Chapter 5 OBSERVATION & RESULT

Anatomy of the heart was described by using 100 specimens of the heart. The specimens were described in context of tricuspid valve, bicuspid valve, aortic valve and pulmonary valve. Eustachian Valve, Coronary Sinus, Thebesian Valve, Chiari Network and left venous valve remnant were also described. All the specimen were carefully observed for variations.

Tricuspid Valve

➢ 5.1 : Topographic Variables Of Tricuspid Valve

Variables of tricuspid valve in number of cusp, shape, number of papillary muscles attached, number of cleft present, number of scallops presents on each cusp were observed as follow.

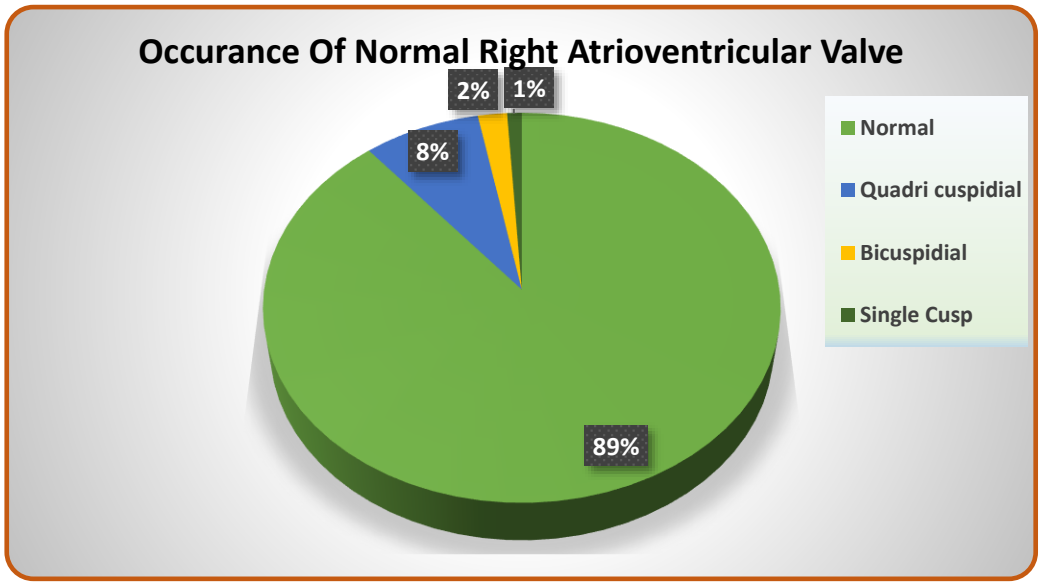
5.1.1 No.Of Cusp Of Right Atrioventricular Valve

Table- 5.1 No. Of Cusp Of Right Atrioventricular Valve

No.Of Cusp Of Right Atrioventricular Valve		Frequency	Percentage
Normal (Tricuspid)		89	89.00%
Abnormal	**Quadricuspidial**	08	8.00%
	Bicuspidial	02	2.00%
	Single Cusp	01	1.00%
Total		100	100.00%

The table no.5.1 describes the incidence of normal tricuspid valve in present study. Tricuspid valve was considered normal if it had three cusps. If there was presence of an additional cusp or a missing cusp, then it was considered as abnormal. Out of total specimen, 11% had abnormal valve among which an additional cusp (four cuspidial) in 8 specimen (Figure No 5.1 & Figure 5.5) and missing cusp (Bicuspidial) (Figure No 5.2) in 2 specimen and in one specimen single cusp was found which was extending along the entire peripheral margin of annulus.(Figure No.3)

Graph- 5.1 No. Of Cusp Of Right Atrioventricular Valve



Among total 100 heart were studied among which 100, 99, 97, 08 number of anteriosuperior cusp, septal cusp, inferior cusp ,additional cusp were found reapectively.

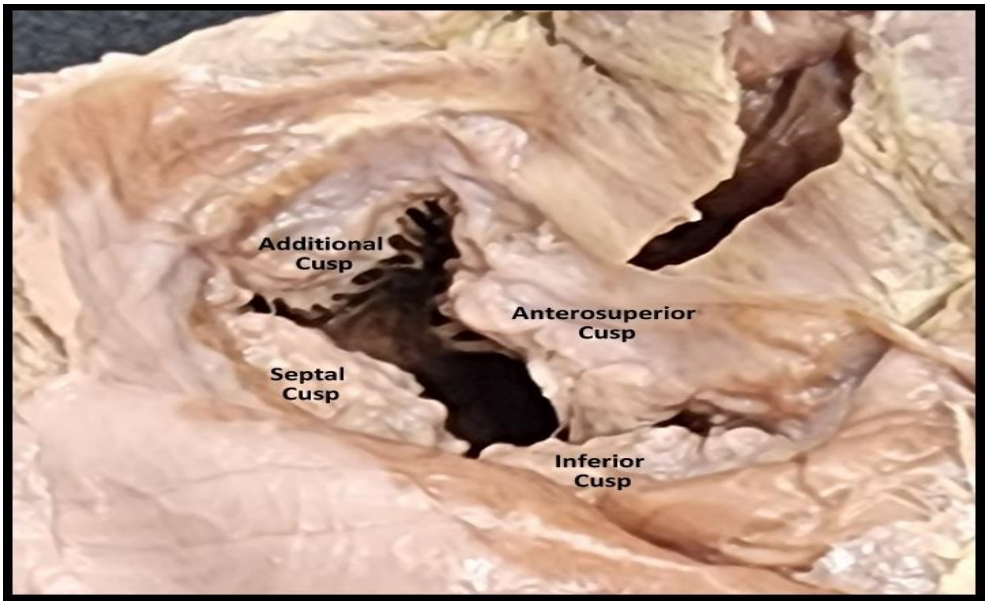


Figure 5.1: Four Cuspidial Right Atrioventricular Valve

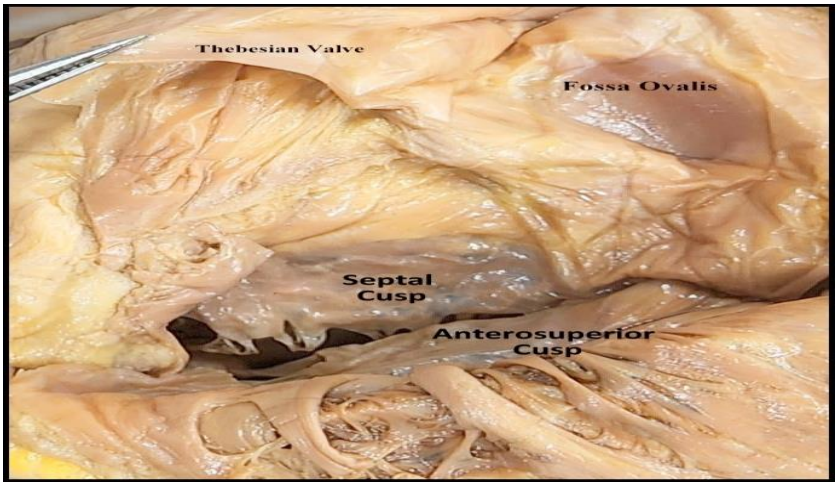


Figure 5.2: Bicuspidial Right Atrioventricular Valve

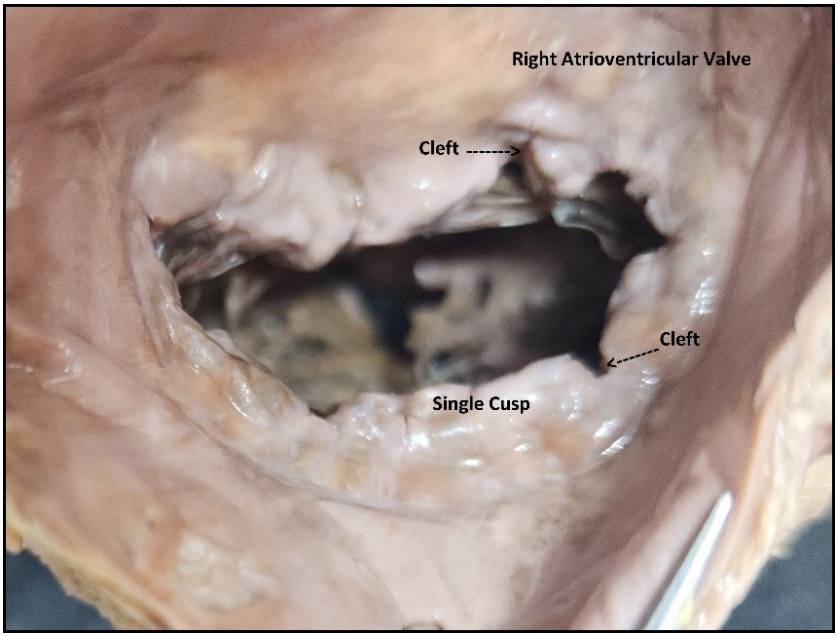


Figure 5.3: Single Cusp Right Atrioventricular Valve

5.1.2 Shape Of Cusps Of Tricuspid Valve

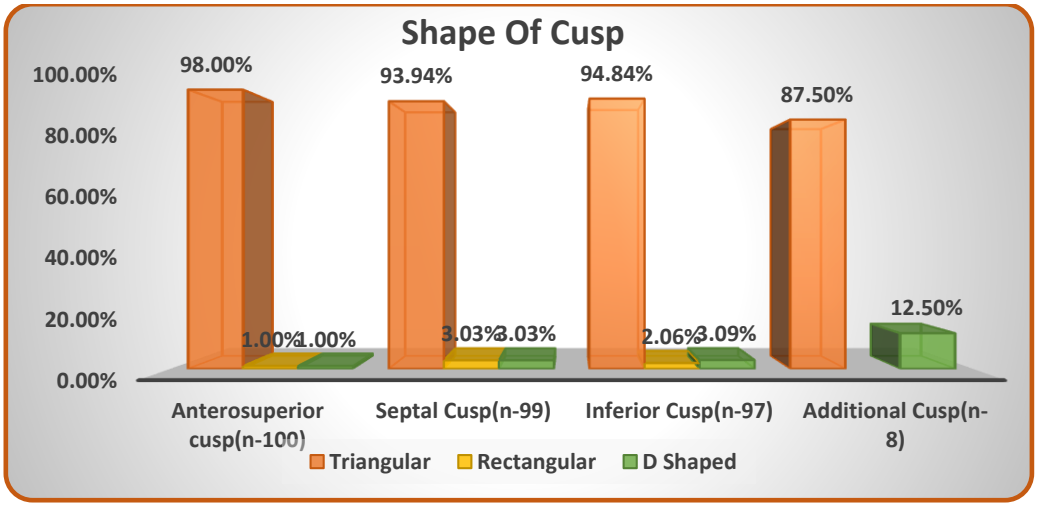
All three cusps of tricuspid valve were observed for their shapes. The shapes of cusp seen were triangular , rectangular (Figure 5.4) and D shaped.(Figure 5.5)

Table 5.2- Shape of Anterosuperior, Septal And Inferior Cusps

Name of Cusp	Shape of Cusp	Frequency	Percentage
Anterosuperior cusp (n-100)	Triangular	98	98.00%
	Rectangular	01	01.00%
	D Shaped	01	01.00%
Septal (n-99)	Triangular	93	93.94%
	Rectangular	3	3.03%
	D Shaped	3	3.03%
Inferior (n-97)	Triangular	92	94.84%
	Rectangular	2	2.06%
	D Shaped	3	3.09%
Additional (n-8)	Triangular	7	87.50%
	D Shaped	1	12.50%

Anterosuperior cusp was observed in 100 specimens with a maximum frequency (n=98) for triangular shape. Septal cusp was observed in 99 specimens with a maximum frequency (n=93) for triangular shape. Inferior cusp was observed in 97 specimens with a maximum frequency (n=92) for triangular shape. Additional cusp was observed in only 8 specimens with maximum frequency (n=7) for triangular shape.

Graph 5.2- Shape of Cusp



All cusps of right atrioventricular valve: Anteriorsuperior cusp, Septal cusp, inferior cusp were of triangular shape in majority followed by rectangular and D shaped respectively. Additional cusp was found triangular shape in majority and D shaped.

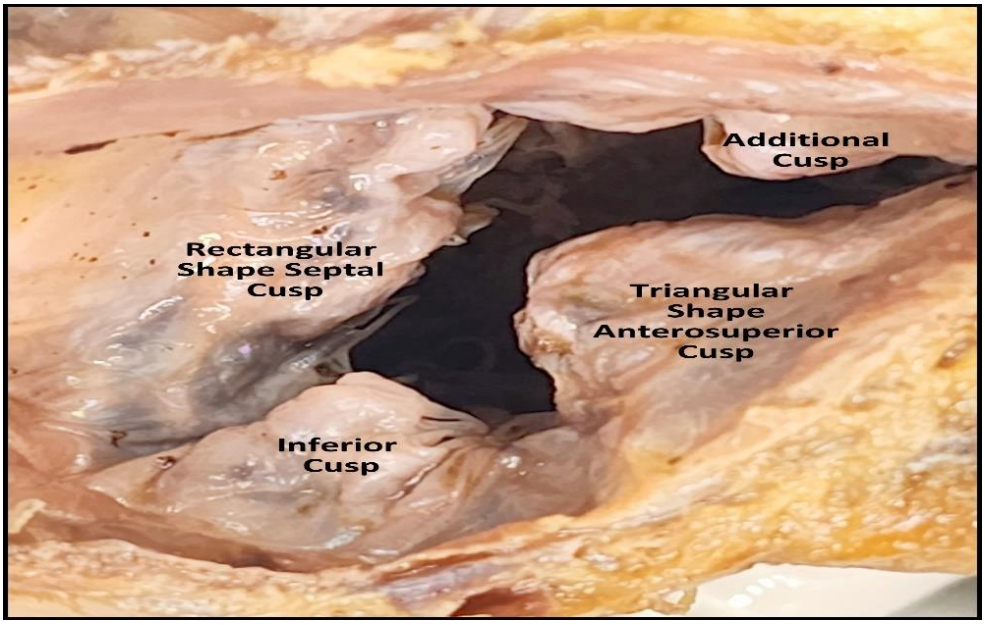


Figure 5.4: Triangular and Rectangular Shape Of Cusp

Figure 5.5: D Shaped Cusp Of Tricuspid Valve

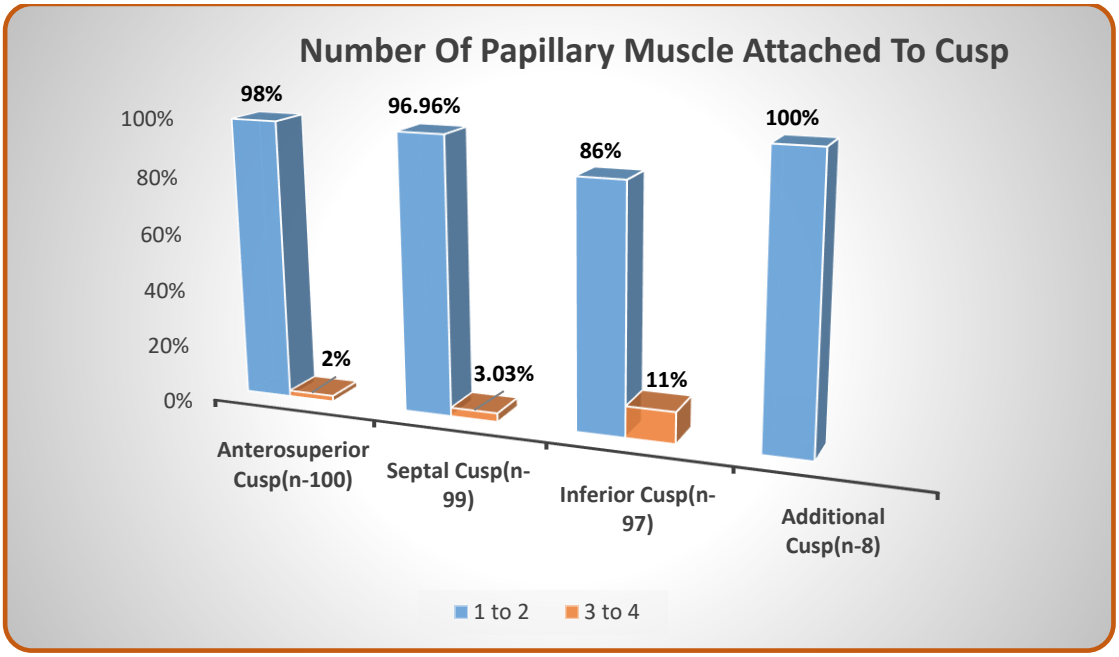
5.1.3 Number of Papillary Muscle Attached To Each Cusp

Table 5.3 -No of Papillary Muscle Attached to Cusp

Cusp	Number Of Papillary Muscle	
	1-2	3-4
Anterosuperior cusp (n-100)	98 (98.00%)	02 (2.00%)
Septal Cusp (n-99)	96 (96.96%)	03 (3.03%)
Inferior Cusp (n-97)	86 (88.65%)	11 (11.34%)
Additional Cusp (n-8)	8 (100%)	00

1-2 papillary muscles were attached to anterosuperior cusp in 98%, septal cusp in 96.96 %, inferior cusp in 88.65% and additional cusp in 100% of the specimen.While 3-4 papillary muscles were attached to anterosuperior in 02%, septal in 3.03%, inferior in 11.34% of specimens. Additional cusp was attached to maximum 2 papillary muscle not more than it.

Graph 5.3 -No of Papillary Muscle Attached to Cusp



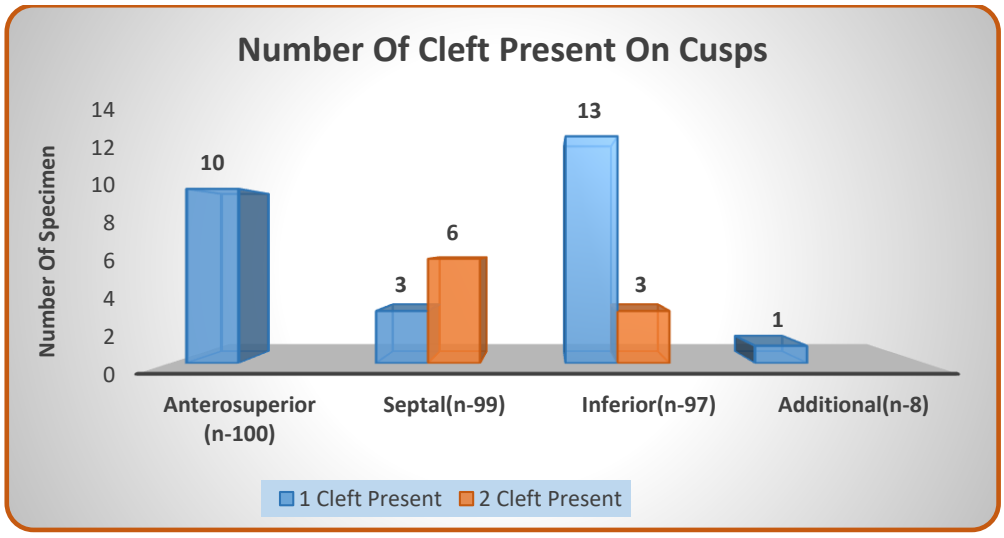
5.1.4 Number Of Cleft Present In Each Cusp

Table 5.4 -No of Cleft Present on the cusp

Cusp	No of Cleft	Frequency	Percentage
Anterosuperior (n-100)	0	90	90.00%
	1	10	10.00%
Septal(n-99)	0	90	90.90%
	1	3	3.03%
	2	6	6.06%
Inferior(n-97)	0	81	83.50%
	1	13	13.40%
	2	3	3.09%
Additional(n-8)	0	7	87.50%
	1	1	12.50%

Clefts were observed in all cusps. Inferior cusp showed maximum clefts with a frequency of 13 specimens with 1 cleft and 3 specimens with 2 cleft, anterosuperior cusp showed 1 cleft in 10 specimens, septal cusps showed 1 clefts in 3 specimen & 2 clefts in 6 specimens and additional cusps showed 1 clefts in 1 specimen.

