SCIENTIFIC LETTER

# CYSTIC TUMOR OF THE ATRIOVENTRICULAR NODE: A CASE REPORT


## ABSTRACT

Primary cardiac tumors are rare anomalies, with an incidence ranging from 0.0017% to 0.03% in autopsies. Among them, atrioventricular (AV) node cystic tumors present as benign congenital anomalies located in the trigone of the atrioventricular node. This type of tumor accounts for approximately 2.7% of all primary cardiac tumors and has the potential to cause severe arrhythmias or sudden death.

This article reviews AV node cystic tumors and discusses its etiology, symptoms, diagnosis, and treatment. Although its exact origin is still uncertain, it is considered a significant congenital anomaly because of its association with sudden cardiac death, which constitutes about 50% of cardiovascular mortality. The absence of visible macroscopic signs underlines the importance of maintaining a high index of suspicion in patients presenting with AV node localized heart block or sudden death, particularly in children, young adults, and women.

Early detection and accurate diagnosis are critical, requiring a thorough evaluation of the cardiac conduction system and detailed tissue analysis. Careful investigation and prompt intervention can significantly improve clinical outcomes and reduce the risk of sudden cardiac death.



***Keywords:*** *cardiac tumors, aortic valve, cystic tumor, AV node.*



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## INTRODUCTION

Primary cardiac tumors are rare clinical anomalies; their incidence varies from 0.0017% to 0.03% in autopsies[1]. Among these tumors, benign tumors are much more frequent than malignant tumors[2]. Within this category, an atrioventricular (AV) node cystic tumor, also known as AV node mesothelioma, stands out as a congenital benign entity located in the trigone of the atrioventricular node in the AV nodal region of the atrial septum[3].

The AV node is a crucial part of the electrical conduction system; it transmits signals from the sinoatrial node to the ventricles and facilitates heart contraction[4]. Any disruption in the atrioventricular node can trigger severe arrhythmias and even sudden death[5]. AV node cystic tumor accounts for 2.7% of all primary cardiac tumors and is the most frequent cause of death among these tumors[6].

This article provides a detailed review of this tumor type, including its etiology, clinical presentation, differential diagnosis, diagnostic methods, surgical and management approaches, and associated outcomes.

## CASE PRESENTATION

A 42-year-old male patient with a history of hypertension controlled with angiotensin II receptor blockers (ARAII) in whom, during routine examinations, a mass on the aortic valve suggestive of fibroelastoma was discovered as an incidental finding. The electroencephalogram (ECG) showed a first-degree AV block. Physical examination revealed no obvious clinical signs.

The transthoracic echocardiogram showed an ejection fraction of 73%, with normal diameters in both ventricles and a tricuspid aortic valve with preserved valvular opening. On the ventricular side of the right and left coronary valve leaflets (LVOT), an adherent mass measuring 13 × 20 mm (area: 2.4 $cm^2$) with a wide base, regular borders, heterogeneous appearance, mobile and prolapsing toward the aortic root in systole was observed. In the first instance, these findings were compatible with a myxoma or fibroelastoma. The mass caused an increase in peak transvalvular pressures. Mild to moderate aortic regurgitation secondary to prolapse of the right coronary valve leaflet into the LVOT with eccentric jet to the anterior leaflet of the mitral valve.

Chest angiotomography revealed that the aortic valve was tricuspid. A mass of heterogeneous density, with regular borders and implantation base, was observed infiltrating the interventricular septum in intimate contact with the right coronary leaflet at the level of the ventricular face and in the left ventricular outflow tract. The mobile mass measured 19.4 × 15.5 mm and prolapsed toward the aortic root during systole. The measurements of the aortic structures were as follows: aortic valvular plane of 20.2 mm × 30.2 mm; sinus aorta with a diameter of 36.1 mm; sino-tubular aorta with a diameter of 29.6 mm; ascending aorta with an anteroposterior diameter of 29.5 mm and lateral diameter of 30.1 mm; aortic arch with a maximum diameter of 25.6 mm; and descending aorta with a diameter of 22.1 mm. The coronary arteries had no anomalies or obstructive plaques (*Figure 1*).

