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RESEARCH ARTICLE

Application of the Alfieri technique for the resolution of tricuspid dysplasia in 7 canines

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Abstract

The application of the Alfieri technique in humans is a well-known and pioneering thechnique that was replaced by modern atrioventricular valve repair strategies.[1,2] This technique in canines and also in humans is yet a valid alternative, particullary to canine tricuspid dysplasia.1 The "strategy" consists to transform the "monorificial" dysplastic tricuspid valve insufficiency into a "biorificial" one by means of a suturing at the level of the valve apposition face in the site of greatest regurgitant flow. The surgical field is cleared from blood by means of occlusion of both venae cavae. With this strategy the reduction of the insufficiency jet was achieved in 7 canine carriers of said congenital pathology. The technique demonstrated its anatomical reliability, repeatability, low mortality, and low cost. Of the total number of cases operated on, one patient died the day after surgery, another patient a year later due to non-cardiac causes, and the rest continue under clinical follow-up at the time of presenting this series.

Introduction:

Tricuspid valvular dysplasia is a congenital heart disease in canines whose current prevalence is unknown. It is characterized by malformation of the tricuspid valve leaflets, chordae tendineae and papillary muscles of the right ventricle, either alone or in combination.[2,3] This set of malformations can occur alone or in combination with other congenital heart diseases, of which the most common in our case material was pulmonary stenosis. It can also occur with mitral valve dysplasia.[4,5] Varying degrees of valvular insufficiency result from tricuspid malformation and in rarer cases tricuspid valve stenosis. Dogs that are mildly affected may not show clinical signs. The disease is usually progressive and develops complications early in the animal's life, such as ascites, pleural effusion, exercise intolerance, syncope, weight loss, and arrhythmias.[6,7,8,9,10,11,12] When right heart failure occurs, one is facing the terminal stage of the disease. Many medical treatments have been tried to eliminate the clinical signs, but they are palliative. For this, we designed a surgery via the inflow occlusion technique for the opening of the right atrium and achieve clear visualization of the tricuspid valve. Using the Alfieri technique -that is to say- placing a stich in the valve apposition zone to transform the uniorificial valve into a bioorificial one, thus decreasing torrential flow to the right atrium.[1,2,13,14]

7 animals were operated, all under one year of age. They were 1 Labrador, 1 Boxer, 2 English Bulldogs and 3 French Bulldogs. With this technique, a single surgical death occurred in 1 of the French bulldogs that presented the pathology combined with pulmonary stenosis. In all cases, it was possible to transform the valve into a bio-orificial valve and reduce the regurgitating flow. The rest of the animals are currently under clinical follow-up.[15]

Materials and methods:

Between 2019 and 2023, our team evaluated 20 canines with a diagnosis of congenital tricuspid dysplasia. Of these 20 animals, 7 were selected as surgical candidates. The general selection criteria were:

1) Absence of severe right congestive failure (without ascites, without pleural effusion, without syncope or intolerance to exercise),

2) Sinus rhythm without intermittent atrial fibrillation.

3) Tricuspid regurgitation: 60% of the right atrial volume onwards and tricuspid regurgitation velocity greater than 2.5m/sec.

Normal right ventricular lateral TAPSE (measured through the septal ring) and a right bundle branch compliance index.

4) Pulmonary artery anatomy within normal. Accordingly, 7 animals were selected, 1 of the Labrador breed, 1 of the Boxer breed, 2 of the English Bulldog breed and 3 of the French Bulldog breed. The weights ranged between 4 and 20kg, the ages were between 4 and 8 months of age, the sexes were 4 females and 3 males, and the size of the tricuspid regurgitation jet was central concentric in 5 animals and eccentric with septal origin in 2 animals.

Methods:

Surgery was designed taking into account the Alfieri technique that is placing a 4-0 Polypropylene stitch at the appositional site between the two leaflets facing the center of the maximum reflux site, in order to provide a palliative solution to tricuspid reflux.

To assess the main site of reflux, a preoperative Doppler echocardiogram was performed using all possible echotomograms to determine the site of greatest reflux.[16,17]

The circulatory occlusion or inflow occlusion technique was used to gain access to the right atrium in normothermia with the heart beating. This allows for a 7 minute occlusion period. If the surgical objective is not achieved in those 7 minutes, the clamp should be released and the heart allowed to beat at normothermia for 10 minutes before performing a second period of occlusion. In all the operated cases except 1, it was possible to perform the surgical technique in less than 7 minutes. The case in which it was necessary to perform more than a "7 minutes session" was a complex case with congenital tricuspid dysplasia and pulmonary valve stenosis. In this individual, 3 episodes of circulatory occlusion were performed.

First, the pulmonary stenosis was resolved and afterwards the tricuspid regurgitation. This was the animal that had a cardiac arrest 24 hours after the operation, the only perioperative death. Another animal died a year from non-cardiovascular causes. The rest of the animals are currently alive and without right ventricular failure.

Surgical technique:

Anesthesia:

The premedication was morphine at 1mg/kg with acepromazine 0.01mg/kg. induction began with ketamine 10mg/kg with midazolam 0.2mg/kg and was continued with isoflurane.[18,19]

1) Positioning the patient:

It was performed was through a right thoracotomy at the level of the 5th intercostal space.

After performing the thoracotomy, the right cranial lung lobe was dislocated in order to gain access to a wider surgical field.

2) Access and control of the great veins:

"Rummel" tourniquets with 2/0 silk were pre-placed over the azygos vein, the cranial vena cava and over the caudal.

3) Pericardiotomy:

An oblique incision was made over the pericardium respecting the phrenic nerve allowing access to the wall of the right atrium on which directing sutures were placed.

4) Atriotomy:

Several sutures of polypropylene pre-assembled with Teflon felt were performed between the apex of the right atrial appendage pointing to the caudal vena cava. The length of the incision was about of 4 cm and the distance from the atrioventricular sulcus was about more than 2cm in order to not distort the geometry of the coronary artery and the tricuspid annulus.

After placing the driving points, a vascular clamp was placed over the right atrium that

included the site where the driving points were placed, and then the atriotomy incision was made with the clamp in place. Once the incision was made, the sequential closure of the tourniquets began and the timing began.

5) The inflow stasis itself:

The tourniquets are always closed from the one with the lowest flow to the one with the highest flow, that is, the azygos is closed first, then the cranial vena and finally the caudal vena. Once the caudal cava is closed, we wait between 7 and 10 right ventricular beats and the clamp was released opened. At this time residual blood begins to flow from the right atrium which must be aspirated.

