

# The Application Of The 256-slice Multi-Detector Computed Tomography (MDCT) With Minimally Added Contrast Volume technique for RVOT Ablation Planning In Brugada Syndrome



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## Keywords:

Brugada syndrome, 256-slice MDCT, RVOT, LV-coronary artery, minimally –added contrast volume MDCT technique, conventional MDCT technique, Hounsfield Unit, ROI

**OBJECTIVE:** To prove that the modified MDCT technique (single scan with minimally added contrast volume technique) can be used effectively in the right ventricular outflow tract (RVOT) and coronary artery structure demonstration and assessment before RVOT ablation with acceptable-readable image quality in cases of Brugada syndrome.

**MATERIALS AND METHODS:** We retrospectively analyzed image quality of Brugada Syndrome patients who were planned for RVOT ablation and underwent 256-slice MDCT scanning using both conventional and modified techniques, i.e. minimally added contrast volume technique with iodinated contrast injection. The quality of the images obtained from MDCT using the modified technique was assessed in terms of acceptability and readability by the criteria of CT attenuation value of the region of interest (ROI) equal to or more than 250 HU (Hounsfield Unit).

**RESULTS:** Between 2009 and 2012, a total of 13 Brugada syndrome patients (13 males mean age of  $44.2 \pm 10.87$  years old, mean weight  $63.61 \pm 9.6$  kg) who were planned for RVOT ablation were enrolled. All these patients underwent MDCT to demonstrate RVOT and coronary artery structure for pre-ablation planning. Nine of thirteen patients underwent 256-slice MDCT using the ECG-gated modified, minimally added contrast volume technique. All these nine patients provided the RVOT and coronary artery images that met acceptable-readable criteria, CT attenuation value  $> 250$  HU). Four of thirteen patients underwent 256-slice MDCT scan using conventional technique of CTA for pulmonary artery. RVOT images of two patients and the coronary artery images of another two patients who underwent 250-slice MDCT scan using ECG-gated conventional technique of CTA for pulmonary artery did not meet the acceptable-readable criteria ( $HU < 250$ ). The analysis showed the optimum contrast volume used in modified technique in our hospital was the value of calculated volume plus 10-15 ml and the total volume was not less than 60 ml for patients weighing 50-75 kilograms, regardless of heart rate, and we would recommend that it should not be less than 60 ml, otherwise image quality is detrimentally affected. Comparing to the MDCT, using the conventional technique in a separate scan to demonstrate RVOT and coronary artery, the exposure dose of radiation of the modified technique was as same as ECG-gated CTA for pulmonary artery scan only and the total contrast dose was also reduced by about one third.

**CONCLUSION:** Using modified minimally added contrast volume technique with the 256-slice MDCT is very convenient and can be used effectively in demonstrating RVOT and coronary artery for RVOT ablation planning in Brugada's syndrome cases with acceptable and readable image quality

**R**adiofrequency ablation (RFA) is a new, alternative treatment for Brugada Syndrome.<sup>1</sup> Radiofrequency ablation, using two catheter navigation systems (CARTO and EnSite), offers advanced ablation therapy for complex arrhythmias. In this technique, the Multi-Detector Computed Tomography (MDCT) images are shown as three dimensional (3D) images constructed to localize the target area. In case of Brugada syndrome, the target for ablation is RVOT. In Brugada syndrome patients, coronary artery disease should always be assessed before ablation operation. MDCT scanning with contrast for RVOT and for coronary artery evaluation may be requested. Although a double CT scan (two separate scans) can provide all necessary information, however the large dose of radiation and iodinated contrast exposure and indeed the cost are matters of concern. In this article, we detailed the modified double-purpose technique of CT scan which could reduce the radiation and contrast exposure dose in RVOT and coronary artery imaging whilst maintaining acceptable-readable image quality