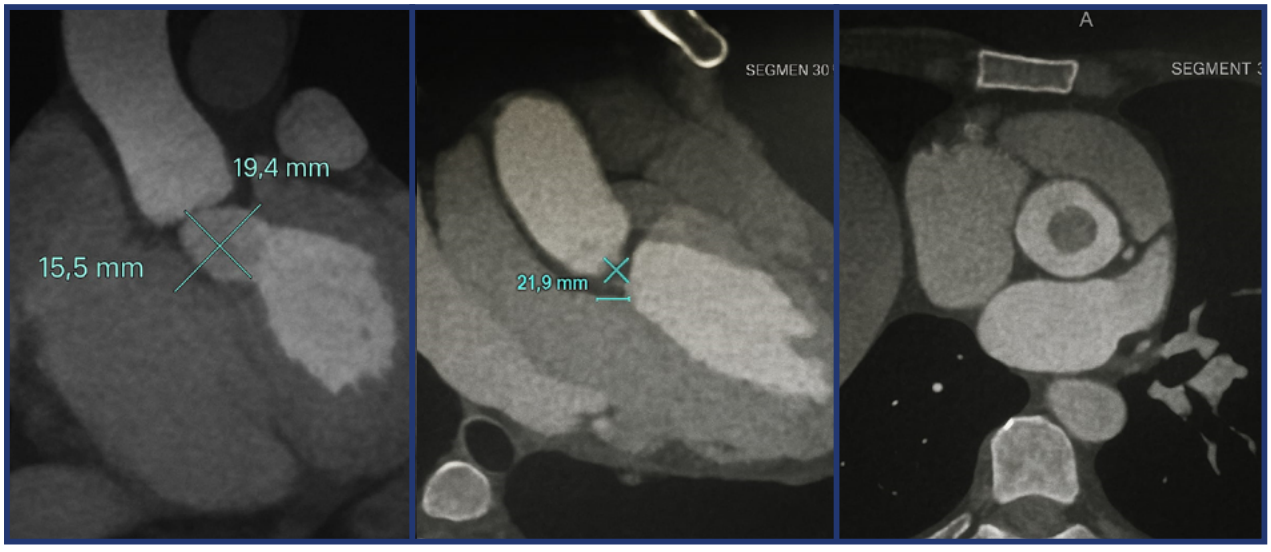


**FIGURE 1.** Angiotomography of the thorax shows a mass of heterogeneous density.

MRI confirms normal diameters of the left and right ventricles, a slight dilatation of the left atrium, and a mass of 15.7 × 13.6 mm attached to the right coronary leaflet, which could correspond to a papillary fibroelastoma.

In this context, it was decided to perform surgery for valve exploration and resection of the tumor. Among the intraoperative findings, a tricuspid aortic valve with the presence of a mass with a wide implantation base that infiltrated the right coronary leaflet (*Figures 2 and 3*) and the subvalvar plane was evidenced. Complete removal of the native valve, partial resection of the membranous septum, and valve replacement with a mechanical prosthesis n.° 23 were indicated. The patient was postoperatively paced with a backup epicardial pacemaker lead with self-pacing.

The obtained samples were sent to the pathology department for analysis, where it was concluded that they were compatible with a cystic tumor, positive for pan keratin (AE1/AE3). Positive carcinoembryonic antigen and positive synaptophysin were detected.

The patient was discharged from the hospital 7 days after surgery, with favorable postoperative evolution.

