of mitral valve regurgitation.

**Keywords:** Papillary muscles; Mitral valve; Fetal heart; Left ventricle.

### How to cite this article:

Ashish E Khokhariya, Kuldeep N Suthar. Study of Numbers of Papillary Muscles in Left Ventricle of Fetal Hearts of Gestational Age from 14 to 40 Weeks. Indian J Anat. 2019;8(4):257-260.

### Introduction

Papillary muscles represent the pillars of trabeculae carnea. Trabeculae carnea i.e., papillary muscles of left ventricle are similar to right ventricle, but are well developed. It presents two groups of papillary muscles anterior and posterior. It attached to cusp of mitral valve by the chordae tendinae.<sup>1</sup> The mitral valvar complex comprises the mitral

orifice and its annulus, valvular leaflets, chordate tendinae and papillary muscles.<sup>2</sup> Papillary muscle is one of the components of the mitral valvar complex, so knowledge of variation in the form of number of papillary muscles is important to the Cardiac surgeon for performing various operative procedures on the mitral valve.

The function of papillary muscles is to prevent the prolapse of AV valve into atria during ventricular systole. So proper functioning of these muscles maintains the integrity of mitral valve, abnormalities of it ranges from a life-threatening emergency (muscle rupture) to an echocardiographic finding of doubtful clinical significance (muscle calcification).<sup>3</sup> So, dysfunction and injury to papillary muscles leads to complications of mitral valve like prolapsed and mitral regurgitation<sup>4</sup> and consequently leads to myocardial infarction and acute cardiac failure.

**Author's Affiliation:** <sup>1</sup>Tutor, <sup>2</sup>Assistant Professor, Department of Anatomy, GMERS Medical College, Dharpur, Patan, Gujarat 384265, India.

**Corresponding Author: Kuldeep N Suthar**, Assistant Professor, Department of Anatomy, GMERS Medical College, Dharpur, Patan, Gujarat 384265, India.

**E-mail:** [dr.kuldeepsuthar@yahoo.co.in](mailto:dr.kuldeepsuthar@yahoo.co.in)

**Received** 23.08.2019 | **Accepted** 04.10.2019

Single papillary muscle is usually associated with other malformations like supramitral valve ring, diffuse subaortic stenosis, coarctation of aorta,<sup>5</sup> valvular aortic stenosis, ventricular septal disease and valvular pulmonary stenosis.<sup>6</sup> Parachute mitral valve is a congenital condition characterized by only one papillary muscle to which all mitral chordae tendinae are attached. The resultant mitral valve is usually stenotic,<sup>5</sup> but it may be purely incompetent or may function normally.<sup>6</sup> An increased number and size of the papillary muscles, as well as their malformation, may cause left ventricular outflow tract obstruction and mitral regurgitation.<sup>7</sup>

Papillary muscles serve an important landmark for the surgeons to reach the commissures. It is especially true of the anterolateral papillary muscle which usually has only one belly.<sup>8</sup> In all surgical procedures, the two papillary muscles are stitched together to correct the disorder, or one of the heads of the anterior papillary muscle is resected and then stitched together with the posterior papillary muscle. If there are more papillary muscle bellies, the number of options to decide the direction and degree of realignment also increases, thereby facilitating the restoration of normal physiological function.<sup>7</sup> Therefore, it is important to have knowledge of the variation in the form of number of papillary muscles.

## Materials and Methods

This study was conducted in B.J. Medical College, Ahmedabad, in the Department of Anatomy after obtaining permission from the ethical committee. These fetuses of both the sexes were collected from the Department of OBS & GYN, B.J. Medical College, Ahmedabad with due permission from concerned parties and authorities. Any fetus which showing gross maceration was excluded from the study. Among fetuses, 17 female and 13 male were there. The heart specimens were preserved by injecting 10% formalin into umbilical vein. Age of the fetuses was determined from LMP & USG report of Mother. Thirty fetal hearts at gestational age from 14 to 40 weeks were dissected. Hearts were removed

with a midline thoracotomy and cutting open the pericardial sac. Now Left ventricle of all hearts was cut opened with an incision from the apex of heart along the left border and extending up to the left atrium. Left ventricular chamber was washed with running tap water to visualize the papillary muscles. The number in anterior and posterior groups of papillary muscles in left ventricle was observed and recorded.

### Inclusion Criteria

Aborted fetuses of gestational age 14 to 40 weeks.

### Exclusion Criteria

- Patients refusing to give consent.
- Aborted fetuses below the gestational age of 14 weeks and macerated fetuses.

## Results

The numbers of papillary muscles in anterior and posterior groups are presented in Table 1.

