

Variations in the pattern of mitral valve leaflets in normal human hearts

Shamim Akhtar Cheema, Anjum Jalal, Naseem Feroz and Jawed Sajid Khan.
Department of Anatomy, Allama Iqbal Medical College, Punjab Institute of Cardiology,
Department of Anatomy, Federal Postgraduate Medical Institute, Shaikh Zayed Hospital and
Department of Cardiovascular Surgery, King Edward Medical College, Lahore.

SUMMARY

Although the mitral valve is known as bicuspid valve by clinicians yet the pattern of the posterior mitral leaflet is highly variable. We have studied 29 hearts of healthy human subjects died in road-side accidents. They included 23 males and 6 females with the mean age of 30.2 ± 10.51 years. The mitral valve was exposed by removing left atrium and gross appearance of cusps at the middle and subvalvular apparatus was exposed. We observed that 17 out of 29 hearts had unicalloped posterior leaflet. Six had one extra scallop at anterolateral commissure and three at posteromedial commissure. Seven heart had triscalloped posterior cusp i.e. one major scallope at middle and one each at commissural areas. This finding have been compared with those of previous studies. There is controversy in literature about considering the scallopes as separate cusp. We believe that the mitral valve is fundamentally a bicuspid structure with indentations at the free margin of posterior cusp which give it a scalloped appearance. However, the scallops at the commissures cannot be called cusp at their own merit.

INTRODUCTION

The mitral valve which is known to the clinicians as bicuspid valve has a lot of variation in its gross appearance. It consists of a large anterior (aortic) and an extensive posterior (mural) leaflets. The posterior leaflet has a number of indentations on its free edge commonly near the commissural areas. The indentations result in a scalloped appearance of the posterior leaflet and their is controversy about considering these scallops as separate cusps.

In this paper we have highlighted our own observations made on 29 normal human hearts and we believe that the posterior leaflet is a scalloped structure and the scallops themselves do not merit to have independent status. This point of view is in line with the studies of other workers discussed in appropriate section. Moreover, the normal function of the valve also strengthens this point of view as described later on.

MATERIALS AND METHODS

Twenty nine human hearts obtained from the forensic department of King Edward Medical College, Lahore were studied. The cause of death in these cases

was such as could not produce any change in the gross anatomy of the heart. The majority of the subjects were young adults and their mean age was 30.2 ± 10.51 years. They included 23 male and 6 female subjects.

The atrial view of the mitral valve was exposed by removing the left atrium. The gross appearance of the mitral valve and the pattern of cusps was noted down meticulously. The annulus was then cut at the middle of the posterior cusp extending into the wall of the left ventricle. A few false chordae were removed. The whole procedure resulted in a very elaborate and nice view of the valve with anterior leaflet in the middle, the anterolateral half of the posterior leaflet on the left and the posteromedial half of the posterior leaflet on the right side. The areas where the anterior and the posterior leaflets were in close apposition were labelled as commissures. It is the commissural areas where additional scallops of the posterior leaflet were noted.

RESULTS

Anterior Mitral Leaflet

The anterior mitral leaflet was always single. There was no notching or cleft. The shape of the leaflet

resembled letter 'D' with slightly larger basal length than vertical height. The mean basal length was 3.952 ± 0.602 cm in males and 3.173 ± 0.402 in females. The average height was 2.517 ± 0.267 cm in males and 2.133 ± 0.383 cm in females. The 3/4 of this height was contributed by the free zone of the leaflet and 1/4 consisted of the positional zone. This ratio was similar in both sexes.

Posterior Mitral Leaflet

We considered the posterior leaflet according to the definition given by Ranganathan et al¹ as all tissue posterior to the commissural area. However, this tissue is never a single and continuous leaflet as is the anterior leaflet. There were tiny creases which in various hearts were deep enough to exhibit indentations of the free edge. This gave rise to formation of more than one scallops. According to the number and arrangement of these scallops we have divided these specimens in three groups as follows:

Group I

This group contained those hearts which had a single posterior leaflet. The majority of subjects i.e. 17/29 belonged to this group.

The average basal length in these cases was 3.54 cm in males and 3.927 cm in females. The average height was 1.15 cm in males and 1.763 cm in females.

