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THE CLINICAL SIGNIFICANCE OF MORPHOLOGICAL STUDY OF VARIATIONS OF PAPILLARY MUSCLES IN ADULT HUMAN HEARTS

Anatomy

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ABSTRACT

Due to affluent lifestyle, a heart disease has become important cause of death. Among heart diseases, Valvular diseases contribute significantly to increased morbidity and mortality. Valve replacements are done using both artificial and cadaveric heart valves. For fixation of a cadaveric heart valve the operating surgeon should be well versed in both the dimensions and normal architecture of both valves of heart. Both ventricles of the heart contain specialized myocardial elements known as the papillary muscles, which play a crucial role in the flow of blood through the heart chambers. In the present study to enumerate the number of papillary muscles in both ventricles and its variation of number of each papillary muscle bellies, shape of papillary muscles and tip of papillary muscles. One hundred and twenty five adult human hearts irrespective of age and sex were used VMKV Medical College Salem, Tamilnadu, India for conducting the study. In the present study the right ventricle papillary muscles with two bellies were found in 6 % of the cases and with three bellies in 72%, four bellies in 19% and five bellies in 3 %. In the present study, the tip of right anterior papillary muscle was undivided in 75%, bifid in 20% and trifid in 5% of the cases. In the tips of right posterior papillary muscle, it was undivided in 5%, bifid in 45% and trifid in 50% of the heart specimens. When the shape of the papillary muscle is altered; it gives rise to increased incidence of ischemia. So the conical shaped papillary muscles appear to be the ideal shape as it facilitates smooth blood flow through the heart.

KEYWORDS

Tip of papillary muscle, shape, muscle bellies

INTRODUCTION

Numerically five papillary muscles exist, three in the right ventricle and two in the left ventricle. The two major papillary muscles in the right ventricle are situated in anterior and posterior aspect. A third smaller muscle has present in medial position together with several smaller and variable muscles attached the ventricular septum.

The papillary muscles play an important role in right ventricular contraction by drawing tricuspid annulus toward the apex thereby causing shortening of the long axis and sphericity of the chamber for ejecting blood Hashimoto K et.al (2001).

Anatomical variations of the right atrioventricular valve may occur in association with other congenital anomalies and syndromes. Also the number, shape and length of the papillary muscles and chordae tendinae are variable. This can be of clinical significance since the papillary muscles play an important role in the contraction of the right ventricle and in the closure of the tricuspid valve so as to prevent ventricular blood from passing back into the right atrium. Theodoros Xanthos, Loannis Dalivigkas et .al (2011).

The apical areas and the papillary muscles are the first regions of each ventricle to undergo contraction. The atrioventricular valve leaflets are therefore initially drawn into the ventricle by the chordae tendineae upon the shortening papillary muscles. The change of attachment of the papillary muscle affected the atrioventricular valve of the ventricle on the left side of the human heart and in turn this affected the efficient function of the atrioventricular valve on the left side. Frater (2011).

Contraction of papillary muscle occurs during ventricle systole and relaxation occurs during ventricular diastole. Maintenance of blood volume during systole and diastole is mainly due to the action of papillary muscles. The movement of the papillary muscles along with the chordae prevents the tandem motion of the cusp. The cusps do not evert due to the pull of its attachments. Structural abnormalities of papillary muscles can result in unexpected complications and death of the patient. So this study aims to highlight the morphological features of papillary muscles of both ventricle of hearts will provide ready guides for the operating cardiac surgeon.

MATERIALS AND METHODS

One hundred and twenty five adult human hearts specimens irrespective of age and sex were used for the present study after obtaining necessary clearances from the Institutional Review Board and Institutional Ethical Committee of VMKV Medical College department of Anatomy Salem, Tamilnadu, India for conducting the study.

The collected heart specimens were immersed in the preservative 10% formalin solution containing (10 liters of normal saline with 1 liter of formaldehyde and 50 ml of glycerin and 5 Gms of powdered thymol were added). The parameters of the study were to count the number of papillary muscles in both ventricles, variations of number of each papillary muscle bellies, shape of papillary muscles and the tip of papillary muscles. The dissection procedure was followed by Cunningham manual (Romanes, 1986). The following materials are used for dissecting instruments, and hand lens.