We observed that single papillary muscle in anterior group of papillary muscles was most common in majority of hearts and single papillary muscle in posterior group of papillary muscles was also most common in majority of hearts in our study (Table 1). Figure 1 shows 2 anterior papillary muscles and 1 posterior papillary muscle. Figure 2 shows 3 anterior papillary muscles and 2 posterior papillary muscles. Figure 3 shows 1 anterior papillary muscle and 2 posterior papillary muscles.

In our study, the single papillary muscle in the anterior group of papillary muscles was most common in 21 (70%) fetuses. 2 anterior papillary muscles were seen in 8 (26.7%) fetuses and 3 anterior papillary muscles in 1 (3.3%) fetus, but we could not see four papillary muscles in the anterior group (Table 1). The single papillary muscle in posterior group of papillary muscles was seen in 25 (83.3%) fetuses, 2 posterior papillary muscles were seen in 4 (13.3%) fetuses, 3 posterior papillary muscles in 1 (3.3%) fetus (Table 1).

**Table 1:** Numbers of Papillary Muscles in Anterior and Posterior Groups in Left Ventricle

Number of Papillary muscles	Anterior group of papillary muscles	Posterior group of papillary muscles
1	21 (70%)	25 (83.3%)
2	8 (26.6%)	4 (13.3%)
3	1 (3.3%)	1 (3.3%)
4	0	0
<b>Total</b>	<b>30</b>	<b>30</b>

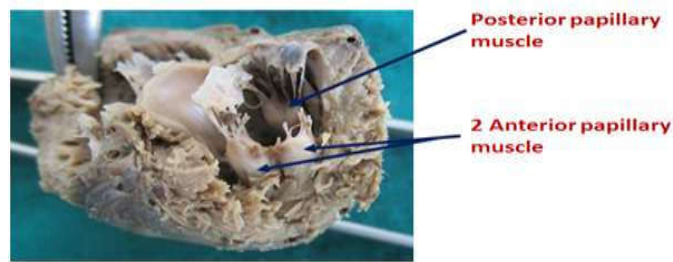


Fig.1: 2 anterior papillary muscles and 1 posterior papillary muscle of left ventricle.

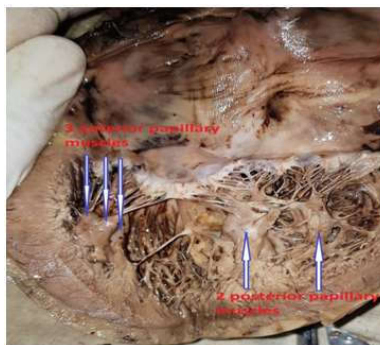


Fig. 2: 3 anterior papillary muscles and 2 posterior papillary muscles of left ventricle.

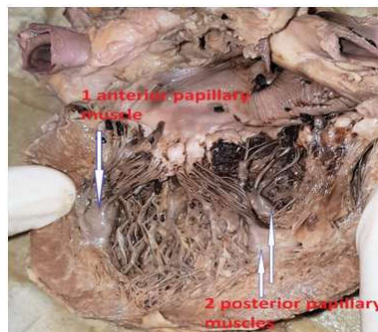


Fig. 3: 1 anterior papillary muscle and 2 posterior papillary muscles of left ventricle.

## Discussion

If we compare the numbers of papillary muscles with previous studies then, Gunnal SA *et al.*,<sup>7</sup> observed many groups of papillary muscles instead of the usual two papillary muscles. They studied the left ventricles in 116 adult human hearts. The classical picture of papillary muscles – the presence of two papillary muscles in the left ventricle – was found in only four (3.44%) specimens, two groups of papillary muscles were seen in 50 (43.11%) specimens, three groups in 37 (31.90%) specimens, and four groups in 25 (21.55%) specimens.

Hosapatna M *et al.*,<sup>9</sup> also observed presence of double anterior papillary muscle (APM) and posterior papillary muscle (PPM) in the left

ventricles in few cases out of 15 cadaveric hearts they studied.

According to Thounaojam OS *et al.*,<sup>10</sup> in the anterior group of papillary muscles, single papillary muscle was most common in 13 (52%), 2 anterior papillary muscles were seen in 11 (44%) and 3 anterior papillary muscles were seen in 1 (4%). Single posterior papillary muscle was seen in 12 (48%), 2 posterior papillary muscles were seen in 8 (32%), 3 posterior papillary muscles in 2 (8%) and 4 posterior papillary muscles in 3 (12%) (Study was done in 25 fetal hearts.)

