

MORPHOMETRIC AND MORPHOLOGICAL STUDY ON THE SEPTO-MARGINAL TRABECULA

Shrikanya M Shet ^{*1}, Kuldeep M D ², Sheela G Nayak ³, V S Pare ⁴, Jyothi S R ⁵, M P Shenoy ⁶.

^{*1} Student, 1st MBBS, K V G Medical College, Sullia, Rajiv Gandhi University Of Health Sciences, Karnataka.

² Student, 1st MBBS, K V G Medical College, Sullia, Rajiv Gandhi University Of Health Sciences, Karnataka.

³ Dean Academics, K V G Medical College, Sullia, Rajiv Gandhi University Of Health Sciences, Karnataka.

⁴ Professor and HOD, Department Of Anatomy, K V G Medical College, Sullia, Rajiv Gandhi University Of Health Sciences, Karnataka.

^{5,6} Assistant Professor, Department Of Anatomy, K V G Medical College, Sullia, Rajiv Gandhi University Of Health Sciences, Karnataka.

ABSTRACT

Background and objectives: Moderator band is a specialized bridge present between the base of the anterior papillary muscle and interventricular septum. It carries the right branch of the bundle of HIS with it. The band is known to prevent the over distension of the right ventricle during the diastolic phase. There is a need of lot of research and studies on the septomarginal trabecula as it proves to be important clinically. Here we measured the length, breadth, height, angle with the interventricular septum, and the superficial marking of Moderator band on the sternocostal surface of the right ventricle is done. This paper describes the morphological variations found in its origin and insertion.

Materials and Methods: 15 formalin-soaked cadaveric hearts were taken from the Department of Anatomy of KVG Medical College, Sullia. The foetal hearts, the hearts with gross pathology, if any are excluded from the study.

Result: The morphometric parameters are tabulated and the morphological variations are noted. The results are compared with the results of the previous studies on the moderator band.

Conclusion: It is confirmed that the thickness of moderator band varies at its origin and insertion. The surface marking of moderator band on sternocostal surface of the heart will help in locating the moderator band through the echocardiography and during cardiac surgeries on right ventricle. The possibility of second moderator band, multiple origin or insertion is more than 20%.

KEY WORDS: Septomarginal trabecula, Surface marking, Right ventricle, Moderator Band.

Address for Correspondence: Shrikanya M Shet, 1st MBBS, K V G Medical College, Kurunjibhag, Sullia, Dakshina Kannada, Karnataka, India. **E-Mail:** shrikanyasagar99@gmail.com

Access this Article online	Journal Information
Quick Response code 	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar 
	Article Information
DOI: 10.16965/ijar.2018.238	Received: 30 Apr 2018 Peer Review: 30 Apr 2018 Revised: None
	Accepted: 30 May 2018 Published (O): 05 Jul 2018 Published (P): 05 Jul 2018

INTRODUCTION

The Moderator Band is a muscular band that

extends from the inter-ventricular septum to the base of the anterior papillary muscle. It takes

part in preventing over distension of right ventricle, hence the name “Moderator band” [1]. Despite many number of studies dedicated to the moderator band, the controversies persist, focussing mostly on its structure, function and evolutionary basis. In 1837 King.T.W [2] named it as the “moderator band” as, according to his concept, the trabecula limited the over-expansion of the right ventricle.

It was Tandler .J [3] who first used the term “Septomarginal trabecula”. He did this based on the attachments of the moderator band. The moderator band acts as a ‘marker’ for the right ventricle. It arises from the body of the inter-ventricular septum and crosses to the lateral wall of right ventricle. The moderator band is accompanied by a set of neuronal fibres from the right bundle branch of the atrio-ventricular conduction system [4]. It controls and coordinates the contraction of anterior papillary muscle. The right branch of ‘His’ bundle located within the muscular part of the septum is continuous with the moderator band. The results of analyses have proved the presence of the fascicle within the moderator band [5].

Some probable ischemic pathologies of the moderator band can cause critical disturbances in the conduction system of heart [6]. The moderator band artery anastomoses with various branches of the right coronary artery at the base of the APM. It can play an important role in the collateral circulation whenever this circulation opens [7]. Collateral flow to the right ventricular musculature, especially through the moderator band artery, protects against massive infarction when there is occlusion in the proximal right coronary artery [8]. An abnormal moderator band can be a source of premature ventricular contractions, monomorphic ventricular tachycardia, and idiopathic ventricular fibrillation [9].

Moderator band may be easily confused as a mass near the apex of ventricle [10].

A 2-dimensional echocardiography can detect a superior shift in the position of the moderator band. A possible risk of sub pulmonary obstruction in those infants with a ventricular septal defect (VSD) can be predicted by the observation in 2D echocardiography [11].

