Study of Papillary Muscles of Mitral Valve in Central Indians

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ABSTRACT

Introduction: Detailed knowledge of normal anatomy and normal variations is vital for accurate interpretation of information by echocardiography and for surgical repair in valvular diseases. Present study aimed to know the morphology of Papillary Muscles of Mitral valve in Central Indians and try to classify certain prominent normal variations.

Material and Methods: The present study was carried on 100 normal human hearts from both sexes of different age. These were preserved in 5% formaline solution. The Mitral valve complex was dissected very carefully to avoid cutting of papillary muscles and chordae tendinae. The morphological study of papillary muscles of Mitral valve was carried out. The anterior and posterior papillary muscles were located in all the cases. Additionally extra-anterior and extra-posterior muscles if present were looked in for.

Result: Extra-anterior papillary muscles were found in 31% hearts while Extra-posterior papillary muscles were found in 25% hearts. The total number of papillary muscles present in the mitral valve ranges from 2 to 5 with an average of 2.63.

Conclusion: Extra papillary muscles could be found anteriorly and posteriorly.

Keywords: Anterior and Posterior Papillary Muscles, Extra-anterior and Extra-posterior Papillary muscles.

INTRODUCTION

Wooley[1] reminded that anatomists had been recording their observations on the structure of cardiac valves since 4th century B.C. In 1840 King T. W.[2] published a work concerning anatomical features and functions of mitral valve. Waller et al[3] described that dysfunction of papillary muscles or rupture of chordae tendinae undermining the support of one or more leaflets of the mitral valve produced regurgitation. Brock R.C.[4] mentioned that the papillary muscles are typically two in number. He further mentioned that extra muscles may exist. Rusted et al[5] pointed out that most frequently a single antero-lateral or double or triple postero-medial papillary muscles were found. Cheichi et al.[6] considered a muscle as single if its apex was not grooved or slightly grooved. Two muscles or a muscle with two heads was considered as double and three muscles or a trifid muscle was considered as triple. They mentioned that the papillary muscles may be single, double, triple or more than three in number. Waller et al[3] mentioned that the apices of the papillary muscles were sensitive indicators of myocardial hypoxia. The present study was carried out to find the extra-papillary muscles present anteriorly and posteriorly in addition to the universally present anterior and posterior papillary muscles.

MATERIAL AND METHODS

The present study was carried on 100 normal human hearts at Netaji Subhash Chandra Bose Medical College, Jabalpur. The hearts were kept in three groups as under:-

GROUP I (children) – Eight, in the age group of 1 to 8 years.

GROUP II (female) – Twenty nine, in the age group of 16 to 80 years.

GROUP III (male) – Sixty three, in the age group of 16 to 61 years.

The hearts were obtained from the post-mortem room and preserved in 5% formaline solution. The Mitral valve complex was dissected very carefully to avoid cutting of papillary muscles and chordae tendinae attached to these. The morphological data of papillary muscles of Mitral valve were studied. The anterior and posterior papillary muscles were located in all the cases. Additionally extra-anterior and extra-posterior muscles if present were looked in for and the records were made.

The following classification has been adopted in the present study:

I. Anteriorly placed papillary muscles:
   a. Anterior papillary muscle
   b. Extra-anterior papillary muscle

II. Posteriorly placed papillary muscles:
   a. Posterior papillary muscle
   b. Extra-posterior papillary muscle

STATISTICAL ANALYSIS

Descriptive statistics like mean and percentage were used to calculate the results. Microsoft office 2007 was used to generate tables.