6) Assessing the precise site of the reflux:

The residual volume of the right ventricle allows us to visualize where the greatest reflux occurs.

7) Placement of the stitches:

It is usually between the appositional site of the septal and posterior leaflet.

For this, 4/0 cardiovascular polypropylene sutures are used.[19,20]

From the atrial point of view, an horizontal U point or an X point was made between the the leaflets selected, taking care to suture the appositional site of the leaflets. Fig 8,9,10,11[21,22]

8) De-airing the heart and returning to normal flow:

Once the "Alfieri".15 is done, the air is purged by placing warm saline solution to fill the entire cavity. Then the clamp is repositioned involving the wall with the directing points. The cava and azygous tourniquets are then released in the opposite direction to that in which they were placed. Finally, the residual air is evacuated by opening the Satinski forceps allowing blood and air to escape. Then the clamp is repositioned when the bleeding is clear and the atriotomy is sutured with 3/0 polypropylene. Finnaly, The clamp is removed and eventual bleeding sites needing additional stitches are performed. The thorax is closed in a standard fashion a thoracostomy tube left for one day. The patient remains hospitalized for a period of 48 hours. An intraoperative echocardiographic study is performed, one immediately after the surgical technique, as well as the follow-up at one month, at 3 months, at 6 months and at one year in all the individuals operated on.

The average time to inflow occlusion in 6 of the 7 animals was 5-6 minutes. On average, low regurgitant flow is between 0.5m/s and 1.5m/s per second in echocardiographic studies. The "biorificial" valve was documented.

No iatrogenic tricuspid stenosis was recorded in subsequent echocardiographic studies.

The entire surgical act was performed in normothermia. The patient who died 24 hours later was the one who suffered the combination with pulmonary stenosis and was the one who spent the longest time with partial occlusions. The suspected death was a gas embolism.

At present, all the animals are under follow-up (except the one that died from non-cardiac causes) and do not present right congestive

heart failure or atrial fibrillation and maintain the bi-orificial tricuspid valve.

Discussion

We have recorded 3 types of pathological lesions in patients with tricuspid dysplasia. The most common is that which occurs with retracted valve leaflets, totally or partially fused to abnormal papillary muscles or muscle bands that cross the lumen of the right ventricle, sometimes configuring two sites of reflux and with great dilation of the right atrium (Fig 1 and 2). The second type registered is the one that occurs with total fusion of the posterior leaflet to the papillary muscles without chordae tendineae (more commonly seen in Labrador retrievers) fig 3 and 4.[4, 5] The third anatomical type (and the of less frequency) is known as Ebstein anomaly, with atrialization of the septal aspect of the right ventricle, the implanted valve plane oblique with respect to the right atrioventricular coronary groove and the septal valve fused to the wall due to failure of delamination Fig. 5.[3,4]

Surgery was considered effective for the two first types of anatomical lesion, but not for the third type.

Associated pathologies:

The most common were fossa ovalis atrial septal defect, persistent left cranial vena cava, and pulmonary stenosis. If the ASD anomaly and tricuspid dysplasia were recorded, we decided to previously close the ASD before solving the tricuspid dysplasia, provided that the patients did not have pulmonary hypertension.

The cases presented here, although they are few in number, allowed us to follow up 6 of the 7 patients operated on over time (since the patient with tricuspid dysplasia and pulmonary stenosis died on the postoperative day). Of these 6 patients, one died a year later due to non-cardiac causes. Fig 6. The rest are still alive and without symptoms. This has shown that the surgical technique is safe, repeatable, economical and, if it is performed on the site of the valve plane where it was previously detected by transthoracic echo or by intraoperative echo, the site of greatest loss of regurgitant jet is effective in reducing the reflux. The latter has been based not only on the decrease in the speed of the post-surgical jet but also on the decrease in the progression of the growth of the right atrium assessed by echocardiography and on the determination of the absence of clinical signs.

Here it is worth opening the discussion about whether it is feasible to only evaluate the result of the surgery of the speed of the regurgitating jet before and after surgery, since we know that load conditions and applied treatments influence the determination of the speed of the jet. The type of prior selection of each patient also influences through what was considered to assess right ventricular function as normal. This is important because in veterinary medicine the utility of the PISA for the tricuspid regurgitation jet is not standardized, therefore it does not exist for pre-surgical evaluation. For all this we take into account several parameters as follows:

the preoperative clinical signs, the evaluation of the right ventricle through the TAPSE, the septal paradoxical movement, the distensibility index of the right branch of the pulmonary artery, the size of the right atrium, the average regurgitant flow with respect to the right atrium, the collapsibility of the caudal vena cava with the respiratory cycle, and the velocity of the regurgitant jet. All the added criteria were considered for the pre-surgical evaluation and to assess post-surgical success. Other determinations were not available.[3,6,7,8]

It is very important to recognize that a very recent work in human medicine demonstrated that the speed of the post-surgical jet in tricuspid regurgitation, after a percutaneous edge-to-edge closure technique, is not as determinant of the success of the surgery as it is opens the possibility of considering new sets of parameters to assess the success of interventions in the tricuspid valve plane. (1)
We also consider it very important to determine the place where the apposition point is applied through pre- or intra-surgical assessment of the place of origin of the maximum regurgitant jet in the valve plane. This demonstrated the transformation of a uniorificial valve to a bioorificial valve without causing iatrogenic post-surgical tricuspid stenosis.

In the same sense,23 the assessment of the tricuspid subvalvular apparatus was very important, for which we made different standard echocardiographic cuts and oblique echocardiographic cuts from the right ventricular outflow tract, in order to determine the type of anomaly and location of the largest loss site.
We believe that, from the best of our knowledge, it is the first time that an attempt has been made to reduce the flow of the tricuspid regurgitant jet in canines with tricuspid dysplasia through a technique such as that of Alfieri, placing an apposition point at the site of maximum regurgitant flow to reduce in a palliative way the effect of tricuspid regurgitation on the right chambers and thus prolong the time and quality of life of the treated animals.

One limitation of the study is not having been able to compare the animals treated surgically with animals treated solely with pharmacological therapy, although the natural history of tricuspid dysplasia without surgical intervention makes it possible to predict right ventricular failure with the high mortality that this entails.

Figures:

Figure 1

Fig 1 - Tricuspid dysplasia in an autopsy specimen. View from the right atrium. Muscular bridges are observed in the lumen of the right ventricle and the leaflets partially adhered to them. The right atrium is severely dilated.

