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REVIEW ARTICLE

Cardiac CT in the evaluation of congenital anomalies- A review Literature

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Abstract
Cardiac computed tomography, also known as CCT, has become more widely used in the evaluation of patients of all ages who have congenital heart disease (CHD), including children and adults. This is in part due to technological advancements in CCT as well as an increase in the number of adults who have palliated CHD. Echocardiography, cardiac magnetic resonance imaging, and cardiac catheterization all benefit from having this modality as an additional option. In comparison to other modalities, CCT is less intrusive, and there is a lower likelihood that it will need anaesthesia. Additionally, it may provide distinctive diagnostic information. To perform optimum CCT imaging, it is very necessary to have in-depth understanding of the specific patient's cardiac anatomy, physiology, surgical repair, and any potential remaining lesions. In this exhaustive analysis, the use of CCT both preoperatively and postoperatively for the most prevalent CHD diagnosis is broken down in great depth. In addition to this, one of our goals is to bring attention to several novel and cutting-edge technologies that have just become commercially accessible and may further improve CCT imaging for patients with CHD.
Keywords: Cardiac CT, congenital anamoly, Children.

Introduction

The most prevalent kind of serious congenital deformity is called congenital heart disease (CHD), and it affects between 0.8% and 1.2% of livebirths across the globe [1]. Imaging of the cardiovascular system is very important in the initial assessment, as well as in the planning of care and the long-term monitoring of these patients. Although echocardiography continues to be the workhorse of noninvasive imaging for patients with CHD, advanced imaging modalities are utilized in numerous scenarios in which additional diagnostic detail is required. This is often the case in the setting of poor image quality, which is due to limited echocardiographic windows [2]. The benefit of cardiovascular computed tomography (CCT) is that it has submillimeter isotropic spatial resolution, fast scan periods, and picture quality that is not restricted by ferromagnetic artefact in patients who have already had earlier treatments. CCT has often been demonstrated to provide diagnostic information and affect care in children with congenital heart disease (CHD) [3].

Radiologists who do CT scans on young children who have congenital heart disease (CHD) should be knowledgeable with the benefits and drawbacks of CT scans, as well as the normal architecture and common pathologic abnormalities seen in patients afflicted by CHD. In this

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extensive study, the primary attention is placed on the most prevalent clinical applications of CCT in CHD.

Review of Literature: Image and CT Scan

Patients who were not able to successfully hold their breath were given an oral dose of chloral hydrate ranging from 50–75 mg/kg in order to sedate them. When it was required, sedative medicines were administered through intravenous injection. Each and every CT examination was carried out using a spiral CT scanner that had four sections. The following settings were used to acquire CT data: a collimation of 1.25 millimetres, a table feed of 3.75 millimetres per second, and a reconstruction interval of 0.5 millimetres. We adopted a weight-based low-dose CT protocol, which consisted of 120 kVp and 30–80 mA. In recent times, 80 kVp has been suggested as the optimal value for contrast material–enhanced CT scans. This is due to the fact that the radiation dosage may be decreased further without compromising picture quality [4].

When the arm vein was utilzed, the contrast agent was combined with an equivalent volume of normal saline solution, and CT examinations were conducted in the caudocranial direction. This was done to reduce the number of artefacts caused by the contrast agent and to obtain homogenous contrast enhancement. To ensure that the contrast agent could be given throughout the whole of the scan, the injection rate had to be altered [5].

When bolus tracking is used, the image capture process is automatically kicked off when the contrast reaches a certain Hounsfield unit (HU) in the structure that has been identified as being of interest. Alternately, manual bolus tracking requires manually activating the scan while real-time imaging of contrast in the region of interest is being performed on the monitoring sequence. Patients who are older (adolescents or adults) and who are less prone to wander about during the scan are ideal candidates for automatic bolus monitoring [5,6].

The acquisition of CT volume data of the highest possible quality is the stage that must be completed prior to the production of diagnostically relevant pictures that have been reformatted. As a result, a radiologist who conducts CT for CHD should be familiar with how to get the best possible results from CT. The CT volume data were then uploaded to a workstation that is readily accessible in the market. Depending on the goal structure and the reason for the picture reformatting, a variety of approaches were used, such as linear or curved planar reformatting, maximum intensity projection (MIP), minimum intensity projection, shaded surface display, and volume rendering (VR). It was necessary to alter the plane of the reorganized picture so that it would match to the long axis of the structure of interest [6].