RESULT

In Group I (children), no extra-anterior papillary muscle was present in 5 cases (62.5%), one extra-anterior papillary muscle was present in 2 cases (25%) and 2 extra-anterior papillary muscles were present in 1 case (12.5%). A total number of 4 extra-anterior papillary muscles were present in 3 cases along with one anterior papillary muscle present in all the 8 cases and thus overall 12 papillary muscles were placed anteriorly in the 8 cases. There was no extra-posterior papillary muscle in 6 cases (75%), one extra-posterior papillary muscle was present in 1 case and 2 extra-posterior papillary muscles were present in the remaining 1 case (12.5%). A total number of 3 extra-posterior papillary muscles were present in 2 cases. One posterior papillary muscle was found in each of the 8 cases and thus overall number of 11 posteriorly placed papillary muscles were found in 8 cases. An average number of 1.5 papillary

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Groups	Anterior	Extra-anterior	Total Anteriorly placed	Average per heart	Posterior	Extra-posterior	Total Posteriorly placed	Average per heart
I (children)	8	4	12	1.50	8	3	11	1.37
II (female)	29	8	37	1.27	29	8	37	1.27
III (male)	63	21	84	1.33	63	19	82	1.30

Table-1: No. of different papillary muscles in the mitral valve complex

Groups	No. of extra-anterior papillary muscles			No. of extra-posterior papillary muscles			
	0	1	2	0	1	2	3
I (children)	5	2	1	6	1	1	0
II (female)	21	8	0	22	6	1	0
III (male)	43	19	1	47	14	1	1

Table-2: No. of extra-anterior and extra-posterior papillay muscles

No. of papillary muscles	Group I (children)	Group II (female)	Group III (male)
2	4	17	32
3	2	9	23
4	1	2	7
5	1	1	1

Table-3: Total number of papillary muscles present

Papillary muscles	Group I (children)	Group II (female)	Group III (male)
Anterior	8	29	63
Extra-anterior	4	8	21
Anteriorly placed	12	37	84
Posterior	8	29	63
Extra-posterior	3	8	19
Posteriorly placed	11	37	82
Total	23	74	166
Average per heart	2.87	2.55	2.63

Table-4: Number of different papillary muscles

muscles and 1.37 papillary muscles were placed anteriorly and posteriorly respectively. Only one papillary muscle was placed anteriorly in 5 cases (62.5%), two papillary muscles were placed anteriorly (25%) in 2 cases and 3 papillary muscles were placed anteriorly in 1 case (12.5%). Only 1 papillary muscle was placed posteriorly in 6 cases (75%), 2 papillary muscles were placed posteriorly in 1 case (12.5%) and 3 papillary muscles were placed posteriorly in the remaining 1 case (12.5%).

In Group II (female), no extra-anterior papillary muscle was present in 21 cases (72.41%) whereas one extra-anterior papillary muscle was present in 8 cases (27.50%). A total number of 8 extra-anterior papillary muscles were present in 8 cases along with one anterior papillary muscle present in all the 29 cases and thus overall 37 papillary muscles were placed anteriorly in 29 cases. There was no extra-posterior papillary muscle in 22 cases (75.86%), one extra-posterior papillary muscle was present in 6 cases (20.68%) and 2 extra-posterior papillary muscles were present in the remaining 1 case (3.44%). A total number of 8 extra-posterior papillary muscles were present in 7 cases. One posterior papillary muscle was found in each of the 8 cases and thus overall number of 37 posteriorly placed papillary muscles were found in 29 cases. An average number of 1.27 papillary muscles were placed anteriorly as well as posteriorly. Only one papillary muscle was placed anteriorly in 21 cases (72.41%) and two papillary muscles were placed anteriorly (25%) in 2 cases and 3 papillary muscles were placed anteriorly in 1 case (12.5%). Only 1 papillary muscle was placed posteriorly in 22 cases (75.86%), two papillary muscles were placed posteriorly in 6 cases (20.68%) and 3 papillary muscles were placed posteriorly in the remaining 1 case (3.44%).

