دور الاشعة المقطعية المتعددة المقاطع فى تقييم وظائف البطين الايسر مقارنة بوسائل التصوير الاخرى

دراسة مقدمة من الطبيبة

ناريمان بركات مصطفى سالمان

بكالوريوس الطب والجراحة

جامعة عين شمس

توطئة الحصول على درجة الماجستير فى الاشعة التشخيصية

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جامعة عين شمس

2012

Role of MSCT in Assessment of left Ventricular Function (LVF) Compared to Other Imaging Modalities In Normal Individuals

Essay

Submitted for partial fulfillment of the master degree in

Radiodiagnosis

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2012

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ILLUSTRATIVE CASES BY MDCT

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Introduction:

Multidetector computed tomography (MDCT) can play a role in diagnosis of coronary artery disease and in the assessment of left ventricle (LV) and right ventricle global function, with initial good correlation results with standard modalities such as transthoracic echocardiography (TTE), single photon emission computed tomography (SPECT), cardiac magnetic resonance imaging (MRI), and invasive techniques angiography. With the latest scanners, regional LV contractility with both qualitative function evaluation by specific postprocessing software can be performed considering simultaneously different parameters plus the subjective visual perception of anomalies of 2-dimensional and 3-dimensional cine-loop models (80).

Cardiac functional assessment provides information about global and regional contractility of the LV, whether in the setting of post infarction recovery, LV hypertrophy (81), and chronic heart failure (82).

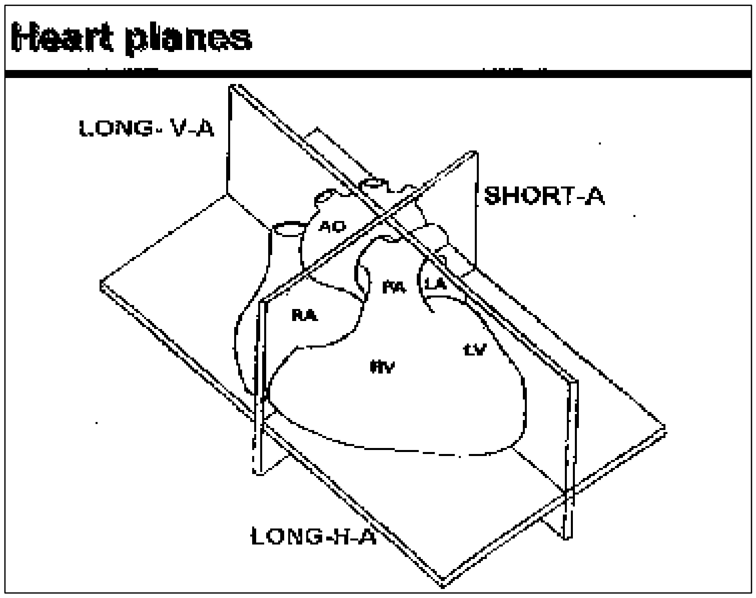


Fig. 19Cardiac anatomic axis (quoted from 28).

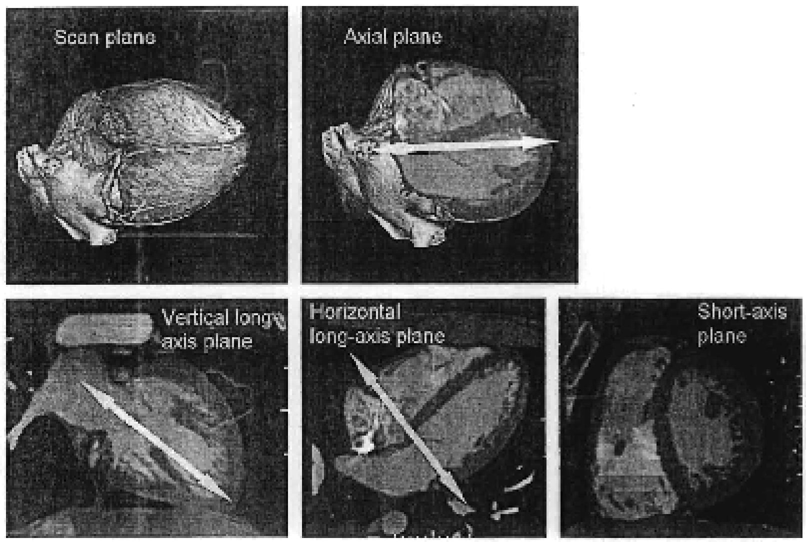


Fig. 20 cardiac anatomic axis. Example of manual generation of 2 MPR long–axis images of the LV (vertical, connecting the apex to the middle of atrioventricular junction, and horizontal, connecting the apex to the middle of mitral valve ring) and resulting double-oblique short-axis images perpendicular to the horizontal long-axis plane (quoted from28).

