

CASE REPORT

# MDCT Venography Evaluation of a Rare Collateral Vein Draining from the Left Subclavian Vein to the Great Cardiac Vein

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## ABSTRACT

Congenital vascular anomalies of the venous drainage in the chest affect both cardiac and non-cardiac structures. Collateral venous drainage from the left subclavian vein to the great cardiac vein is a rare venous drainage pattern. These anomalies present a diagnostic challenge. Multi-detector computed tomography (MDCT) is useful in the diagnosis and treatment planning of these clinically complex disorders. We present a case report of an 18-year-old Caucasian male who came to our institute for evaluation of venous drainage patterns to the heart. We describe the contrast technique of bilateral dual injection MDCT venography and the imaging features of the venous drainage patterns to the heart.

**Key words:** Dual contrast media injection, multi-detector computed tomography venography, superior vena cava

## INTRODUCTION

Multi-detector computed tomography (MDCT) venography is an effective tool in demonstrating the complex venous vasculature present in congenital heart disease, especially extra-cardiac pathology.<sup>[1,2]</sup> In most syndromes, patients often have unusual arteriovenous connections. MDCT venography allows accurate identification of the cardiac and extra-cardiac arteries and veins and their relationships

to both atria and ventricles. The enhanced preoperative understanding of congenital heart disease provided by MDCT venography allows intensive surgical planning with the potential to reduce post-surgical complications.

## CASE REPORT

An 18-year-old Caucasian man with a complex congenital heart disease had attacks of ventricular tachycardia and oxygen saturation levels that showed discrepancy between the upper and the lower extremities. The patient was referred to our institution for evaluation of the complex angioarchitecture of venous blood draining into the heart, especially the superior vena cava. Bilateral MDCT venography of the thoracic venous system performed demonstrated significant collateral venous blood supply from the left subclavian vein to the coronary

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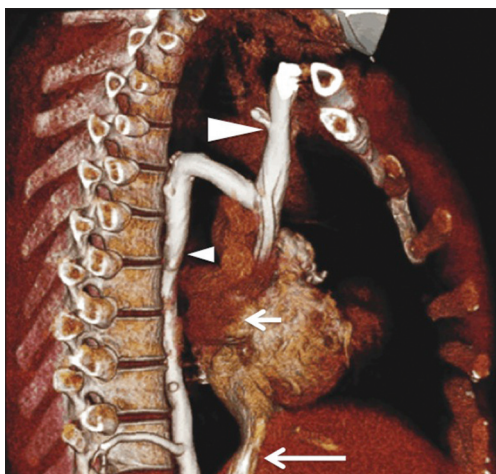
sinus via the left superior intercostal vein and unusual collateral left vein that drained into the great cardiac vein, and markedly dilated superior vena cava, inferior vena cava, and azygous vein [Figures 1 and 2].

### MDCT venography technique

Bilateral dual injection MDCT venography was performed using a 256-MDCT scanner (Philips iCT; Philips Healthcare, Cleveland Ohio, USA) with the patient positioned supine with arms by his side. Anterior-posterior and lateral scout scans were performed, with a scan range from the apex of the chest to the costophrenic angle. The scan parameters were: Detector width  $256 \times 0.625$  mm; pitch 0.9; rotation time 0.4 s; exposure factors 100 kVp, 200 mA, with z-axis modulation; and scanning time of 2.6 s. A caudocranial scan direction was employed.

### Contrast bolus geometry

Bolus geometry is the pattern of enhancement, after intravascular injection of contrast material, measured in a region of interest (ROI), plotted on a time (s)/attenuation Hounsfield units (HU) curve. We employed the test bolus technique where one ROI was plotted inside the superior vena cava and another in the pulmonary trunk. A small amount of contrast material was (10 ml) injected at the same rate as the main bolus using a power injector, where the initial rate was 3 ml/s which was then decreased exponentially to 2.2 ml/s over the duration of the injection using bolus shaping software. This ROI assessed the time to peak (TTP) and determined the arteriovenous circulation time for thoracic vasculature [Figure 3].



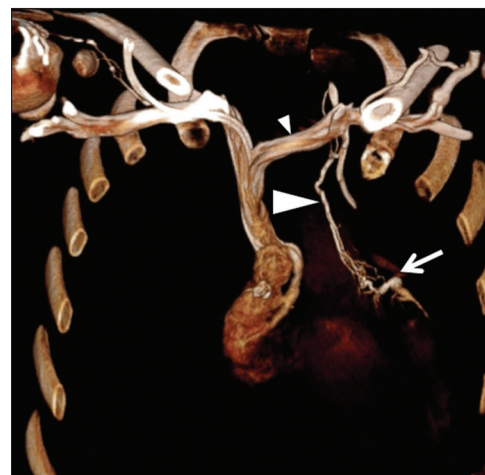
**Figure 1:** 18-year-old male with complex congenital heart disease had attacks of ventricular tachycardia and oxygen saturation levels that showed discrepancy between the upper and the lower extremities, later diagnosed with a rare collateral vein draining from the left subclavian vein to the great cardiac vein. Three-dimensional MDCT of the heart and thorax demonstrates extraordinary dilated azygous vein (small arrowhead) draining into the superior vena cava (large arrowhead), and the inferior vena cava (large arrow) draining directly into the right atrium (small arrow).

