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A Study of Human Right Ventricular False Tendons: Morphology And its Clinical Significance

KEYWORDS: false tendons, right ventricle, morphology.

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ABSTRACT *False tendons (FT) have been extensively appreciated on gross morphological as well as echocardiographic studies. These are cord like fibromuscular bands present in the ventricles which do not attach to the valve leaflets. They represent normal anatomic structures with possible clinical outcomes. We have described the detailed morphology of false tendons in the right ventricle of heart according to its length, thickness, location and distribution. Very few studies have so far done on morphology and outcomes of false tendons in the right ventricle. Out of 50 formalin fixed hearts, we observed the presence of false tendons in 43(86%). They were 2-10 in number in an individual specimen and run horizontally in the right ventricle. Range of length for false tendons in our study was between 5mm to 18mm. Longest were those extending between the papillary muscle and free wall of the right ventricle (mean= 16mm) while shortest were those between septomarginal trabeculae and septum (mean= 7mm). Various types of connections of false tendons and other structures of the right ventricle were observed. False tendons between papillary muscle and ventricular free wall were most common and found in basal segment of the right ventricle (32.5%). Least frequent (9.4%) were false tendons connecting the two papillary muscles or individual segment of the papillary muscles.*

INTRODUCTION:
False tendons (FT) are discrete, cord like fibromuscular bands present in the ventricles, which do not attach to the valve leaflets unlike the true chordae[1, 2]. Various terms have been used in literature for these structures like moderate bands[3] (Turner, 1893), fibromuscular ribbons[3] (Grzybiak et al. 1966), false tendons[3] (Pomerance, 1975). False tendons have generally been considered as normal anatomic variants[4,5] but numerous clinical abnormalities have been reported[1,3,4]. Cardiologists are now interested because of their possible association with innocent murmur[4] and role in ventricular arrhythmias[1,4]. Reports also suggest thromboembolic events, diagnostic errors in echocardiography and their influence on cardiac pacemaker's electrode[1]. False tendons have been classified according anatomic and echocardiographic criteria[4]. The false tendons are fine and filamentous which makes them difficult to reliably detect echocardiographically with low prevalence of 0.3% [6]. False tendons may arise anywhere from the ventricular cavity[4]. They are rarely described in textbooks of anatomy and advent of echocardiography has drawn focus on them [5].

Despite their substantial clinical significance, very few cadaveric morphological studies have so far done on right ventricle of heart as compared to presence of false tendons in left ventricle until now and thus it justifies the need to undertake a detailed gross study of false tendons in right ventricle according to length, thickness, location and distribution.

Materials and methods:
The research specimens consisted of 50 human hearts of both sexes, aged approximately 65years, without any grossly visible pathologic lesions that were available in the department of anatomy, Sri aurobindo medical college and P.G. institute, Indore (M.P.). All hearts were fixed in 10% formalin.

Before dissection they were thoroughly washed. To expose the cavity of right ventricle (RV), it was incised near apex for 1 cm length and after probing it with finger, the incision was extended without disturbing the tricuspid components. The incision extended along diaphragmatic surface 0.5cm away from right border of heart and the valve was precisely dissected along its annulus. Also, right atrium was removed. The cavity was washed again and blood clots were removed.

Now, the RV was carefully examined for false chordae tendineae. Their presence or absence, number, length and thickness were observed. Location was noted according to its base-apex level in the cavity and points of attachments within the ventricle. Length was measured using digital vernier caliper. Histological examination was not included in the present study. Data was statistically evaluated using SSPS software.

Results:
In present study, out of the 50 specimens, 43(86%) had one or more types of false tendons. In an individual specimen we found minimum 2 and maximum 10 numbers of false tendons. The range of length was seen to be between minimum 5mm to maximum 18mm. On gross appearance, false tendons were thin fibrous structures with thickness between 1mm- 4mm and usually directed horizontally with only few obliquely oriented.

Most frequently false tendons were located between papillary muscle and ventricular free wall (32.5%). Usually anterior and posterior papillary muscles were found to be connected to the wall of the right ventricle (Figure1and 2) as compared to the septal papillary muscle. These were commonly seen in the basal region of the ventricle with mean length of 16mm (Table1). Tendons mostly connect basal or middle part of the muscle to the wall.

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False tendons connecting papillary muscle with the ventricular septum were seen in 25.5% of the specimens with men length of 13mm. These usually connect anterior papillary muscle to the septum (Figure2) and those tendons that connect posterior papillary muscle to the septum were usually very short. False tendons in these locations were largely present in middle segment of the cavity.

