

CASE REPORT

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## Quadricuspid Aortic Valve Defined by Echocardiography and Cardiac Computed Tomography

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**Abstract:** A 54 year old female presented with lower extremity edema, fatigue, and shortness of breath with physical findings indicative of advanced aortic insufficiency. Echocardiography showed severe aortic regurgitation and a probable quadricuspid aortic valve. In anticipation of aortic valve replacement, cardiac computed tomography (Cardiac CT) was performed using 100 kV, 420 mA which resulted in 6 mSv of radiation exposure. Advanced computing algorithmic software was performed with a non-linear interpolation to estimate potential physiological movement. Surgical photographs and in-vitro anatomic pathology exam reveal the accuracy and precision that preoperative Cardiac CT provided in this rare case of a quadricuspid aortic valve. While there have been isolated reports of quadricuspid diagnosis with Cardiac CT, we report the correlation between echocardiography, Cardiac CT, and similar appearance at surgery with confirmed pathology and interesting post-processed rendered images. Cardiac CT may be an alternative to invasive coronary angiography for non-coronary cardiothoracic surgery with the advantage of providing detailed morphological dynamic imaging and the ability to define the coronary arteries non-invasively. The reduced noise and striking depiction of the valve motion with advanced algorithms will require validation studies to determine its role.

**Keywords:** quadricuspid aortic valve, Cardiac CT, four-leaf clover aortic valve, echocardiography

Video Abstract Available from <http://la-press.com/t.php?i=va002>

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## Introduction

A case of a quadricuspid aortic valve is presented. Echocardiography and cardiac computed tomography (Cardiac CT) defined the aortic valve and coronary arteries. Non-invasive coronary imaging obviated the need for invasive angiography in preparation for aortic valve surgery. Cardiac CT advanced post processing may complement echocardiography for quadricuspid aortic valve visualization.

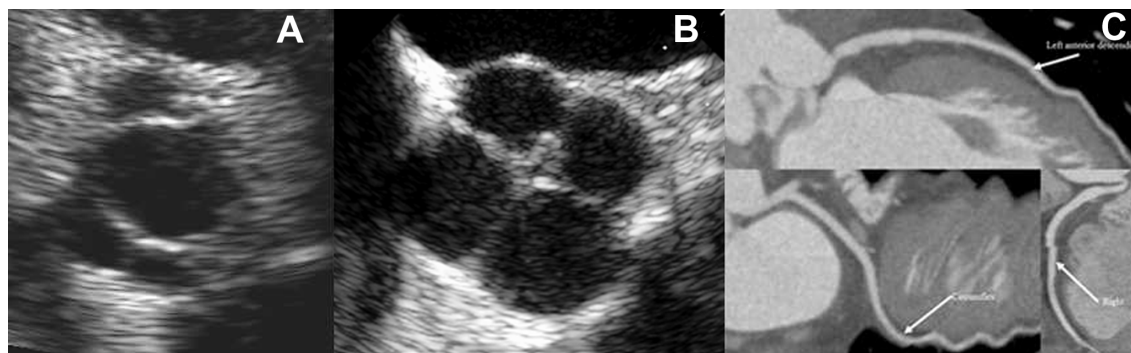
## Case Report

A 54 year old female presented with lower extremity edema, fatigue, and shortness of breath with physical findings indicative of advanced aortic insufficiency. Transthoracic echocardiography showed severe aortic regurgitation and a quadricuspid aortic valve (Fig. 1A, Movie 1). A transesophageal echocardiogram was performed to better define the quadricuspid aortic valve (Fig. 1B Movie 2). In anticipation of aortic valve replacement, cardiac computed tomography (Cardiac CT) was performed using 100 kV, 420 mA which resulted in 6 mSv of radiation exposure. Coronary arteries were normal with no calcified or non-calcified plaque (Fig. 1C). Cardiac CT revealed a type E quadricuspid<sup>1</sup> or Type III<sup>2</sup> (“four-leaf clover”) aortic valve, with three cusps of similar size and one smaller cusp. Cardiac CT also showed lack of co-adaptation of the valve in diastole indicative, of aortic insufficiency (Fig. 2A and B, Movie 3). Advanced computing algorithmic software was performed. These images were created using a non-rigid registration based algorithm which matched the boundaries of the phases from areas of interest over time thus accounting for the

