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Anatomical Study by Dissection of the Tricuspid Valve in Senegalese Melanoderma

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Abstract

The tricuspid valve is subject to multiple variations with respect to the modal variety, knowledge of these variations is essential to the practice of cardiac surgery. The objective of this work was to identify the anatomical variations of the tricuspid valve and to clarify their implications.

This was an anatomical study by dissection of 21 formalin hearts, taken from Senegalese melanoderms anatomical subjects. The morphometry of the cusps and the annulus was studied and analyzed statistically.

The ring shape was circular in 10 hearts and elliptical in 11 with an average diameter of 3.86 cm and an average circumference of 12.1 cm. Fifteen anatomical pieces contained 3 cusps; 2 had 2 and the rest had 4. Statistical analyzes revealed that as the number of cusps increases, the width of the anterior cusp decreases.

This work made it possible to highlight the anatomical variations of the tricuspid valve concerning the cusps and to establish averages concerning the morphometric values of the latter as well as their impact in its surgical management.

Keywords: Cusps; Human heart; Valvular apparatus.

INTRODUCTION

The tricuspid valve (TV) is a dynamic anatomical structure that is part of the valvular system of the heart and helps establish unidirectional blood flow in the right heart chambers. TV is subject to multiple lesions that can be acquired or congenital (Ebstein disease). In Senegal, a study carried out on infective endocarditis of right heart showed that tricuspid valve is the most affected with a prevalence of 21.4%.[1] Tricuspid insufficiencies are much more common than tricuspid stenosis (respectively 75 and 25%).[2] Their surgical corrections involve valve replacement or reconstructive surgery. Surgery for acquired tricuspid lesions is dominated by conservative surgery for functional tricuspid insufficiency.[3,4] According to data from the literature, there would be multiple variations of VT with respect to the modal variety.[5-12] It was thus about the existence of a muscular or membranous connection between the papillary muscle and the cusps, accessory cusps, and foramina within the valve leaflets. Knowledge of these variations is essential to the practice of cardiac surgery, which

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is intended to be precise and efficient. The aim of this work was to identify the anatomical variations of the tricuspid valve and to clarify their surgical implications.

MATERIAL AND METHOD

Material

We took 21 hearts from fresh cadavers of adults of both sexes in the anatomo-pathology departments of Aristide Le Dantec Hospital and Idrissa Pouye General Hospital. Cadavers whose circumstance of death was a natural death were not included in our series, as were those with macroscopically visible cardiac lesions.

The instruments used were: a double decimeter, a compass, an 8-megapixel digital camera, a computer, a magnifying glass (× 3) with a diameter of 10 centimeters, formalin dosed at 10%.

METHOD

The removal of hearts was done in the autopsy's room and the dissection of tricuspid valves, in the laboratory of anatomy and organogenesis of *Dakar Cheikh Anta Diop University* following two stages: an atrial stage then a ventricular one.

The atrial approach was initially performed using *Rouviere*'s technique [13]. We carried out on the external face of the right atrium, a "U" incision whose concavity was directed backwards and upwards towards the base of the heart, so as to be able to fold back a flap formed of all the external wall of the right atrium which was then resected. This incision went from the right edge of the superior vena cava to the tip of the right auricle perpendicular to the coronary sulcus, then it continued parallel to the coronary sulcus to the orifice of the mouth of the inferior vena cava. Finally, it was worn horizontally and parallel to the first segment, therefore also perpendicular to the coronary sulcus.

For 17 specimens, the approach was modified to better expose the TV with a "V" incision: this was performed vertically along the superior vena cava then along the atrioventricular sulcus, resulting in a "V" shape. V" open top and back. The lateral wall of the right atrium was then resected.

The right ventricular approach was performed using Rouvière's technique [13]. It began with a vertical section of pulmonary artery's wall the passing between the right anterior and lateral pulmonary sigmoid valves. We extended the incision on the right ventricle along the interventricular septum. The two lips of the incision were removed and part of the anterior wall of the right ventricle was resected. This resection was sometimes slightly modified to circumvent the anterior papillary muscle. Thus, care was taken to keep the anterior papillary muscle intact. Then we made another ventricular incision parallel to the atrioventricular (coronary) groove; from the pulmonary orifice to the left border of the heart.