Next in frequency were false tendons between septomarginal trabeculae and septum (21%) that were generally short with mean length of 7mm (shortest) and found in middle region of the right ventricle (Figure1).

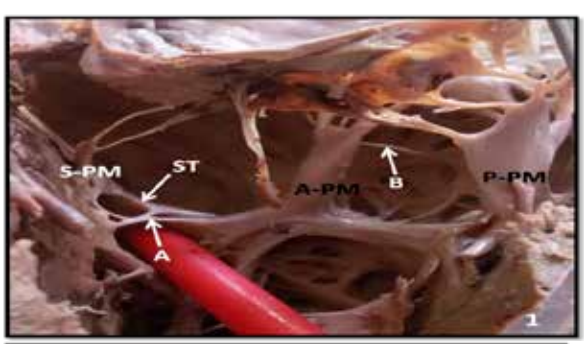
False tendons connecting the free wall of right ventricle were usually found in apical region in 11.6% of the specimens with mean length of 10mm (Figure3). In apical region false tendons should be distinguished from trabeculations which are grossly muscular and very thick.

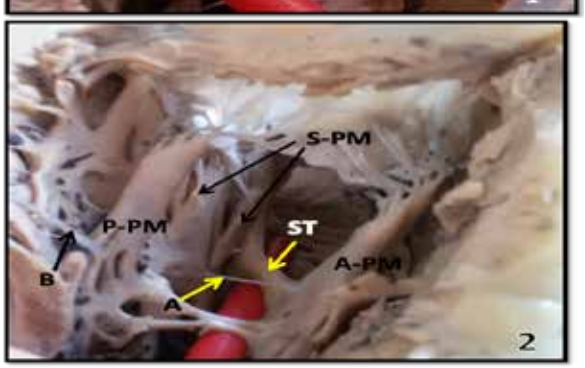
TABLE – 1

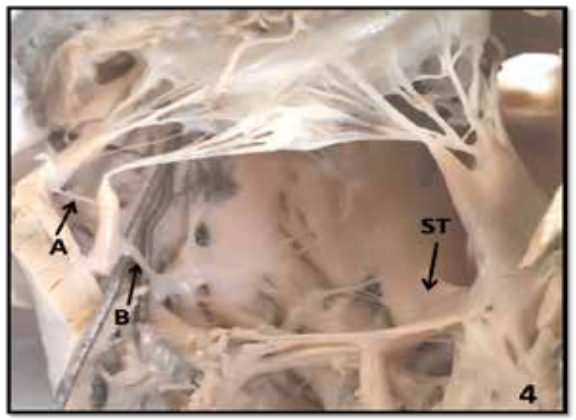
Type	Location (Based on point of attachment)	Relative frequency (%)	Mean length (mm)	Base- apex level (Most common)
1	PM-VFW	32.5	16	Basal
2	PM-VS	25.5	13	Middle
3	ST-Other region	21	7	Middle
4	VFW-VFW	11.6	10	Apical
5	PM-PM	9.4	12	Middle

Table1 shows:- Prevalence and features of various types of false tendons in right ventricle. PM= Papillary muscle, VFW= Ventricular free wall, VS= Ventricular septum, ST= Septomarginal trabeculae.

Least frequently (9.4%) we found false tendons connecting the two papillary muscles or individual segment of the papillary muscles (Figure4) with mean length of 12mm and usually seen in middle segment of the ventricle. It was difficult to access chordae connecting anterior and posterior papillary muscle in our study because the ventricular cavity was opened through diaphragmatic surface.







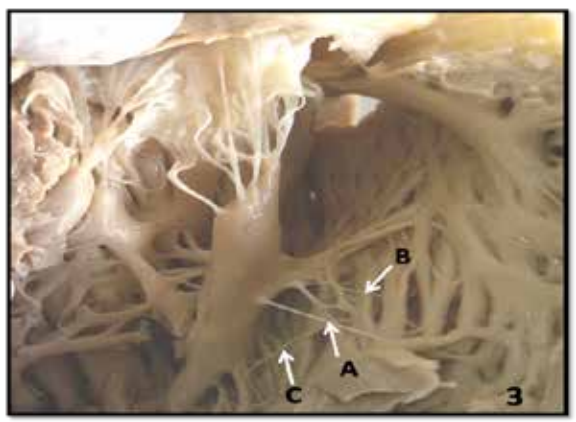


Figure1-4. Right ventricular cavity is seen from diaphragmatic aspect in all the above photographs. A-PM= Anterior papillary muscle, P-PM= Posterior papillary muscle, S-PM= Septal papillary muscle, ST= Septomarginal trabeculae.