STASTICALANALYSIS

The subjected to statistical analysis using SPSS software version 16. The range and mean were calculated.

RESULT

NUMBER OF PAPILLARY MUSCLES:

In the present study the anterolateral and posteromedial papillary muscles of the right ventricle were found in all the 125 heart specimens (100%) examined. But right septal papillary muscle was present only in 75 specimens (60%).In the left ventricle the anterior and posterior papillary muscles were present in all the 125 heart specimens (100%) (Fig.1).

VARIATION OF PAPILLARY MUSCLE BELLIES:

In the left ventricle two bellied papillary muscles were found in 75% of specimens, three bellies in 9%, four bellies in 11% and five bellies in 5% of the specimens. (table.1).

In the present study the right ventricle papillary muscles with two bellies were found in 6 % of the cases and with three bellies in 72%, four bellies in 19% and five bellies in 3 %. Various shapes of papillary muscle absorbed in the present study are shown in (fig.2: 2a, 2b, 2c, 2d.2e and 2f).

SHAPE OF THE PAPILLARY MUSCLES:

In the present study also, varied shapes of papillary muscle was noticed. In the right ventricle, all the anterolateral papillary muscles were conical in shape (100%). Posteromedial papillary muscles were conical in 2% and cylindrical 98% (fig.3) and the septal papillary muscle was conical in shape in all the heart specimens (100%).

In the present study, the anterior papillary muscle of the left ventricle was conical in shape in all the specimens (100%) and the posterior papillary muscle was conical 10%, cylindrical 60% and pyramidal in 15% and broad apexed in 15% (fig 4).

PAPILLARY MUSCLES ENDS OR TIP OF THE MUSCLE:

In the present study, the tip of right anterior papillary muscle was undivided in 75%, bifid in 20% and trifid in 5% of the cases. In the tips of right posterior papillary muscle, it was undivided in 5%, bifid in 45% and trifid in 50% of the heart specimens. In the septal papillary muscle, the tips were undivided in 80% and bifid in 20% (fig .5).

DISCUSSION

Normally there are five papillary muscles in the hearts of which three papillary muscles are in the right ventricle; they are named according to their position as: anterolateral, posteromedial and septal. The left ventricle contains two papillary muscles namely the anterolateral and posteromedial.

In the present study the anterior papillary muscle of the right ventricle compared with the previous studies is shown in (table.2). The right anterolateral papillary muscle was found in 100% of the specimens in all the previous studies including the present study except in study reported by Begum (2006) 92%.

Aktas et al., (2004) stated that the number of bellies of papillary muscles in the right ventricle may vary from a minimum of two bellies to a maximum of nine bellies. Their study was based on medico legal postmortem of four hundred cases. They found that in some of the cases the frequent cause of cardiac death was found to be one headed anterior papillary muscle. Cardiac death also occurred due to the absence, or lower ratio of attachment bridges of posterior papillary muscles.

Due to the morphological variations and rupture of papillary muscle are caused by (AV) deformity like tricuspid and mitral regurgitation due to defective or improper valve closure. One of the papillary muscles may rupture and in such circumstances, surgical procedure for papillary muscle repositioning would be necessary when the data, on the morphology of the papillary muscle will be of use.

In our study papillary muscle possessing, up to five papillary muscles bellies were observed in both ventricles. Papillary muscles possessing varying number of bellies are illustrated in fig 2b.

Hosapatna et al; (2014) in a study on 15 hearts has reported the shape of papillary muscles in the right ventricle. Majority (13 hearts) of the papillary muscle were cone shaped. Flat topped papillary muscles were observed in two specimens. In the left ventricle all the anterior, posterior papillary muscles were cone shaped in all the 15 hearts examined.

Gunnal et al., (2013) have observed that the shape of papillary muscles affects the blood flow in heart. In their study it was noted that, among the left ventricle papillary muscle, majority were conical in shape (45.51%) and the other shapes observed were pyramidal in 26.73%, broad apexed in 50.48% and fan shaped papillary muscles in 12.93%.