## Materials and Methods

Between 2009 and 2012, a total of 13 cases of Brugada syndrome were scheduled for RFA and underwent 256-slice MDCT scan for RVOT and coronary artery structure demonstration. Exclusion criteria included patients at risk for severe iodinated contrast agent allergy, severe asthma with bronchodilator dependence or elevated serum creatinine > 1.5 mg/dl. To verify the effectiveness of the modified, minimally added contrast volume technique, we retrospectively assessed the image quality of RVOT and coronary artery in terms of CT attenuation value  $\geq 250$  HU which is the minimum requirement value for MDCT diagnostic image.<sup>2</sup>

### *CT angiography (CTA) for RVOT and coronary artery*

CT studies were performed on 256-slice MDCT (Brilliance ICT, Philips, Netherlands) scanner with bolus tracking protocol. A bolus volume of iodinated contrast injection was calculated by the formula of scan time (5 -6 sec. for pulmonary artery scanning) plus post threshold delayed time (~5 sec.) and multiplied by flow rate (4.5-6 ml/sec.) as per Philips company protocol. Five to fifteen (5-15) milliliters of contrast agent was added to the calculated volume. A contrast bolus was injected into brachial vein at a flow rate of 4.5-6 ml/sec., followed by 50 ml. saline solution injection. The tracking position was placed at the pulmonary trunk and scan started automatically at 5 sec. after reaching the threshold (100 HU). Cardiac scan length covered from the carina angle to 2-3 cm. below the diaphragm using the following parameters: x-ray tube potential 120-140 kV, tube current 471 MA, slice collimation 128x0.625 mm., table speed of 44 mm/sec., and pitch 0.16. The slice thickness was of 0.625 mm. The mean RVOT- coronary artery scan time was 5 sec. The retrospective electrocardiographic gating

was routinely used for cardiac phase selection. The CT attenuation HU value of the ascending aorta was used to represent the HU value of the coronary artery. The CT attenuation HU value was measured at the RVOT itself. The MDCT image data was independently and blindly analyzed by three experienced cardiac CT specialists. The acceptable/readable RVOT and coronary artery image quality for pre-ablation CARTO sound image-merging process and assessment was determined using CT attenuation value  $\geq 250$  HU as a cutoff criteria. The patient's body weight (kg), calculated and actual contrast use (ml), the total added volume of contrast (ml), the CT attenuation value of RVOT(HU) and of ascending aorta-coronary artery (HU) were reported in range.

## Results

In our study, thirteen Brugada syndrome patients were recruited. The average age of the patients was 53.8 years old and the average weight was 63.6 kilograms (range 51-78 kg). The heart rate of all patients ranged from 52-91 beats per minute. All of these patients were planned for RVOT catheter ablation, using CARTO sound navigator. The 256-slice MDCT scan with contrast injection was requested for RVOT and coronary structure demonstration in all patients. Nine patients (9/13) underwent 256-slice CT scan using the modified double purpose technique. All of RVOT structures and coronary artery segments were studied. The MDCT image quality of the right ventricular outflow tract (RVOT) and coronary artery as acceptable/readable use a cutoff criteria of CT attenuation of the region of interest that is equal or more than to 250 HU (Hounsfield unit). CT attenuation value of 250 HU is the minimum requirement value for diagnostic images.<sup>2</sup> Four patients (4/13) underwent the conventional technique for CT angiography for pulmonary artery. The CT attenuation value of the RVOT and ascending aorta-coronary artery of all nine patients (100%) who underwent 256-slice MDCT scan with the modified, minimally added contrast volume technique met the cutoff point criteria (Table 1, Table 2).