In the process of three-dimensional reformatting, the shaded surface display was used for the evaluation of the airway and lung, while virtual reality was utilized for the evaluation of the cardiovascular structures. For the purpose of precisely determining the diameter of the structure in issue as well as its area, thin-section multiplanar reformatting was used.

In order to do CCT in patients who have CHD as effectively as possible, a comprehensive grasp of the anatomy and physiology of the heart is required. It is very crucial to use the correct terminology when referring to this specific group of patients in order to guarantee accurate transmission of results. A segmental approach to coronary heart disease involves evaluating each individual segment of the heart in addition to the connections that exist between the segments. It is important to ascertain the thoracic and abdominal situs (also known as sidedness) initially in order to establish a general anatomic framework.

Conditions that are typical in pathology

On reformatted CT scans that have been customized to the pathologic conditions that are of interest, typical manifestations of the different CHDs may be seen. These manifestations

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almost always point to a stenosis, blockage, defect, or connection issue. Catheter cardioangiography, magnetic resonance imaging (MR) [7,8], and computed tomography (CT). Every discovery from the CT was substantiated by either echocardiography, catheter cardioangiography, or surgical intervention.

Interrupted Aortic Arch

An interrupted aortic arch, also known as an interrupted aortic arch (IAA), is a separation that occurs between the ascending and descending aortas [9]. This condition is categorised according to the location of the interruption, as follows: There are three subtypes of subclavian arteries: subtype 1, which is a normal subclavian artery; subtype 2, which is an abnormal subclavian artery; and subtype 3, which is an isolated subclavian artery that originates from the ductus arteriosus. Evaluation of the distance between the proximal and distal segments, the size of a patent ductus arteriosus (PDA), the narrowest dimension of the left ventricular outflow tract, and other cardiac structural abnormalities are important for surgical planning. In addition to the type of IAA, this evaluation must be performed. The presence of a right-sided descending aorta together with an aortic interruption nearly invariably indicates the presence of DiGeorge syndrome.

Tetralogy of Fallot (TOF)

The most frequent type of cyanotic congenital heart disease (CHD). It accounts for between 4 and 6% of all cases of CHD and affects around one in three thousand live newborns. TOF is distinguished by an anterior deviation of the conal ventricular septum, which is accompanied by an anterior malalignment ventricular septal defect, aortic override over the ventricular septum, and blockage of the pulmonary outflow route [10].

A condition known as coarctation of the aorta

The constriction occurs immediately distal to the left subclavian artery in cases with typical coarctation [7,8]. Coarctation of the left subclavian artery at or immediately proximal to that vessel is very uncommon but may jeopardise that vessel. There is a possibility of the development of an abnormal right subclavian artery at or below the coarctation. The ridge on the inside of the coarctation corresponds to an exterior indentation that includes almost all of the coarctation except for the ventral part. In most cases, the area of the aorta immediately distal to the coarctation will be dilated. In newborns, it is more common to see a condition known as tubular hypoplasia, which describes a uniform constriction of the aortic arch. There is a possibility that a localized coarctation and tubular hypoplasia might develop simultaneously or separately. (Figure 1)

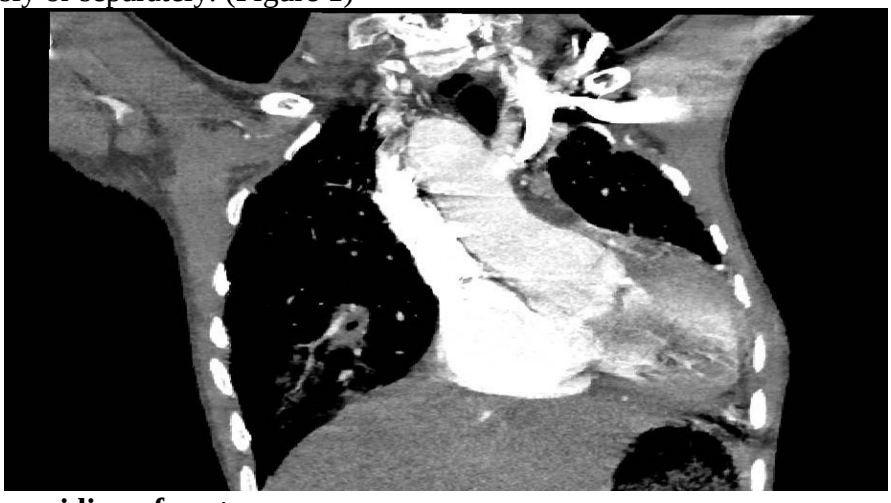

Figure 1: Overriding of aorta

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Double outlet right ventricle

Also known as DORV is a kind of congenital heart disease (CHD) that is distinguished by the fact that both the pulmonary artery and the aorta originate from the right ventricle. DORV is most often accompanied with a ventricular septal defect (VSD). It is a very rare form of CHD, with an estimated incidence of 0.13 cases per 1000 babies that occur naturally [11].