In short, we first proceeded to an in situ inspection of the VT then secondarily to its removal from the heart after section of the tendinous chordae of the interventricular septum, of the papillary muscles at their base, and resection of the atrioventricular ring. at the level of its attachment zone on the orifice. During the morphological and morphometric analysis, we determined the number of cusps and the presence of accessory cusps, their dimensions (width, depth and calculated area) and the presence on their atrial side of foramina (true or false).

Thus, we used *Skwarek*'s classification of TV [14] to classify TV according to the number of cusps:

- Type 0: TV with 2 cusps;
- Type 1: TV with 3 cusps;
- Type 2: TV with 4 cusps including an accessory cusp;
- Under type 2A: the accessory cusp is located between the septal cusp and the posterior cusp.
- Subtype 2B: the accessory cusp is located between the anterior and septal cusps.
- Under type 2C: the accessory cusp is located between the posterior and anterior ones.
- Type 3: TV has 5 cusps including two accessory cusps.
- Type 4: TV has 6 cusps including three accessory cusps.
- Type 5: TV with 7 cusps including four accessory cusps.
- Next, we measured the width and depth (cm) for each cusp.
- The depth corresponds to the distance between the tricuspid ring and the apex of the cusps.
- The width is the greatest distance between two adjacent commissures.
- The area of the cusp was calculated according to the formula S (cm^2) = (width (cm) × depth (cm)) ÷ 2; in view of the cusps which appeared roughly triangular.

The large diameter of the ring was measured using a compass then this measurement was

reported to the graduated ruler and obtained in centimeters. Due to the shape of the tricuspid ring, roughly comparable to a circle, its circumference was calculated according to the formula: Circumference (cm) = π × large diameter (cm);

Finally, we took a photo of the specimen.

Statistical tests were carried out on the following different parameters:

- Age of the heart;
- Weight of the heart;
- Shape of the TV ring;
- Circumference of the TV ring;
- Number of TV cusps;
- Dimensions (width, depth) of the different particular cusps of the TV.

On these parameters, we performed bivariate statistical analyzes in order to better study the correlation or association between them, in particular:

- Age and shape of the tricuspid ring;
- Weight of the heart and the shape of the tricuspid ring on the one hand; and the circumference of the tricuspid ring, on the other hand;
- Circumference of the tricuspid ring and the depth of the cusps;
- Comparison of means between the dimensions of the cusps and the number of cusps categorized into two variables. A first group included specimens with valves with 4 cusps (> 3) and a second, contained specimens with valves made with at most 3 cusps (≤ 3).

RESULTS

The ring had a circular shape for 10 hearts (47.6%) and elliptical for 11 hearts (52.4%). The average diameter of the tricuspid ring was 3.86 centimeters (cm) (± 0.59) with extremes of 3.3 and 4.4 cm. The average circumference was 12.1 cm (± 1.87) with extremes of 8.5 and 15.4 cm, it was 15.5 cm in men and 11 cm in women.

We found 3 commissures out of 15 hearts: these are the anteroposterior, posteroseptal and anteroseptal commissures. Two hearts presented 2 commissures and 4 other hearts, 4 commissures.

Fifteen (15) valves (71.4%) contained 3 cusps (Fig. 8); two (9.5%) had 2 cusps and finally 4 (19.1%) had 4 cusps. In these latter cases, the supernumerary or accessory cusp was located between the posterior and septal cusps. Thus, we noted that TV of type 0 were 9.5%, those of type 1 represented 71.4% and those of type 2 were at 19.1%. These corresponded to a 2A subtype.

The measurements of the anterior cusp were predominant over the others with a width of 3.34 cm, a depth of 2.12 cm and an average surface of 3.6 cm 2 as shown in table I.

The mean width of the anterior cusp was greater (4.7 cm) in the specimens with two cusps in contrast to the mean width of the posterior cusps which was greater in the specimens with three cusps (3.2 cm) as illustrated in the table II.