The presence of moderator band is one of the features which differentiates an anatomical right ventricle from anatomical left ventricle [12]. The histology of the moderator band was explained by Turner [13]. The presence of moderator band in the ventricle is of high significance as the opening and closure of the atrioventricular valves is regulated by the anterior papillary muscle via chordae tendinae.

A proper and good knowledge of the location, variations and surface marking of moderator band helps in various cardio-surgical procedures and in echocardiography.

Here, in our study, the morphological parameters are measured and the results are tabulated and compared with results from previous studies. This study is helpful for radiologists and anatomists in their studies regarding the moderator band. Also, the surgeons can more efficiently correct the defects in the trabecula by the knowledge of its morphology and variations associated [14].

MATERIALS AND METHODS

Materials: 15 formalin soaked cadaveric specimen of hearts were chosen from the Department of Anatomy, KVG Medical College, Sullia. The foetal hearts, neonatal hearts, the hearts with gross pathology, if any, externally or internally are excluded from the study. The criteria like age and sex of the specimen were excluded from the study. Scalpel, toothed forceps, blunt-end forceps and pointed forceps, needle pointer, digital vernier callipers, measuring tape, magnifying lens, transparent protractor, ordinary thread, pen torch, hand digital camera and markers were used during the study.

A parallel incision is placed along the upper border of right ventricle, around 1.5 to 2cm below and to the right surface of the pulmonary trunk .Starting from the left end, the incision is extended till the right border. It was made sure that the chordae tendinae were not cut. The incision is extended from the right end, downwards .1cm parallel along the right border, the region of the right ventricle was cleaned thoroughly using cotton and water. Once the anterior papillary muscle is seen the incision from the left upper end is done, in parallel and, 0.5 cm from interventricular groove, tracing down extending

the incision to reach the origin of the moderator band. It was made sure that the anterior papillary muscle was not damaged by the incision. In specimen which had very thick walled right ventricle, the upper sternocostal wall is dissected and detached completely till proximal to the papillary attachment. The blood clot is removed with forceps and spray of water.

Measurement of the Length: The length of the moderator band is measured from the septal end to the base of the anterior papillary muscle by using either digital vernier callipers or by placing a thread throughout its course and measuring its length on scale. These methods help in getting accurate measurements.

Measurement of the Thickness: The thickness of the moderator band was measured accurately using the digital vernier callipers at three different segments.

- a. at the base i.e., the origin from the inter ventricular septum
- b. at the midpoint of the trunk of the band
- c. at the insertion of band into the papillary muscle.

In specimens that showed multiple trunks for their origin and insertion, the length and thickness were measured from the main trunk.

Measurement of the Angle: The angle between the longitudinal axis of the moderator band and the superior part of the body of inter-ventricular septum is measured using a transparent protractor, taking the origin of the moderator band from the IV septum as the midpoint.

Surface marking of moderator band on sternocostal surface of right ventricle:

The depth of moderator band origin was measured by considering two parameters.

- a. from the apex of the heart
- b. From the junction between the right and inferior borders of the heart just below the opening of the inferior vena cava.

A probe or a pointer was inserted from the sternocostal surface to coincide with the origin of moderator band interiorly. The probe was inserted perpendicular to the plane of the table or hand supporting the specimen. It was made sure that the heart was held in anatomical position. The distance of this marking from the

apex was measured using a measuring tape. Also, the distance from the junction between right and inferior borders was noted using the measuring tape.

Measurement of the superficial surface marking of the moderator band on the sternocostal surface of the right ventricle is done by inserting a needle at the origin of the moderator band from the inter-ventricular septum. Its distance from the right border which is at the junction at right atrium between the opening of superior and inferior vena cava and to the apex of the heart is measured. The apex of the heart and the junction between inferior and right borders of heart were marked separately.

Measurement of Height: The distance from the centre of the septal cusp to the base of moderator band was considered as the height in the study.

Collection and recording of data: The measurements are taken manually and noted down. All measurements involving length are taken in millimetres except the surface marking which is taken in centimetres. The parameter involving angle is taken in degrees.

The results are compared with previous studies and variations. Morphology and morphometry are plotted in tabular column.

