Role of MSCT in Assessment of Left Ventricular Function (LVF) Compared to Other Imaging Modalities

Assay

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Abstract

Cardiac morbidity and mortality are closely related to cardiac volumes and global left ventricular (LV) function, expressed as left ventricular ejection fraction. Accurate assessment of these parameters is required for the prediction of prognosis in individual patients as well as in entire cohorts.

The current standard reference for left ventricular function assessment is the analysis by short-axis magnetic resonance imaging. In recent years, major extensive technological improvements have been achieved in computed tomography. The most marked development has been the introduction of the multidetector CT (MDCT), which has significantly improved temporal and spatial resolutions.

In order to assess the current status of MDCT for analysis of LV function, the current study on this subject was done. The data presented in this study indicate that the global left ventricular functional parameters measured by contemporary multi-detector row systems combined with adequate reconstruction algorithms and post-processing tools show a narrow diagnostic window and are interchangeable with those obtained by MRI.

This study also compared between role of MDCT in analysis of LV function and other reference modalities such as trans-thoracic echo (TTE), SPECT, MRI and invasive techniques as cine ventriculography (CVG).

Key words: Global left ventricular function; left ventricular ejection fraction; MDCT; MRI ;TTE ; SPECT ; CVG.

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List of Abbreviations

- *CPR ---------------------------------- Curved planar reformation*
- *CTDI --------------------------------- CT dose index.*
- *CVG --------------------------------- Cine ventriculography*
- *DLP ---------------------------------- Dose-length product*
- *EBCT --------------------------------Electron-beam CT*
- *EF ------------------------------------ Ejection fraction*
- *FOV ---------------------------------- Field of view*
- *IVC ----------------------------------- Inferior vena cava.*
- *LA ------------------------------------ Left atrium*
- *LV ------------------------------------ Left ventricle*
- *LV-EDV ---------------------------- Left ventricle end diastolic volume*
- *LV-ESV -----------------------------Left ventricle end systolic volume*
- *LVF ----------------------------------- Left ventricular function*
- *MDCT ------------------------------- Multi-detector row CT*
- *MIP ---------------------------------- Maximal intensity projection*
- *MPR -------------------------------- Multi-planar reformation*
- *MRI --------------------------------- Magnetic resonance imaging*
- *MSCT ------------------------------ Multi-slice CT*
- *RA---------------------------------- Right atrium*
- *RRP ------------------------------- Resting refractory period*
- *RV ----------------------------------Right ventricle*
- *SPECT ---------------------------- Single positron emitting tomography*
- *SSD --------------------------------- Shaded surface display*
- *SVC ------------------------------- Superior vena cava*
- *TR --------------------------------- Temporal resolution*
- *TTE ------------------------------- Trans thoracic echo*
- *VR --------------------------------- Volume rendered*

INTRODUCTION

Left ventricular (LV) function is an important parameter for predicting the prognosis of all cardiac patients such as coronary artery disease patients therefore, an assessment of LV function is important for making a clinical diagnosis, for imaging and for following up these patients ***(1)***.

A variety of imaging techniques have been introduced to measure LV function. Widely available echocardiography is operator and acoustic window -dependant ***(2).*** Cineventriculography has many disadvantages such as invasiveness, the need of use of iodinated contrast medium; patients are exposed to ionizing radiation and the geometric limitations that result from the projection images ***(3).*** Radionuclide ventriculography is limited by its low spatial and temporal resolution ***(4)***. The introduction of cardiac MRI allowed major progress concerning the temporal and spatial resolution and allowed image acquisition in any desired plane. Several studies have shown that the accuracy and reproducibility of cardiac MRI are excellent for making quantitative LV function measurements ***(5).***

Recently, multi slice computed tomography (MSCT) has been introduced as a new and promising tool for assessment of LV function ***(6).*** Because, data acquisition in MSCT is continuous, image information for any phase of cardiac cycle is inherently contained in the CT data set. Thus, systolic and diastolic image series may be generated, which then allow determination of LV end diastolic (LV-EDV) volume and LV end systolic volume (LV-ESV) ***(7).*** Initial studies showed that the global LV function parameters obtained with MDCT are in good agreement with results from cine MRI ***(8).***