Patent Ductus Arteriosus

PDA is an abbreviation that stands for prolonged patency of the ductus arteriosus beyond the point when it can function normally after birth. An uncomplicated PDA makes the connection between the proximal descending aorta and the ceiling of the main pulmonary artery close to the orifice of the left pulmonary artery. This connection is found below the origin of the left subclavian artery [12]. PDA often develops from the undersurface of the aortic arch and inserts into the proximal left pulmonary artery in cases when there is blockage to the outflow of blood from the right ventricle.

A coronary artery fistula is one kind of coronary artery anomaly. Other types of coronary artery abnormalities include anomalous origin from the contralateral facing aortic sinus and anomalous left coronary artery from the pulmonary trunk. Imaging techniques that are not intrusive are helpful for tracing the coronary artery's beginning and following its path. It is essential to ascertain if the anomalous artery is located between the pulmonary trunk and the aorta. In addition, while contemplating a surgical strategy for tetralogy of Fallot or transposition of the great arteries, it is essential to be aware of any abnormal paths that the coronary artery may take.

Pulmonary Atresia with Ventricular Septal Defect

The lesion displays the morphologic features of an extreme form of tetralogy of Fallot when it is characterized by pulmonary atresia in conjunction with a ventricular septal defect (VSD) and concordance between the atrioventricular and ventriculoarterial structures. It is possible for there to be, or not be, a central pulmonary artery, and for the branch pulmonary arteries to either confluence or not confluence with one another [12]. (Figure 2)

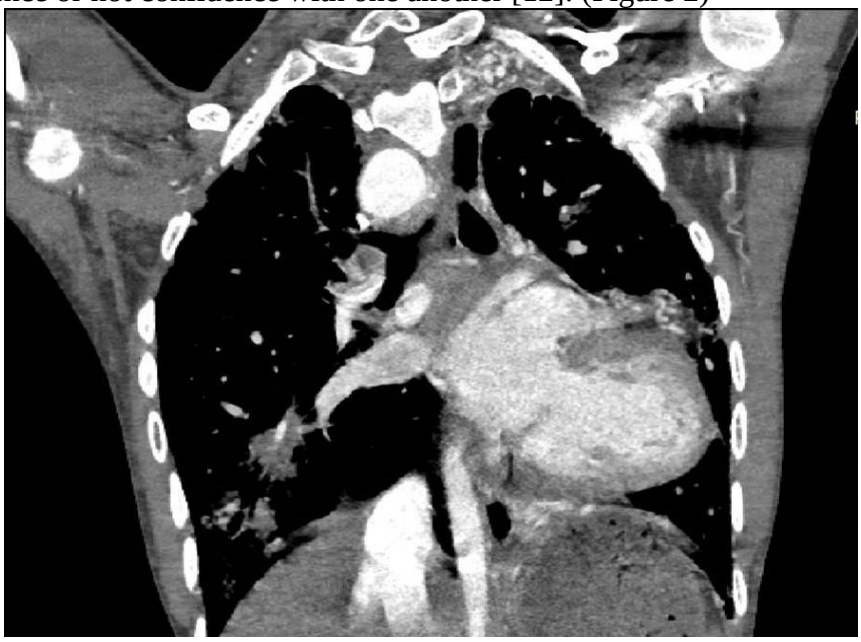

Figure 2: Pulmonary atresia

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The Ebstein Anomaly

The Ebstein anomaly is characterized by a repositioning of the attachment of the tricuspid valve leaflets from the atrioventricular junction to the right ventricular chamber, which then leads to an atrialization of the entrance of the right ventricle [13]. When the tricuspid valve attachment is displaced, it nearly usually only affects the septal and posterior leaflets, and the degree of displacement is at its worst at the commissure that separates these two leaflets. The nondisplaced anterior leaflet is typically big and redundant, and its mobility varies depending on the degree to which it is tethered to the right ventricular wall. This is because the nondisplaced anterior leaflet is a part of the mitral valve.

Atresia of the Tricuspid Valve

The morphologic right atrium does not have any direct connection with the right ventricle in patients who have atresia of the tricuspid valve. Tricuspid atresia may present in any of two different ways. Areolar sulcus tissue fills the space left by the absence of the right atrioventricular link in the more frequent form [14]. An atretic tricuspid valve is present in the more uncommon form of the condition.