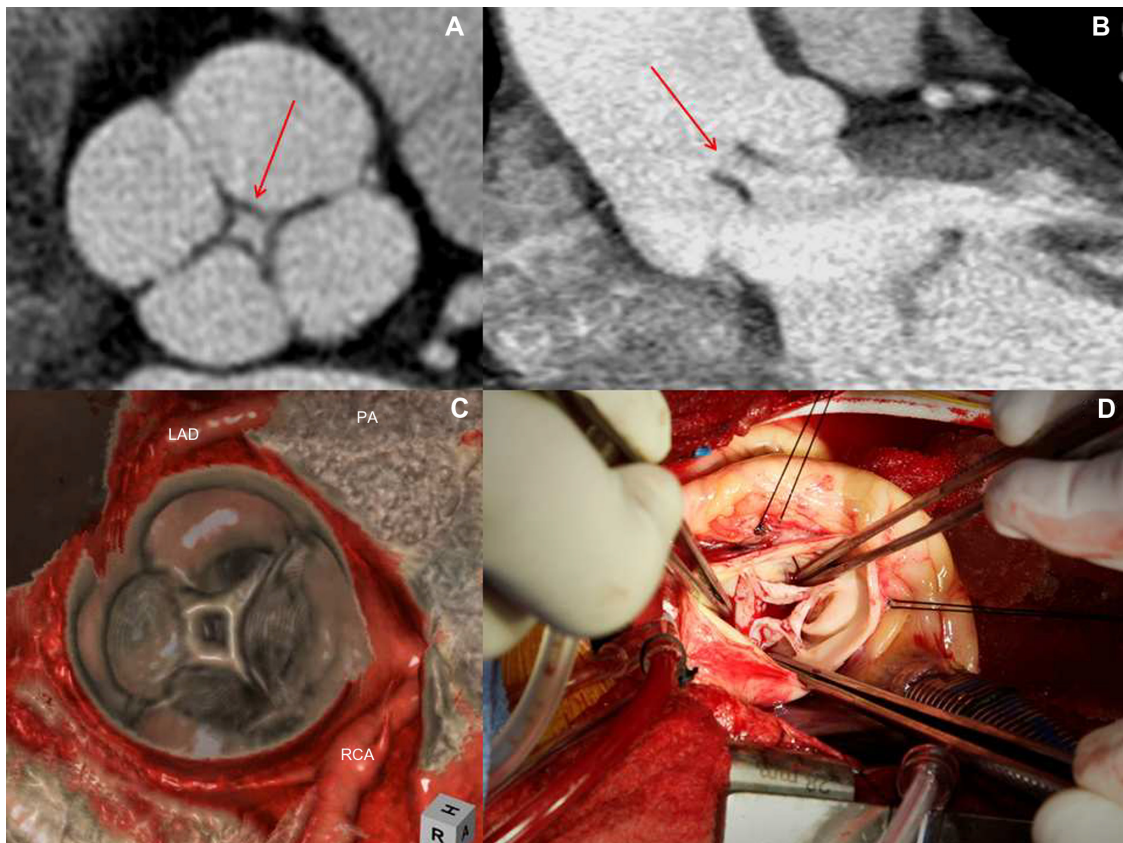
hearts continuous deforming movements during the cardiac cycle. This technology may more accurately reflect true cardiac movement non-invasively. This technique tracks the movement of individual voxels through space and time in an attempt to reduce noise, improve motion coherence and functional analytics (Ziosoft Inc, USA)<sup>3</sup> (Fig. 2C, Movie 4). Surgical photographs and in-vitro anatomic pathology exam confirmed the findings (Fig. 2D).

## Discussion

Echocardiography is the gold standard for the diagnosis of quadricuspid aortic valves and less than 300 cases have been reported.<sup>2</sup> A few cases of quadricuspid aortic valves have been reported with Cardiac CT<sup>4</sup> but even fewer have been reported with surgical confirmation or with advanced multiphase post processing techniques. Both echocardiography and Cardiac CT may reveal with accuracy and precision the details of a quadricuspid aortic valve. Advanced algorithmic software for Cardiac CT may provide additional details although validation studies are needed to define the role of this technology in the evaluation of valvular disease. Cardiac CT is an alternative to invasive coronary angiography in preparation for cardiothoracic surgery and also provides detailed morphological dynamic imaging to complement echocardiography. Finally, Cardiac CT may be helpful when the transthoracic echo window limits visualization and as an alternative to transesophageal echocardiography. The potential for algorithmic software for Cardiac CT post processing is encouraging.



**Figure 1.** (A and Movie 1) Short axis echocardiographic image of the quadricuspid aortic valve with movie. (B and Movie 2) Transesophageal image of the quadricuspid aortic valve with movie. (C) Normal left anterior descending, circumflex and right coronary arteries obviating the need for invasive coronary angiography.



**Figure 2.** (A and **Movie 3**) Diastolic images from cross sectional multiphase reconstruction demonstrating four instead of three leaflets. There is lack of co-adaptation of the aortic valve in diastole indicative of aortic insufficiency. (B) Coronal view of the aortic valve in diastole demonstrating contrast contiguous between the aorta and left ventricle indicative of aortic insufficiency. (C and **Movie 4**) Post processed image of the cross-section using voxel to voxel alignment and a noise reduction algorithm revealing lack of co-adaptation of the four leaflets in diastole. (D) Operative appearance of the quadricuspid aortic valve.

## Disclosures

Author(s) have provided signed confirmations to the publisher of their compliance with all applicable legal and ethical obligations in respect to declaration of conflicts of interest, funding, authorship and contributorship, and compliance with ethical requirements in respect to treatment of human and animal test subjects. If this article contains identifiable human subject(s) author(s) were required to supply signed patient consent prior to publication. Author(s) have confirmed that the published article is unique and not under consideration nor published by any other

publication and that they have consent to reproduce any copyrighted material. The peer reviewers declared no conflicts of interest.

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## Supplementary Data

Supplementary videos are available from  
8952Supplementarydata.zip.

A video abstract by the authors of this paper is  
available. video-abstract002.mov.

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