Table I: Average measurements of TV's different cusps

Average measurements	Anterior cusp	Posterior cusp	Septal cusp	Accessory cusp
Average width (cm)	334(0.9)	2.92(1.04)	2 .63(0.94)	0.39(0.84)
Average depth (cm)	2.12(0.54)	1.7(0.6)	1.8(0.83)	0.36(0.82)
Average area (cm²)	3.6(1.47)	2.9(1.46)	2.5(1.47)	0.38(0.87)

Among the 21 pieces, 18 (85.71%) contained natural foramina. There were 52 natural foramina including 11 true (Fig. 9) and 41 false (Fig. 10) as summarized in Table III.

Our bivariate static analyzes revealed that:

- The age of the heart has no influence on the

Table II: The relationship between cusp width and the number of cusps per specimen.

Number of cusps per specimen	2 cusps	3 cusps	4 cusps
Average anterior cusp width (cm)	4.7	3.3	2.6
Mean posterior cusp width (cm)	2.1	3.2	2.3
Mean septal cusp width (cm)	2.5	2.54	2.3

Table III : Number of natural foramina observed in our series.

Specimens	Number of natural foramina	
	true	False
18	11	41
3	0	0

shape of the tricuspid annulus (p = 0.86).

- There was no relationship between the weight of the heart and the shape of the tricuspid annulus (p = 0.37).
- The weight of the heart had no influence on the circumference of the tricuspid annulus (p = 0.38).
- There was no correlation between the annulus circumference and the depth of the anterior, posterior and septal major cusps (p = 0.88; p = 0.64; p = 0.57).
- The categorization of the number of cusps in relation to the respective mean widths of the anterior, posterior and septal cusps gave respective p-values of 0.0386, 0.096 and 0.18.

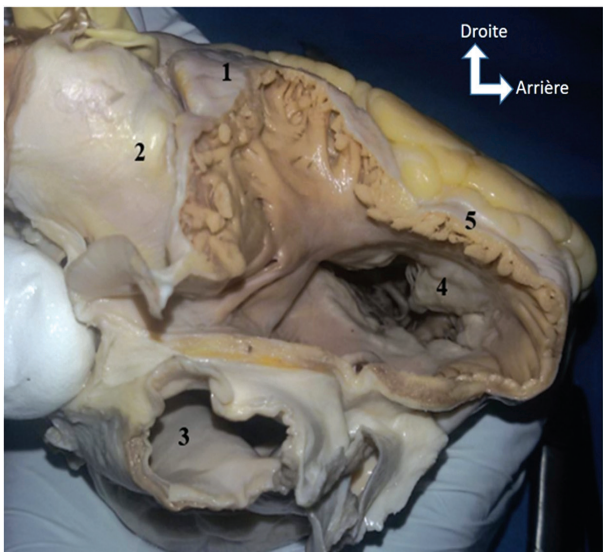

Fig. 1: Abord atrial de la valve tricuspide (atrium droit partiellement réséqué). 1. Auricule droit sectionné. 2. Aorte ascendante. 3. Atrium gauche. 4. Valve tricuspide. 5. Sillon atrio-ventriculaire (coronaire) droit

Therefore, as the number of cusps increased, the width of the anterior cusp decreased. For the other posterior and septal cusps, there was no influence between their respective width and the number of cusps.

- There was no relationship between the number of cusps and the depth of the anterior, posterior and septal cusps (p = 0.62; p = 0.22; p = 0.81).