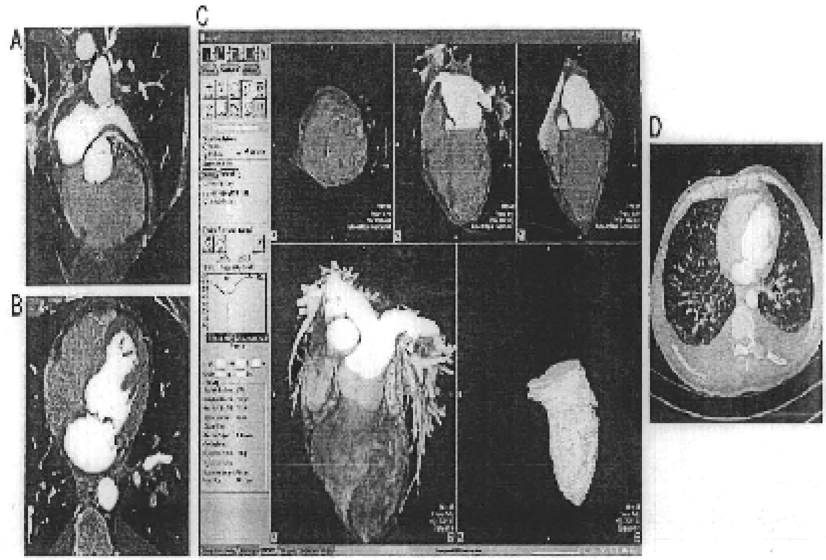


Fig. 21 Example of global cardiac assessment in a 59-year-old man with known diffuse ischemic disease and acute chest pain, at 64-MDCT (Somatim Sensation 64, Siemens Medical Solutions, Forchheim, Germany). Reformations were performed on a dedicated workstation (Vitra 2, Vital Images). In this case, with only one acquisition of the entire thorax, it was possible (A) to diagnose a sub-occlusion of proximal left anterior descending coronary artery with calcified (arrow) and non-calcified (head arrow) plaques, and an acute

infarction myocardial area in the apex (arrow in B). C it was also possible to exclude aortic dissection and PE (as shown in volume rendering image), and evaluate EF (31%) and ESV (133 mL) that are very important additional independent prognostic factors. D, Finally with lung parenchyma window is demonstrated pulmonary dema and bilateral pleural effusion, indicating heart failure (Quoted from 28).

LEFT VENTRICULAR FUNCTIONS ASSESSMENT:

LV Global Function Assessment:

(I) Volume and Mass Calculation Approaches:

* **Area-length method.** Is based on a vertical or horizontal long-axis view.

The longest length (L) of the left ventricular cavity is measured from the aortic valve to the apex and the ventricular area (A) as the surface within traced endocardial contours.

Assuming that the shape of the LV approximates a prolate ellipse, the LV volume (V_{LA}) is calculated by the formula:

$$V_{LA} = (8/3) \times A^2/\pi L$$

Because of geometric assumptions, this method is not accurate for remodeling ventricles (83).

- **Simposn's Method:** Endocardial contour all short-axis images showing left-ventricular cavity are traced with papillary muscle being included into left-ventricular cavity to calculate the cross-sectional area A of each section. Left ventricular-volume (V_{SA}) are calculated by adding all measured cross-sectional areas A_N multiplied by the intersection thickness S:

$V_{SA} = \Sigma A_N \times S$ (84).

- **Left ventricular mass LV_M**: is calculated by adding all cross-sectional myocardial areas (within the traced endocardial and epicardial borders at the end-diastole) multiplied by the section thickness and by the myocqardial density (1.05g/cm^3).

$LV_M = A_N \times S \times o$ (83)

- **Threshold-based voxel calculation**: measurement is achieved using a segmentation technique based on the attenuation differences between myocardium and contrast in cardiac chambers. Normally the user has to establish the valvular annulus level (because of the similar attenuation in the atrium and ventricle), then the sum of all contiguous voxels exceeding a predefined attenuation threshold under the chosen valvular level, express LV volume. It can be calculated on each MPR view or on the whole volume. In fact, owing to the proper volumetric acquisition of data and to the Isovolumetric voxel size, of newest 64-slice CT scanners, this approach should be considered the most reliable, reproducible, and fast method. Pixels included in the segmentation are generally displayed with a different color (purple, blue, etc) depending on the manufactures. If automatic segmentation is not accurate, attenuation threshold can be modified to make the color fit better the cavity. Evaluation of global ventricular contractility is derived from calculation of end-systolic-volume (ESV), end-diastolic-volume (EDV), stroke volume (SV), and ejection fraction (EF) (85 & 86).

(II) Ejection fraction: EF describes the relative changes of EDV to ESV and reflects the global ventricular function: the normal LV ejects 50% to 70% of EDV during systolic contraction. EF is calculated according to the formula:

$$EF = \frac{(EDV - ESV)}{EDV} \times 100\%$$

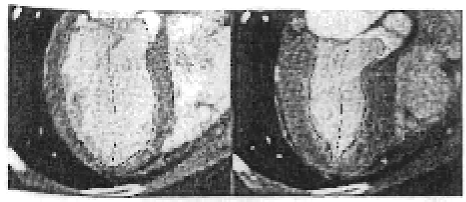
In ischemic cardiac disease, the EF is a more powerful predictive factor of outcome than the number of vessels involved. The Coronary Artery Surgery Study (CASS) registry data demonstrate that the patients with only 1 coronary vessel disease but decreased EF have higher mortality than patients with 2 or 3 vessels involved but normal EF (87).

It has been also demonstrated that EF can predict cardiac failure in patients with uncomplicated acute myocardial infarction (88).

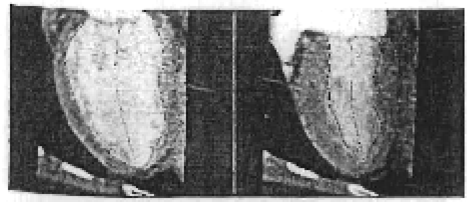
Moreover, among patients with previous myocardial infarction and EF <40%, ESV represents an additional independent prognostic factor (89)

(III) Stroke volume SV is the abosolute change in the LV volume **SV (mL) – EDV – ESV.**

A Longitudinal shortening
15-25%



B Longitudinal Shortening
15-25%



C Circumferential shorten
30-50%.

D Wall thickness 40-50%.

E Ejection fraction 50-70%