Graph 5.4-No of Cleft Present On The Cusp



Two cleft were present in septal cusp 6.06% and inferior cusp in 3.09% specimen. One cleft was observed on Inferior cusp in 13.40% followed by additional cusp in 12.50%, anterosuperior cusp in 10%, and septal cusp 3.03% .

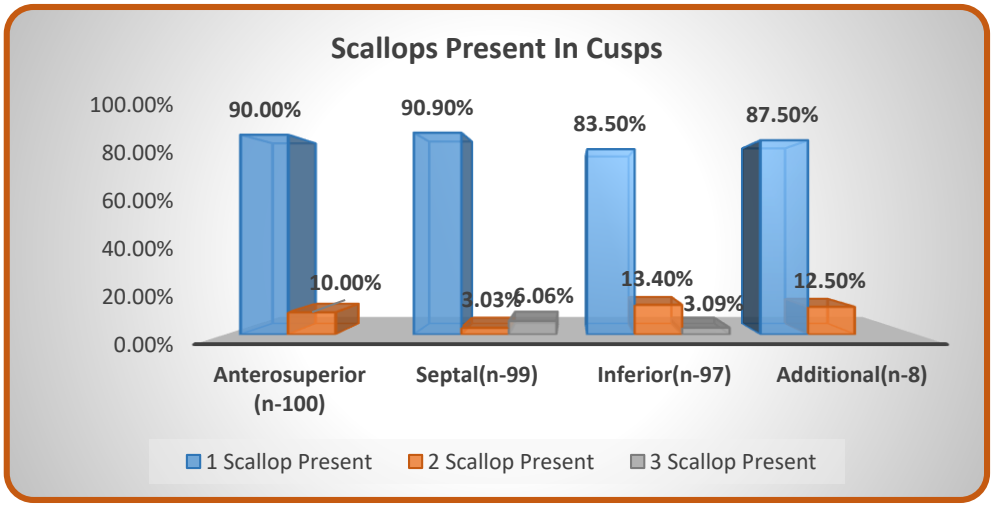
5.1.5 Number Of Scallops Present In Each Cusp

Table 5.5-No of Scallops on Cusp

Cusp	No of Scallops	Frequency	Percentage
Anterosuperior (n-100)	1	90	90.00%
	2	10	10.00%
Septal(n-99)	1	90	90.90%
	2	3	3.03%
	3	6	6.06%
Inferior(n-97)	1	81	83.50%
	2	13	13.40%
	3	3	3.09%
Additional(n-8)	1	7	87.50%
	2	1	12.50%

Scallops was observed on all cusps with a maximum of 3 scallops on inferior cusp in 3 specimens,2 scallops in 13 specimens and 1scallops in 81 specimen. Anterosuperior cusp showed 2 scallops in 10 specimens and 1 scallops in 90 sepcimen. Septal cusp showed 3 scallops in 6 specimens, 2 scallops in 3 specimens and 1 scallop in 90 specimens. Additional cusps also showed 2 scallops in 1specimen and 1 scallops in 7 specimens.

Graph 5.5-No of Scallops on Cusp



Three scallops were present only in septal cusp 6.06% and inferior cusp in 3.09%.Two scallops were observed on Inferior cusp in 13.40% followed by additional cusp in 12.50%, anterosuperior cusp in 10%, and septal cusp 3.03% .One scallop was present maximum in septal cusp in 90.90% followed by Anterosuperior cusp in 90%, additional in 87.50% and inferior cusp in 83.50%.

➢ 5.2 : Dimensions Of Variables Of Tricuspid Valve

Various morphometric measurements like length and width of cusps & annular circumference of tricuspid valve were measured with help of varnier caliper in mm. All the data was analysed as follow.

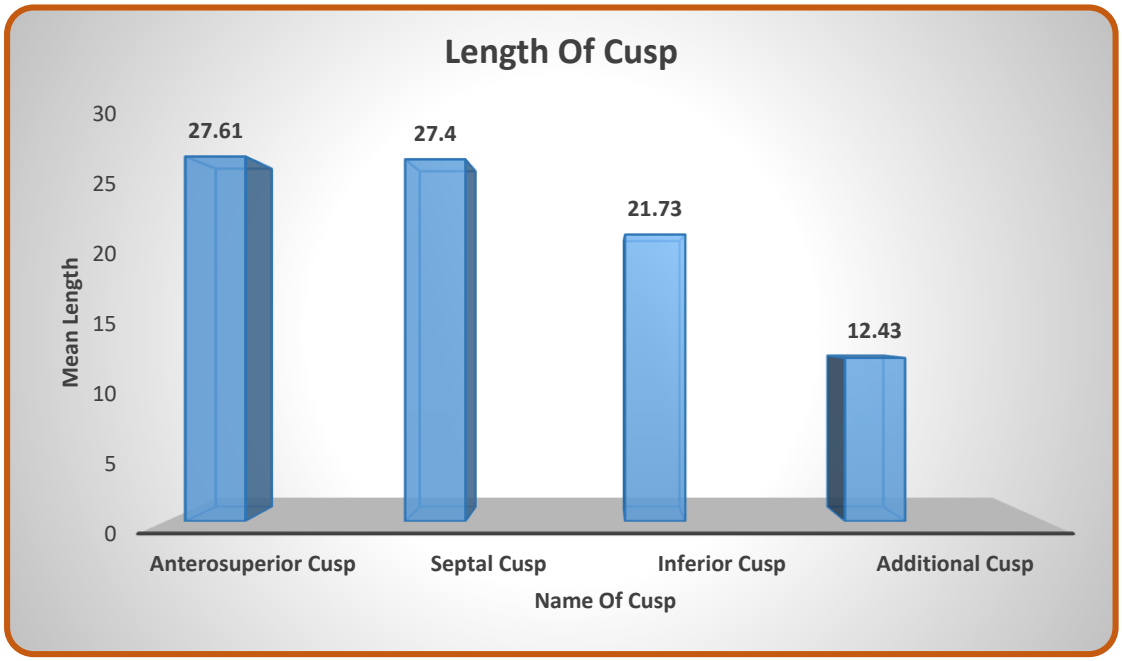
5.2.1 Length Of Anterosuperior, Septal And Inferior Cusp

Table 5.6: Length Of Cusps Of Tricuspid Valve

Length of Cusp (in mm)	Mean	Standard Deviation	Minimum	Maximum
Anterosuperior Cusp	27.61	6.84	10.91	64.92
Septal Cusp	27.40	4.84	14.20	42.80
Inferior Cusp	21.73	4.63	08.17	32.77
Additional Cusp	12.43	4.68	5.07	23.51

In present study mean length of anteriosuperior , septal, inferior cusp and additional was 27.61,27.40,21.73,12.43 mm with minimum 10.91,14.2,8.17,5.07 mm and maximum 64.92,42.82,32.77,23.51 mm respectively.

Graph 5.6: Length Of Cusps



The mean length of anterosuperior cusp was measured 27.61 ± 6.84 mm followed by septal cusp 27.40 ± 4.84 mm, inferior cusp as 21.73 ± 4.63 mm and that of the additional cusp was 12.43±4.68. In present study anterosuperior was found largest followed by septal,inferior and additional cusps.

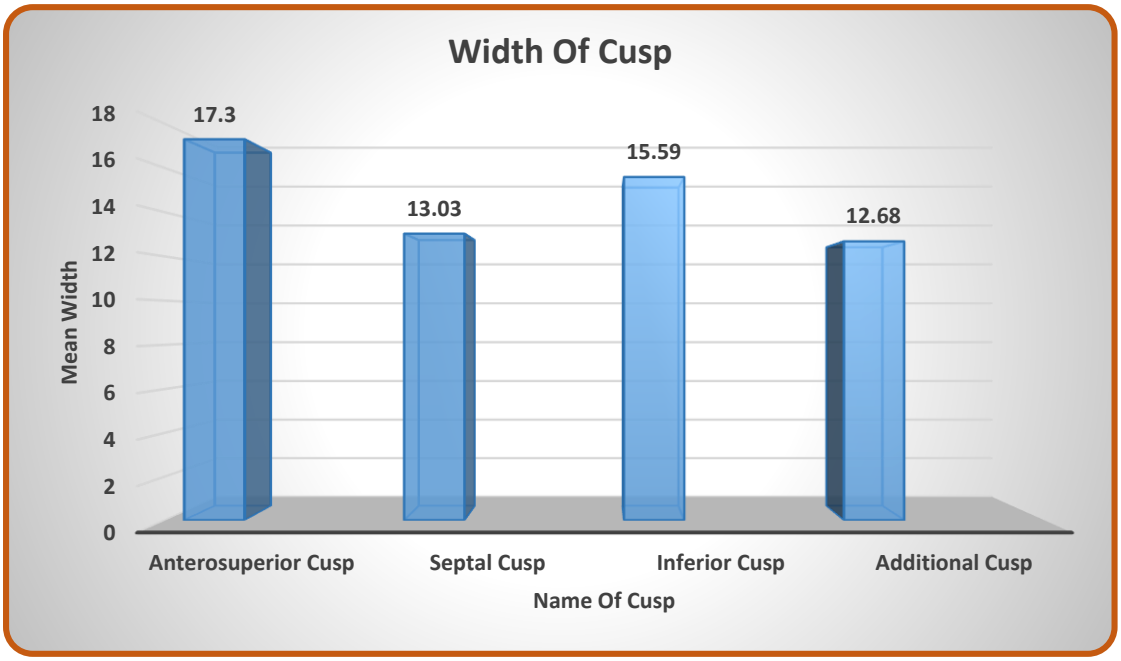
5.2.2 Width of Anteiorsuperior, Septal And Inferior Cusp

Table 5.7-Width Of Cusps Of Tricuspid Valve

Width of Cusp (in mm)	Mean	SD	Minimum	Maximum
Anterosuperior Cusp	17.30	3.10	8.02	28.57
Septal Cusp	13.03	3.03	7.12	23.79
Inferior Cusp	15.59	3.69	6.28	21.79
Additional Cusp	12.68	6.79	5.07	23.51

In present study mean width of anteriosuperior , septal, inferior and additional cusp was 17.30,13.03,15.59,12.68 mm with minimum 8.02,7.12,6.28,5.07mm and maximum 28.27,23.79,21.79, 23.51 mm respectively.

Graph 5.7 Width Of Cusps Of Tricuspid Valve.



The average width of anterosuperior cusp was measured as 17.29 ± 3.09 mm, septal cusp as 13.02 ± 3.03 mm, inferior cusp as 15.58 ± 3.69 mm and that additional cusp as 12.68± 6.79 mm. The anterosuperior cusp being largest followed by inferior, septal and additional.

5.2.3 Annular Circumference Of Tricuspid Valve

Table 5.8 - Annular Circumference Of Tricuspid Valve

Variable	Mean	Standard Deviation	Minimum	Maximum
Annular Circumference (in mm)	91.12	18.65	47.01	132.23

The annular circumference of tricuspid valve was measured as 91.12 ± 18.65 mm with values ranging from 47.01 to 132.23 mm.

Bicuspid Valve

➢ 5.3- Topographic Variables of Bicuspid Valve

Bicuspid valve was described and analysed for number, shape of cusp, number of papillary muscles attached to cusp, number of chordae attached to cusp, number of cleft present on cusp and number of scallops present on cusp as follow.

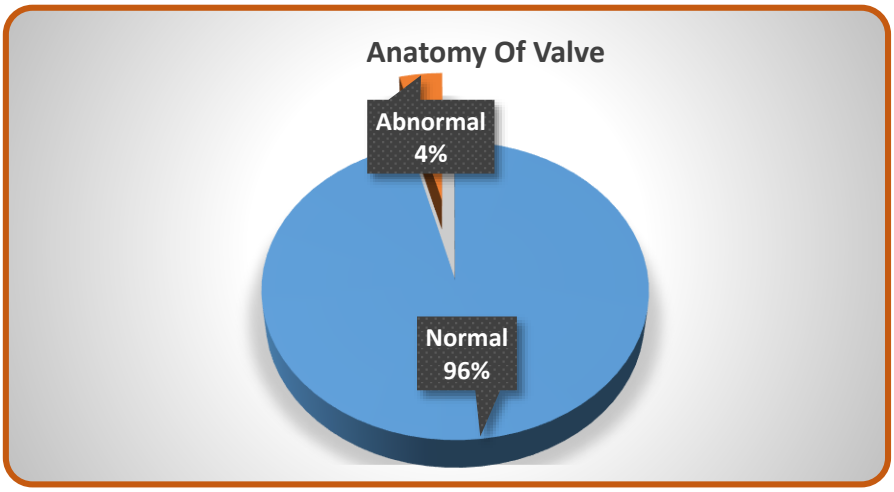
5.3.1 Distribution Of Valve

Table 5.9 -Anatomy of Bicuspid Valve

Bicuspid Valve	Frequency	Percentage
Normal	96	96.00%
Abnormal	04	4.00%
Total	100	100%

The table 5.9 describes anatomy of bicuspid valve. Bicuspid valve was considered normal if it had two cusps. If there was presence of an additional cusp or a missing cusp, then it was considered as abnormal. Out of total specimen, 96% had normal valve and 04% specimen had abnormal valve having additional cusp in it. (Figure 5.6)

Graph 5.8-Anatomy of Bicuspid Valve



Total 100 heart specimens were included in study among which anteromedial cusp and posterolateral cusp 100 number each while additional cusp o4 number were found.

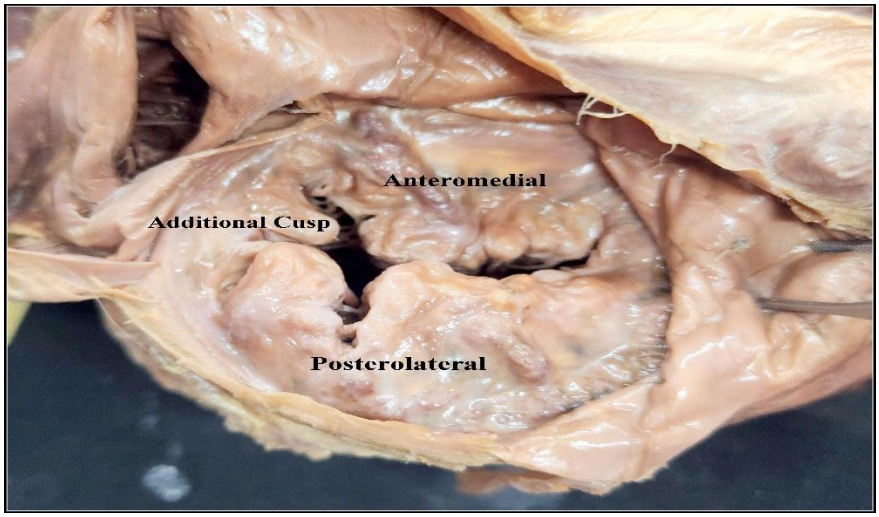


Figure 5.6: Presence Of Additional Cusp In Left Atrioventricular Valve

5.3.2 Shape Of Cusp Of Bicuspid Valve

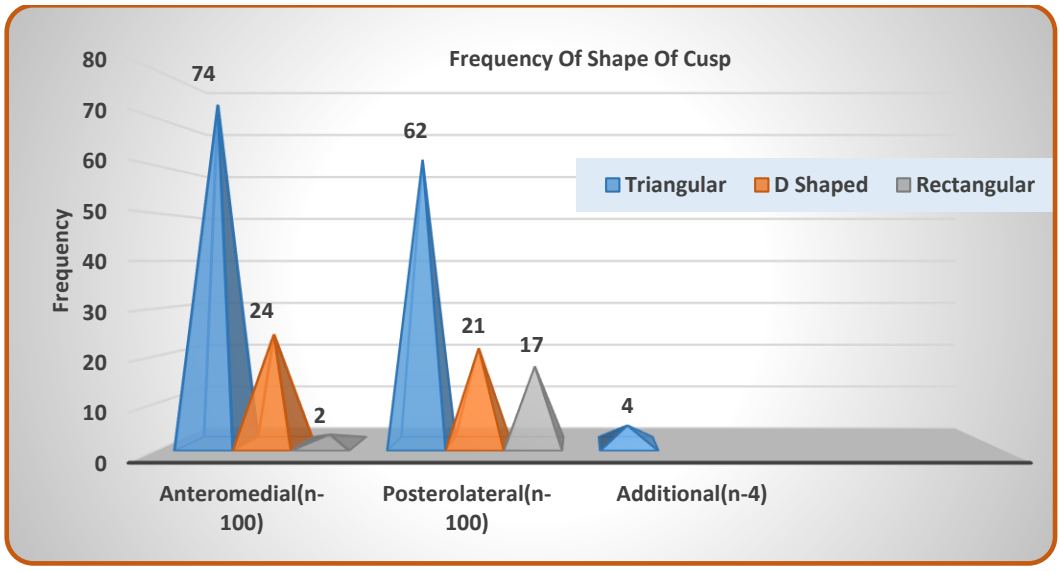
Shape of anteromedial, posterolateral and additional cusp was described either triangular, rectangular or D shaped.

Table-5.10 Shape Of Cusps Of Bicuspid Valve

Shape of Cusp	Frequency	Percentage
Anteromedial cusp(n-100)		
Triangular	74	74.00%
D Shaped	24	24.00%
Rectangular	2	2.00%
Posterolateral(n-100)		
Triangular	62	62.00%
D Shaped	21	21.00%
Rectangular	17	17.00%
Additional (n-4)		
Triangular	4	100.00%

Anteromedial cusp showed 74 specimens with triangular shape followed by 24 specimens with D shaped and 02 specimens with rectangular shape. Posterolateral cusp showed triangular shape in 62 specimens followed by D-shaped in 21 specimens and rectangular shape in 17 specimens. Additional cusp was observed in 4 specimens showed triangular shape in all specimens.

Graph 5.9-Shape of Cusp



In present study anteromedial and posterolateral cusps were of triangular followed by D shaped and rectangular. Among anteromedial and posterolateral triangular shape was 74% and 62%, D shape was 24% and 21% and rectangular shape was 2% and 17% respectively. Addtional cusp were found only of triangular in shape which was 4%.

