Preoperative evaluation in a case of Tetralogy of Fallot

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History

A 5-month-old baby was born with heart murmurs. An echocardiogram revealed a ventricular septal defect (VSD), an overriding aorta, a right ventricular outflow tract (RVOT) obstruction, an enlarged left heart and regurgitation of both mitral and tricuspid valves. A Tetralogy of Fallot (TOF) was suspected. The patient was admitted to the hospital for surgical repair. A cardiac CT angiography (cCTA) was requested for preoperative evaluation.

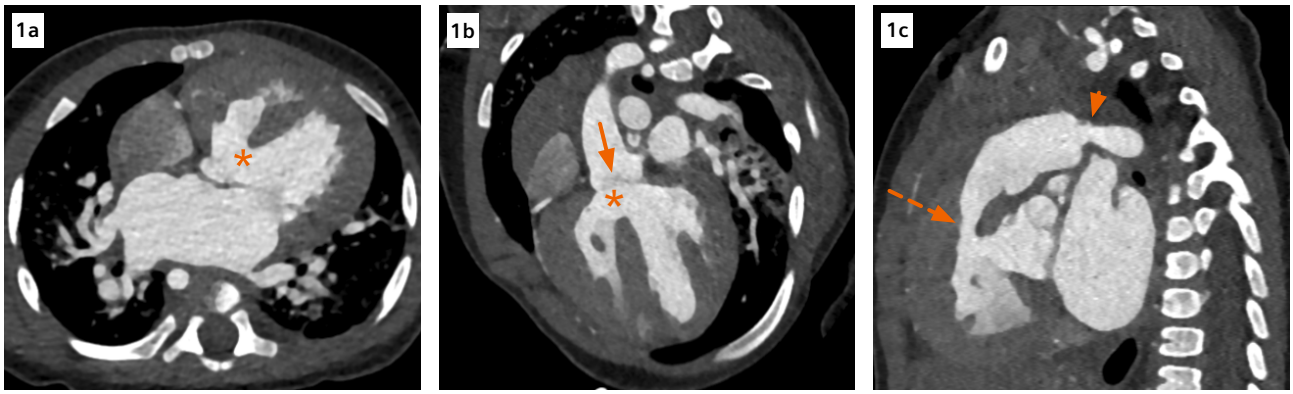
Diagnosis

cCTA images showed a VSD with an overriding aorta and a severe obstruction of the RVOT, consistent with echocardiographic findings. Both the left (LV) and right ventricle (RV) were hypertrophic. The left atrium (LA) and the LV were significantly enlarged. The origin of the left pulmonary artery (LPA) was moderately narrowed. The aortic arch and the thoracic aorta were right-sided. The right common carotid artery (RCCA) and the right subclavian artery (RSA) originated off the right aortic arch and were seen as the first and the second branch. An aberrant common trunk, shared by the left common carotid artery (LCCA) and the left subclavian artery (LSA), took off distally to the RSA. The trunk was retrotracheal and retroesophageal, causing no obvious compression. The origins and courses of the coronary arteries were normal. The pulmonary arteries and veins appeared to be proximally dilated with heterogeneous hyper- and hypodense areas seen in the lungs, suggesting pulmonary congestion. There was no evidence of an arterial-venous shunt (AVS), or of major aortopulmonary collateral arteries (MAPCAs).

Subsequently, the patient underwent a total repair of the TOF – a corrective surgical procedure that involves closure of the VSD and relief of the RVOT obstruction. A postoperative (one day) echocardiogram confirmed the success of surgery. The patient recovered uneventfully and was discharged two weeks after the operation.

Comments

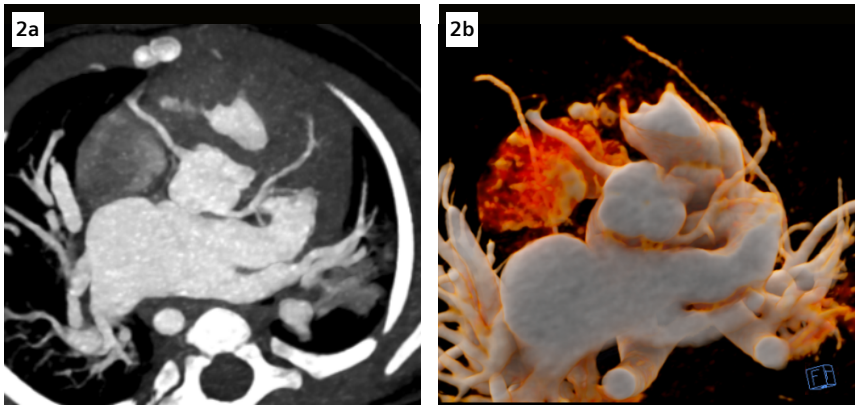
TOF is the most common congenital cyanotic heart disease. Recent advances in surgical repair facilitate survival of the affected patients into adulthood with a good quality of life. The appropriate timing, strategy and planning of the surgical intervention rely greatly upon an accurate preoperative imaging assessment. Although patients with TOF share four characteristic features (subaortic VSD, overriding aorta, RV hypertrophy and RVOT obstruction), many anatomic variants exist. [1] Therefore, it is important to evaluate not only intracardiac structures but also extracardiac anomalies, such as variant coronary anatomy, right-sided aortic arch, MAPCAs, alterations in the lungs or compression of the airways – these findings may alter the usual surgical approach. Echocardiography remains the mainstay for the diagnosis of TOF, however, with continued technological advances, CT now plays an increasing role in the evaluation and management of TOF. [2] One of the challenges of CT scanning on babies is the motion artifacts caused by their fast heartbeat and inability of breath holding. The radiation exposure is also a major concern. This case is performed on a Dual Source CT scanner, SOMATOM Force, which provides a high temporal resolution of approximately 66 ms – a feature that is essential for motion-artifact reduction in image acquisition. Although the baby's heart rate varied between 111—120 bpm, and the baby was free breathing during the scanning, the images acquired in the systolic phase with prospective ECG triggering achieved optimal quality. A 70 kV setting, selected automatically by CARE kV – an automated feature that adjusts the tube voltage, tailored to the individual patient, the system capabilities and the clinical task, is applied to enhance the contrast-to-noise ratio, prompting a potential reduction