Although, conventional cardiac CT (single detector row) has several potential uses, including (a) coronary artery imaging (b) morphological information with high resolution (c) wall motion and systolic thickening (d) myocardial perfusion assessment and (e) LV volume assessment as a functional parameter ***(9).*** The development of multidetector row CT MDCT has boosted the use of conventional sub-second helical CT for cardiac imaging in the clinical setting as MDCT is useful to assess LV-EDV, LV-ESV and ejection fraction EF, using the same data obtained from coronary artery imaging ***(10).***

Aim of work:

The purpose of this study is to evaluate the feasibility of MSCT for the assessment of global and regional left ventricular functions compared to other imaging modalities such as, transthoracic echo (TTE), cine-ventriculography (CVG), SPECT scanning and cine MRI.

CHAPTER (I)

ANTOMY OF THE HEART

CARDIAC SIZE, SHAPE AND EXTERNAL FEATURES

The heart is a hollow fibromascular organ, of somewhat conical form, with a base, apex and a series of surfaces which are enclosed in the pericardium. It occupies the mediastinum between the lungs and their pleural coverings. It is placed obliquely behind the body of the sternum and the costal cartilage and ribs. Average adult heart is about 12 cm from base to apex, 8-9 cm in its broadest diameter and 6 cm anteroposteriorly ***(11).***

CARDIAC BASE, APEX, SURFACES AND BORDERS

Posterior aspects of the heart- The true cardiac base is somewhat quadrilateral, with curved lateral extension. It faces back and to the right, separated from thoracic vertebrae (5^{th} to 8^{th} in the recumbent, 6^{th} to 9^{th} in the erect posture) by the pericardium, right pulmonary veins, oesophagus and aorta. It is formed mainly by the left atrium, and partly by the posterior part of the right atrium. It extends superiorly to the bifurcation of the pulmonary trunk and inferiorly to the posterior part of the atrioventricular groove containing the coronary sinus and branches of the coronary arteries. It is limited to the right and left by the rounded surfaces of the corresponding atria. These are separated by the shallow interatrial groove. The point of junction of atrioventricular, interatrial and posterior interventricular grooves termed the crux of the heart. Two pulmonary veins on each side open into the left atrial part of the base where the SVC and IVC open into the upper and lower parts of the right atrial basal regions the area of the LA between the openings of the right and the left pulmonary veins form the anterior wall of the oblique pericardial sinus. The description of the anatomical base reflects the usual position of the heart in the thorax. Some confusion may be produced by the other current usages of the term 'base'. It is often applied to the segment of atrioventricular and ventriculoatrial junctions through the atrioventricular groove. This area is better termed the base of the ventricles. In clinical practice, auscultation on or near the parasternal part of the 2nd intercostals is described as occurring at the clinical "base" to make the contrast with clinical 'apex' such descriptions while than perfect anatomically.

Anatomical apex of the heart- It is the conical apex of the left ventricle which is directed down, forwards and to the left. The left lung and pleura overlap it. It is located most commonly behind the 5^{th} left intercostals space, near or a little medial to the mid-clavicular line.

Anterior, sternocostal surface of the heart- Facing forwards and upwards and its anterior surface has an acute right and more gradual left convexity (**Fig 1**). It consists of an atrial area above and to the right and a ventricular part below and to the left of the atrioventricular groove; the atrial area is occupied almost entirely by the RA.

The LA is largely hidden by the ascending aorta and the pulmonary trunk. Only a small part of the left appendage projects forwards to the left of the pulmonary trunk. Of the ventricular region, about one third is made up by LV and two thirds by the RV. The site of the septum between them is indicated by the anterior interventricular groove. The sternocostal surface is separated by the pericardium from the body of the sternum, the sternocostal muscle and the 3rd to 6th costal cartilages. Owing to the bulge of the heart to the left, more of this surface is behind the left costal cartilages than behind the right ones. It is also covered by pleural membranes and by the thin, anterior edges of the lungs, except for triangular area at the cardiac incisures of the left lung. The lungs and their pleural coverings are variable on degree of overlapping the heart.