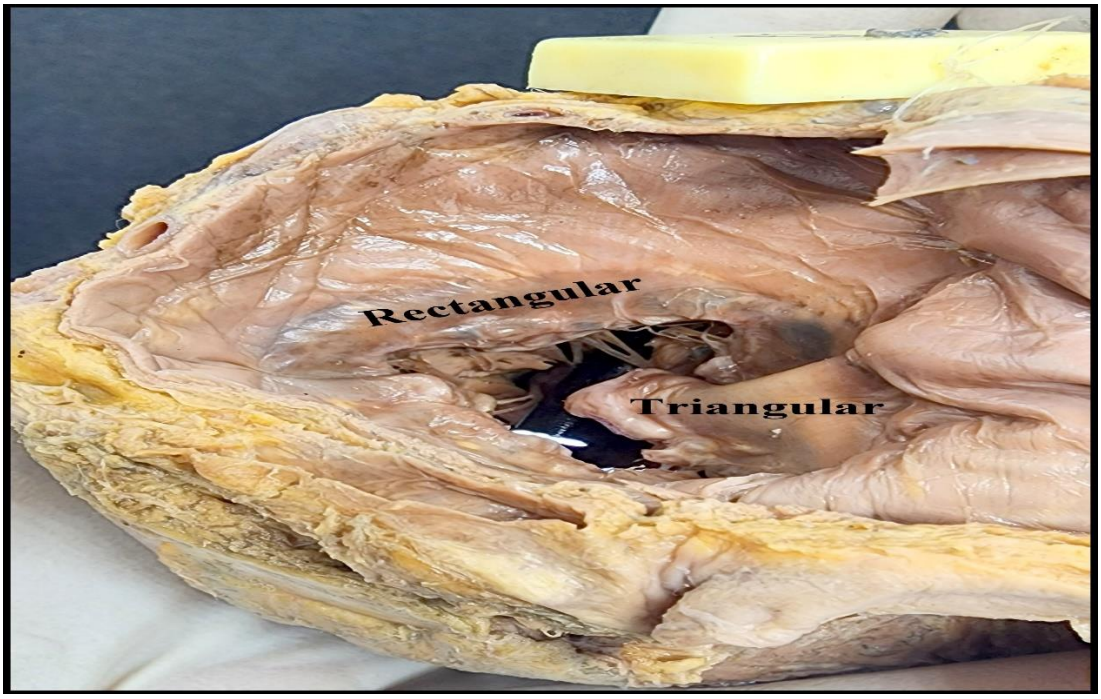


Figure 5.7 Rectangular & Triangular Shape Of Cusp

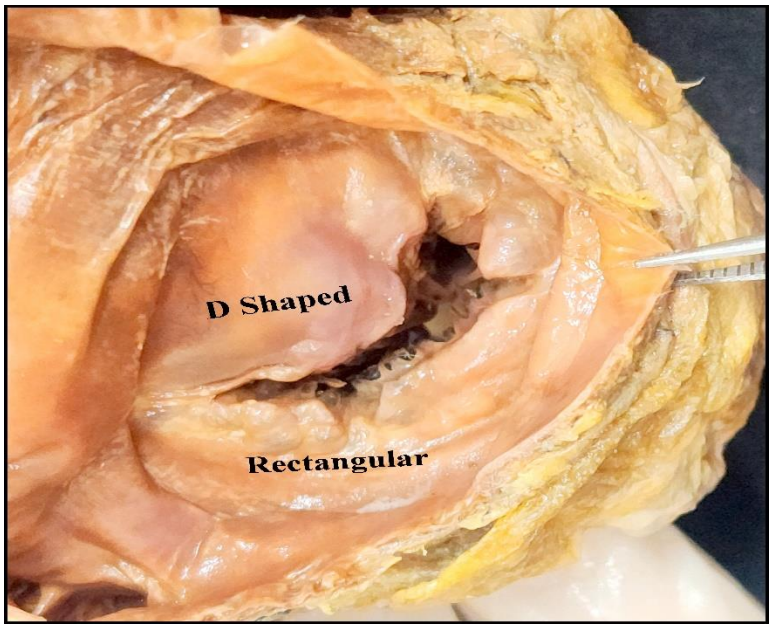


Figure 5.8 D Shaped And Rectangular Bicuspid Valve

5.3.3-Number Of Papillary Muscle Attached To Each Cusp

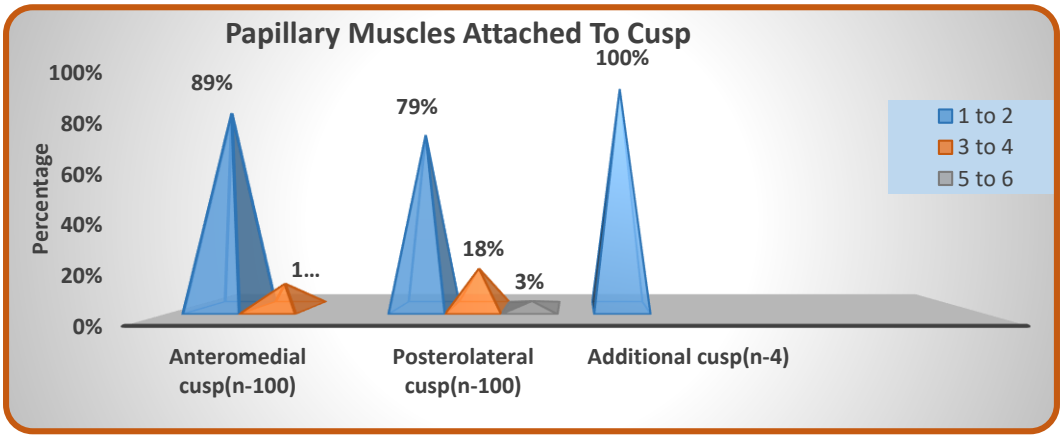
Papillary muscle were found to be attached with anteromedial, posterolateral and additional cusp which were anterior papillary muscle and posterior papillary muscle.

Table 5.11 Papillary muscle attached to Anteromedial Cusp

Cusp	No of Papillary muscles	Frequency	Percentage
Anteromedial cusp(n-100)	1-2	89	89%
	3-4	11	11%
Posterolateral cusp(n-100)	1-2	79	79%
	3-4	18	18%
	5-6	03	03%
Additional cusp(n-4)	1-2	08	100%

1-2 papillary muscles were attached to anteromedial, posterolateral, additional cusp in 89, 79, 8 of the specimens and 3-4 papillary muscles were attached to anteromedial, posterolateral cusp in 11, 18 of the specimens respectively while 5-6 papillary muscles were attached only to posterolateral cusp in 03 specimens. Additional cusp was attached to 1-2 papillary muscles not more than it.

Graph 5.10-No of Papillary Muscle Attached to Cusp



1-2 papillary muscles were attached to 89%, 79%, 100% specimens of anteromedial, posterolateral, additional cusp respectively. 5-6 papillary muscles were attached only to posterolateral cusp in 3% specimens.

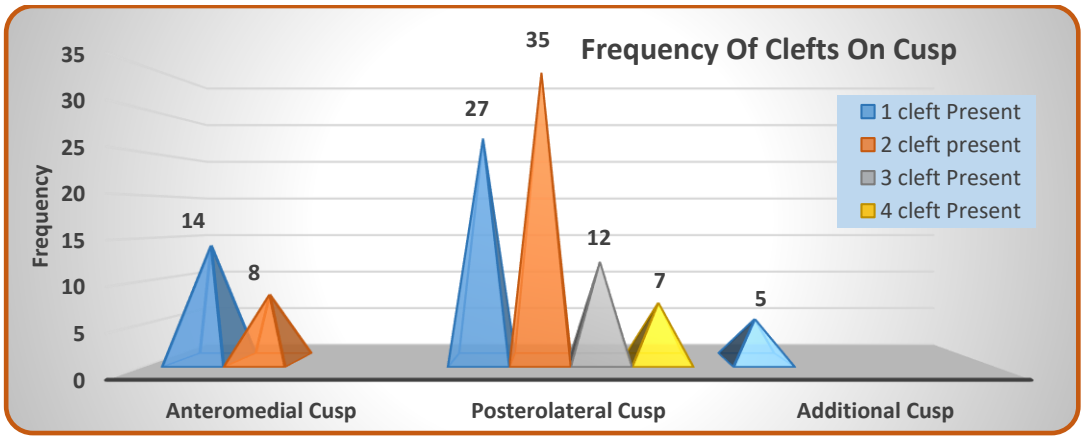
5.3.4 Number Of Cleft Present On Each Cusp

Table-5.12 No Of Cleft Present on The Cusp

No of Cleft	Frequency	Percentage
Anteromedial cusp		
0	78	78.00%
1	14	14.00%
2	8	8.00%
Posterolateral cusp		
0	19	19.00%
1	27	27.00%
2	35	35.00%
3	12	12.00%
4	7	7.00%
Additional		
0	95	95.00%
1	5	5.00%

Clefts were observed in all cusps. Posterolateral cusp showed maximum clefts with a frequency of 35 specimens with 2 clefts, 27 specimens with 1 cleft, 12 specimens with 3 clefts and 7 specimens with 4 clefts. Anteromedial cusp showed 1 cleft in 14 specimens and 2 clefts in 8 specimens. There were 5 specimens with 1 cleft in additional cusp.

Graph-5.11 No Of Cleft Present On The Cusp



Posterolateral cusp showed four and three clefts in 07% and 12% specimens respectively.Two clefts were 35% and 8% in posterolateral and anteromedial cusps.One cleft was 27%,14%,5% in posterolateral,anteromedial,additional cusp respectively. It was observed that maximum number of clefts were present in posterolateral cusp.(Figure 5.9)

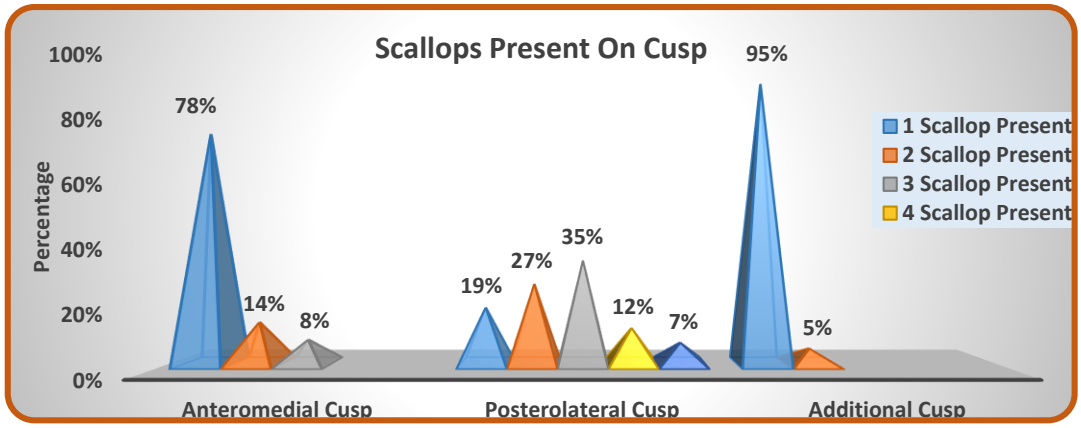
5.3.5 Number Of Scallops Present On Each Cusp

Table-5.13 No Of Scallops On Cusp

No of Scallops	Frequency	Percentage
Anteromedial cusp		
1	78	78.00%
2	14	14.00%
3	8	8.00%
Posterolateral cusp		
1	19	19.00%
2	27	27.00%
3	35	35.00%
4	12	12.00%
5	7	7.00%
Additional Cusp		
1	95	95.00%
2	5	5.00%

Scallops were observed on all cusps. Anteromedial cusp showed 1 scallop in 78 specimens, 2 scallops in 14 specimens and 3 scallops in 08 specimens. Posterolateral cusp showed maximum scallops with 5 scallops in 07 specimens, 4 scallops in 12 specimens, 3 scallops in 35 specimens, 2 scallops in 27 specimens and 1 scallop in 19 specimen.Additional cusps also showed 2 scallops in 5 specimens whereas 95 specimen had 1scallop.(Figure 5.9)

Graph-5.12 No Of Scallops On Cusp



Four & Five scallops were present only in posterolateral cusp in 12% and 7% of specimen respectively. Three scallops were observed on posterolateral cusp in 35% specimens followed by anteromedial cusp in 8% specimens. Two scallops were observed on posterolateral, anteromedial, additional cusps in 27%,14%,05%specimens. One scallop was present maximum in additional cusp in 95% followed by anteromedial cusp in 78%, and posterolateral in 19%.Posterolateral cusp showed maximum 5 number of scallops not more than it.

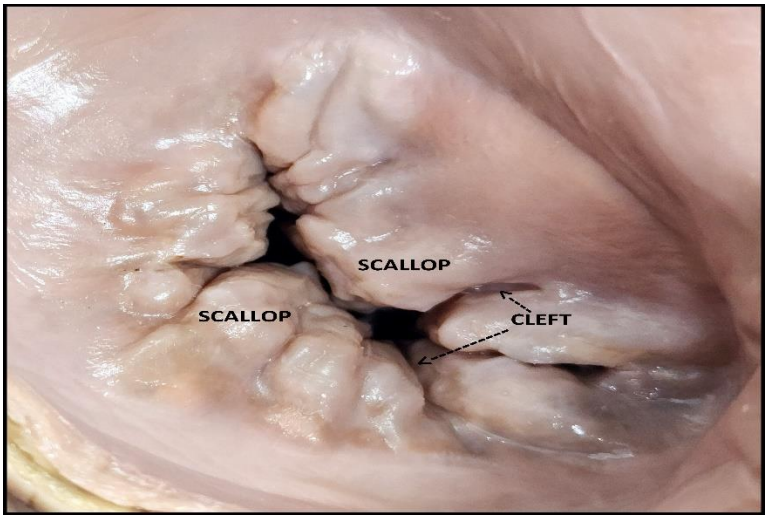


Figure 5.9: Cleft & Scallop On Bicuspid Valve

➢ 5.4 Dimensions Of Bicuspid Valve

Various morphometric measurements like length and width of cusps & annular circumference of Bicuspid valve were measured with help of Varnier calliper in mm. All the data was analysed as follow.

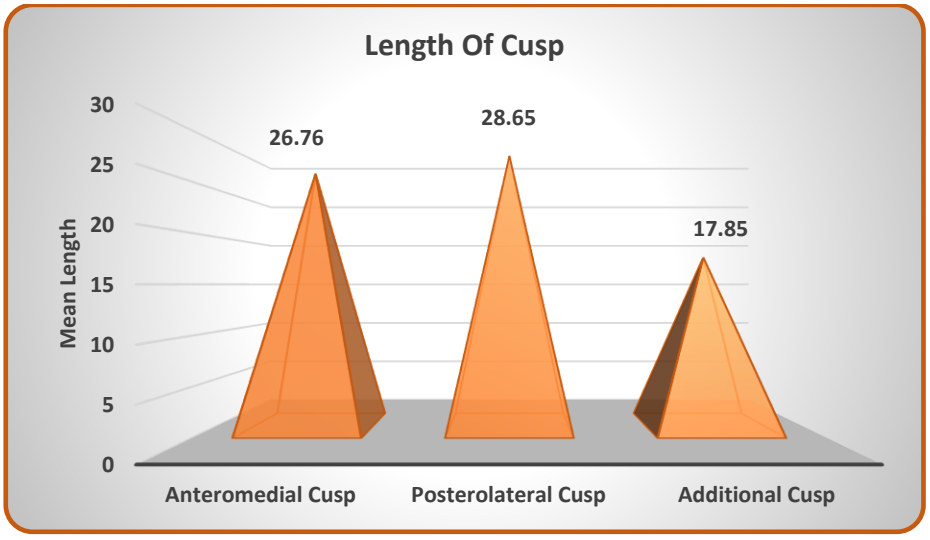
5.4.1 Length Of Anteromedial And Posterolateral Cusp

Table 5.14-Length of Cusp of Valve

Length of Cusp	Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Anteromedial Cusp	26.76	4.16	9.08	39.82
Posterolateral Cusp	28.65	4.16	15.85	42.34
Additional Cusp	17.85	4.48	10.89	20.31

In present study mean length of anteriomedial , posterolateral and additional cusp was 26.76,28.65,17.85 mm with minimum 09.08,15.85,10.89 mm and maximum 39.82,42.34,20.31mm respectively.

Graph 5.13-Length of cusp of valve



The mean length of posterolateral cusp was measured 28.65 ± 4.16 mm followed by anteromedial cusp 26.76 ± 4.16 mm and that of the additional cusp was 17.85±4.48. In present study posterolateral was found largest followed by anteromedial and additional cusps.

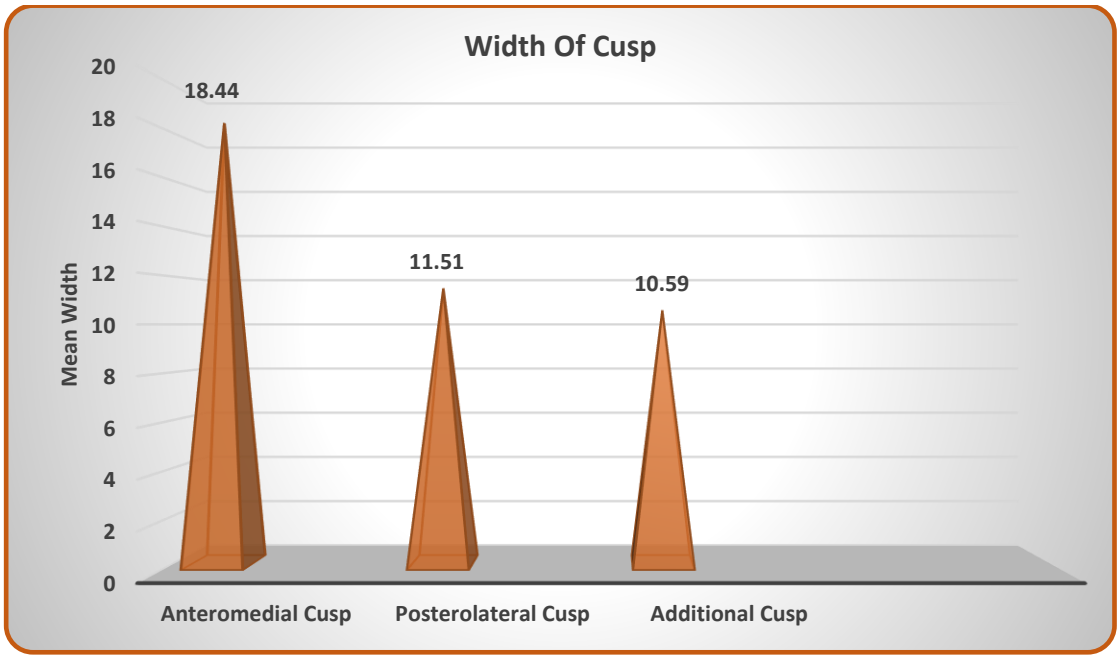
5.4.2 Width Of The Cusps Of Bicuspid Valve

Table 5.15 Width Of The Cusps Of Bicuspid Valve

Width of Cusp	Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Anteromedial Cusp	18.44	3.04	7.31	26.31
Posterolateral Cusp	11.51	2.52	5.01	23.10
Additional Cusp	10.59	2.95	7.3	14.38

In present study mean width of anteriomedial, posterolateral and additional cusp was 18.44,11.51,10.59 mm with minimum 07.31,05.01,07.03 mm and maximum 26.31,23.10,14.38 mm respectively.

Graph 5.14 Width of the Cusps Of the Valve



The mean width of anteromedial cusp was measured 18.44 ± 3.04 mm followed by posterolateral cusp 11.51 ± 2.52 mm and that of the additional cusp was 10.59±2.95. In present study posterolateral was found largest followed by anteromedial and additional cusps.

5.4.3 Annular circumference of bicuspid valve

Table 5.16 Annular Circumference Of Valve

Variable	Mean (SD)	Standard Deviation	Minimum	Maximum
Annular Circumference (in mm)	84.11	14.25	65.23	130.41

The annular circumference of bicuspid valve was measured as 84.11 ± 14.25 mm with values ranging from 65.23 to 130.41 mm.

Aortic Valve

➢ 5.5 Topographic Variables Of Aortic Valve

5.5.1 Distribution Of Aortic Valve

Table.5.17 Distribution of Aortic Valve

Anatomy of Aortic Valve	Frequency	Percentage
Normal	100	100%
Abnormal	00	00
Total	100	100%

Out of 100 heart specimens aortic valve were observed in all the specimen. All aortic valves were normal having three cusps. Cusps were identified as right coronary cusp ,left coronary cusp and non-coronary cusp. Normally Right coronary cusp termed so because it give rise to origin of right coronary artery and left coronary cusp is termed so because it gives origin to left coronary artery.