Four patients who underwent conventional technique of CTA (CT angiography) for pulmonary artery did not meet the acceptable readable criteria in a single scan as shown in Table 3. The averaged contrast volume used in the conventional technique was as calculated volume. The averaged contrast volume use in modified technique was the calculated volume plus 5-15 ml in any heart rate. By the result of CT attenuation value analysis, the recommended volume of contrast use was calculated volume plus 10-15 ml for the patient's weighs less than 80 kg regardless of the heart rate and the total volume should not be less than 60 ml. For the modified, minimally added contrast volume technique, we used the same protocol as for pulmonary artery scanning and added some contrast agent. The radiation dose exposure of the patients who underwent 256-slice MDCT using the modified technique was the same as the dose needed to perform ECG-gated 256-slice MDCT scan for pulmonary artery.

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**Table 1:** Demonstration of CT attenuation value of RVOT-Coronary artery image evaluation using modified technique (9 cases)

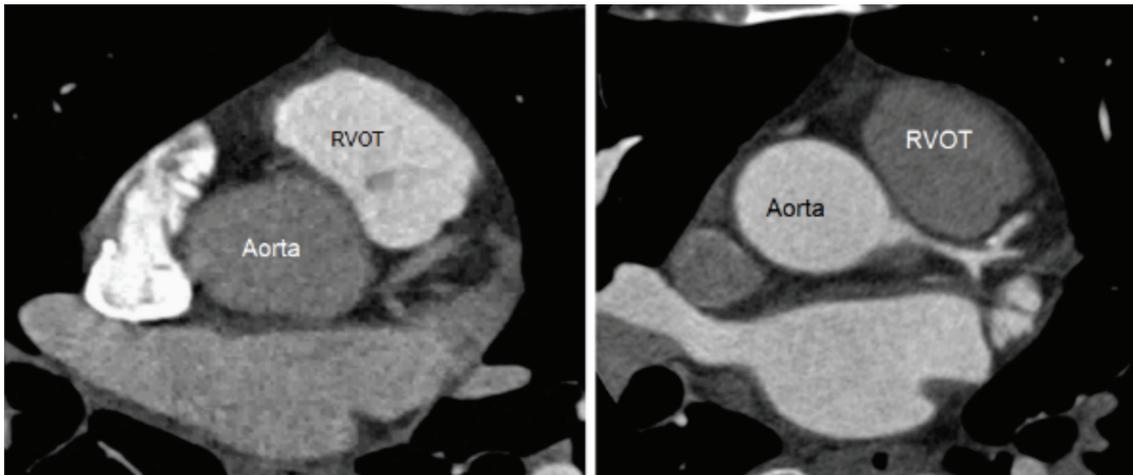
Body weight (kgs)	Calculated contrast volume (ml.)	Actual contrast volume (ml.)	Added contrast volume (ml.)	CT attenuation value of RVOT(HU.)	CT attenuation value of Ascending aorta (HU.)
<b>&gt; 75</b>					
78	50-55	60-65	5-10 (8)	>250	>250
76	50-55	70-75	10-15(15)	>300	>250
<b>&gt; 70</b>					
71	50-55	60-65	10-15 (10)	>300	>250
71	55-60	65-70	10-15 (10)	>400	>250
<b>&gt; 65</b>					
67	55-60	70-75	10-15 (14)	>250	>400
<b>&gt; 60</b>					
61	50-55	60-65	10-15 (12)	>250	>400
<b>&gt; 50</b>					
52	50-55	50-55	15- 20 (15)	>400	>400
51	50-55	60-65	10-15 (10)	>300	>300
51	50-55	60-65	10-15 (10)	>300	>400

**Table 2:** Demonstration of Average CT attenuation value of RVOT - Coronary artery images using modified technique (9 cases)

