



UNIVERSITY OF WEST ATTICA

DEPARTMENT OF BIOMEDICAL ENGINEERING

COURSE: PROBABILITIES, BIostatISTICS AND SYSTEM  
RELIABILITY

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# The correlation between CT MRI techniques on heart diseases' diagnosis

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## 1 Keywords

Biostatistics, analysis, anatomy, heart, CT, MRI, RAV (right atrium volume), systole, diastole

## 2 Introduction

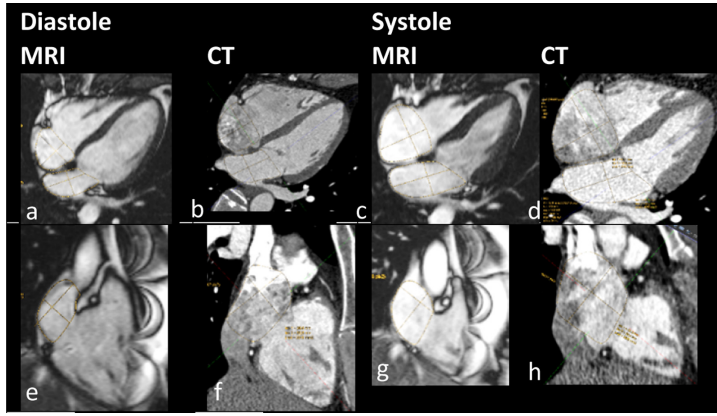
The aim of this assignment is to enlighten the differences between CT and MRI methods on heart diseases' diagnosis by using data of a statistic analysis. Studies have shown that monitoring of the RAV is of prognostic interest for cardiopulmonary diseases. RAV is estimated by measuring either single diameters, areas, or three-dimensional functional data sets. So, it is needed to be found a quick and reliable method to interpret the RAV. MRI is appropriate for volumetry of the heart due to natural high soft tissue contrast, free image plane placement lack of radiation and high temporal resolution. On the contrary, CT gives optimized contrast protocols, the high-speed scanning has enhanced image quality and radiation exposure will be diminished on an acceptable level.

## 3 Materials and methods

In this study 29 patients were examined by CT and MRI within the period of 90 days. These patients were supposed neither suffering from cardiac arrhythmia nor receiving beta-blockers. CT examinations were performed with a 64-slice dual source scanner and the patients were dispensed 20ml iopromide, followed by contrast bolus of 115ml and a 40ml saline bolus chaser. On MRI examinations, 21 patients were examined by retrospective gating (MRI data are acquired continuously) while 8 patients were examined by prospectively triggered sequential scan (MRI data are acquired only after a detection of a desired physiologic event). All scans were performed with a collimation of 64 x 0.6mm, 320 effective mAs, tube voltage was 100kV for BMI  $\leq 25$  kg/m<sup>2</sup> and 120kV for BMI  $> 25$  kg/m<sup>2</sup>, rotation time was 0,33 sec and reconstructed matrix 512 x 512.

## 4 Measurements

Both records were evaluated in end diastolic and, if possible, in end systolic phase. In order to assess data better, Simpson's method was applied. On this method, direct volumetry was performed by drawing free-hand regions of interest (ROI) in each slice in the right atrium in the 2-chamber plane. Some of heart's units like atrial appendages, vena cava, venus sinus and pulmonal veins were excluded. Each region of interest was multiplied with slice thickness and summed up. It was also done surrogate volume approximation by using the biplane method and the elipsoid method as seen on the picture.



Two doctors were put to measure surrogate diastolic RAV values by the images of CT and MRI. In MRI it was doable to measure only surrogate volume approximation of the 2-chamber 4-chamber view.