In the present study shape of the anterior papillary muscle in the right ventricle was predominantly conical (100%) as described in literature but the posterior papillary muscle of the right ventricle was predominantly cylindrical(98%) which is not described in literature.

In the left ventricle the anterior papillary muscle was conical (100%) as described in literature but the posterior papillary muscle of the left ventricle was also predominantly cylindrical (60%). This assumes significance because, when the shape of papillary muscle is conical, the blood flow through the ventricles is normal. When the shape of the papillary muscle is altered; it gives rise to increased incidence of ischemia. (fig.2).

Begum et al; (2006) have observed that the tips anterior papillary muscle of the right ventricle was single in 92% of the cases. The posterior papillary muscle tips were double in 32% and single in 28% of the cases. The septal papillary muscle tips were single in 46% cases while in 30% of the cases it was absent.

Loukas et al., (2001) in their study observed that in the right septal papillary muscle the tip was single in 51.8%, double in 32.9% and triple septal papillary muscle tips were found in 15.2%. Additionally it was observed that accessory single septal papillary muscle was present in 42 specimens, double septal papillary muscles in 32 specimens and triple septal muscles in 26 specimens.

Ozan et al., (2012) in their study have reported that in the left ventricle, the tip of papillary muscle in 43.3% of the cases was single and smooth. In 30% of papillary muscles, it had single belly of origin and the end was bifid. Tip of papillary muscles were trifid in 26.7%.

Observations on the tip of papillary muscle in left ventricle in the present study: the anterolateral papillary muscle tip was undivided in 2%, bifid papillary muscle in 80% and trifid muscle in 18%.The left posteromedial papillary muscle tip was bifid in 75% (fig.6c) and trifid in 25% of the muscles. The variations in the ends of papillary muscles are shown in the (fig.6). When compared with the previous studies the percentage of undivided tips of septal papillary muscles was significantly higher in the present study.

Conclusion

In the present study papillary muscles of both ventricles exhibited considerable variation differing from what is conventionally described in literature. This could be due to the fact that the standard literature describes the normal anatomy of western population. In the present study, in 40% of the specimens the septal papillary muscle was absent in right ventricle.

The shape of the anterior papillary muscle in the right ventricle was predominantly conical as described in literature and the posterior papillary muscle of the right ventricle was predominantly cylindrical which is not described in literature. This assumes significance because, when the shape of papillary muscle is conical, the blood flow through the ventricles is normal. When the shape of the papillary muscle is altered; it gives rise to increased incidence of ischemia. So the conical shaped papillary muscles appear to be the ideal shape as it facilitates smooth blood flow through the heart.

Hence in depth knowledge of the anatomy of the papillary muscle regarding the numbers, shape of papillary muscles is necessary for successful cadaveric heart valve replacement surgeries.

Fig.1:Percentage of occurrence of papillary muscles

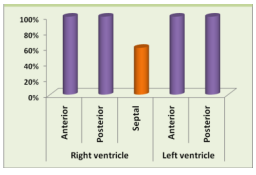


Fig: 3varying shape of papillary muscles in both ventricles

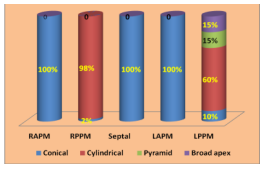
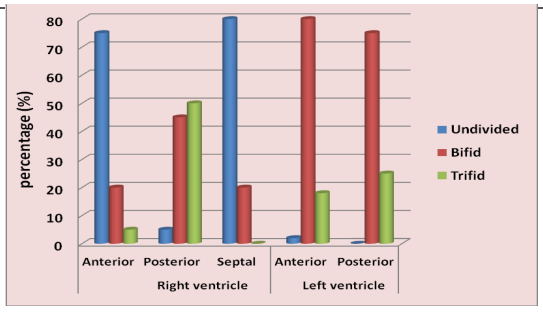