Figure1. Showing A= False tendon connecting septomarginal trabeculae and ventricular septum, B= False tendon between anterior papillary muscle and ventricular free wall.

Figure2. Showing A= False tendon between anterior papillary muscle and ventricular septum, B= False tendon between posterior papillary muscle with ventricular free wall.

Figure3. Showing A= False tendon between papillary muscle and ventricular free wall, B and C= False tendon extending between the ventricular free wall itself.

Figure4. Showing A= False tendon between the two posterior papillary muscles, B= False tendon between posterior papillary muscle and base of small nipple like septal papillary muscle.

Discussion:

Right ventricular false tendons (FT) have been studied rarely so far by the previous workers. Most of the literature describes false tendons of left ventricle and these were first described by Turner (1896)[2] and with the advent of 2D-echocardiography curiosity has increased regarding their presence and effects on functional mechanism of heart.

Prevalance of FT differ in various studies mainly because of different methodologies used. In anatomic studies the prevalence of FT range between 46 to 55%, while in echocardiographic study it range from 0.2 to 71% [5]. Right ventricular false tendons were reported in 100% of the specimens by Kosinski et al. (2012)[1] while Loukas et al. 2008

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found them in 35% only[6] and in present study FT were seen in 86% of the hearts and they were 2-10 in number in an individual specimen and run horizontally in the cavity.

Various types of connections of FT and other structures of ventricle were observed in present study. FT between papillary muscle and ventricular free wall was most common, longest and found in basal segment of the cavity. Next in frequency was FT between papillary muscle and ventricular septum, seen in middle segment. Further, false tendons between septomarginal trabeculae and septum were close in frequency and seen in middle region, these were also shortest in length. FT connecting free wall of ventricle was less common and usually present in apical segment. This region generally had thick muscular trabeculations and those greater than 4mm were excluded. Least frequent was FCT between papillary muscles.

Kosinski et al. 2012 observed FT between trabeculae carnae or between the ventricular free wall below the bases of papillary muscles to be the most frequent (31%) [1], while in present series it was seen in 11.6% of the specimens only and most frequent type was the one between papillary muscle and free wall (32.5%). Least frequent was FT connecting segments of the papillary muscles as well as amongst major papillary muscles, which was in agreement with Kosinski et al. 2012.

Loukas et al. 2008 described FT extending between papillary muscle and ventricular septum to be the most common type[6], while in our study it was second most common variety (25.5%).

Range of length for FT in our study was between 5mm to 18mm. Also longest were the FT extending between the papillary muscle and free wall of the ventricle (mean= 16mm) while shortest were those between septomarginal trabeculae and septum (mean= 7mm). Findings in the present study are close to that found by Loukas et al. 2008 who observed the mean length to be 18±7mm [6].

Various terms have been used in literature for false chordae tendineae so far with reference to left ventricle. The term 'moderator band' (Turner, 1983) or 'septomarginal trabeculae' (Goshal, 1975) were also used[3]. But this seems to be misleading because of presence of structure with similar name in right ventricle[7] that extends from the base of the anterior papillary muscle to the interventricular septum.

Two-dimensional echocardiography often causes misinterpretion of false tendons as flail chordae tendineae or mural thrombi[2]. False tendons may cause abnormal acoustic phenomena by causing vibrations of flowing blood[1]. False tendons contain fibrous tissue, elastic fibers as well as myocardial fibers. Due to the presence of conduction tissues it may lead to electrophysiological changes[5] like ventricular premature contractions, ECG repolarization abnormalities and preexcitation[3]. Roberts W.C (1969) mentioned the association between false tendons and innocent murmur[8]. Premature ventricular contraction can originate from either right or left ventricle due to left bundle branch block[9]. It has been mentioned that interventricular septum and moderator band (in the right ventricle) has Purkinje fibers and nerves which is the direct continuation of right bundle branch[10]. Since false tendons attach to the ventricular wall, it may stretch purkinje fibers and that may lead to arrhythmias[4,9]. Apart from conduction abnormalities, recent studies have shown the possible role of false tendons in mediating alternative conduction pathway which compensates for the propagation delay and reduction in total activation time that may be augmented due to bundle branch block[11].

CONCLUSIONS:

The available literature suggest the clinical significance and the possible role that these false tendons may play in normal as well as pathological conditions or even the protective function that may be of interest to cardiologists. Their detailed anatomic description in the right ventricle seems to be justified as false tendons were so far described as a clinical problem mostly referring to left ventricle. Further work on the subject shall include histological aspects to deepen the available knowledge and elaborate future perspective.

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