In the study of 105 normal hearts, Cheichi *et al.*<sup>11</sup> found that the antero-lateral papillary muscles were single in 87 (82.80%), double in 15 (14.30%) and triple in 3 (2.90%) and the postero-medial

papillary muscles were single in 31 (29.50%), double in 57 (54.30%), triple in 12 (11.40%) and even more than three in 5 (4.80%) hearts. Bhagya Shree *et al.*<sup>12</sup> studied the numbers of papillary muscles of the left ventricle in 50 adult human cadavers, they observed anterior (anterolateral) papillary muscle was composed of a single belly in 43 (86%) hearts and two bellies in 7 (14%) hearts and posterior (posteromedial) papillary muscle was composed of a single belly in 7 (14%) hearts, two bellies in 28 (56%) hearts, three bellies in 10 (20%) hearts, four bellies in 5 (10%) hearts. Ranganathan & Burch<sup>13</sup> and Victor & Nayak<sup>14</sup> also found the one or two anterior papillary muscle in majorities of the hearts but they occasionally found more than two anterior papillary muscles, which was not found in our study.

If we do comparison of all studies concerned with numbers of papillary muscles in anterior and posterior groups of papillary muscles then, some studies show that single papillary muscle in anterior group is most common including our study (Table 1) and double papillary muscles in posterior group are most common which was not seen commonly in our study.

## Conclusion

We found many variations in the form of numbers of papillary muscles in anterior and posterior group of papillary muscles which was matched with some studies. This study may be helpful to anatomists and cardiothoracic surgeons. Many studies have shown that variations in the morphology of papillary muscles are of significance in surgical procedures.<sup>15-17</sup>

## References

1. Singh V. Pericardium and heart. In: Vishram Singh, editor. Textbook of Anatomy. Upper limb and thorax vol-1, 2<sup>nd</sup> ed. New Delhi: Elsevier; 2014.p.266-70.
2. Gabella G. Cardiovascular system. In: Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE *et al.* editors. Gray's Anatomy, the Anatomical basis of Medicine and Surgery. 38<sup>th</sup> ed. Philadelphia, London: Churchill Livingstone; 1995. P.1472-87.
3. Madu EC, D'Cruz IA. The vital role of papillary muscles in mitral and ventricular function: echocardiographic insights. Clin Cardiol. 1997;20:93-98.
4. Burch GE, DePasquale NP, Phillips JH. The syndrome of papillary muscle dysfunction. Am Heart J. 1968;75(3):399-415.
5. Shone JD, Sellers RD, Anderson RC, *et al.* The developmental complex of "parachute mitral valve", supra-aortic ring of left atrium, subaortic stenosis and coarctation of aorta. The Am J Cardiol. 1963;7:14-24.
6. Glancy DL, Chang MY, Dorney ER, *et al.* Parachute mitral valve. Further observations and associated lesions. Am J Cardiol. 1971;27:309.
7. Gunjal SA, Wabale RN, FM. Morphological variations of papillary muscles in the mitral valve complex in human cadaveric hearts. Singapore Med J. 2013;54(1):44-8.
8. Ranganathan N, Lam JHC, Wigle ED, *et al.* Morphology of the human mitral valve. II. The valve leaflets. Circulation. 1970;41:459-67.
9. Hosapatna M, D Souza A, Das AM, *et al.* Morphology of papillary muscles in human adults: a cadaveric study. IJMS. 2014;6(4):168-72.
10. Singh TO, Naranbabusingh T, Gangmei G, *et al.* Morphological Study of Left Sub-Valvular Apparatus in Human Foetal Hearts. IOSR J Dent Med Sci. 2016;15(1):15-9.
11. Chiechi MA, Lees WM, Thompson R. Functional Anatomy of the Normal Mitral Valve. J. Thoracic Surgery. 1956;32:378-98.
12. Shree B, Singla RK, Sharma RK, *et al.* A study of papillary muscles of the left ventricle in the Adult human cadavers. Int J Anat Res. 2016;4(2):2285-93.
13. Ranganathan N, Burch GE. Gross morphology and arterial supply of the papillary muscles of left ventricle of man. Am Heart J. 1969;77(4):506-16.
14. 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.
15. Bryant R, Smedira NG. Papillary muscle realignment for symptomatic left ventricular outflow tract obstruction. J Thorac Cardiovasc Surg. 2008;135:223-4.
16. Yousefnia MA, Mandegar MH, Roshanali F, *et al.* Amouzadeh Papillary muscle repositioning in mitral valve replacement in patients with left ventricular dysfunction. Ann Thorac Surg. 2007;83:958-63.
17. Kochi K, Okada K, Watari M, *et al.* Papillary muscle resection as a treatment for midventricular obstruction. Ann Thorac Cardiovasc Surg. 2002;8:109-11.