Fig.5 Tip of papillary muscles in both ventricles



TABLES AND FIGURES

FIG 2: PAPILLARY MUSCLE WITH VARYING NUMBER OF BELLIES IN BOTH VENTRICLES

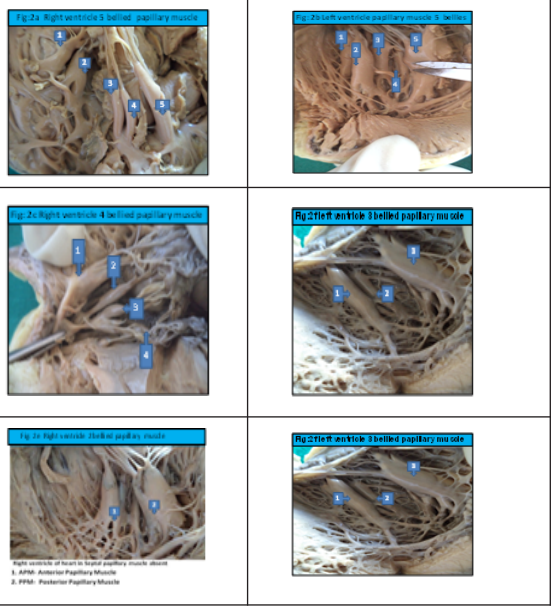


Fig 4. VARIANT SHAPES OF PAPILLARY MUSCLES

Fig 4a. BROAD APEX

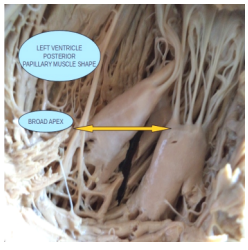


Fig 4b .CYLINDRICAL

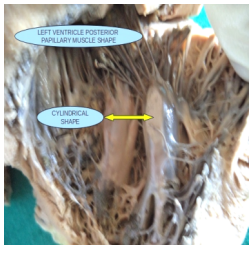


Fig 4c. PYRAMIDAL / CONICAL

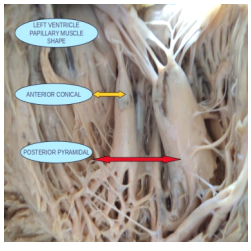


Fig 4d. CYLINDRICAL

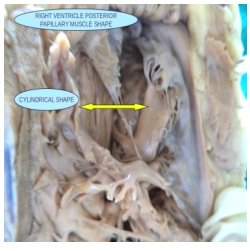


Fig 6 :TIP OF PAPILLARY MUSCLES

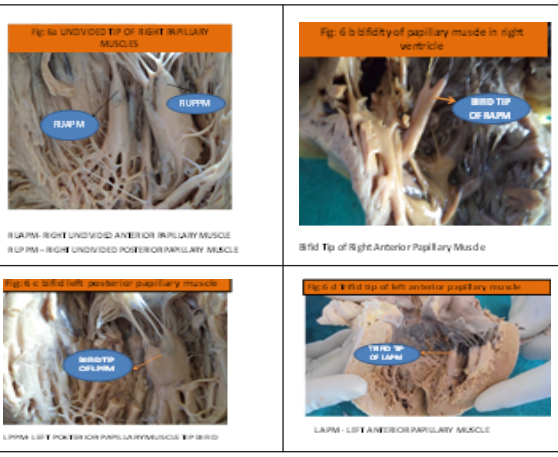


Table: 1. Number of bellies of the papillary muscle of both ventricles

N= 125 hearts	Papillary muscle of right ventricle (%)	Papillary muscle of left ventricle (%)
2 bellies	6	75
3 bellies	72	9
4 bellies	19	11
5 bellies	3	5

Table: 2. Comparison of incidence of anterior papillary muscles in the right ventricle

Sl. No	Author / Year / Race	Country	No. of heart studied	Anterior papillary muscles
1.	Wafae /1990/ South Americans	Brazil	50	100 %
2.	Gerola /2001/ South Americans	Brazil	50	100 %
3.	Nigri / 2001/ Hispanic	Boston(USA)	79	100 %
4.	Motabagani/ 2006/ Asian	South India	10	100%
5.	Begum /2006/ Asian	Bangladesh	50	92%
6.	Harsha /2014/ Asian	South India	96	100%
7.	Present study/2018/ Asian	South India	125	100%

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