Figure 2

Fig 2 - Canine tricuspid dysplasia. Specimen preserverd in formaldeide 10% in a non surgical case. The septal leaflet of the clefted tricuspid valve is observed and adhered to the septum. View from the right atrium.

Figure 3

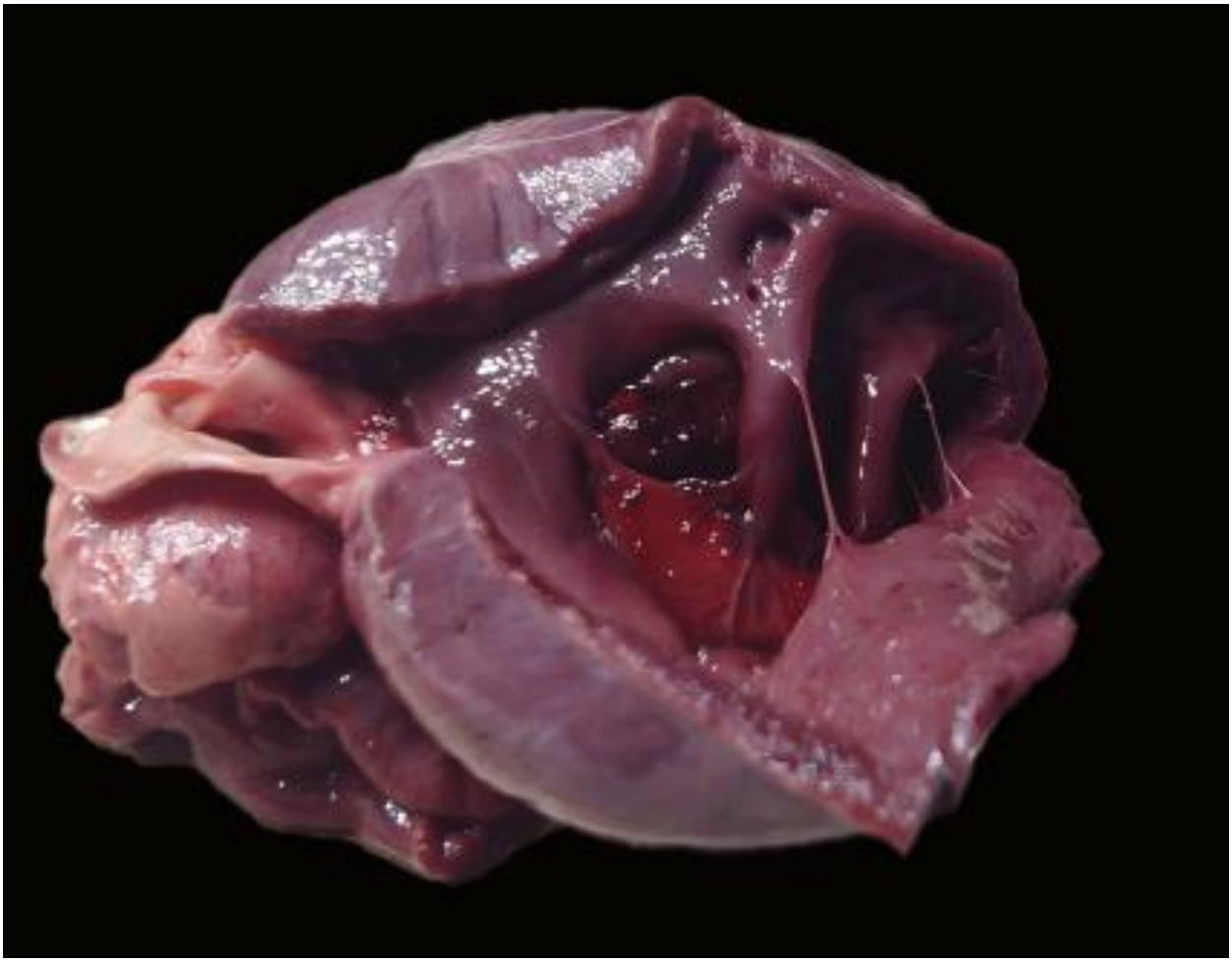

Fig 3 - Autopsy specimen of a medical treated canine tricuspid dysplasia in the Labrador breed. View from the right ventricle. The posterior leaflet adhered to the papillary muscles and the absence of the tendinous chords can be observed. The animal died one year after the diagnosis.

Figure 4

Fig 4 - Same as Fig 3 seen from the right atrium, the septal leaflet adhered to the septum is observed.