5.5.2 Position Of Ostium In Comparison With Annulus

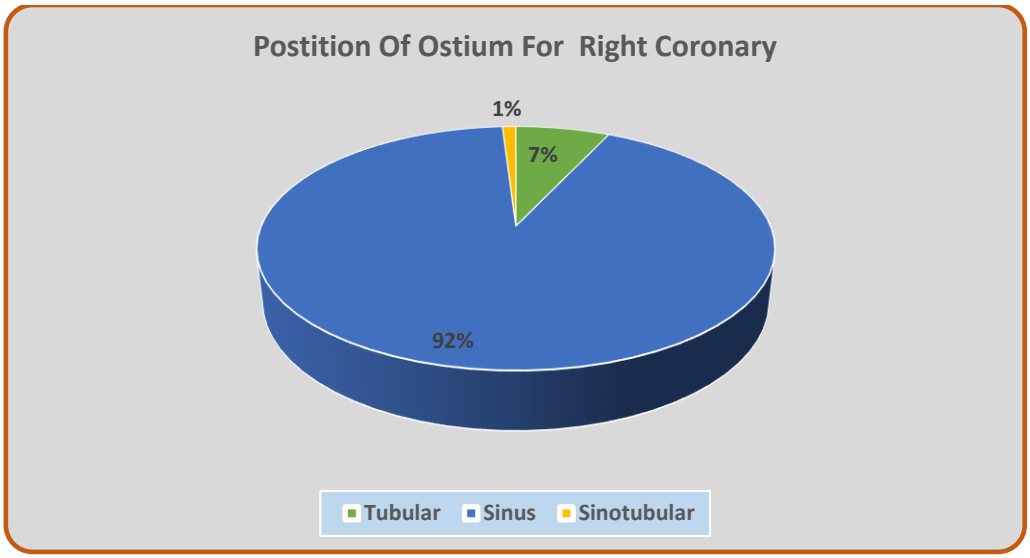
Table 5.18 Position Of Ostium (Figure 5.10,5.11 & 5.12)

Postion of Ostium	Frequency	Percentage
Right Coronary		
Above Annulus(Tubular)	7	07%
Below Annulus(Sinus)	92	92%
At annulus(Sinotubular)	01	1%
Left Coronary		
Above Annulus(Tubular)	11	11%
Below Annulus(Sinus)	89	89%

In the right coronary cusp 7 specimens were found with the position of the ostium Above Annulus(Tubular), where as it was found below Annulus (Sinus) in 92 specimens. The postion of ostium was at level of annulus (Sinotubular) in 1 specimen in the right coronary cusp. There were 11 specimens with the position of ostium above annulus(Tub

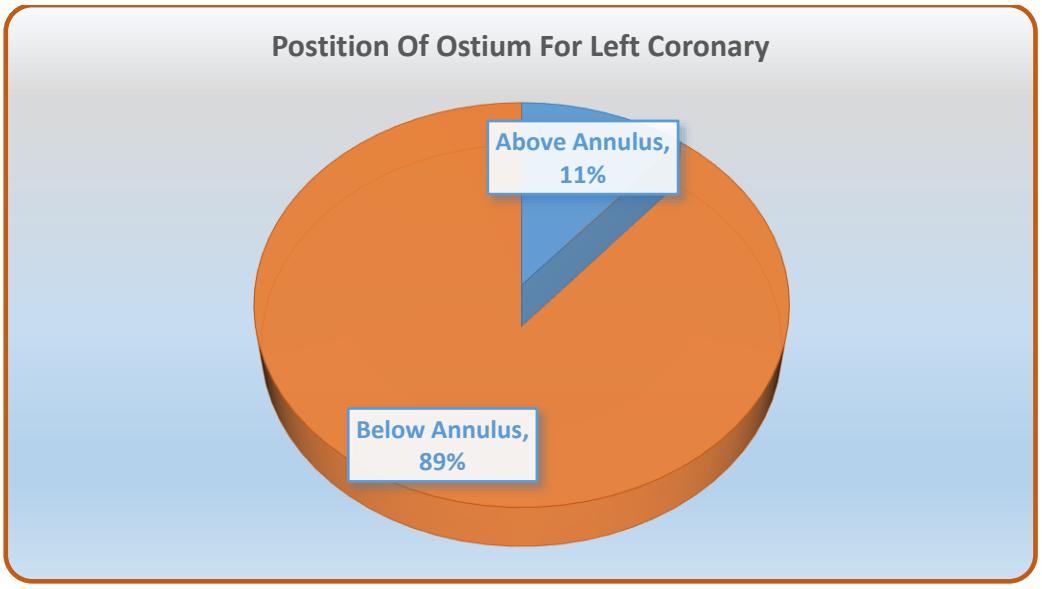
ular) and 89 specimens below Annulus(Sinus) in the left coronary cusp.

Graph-5.15 Position of Ostium for Right Cusp Left Coronary



Majority of the specimens (92%) had ostium positioned below the annulus in the right coronary cusp.

Graph-5.16 Position of Ostium for Left Coronary



Majority of the specimen (89%) had ostium positioned below the annulus in left coronary cusp.

Figure 5.10 Position Of Coronary Ostia-Above Annulus & At Annulus

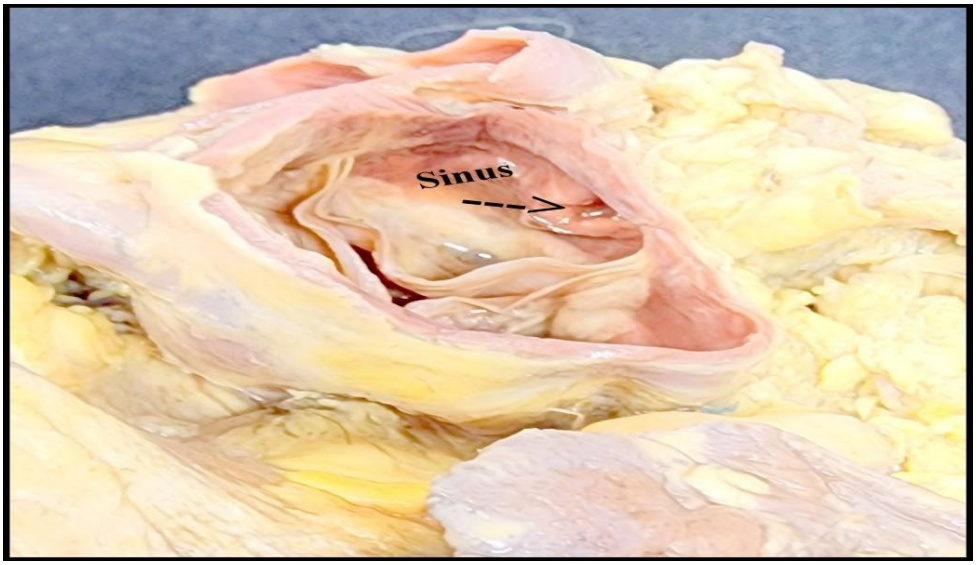


Figure 5.11 Sinus Position Of Coronary Ostia

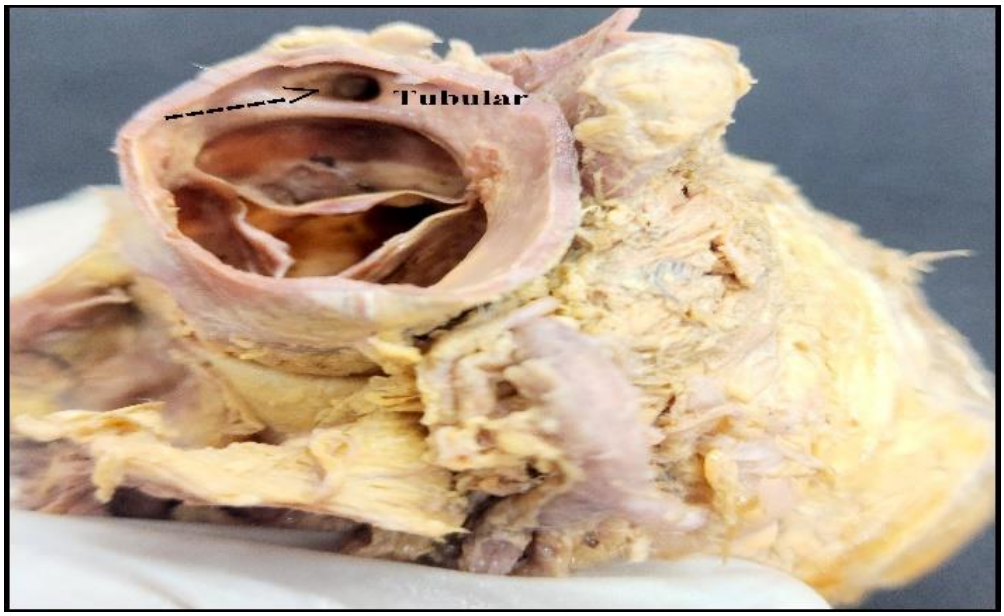


Figure 5.12:Tubular Position Of Coronary Ostia

➢ 5.6 Dimensions of Variables Of Aortic Valve

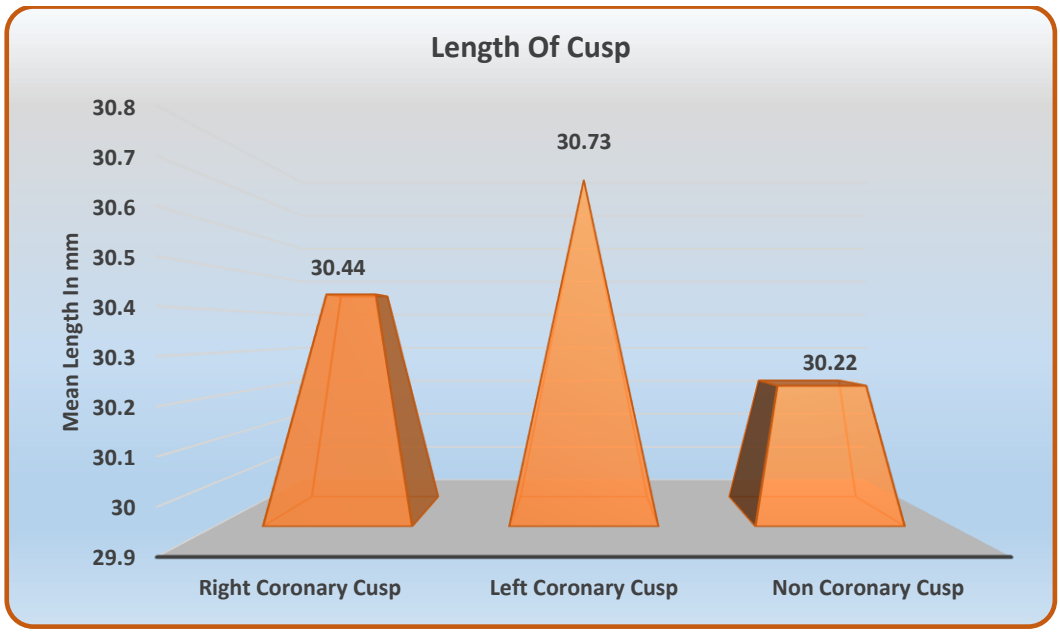
5.6.1 Length Of Cusp

Table-5.19 Length Of Cusp

Length of Cusp	Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Right Coronary Cusp	30.44	1.37	26.38	34.2
Left Coronary Cusp	30.73	1.51	25.84	34.6
Non Coronary Cusp	30.22	1.84	23.78	34.86

In present study mean length of right coronary ,left coronary, non-coronary cusp was 30.44,30.73,30.22 mm with minimum 26.36,25.84,23.78 mm and maximum 34.2,34.6,34.86 mm respectively.

Graph-5.17 Length of Cusp



All three cusps of aortic valve were similar in length as well as width, with average values of length for right coronary cusp as 30.44 ± 1.37 mm, left coronary cusp as 30.73 ± 1.51 mm and that of non-coronary cusp as 30.22 ± 1.84 mm.

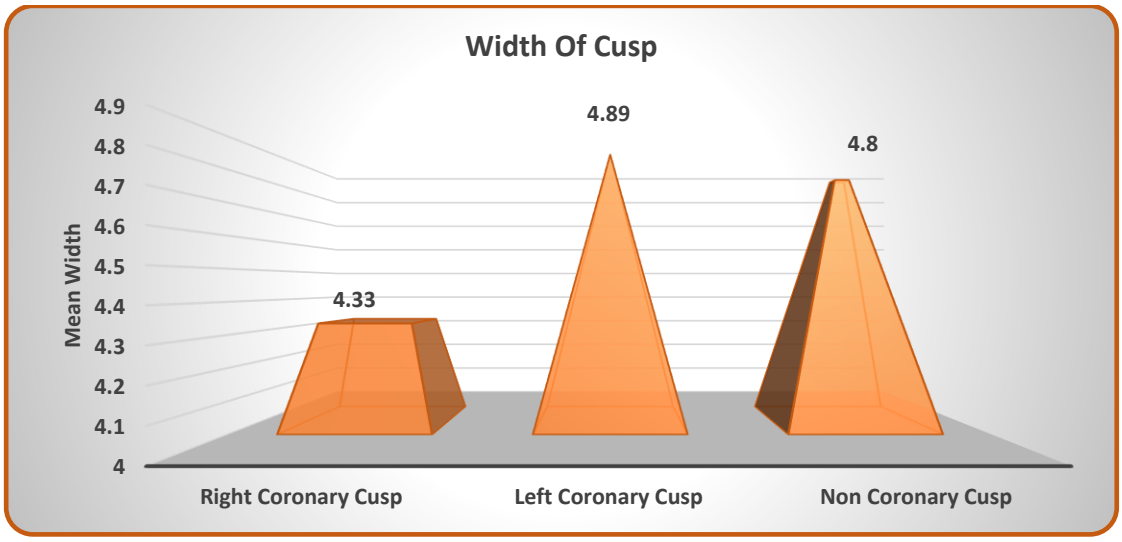
5.6.2 Width Of Cusp

Table-5.20 Width Of Cusp

Width of Cusp	Mean(mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Right Coronary Cusp	4.33	0.72	3.4	7.72
Left Coronary Cusp	4.89	0.92	3.53	8.51
Non Coronary Cusp	4.80	1.43	3.54	7.85

In present study mean width of right coronary, left coronary, non-coronary was 4.33, 4.89, 4.80 mm with minimum 3.4, 3.53, 3.54 mm and maximum 7.72, 8.51, 7.85 mm respectively.

Graph-5.18 Width Of Cusp



The average values of width for right coronary cusp was 4.33 ± 0.72 mm, left coronary cusp was 4.89 ± 0.92 mm and that of non-coronary cusp as 4.80 ± 1.43 mm.

5.6.3 Annular Circumference Of Valve

Table 5.21 Annular Circumference

Annular Circumference	Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
	75.14	1.82	71.24	78.89

In present study mean annular circumfereance of aortic valve was 75.14 mm with minimum 71.24 mm and maximum 78.89 mm respectively.

The average annular circumference of aortic valve was calculated as 75.13 ± 1.82 mm with values ranging from 71.24 to 78.89 mm.

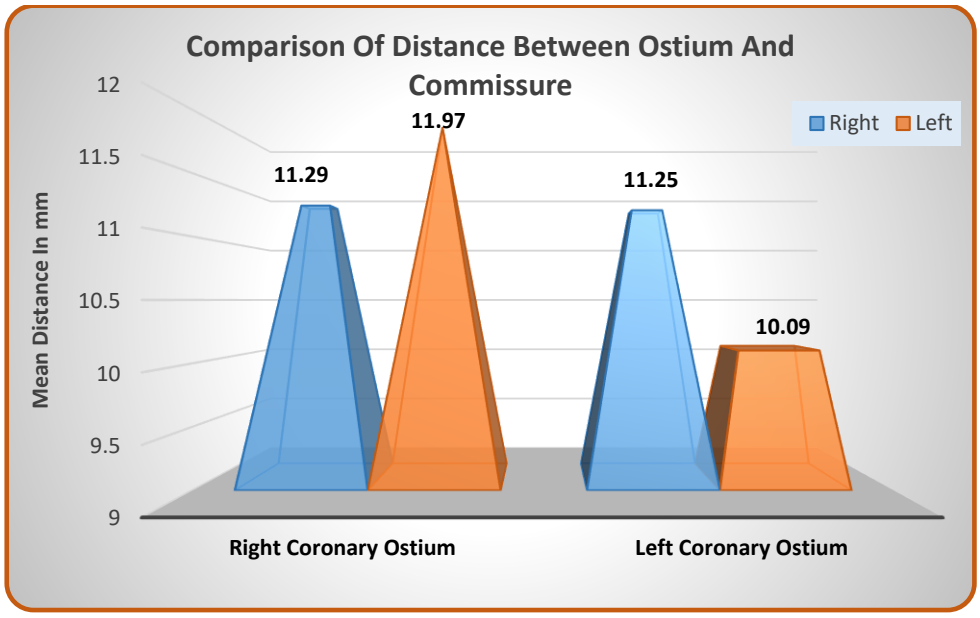
5.6.4 Distance Between Coronary Ostium And Commissure Of Cusp

Table-5.22 Distance Of Ostium

Distance of Ostium	Mean in mm	Standard Deviation	Minimum in mm	Maximum in mm
Right Coronary				
Right	11.29	1.21	8.35	14.02
Left	11.97	1.93	9.45	26.52
Left Coronary				
Right	11.25	1.75	7.34	19.29
Left	10.09	1.25	7.56	13.88

The mean distance of right coronary ostium from right and left commissure of cusp was measured as 11.29 ± 1.21 mm and 11.97 ± 1.93 mm respectively. While the distance between right and left side of the left coronary cusp was measured as 11.25 ± 1.75 mm and 10.09 ± 1.25 mm respectively.

Graph-5.19 Comparison Of Distance Between Coronary Ostium And Commissure Of Cusp



From above graph it was observed that the commissural distance on right side in both, right coronary ostium and left coronary ostium, was 11.29 mm and 11.25 mm respectively, which was almost same. On the contrary on left side the commissural distance between right coronary ostium and left coronary ostium, was 11.97 mm and 10.09 mm respectively, which showed that left coronary ostium placed more towards left.