RESULTS

Length: The length of the moderator band is measured from its origin from the IV septum to its insertion at the anterior papillary muscle using digital vernier callipers. The mean length is found to be 12.88mm with a wide range of 5.0mm to 25.0mm

Thickness: The thickness of the moderator band is taken at three different segments of the moderator band. At base, the mean value is found to be 3.74mm with a range of 2.0mm to 9.0mm. At its trunk, the mean value is found to be 3.37mm with a range of 2.0mm to 8.5mm At its insertion, the mean value is found to be 4.52mm with a range of 2.8mm to 9.0mm

Angle: It is measured from the body of IV septum to the longitudinal axis of moderator band. The mean angle is calculated as 115.5°. It ranged from 80° to 140°. The lower limit of 80° appeared due to specimen 5 which showed a

Table 1: Parameter table.

	MORPHOLOGICAL PARAMETERS (Length in millimetres and Angle in degrees)	'1	'2	'3	'4	'5	'6	'7	'8	'9	'10	'11	'12	'13	'14	'15	MEAN
1	LENGTH	17	14	25	19	11	21	6	22	7.2	8	21	5	6	5	6	12.88
2	THICKNESS AT BASE	2.8	5	3.5	4.5	6	6.5	9	2	2.2	2.5	3.5	2.1	2.2	2.1	2.2	3.74
	AT TRUNK	2.2	3.5	2.5	3	5.2	5	8.5	3	2	2	2.5	3.1	3	2.8	2.5	3.37
	AT INSERTION	3	4	4	5.5	6.4	8.5	9	4	3	3	4	3.5	3.5	3.6	2.8	4.52
3	ANGLE	132°	120°	140°	110°	80°	125°	130°	120°	135°	140°	115°	90°	120°	130°	122°	115.5°
4	DEPTH (Surface marking of Moderator Band on the sternocostal surface at its origin): FROM APEX (in cm's)	5.7	3.8	5.5	5.9	4.6	6.5	5.6	6.3	5.3	4.3	6.8	4.6	4.2	5	5.2	5.41
	FROM THE JUNCTION B/W RIGHT AND INFERIOR BORDERS	5.2	4.2	6.8	6	5.2	7.5	5.8	5.6	4.7	5.1	5.3	4.8	4.6	5.1	4.9	5.68
5	HEIGHT	28	21	26	20	34	22	24	28	13	14	27	21	24	22	24	23.2
6	VARIATION IN ORIGIN	+	-	-	-	+	-	+	+	-	+	-	-	-	-	-	
7	VARIATION IN INSERTION	-	-	+	+	-	-	+	-	+	-	-	-	-	+	-	

variation. Otherwise, angle ranged from 90° to 140°.

Surface marking: The depth is measured from the base of moderator band, to the apex, the mean value is found to be 5.41cm to the junction between the right and inferior borders: the mean value is found to be 5.68cm

Height: It is measured from the centre of the septal cusp to the base of the moderator band. The mean value is found to be 23.2mm ranging from 13.0mm to 34.0mm.

OBSERVATIONS

Variations are found in the moderator band at different levels which are remarkable. Out of the 15 hearts that were chosen as the specimens for the study, 10 hearts had the moderator bands that were arising and getting inserted without branching. The other 5 specimens showed moderator bands which were branched i.e., the bands had either more than one origin or more than one insertion points.

In two of those four moderator bands, the band was found to be originating as two slips which later united to travel as a single band further. In the other two bands that were assessed, band was originating as a single entity but inserted to the base of APM with two slips. The two slips were getting inserted separately at the anterior papillary muscle or to the ventricular wall.

There was one specimen (specimen 5) which had three anterior papillary muscles. The same specimen was found with an angle of 80° from the plane of inter-ventricular septum to the longitudinal axis of the band. This angle usually ranges around 115°. Here the origin of moderator band is placed in a deeper plane than the APM. Hence the upturned course of the band, that makes an acute angle with septum than the usual obtuse angle. In one heart, it was found that after the moderator band got partially inserted into the base of the APM, the band was extending till the anterior wall of the right ventricle (**Fig. 1**)

Fig. 1: Observe the moderator band extending to get inserted into the anterior wall of the right ventricle. The base of the APM had to be dissected to observe the further insertion of moderator band.

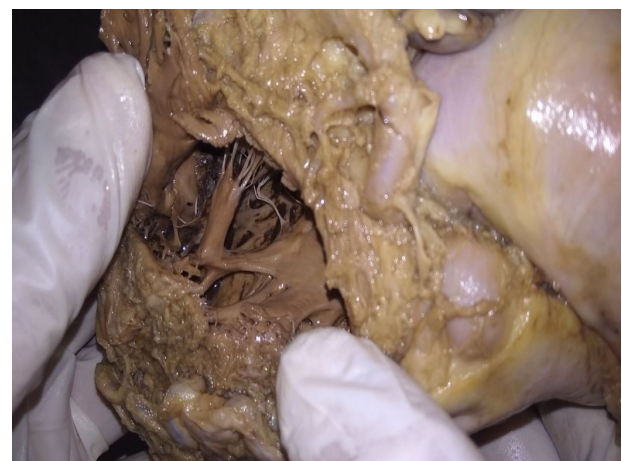


Fig. 2: showing the origin of moderator band (orange circle). The blue line indicates the usual course. The orange lines indicate the distance of the origin of moderator band from apex and from the lower end of right border.