Figure 5

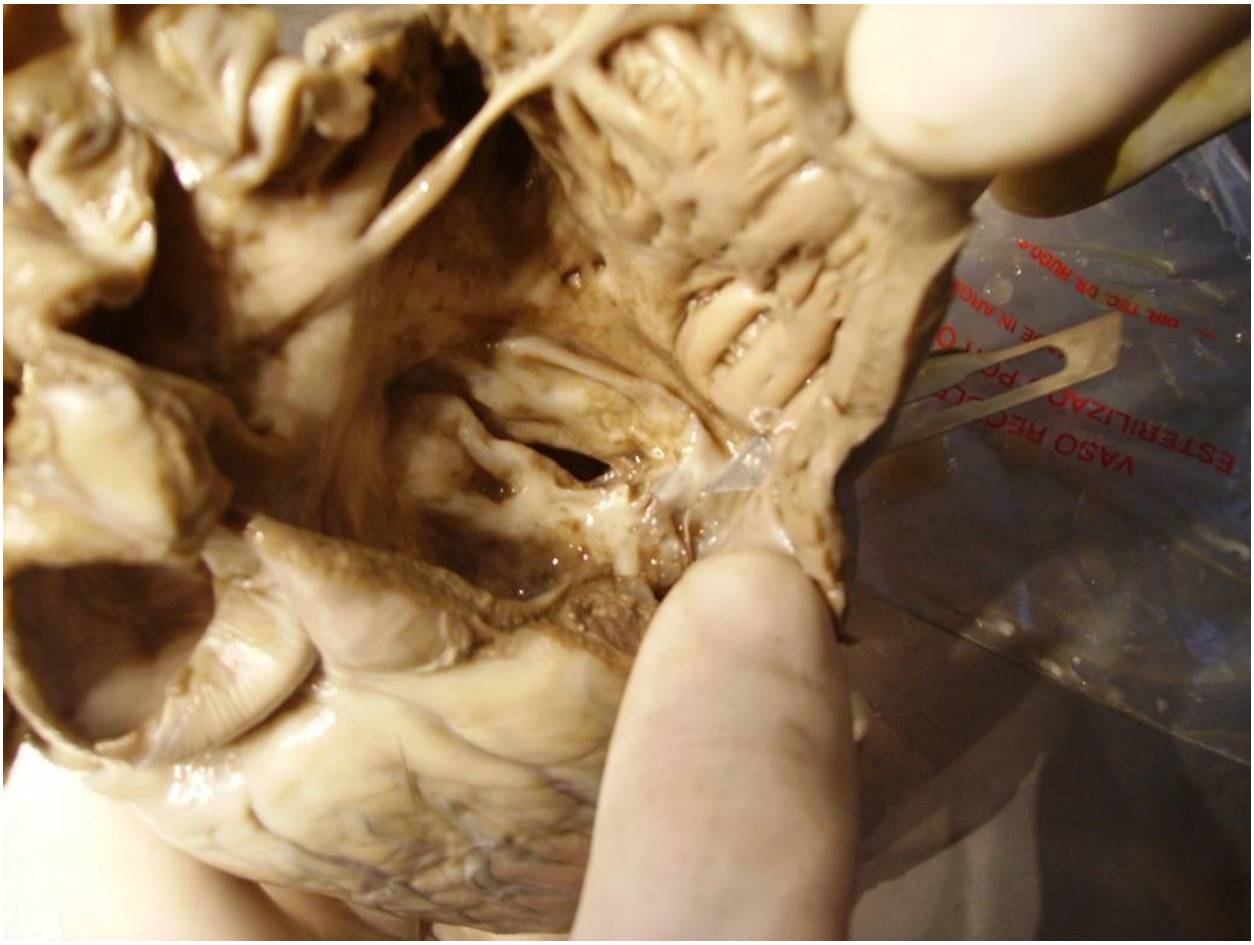

Fig 5 - Formolized heart of a non operated canine tricuspid dysplasia. View from the right atrium. The scalpel blade is inserted at the level of the right atrioventricular groove, the implantation of the valve is inferior to the groove. The septal leaflet is deformed and stuck to the septum. Dysplasia Ebstein anomaly type.

Figure 6

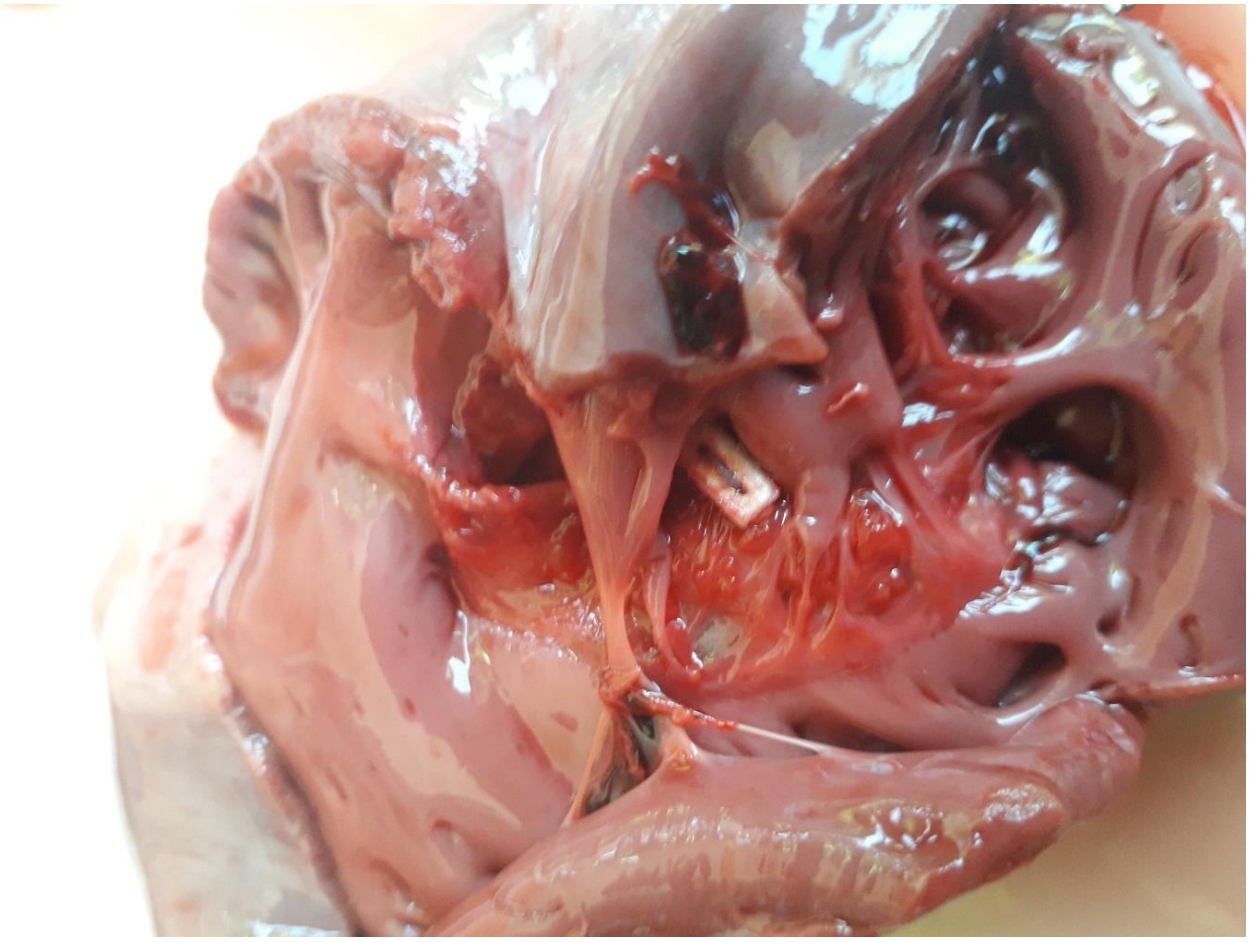

Fig 6 - Autopsy photo of resolution of tricuspid dysplasia. Surgical patient. View from the right ventricle, the stich with the Teflon patch positioned on the leaflet apposition face is observed. This patient died one year after the operation for non-cardiac causes.