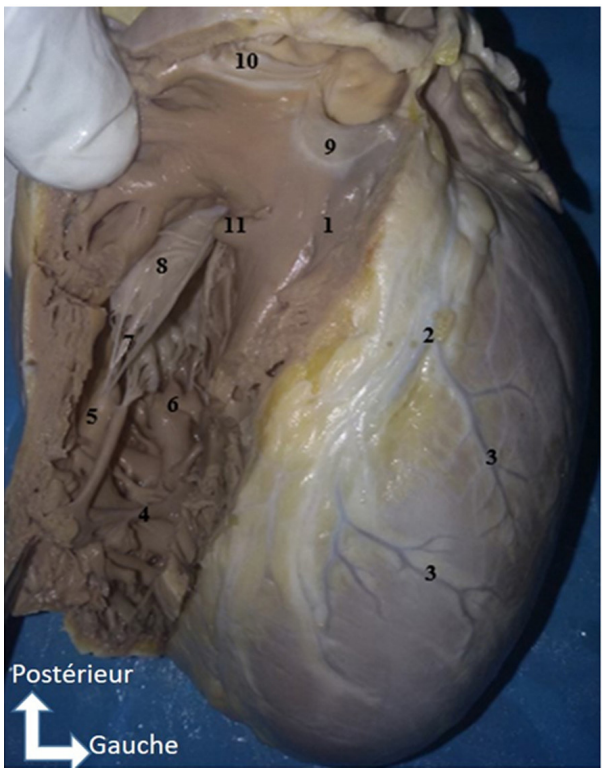

Fig. 2: Incision ventriculaire droite le long du sillon interventriculaire antérieur et résection de la paroi ventriculaire antérieure. 1. Septum interventriculaire. 2. AIVA. 3. Branches artérielles ventriculaires gauches. 3. Colonnes charnues de 2ème ordre. 4. Muscles papillaires antérieurs (piliers antérieurs) accolés. 5. Muscles papillaires antérieurs (piliers antérieurs) accolés 6. Muscle papillaire postérieur (pilier postérieur). 7. Cordages tendineux. 8. Cuspide antérieure. 9. Sigmoïde pulmonaire antérieure. 10 Sigmoïde pulmonaire latérale gauche. 11. Muscle papillaire septal

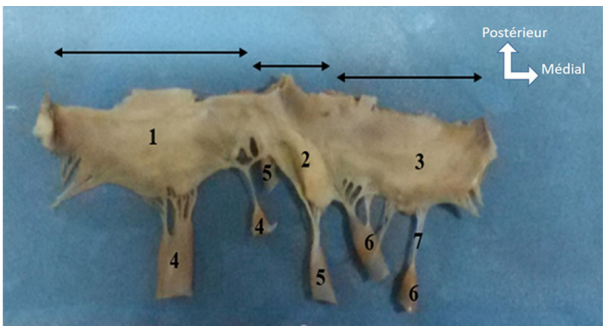

Fig. 3: Face atriale de la valve tricuspide prélevée après dissection et étalée 1. Muscle papillaire antérieur. 2. Muscles papillaires septaux. 3. Muscle papillaire postérieur. 4. Cordages tendineux de deuxième ordre. 5. Cordages tendineux septaux sectionnés. 6. Commissure postéro-septale. 7. Commissure antéro-postérieure.

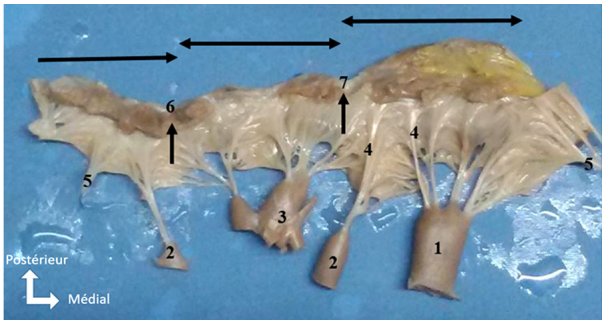

Fig. 4 : Face ventriculaire de la valve tricuspide prélevée après dissection et étalée. 1. Muscle papillaire antérieur. 2. Muscles papillaires septaux. 3. Muscle papillaire postérieur. 4. Cordages tendineux de 2ème ordre. 5. Cordages tendineux septaux sectionnés. 6. Commissure postéro-septale. 7. Commissure antéro-postérieure.

Fig. 5: Vrai foramen situé sur la cuspide postérieure d'une valve tricuspide réséquée. 1. Vrai foramen. 2. Voile tricuspide postérieure. 3. Cordages tendineux.