In Group III (male), no extra-anterior papillary muscle was present in 43 cases (68.25%), one extra-anterior papillary muscle was present in 19 cases (30.15%) and 2 of these were found in 1 case (1.58%). A total number of 21 extra-anterior papillary muscles were present in 20 cases along with one anterior papillary muscle present in all the 63 cases and thus overall 84 papillary muscles were placed anteriorly in 63 cases. There was no extra-posterior papillary muscle in 47 cases (74.60%), one extra-posterior papillary muscle was present in 14 cases (22.22%), 2 extra-posterior papillary muscles were present in 1 case (1.58%) and 3 of these were present in the remaining 1 case (1.58%). A total number of 19 extra-posterior papillary muscles were present in 16 cases. One posterior papillary muscle was found in each of the 63 cases and thus overall number of 82 posteriorly placed papillary muscles were found in 63 cases. An average number of 1.33 papillary muscles were placed anteriorly and 1.30 papillary muscles were placed posteriorly per case. Only one anteriorly placed papillary muscle was seen in 43 cases (68.25%); two papillary muscles were present in 19 cases (30.16%) and 3 were found in the remaining 1 case (1.58%). Forty seven cases (74.60%) showed the presence of 1 posteriorly placed papillary muscle; fourteen cases (22.22%) had 2 posteriorly placed papillary muscles; in 1 case (1.58%) there were 3 and in the remaining 1 case (1.58%) there were 4 posteriorly placed papillary muscles.

Thus in the present study extra-anterior papillary muscles and extra-posterior papillary muscles were found in 31% and 25% hearts respectively.

Situation of Extra-anterior papillary muscles

In Group I (children), a total number of 4 extra-anterior papillary muscles were found in 3 cases. In 1 case 1 extra-anterior papillary muscle was present antero-superior to the anterior papillary muscle while in the other 2 cases there were 1 and 2 extra-anterior papillary muscles present on the left side of the anterior papillary muscle respectively.

In Group II (female), in all the 8 cases, 1 extra-anterior papillary muscle was situated on the left side of the anterior papillary muscle.

In Group III (male), 19 cases showed the presence of 1 extra-anterior papillary muscle. In 16 cases it was present on the left side of the anterior papillary muscle; in 2 cases it was present superior to the anterior papillary muscle and in 1 case it was situated anterior to the anterior papillary muscle. Two extra-anterior papillary muscles were found on the left side of the anterior papillary muscle in the only 1 case.

Situation of Extra-posterior papillary muscle

In Group I (children), one extra-posterior papillary muscle was found on the left side of posterior papillary muscle in 1 case and 2 of these were found on the right side of the posterior papillary muscle in the other case.

In Group II (female), 1 extra-posterior papillary muscle was found on the right side of the posterior papillary muscle in 5 cases and 1 extra-posterior papillary muscle was present on the left side of the posterior papillary muscle in 1 case. Two extra-posterior papillary muscles were found on the left side of the posterior papillary muscle in the remaining 1 case.

In Group III (male), 14 cases showed the presence of 1 extra-posterior papillary muscle. In 9 of these it was present on the left side of the posterior papillary muscle, in 4 cases it was present on the right side of the posterior papillary muscle and in 1 case it was placed postero-superior to the posterior papillary muscle. Two extra-posterior papillary muscles were situated posterior to the posterior papillary muscle in 1 case and 3 extra-posterior papillary muscles were found on the left side of the posterior papillary muscle in the remaining 1 case.

In Group I (children), a total number of 23 papillary muscles were present. The number of papillary muscles ranged from 2 to 5 with an average of 2.87 per case. Two papillary muscles were present in 4 cases; three were present in 2 cases; four were present in 1 case and 5 were found in the remaining 1 case.

In Group II (female), a total number of 74 papillary muscles were present. The number of papillary muscles ranged from 2 to 5 with an average of 2.55 per case. Two papillary muscles were present in 17 cases; three were present in 9 cases; four were present in 2 cases and 5 were found in the remaining 1 case.