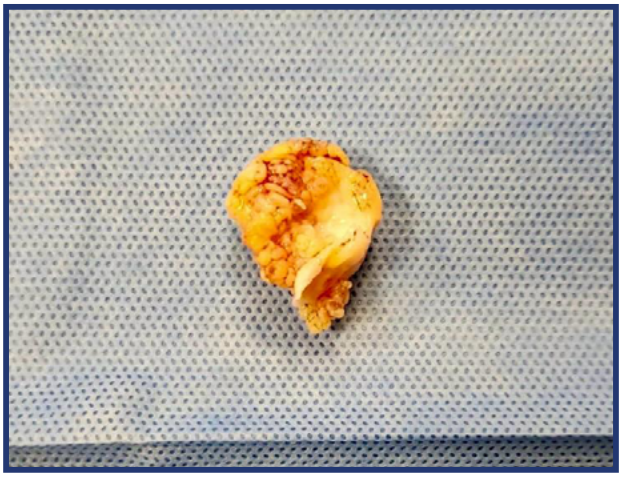

**FIGURE 2.** Wide implantation mass attached to the right coronary leaflet.

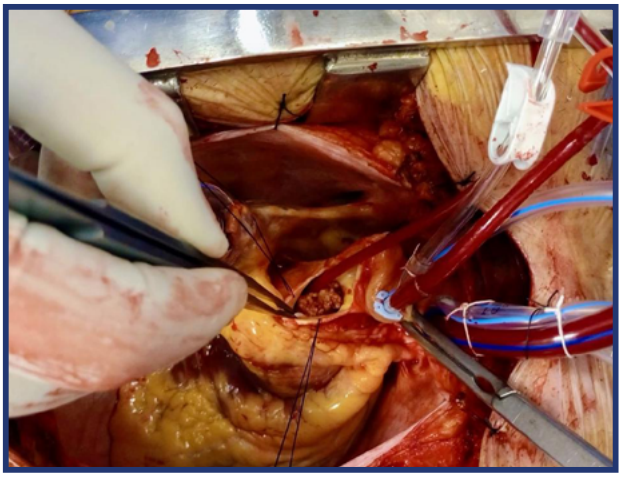

**FIGURE 3.** Excision of the right coronary valve mass.

## DISCUSSION

### Etiology and presentation

Although its precise etiology is not fully elucidated, AV node cystic tumor is considered a congenital anomaly[2]. Clinically, patients may present with symptoms related to conduction system dysfunction, ranging from palpitations to syncope or sudden death[7].

The cystic tumor of the atrioventricular node has raised several discussions about its origin and histological characteristics. Despite its name, this tumor does not appear to have a mesothelial origin. The term "mesothelioma" proves inappropriate since it is based on historical observations on the similarity of the tumor cells to mesothelial cells and an adenomatoid tumor[3,5].

### Histological origin and controversies

The histogenesis of AV node cystic tumors is still controversial. The prevailing theory suggests this tumor originates from endodermal tissue remnants during the heart's embryogenesis. These elements may be similar to the solid cell nests in the thyroid, raising the possibility that the tumor is derived from tissue trapped in the AV nodal region during embryonic development[3,5].

Studies have indicated that 10% of individuals with AV node cystic tumors also have defects in midline development along the central vertical body axis, suggesting a genetic defect in embryologic tissue migration with a possible familial component[2].

This type of tumor was first described in 1911. Although it is a rare entity, it has been diagnosed in a wide range of ages, from birth to 89. The mean age at diagnosis is approximately 38 years, and it shows a marked predominance in women, with a female-to-male ratio of 3:1[7].

### Demographic and epidemiological characteristics

These tumors can occur in individuals of any or all ethnicities, suggesting a relatively even distribution worldwide[4].

### Clinical associations and related conditions

AV node cystic tumor has been associated with several congenital anomalies and medical conditions, including:

- Complex congenital heart disease: This suggests a possible relationship between the tumor and the development of congenital heart defects[6].

- Thyroglossal cysts: An association has been observed since they are anomalies of the thyroid gland derived from embryonic remains[3].
- Ovarian and breast cysts: Cysts in other areas of the body, such as the ovaries and breasts, have also been reported in association with AV node tumor[7].
- Encephalocele: This is a brain malformation in which a portion of the brain protrudes through a defect in the skull[2].
- Emery-Dreifuss muscular dystrophy: This X-linked recessive genetic disorder, which affects skeletal and cardiac musculature, has also been associated with the presence of AV node cystic tumors[5].

AV node cystic tumor is a lesion that, in most cases reported in the literature, is detected post-mortem. Due to its location in a critical heart area, this neoplasm can significantly interfere with the electrical conduction system, leading to various cardiac conduction problems[1,8].

