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ANATOMICAL CHARACTERIZATION OF A GIANT EUSTACHIAN VALVE: A CASE REPORT FROM A FORMALIN-FIXED SPECIMEN

CARACTERIZAÇÃO ANATÔMICA DE UMA VÁLVULA DE EUSTÁQUIO GIGANTE: RELATO DE CASO A PARTIR DE UM ESPÉCIME FIXADO EM FORMALINA

CARACTERIZACIÓN ANATÓMICA DE UNA VÁLVULA DE EUSTAQUIO GIGANTE: REPORTE DE CASO A PARTIR DE UN ESPÉCIMEN FIJADO EN FORMALINA

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ABSTRACT

The Eustachian valve is a remnant of the right valve of the sinus venosus, typically found at the junction of the inferior vena cava (IVC) and the right atrium. While usually small and inconspicuous, anatomical variants exist where the valve is enlarged, termed a "Giant Eustachian Valve" (GEV). This report details the gross anatomical findings of a GEV identified during the dissection of a formalin-fixed human heart. The emphasis is placed on the morphological characteristics, embryological origin, and clinical implications of this rare anatomical variant.

Keywords: Eustachian Valve. Giant Eustachian Valve. Right Atrium. Anatomical Variant.

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RESUMO
A válvula de Eustáquio é um remanescente da válvula direita do seio venoso, geralmente localizada na junção da veia cava inferior (VCI) com o átrio direito. Embora normalmente seja pequena e pouco evidente, existem variantes anatômicas nas quais a válvula se apresenta aumentada, sendo denominada “Válvula de Eustáquio Gigante” (VEG). Este relato descreve os achados anatômicos macroscópicos de uma VEG identificada durante a dissecação de um coração humano fixado em formalina. A ênfase é colocada nas características morfológicas, na origem embriológica e nas implicações clínicas dessa rara variante anatômica.

Palavras-chave: Válvula de Eustáquio. Válvula de Eustáquio Gigante. Átrio Direito. Variante Anatômica.

RESUMEN
La válvula de Eustaquio es un remanente de la válvula derecha del seno venoso, generalmente localizada en la unión de la vena cava inferior (VCI) con la aurícula derecha. Aunque normalmente es pequeña y poco evidente, existen variantes anatómicas en las que la válvula se encuentra agrandada, denominándose “Válvula de Eustaquio Gigante” (VEG). Este reporte describe los hallazgos anatómicos macroscópicos de una VEG identificada durante la disección de un corazón humano fijado en formalina. Se hace énfasis en las características morfológicas, el origen embriológico y las implicaciones clínicas de esta rara variante anatómica.

Palabras clave: Válvula de Eustaquio. Válvula de Eustaquio Gigante. Aurícula Derecha. Variante Anatómica.

1 INTRODUCTION

The Eustachian valve (EV), also referred to as the valve of the inferior vena cava (IVC), is a crescent-shaped fold of endocardium located at the junction between the inferior vena cava and the right atrium. Embryologically, this structure represents the inferior portion of the right valve of the sinus venosus and constitutes an important remnant of fetal cardiac circulation. During intrauterine life, the EV plays a crucial physiological role by directing oxygenated blood returning from the placenta through the inferior vena cava toward the foramen ovale, thereby facilitating preferential shunting of blood into the left atrium and bypassing the nonfunctional fetal pulmonary circulation (Anderson et al., 2013; Sadler, 2019).

Following birth and the establishment of pulmonary circulation, the functional importance of the Eustachian valve diminishes. Consequently, the structure typically undergoes progressive regression and persists only as a small endocardial ridge at the entrance of the inferior vena cava into the right atrium in most adults (Standring, 2021). Nevertheless, variations in the degree of regression may result in persistence of a prominent valve projecting into the right atrial cavity.

Although a persistent EV is generally considered a benign anatomical variant and often remains clinically silent, unusually enlarged valves have been associated with several potential clinical implications. These include thrombus formation, bacterial endocarditis, obstruction or redirection of intracardiac blood flow, and technical difficulties during transvenous catheterization or device implantation procedures (Schneider et al., 1995; Loukas et al., 2010). In the literature, a giant Eustachian valve (GEV) has been commonly defined as a valve exceeding 10 mm in length or demonstrating marked elongation into the right atrial lumen.

Most descriptions of GEVs originate from echocardiographic evaluations or intraoperative observations. However, detailed anatomical documentation based on preserved cardiac specimens remains limited. Gross anatomical examination provides a unique opportunity to evaluate the true morphology, dimensions, and spatial relationships of this structure without the influence of hemodynamic forces or imaging artifacts.