## 5 Statistical tools

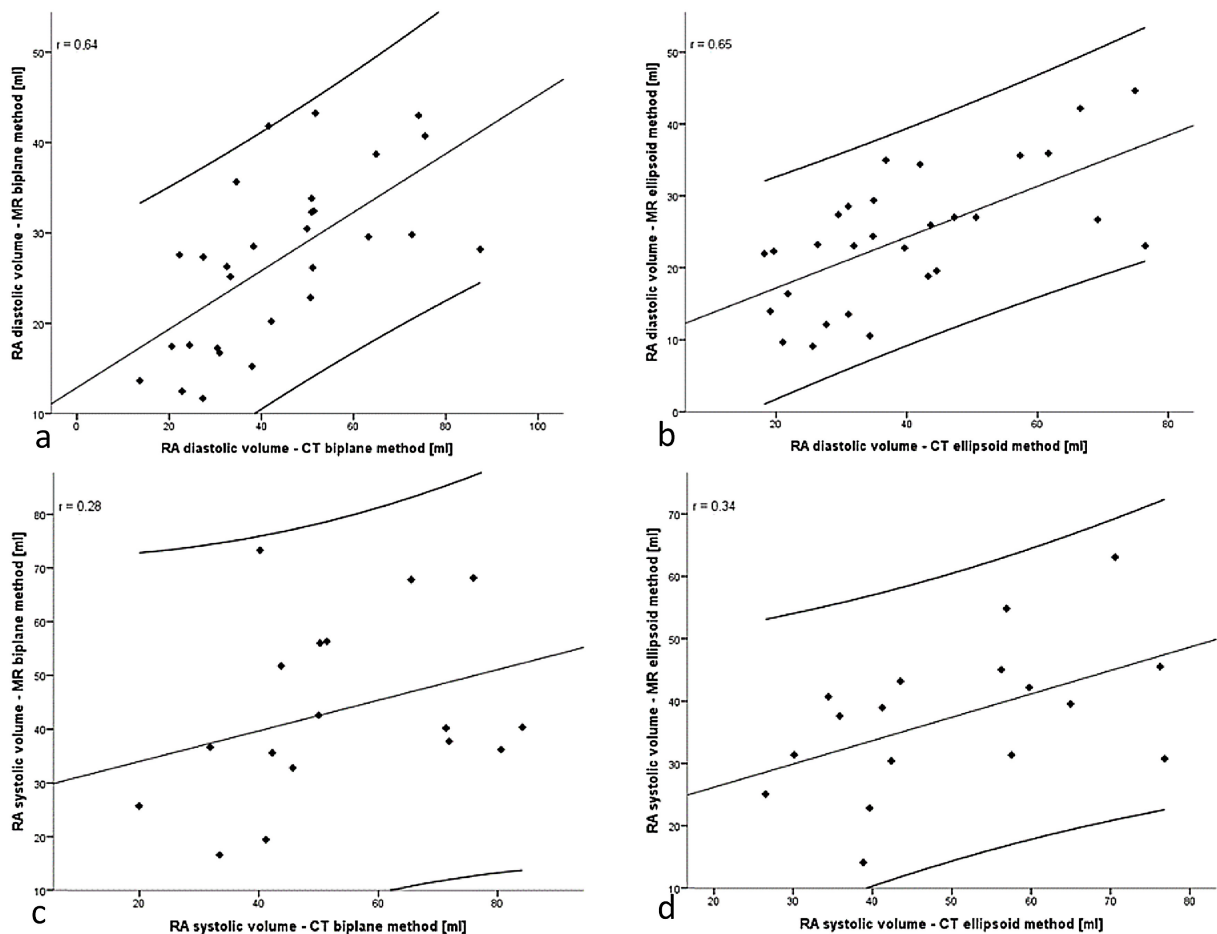
In order to detect significant differences between data, t-test was applied. Furthermore, to present the accuracy of measurements, Pearson's Lin's correlations were calculated. To analyze the agreement between data Bland-Altman plots were used. For all statistical analysis, a p-value of less than 0,05 was considered significant.

## 6 Results

29 patients underwent cardiac CT and MRI in an intervening period of  $17 \pm 20$  days. The majority of the examinations were done in a setting of chest pain in order to exclude coronary heart disease and myocarditis (23 patients). 2 patients were

examined for follow up of known coronary heart disease and 2 were examined for additional dilated cardiomyopathy. One of the patients was diagnosed with angiosarcoma of the right atrium and another with a chronic abscess near the aortic valve. 17 patients had both best systolic and diastolic CT images while 12 had only diastolic images documented. Mean value of the heart rate in CT was 67 while in the MRI was 72 ( $p=0,02$ ). Mean body surface was found  $1,9\pm0,2$  m<sup>2</sup>. Aortic diameter was documented in both examinations 22.00mm. CT and MRI volumetry of the right atrium is correlated on figure 2. Columns one and two show RA diastole and columns three and four show RA systole.

	r	Pc	r	Pc
CT Simpson's-CT biplane	0,8	0,76	0,82	0,72
CT Simpson's-CT ellipsoid	0,77	0,66	0,79	0,61
MRI-CT biplane	0,64	0,58	0,32	0,28
MRI-CT ellipsoid	0,65	0,76	0,51	0,34



As it appears on the Bland-Altman plots, the first two diagrams that show correla-

tion between methods on RAV in diastolic phase have bigger correlation than those on systolic phase. This happens probably due to small sample size. It is also noticeable that, bigger the Lin's or Pearson's correlation is, bigger the density of dots on the plot is. Generally, RAV values were lower in MRI compared to CT. This is of course in line with previous studies. Differences between values on CT and MRI arise from the fact that CT is recorded in inhalation while MRI is recorded in exhalation. Underlying a constant cardiac output, the filling of cardiac chambers is reduced in case of higher heart rate. Furthermore, in CT high flow could enlarge the right atrium.

## 7 Conclusions

The concordance between two methods is moderate and there are broad limits of agreement. Biplane method is a very useful tool for estimating atrial volumes, but it is susceptible to faults. The limitation of the study is that the data have been recorded in different days so there might be alteration in cardiac function. Multi-slice MRI examinations and optimized CT contrast injection protocols should be used in the future in order to get the ideal data within a short time.