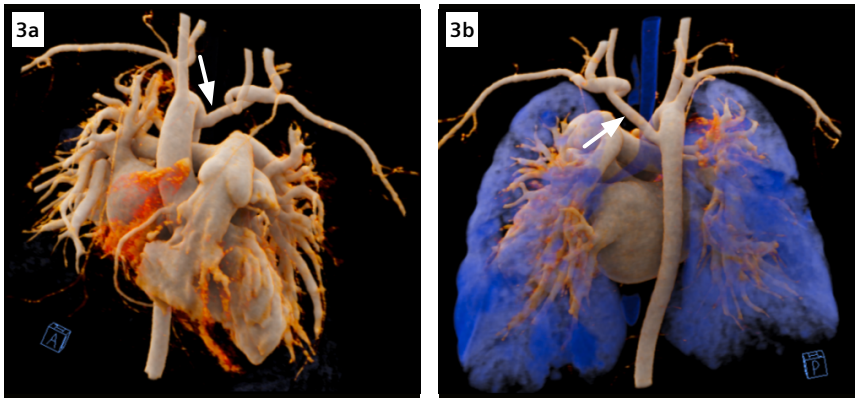
1 MPR images show a VSD (asterisk), an overriding aorta (arrow), an RVOT obstruction (dotted arrow), hypertrophic LV and RV, enlarged LA and LV and a narrowed origin of the LPA (arrowhead).

of the amount of contrast agent needed (8 mL) and radiation dose (2.5 mGy). A cinematic volume rendering technique (cVRT), providing a three-dimensional life-like visualization, facilitates the communication between physicians.

As shown in this case, cCTA is a reliable, non-invasive imaging method capable of depicting detailed cardiac anatomy and morphology for assessment of anatomical variants and associated anomalies. This helps physicians in the preoperative evaluation of the complex anatomical findings of a TOF. ●



2 A MIP (Fig. 2a) and a cVRT image (Fig. 2b) show both coronary arteries with normal origins and courses.

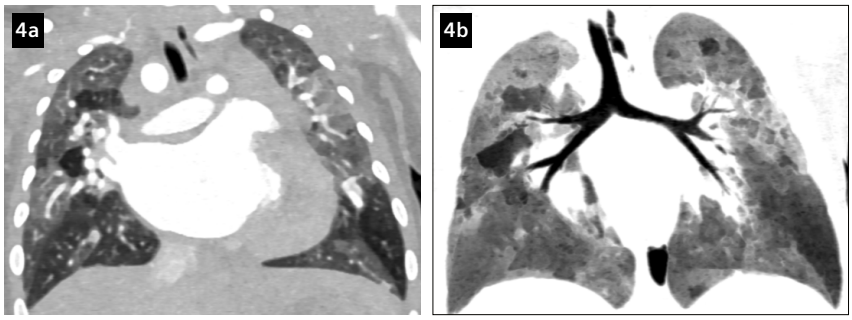


3 cVRT images with anterior (Fig. 3a) and posterior (Fig, 3b) views show a right-sided aortic arch and thoracic aorta, the RCCA, the RSA and the aberrant common trunk (arrows) shared by the LCCA and the LSA. The pulmonary arteries and veins appeared to be proximally dilated.

References

[1] Shaaban et al. Multi-detector computed tomography in the assessment of tetralogy of Fallot patients: is it a must? The Egyptian Heart Journal (2020) 72:17.

[2] Zucker, E.J. Computed tomography in tetralogy of Fallot: pre- and postoperative imaging evaluation. Pediatr Radiol 52, 2485–2497 (2022). https://doi.org/10.1007/s00247-021-05179-5.



4 **A coronal MPR image (Fig. 4a) shows a cardiomegaly and heterogeneous hyper- and hypodense areas in the lungs, suggesting pulmonary congestion. The tracheo-bronchial tree appears normal in a MinIP image (Fig. 4b).**

Examination Protocol

Scanner	**SOMATOM Force**
Scan area	Thorax
Scan mode	Prospective ECG triggered sequential mode
Scan length	87.8 mm
Scan direction	Cranio-caudal
Scan time	3.2 s
Tube voltage	70 kV
Effective mAs	198 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	2.5 mGy
DLP	5.1 mGy*cm
Rotation time	0.25 s
Slice collimation	152 x 0.6 mm
Slice width	0.6 mm
Reconstruction increment	0.4 mm
Reconstruction kernel	Bv40
Heart rate	111–120 bpm
Contrast	**320 mg/mL**
Volume	8 mL + 6 mL saline
Flow rate	0.8 mL/s
Start delay	Bolus tracking using the cardiac 4-chamber view with manual trigger + 2 s