Inferior, diaphragmatic surface of the heart- Largely horizontal, it slopes down and forwards a little towards the apex. It is formed mainly by the ventricles (chiefly the left) and rest mainly upon the central tendon, but also apically on a small area of the muscular part of the diaphragm. It is separated from the anatomic base by the atrioventricular groove and is traversed obliquely by the posterior interventricular groove.

Left surface of the heart- Facing up, back and to the left, it consists almost entirely of the obtuse margin of the LV, but has a small part of the LA and its auricle contributing superiorly. Convex and widest above, and crossed here by the atrioventricular groove, it narrows to the cardiac apex. It is separated by the pericardium from the left phrenic nerve and its accompanying vessels, and by the left pleura from the deep concavity of the left lung.

Right surface of the heart- A rounded surface formed by the right atrial wall and is separated from the mediastinal aspect of the right lung by the pericardium and the pleural coverings. Its convexity merges below into the short intra thoracic part of the IVC and above into the SVC. The terminal groove *(sulcus terminalis)* is a prominent land mark between the true atrial and the venous component of the right atrium, curving approximately along the junction of the sternocostal and right surfaces.

Upper border of the heart- It is atrial (mainly the left atrium). Anterior to it are the ascending aorta and the pulmonary trunk. At its extremity the SVC enters the RA.

Right border of the heart- Corresponding to the RA, the profile of the right border is slightly convex to the right and it approaches the vertical.

Inferior border of the heart- Also known as the acute margin of the heart, it is sharp, thin and nearly horizontal. It extends from the lower limit of the right border to the apex and it is formed mainly by the RV, with a small contribution from the LV near the apex.

Left border of the heart- Also known as the obtuse margin, it separates the sternocostal and left surfaces. It is round and mainly formed by the LV but, to a slight extent superiorly, is formed by the auricle of the LA. It descends obliquely, convex to the left, from the auricle to the cardiac apex ***(11).***