## Impact on the cardiac conduction system

AV node cystic tumors can cause defects in the cardiac conduction system. In more than 65% of affected patients, this can result in complete heart block, a condition in which electrical impulses fail to pass from the atrium to the ventricle. In addition, in approximately 15% of patients, partial AV block is observed, which involves a partial interruption in the transmission of impulses between the atria and ventricles[1].

This tumor can lead to other abnormalities in the electrical conduction of the heart, including:

- Intra-atrial conduction defect[5].
- Paroxysmal atrial arrhythmias[3].
- Spontaneous intermittent preexcitation[7].

These abnormalities can lead to arrhythmias and manifest with symptoms such as palpitations, chest pain, dyspnea, dizziness, and syncope[4].

## Potential Complications

Complications associated with AV node cystic tumors can be severe, including the following:

- Myocardial infarction: interruption of blood flow due to severe arrhythmias can lead to cardiac tissue death[8].
- Stroke: Arrhythmias can increase the risk of clot formation, which could travel to the brain and cause a stroke[9].
- Sudden cardiac death: Severe interference with the conduction system can lead to sudden cardiac arrest[1].

## Diagnosis

Diagnosis requires a comprehensive approach, beginning with a thorough evaluation of the patient's medical and family history, complemented by a complete physical examination. This process includes a thorough physical examination to identify abnormal heart sounds that may indicate underlying pathology[1].

A series of diagnostic studies is essential for accurate evaluation. Echocardiography is a fundamental tool in detecting and evaluating cystic tumors, as it allows visualization of the heart's structure and the lesion in question. Electrocardiogram (ECG) and electrophysiological studies allow one to analyze the heart's electrical activity and detect possible alterations[3].

Imaging studies, such as magnetic resonance imaging (MRI) and computed tomography (CT) of the heart, provide detailed information on the location and characteristics of the lesion.

Laboratory studies, including those of electrolytes, complete blood count, and thyroid hormone levels, are also advisable. These tests can help identify arrhythmia triggers related to the cystic tumor[4].

The AV node supply usually originates predominantly from the right coronary artery. In this context, selective angiography may be a key tool in identifying cystic tumors[7].

A tumor tissue biopsy is essential for an accurate and definitive diagnosis. This procedure includes standard tissue blocks covering the atrioventricular region and surrounding areas such as the sinoatrial region, the His bundle, and regional samples from both ventricles[8].

The combination of advanced imaging techniques and targeted biopsies provides a complete view of the tumor, facilitating a more accurate diagnosis and an appropriate treatment plan for affected patients[10].

### *Pathological anatomy*

The macroscopic findings of a cystic tumor of the atrioventricular (AV) node can be highly variable. These tumors usually present as small multicystic lesions, ranging in size from 2 mm to 2 cm. In most cases, they manifest as a thickening of the atrial septum or as a slightly elevated lesion in the region where the AV node is typically located, i.e., at the base of the atrial septum within the trigone of the atrioventricular node[1].

Often, the tumor extends from the coronary sinus ostium in the right atrium to the membranous septum and encompasses the upper part of the valvular septal valve. Occasionally, the lesion is not prominent and goes unnoticed during routine examinations[2].

Microscopically, these tumors have a distinctive composition that includes cysts, ducts, and solid nests of cells. The cysts within these tumors are

lined by benign, non-ciliated cells with an epithelial appearance. These cells may be flat or cubic and are arranged in single or multiple layers. The nuclei of these cells are bland, and the cell nests may resemble squamous or transitional epithelium. These nests are embedded in a dense fibrous stroma containing collagen and elastin fibers. In some cases, squamous differentiation and calcification of the luminal debris may be observed[3].

The remains of the AV node can be identified only rarely. Inflammatory cells and fibrosis may also be found in the specimen. It is relevant to note that smooth muscle, mitotic figures, and atypia are not observed, characteristics that would be indicative of malignancy[5].

From the immunohistochemical point of view, the AV node cystic tumor cells show positive staining with alcian blue and PAS, evidencing resistance to digestion by hyaluronidase and diastase, respectively. The main cells of the lesion are positive for cytokeratins, epithelial membrane antigen (SMA), carcinoembryonic antigen (CEA), CA19.9 carbohydrate antigen, p63, BCL2, and galectin 3.