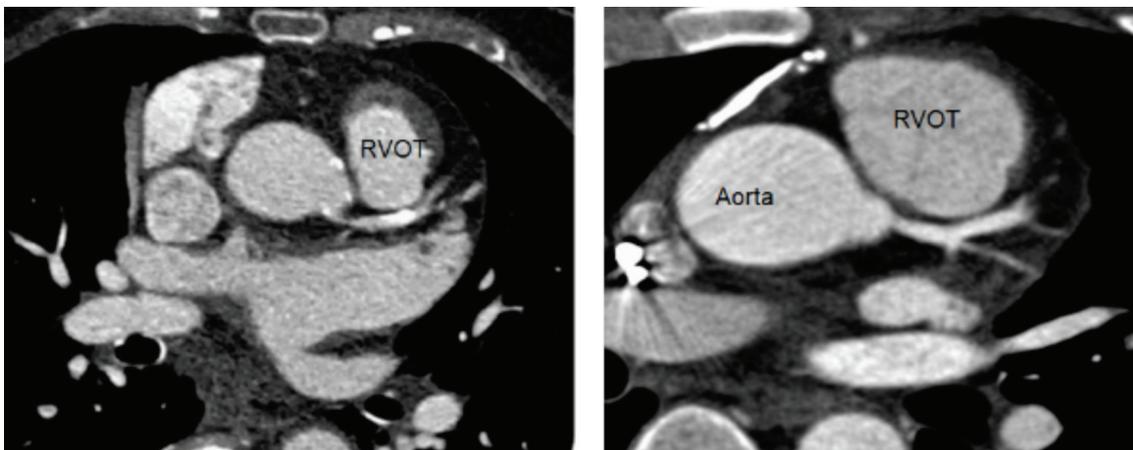
Body weight (kgs)	Mean calculated contrast volume (ml.)	Mean actual contrast volume (ml.)	Mean added contrast volume (ml.)	Mean ROI of RVOT (HU.)	Mean ROI of Ascending aorta (HU.)
BW>60 kgs (6 cases)	52.7± 3.5	63.7± 5.9	11.5± 3.5	333.2± 36.6	298.0 ± 77.1
BW<60 kgs (3 cases)	47.6± 2.9	63.3± 5.8	11.7± 2.5	369.9± 40.6	398.9 ± 84.9

**Table 3:** Demonstration of Average CT attenuation value of RVOT - Coronary artery images using modified technique (9 cases)

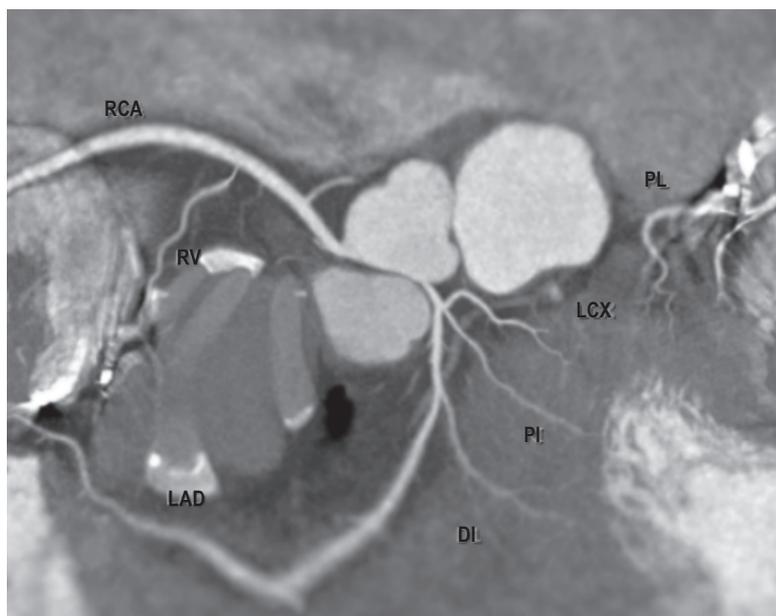
Body weight (kgs)	Mean calculated contrast volume (ml.)	Mean actual contrast volume (ml.)	Mean added contrast volume (ml.)	Mean ROI of RVOT (HU.)	Mean ROI of Ascending aorta (HU.)
<b>&gt; 60</b>					
66	50-55	50-55	0	>250	<b>&lt;250</b>
66	60-65	60-65	0	<b>&lt;250</b>	>300
65	55-60	55-60	0	>400	<b>&lt;250</b>
<b>&gt; 50</b>					
51	50-55	50-55	0	<b>&lt;250</b>	>250