Figure 7

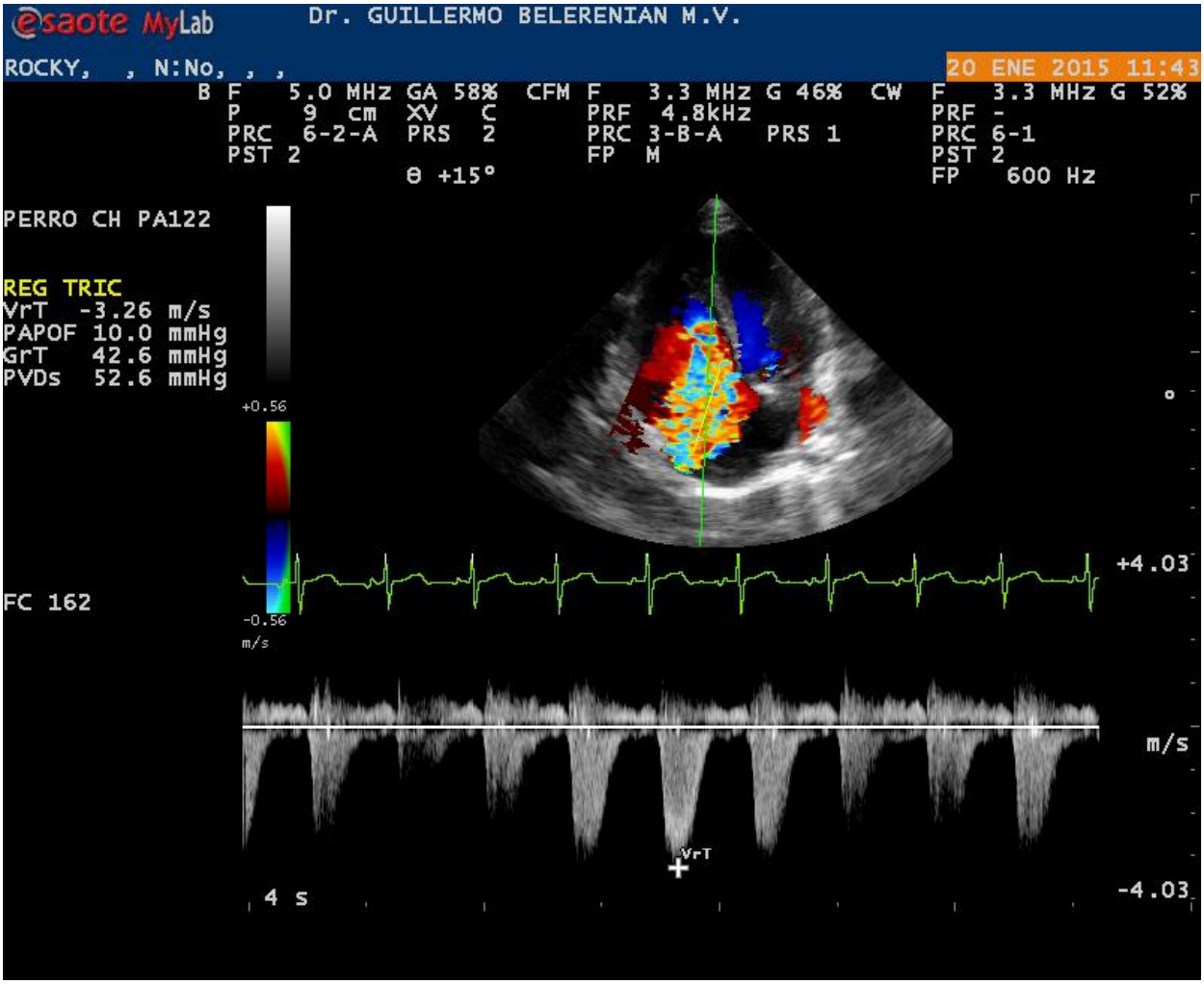

Fig 7 - Canine patient with severe tricuspid regurgitation due to congenital dysplasia.

Figure 8

Fig 8 - canine patient diagnosed in 2020 with severe tricuspid dysplasia.

Figure 9

Fig 9 - Same patient as in Fig 8 operated with the Alfieri technique, a decrease in the velocity of the tricuspid regurgitation jet is observed, the patient is asymptomatic.

