



RESEARCH ARTICLE

Atrioventricular heart valves of indigenous cattle (*Bos indicus*): The morphology and morphometry

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Özet

Islam MN, Hossain FMA, Akhtar S, Alam M. Yerli sığır (*Bos indicus*) ırkının atrioventricular kalp kapakçıkları: Morfoloji ve morfometri. *Eurasian J Vet Sci*, 2012, 28, 1, 01-04

Amaç: Bu çalışmanın amacı, sığır atrioventricular kalp kapakçıklarında yer alan chordae tendineae'ların uzunluk ölçümleri ve morfolojisinin ilerde yapılacak biyoprotezler için incelenmesidir.

Gereç ve Yöntem: Çalışmada sığırlardan alınan kırk atrioventricular kalp kapakçığı kullanıldı. Valva tricuspidalis ve valva bicuspidalis, temin edilen kalplerin el ve makas yardımı ile dikkatlice açılması ve ventriküler miyokardiyum'un uzaklaştırılması ile toplandı. Toplanan kapakçıklar pamuğa sarılarak kapakçıkların normal yapısı korunmaya çalışıldı ve daha sonra %10 formol solusyonu içerisinde muhafaza edildi.

Sonuç: Valva tricuspidalis'e ait cuspis angularis, cuspis septalis ve cuspis parietalis'in uzunlukları arasında yaşa bağlı önemli istatistikî fark ($p<0.01$) tespit edildi. Bu durum valva bicuspidalis'in cuspis parietalis'i ($p<0.01$) ve cuspis septalis'i ($p<0.05$) içinde doğrulandı. Cuspis septalis'e ait chordae tendineae'ların ortalama uzunluğunun 2.5 yaşlı grupta cuspis parietalis'e ait olanlardan daha uzun olduğu tespit edildi.

Öneri: Kalp kapakçıklarını oluşturan yapıların yerleşimi, valve tricuspidalis ve bicuspidalis aynı zamanda musculus papillaris, chordae tendineae ve antrioventricular iletim yolları klinik açıdan ve gelecekte yapılacak biyoprotezler için önem arz etmektedir.

Abstract

Islam MN, Hossain FMA, Akhtar S, Alam M. Atrioventricular heart valves of indigenous cattle (*Bos indicus*): The morphology and morphometry. *Eurasian J Vet Sci*, 2012, 28, 1, 01-04

Aim: The aim of the study was to detect the gross morphology and measurement of the length of chordae tendineae of bovine atrioventricular heart valves for future bioprostheses.

Materials and Methods: Forty atrioventricular heart valves were obtained from cattle. The tricuspid and bicuspid valves were harvested by opening the four chambers of the collected heart specimen by placing finger tightly into the cusps of the valves and then the ventricular myocardium muscle trimmed out by scissor slowly. Harvested valves were gently packed with cotton wool to maintain the normal architecture of the leaflets and then preserved in 10% formalin solution.

Results: A strongly significant ($p<0.01$) difference was found amongst the age group of anterior, intermediate and posterior cusps of the tricuspid valves. It's also same for the posterior cusp of the bicuspid valve ($p<0.01$), although a statistically significant ($p<0.05$) difference was found for anterior cusps of the bicuspid valves. The mean length of the chordae tendineae of anterior cusp of 2.5 years age group was higher than posterior cusp.

Conclusion: The arrangement of the valvular apparatus, the close relation tricuspid and bicuspid valves and adjacent structures like papillary muscles, chordae tendineae and atrioventricular conduction bundle are all important in the clinical arena for future bioprostheses and other vital purposes.

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► Introduction

The heart valves were historically considered passive structures that function through the haemodynamic forces created by the contraction and relaxation of the myocardium (Borin et al 2006). Atrioventricular heart valves are smaller in size and prevent the back-flow from the ventricles into the atrium during systole. Unlike the tricuspid valve which is separated by muscle from pulmoner ostium, the pulmonary valve, the mitral valve is immediately adjacent to the aortic valve (Ho 2002). They are affixed to the wall of the ventricle by chordae tendineae, thread-like bands of fibrous tissue which attach on one end to the edges of the tricuspid and mitral valves of the heart and on another end to the papillary muscles, small muscles within the heart that serve to anchor the valves, and thwart the valves from inverting (Moore and Agur 2007). The chordal rupture is highly associated with the thinner marginal chords and peak systolic stresses (Nazari et al 2000) and may lead to infective endocarditis and various connective tissue disorders (Portugese et al 1998).

The tricuspid valve is the three-flapped valve on the right side of the heart, between the right atrium and the right ventricle which stops the backflow of blood between the two. It is strongly related with Ebstein's anomaly (Boston et al 2006) and infective endocarditis (Butany et al 2006). It opens to allow the de-oxygenated blood collected in the right atrium to flow into the right ventricle. It closes as the right ventricle contracts, preventing blood from returning to the right atrium; thereby, forcing it to exit through the pulmonary valve into the pulmonary artery (Weind et al 2000).