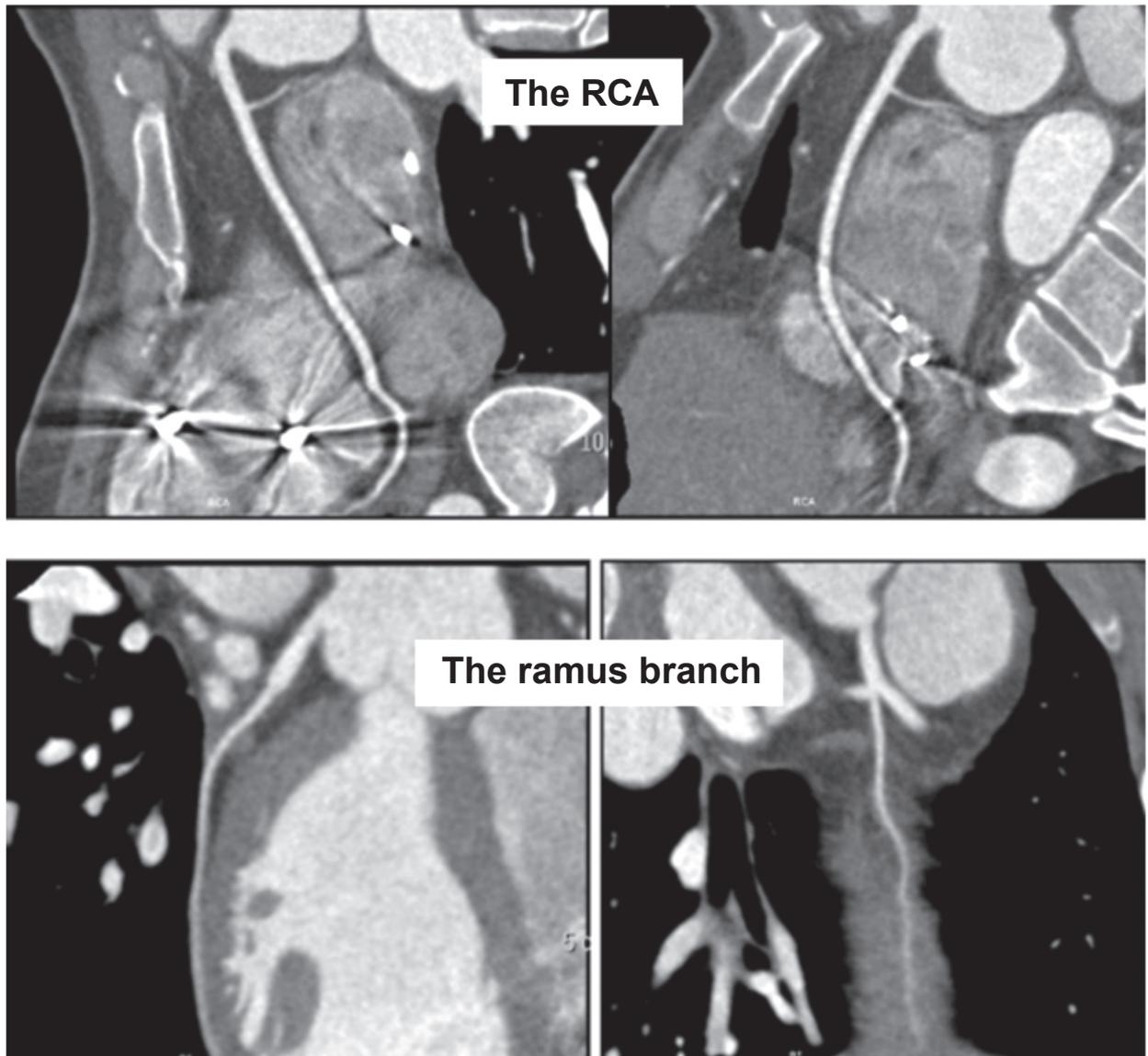
**Figure 1:** Demonstration of the RVOT images and ascending aorta-coronary arteries obtained from 256-slice MDCT using conventional technique