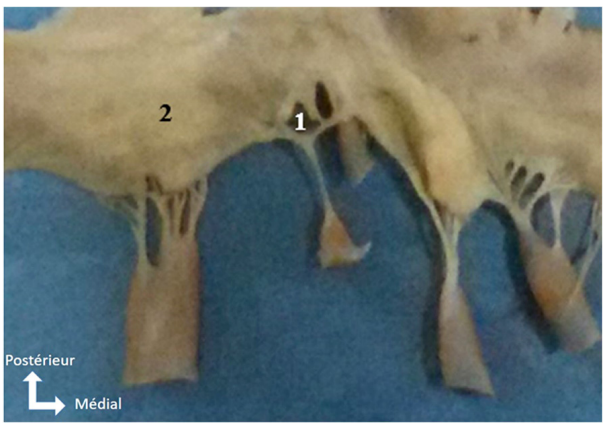

Fig. 6: face atriale d'un voile tricuspide mettant en évidence un faux foramen situé sur la cuspide postérieure d'une valve tricuspide réséquée. 1- Faux foramen sur la cuspide postérieure. 2- Cuspide antérieure.

DISCUSSION

For Silver[8] the tricuspid valve annulus is best appreciated on an atrial view which reveals a roughly triangular shape. However, SKWAREK[12] adds that the shape of the right atrioventricular ring evolves during life from a triangular shape to a more elliptical shape. In fact, he made cross-sections of the right atrium parallel to the plane of the atrioventricular orifice which show a circular or elliptical shape of the annulus. While right ventricular sections made from the apex show a triangular ring. He concludes that one of the two cavities exerts a great influence on the shape of the tricuspid valve. Our method which proceeds to the resection of the atrial wall, allowed us to observe an elliptical shape of the annulus in 52.4%. This elliptical shape was predominant over the circular one, contrary to the findings of SKWAREK.[14]

In the design of heart valve prostheses, there is a circular shape of the rings of mechanical prostheses or bioprostheses.[15] The average circumference of the ring is evaluated at 9.7 cm (± 1.029) and 9.496 cm (± 1.059) respectively by KUJUR et al[6] and Rohilla et al[16] who worked on Indian populations. These values are lower than ours. This difference could be due to racial specificities. Also, our methods of determining the measurements are different, Kujur et al[6] uses a malleable aluminum wire and Rohilla[16] a surgical silk thread and both determined the circumference of the tricuspid valve annulus by direct affixing of the thread. along the circumference of this ring. In our study, the use of the circle formula was used to determine the circumference, with a more frequent elliptical ring shape, which could be the cause of these differences in values. Similarly, calculating the perimeter of the ellipse is very complicated. This would explain the process used by some authors.[6,16] Other authors have reported circumference values according to sex. In men, it is 11.4 cm (± 1.1) for SILVER et al[8] and 10.7 cm to 12.1 cm for SKWAREK et al[17] on the one hand and on the other hand in women respectively 10.8 cm (± 1.1) and 10.4 to 11.08 cm. In female specimens, our results are superimposable to those of the latter. As for the values for male specimens, they are lower than ours.

TEI CHUWA et al[18] notes cyclical variations in the tricuspid annular circumference which depend on the cardiac cycle (systole/diastole). Thus, using two dimensional echocardiography in 16 normal subjects, he reports a maximum average value and a minimum average value of the annular circumference which are respectively 11.9 cm (±0.9) and 9.6 cm (±0. 9). These echocardiographic values

obtained on living subjects are comparatively lower than ours obtained after dissection of anatomical specimens.

Concerning the commissures which are introduced by the clinicians as corresponding to the part of the valve contained between the fibrous annulus and the peak of the intercuspidal incision. The names of the commissures are compound words based on the adjoining cusps. We observed two commissures on a heart in two cases of bicuspid valve.