Pulmonary Valve

➢ 5.7 Variables Of Pulmonary Valve

5.7.1 Distribution Of Pulmonary Valve

Table-5.23 Distribution Of Pulmonary Valve

No of Cusp	Frequency	Percentage
Normal	100	100%
Abnormal	00	00
Total	100	100%

In 100 heart specimen all the pulmonary valve were of normal, having three cusps. Cusps were named as right anterior, left anterior and posterior.(Figure 5.13 & 5.14)

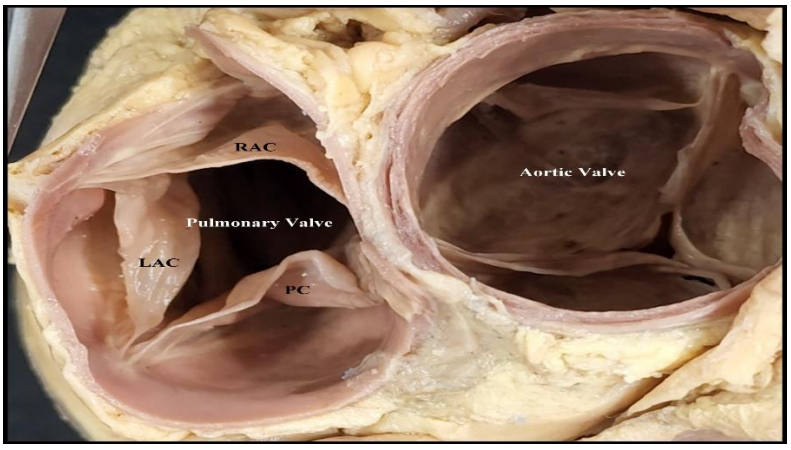


Figure 5.13 Cusps Of Pulmonary Valve

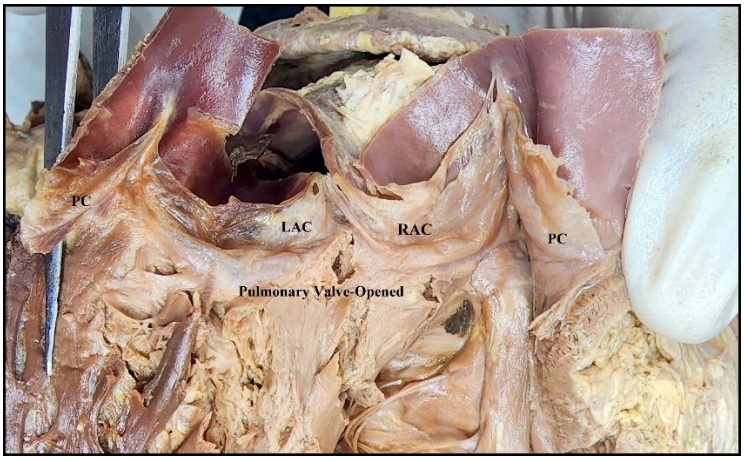


Figure 5.14 Open Pulmonay Valve

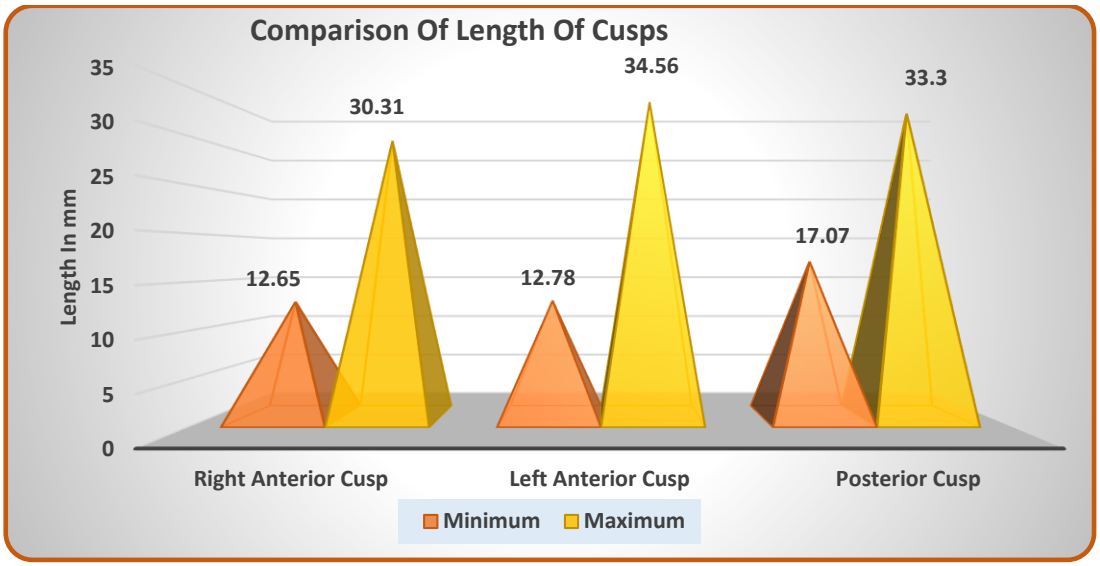
5.7.2 Length Of Cusps

Table-5.24 Length Of Cusps

Length of Cusp	Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Right Anterior Cusp	22.56	4.08	12.65	30.31
Left Anterior Cusp	23.27	4.49	12.78	34.56
Posterior Cusp	24.11	4.39	17.07	33.30

The average value of length for right anterior cusp was 22.56 ± 4.08 mm, left anterior cusp was 23.27 ± 4.49 mm and that of posterior cusp was 24.11 ± 4.39mm.

Graph-5.20 Comparison Of Length Of Valve



Maximum length of left anterior, posterior and right anterior cusp was 34.56, 33.3, and 30.31 mm respectively. Minimum length of posterior cusp showed highest value 17 mm followed by left anterior 12.78 mm and right anterior 12.65 mm.

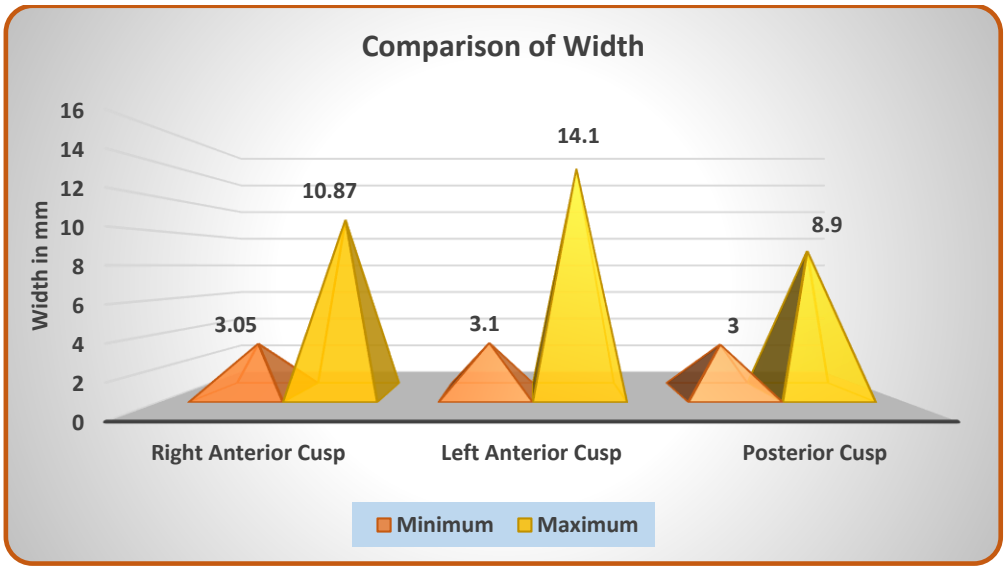
5.7.3 Width Of Cusps

Table-5.25 Width Of Cusps

Width of Cusp	Mean (SD)	Standard Deviation	Minimum	Maximum
Right Anterior Cusp	4.69	1.08	3.05	10.87
Left Anterior Cusp	4.64	1.42	3.10	14.10
Posterior Cusp	4.71	1.03	3	8.9

The average value of width for right anterior cusp was 4.69 ± 1.08 mm, left anterior cusp was 4.64 ± 1.42 mm and that of posterior cusp was 4.71 ± 1.03 mm.

Graph-5.21 Comparison Of Width Of Cusps



Maximum width showed was left anterior 14.1 mm , right anterior 10.87mm and posterior 8.9mm in decreasing order.

5.7.4 Annular Circumference Of Valve

Table-5.26 Annular Circumference Of Valve

Annular Circumference of valve	Mean (SD)	Standard Deviation	Minimum	Maximum
	65.06	6.85	49.28	78.71

The average annular circumference of pulmonary valve was calculated as 65.06 ± 6.85 mm with values ranging from 49.28 to 78.71 mm.

Papillary Muscle

➢ 5.8 Variables Of Papillary Muscle

5.8.1 Distribution Of Papillary Muscle

Table-5. 27 Distribution Of Papillary Muscle

Side	No.of Papillary muscles	0	1	2	3	4	5	6	Total
Right	APM(n-132)								
	Number Of Heart	00	72	26	00	02	00	00	
	Incidence Of Papillary Muscle	00	72	52	00	08	00	00	132
	PPM (n-154)								
	Number Of Heart	09	51	27	08	00	05	00	
	Incidence Of Papillary Muscle	00	51	54	24	00	25	00	154
	SPM (n-69)								
	Number Of Heart	53	37	07	00	00	00	03	
	Incidence Of Papillary Muscle	00	37	14	00	00	00	18	69
Left	APM (n-116)								
	Number Of Heart	03	78	19	00	00	00	00	
	Incidence Of Papillary Muscle	00	78	38	00	00	00	00	116
	PPM (n-178)								
	Number Of Heart	00	37	38	16	06	03	00	
	Incidence Of Papillary Muscle	00	37	54	48	24	15	00	178

Graph No-5. 22 Incidence Of Papillary Muscle

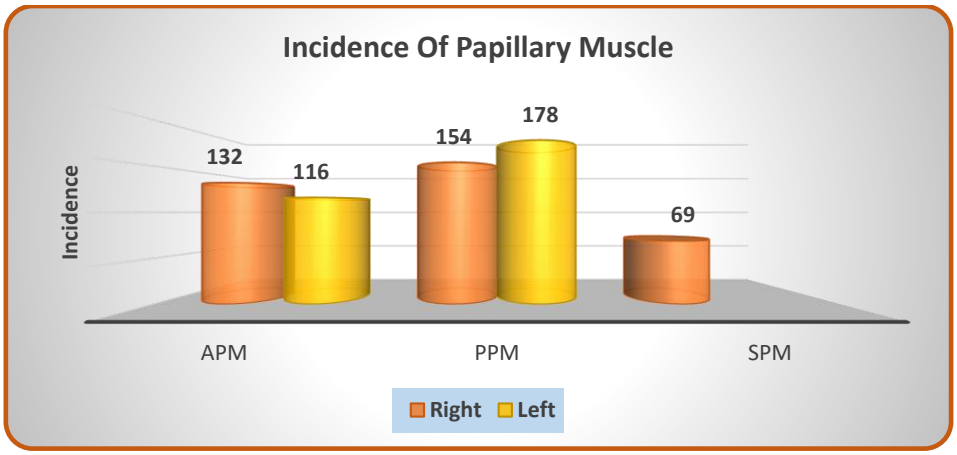


Table and Graph showed that in right ventricle,132 anterior papillary muscle(APM) ,154 posterior papillary muscle(PPM) and 69 septal papillary muscle(SPM) were present.While in left ventricle 116 anterior papillary muscle (APM) and 178 posterior papillary muscle(PPM) were observed.(Figure 5.15)

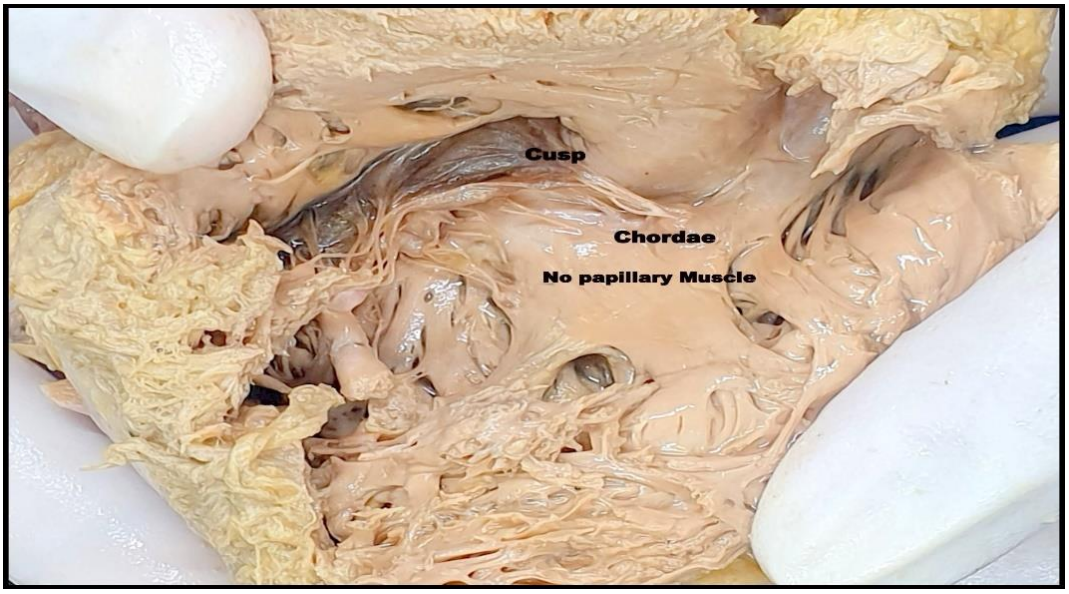


Figure 5.15-Missing Septal Papillary Muscle

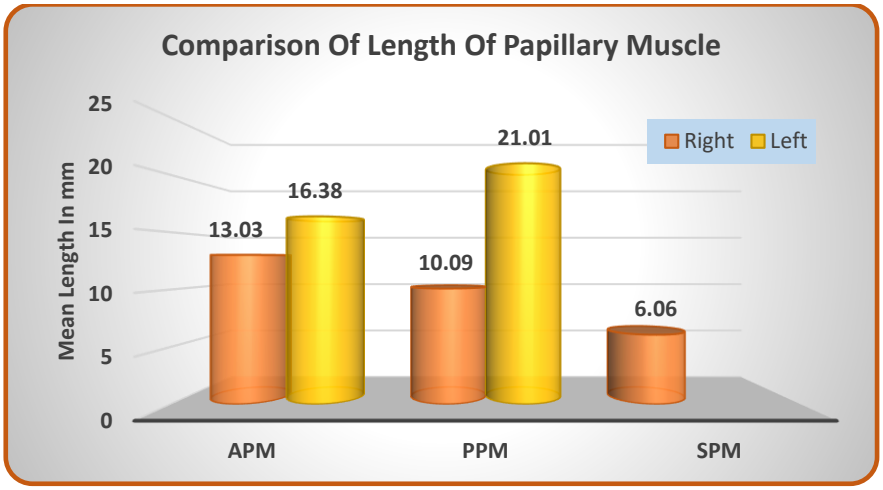
5.8.2 Length Of Papillary Muscle

Table- 5. 28 Length of Papillary Muscle

Length(mm)		Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
Right	APM (n-132)	13.03	2.44	8.50	20.63
	PPM (n -154)	10.09	2.89	6.58	22.17
	SPM (n-69)	6.06	1.07	3.33	9.96
Left	APM (n-116)	16.38	2.55	12.11	29.26
	PPM (n-178)	21.01	2.20	8.9	26.23

In present study the mean length of APM was 13.03 ± 2.44 mm and 16.38 ± 2.55 mm on right and left side respectively. The mean length of PPM was 10.09 ± 2.89 mm and 21.01 ± 2.20 mm on right and left side respectively. The mean length of SPM was 6.06 ± 1.07 mm and on right side.

Graph 5.23 Comparison Of Length Of Right And Left Papillary Muscle



The mean length of papillary muscle was longer in the left ventricle when compared to the right ventricle.

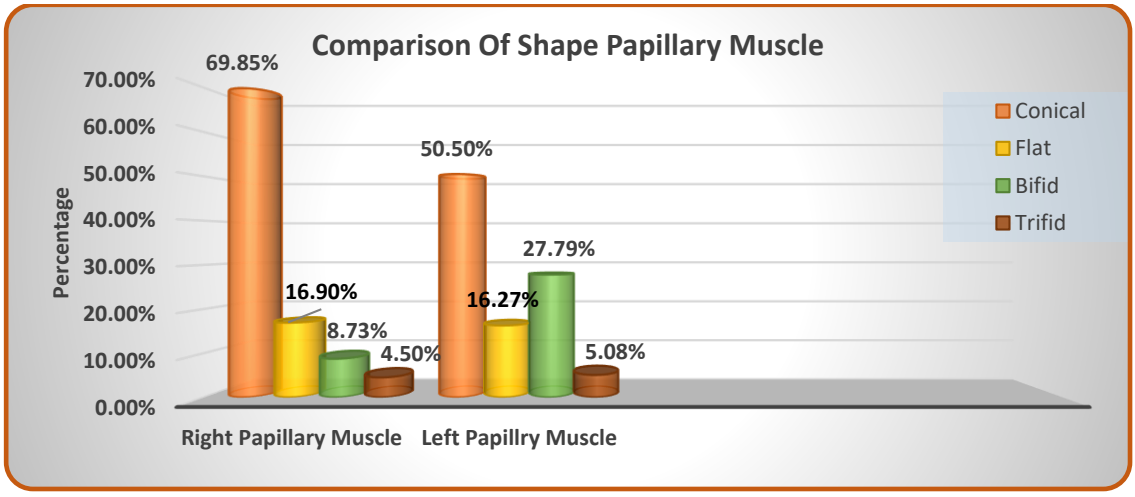
5.8.3 Shape Of The Papillary Muscle

Shape of the tip of papillary muscle were identified as conical (Figure-5.16), flat (Figure 5.17), bifid (figure 5.18) or trifid (Figure 5.19).

Table 5.29- Distribution Of Papillary Muscle According To Shape

No of Papillary muscles	Frequency	Percentage
Right Papillary Muscle (n-355)		
Conical	248	69.85%
Flat	60	27
Bifid	31	8.73%
Trifid	16	4.50%
Left Papillary Muscle (n-295)		
Conical	149	50.50%
Flat	48	16.27%
Bifid	82	27.79%
Trifid	15	5.08%

Graph 5.24-Comparison between shape of papillary muscle in right and left ventricle



It was observed from table & graph that in right the ventricle papillary muscles were of predominantly conical 69.85% followed by flat 16.90%, bifid 8.73% and trifid 4.5% specimens. While in left ventricle papillary muscles were predominantly conical in 50.50% followed by followed by bifid 27.79%, flat 16.2% and 5.08% specimens .Incidence of bifid and trifid shape were higher in left ventricle than the right ventricle.