Figure 10

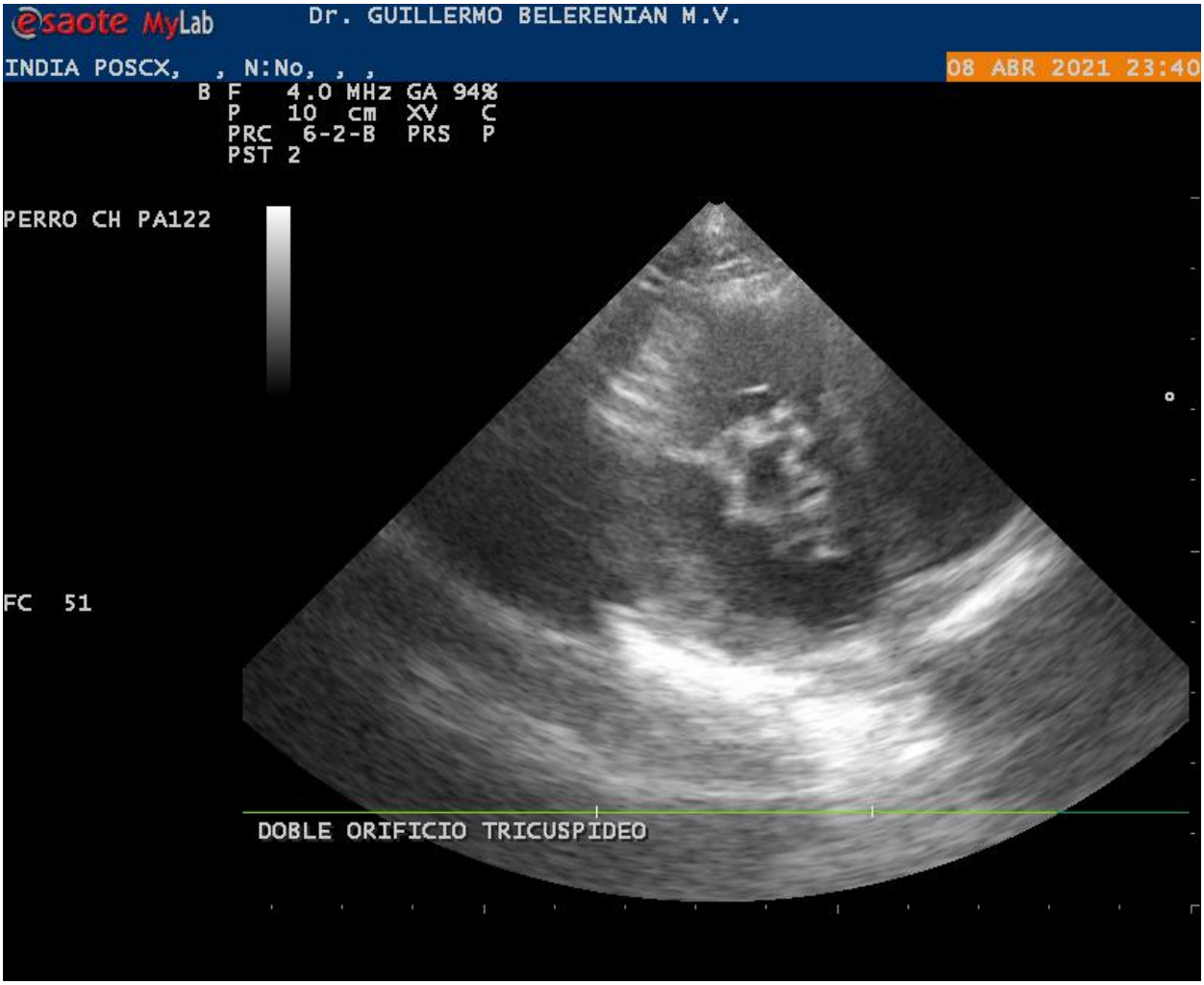

Fig 10 - Echocardiogram of the same patient in the late postoperative period where the double tricuspid orifice is observed as a result of the point placed on the apposition face of the leaflets.

Figure 11

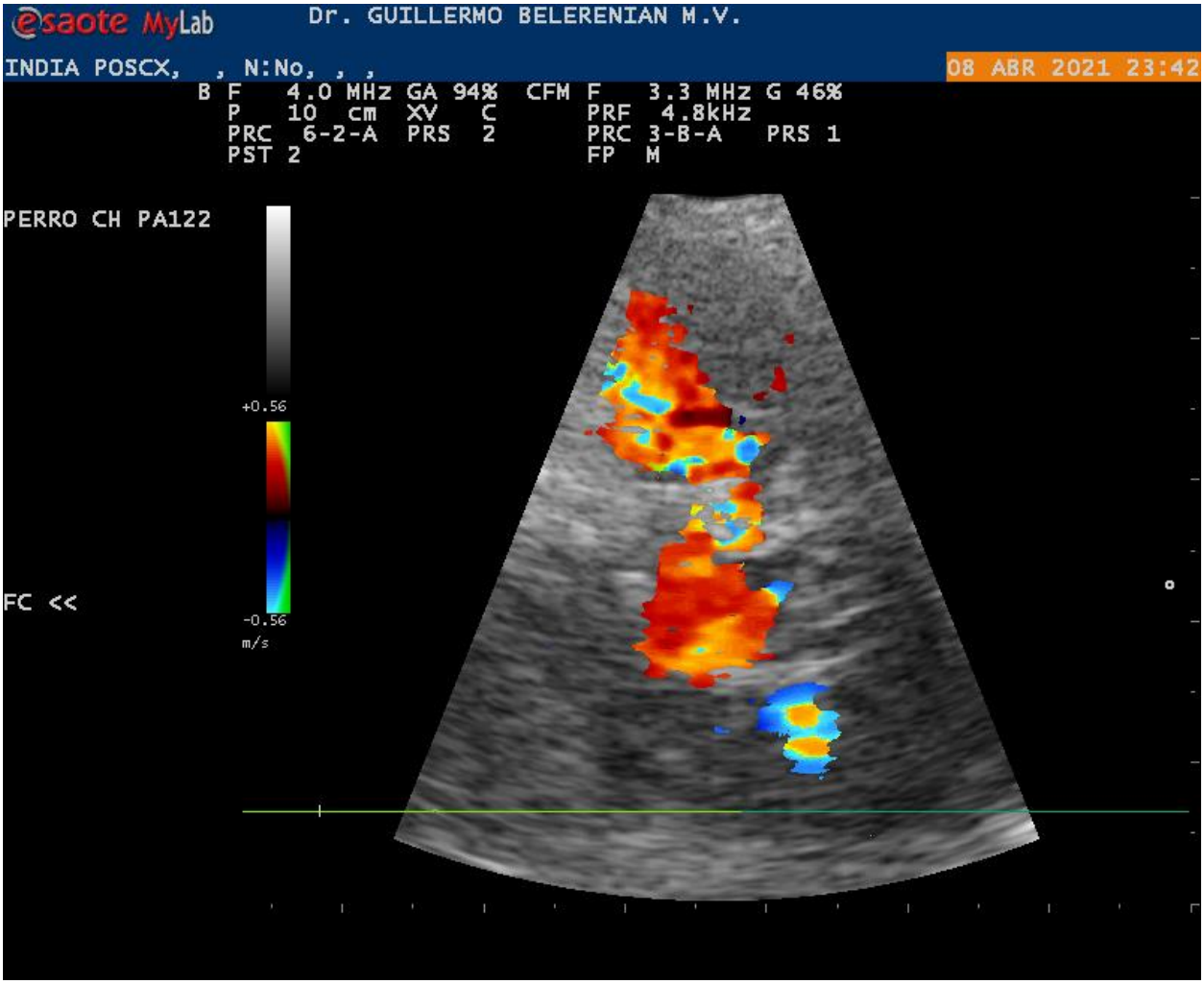

Fig 11 - Zoom on the double tricuspid orifice, an hourglass flow is evident with color Doppler as a result of the partition of the previous torrential flow due to the placement of the suture in the leaflets.