The mitral valve separates the left atrium from the left ventricle. It opens to allow the oxygenated blood collected in the left atrium to flow into the left ventricle. It closes as the left ventricle contracts, preventing blood from returning to the left atrium (Pai et al 2003). The gross anatomical studies of the semilunar heart valves was carried out in different species of animals including indigenous cattle (Akhtar et al 2011), however the new anatomical studies are necessary in this area.

The aim of this research was to detect the gross morphology and measurement of the length of chordae tendineae of bovine atrioventricular heart valves for future bioprosthesis. Although the length of chordae tendineae is a part of main aim of this paper, the importance of the length of chordae tendineae was not mentioned in the introduction section.

► Materials and Methods

Twenty bovine heart samples were collected from Government approved slaughterhouse under Sylhet City Corporation, and subjected to dissection in the

Laboratory of the Department of Anatomy and Histology, Faculty of Veterinary and Animal Sciences, Sylhet Agricultural University. The valves were harvested by opening the related chambers of the collected heart specimen under the pertinent aseptic measures (Islam et al 2002) and finally preserved for study purpose (Akhtar et al 2011). The length of the chordae tendineae of tricuspid valve and bicuspid valve were measured regarding the length in between the cusps of the valve and the papillary muscles (Lafraia et al 2006).

Data were analyzed by ANOVA and Tukey test (SPSS 13). Data are expressed as mean±SE. Significance was accepted at a level of $p<0.05$.

► Results

• The tricuspid valve

The normal tricuspid valve had three leaflets and three papillary muscles. The three leaflets or cusps were anterior, septal or intermediate and posterior cusps (Figure 1). Anterior and posterior terms are usually used for human not domestic animals because of quadruped walking, please modify them if possible: The lengths of the chordae tendineae of the anterior, intermediate and posterior cusps of tricuspid valve of different age group of cattle were presented in the Table1.

Table 1. Length of chordae tendineae (ct) of anterior, intermediate and posterior cusps of tricuspid valve of different age group in mm of the total number of indigenous cattle (n=20, mean±SE).

Age groups	Anterior cusps	Intermediate cusps	Posterior cusps
0-1 year	22.6±0.55 ^d	19.6±0.55 ^b	20.4±0.55 ^d
1.5 years	23.6±0.55 ^c	21.4±0.55 ^{ab}	21.6±0.55 ^c
2 years	24.8±0.45 ^b	22.8±2.95 ^a	23.0±0.71 ^b
2.5 years	25.6±0.55 ^a	23.2±0.45 ^a	24.4±0.55 ^a

^{a-d}: Different letters in the same column are statistically significant (Tukey test, $p<0.05$).

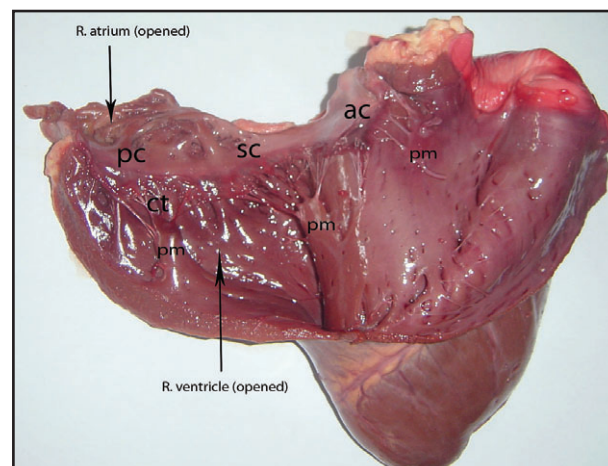


Figure 1. Tricuspid valve opened showing three cusps like anterior (ac), septal (sc) and posterior (pc), chordae tendineae (ct) and papillary muscles (pm).

• The mitral valve

The mitral valve has two leaflets. These are notably different in shape and circumferential length. In oblique location of the valve, its two leaflets do not occupy anterior/posterior positions nor is one of the leaflets “septal”. The septal leaflet was characteristic of the tricuspid valve whereas neither of the mitral leaflets was attached to the septum. The anterior and posterior are “aortic” and “mural”. The length of the chordae tendineae of the anterior and posterior cusp of the bicuspid valve of different age group of cattle were presented in the Table 2 and Figures 2 and 3.

Table 2: Length of the cusps of the bicuspid of different age group in mm of the total number of indigenous cattle (n=20, mean±SE).

Age groups	Anterior cusps	Posterior cusps
0-1 year	22.6±0.55 ^b	22.6±0.55 ^b
1.5 years	23.6±0.55 ^{ab}	23.6±0.55 ^b
2 years	24.6±0.55 ^{ab}	24.8±0.45 ^a
2.5 years	27.8±5.17 ^a	25.6±0.55 ^a

^{a-c}: Different letters in the same column are statistically significant (Tukey test, $p < 0.05$).