In Group III (male), a total number of 166 papillary muscles were present. The number of papillary muscles ranged from 2 to 5 with an average of 2.63 per case. Two papillary muscles were present in 32 cases; three were present in 23 cases; four were present in 7 cases and 5 were found in the remaining 1 case.

Thus in 100 hearts a total number of 263 papillary muscles were observed with an average of 2.63 per hearts.

DISCUSSION

The Papillary Muscles are muscles located in the Right and Left Ventricles of the Heart. They are connected to the cusps of Atrio-ventricular valves (Tricuspid and Mitral valves) via the chordae tendinae which are white fibrous collagenous cords. These muscles contract to prevent inversion or prolapse of these valves in systole. In 39th edition of Gray's Anatomy (2005)[7] it has been described that anterior and posterior papillary muscles of the Mitral valve, vary in length and breadth and these may be bifid. The Anterior papillary muscle arises from the sternocostal mural myocardium and the Posterior papillary muscle arises from the diaphragmatic region.

Brock R.C.[4] mentioned that the papillary muscles are typically two in number. He further mentioned that extra muscles may exist. Rusted et al[5] pointed out that most frequently a single antero-lateral or double or triple postero-medial papillary muscles were found. Cheichi et al[6] considered a muscle as single if its apex was not grooved or slightly grooved. Two muscles or a muscle with two heads was considered as double and three muscles or a trifid muscle was considered as triple. They mentioned that the papillary muscles may be single, double, triple or more than three in number. In their study 82.80% of the antero-lateral papillary muscles were single and 70.50% postero-medial papillary muscles were multiple. In the present study bifid and trifid muscles are not considered as double or triple and hence the classification of the muscles done by Chiechi et al[6] is not agreed upon. Extra Papillary muscles have been observed anteriorly as well as posteriorly as earlier mentioned by Brock R.C.[4] Ranganathan et al[8] mentioned that antero-lateral papillary muscle usually possesses one belly whereas posterior papillary muscle has frequently two or more bellies. They have not mentioned about the presence of extra papillary muscles. Waller et al[3] had mentioned that there are two groups of muscles located below the two commissures and the apices of the papillary muscles were sensitive indicators of myocardial hypoxia. Gunnal S.A. et al[9] in their study on 116 cadaveric hearts also found that the anterior and posterior papillary muscles were mostly found in groups instead of an anterior and a posterior papillary muscle. Madu E.C. et al[10] mentioned that a third accessory papillary muscle is present in uncommon cases. It is based closer to the apex of left ventricle in comparision to the anterior and posterior papillary muscles. The significance of such an extra papillary muscle is that during echocardiography it may be mistaken for mural thrombi, especially if that segment of left ventricle is infarted. However, in the present study Extra-anterior and Extra-posterior papillary muscles were found in 31% and 25% hearts respectively.

Extra-anterior and Extra-posterior papillary muscles were present on the left side of the anterior papillary muscles and posterior papillary muscles in 87.87% and 48% respectively. Oosthoek et al[11] also noted the presence of a third papillary muscle. S.Y. Ho[12], however, mentioned that there are usually groups of papillary muscles arranged fairly close together. At their bases the muscles sometimes fuse or have bridges of muscular or fibrous continuity before attaching to the ventricular wall. According to Yousefnia M.A. et al[13] and Bryant R.et al[14], the treatment of choice for symptomatic left ventricular outflow tract obstruction and dysfunction is realignment and repositioning of Papillary muscle. Kochi K. et al[15], Dreyfus G.D. et al.[16], Yousefnia M.A. et al (2007)[13] and Bryant R. et al[14] have stressed upon the great importance of the knowledge of variations in the morphology of papillary muscles for the cardiac surgeons.

CONCLUSION

The total number of papillary muscles present in the mitral valve complex ranged from 2 to 5 with an average of 2.63. Extra-anterior papillary muscles and extra-posterior papillary muscles could be found. In the present study Extra-anterior and Extra-posterior papillary muscles were found in 31% and 25% hearts respectively.

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