Figure 12

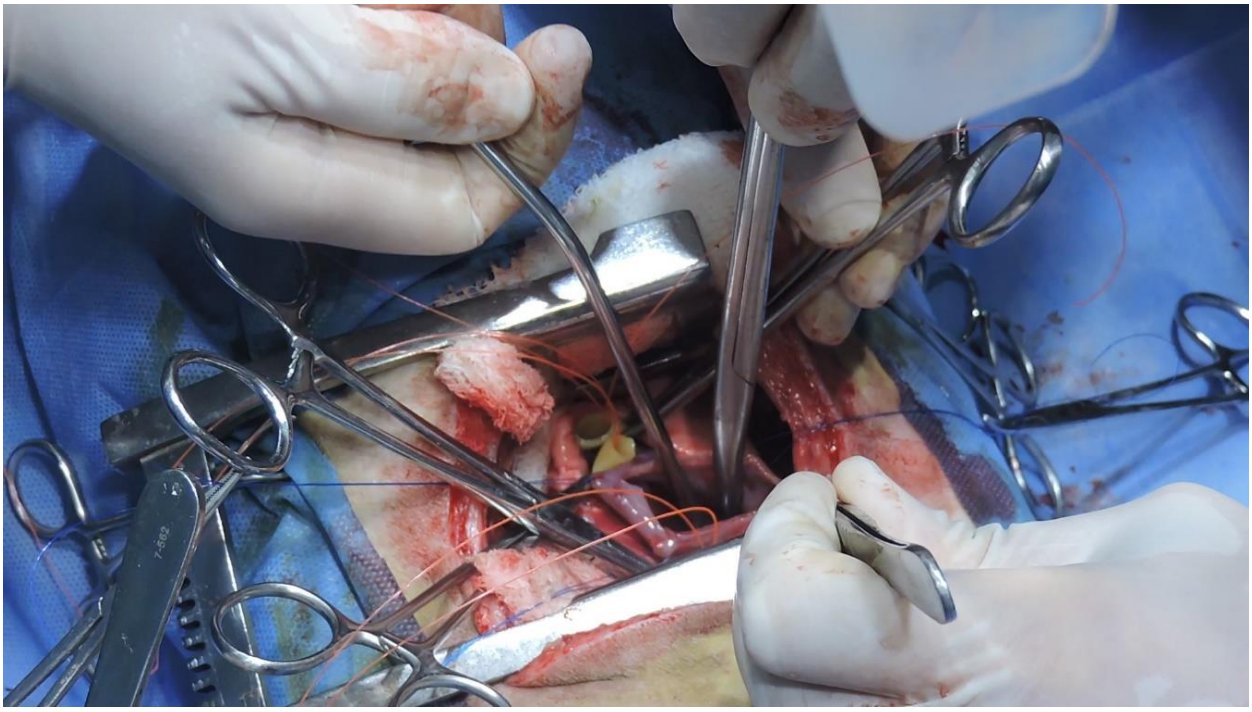

Fig 12. Placement of the suture point under direct vision in the leaflets using the circulatory occlusion technique.

Figure 13

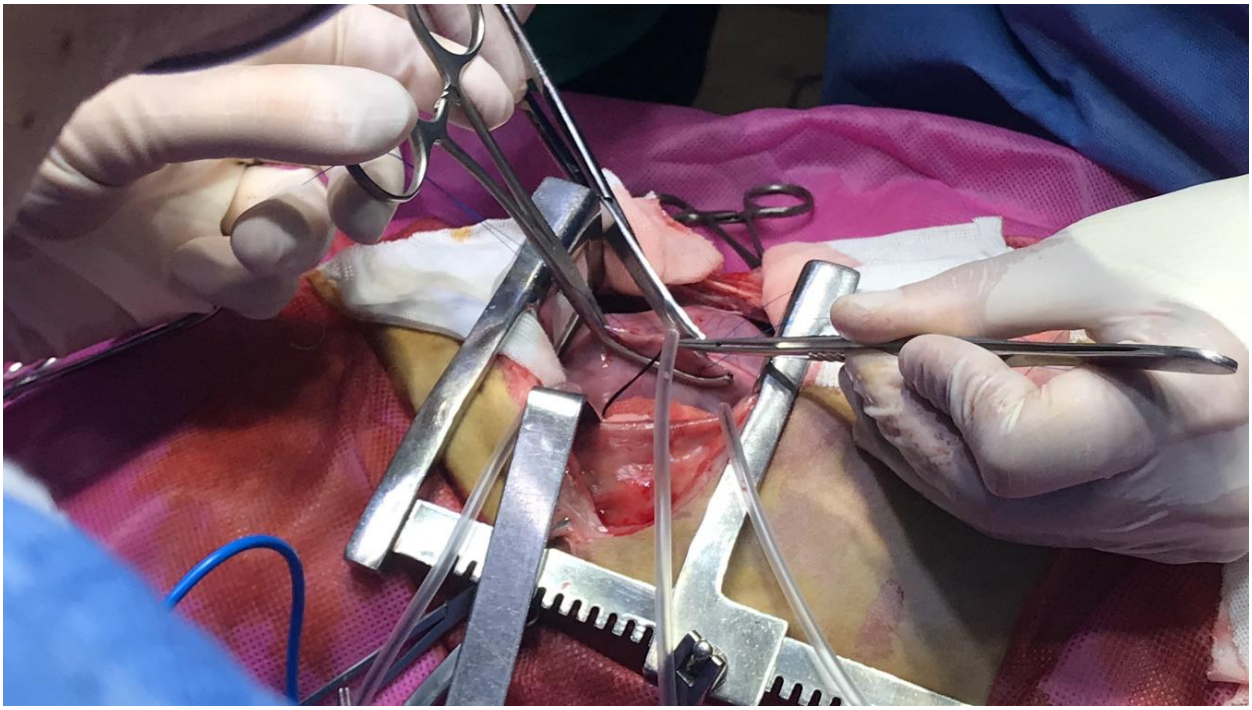

Fig 13 View of the closure of the right atriotomy in another patient.

Conclusion

We believe that, to our knowledge, it is the first time that an attempt has been made to reduce the flow of the tricuspid regurgitant jet in canines with tricuspid dysplasia through a technique such as that of Alfieri, placing an apposition point at the most precise site of maximum regurgitant flow to reduce in a palliative way the effect of tricuspid regurgitation on the right chambers and thus prolong the time and quality of life of the treated animals. Although the Alfieri technique has a real but small place in in Human Medicine in virtue of the overwelming more stable repair techniques, we estimate that it can be very useful in canines due to the lower life expectancy of this species.

The inflow occlusion right atrial approach is also feasible with a reduced surgical and post-surgical costs with low mortality.

One limitation of the study is not having been able to compare the animals treated surgically with animals treated solely with pharmacological therapy, although the natural history of tricuspid dysplasia without surgical intervention makes it possible to predict right ventricular failure with the high mortality that this entails.