**Figure 2:** Demonstration of the RVOT images and ascending aorta-coronary arteries obtained from 256-slice MDCT using modified minimally added contrast volume technique



**Figure 3:** Multiplanar reconstruction (MPR) image of all coronary arteries obtained from 256-slice MDCT scan with using modified, minimally added contrast volume technique



*Figure 4: MPR image of all coronary arteries obtained from 256-slice MDCT scan using modified technique*

## Discussion

The modified minimally MDCT technique was proposed with the aim of demonstrating the RVOT and coronary artery in single scan to simultaneously lower the contrast and radiation exposure dose but with no degradation of the image quality. The important factors which impact image quality are heart rate, breath holding and patient weight. For the modified technique, we used the same protocol as for pulmonary artery scanning and added some contrast agent. Comparing to the conventional technique, the averaged volume of contrast use was reduced by about 30% of that used in conventional techniques for coronary artery (at least 45 ml) and pulmonary artery scan (at least 45 ml). In addition,

radiation and contrast exposure dose was significantly lower compared to the conventional technique. ECG-gated triple rule-out technique is the model of our study. It has been proposed to be used to rule out diseases of the aorta, coronary and pulmonary arteries. The differences between ECG gated triple rule-out protocol and ours are the location of tracker placement. With regard to our protocol, the tracker location was the pulmonary artery and all protocol parameters were fixed as in CTA for pulmonary artery scan, except the volume of contrast use. Contrast volume that is used as following the triple rule-out technique protocol is higher than our protocol because triple rule-out technique is used for three regions

of study. The total contrast use for 256-slice MDCT using triple-rule-out technique is at least 70 ml (scan time 8 sec. for whole aorta scanning) plus post threshold delayed time (~6 sec.) and multiplied by flow rate (5-6 ml/sec.) as per Philips company protocol. Furthermore, ECG-gated triple protocols remain challenging because of limited ability of subvolume MDCT scanners to rapidly cover a large volume (at least from aortic arch to cardiac inferior wall), the requirement of large volume iodine contrast and high radiation dose.<sup>4</sup> Pre-ablation preparation in Brugada syndrome needs only two regions of study, RVOT and coronary artery. Hence it is not necessary to use triple rule-out protocol for this purpose. The modified, minimally added contrast volume technique protocol has no limitations as triple rule-out protocol and also reduces the contrast and radiation exposure dose by nearly a half compared to two scans with conventional technique (10-12 millisievert (mSv) for ECG-gated pulmonary artery, 16 mSv for ECG-gated coronary artery scan). Compared to triple rule-out protocol, the radiation exposure dose of our modified technique is lower (19 mSv VS 10-12 mSv). By these advantages of our technique, this modified technique could be applied for two regions of study

## Conclusion

## References

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The 256-slice MDCT scan with modified, minimally added contrast volume technique is a single MDCT scan technique which can be used effectively in demonstrating RVOT and coronary artery for pre-RVOT ablation planning with acceptable and readable image quality in Brugada syndrome patients whose body weight is in the range of about 50-75 kilograms. The proposed calculated formula for contrast volume is scan time (5-6 sec. for pulmonary artery scanning) plus post threshold delayed time (~5 sec.) and multiplied by flow rate (4.5-6 ml/sec.) plus 10-15 ml.

## Study limitations

According to the results from our relatively small number of subjects, the proposed calculation for contrast volume use in the modified technique cannot be extended to the patient who has a body weight of more than 75 kilograms without corresponding decrease in image quality. All of our subjects were Thai people, who have on average a lower body weight than Caucasians.

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