Therefore, the present study reports the anatomical identification of a giant Eustachian valve in a formalin fixed human heart specimen. The morphological characteristics of this variant are described, and its potential clinical and anatomical implications are discussed.

2 CASE REPORT

The analyzed specimen consisted of an adult human heart preserved in 10% formalin, belonging to the anatomical collection of the laboratory and used for teaching and research purposes. Prior to dissection, the specimen was rinsed with running water to remove excess fixative and positioned in anatomical orientation, allowing clear identification of the atrial surfaces and the venous inflow structures.

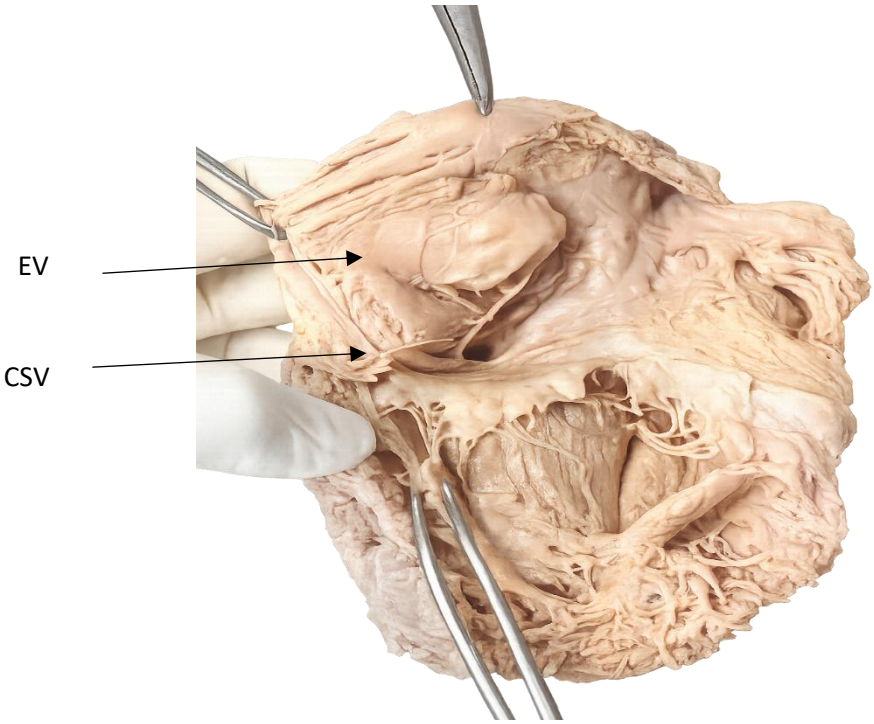
Macroscopic examination revealed the presence of a markedly enlarged Eustachian valve (valvula venae cavae inferioris) arising from the margin of the ostium of the inferior vena cava. The structure exhibited a semilunar configuration, projecting from the anteroinferior margin of the inferior vena cava ostium toward the right atrial cavity. Morphometric measurements were obtained using a digital caliper with a precision of 0.01 mm. The valve measured approximately 2.8 cm in length and 1.5 cm in maximum width, values considerably greater than those typically described for the Eustachian valve in adult hearts, in which the structure usually persists only as a small endocardial ridge measuring less than 1 cm.

The valve displayed a semilunar morphology, with its convex margin firmly attached to the rim of the inferior vena cava ostium, while its free edge was directed medially and slightly superiorly toward the interatrial septum. The free margin extended toward the region of the fossa ovalis, approaching the limbus of the fossa ovalis without covering the septal depression. Importantly, the structure did not interfere with the right atrioventricular orifice and did not obstruct the inflow pathway toward the tricuspid valve.

An additional finding was the presence of a Chiari network, characterized as a fenestrated remnant of the right valve of the sinus venosus. This structure originated near the free edge of the inferior vena cava valve and extended into the right atrial cavity. The network consisted of multiple delicate strands of connective tissue, forming a reticular configuration that projected freely into the atrial lumen. These filaments appeared thin, irregularly distributed, and loosely attached to the adjacent endocardial surfaces. Overall, the specimen demonstrated a well-preserved example of a giant Eustachian valve associated with a Chiari network, allowing detailed visualization of the anatomical relationships between the inferior vena cava valve, the interatrial septum, and the right atrial cavity.

Figure 1

Giant Eustachian Valve in the Right Atrium



Note: EV- Eustachian valve; CSV- Coronary sinus valve.

3 DISCUSSION

The Eustachian valve represents a remnant of the right valve of the sinus venosus, an embryological structure that plays a critical role in directing venous return during fetal circulation. During cardiac development, the sinus venosus becomes progressively incorporated into the posterior wall of the right atrium, while the right venous valve guides oxygenated blood arriving through the inferior vena cava toward the foramen ovale.

