Clinical application of MDCT with bolus contrast enhancement in the diagnosis of congenital heart disease

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Learning objectives

Technological advances and medical advances in surgical correction of congenital malformations of the cardiovascular system increase the demands on quality diagnostic tool, which corresponds to a high information content of the method in conjunction with its non-invasive.

Echocardiography is the primary method of diagnosis of CHD in children with the assessment of intracardiac morphology, intracardiac hemodynamics and ventricular function of the heart.

In some cases, this method may not provide complete information about the anatomy of the malformations of the cardiovascular system.

The use of MDCT angiography due to high accuracy in the visualization of intracardiac anatomy details of vice, disease of the aorta and its branches, systemic venous and pulmonary vessels. MDCT angiography is particularly useful for determining the presence and extent of stenosis of the trachea and bronchi caused by compression of the blood vessels (for suspected “vascular ring”), or when symptoms of respiratory disorders in patients with a planned heart surgery.
Background

In 2012 in our center cardiovascular surgery performed 431 operations for the correction of CHD. CT with contrast done to children aged 0 to 16 years. The studies were conducted in the preoperative and postoperative period. All children up to perform MSCT was performed clinical examination, functional research methods (ECG, echocardiography). MDCT with intravenous contrast was performed on 64-slice CT scanner. Studies were performed without ECG synchronization, which reduced radiation dose to the patient (for the apparatus of our class), it reduces the quality of the assessment of intracardiac structures, including valve apparatus, the coronary arteries, but the anatomy of internal thoracic arteries and veins is determined with high accuracy. A bolus of non-ionic iodinated contrast media was carried out by means of an injector at a rate of 0.7-1.5 ml / s. Contrast agent dose is individually based on 1 to 1.8 ml / kg body weight. Optimal scan time was chosen individually by using tracking software bolus (Bolus traking) with the installation of the zone of interest, depending on the task. Studies were performed with sedation medication and without sedation. Image analysis included the study of anatomy on axial tomograms, the construction of MPR and VRT reconstructions.
Among the surveyed children were found pathology: general ductus arteriosus 17 cases (11%); coarctation of the aorta 42 (27%); kinking of the aortic arch-1 (0,6%); hypoplasia of the distal part of the arc of the isthmus in combination with stenosis of the pulmonary artery 1 (0,6%); aortic arch interruption-3 (1,9%); anomalous pulmonary venous drainage 24 (15%); tetralogy of Fallot 14 (9%); double discharge of vessels-7 (4,5% ); pulmonary atresia-12 (7,8%); Ebstein's anomaly-2 (1,3%); a single ventricle-6 (3,9%); stenosis of the pulmonary veins 1 (0,6%); compound combined congenital heart disease 23 cases (14,8%).

MSCT with coarctation of the aorta (Fig. 1, 2, 3) shows the location and length of the narrowed segment and identifies the degree of hypoplasia of the aortic arch, poststenotic expansion of the descending aorta, especially the location and discharge of arterial collaterals, the relationship of the brachiocephalic arteries, narrowing their proximity. Ability morphometry of aortic arch hypoplasia in her anatomy and identification of defect with coarctation of MSCT is an advantage because the nosology can occur in isolation or in various combinations. Carrying MSCT aortografii - an important step in the planning of surgical treatment.

Break of the aortic arch is a complete separation of the ascending and descending aorta (Fig 4,5,6). The value of MSCT in this type of pathology is in the exact anatomical description of the defect, the presence of arterial collaterals, as well as the ability to assess postoperative results, including the exclusion of stenosis of the anastomosis, the formation of re-coarctation, pseudoaneurysm.

MSCT is important information for surgical planning (radical surgery or hemodynamic correction of vice?) at the output of obstruction portion of the right ventricle in patients with tetralogy of Fallot and pulmonary atresia (Fig. 7,8,9). According to some authors, the sensitivity of the method in the diagnosis of congenital anomalies of pulmonary artery close to 90% accuracy - 93%, and specificity - to 100% (Westra SJ, et al, 1999). The accuracy echocardiography this pathology diagnosis is 65%. Postoperative MSCT assists in the diagnosis of stenosis of internal and external compressions pulmonary arteries, as well as assessing aorto-pulmonary anastomoses .

Anomalous pulmonary venous drainage (Fig. 10,11). Often, when setting the type of anomalous messages enough echocardiography. However, in cases of mixed forms of abnormal drainage supracardiac connection and infracardiac connection of abnormal drainage passing through the collector of abnormal lung parenchyma, MSCT provides complete information about the anatomy of the defect.

Stenosis of the pulmonary veins (Fig. 12). MDCT accurately detects the presence, location, extent of pulmonary vein stenosis, and accompanying changes in lung parenchyma, and may be used in this pathology as dynamic observation.
Compression of the airway in CHD (Fig. 13). MSCT provides a complete characterization of abnormal vessels, estimates the length of narrowing of the trachea and bronchi, the state of lung parenchyma. When planning a minimally invasive endoscopic surgery for this disease clearly defined anatomic relationships is the key to the success of surgical treatment.

MSCT is widely used to evaluate the results of surgical treatment of CHD: determine the permeability and the presence of contractions of vascular prostheses or homografts, the formation of re-coarctation, aneurysm in the area of anastomosis, anastomotic leak, external compression and contraction of vascular structures, bronchi (Fig. 14,15,16).
Fig. 2: Fig. 2 coarctation of the aorta with kinking of the aortic arch

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**Fig. 3:** Fig. 3 hypoplasia of the ascending aorta, ductus arteriosus, yuksta ductal coarctation of the aorta

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**Fig. 4:** Fig. 4 interruption of the aortic arch, type A

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**Fig. 5:** Fig.5 interruption of the aortic arch, type B

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**Fig. 6:** Fig. 6 interruption of the aortic arch, type B

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Fig. 7: Fig. 7 pulmonary atresia, type I

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**Fig. 8:** Fig. 8 pulmonary atresia, type II ###

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Fig. 9: Fig. 9 pulmonary atresia, type IV ###

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Fig. 10: Fig. 10 total anomalous pulmonary venous drainage into the inferior vena cava

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**Fig. 11:** Fig. 11 total anomalous pulmonary venous drainage into the superior vena cava

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Fig. 12: Fig. 12 stenosis of the pulmonary veins

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**Fig. 13:** Fig. 13 compression of the bronchial pulmonary artery

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Fig. 14: Fig. 14 results of surgical treatment: compression of the left main bronchus

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Fig. 15: Control after endovascular treatment: stenting of aortic

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Fig. 16: Fig.16 stenting of the pulmonary veins

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Conclusion

Despite the radiation exposure and the need for contrast agents with intravenous contrast MSCT in the diagnosis of congenital malformations of the cardiovascular system has a high resolution, non-invasive and more informative.

Our experience shows that when testing children, including infants, MSCT can provide valuable diagnostic information about CHD, detailing the anatomy of vice, to assess the state of the aorta, brachiocephalic artery, pulmonary arteries and veins to provide accurate morphometric data for preoperative planning, to characterize the bronchial tree and lung parenchyma, to assess the postoperative results.

Thanks to the expeditious conduct of research and the possibility of the diagnostic procedure without sedation, this method can be used even in children with critical CHD.
References