There is a muscular portion as well as a membranous portion of the ventricular septum. The more apical attachment of the septal leaflet of the tricuspid valve is what further subdivides the membranous septum into the atrioventricular and interventricular components of the heart. This is done by the tricuspid valve. There are three parts that make up the muscular septum: the inlet, the trabecular, and the outlet components. (Figure 3)

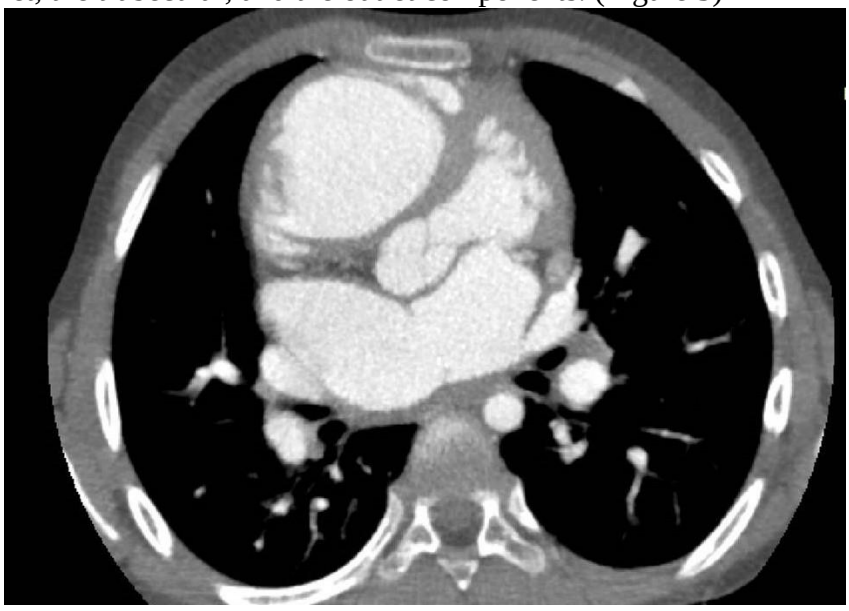

Figure 3: large atrial septal defect

There is an irregularity in the arrangement of the leaflets of the atrioventricular valve (anterior and posterior bridging leaflets, right and left mural leaflets, anterosuperior leaflet). The typical wedged position of the aortic valve has been disrupted, resulting in an anterior-superior displacement of the valve. The left ventricle has a shorter intake and a longer outflow than the right ventricle does.

Unusual beginning of the coronary artery at the aortic root

Coronary abnormalities are one of the most prevalent findings on autopsy in the population of young athletes. Sudden cardiac death (SCD), which is the most common medical cause of death in sports, is the main cause of mortality in athletes. Despite the exposure and attention

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that sudden cardiac death in athletes gets, there is still a great deal that is unknown about the risk factors and triggers for sudden cardiac death, particularly in individuals who have been identified with an aberrant aortic origin of the coronary artery (AAOCA).

The Great Arteries Are Reversed Due to a Congenitally Corrected Transposition

A disorder known as congenitally repaired transposition of the great arteries is characterized by discordant atrioventricular and ventriculoarterial connections. This condition may affect infants as well as adults [8]. Accordingly, the state is considered to be normal from a hemodynamic standpoint when there are no additional cardiac abnormalities present [15].

Utilization of cutting-edge technology in individuals suffering from coronary heart disease

There have been a lot of interesting advances in CT scanner technology and post-processing technology recently, and both of these can be used to enhance the use of CCT for CHD. Scanners of a more recent generation are capable of high-resolution imaging as well as quick imaging, which enables detailed scans to be performed on even the tiniest patients with a minimal need for anaesthesia [16-20].

Because CT imaging takes less time and requires less sedation than MR imaging does, it is easier to conduct on a patient who is unstable and needs extensive monitoring and care. Because of the constriction of the airway that the vascular structure causes, the patient may not be able to be successfully weaned off the ventilator after the operation. CT scans provide for an accurate assessment of the connection that exists between the vasculature and the airway. This information is important for surgical care, but it is not available by any other imaging method. In addition, the postprocessing of CT scans takes around one hour at the moment [15-18].

Conclusion

The morphologic examination of coronary heart disease may benefit from the imaging modality of CT. Images that have been reformatted using multisection spiral CT may differentiate between the normal and pathologic morphologic aspects of the cardiovascular structures in an exact and methodical manner.

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