Figure 5.16: Conical Shaped Papillary Muscle (PM)

Figure 5.17: Flat Shaped Papillary Muscle

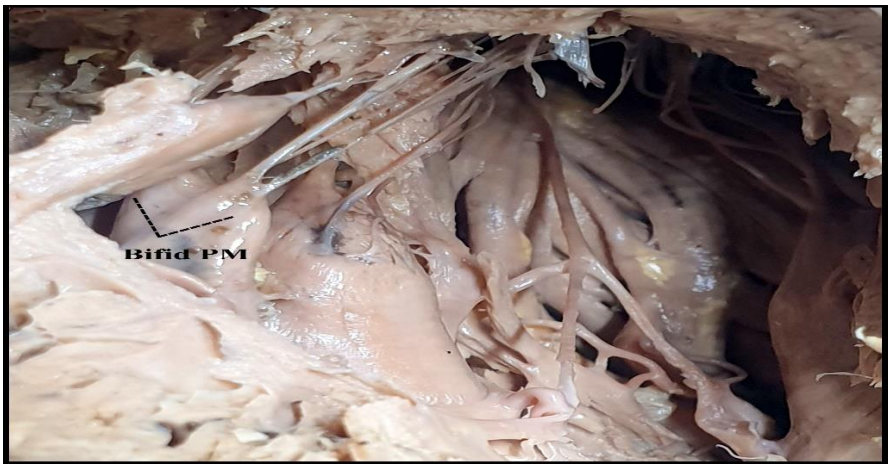


Figure 5.18: Bifid Papillary Muscle

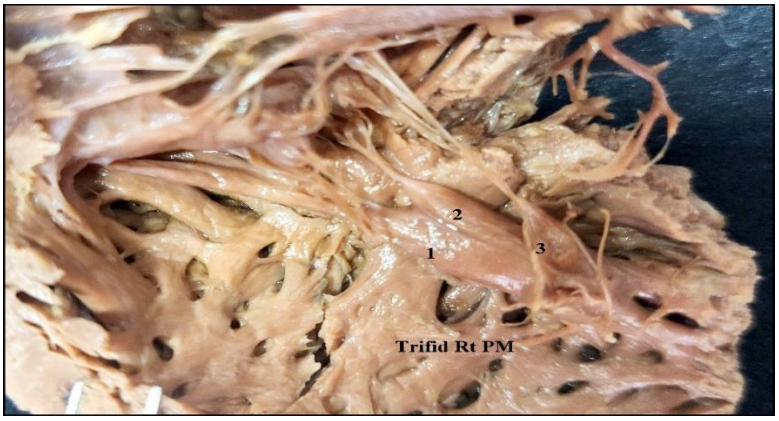


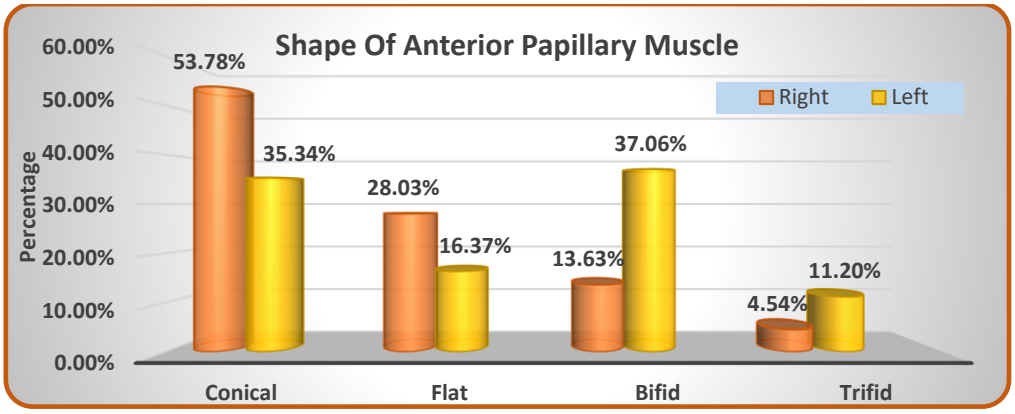
Figure 5.19:Trifid RightPapillary Muscle

Table 5.30-Shape of Tip of Right And Left papillary muscle

No of Papillary muscles	Frequency	Percentage
Right		
APM(n-132)		
Conical	71	53.78%
Flat	37	28.03%
Bifid	18	13.63%
Trifid	06	4.54%
PPM(n-154)		
Conical	111	72.07%
Flat	23	14.93%
Bifid	10	6.49%
Trifid	10	6.49%
SPM(n-69)		
Conical	66	94.65%
Flat	00	00
Bifid	03	4.34%
Trifid	00	00
Left		
APM(n-116)		
Conical	41	35.34%
Flat	19	16.37%
Bifid	43	37.06%
Trifid	13	11.20%
PPM(n-178)		
Conical	108	60.67%
Flat	29	16.29%
Bifid	39	21.91%
Trifid	02	1.12%

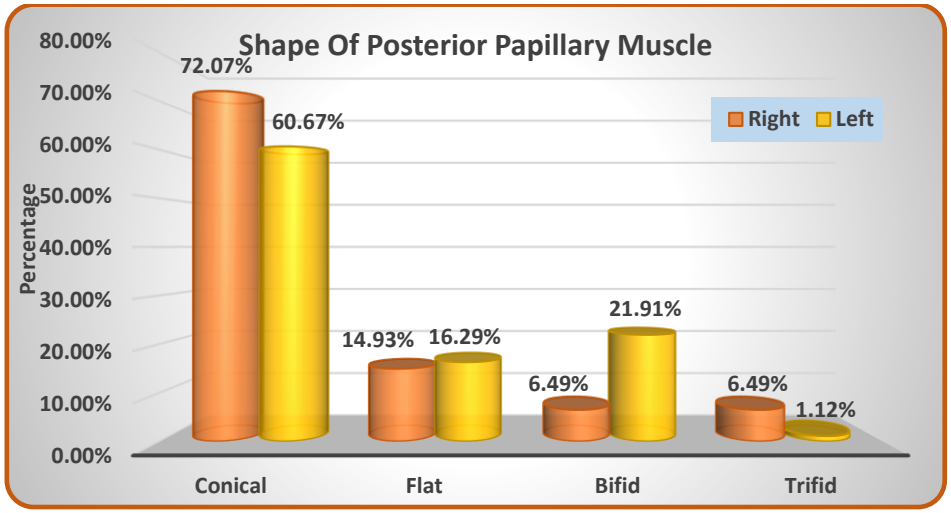
The shape of the septal papillary muscle, which was found only in the right ventricles, was found to be conical in 66 (94.65 %) and bifid in 03(4.34%) of specimens.

Graph 5.25-Comparison between the shape of anterior papillary muscle (APM) in right and left ventricles



The shape of anterior papillary muscle in the right ventricle observed conical 53.78% and flat 28.03% were more than shape in left ventricle anterior papillary muscle. While anterior papillary muscle in left side were found bifid in 37.06% specimen and trifid 11.20% in specimen, which was higher than right sided papillary muscle.

Graph 5.26-Comparison between the shape of posterior papillary muscle (PPM) in right and left ventricles



The shape of posterior papillary muscle in the right ventricle observed conical 72.07% was more than shape in left ventricle posterior papillary muscle. While posterior papillary muscle in left side were found flat in 16.26% specimens, bifid in 21.91% specimens, which was higher than right sided papillary muscle.Trifid shaped right papillary muscle were found more in right ventricle than the left ventricle.

5.8.4 Pattern Of Papillary Muscle

According to number of papillary muscle present it can be classified as classical-single papillary muscle present,2 group-2 papillary muscle present(Figure 5.20), 3 group-3(Figure 5.21) papillary muscle present, 4 group-4papillary muscle (Figure 5.22) present and so on. Pattern of papillary muscle in right and left ventricle was analysed as below.

Table 5.31 - Pattern of Papillary Muscle

No of Papillary muscles	Frequency	Percentage
Right		
APM		
Classical	72	72%
2group	26	26%
4group	2	2%
PPM		
Classical	51	51%
2Group	27	27%
3Group	08	08%
5Group	5	5%
SPM		
Classical	37	37%
2Group	7	7%
6Group	3	3%
Left		
APM		
Classical	78	78%
2Group	19	19%
PPM		
Classical	37	37%
2Group	38	38%
3Group	15	15%
4Group	06	06%
5Group	03	03%

The pattern of septal papillary muscles, present only in right ventricles, was in majority seen to be of classical variety in 37% followed by 2group in 07% and 6group in 3% of specimens.

Figure 5.20: 2group Papillary Muscle

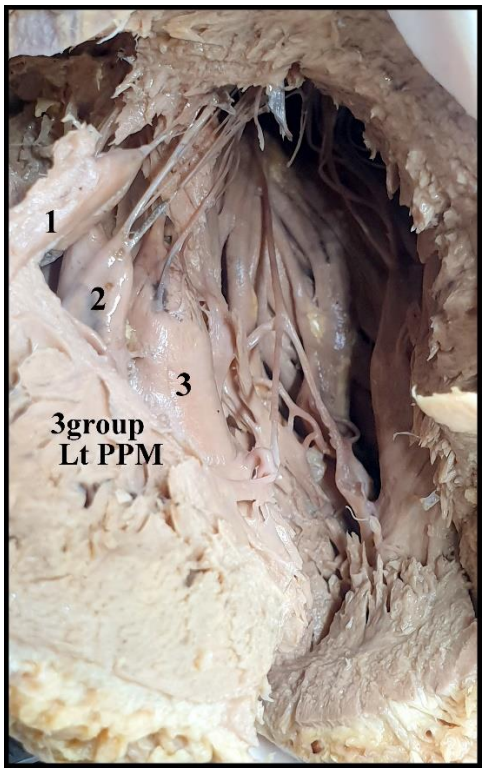


Figure 5.21: 3group Papillary Muscle

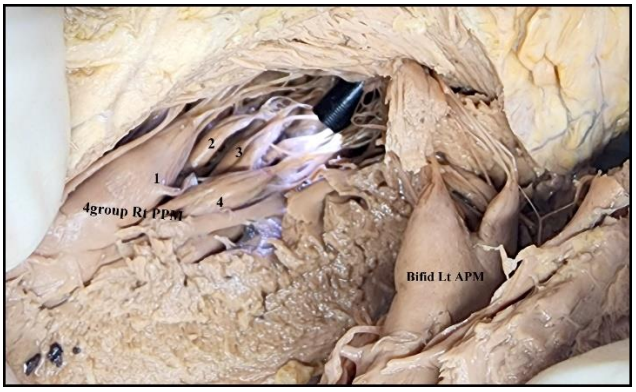
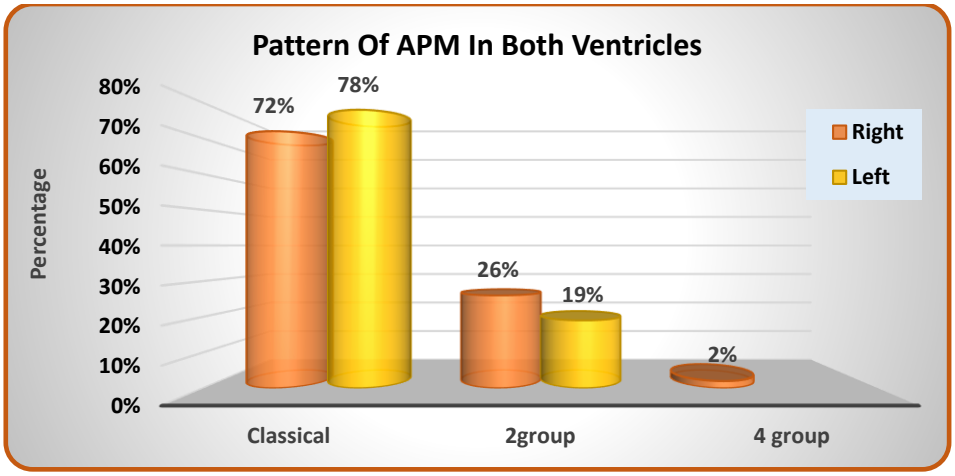


Figure 5.22: 4group & Bifid Left Papillary Muscle

Graph 5.27-Comparison between the pattern of anterior papillary muscle (APM) in right and left ventricles

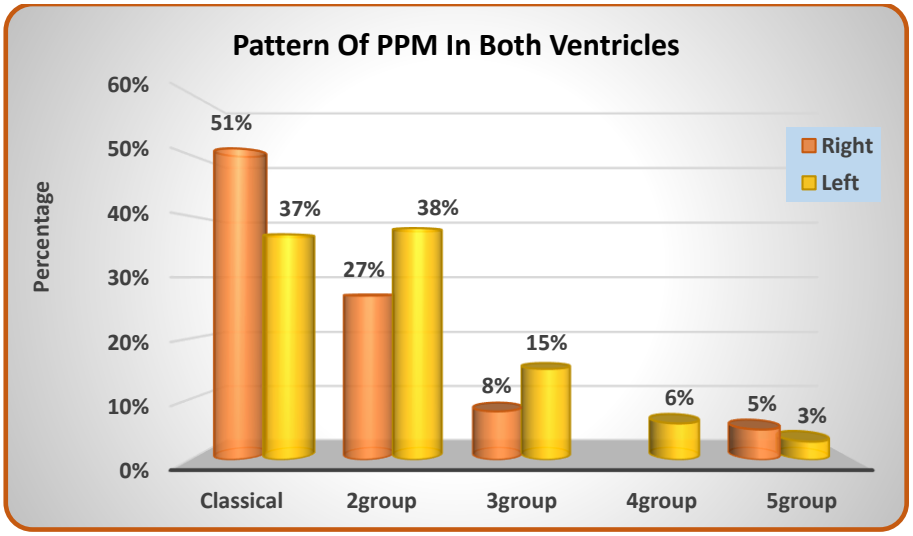


The pattern of each papillary muscle was noted carefully. In the right ventricle, the pattern of anterior papillary muscle was seen as the classical in 72% (72), 2groups in 26% and 4group in 2 %specimen.

The left ventricles revealed the classical pattern in 78 % , the 2group pattern in 19% specimens. 4group pattern of APM was not found in left ventricle.

Graph 5.27 represents the comparison between the pattern of posterior papillary muscles in the right and left ventricles.

Graph 5.28-Comparison between the pattern of posterior papillary muscle (PPM) in right and left ventricles



The pattern of posterior papillary muscles in the right ventricle showed the classical type in 51 % specimen, the 2group type in 27% cases, the 3group type in 08% cases, and the 5group type in 5%of total cases. The 4group and 6group pattern were seen missing among posterior papillary muscles of the right ventricle in this study. However, the SP pattern was additionally seen in these muscles on the right side in 10% (5) cases. The posterior papillary muscles of left ventricles in our study were of the classical variety in 37%hearts, 2group in 38% , 3group in 16% (48), 4group in 6% (24), and 5group in 3% (15) of total specimens. Graph 5.28 represents the comparison between the pattern of posterior papillary muscles in the right and left ventricles.

Coronary Sinus And Thebesian Valve

➢ 5.9 Variables Of Coronary Sinus And Thebesian Valve

5.9.1 Distribution Of Thebesian Valve

Table No 5.32-Distribution Of Thebesian Valve

Presence of Thebesian Valve (n-100)	Frequency	Percentage
Present	76	76.00%
Absent	24	24.00%

Thebesian valve was seen in 76% of the specimens.(Figure 5.23)

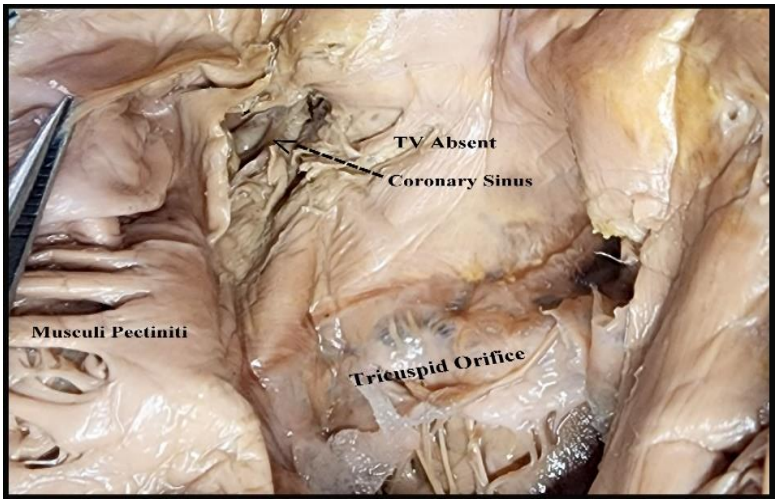
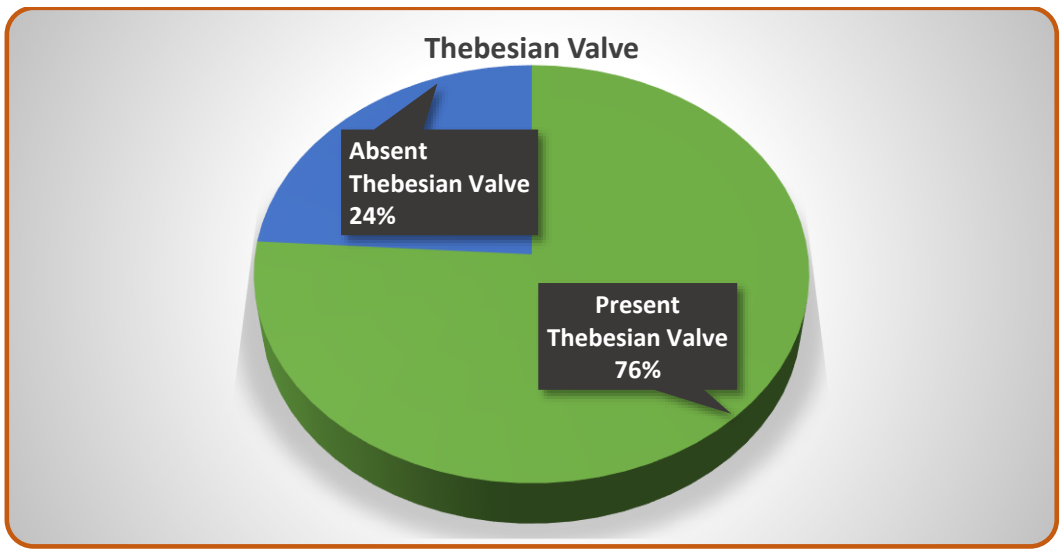


Figure 5.23 : Absent Thebesian Valvle On Coronary Sinus

Graph No. 5.29- Presence of Thebesian Valve



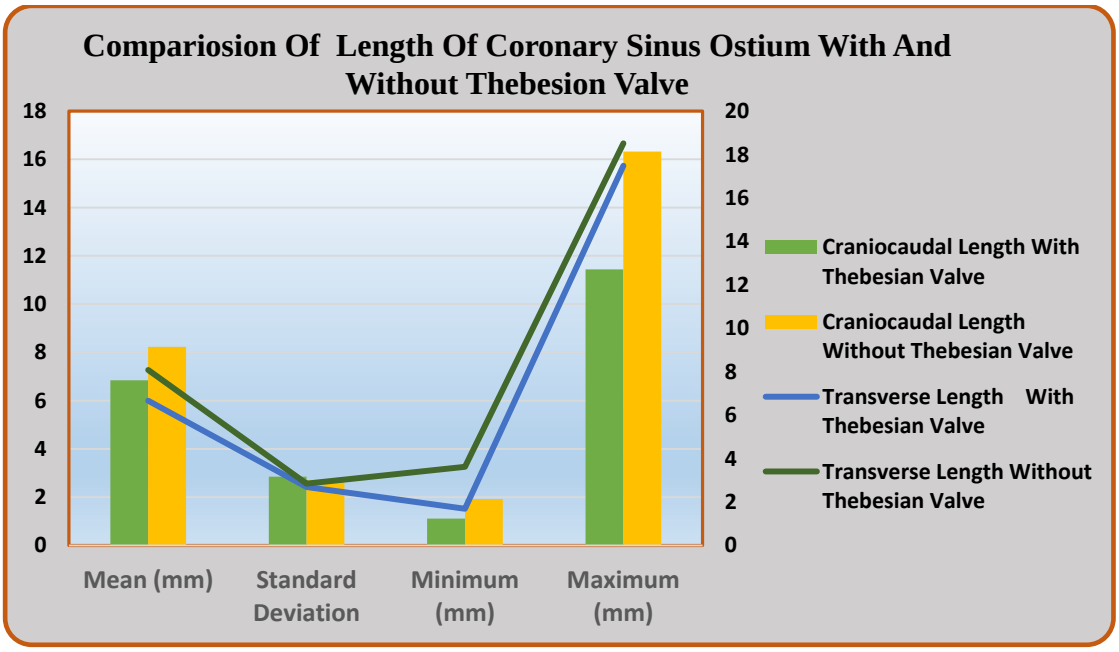
5.9.2 Length Of Coronary Sinus

Table 5.33- Length Of Coronary Sinus

Parameter		Mean (mm)	Standard Deviation	Minimum (mm)	Maximum (mm)
With Thebesian Valve (n-76)	Craniocaudal Length	6.84	2.85	1.11	11.44
	Transverse Length	6.66	2.69	1.69	17.48
Without Thebesian (n-24) Valve	Craniocaudal Length	8.23	2.69	1.92	16.32
	Transverse Length	8.08	2.85	3.62	18.51

In the current study it was observed that the mean craniocaudal length with a Thebesian valve is 6.84 ± 2.85 mm, a minimum length of 1.11 mm, and a maximum length of 11.44 mm. The mean craniocaudal length without thebesian valve was 8.23 ± 2.69 mm, a minimum length of 1.92 mm, and a maximum length of 16.32 mm. The mean transverse length with a Thebesian valve was 6.66 ±2.69 mm, a minimum length of 1.69 mm and a maximum length of 17.48 mm. The mean length with thebesian valve was 8.08 ± 2.85 mm, a minimum length of 3.62 mm and a maximum length of 18.51 mm.

Graph-5.30 Comparison Of Length Of Coronary Sinus



The mean craniocaudal length without a Thebesian valve was higher in comparison to carniocaudal length with thebesian valve.The mean transverse length without a Thebesian valve was higher in comparison to transverse length with thebesian valve.