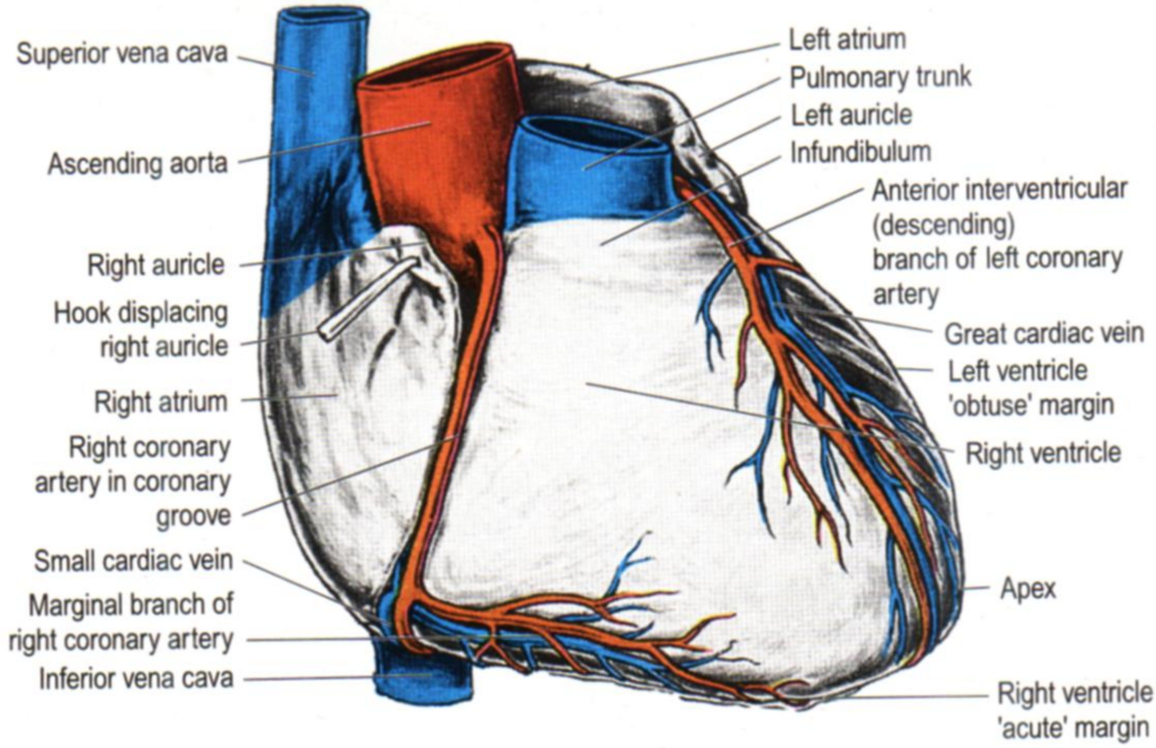

Fig.1 Anterior or sternocostal surface of the heart (11).

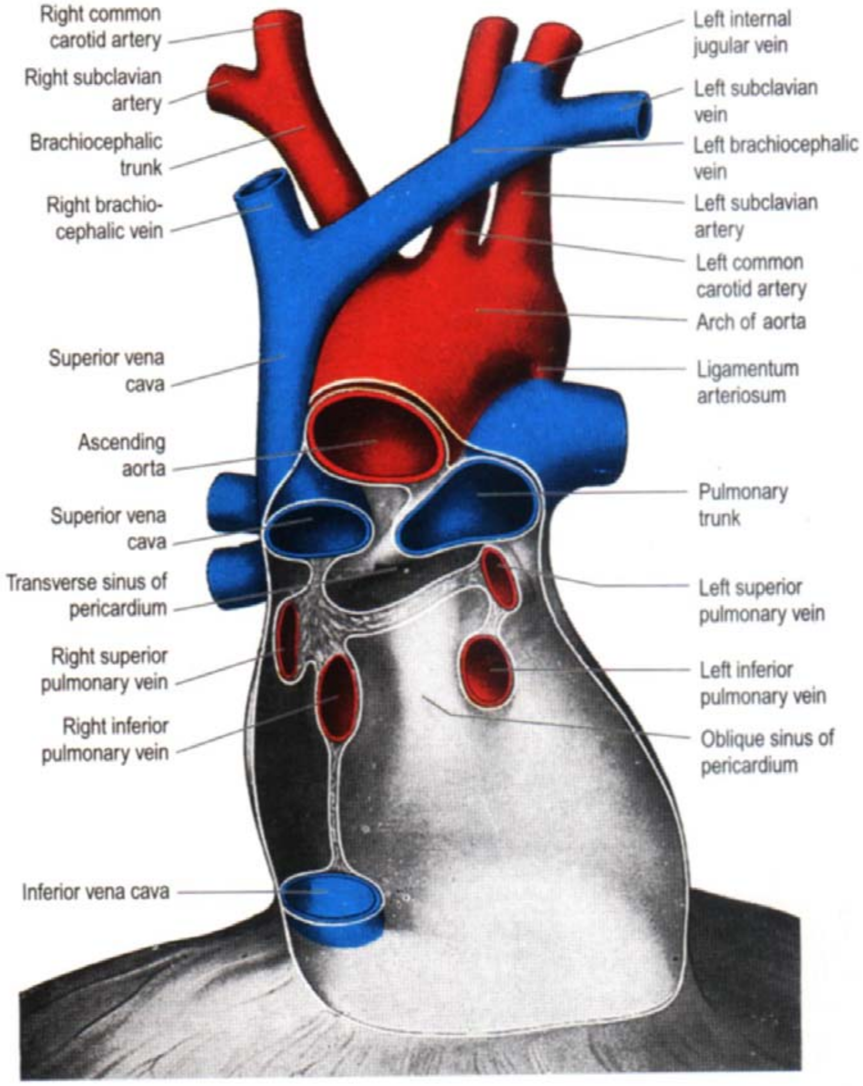

Fig.2 Interior of the serosal pericardial sac after section of the large thoracic vessels at their cardiac origin and removal of the heart (11).