For Victor and Nayak[19], bicuspid is the rule. He states that there is normally a septal cusp and a parietal cusp. The latter corresponded to the posterior and anterior cusps classically described in the literature. The commissures are therefore important landmarks when carrying out certain surgical techniques (such as the KAY technique, the commissural plication, the commissurotomy) hence the need to clearly identify them according to their situation in relation to the different cusps. Consequently, according to Chauvaud[3], the following surgical techniques are noted.

The KAY technique: this involves performing bicuspidization by closing the posterior cusp. It is performed using the anteroposterior and posteroseptal commissures. It is an annuloplasty technique aimed at reducing the annular circumference in the event of dilation. The stitches are passed through the tricuspid ring at the level of the commissures located on either side of the posterior cusp. It leads to total obliteration of the posterior cusp by tightening the points, thus reducing the annular perimeter;

- The commissural plication: we place plication points ("X" points) on the antero-posterior and postero-septal commissures. The wider the grip of the point, the greater the annular reduction. This is a complementary procedure used in tricuspid annuloplasty in the case of TI secondary to tricuspid endocarditis.[20]
- In tricuspid stenosis (very often secondary to carcinoid syndrome or acute rheumatic fever), commissurotomy is a restorative technique used in surgical treatment. It is performed with a scalpel on the antero-septal and sometimes postero-septal commissure, sometimes the commissurotomy is limited to the septal commissure alone or is extended over the cords when these are fibrous or retracted.[3,21]

The number of cusps and their configuration are still controversial. According to literature data, the number of cusps varies, also accessory cusps can be found between the main cusps.[5,6,11,17,23]

According to Kujur[6], these accessory cusps consist of an endocardial fold reinforced by fibrous tissue and in reality, they simply allow a better coaptation of the valve.

Type 1 TV (with 3 cusps) is predominant in our series with a percentage of 71.4%. This is observed in other authors[5,22] including KUJUR[23] in whom this percentage increases to 100. This would be explained by the fact that KUJUR worked on the Asian type on a sample of 42.

Type 2 TV is also present in 19.04% of our specimens. Its predominance is observed in a large number of authors.[9,24]

The subtype is not specified by all the authors.[24] Skwarek and al report subtype 2A at a lower rate than ours. For GEROLA[5], the subtype is 2C.

Type 0 VT was present in only 9.52% of the specimens in our series. This bicuspid type variation is rarely observed in the literature.[5,22] Its value reaches 18% for GEROLA 5 and is lower (5.83%) for.[22]

In most anatomy treatises, the tricuspid valve has 3 cusps. On the other hand, for Victor and Nayak[19], the bicuspid is the rule, with a septal cusp and a parietal cusp. The presence of one or more clefts (related to its functional mobility) gives the appearance of 2 posterior and anterior cusps, or cusps called accessory cusps, on the latter. This would partly justify tricuspid valve replacement with a mitral homograft.

The other variations relating to the number of cusps (types 3, 4 and 5) are not observed in our series but are reported in the literature [14, 22, 24]. Mishra and al[22] report multiple variations in the dimensions of the TV cusps. Indeed, in his study, the anterior cusp is the widest followed by the septal cusp and finally the posterior cusp.

As for Kujur and al[23] also, our work reveals that the anterior cusp is the widest among the 3 cusps. As for, Rohilla and al[16], in his study concerning 86 hearts, reports a greater width of the septal cusp with an average attachment zone of 2.874 cm.

Concerning the depth, that of the anterior cusp is the most important for all the authors.[9,16,25]

It emerged from our study that the higher the number of cusps (3 or 4), the smaller the width of the anterior cusp; therefore, we believe that the accessory cusp would develop at the expense of the anterior cusp. This could be justified by the study

of Skwarek and al[14] which reveals that the number of cusps of the tricuspid valve increases during evolution but the rules of this process are unknown. Based on his results, he advances the thesis that the accessory cusp had separated from the main cusp and that it is impossible to establish explicit links to the main cusps from which the accessory ones have separated. Thus, he asserts that the mechanism of accessory cusp separation is a complex process. Indeed, our statistical tests show that, the more the number of cusps increases, the more the width of the anterior cusp decreases. *Rohilla* and al[16] agrees with us about his series of 86 Specimens. He also, contrary to us, found a statistically significant correlation between the number of cusps and the width of the posterior cusp, however, he agrees with the conclusions of Salomon and Nayak in relation to the bicuspid.