5.9.3 Type Of Thebesian Valve

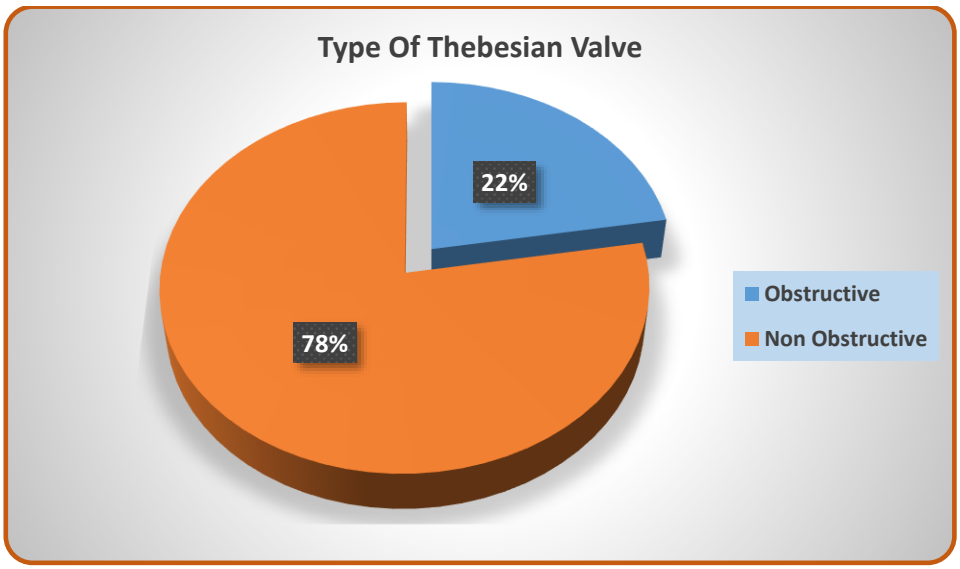
According to extent of attachment over the coronary sinus ostium the thebesian valve was typed as obstructive –completely covers the coronary sinus ostium or non-obstructive-partially covers the coronary sinus ostium.

Table No. 5.34- Distribution Of Valve

Covering the Coronary Sinus (n-76)	Frequency	Percentage
Partially (Non-Obstructive)	59	77.63 %
Completely (Obstructive)	17	22.36 %

Out of 76, majority of the specimen 59 (77.63%) had only thebesian valve partially (non-obstructive) covering coronary sinus ostium. 17 specimens (22.36%) were obstructive type completely covering the coronary sinus ostium. (Figure 5.24)

Graph No. 5.31-Type Of Thebesian Valve



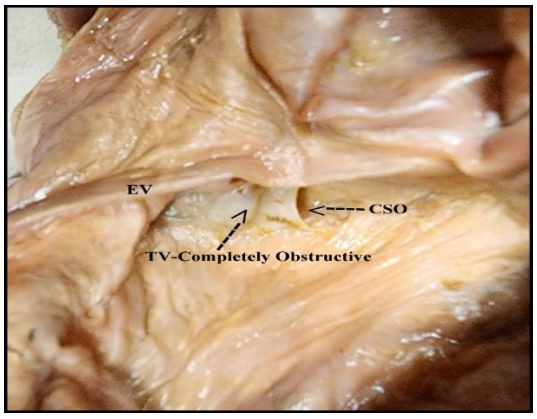


Figure 5.24: Completely Obstructive Thebesian Valve

(EV-Eustachian Valve, TV-Thebsian Valve, CSO-Coronary Sinus Orifice)

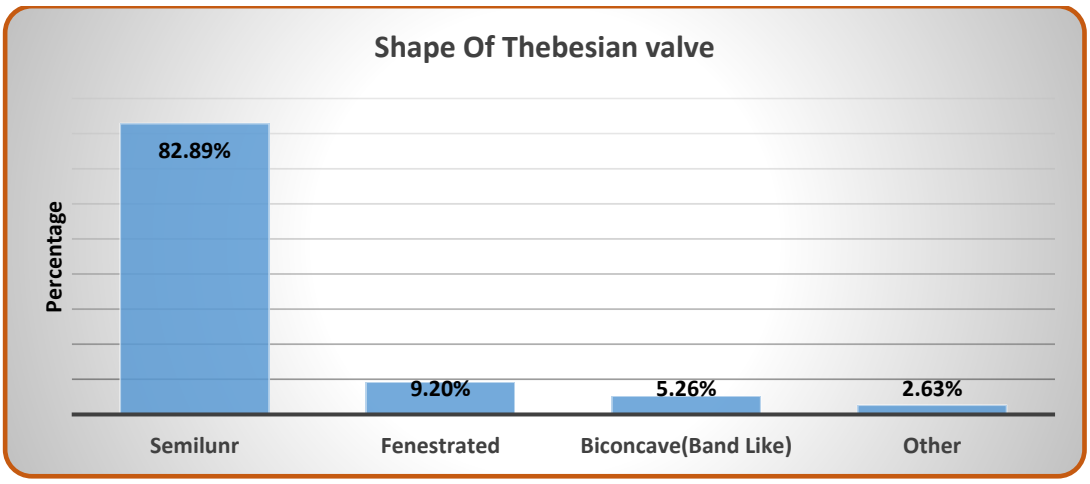
5.9.4 Shape Of Thebesian Valve

Table No. 5.35- Shape Of Thebesian Vavle

Thebesian Valve Shape(n-76)	Frequency	Percentage
Semilunar	63	82.89%
Fenestrated	7	9.20%
Biconcave(Band Like)	4	5.26%
Other	2	2.63%

Majority of the specimens 63 (82.89%) had semilunar shape (Figure 5.25) of the thebesian valve followed by fenestrated 7 (9.20%) (Figure 5.26), bi-concave-Band like 4 (5.26%) (Figure 5.27) and other shape 2 (2.63%) (Figure5.28).

Graph-5.32 Shape of Thebesian Valve



Majority of the specimens had semilunar shape of the thebesian valve.

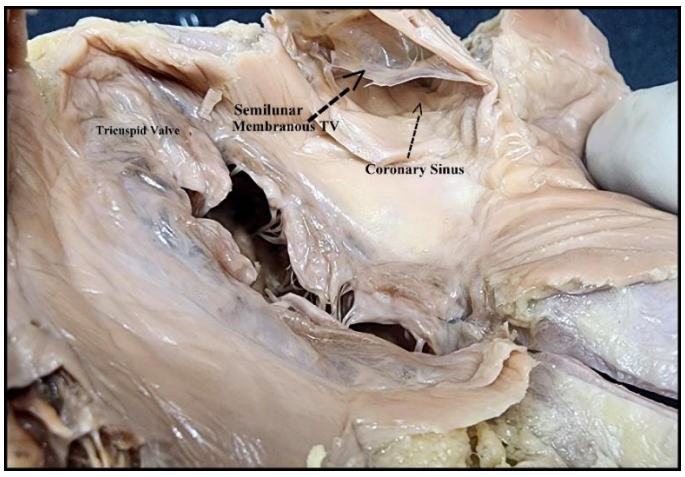


Figure 5.25-Semilunar Thebesian Valve

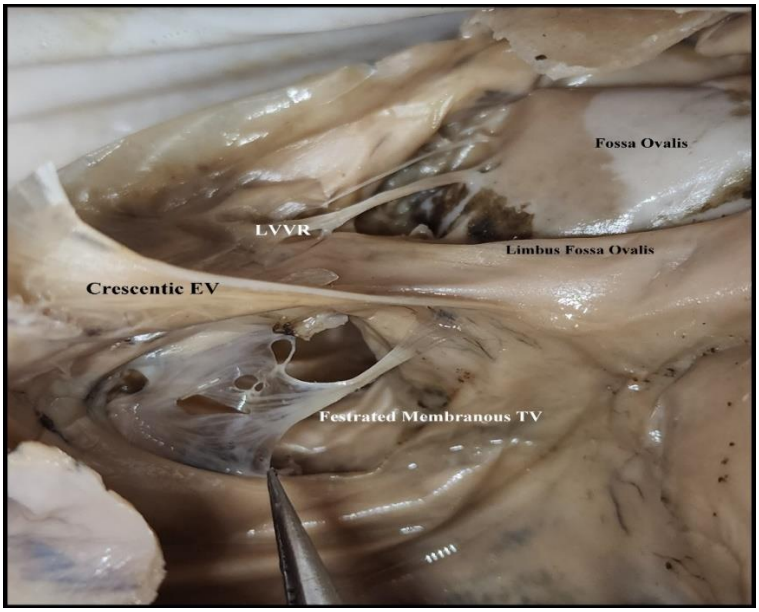


Figure 5.26: Fenestrated Membranous Thebesian Valve

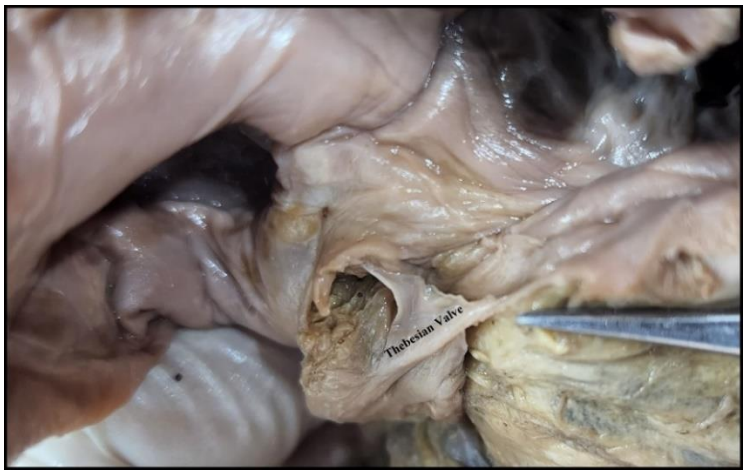


Figure 5.27: Biconcave Band Like Thebesian Valve

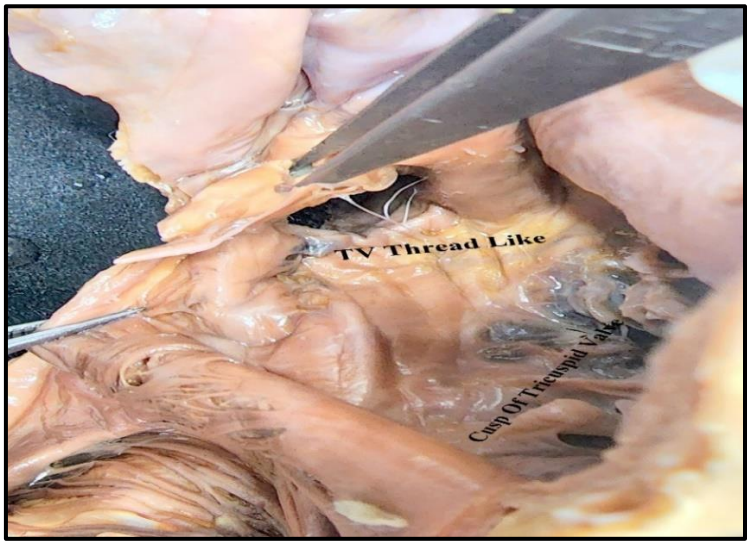


Figure 5.28-Thread Like (In this study Other) Thebesian Valve

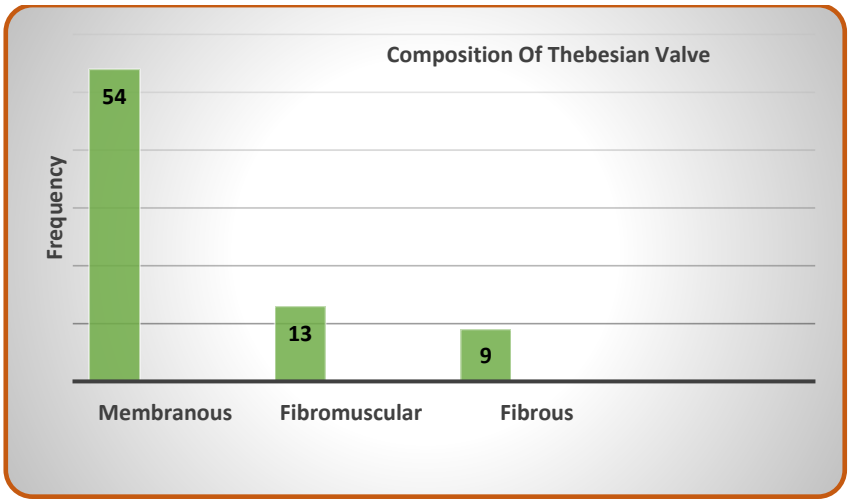
5.9.5 Composition Of Thebesian Valve

Table No.5.36- Composition Of Thebesian Valve

Thebesian Valve Composition (n-76)	Frequency	Percentage
Membranous	54	71.05%
Fibro muscular	13	17.10%
Fibrous	9	11.84%
Site of attachment (n-76)		
Caudal Right	76	100.00%

71.05 % (n-76) had membranous(Figure 5.25 and Figure 5.26) composition of the thebesian valve followed by fibromuscular (Figure 5.29) in 17.10 % and fibrous(figure 5.27) in 11.84%. All specimens had caudal right attachment.

Graph-5.33 Composition of Thebesian Valve



Majority of the specimen had membranous composition of the thebesian valve.

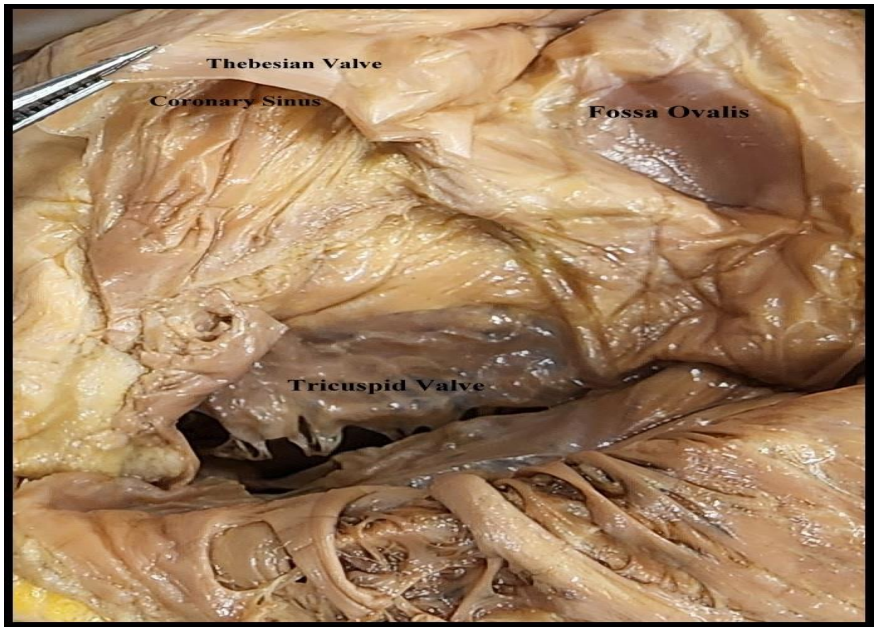


Figure 5.29: Fibromuscular Thebesian Valve

Eustachian Valve

➢ 5.10 Variables Of Eustachian Valve

5.10.1 Distribution Of Eustachian Valve

Table-5.37 Distribution Of Eustachian Valve

Presence of Eustachian Valve (n-100)	Frequency	Percentage
Present	67	67.00%
Absent	33	33.00%

67% of the specimens showed presence of Eustachian valve(Figure 5.30) in 100 specimens of heart.

Graph-5.34. Incidence Of Eustachian Valve

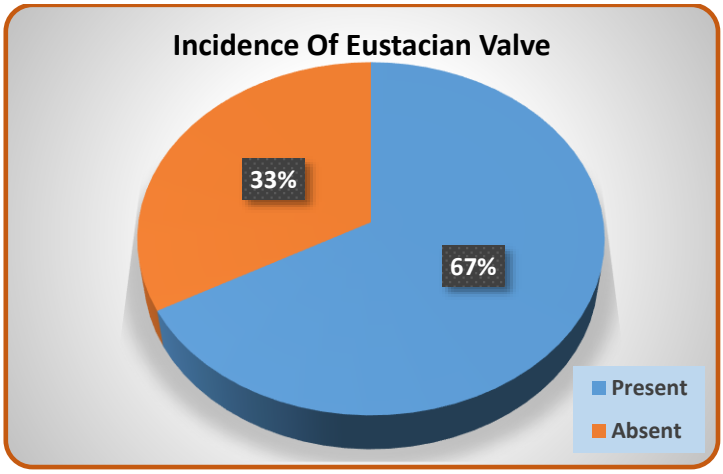


Figure 5.30- Shows Presence of Eustchian Valve

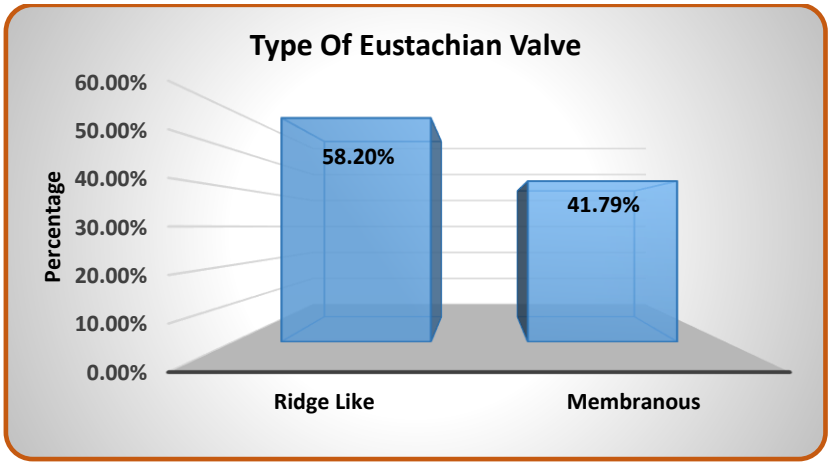
5.10.2 Type Of Valve

Table No.5.38 -Type of Eustachian Valve

Type of Valve (n-67)	Frequency	Percentage
Ridge Like	39	58.20 %
Membranous	28	41.79 %

Among 67 specimens incidence of ridge like (Figure 5.31) and membranous Eustachian(Figure 5.32)valve were 39 and 28 respectively.

Graph No.-5.35 Type of Eustachian Valve



67% of the specimens showed presence of Eustachian valve with ridge like appearance in majority of the specimens (58.20%) followed by membranous appearance in 41.79% specimens.

