Computed Tomography: Dimensions, Volumes and Mass

Semi-automatic quantification of aortic root progressive dilation by automatic co-registration of computed tomography angiograms: a preliminary comparison with manual assessment in Marfan patients

Dux-Santoy L.[1]; Teixido-Tura G.[1]; Ruiz-Munoz A.[1]; La Mura L.[2]; Valente F.[1]; Lopez-Sainz A.[1]; Galian L.[1]; Gutierrez L.[1]; Gonzalez-Alujas T.[1]; Sao-Aviles A.[1]; Ferreira Gonzalez I.[1]; Evangelista A.[1]; Rodriguez-Palomares JF.[1]; Guala A.[1]

[1]UNIVERSITY HOSPITAL VALL D" HEBRON, VHIR, UNIVERSTITAT AUTONOMA DE BARCELONA, Barcelona, Spain
[2]Federico II University, Department of Advanced Biomedical Sciences, Napoli, Italy

Funding Acknowledgements: Type of funding sources: Public Institution(s). Main funding source(s): Spanish Ministry of Science, Innovation and Universities Instituto de Salud Carlos III

Background. Dilation of the aortic root is a key feature of Marfan syndrome and it is related to the occurrence of aortic events and death. On top of maximum diameter, rapid annual growth rate is suggested by guidelines for indication of aortic root replacement. Current gold-standard for aortic root diameter assessment is manual quantification on multiplanar reformatted 3D computed tomography (CT) or magnetic resonance angiogram. However, inter- and intra-observer reproducibility are limited and different measurement methods, i.e. cusp-to-cusp and cusp-to-commissure, may be used in different clinical centres, leading to difficulties in the clinical assessment of progressive dilation.

Purpose. We aimed to test whether aortic root growth rate during follow-up can be reliably quantified by semi-automatic co-registration of two CT angiograms.

Methods. Seven Marfan syndrome patients, free from previous aortic surgery, with a total of 11 pairs of CT were identified. Manual assessment of six aortic root diameters (right-non coronary -RN- , right-left -RL- and left-non coronary -LN- cusp-to-cusp and R, L and N cusp-to-commissure) was obtained from all CTs by an experienced researcher blind to semi-automatic results. The thoracic aorta and the outflow tract were semi-automatically segmented in the baseline CT and commissure and cusps were manually located. A 10 mm-thick region of interest containing the aortic wall was automatically generated from segmentation boundary. Co-registration was obtained with three, fully-automatic steps. Firstly, baseline and follow-up CT scans were aligned by means of a rigid registration. Then, scans were co-registered with multi-resolution affine followed by b-spline non-rigid registrations based on mutual information metric. The transformation pertaining to the location of baseline commissure and cusps points was used to locate the same points in the follow-up scan (Fig. 1 top).

Results. Follow-up duration was 35 ± 22 (range 12-70.3) months. Automatic quantification of diameter growth during the follow-up was obtained in 62 out of 66 (94%) diameter comparisons. High Pearson correlation coefficients (R) and ICC were found between manual and semi-automatic assessment of growth rate, both for cusp-to-cusp and cusp-to-commissure diameters: R = 0.727 and ICC = 0.678 for RN; R = 0.822 and ICC = 0.602 for RL; R = 0.648 and ICC = 0.668 for LN; R = 0.726 and ICC = 0.711 for R; R = 0.911 and ICC = 0.895 for L and R = 0.553 and ICC = 0.482 for N. Scatter and Bland-Altman plots for all growth rates (Fig. 1) confirmed very good correlation (R = 0.810) but a slight tendency (R=-0.270) for underestimation at high growth rate. No correlation was found between follow-up duration and difference between techniques (R = 0.06).

Conclusions. Semi-automatic quantification of aortic root growth rate by co-registration of pairs of CT angiograms is feasible for follow-up as short as one year. Larger studies are needed to confirm these preliminary data.

Abstract Figure. CT measurements. Automatic vs manual.