This preferential streaming facilitates the passage of well-oxygenated blood into the left atrium and bypasses the nonfunctional fetal pulmonary circulation (Sadler, 2019; Anderson et al., 2013). After birth, with the establishment of pulmonary circulation and functional closure of the foramen ovale, the hemodynamic role of the Eustachian valve becomes obsolete and the structure usually undergoes progressive regression, persisting only as a small endocardial ridge at the junction of the inferior vena cava and the right atrium in most adults (Standring, 2021). However, incomplete regression may result in persistence and, in rare cases, hypertrophy or elongation of the structure, producing what has been described as a giant Eustachian valve (Loukas et al., 2010). The coexistence of a Chiari network, as observed in the present specimen, further supports the concept of incomplete involution of embryological venous valve structures and represents part of the same

developmental spectrum derived from the right valve of the sinus venosus (Schneider et al., 1995; Loukas et al., 2010).

From an anatomical perspective, the most notable feature observed in this case was the considerable length and structural robustness of the valve. In living patients, giant Eustachian valves are frequently described as thin and mobile structures that oscillate with intracardiac blood flow and may be detected incidentally during echocardiographic examinations (Yater, 1929; Loukas et al., 2010). In contrast, formalin fixation leads to loss of tissue compliance while preserving the overall morphology and spatial relationships of cardiac structures. Although fixation may alter tissue elasticity, it allows accurate gross anatomical assessment and direct measurement of structural dimensions, which can be challenging in vivo due to cardiac contraction, respiratory motion, and limitations of imaging modalities. Consequently, anatomical documentation in preserved specimens provides an important complementary perspective to imaging-based observations (Standring, 2021).

Another relevant anatomical aspect is the spatial relationship between the Eustachian valve and the interatrial septum, particularly the fossa ovalis. In the present specimen, the valve projected into the right atrial cavity without obstructing the fossa ovalis. However, previous reports have described cases in which a prominent Eustachian valve partially overlies the interatrial septum and may interfere with interatrial septal access (Schneider et al., 1995). Such an anatomical configuration may complicate procedures involving the foramen ovale, including transcatheter closure of a patent foramen ovale or atrial septal defect, as well as electrophysiological procedures requiring catheter manipulation within the right atrium.

From a clinical standpoint, persistence of a large Eustachian valve may have several implications. One of the most relevant is the potential for diagnostic confusion during cardiac imaging. On transthoracic or transesophageal echocardiography, a prominent Eustachian valve may mimic pathological intracardiac structures such as right atrial tumors, thrombi, or vegetations (Schneider et al., 1995; Loukas et al., 2010). Careful identification of its anatomical continuity with the inferior vena cava and its typical location at the caval–atrial junction are essential for distinguishing this normal variant from pathological findings. In addition, an enlarged valve may interfere with catheter advancement from the inferior vena cava into the right atrium during interventional cardiology procedures, occasionally altering catheter trajectory or causing mechanical obstruction (Loukas et al., 2010).

Furthermore, the association between a giant Eustachian valve and a Chiari network may increase the thrombogenic potential within the right atrium. The network-like configuration formed by these structures may create areas of relative blood flow stagnation

that favor thrombus formation, particularly in individuals with underlying hypercoagulable conditions (Schneider et al., 1995). Although such complications are uncommon, awareness of these anatomical variants is important for accurate interpretation of cardiac imaging and for planning interventional procedures.

Finally, methodological limitations inherent to anatomical studies based on preserved specimens should be acknowledged. Formalin fixation is known to induce tissue dehydration, shrinkage, and increased rigidity, which may influence absolute morphometric measurements (Standring, 2021). Therefore, the dimensions reported in this study represent post-fixation values. Nevertheless, despite these alterations in tissue mechanical properties, the gross anatomical relationships and morphological characteristics of the valve remain reliable, supporting the relevance of cadaveric examination as a complementary approach to imaging-based studies.

4 CONCLUSION

This report documents the gross anatomical identification of a giant Eustachian valve in a formalin-fixed human heart, measuring 2.8 cm in length and associated with a Chiari network. Although typically regarded as a benign anatomical variant, a giant Eustachian valve may have important clinical implications. Its presence can mimic intracardiac masses on imaging studies and may interfere with catheter-based procedures performed through the inferior vena cava. Consequently, awareness of this anatomical variation is essential for accurate diagnostic interpretation and for safe planning of interventional and surgical procedures involving the right atrium. Gross anatomical documentation of such variants contributes to a more comprehensive understanding of cardiac morphology and complements imaging-based observations. Continued reporting of these anatomical findings may help refine the recognition and clinical management of rare intracardiac anatomical variants.

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