Total tricuspid valve replacement procedures, which are delicate, require respecting the septal cusp and the anteroseptal commissure in order to avoid trauma to the HIS beam.[3] Indeed, the attachment zone of the septal cusp on the valvular annulus limits the triangle of KOCH, with the tendon of TODARO and the coronary sinus. Identifying this triangle helps to avoid lesion of the HIS bundle located at its apex during plastic surgery and replacement of the tricuspid valve.[26] Cusp variations are involved in certain malformations such as EBSTEIN disease, which combines a tricuspid anomaly on the one hand and a right ventricular anomaly on the other.[27] We thus note, an implantation of the septal cusp made on the interventricular septum (not on the tricuspid ring), a posterior cusp attached to the posterior wall of the RV, a normal implantation of the anterior cusp sometimes moved on the moderator band, an always dilated tricuspid ring, sometimes non-existent short tendon cords and an atrialized RV (intermediate chamber) due to displacement of the insertion of the cusps. It is a rare congenital anomaly (1 to 5 cases per 100,000 births), which most common expression is tricuspid insufficiency.[27]

The natural foramina observed on the cusps are reported by *Skwarek* and al[28] with a percentage of 11.21%, much lower than ours which is 85.71%. These natural foramina may be responsible for the additional jets observed during echocardiography as well as the subclinical insufficiency of the tricuspid valve[29], especially since *Gallet*[30] reports that TI is physiological in 65 to 75% of normal subjects.

CONCLUSION

This work made it possible to highlight the anatomical variations of the TV concerning the cusps whose anatomy's knowledge coupled with morphometric data and the morphological variations, should allow a better approach of tricuspid pathology and surgical management.

REFERENCES

1. Ndiaye Mb, Diao M, Pessinaba S, Bodian M, Kane Ad, Mbaye A, Dia Mm Et Al Aspects épidémiologiques, cliniques et échographiques des endocardites infectieuses du cœur droit au Sénégal: 6 observations cliniques Médecine Tropicale. 2011 ;7 (1):484-6.
2. www.chirurgiecardiaquejacquescartier.com: Chirurgie de la valve tricuspide Date d'accès : 7 juin 2018 : 18 : 36.
3. Chauvaud S. Chirurgie des lésions acquises de la valve tricuspide. Encycl Méd Chir (Editions Scientifiques et Médicales Elsevier SAS, Paris, tous droits réservés), Techniques chirurgicales - Thorax, 42-540, 2002, 8 p.
4. Fondard O. Lésions acquises de la valve tricuspide. EMC (Elsevier Masson SAS, Paris), Cardiologie, 11-012-A-10,2006.
5. Gerola Lr, Wafae N, Vieira M-C, Juliano Y, Smith R, Prates J-C. Anatomic study of the tricuspid valve in children. Surgical and Radiologic Anatomy. 2001;23(3):149–53.
6. Kujur B, Thakur N, Prasad R. Morphological study of tricuspid valve and its variation in adult human hearts. International Organization of Scientific Research Journal of Dental and Medical Sciences. 2016;15(9):72-8.
7. Nigri Gr, Di Dio Lja, Baptista Cac. Papillary muscles and tendinous cords of the right ventricle of the human heart morphological characteristics. Surgical and Radiologic Anatomy. 2001;23 (1):45–9.
8. Silver Md, Lam Jhc, Ranganathan N, Wigle Ed. Morphology of the human tricuspid valve. Circulation. 1971;43(3):333–48.
9. Skwarek M, Dudziak M, Hreczecha J, Grzybiak M. The connection between the papillary muscles and leaflets of the tricuspid valve. Folia morphologica. 2006;65(4):322–8.
10. Skwarek M, Hreczecha J, Grzybiak M, Kosiński A. Remarks on the morphology of the papillary muscles of the right ventricle. Folia morphologica. 2005;64(3):176–82.
11. Wafae N, Hayashi H, Gerola Lr, Vieira Mc. Anatomical study of the human tricuspid valve. Surgical and Radiologic Anatomy. 1990;12(1):37–41.
12. Wafae N, Cruiz R, Abraham M, Freire Ch, Demarchi Gt, Wafae Gc. Anatomy of the tendinous

cords of the interventricular septum of the human heart. Italian journal of anatomy and embryology=Archivio italiano di anatomia ed embriologia. 2008;113(4):273–9.