### Contrast medium administration

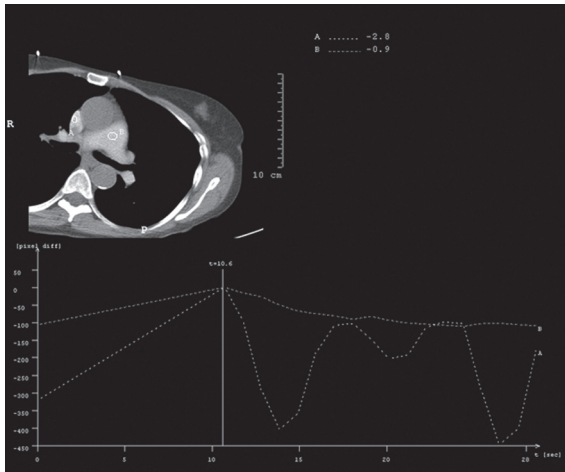
Contrast material was injected with an automated dual barrel power injector (Optivantage; Covidien, Cincinnati, OH, USA) via a 20-gauge venous catheter in each arm (right and left sides). Bilateral antecubital venous access was used in this study because it provides uniform contrast distribution into the heart for the contrast material to pass through the venous system with the least amount of dilution, promoting good image quality during computed tomography angiography (CTA) at reduced contrast volumes.<sup>[3]</sup> Bilateral simultaneous injection occurred at 3 ml/s, employing a 20:80 contrast to saline ratio mix in each syringe. The volume of contrast used totaled to 40 ml (this included 20 ml of contrast and 80 ml of saline in each syringe).

### DISCUSSION

Identification of the components of the cardiac congenital anomalies is vital for devising a management plan. Echocardiography and angiography are the current modalities of choice for evaluating congenital heart diseases. However, there has been an increased role of MDCT as a superior imaging modality used prior to surgical intervention for providing detailed anatomical and functional information of venous anomalies with 2D-reformatted and 3D-reconstructed images.<sup>[4]</sup> This patient required an assessment of the systemic venous return to the heart, especially to the left superior intercostal vein, collateral vein draining into the coronary sinus, and the great cardiac vein. Optimal and diagnostic images are vital in understanding patients' anatomy



**Figure 2:** 18-year-old male with complex congenital heart disease had attacks of ventricular tachycardia and oxygen saturation levels that showed discrepancy between the upper and the lower extremities, later diagnosed with a rare collateral vein draining from the left subclavian vein to the great cardiac vein. Three-dimensional MDCT of the heart and thorax demonstrates the collateral vein (large arrowhead) from the left subclavian vein (small arrowhead) draining into the great cardiac vein (arrow).



**Figure 3:** 18-year-old male with complex congenital heart disease had attacks of ventricular tachycardia and oxygen saturation levels that showed discrepancy between the upper and the lower extremities, later diagnosed with a rare collateral vein draining from the left subclavian vein to the great cardiac vein. Determination of contrast bolus transit time using test bolus injection shows that the region of interest is placed inside the superior vena cava (circle A) and in the pulmonary trunk (circle B). Resulting enhancement curves display the time needed to reach the peak of maximum contrast enhancement for test bolus.

and cardiovascular hemodynamics. Additionally, it is necessary to take into consideration the contrast medium administration and parameters that affect bolus geometry as it needs to be carefully configured to match the venous enhancement pattern of complex angioarchitecture during MDCT venography.<sup>[5-9]</sup>

There are limited studies on CT direct venography for evaluating thoracic venous return. However, one study conducted by Kim et al., using CT venography in the diagnosis of benign thoracic central venous obstruction, employed bilateral upper extremity injection with a total volume of 200 ml of contrast medium and scan delay of 20-40 s.<sup>[10]</sup> However, in our case, we employed a reduced amount of contrast medium (40 ml in total) by using the test bolus technique at the level of the superior vena cava for optimal enhancement.

## CONCLUSION

Evaluation of complex venous angioarchitecture in patients with vascular anomalies has considerably improved

with the use of MDCT direct venography when injecting contrast media bilaterally and simultaneously via the upper extremity.

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