Group II

This group contained those hearts which showed division of posterior leaflet into two scallops. The basal length of the leaflet was divided among these scallops symmetrically i.e. There was no uniform pattern that which scallop will be the bigger one. Therefore according to the location of the smaller scallops this group was further divided into two subgroups i.e. subgroup II-a &

Subgroup II-a had an extra scallop at anterolateral commissural area. It consisted of three hearts which were all males.

Subgroup II-b had additional scallop at posteromedial commissural area. It also consisted of three hearts which were again all from male subjects.

Group III

Group III contained hearts which had posterior leaflet divided in three scallops. The extra scallops were located at both anterolateral and posteromedial

commissures and the basal length was divided asymmetrically. The group had seven hearts out of which six were from male and one from female subjects.

Table 1 & 2 show the number of scallops and comparison of data from similar studies done by other workers.

Table 1: Scallops of Posterior Mitral Leaflet in 23 Male and 6 Female Hearts.

Pattern	Male Hearts	Female Hearts	Total
Uniscalloped	11	5	16
Biscalloped	6	0	6
Triscalloped	6	1	7
Total	23	6	29

Table 2: Comparison of the Results of Various Studies Regarding the Number of Scallops of Posterior Mitral Leaflet.

Pattern	Chiechi		Ranganathan		Present Study	
	n	%	n	%	n	%
Uniscalloped	41	39	nil	0	16	55
Biscalloped	42	40	2	4	6	21
Triscalloped	22	21	46	92	7	24
Quadriscalloped	nil	0	2	4	nil	0
Total	105	100	50	100	29	100

DISCUSSION

The description of the cusps or leaflets of the mitral valve has always been a big issue. A corollary of terms exists in the literature which serves only to increase confusion of readers. It proves the diversity in the gross appearance of a normal mitral valve which is so simply called as bicuspid valve by most of the clinicians.

The best way to avoid confusion is to divide the continuous veil of the valve tissue into anterior and posterior leaflets according to the description of Ranganathan et al¹. They proposed to consider posterior leaflet as all tissue posterior to the commissural area. Ranganathan et al have stated that posterior leaflet as defined above had indentations at its free edge and hence had a scalloped appearance. However, they do not consider these scallops as accessory cusps or leaflets.

On the contrary since early 1952 there existed the concept of additional commissural leaflets. This idea was put forth by Harken and his colleagues². They stated that 75% of the hearts they studied contained additional commissural leaflets. Although this study had a big logistic evidence in favor of additional commissural leaflets yet it was immediately counterblasted by the views of Rusted et al³. They preferred to regard the

posterior leaflet as one unit and stated that the tiny indentations were present in only 5% of the hearts they studied. Even in these cases they were reluctant to label any area between such indentations as separate or additional leaflet. Nevertheless, they admitted that folding and pleatings were very common in the posterior leaflet to an extent of 42%. Chiechi et al⁴ also had similar view in denting the existence of separate commissural cusps and considered them as scallops of a single posterior leaflet.

In a recent article Victor and Navak⁵ have tried to deal with this controversy from a functional point of view. They believe that the inconstant commissural scallops varying in size and number do not merit an exclusive status. They have stressed that during diastole these extra scallops allow the central part of the mural leaflet to move away from the anterior leaflet by unfolding. In other words these scallops are the integral part of the posterior leaflet to play some specialized role in the normal functioning of it.

There have been some attempts to define the individually of any cusps or leaflets on the basis of areas separating them. This brought forth a large number of terminology like commissures cleft, slits and junctional zones etc. Majority of these terms need definition of other structures like chordae tendinae and papillary muscles. Unfortunately these structures are themselves highly variable in their own pattern. This variability of pattern has been elaborated beautifully by various authors including Victor and Navak⁵ and Becker & De wit⁶. Thus the significance of terms defined in this way becomes highly questionable and therefore Robert H. Anderson is justified to point that it is a less than perfect philosophical principle to define one variable structure in terms of another structure which is itself variable⁷.

CONCLUSIONS

The normal mitral valve has two leaflets separated by two commissures. The anterior leaflet single and its free edge does not contain any indentations. Posterior leaflet is quite often notched indentations and therefore is divisible into various scallops. These indentations are never deep enough to be called commissures and therefore all the scallops are considered as a part of posterior leaflet and not as accessory cusps.

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