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None

References:

1. Coisne A, Scotti A, Taramasso M, Granada JF, Ludwig S, Rodés-Cabau J, Lurz P, Hausleiter J, Fam N, Kodali SK, Pozzoli A, Alessandrini H, Biasco L, Brochet E, Denti P, Estevez-Loureiro R, Frerker C, Ho EC, Monivas V, Nickenig G, Praz F, Puri R, Sievert H, Tang GHL, Andreas M, Von Bardeleben RS, Rommel KP, Muntané-Carol G, Gavazzoni M, Braun D, Lubos E, Kalbacher D, Connelly KA, Juliard JM, Harr C, Pedrazzini G, Philippon F, Schofer J, Thiele H, Unterhuber M, Himbert D, Alcázar MU, Wild MG, Jorde U, Windecker S, Maisano F, Leon MB, Hahn RT, Latib A. Prognostic Value of Tricuspid Valve Gradient After Transcatheter Edge-to-Edge Repair: Insights From the TriValve Registry. JACC Cardiovasc Interv. 2023 Mar 10:S1936-8798(23)00452-1.
doi: 10.1016/j.jcin.2023.01.375. Epub ahead of print. PMID: 36948892.

2. De Bonis M, Lapenna E, Alfieri O. Edge-to-edge Alfieri technique for mitral valve repair: which indications? Curr Opin Cardiol. 2013 Mar;28(2):152-7.
doi: 10.1097/HCO.0b013e32835b9256.
PMID: 23147777.

3. Chetboul V, Poissonnier C, Bomassi E, Jamin C, Pouchelon JL, Tissier R, Desquilbet L. Epidemiological, clinical, and echocardiographic features, and outcome of dogs with Ebstein's anomaly: 32 cases (2002-2016). J Vet Cardiol. 2020 Jun;29:11-21. doi: 10.1016/j.jvc.2020.03.003. Epub 2020 Apr 3. PMID: 32348933.

4. Famula TR, Siemens LM, Davidson AP, Packard M. Evaluation of the genetic basis of tricuspid valve dysplasia in Labrador Retrievers. Am J Vet Res. 2002 Jun;63(6):816-20. doi: 10.2460/ajvr.2002.63.816. PMID: 12061526.

5. de Madron E, Kadish A, Spear JF, Knight DH. Incessant atrial tachycardias in a dog with tricuspid dysplasia. Clinical management and electrophysiology. J Vet Intern Med. 1987 Oct-Dec;1(4):163-9. doi: 10.1111/j.1939-1676.1987.tb02010.x. PMID: 3506101.

6. Navarro-Cubas X, Palermo V, French A, Sanchis-Mora S, Culshaw G. Tricuspid valve dysplasia: A retrospective study of clinical features and outcome in dogs in the UK. Open Vet J. 2017;7(4):349-359. doi: 10.4314/ovj.v7i4.11. Epub 2017 Dec 9. PMID: 29296595; PMCID: PMC5738889.

7. Pasławska, Urszula, Noszczyk-Nowak, Agnieszka, Janiszewski, Adrian and Nicpoń, Józef. & Tricuspid Dysplasia in Dogs" Journal of Veterinary Research, vol.57, no.1, 2013, pp.123- 126.
https://doi.org/10.2478/bvip-2013-0023

8. Tricuspid valve dysplasia in dogs. S. Favril, B.J.G. Broeckx , H. de Rooster, P. Smets, L. Peelman, C. Bavegems.
DOI : 10.21825/vdt.v87i1.16091

9. Andelfinger G, Wright KN, Lee HS, et al. Canine tricuspid valve malformation, a model of human Ebstein anomaly, maps to dog chromosome 9. J Me d Genet 2003;40:320–4.

10. Liu SK, Tilley LP. Dysplasia of the tricuspid valve in the dog and cat. J Am Vet Med Assoc 1976;169:623–30.

11. Chetboul V, Tran D, Carlos C, et al. Congenital malformations of the tricuspid

valve in domestic carnivores: a retrospective study of 50 cases. Schweiz Arch Tierheilkd 2004;146:265–75.

12. Hoffmann G, Amberger CN, Seiler G, Lombard CW. Tricuspid valve dysplasia in fifteen dogs. Schweiz Arch Tierheilkd 2000;142:268–77.

13. Belluschi I, Buzzatti N, Castiglioni A, Alfieri O, De Bonis M. The Alfieri's edge-to-edge technique for mitral valve repair: from a historical milestone of cardiac surgery to the origin of the transcatheter era. Mini-invasive Surg 2020;4:58.
http://dx.doi.org/10.20517/2574-1225.2020.48

14. Sutherland BJ, Pierce KV, Heffner GG, Scansen BA, Miller MW, Grey P, Orton EC. Surgical repair for canine tricuspid valve dysplasia: Technique and case report. J Vet Cardiol. 2021 Feb;33:34-42. doi: 10.1016/j.jvc.2020.11.001. Epub 2020 Nov 10. PMID: 33279771.

15. Chul Park, Chi-Bong Choi, Jung-Hyang Sur1, Byung-Hyun Chung,and Hee-Myung Park. Tricuspid valve dysplasia(TVD) in an American cocker spaniel dog. Korea J Vet Res(2004) 44(1) : 125~129

16. Stephen, J. Ettinger and Edward, C. Feldman, In: Textbook of Veterinary Internal Medicine. pp. 795-796, 5th ed. Saunders, Philadelphia, 2000, 137.

17. Philip, R. Fox, David Sisson and N. Sydney Moïse, In: Textbook of Canine and Feline Cardiology. pp. 524525, 2nd ed. Saunders, Philadelphia, 1999.

18. June, A. Boon. In: Manual of Veterinary echocardiography. pp. 424-431, 1st ed. Lippincott, Baltimore, 1998.

19. Mark D. Kittleson DVM PhD, Richard D. Kienle DVM. Small Animal Cardiovascular Medicine. Chapter 17, Congenital Abnormalities of the Atrioventricular Valves, Tricuspid Valve Dysplasia.

20. Afecciones cardiovasculares en pequeños animales, 2ed. Belerenian, G. Mucha, C.J., Camacho, A.A., Manubens Grau, J. Ed Intermedica, 2007.

21. Actualización en cardiología Veterinaria Tomo 1. Ed Intermedica. 2023. Guillermo Belerenian, Cristian Daniel Rodriguez.

22. Cirugía cardíaca en animales de compañía: Técnicas con el corazón latiendo. Editorial Académica Española (2017). Guillermo Belerenian, Cristian Daniel Rodriguez.

23. Ottavio Alfieri, Francesco Maisano, Michele De Bonis, Pier Luigi Stefano, Lucia Torracca, Michele Oppizzi, Giovanni La Canna. The double-orifice technique in mitral valve repair: A simple solution for complex problems, The Journal of Thoracic and Cardiovascular Surgery, Volume 122, Issue 4, 2001, Pages 674-681, ISSN 0022-5223, https://doi.org/10.1067/mtc.2001.117277.