► Discussion

The present finding is consistent to Van Pragh et al (2003); Bartram et al (1998), who reported that the tricuspid valve comprises three cusps or leaflets; the largest one is the anterior cusp and interposed between the atrioventricular orifice and the second, the posterior and the third, the medial or septal cusp, to the ventricular septum. This result is in partial agreement with Borin et al (2006), who reported that the tricuspid valve possess a triangle orifice bounded by the free margins of three leaflet, anterior, posterior and septal. The anterior leaflet was always largest, triangular and devoid of the left. The posterior leaflet was second in size and also triangular.

The tendinous cords were found as the string-like structures that attached the ventricular surface or the free edge of the leaflets to the papillary muscle. The tendinous cords of the mitral valve are attached to two groups of papillary muscles. Cords arised from the apices of the papillary muscles were attached to both aortic and mural leaflets of the valve (Figure 2). Regarding tendinous cords, Perloff and Roberts (1972), who observed the same findings to the arrangement and architecture of the chordae tendineae in between the papillary muscles and the cusps of both tricuspid and bicuspid valves.

In connection of the papillary muscles and left ventricular wall, Burch and Giles (1972), who reported that the tendinous cords arise from the tips of the papillary muscles and alterations in the size and shape of the left ventricle can distort the locations of the papillary muscles, resulting in valvar function

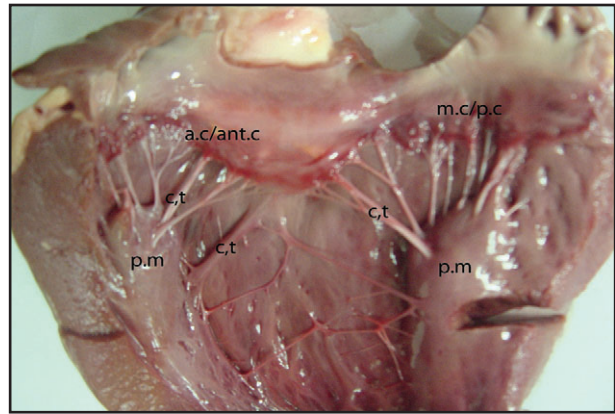


Figure 2. Mitral valve opened showing two cusps, apical or anterior (ac/ant.c) and mural or posterior (pc/mc), papillary muscles (pm) and chordae tendinae (ct).

being disturbed. There was not found any blood vessels on the cusps of any heart valve. In this connection, Weind et al (2000) reported that the presence of a vasculature increased the metabolic activity of the cusp by diffusion and they also observed that for tissue oxygenation normal aortic heart valves contain a vascular bed with more tissue thickness.

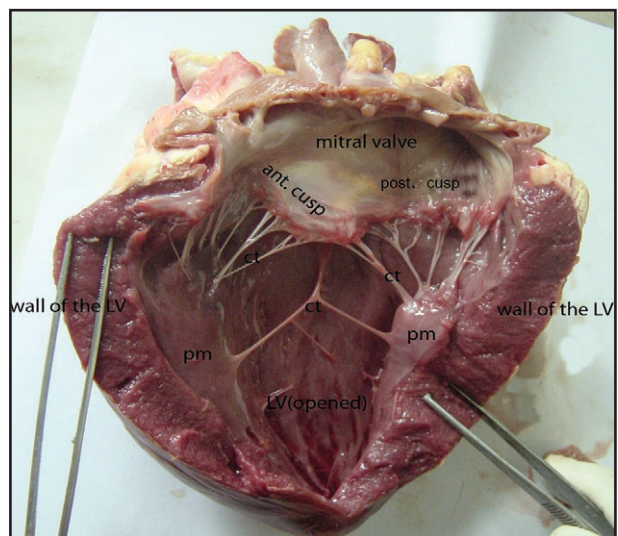


Figure 3. Mitral valve opened showing two cusps (anterior and posterior cusps), papillary muscles (pm) and chordae tendinae (ct).

The length of the chordae tendineae of the anterior cusps of mitral valve was significant ($p < 0.01$) and in case of the posterior cusp it was statistically significant ($p < 0.05$). The mean length of the chordae tendineae of anterior cusp of 2.5 years age group was higher than posterior cusp. In this relation, Walmsley (1929) also observed the similar findings and reported that the “mitral” resemblance to a plan view of the bishop’s mitre. Guarding the inlet to the left ventricle, the mitral valve prevents backflow to the left atrium during ventricular systole. The annulus marking the hingeline of the valvar leaflets is more D shaped. Perloff and Roberts (1972), who reported that the mitral valve requires all its components, together with the

adjacent atrial and ventricular musculature, in order to work properly. The valvar complex comprises the annulus, the leaflets, the tendinous cords, and the papillary muscles that also corroborated with the findings of Ho (2002).

► Conclusions

The findings of this research will be a valuable tool regarding atrioventricular heart valves of indigenous cattle of Bangladesh for future bioprosthesis purposes and further studies of histological and immunological connections will require gaining so.

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