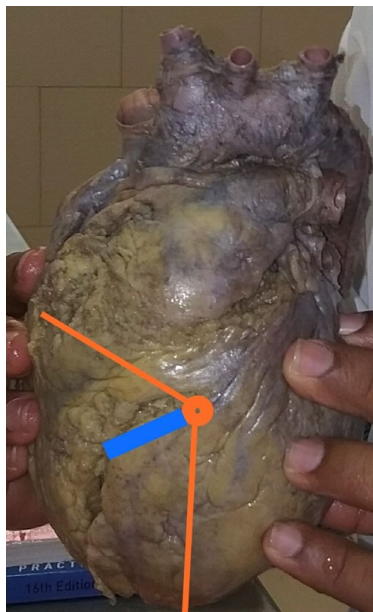
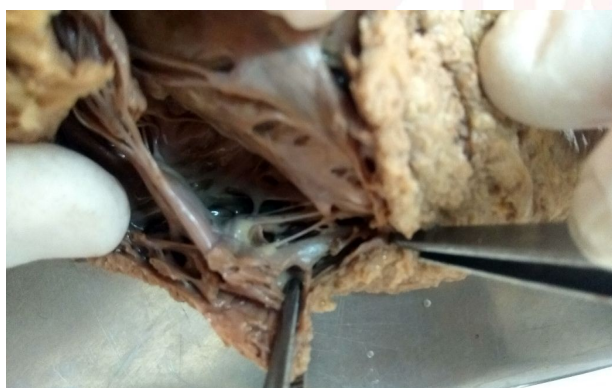


Fig. 3: Observe the two separate moderator bands getting inserted to three APMs. One of them measured 1mm.



DISCUSSION

The anatomical study of moderator band is very important in correction of high located congenital ventricular septal defects [15]. A hypertrophy of moderator band can lead to double chambered right ventricle and which in turn leads to the stenosis of pulmonary outlet [16]. The result obtained as shown in parameter table is compared with the few similar studies. In Praveen Shenoy et al [17] study, the mean length was found to be 15.06mm as well as the surface marking is also agreeable with our study (**Fig. 2**). In Loukas M et al [14] study, 42% of the hearts were short and thick with a mean length of 16.23 +/-2.3 mm. In our study is in agreeable with the mean deviation with these two studies.

In the study of Adam Kosinski et al [18], the thickness ranged from 3 to 5mm in 56% of the hearts. In Loukas M et al [14] study, the mean thickness was 4.5+/-1.8mm with a range of 1.3 to 8.4mm which tallies with the values we obtained. In Mamatha H et al [19] study the mean thickness found is near match with our study. In their study they found one moderator band of 1mm thick. In our study too we have found a specimen with 1mm thickness. However in our study the thickness differs at the origin, the midpoint and at the insertion, the origin of false chordae tendinae which agrees with the Praveen Shenoy M et al study [20].

In the study of Praveen Shenoy et al [17], the mean angle got was 115° with a narrow angle of 110°-120°. In Raghavendra A Y et al [20] study, the mean height is found to be 36mm, but in our study it is found to be 23.2mm.

In our study we found 5 hearts with two or more insertion and origin. In 1 heart 2 moderator bands were observed in which one of them measured 1mm (**Fig. 3**).

CONCLUSION

In our study, the surface marking of the moderator band on sternocostal surface of the right ventricle is done. The procedure elaborated here will help the surgeons and in echocardiography to precisely locate the moderator band. By the observation of various specimens, it can be concluded that the moderator band need not originate or get inserted as a single strand. Strands of the moderator band can arise and get inserted as more than one slips. It is confirmed that the thickness of the moderator band varies along its course. The origin of the moderator band usually lies at a higher plane than its insertion. This is confirmed by obtaining an obtuse angle between the superior part of interventricular septum and the trabecula. It was also found that false chordae tendinae can arise from the moderator band.

