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4D flow MRI: A Clinical Oriented Platform for The Evaluation of Cardiovascular Pathologies

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Introduction 4D flow MRI is an established technique able to acquire information of the complex *in-vivo* fluid-dynamic phenomena during a cardiac cycle. This technique inherently offers the possibility to identify sound fluid-dynamic markers for a prompt evaluation of several cardiovascular pathologies [1]. However, 4D flow is not currently used in clinical practice due to its laborious post-processing. The proposed work focused on the application of a fast, easy-to-use and clinical-oriented Matlab-based platform for the analysis of 4D flow datasets.

Materials and Methods To exploit the capabilities of the developed platform, we analysed a heterogeneous pool of patients: an aortic coarctation (AC, age: 13; sex: Male), a congenital Fontan (CF, age: 20; sex: Female), an ischemic left ventricle (ILV, age: 63; sex: Male). A healthy volunteer (HV, age: 26; sex: Male) was analysed as a control. 4D flow MRI acquisitions were performed on a 1.5 T Siemens. The acquisition parameters were chosen accordingly to the anatomical district and pathology (e.g., isotropic voxels spacing of 1.7 - 2.3 mm^3 and VENCs of 100-300 cm/s). The platform was adopted to investigate the effects of the different pathological fluid dynamics with respect to healthy conditions, in terms of flow rate waveforms, velocity peaks, jets eccentricity, vorticity and helicity fields, and wall shear stress profiles [2].

Results The comparison between patient datasets and the healthy control conditions highlighted significant differences, by means of fluid dynamics alterations. Specifically, high velocity and wall shear stress peaks (e.g. AC patient in the descending aorta), dissipative vortex formations (e.g. ILV patient during the diastolic filling phase) and asymmetries of blood venous return (CF patient) were observed.

Discussions and Conclusions The analysis of the heterogeneous pool of patients was able to prove the capabilities of the developed platform. Significant differences were found between the patients and the control subject, by means of both qualitative and quantitative data. In conclusion, our aim was to provide a reliable and comprehensive support for clinicians , in order to deepen the analysis of cardiovascular pathologies relying on the *in-vivo* non-invasive measurement of the 4D blood hemo-dynamics.

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