Four-Dimensional Cardiac Image by Helical Computed Tomography

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Ultrasound and MRI are useful in assessing wall motion and systolic thickening with 2D images. Volumetric data of the helical CT provide frozen 3D images. We sought to determine whether helical CT could assess left ventricular wall motion with 3D animation. We have developed a new cardiac application, ventriculography by 4D enhanced helical CT (4D-CT-VG), which can assess wall motion with 3D animation from any perspective. We demonstrate representative 4D-CT-VG in 3 patients with acute myocardial infarction. In all 3 patients, akinetic areas assessed by 4D-CT-VG were concordant with those evaluated by conventional left ventriculography (LVG) (Figure).

Method of 4D-CT-VG

At 50 seconds from the beginning of intravenous administration of a contrast medium (1.5 mL/s, total dose 100 mL), the scan was started and covered the patient's entire heart during a single breath-hold, by use of an ECG-gating technique. Scan parameters used were 3-mm-thick collimation, 3-mm per rotation table speed, 0.8 second per rotation, and ≈40 rotations (32 seconds) through 12 cm in total. The helical CT scanner was a ProSeed-SA (GE Yokogawa Medical Systems; the American version is called ProSpeed-Advantage, GE Medical Systems). The workstation was Indigo2 (Silicon Graphics Japan), and the software used was a Dr View R 4.0 (Asahikasei Jouhou System). By use of a 0.3-mm (0.08-second) interval (10 slices per rotation) overlapping reconstruction, ≈400 transaxial slices, including various cardiac phases, were obtained and transferred to the workstation. Data sets in identical cardiac phases were extracted (10 to 13 phases, depending on the heart rate) from the 400 transaxial images. Then, 3D images of all cardiac phases were reconstructed. Left ventricular cavity images were extracted by application of a certain threshold (CT attenuation number) to render 3D images. The 3D animation was produced by paging these 3D images in cardiac phase order. The interval between transaxial slices within a data set of the cardiac phase often had different relative table distances from beat to beat. Gaps between slices were seen in patients whose heart rate was $<$75 bpm (R-R interval $>$0.8 second). The workstation could deal with the interval variances and could interpolate the gaps. It took ≈30 minutes to prepare 3D animation, or 4D-CT-VG.

Our method will potentially provide assessment of left ventricular volumes, such as end-diastolic and end-systolic volumes, and ejection fraction in 3D fashion. The 4D-CT-VG will be more practical when a packaged software that can handle all procedures within a few minutes is developed. Recently released subsecond helical CT with multirow detectors will promote cardiac application of the helical CT.

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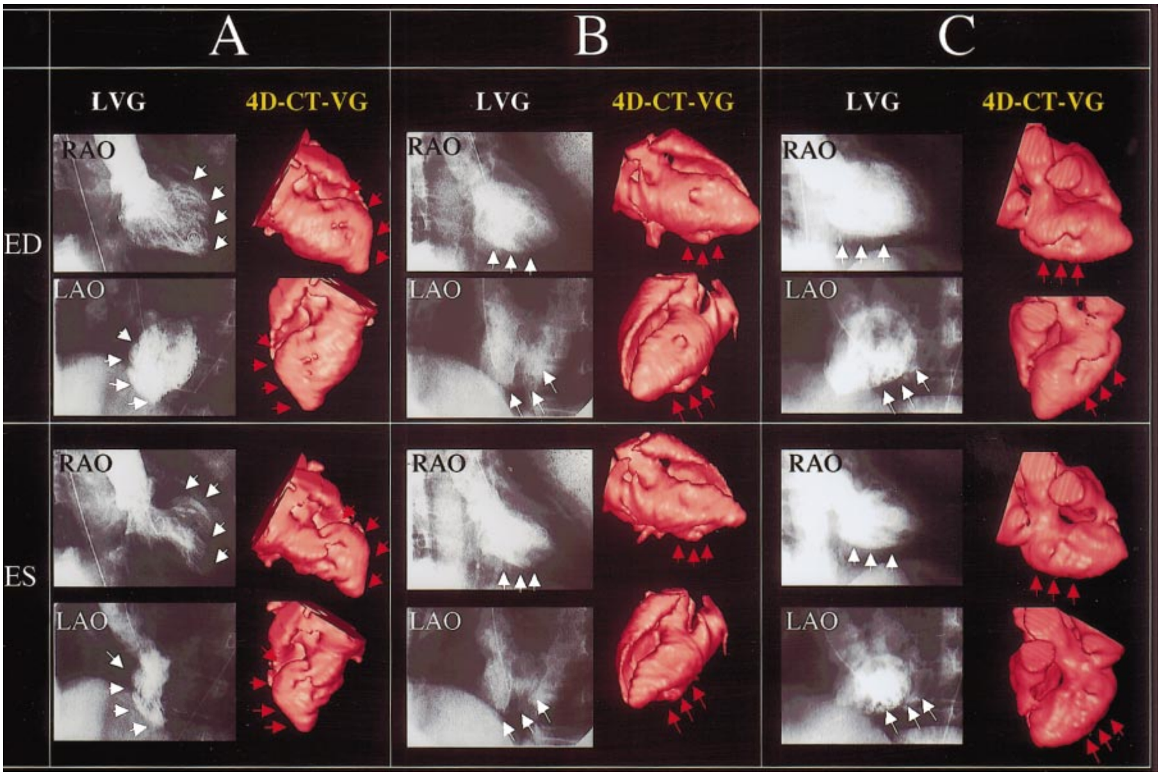

Conventional LVG and the corresponding 4D-CT-VG of 3 patients with acute myocardial infarction (A, broad anteroseptal wall; B, localized inferior wall; and C, inferolateral wall). Wall motion abnormalities (akinesis) in the infarct lesions evaluated by 4D-CT-VG were concordant with those observed by LVG (arrowheads). With 4D-CT-VG, observation of left ventricular wall motion is possible in any direction, interactively (postprocessing interactive manner). ED indicates end diastole; ES, end systole; RAO, right anterior oblique; and LAO, left anterior oblique.

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