ABBREVIATIONS

APM - Anterior papillary muscle

IV septum - Inter- ventricular septum

Conflicts of Interests: None

REFERENCES

- [1]. Peter L Williams: Grays Anatomy. 39th edition, Churchill Living stone. 2005, pp 1002-1003.
- [2]. King T.W. An essay safety-valve function in the right ventricle of the human heart and the gradations of this function in the circulation of warmed-blooded animals. *Guy's Hosp. Rep.* 1837;2:104-178.
- [3]. Tandler J. Anatomie des Herzens [German] Gustav Fischer, Jena. 1913; 1-3
- [4]. S Y Ho, P Nihoyannopoulos. Anatomy echocardiography and normal right ventricular Dimensions Heart. 2006; 92(Suppl 1):2-13.
- [5]. Kosiński A, Grzybiak M, Nowiński J, Kędziora K, Kuta W, Dbrowska-Kugacka. Morphological remarks regarding the structure of conduction system in the right ventricle. *Kardiologia Pol.* 2012; 70(5):472-476.
- [6]. Geoffrey Farrer-Brown, Vascular Pattern of Myocardium of Right Ventricle of Human Heart. *Brit. Heart J.*, 1968;30:679.
- [7]. Reig J, Albertí N, Petit M. Arterial vascularization of the human moderator band: an analysis of this structure's role as a collateral circulation route. *Clin Anat.* 2000; 13(4):244-50.
- [8]. H M Haupt, G M Hutchins, G W Moore. Right ventricular infarction: role of the moderator band artery in determining infarct size. *Circulation.* Jun 1983; 67(6):1268-72.
- [9]. Sadek MM, Benhayon D, Sureddi R, Chik W, Santangeli P, Supple GE et al. Idiopathic ventricular arrhythmias originating from the moderator band: Electrocardiographic characteristics and treatment by catheter ablation. *Heart Rhythm.* 2015 Jan. 12(1):67-75.
- [10]. SR Mittal. Moderator Band Wrongly Interpreted as RV Mass. *JAPI.* August 2012; 60:1-3.
- [11]. Wong PC, Sanders SP, Jonas RA, Colan SD, Parness IA, Geva T et al. Pulmonary valve moderator band distance and association with development of double-chambered right ventricle. *The American journal of cardiology.* 1991 Dec 15; 68(17):1681-6.
- [12]. Haddad F, Couture P, Tousignant C, Denault AY., The right ventricle in cardiac surgery, a perioperative perspective: II. Pathophysiology, clinical importance, and management *Anesth Analg.* 2009 Feb; 108(2):422-33.
- [13]. W. Turner. Moderator Band in Left Ventricle and Tricuspid Left Auriculo-Ventricular Valve. *J Anat Physiol.* 1898 Apr; 32(Pt 3):373-376.
- [14]. Loukas M, Klaassen Z, Tubbs RS, Derderian T, Paling DA, Chow D, Patel S, Anderson RH. Anatomical observations of the moderator band. *Clinical Anatomy.* 2010 May 1;23(4):443-50.
- [15]. Richard A Jonas., *Comprehensive Surgical Management of Congenital Heart Disease.* J R Soc Med. 2004 Aug; 97(8):407-408.
- [16]. Theodoros Xanthos, Ioannis Dalivigkas, Konstantinos A. Ekmektzoglou. Anatomic variations of the cardiac valves and papillary muscles of the right heart. *IJAE* 2011; 116(2):111-126.
- [17]. Praveen Shenoy, Martin Lucas, Vinay KV, Amith Ramos. Morphometric study of septomarginal trabeculae (moderator band). *Int J Anat Res* 2016;4(4):3302-3308.
- [18]. Adam Kosiński, Dariusz Kozłowski, Janusz Nowiński. Morphogenetic aspects of the septomarginal trabecula in the human heart, *Arch Med Sci.* 2010 Oct; 6(5): 733-743
- [19]. Mamatha H, Divya Shenoy, Antony Sylvan D' Souza, Prasanna LC, Suhani Sumalatha. Morphometric Study on the Septomarginal Trabeculae in South Indian Cadavers. *RRJMHS* 2013;2 (2):65-70.
- [20]. Praveen Shenoy M, Martin Lucas A, Morphological and Morphometric study of Septomarginal trabeculae (moderator band). *GJRA - GLOBAL JOURNAL FOR RESEARCH ANALYSIS.* 2018;7(2):451-482.
- [21]. Raghavendra AY, Kavitha AK, Tarvadi P, Harsha CR. Anatomical study of the moderator band. *Nitte University Journal of Health Science.* 2013;3(4).s

How to cite this article:

Shrikanya M Shet, Kuldeep M D, Sheela G Nayak, V S Pare, Jyothi S R, M P Shenoy. MORPHOMETRIC AND MORPHOLOGICAL STUDY ON THE SEPTOMARGINAL TRABECULA. *Int J Anat Res* 2018;6(3.1):5458-5463. DOI: 10.16965/ijar.2018.238