13. Rouviere H. Précis d'anatomie et de dissection. Paris : Masson et Cie. 6ème Ed. 1939, 871 p.
14. Skwarek M, Hreczecha J, Dudziak M, Jerzemowski J, Grzybiak M. The morphology and distribution of the tendinous chords and their relation to the papillary muscles in the tricuspid valve of the human heart. Folia morphologica. 2007;66(4):314–22.
15. Leguerrier A, Flecher E, Fouquet O, Lelong B. Prothèses valvulaires cardiaques. EMC (Elsevier Masson SAS, Paris), Cardiologie, 11-013-A-30, 2009.
16. Rohilla A, Singh K, Rohilla J, Chhabra S. Tricuspid Valve Morphometry: A New Learning from Cadavers. Anat Physiol.2015;5(4):1–4.
17. Skwarek M, Hreczecha J, Dudziak M, Jerzemowski J, Szpinda M, Grzybiak M. Morphometric features of the right atrioventricular orifice in adult human hearts. Folia morphologica. 2008;67(1):53–7.
18. Tei C, Pilgrim Jp, Shah P M, Ormiston Ja, Wong M. The tricuspid valve annulus: study of size and motion in normal subjects and in patients with tricuspid regurgitation. Circulation. 1982; 66(3):665–71.
19. Victor S, Nayak Vm. The Tricuspid Valve Is Bicuspid. The Journal of Heart Valve Disease. 1994;3(1):27-36.
20. Chauvaud S. Endocardite tricuspide. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Thorax, 42-735-C, 2007.
21. Jouan J. Pathologies acquises de la valve tricuspide EMC. EMC-Cardiologie 2014 ;9(4) :1-11[Article11-012-A-10].
22. Mishra Pp, Manvikar Pr, Mishra A, Puranam V. Variations in the Number and Morphology of Cusps of the Tricuspid Valve: A cadaveric study. International Journal of Biomedical Research. 31 janv 2016;7(1):39 43.
23. Kujur B, Thakur N, Prasad R. Morphological Study of Chordae Tendineae of Right ventricle in Embalmed Human Cadavers. International Organization of Scientific Research Journal of Dental and Medical Sciences. 2016;15(9):72-6.
24. Skwarek M, Grzybiak M, Kosiński A, Hreczecha J. Notes on the morphology of the tricuspid valve in the adult human heart. Folia morphologica. 2004;63(3):319–24.
25. Lama P, Tamang Bk, Kulkarni J. Morphometry and aberrant morphology of the adult human tricuspid valve leaflets. Anat Sci Int. 2016;91:143–50.
26. Tretter Jt, Sarwark Ae, Anderson Rh, Spicer De. Assessment of the anatomical variation to be found in the normal tricuspid valve. Clinical Anatomy. 2016;29(3):399–407.
27. Chauvaud S. Anomalie d'Ebstein: techniques chirurgicales, valvulaires et ventriculaire. EMC (Elsevier Masson SAS, Paris), Techniques chirurgicales - Thorax, 42-841, 2008.
28. Skwarek M, Hreczecha J, Grzybiak M, Kosiński A. Unusual anatomical features of the right atrioventricular valve. Folia morphologica. 2005;64(3):183–7.
29. Skwarek M, Hreczecha J, Dudziak M, Grzybiak M. The morphology of the right atrioventricular valve in the adult human heart. Folia morphologica. 2006;65(3):200–8.
30. Gallet B. Etiologies des fuites tricuspides et évaluation échocardiographique. AMC pratique. 2014;(224):9-16.