On the other hand, neuroendocrine cells in the lesion show positive staining for CAM5.2, pan-keratin (AE1/AE3), ACE, calcitonin, chromogranin, synaptophysin, and thyroid transcription factor 1 (TTF1). In contrast, the lesion is negative for keratin 20 (CK20), p53, Bcl-2, cyclin D1, vimentin, CD31, factor VIII-related antigen, estrogen and progesterone receptors, thrombomodulin, Wilms tumor 1, and calretinin. These findings provide a detailed profile and aid in accurately identifying and classifying AV cystic tumors[4].

## Management

Surgical intervention should always be considered urgently at the time of diagnosis.

### *Surgical resection methods*

Several surgical methods have been developed for the removal of AV node cystic tumors. However, because of the rarity of these tumors and the difficulties associated with their ante-mortem diagnosis, no uniform protocol for surgical resection has been established. This has resulted in a lack of standardization in surgical and therapeutic approaches to treat these lesions.

The decision to perform a total or partial resection of the tumor is still controversial. The appropriate surgical approach depends on several factors, including the patient's clinical presentation, the diagnostic methods used, and the size of the tumor and its location. These factors influence surgical planning and treatment results[3].

**Complete excision** of the tumor can be performed by sternotomy, with extracorporeal circulation (ECC) support, including ascending aortic cannulation, direct bicaval venous cannulation, and atriotomy is performed.

During surgery, a thorough exploration of the valvular and subvalvular plane should be performed to define the surgical strategy. Partial or complete resection of the tumor material is performed and sent for rapid cytodiagnosis to detect malignant cells or possible bacterial infections. Subsequently, the cavity is washed, the tumor is resected along with a portion of the interatrial or interventricular septum to which it is attached, and the excised tissue is sent to pathology for definitive analysis.

Complete resection is often necessary regardless of the need for implantation. Partial excision has been explored as an alternative to complete resection to minimize the risk of damage to the cardiac conduction system and reduce the likelihood of heart block, which may require pacemaker implantation.

Despite the lack of reports on tumor recurrence after complete resection, **partial excision** may offer advantages in minimizing the risk of complications[10].

The technique for partial excision is similar to that used in complete resection, with the main exception being managing the tumor mass. The key to this technique is thoroughly evaluating the boundaries between the atrial and cyst walls. Careful drainage of the cystic fluid and detailed examination from inside and outside the cyst are required. Resection is limited to the cyst wall protruding into the right atrium and is performed by opening the atrial surface.

Close follow-up after partial excision is crucial to detect residual AV node dysfunction. Depending on postoperative findings, antiarrhythmic medications may be necessary, and pacemaker implantation may need to be considered to manage any AV block that may arise after surgery.

The prognosis for patients with AV node cystic tumors is usually favorable with early diagnosis and complete surgical resection. Although these tumors are benign, they may be associated with severe cardiac arrhythmias that, in turn, can lead to sudden death. These tumors are often only discovered during a post-mortem examination, as the symptoms may be subtle or misinterpreted[7].

## Relationship to the tumor site

Patients with tumors located in the atrial region tend to have a more favorable prognosis, with partial rather than complete heart block. This location may be associated with less severe symptoms and a reduced risk of lethal arrhythmias.

Tumor location may influence prognosis, while tumor size does not appear to be a determining factor in the severity of symptoms[4].

## CONCLUSIONS

AV node cystic tumor is the most frequent primary cardiac tumor associated with sudden cardiac death. Sudden death accounts for approximately 50% of cardiovascular mortality, highlighting the seriousness and importance of addressing this type of tumor urgently.

Due to the lack of obvious macroscopic signs that may indicate the presence of the tumor, it is crucial to maintain a high index of suspicion in patients presenting with heart block located in the AV node or suffering from sudden cardiac death. This is especially relevant to children, young adults, and women, who can be affected by this condition.

Early identification and accurate diagnosis require a thorough evaluation of the cardiac conduction system, including tissue sampling for definitive analysis.

In summary, thorough investigation and prompt intervention can significantly improve clinical outcomes and reduce the risk of sudden cardiac death in these patients.

**Declarations**

The authors declare no conflict of interest.

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