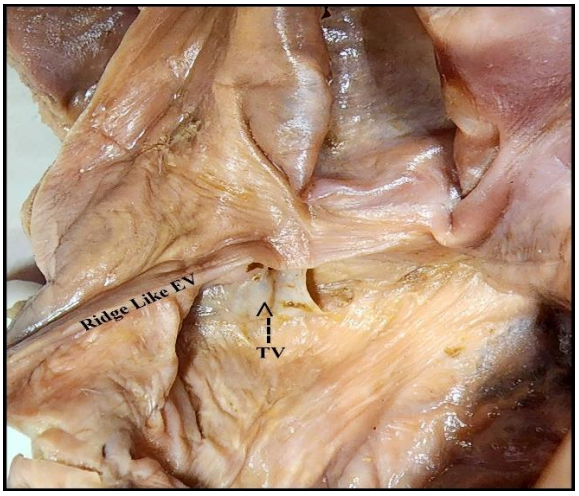


Figure 5.31: Ridge Like Eustachian Valve

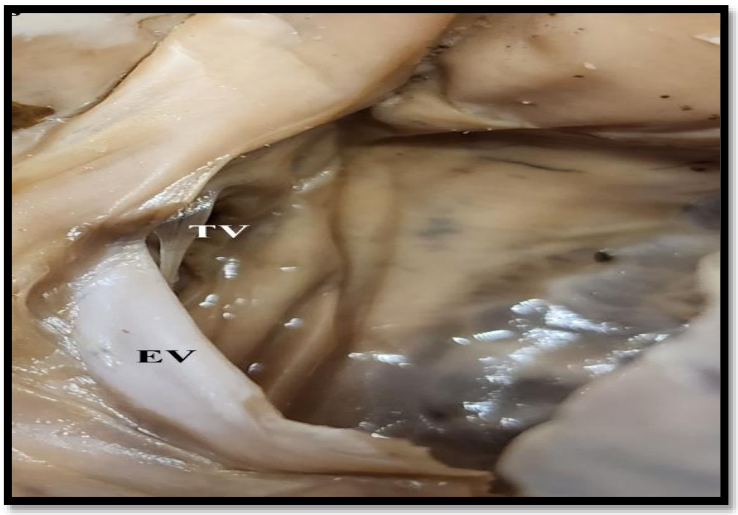


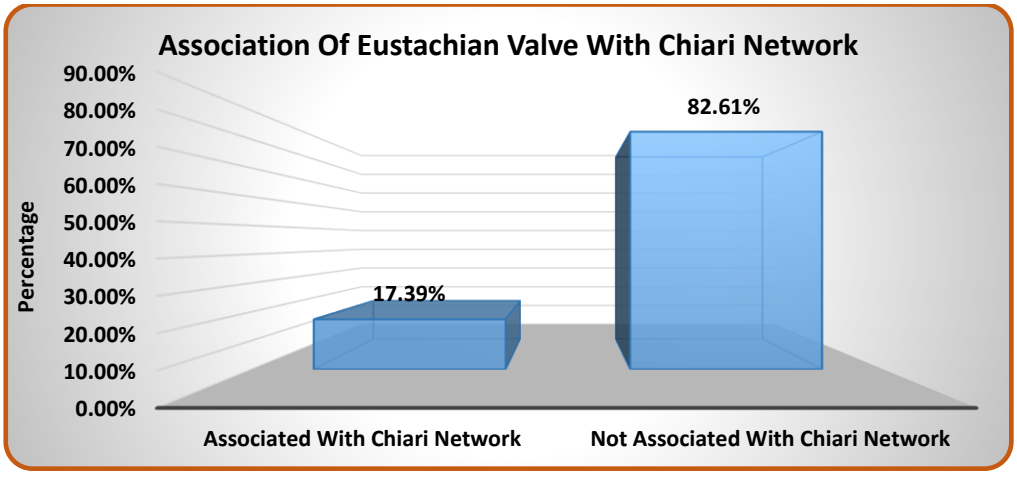
Figure 5.32- Membranous Eustachian Valve
(EV-Eustachian Valve,TV-Thebesian Valve)

5.10.3 Association Of Eustachian Valve With Chiari Network

Table No.5.39-Association with Chiari Network

Associated with Chiari (n-67)	Frequency	Percentage
Yes	14	17.39%
No	57	82.61%

Graph No 5.36 -Association with Chiari Network



Majority of the specimens (82.61%) were not associated with chiari network.

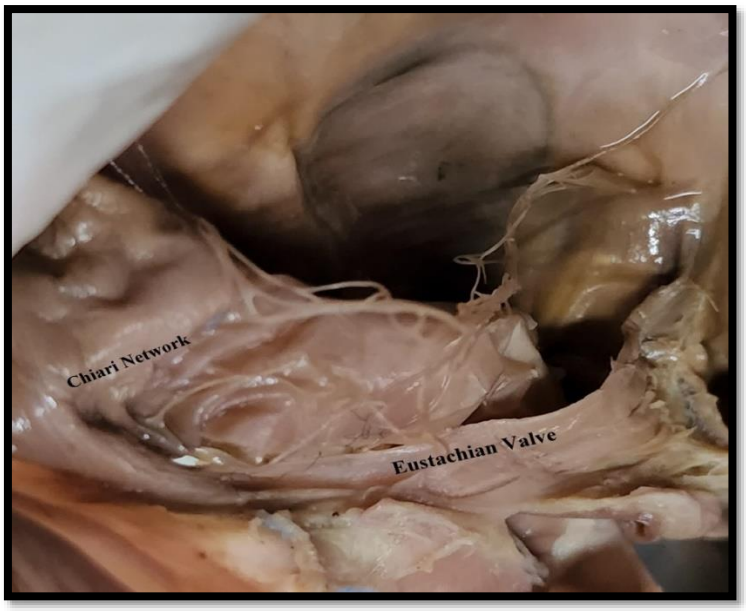


Figure 5.33 : Shows Eustachian valve associated with chiari Network

Chiari Network

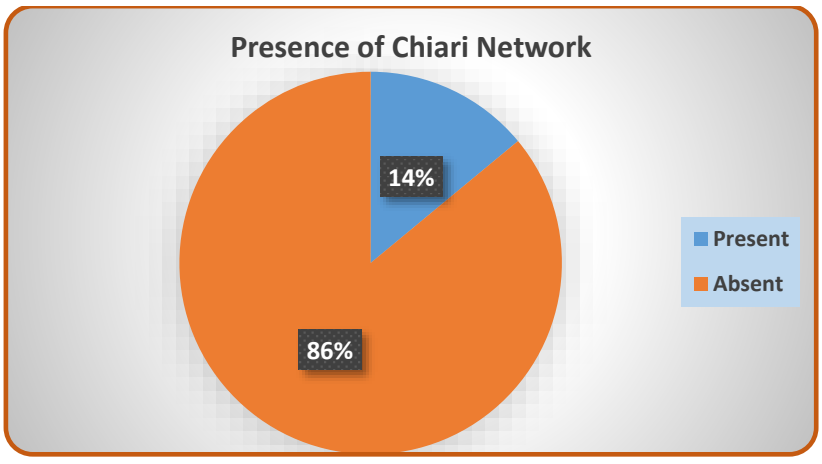
➢ 5.11 Variables Of Chiari Network

5.11.1 Distribution Of Chiari Network

Table 5.40- Distribution Of Chiari Network

Chiari Network (n-100)	Frequency	Percentage
Present	14	14.00%
Absent	86	86.00%

Graph 5.37- Incidence Of Chiari Network



Chiari network was present only in 14% of specimens (Figure 5.34). In majority of specimen (86%) it was absent.

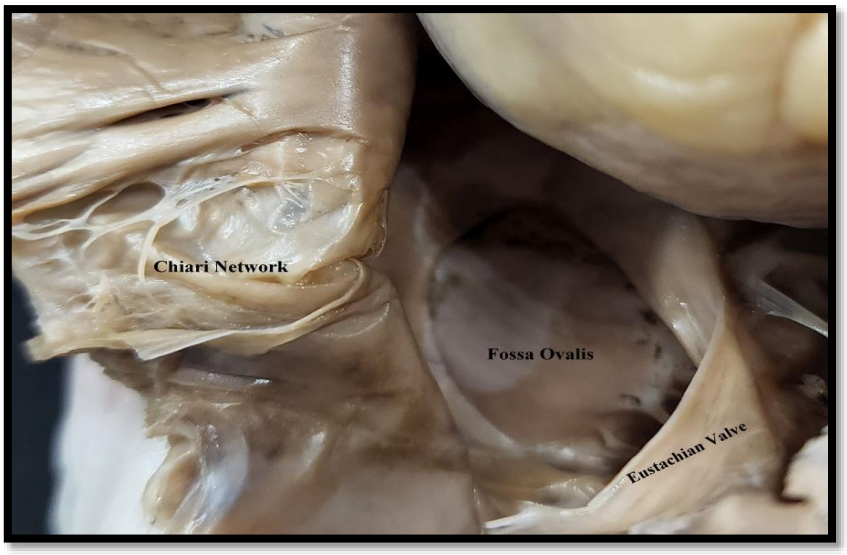


Figure 5.34-Shows Presence Of Chiari Network

5.11.2 Morphology Of Chiari Network

Table No 5.41- Morphological Variables Of Chiari Network

Variable	Frequency	Percentage
Structure (n-14)		
Reticular Network of fine strand	14	100.00%
Primary attachment to IVC (n-14)		
Yes	14	100.00%
Extent Of Chairi Network To		
Coronary Sinus	8	57.14%
Right Atrial Wall	6	42.86%
Association with left venous valve (n-14)		
Yes	04	28.57%
No	10	71.42%

In present study there were incidence of presence of chiari network in 14 specimens which were in the form of reticular network of fine strand (Figure 5.35). All the cases were having primary attachment on valve of Inferior Vena Cava (Figure 5.36), then fine reticular chiari network was either extend up to coronary sinus in 8 specimen or towards atrium-wall or cavity 6 specimen. Out of 14 four specimens also showed presence of left venous valve remnant (Figure 5.37).

Figure 5.35: Chairi Network Reticular Network Of Fine Strand

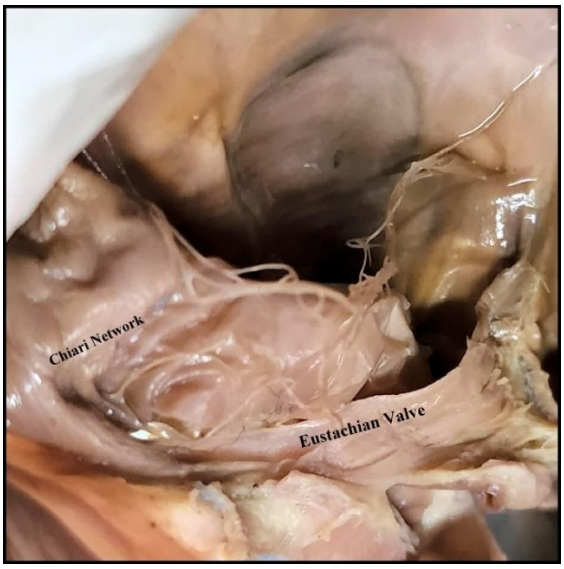


Figure 5.36: Chairi Network Primary Attachment On Eustachian Valve

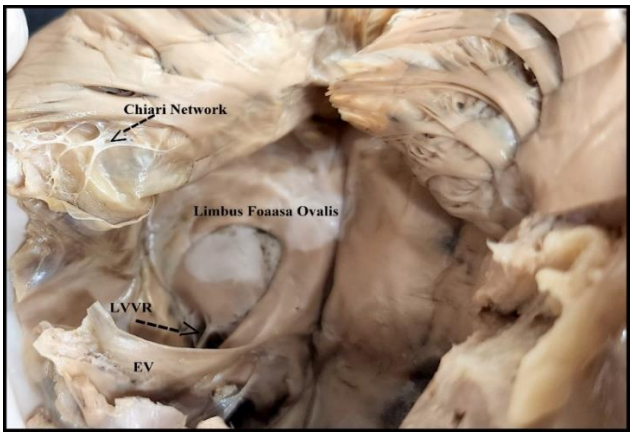


Figure 5.37: Chiari Network Associated With Left Venous Valve Remnant

Left Venous Valve Remnant

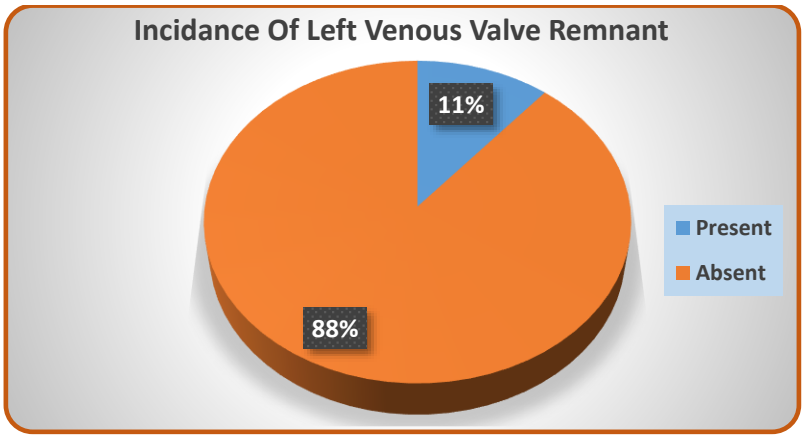
➢ 5.12 Variables Of Left Venous Valve Remnant

5.12.1 Distribution Of Left Venous Valve Remnant

Table 5.42 Distribution Of Left Venous Valve Remnant

Left Venous Valve	Frequency	Percentage
Present	11	11.00%
Absent	88	88.00%

Graph 5.38 Distribution Of Left Venous Valve Remnant



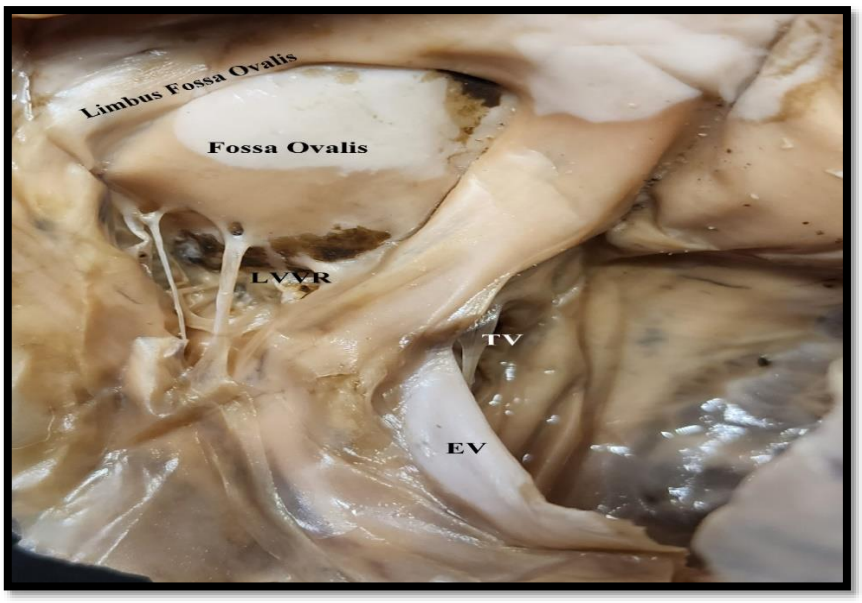


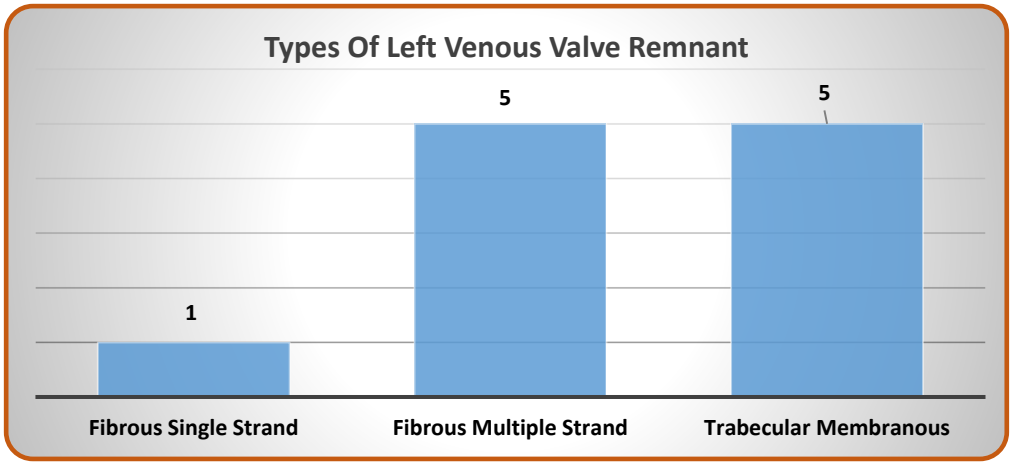
Figure 5.38: Shows Presence Of LVVR Over The Fossa Ovalis
(LVVR-Left Venous Valve Remnant, EV-Eustachian Valve, TV-Thebesian Valve)

5.12.2 Types Of Left Venous Valve Remnant

Table 5.43-Types Of Left Venous Valve Remant

Types (n-11)	Frequency	Percentage
Fibrous Strand Single	01	9.02%
Fibrous Strand Multiple	05	45.49%
Trabecular Membranous	05	45.49%

Graph 5.39-Types Of Left Venous Valve Remant



Left venous valve remnant with fibrous multiple strand (Figure 5.38 and Figure 5.39) and trabecular membranous were found in 5 specimen each while fibrous single strand type was observed only in 1 specimen.

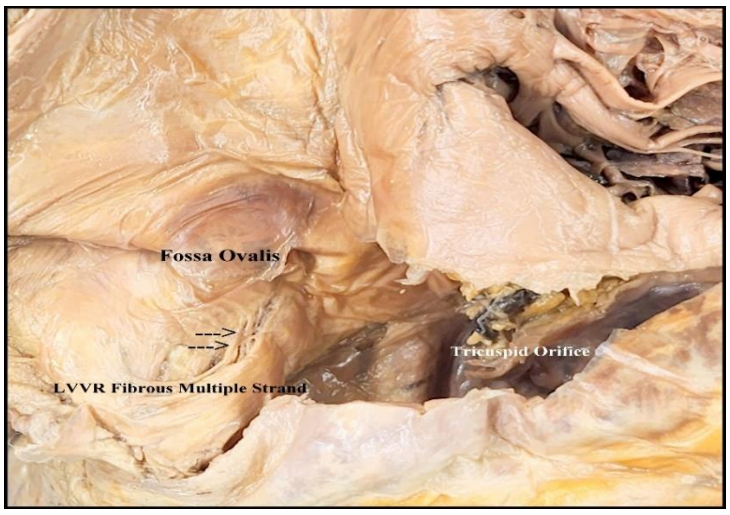


Figure 5.39: LVVR With Fibrous Multiple Strand

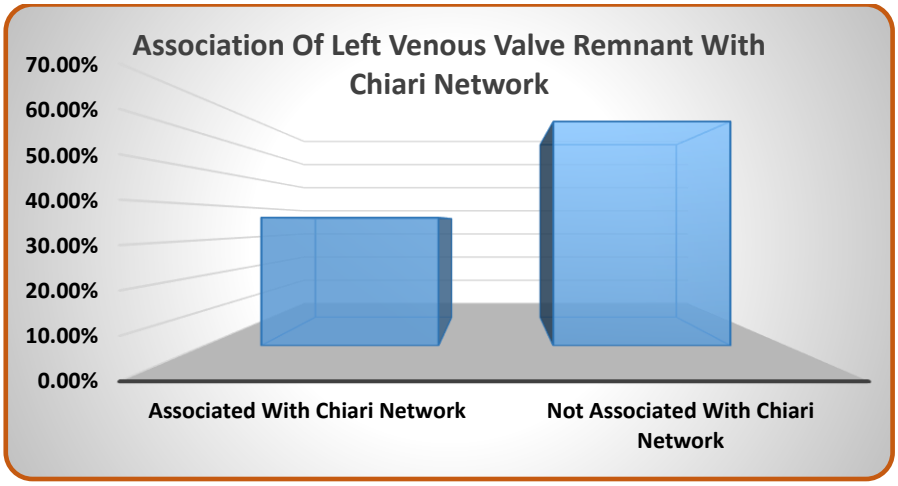
(LVVR-Left Venous Valve Remnant)

5.12.3 Association of Left Venous Valve Remnant With Chiari Network

Table 5.44 -Association Of Left Venous Valve Remnant With Chiari Network

Association with Chiari Network (n-11)	Incidence	Percentage
Yes	04	36.36%
No	07	63.63%

Graph 5.40-Association Of Left Venous Valve Remnant With Chiari Network



From above graph it was observed that 36.36 % (04) specimen were showed presence of both left venous valve remnant and chiari network (Figure 5.37).