A NOVEL MULTIPLANE SCANNING STEREO PIV SETUP TO INVESTIGATE LEFT VENTRICULAR FLOW

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1. INTRODUCTION

Various experimental studies have been conducted to obtain a better understanding of the flow field in the left ventricle (LV). In particular, in vitro PIV studies have been performed to investigate the flow field in a 2D plane [1], or to reconstruct the 3D flow structures numerically from 2D velocity data [2].

The intraventricular flow, however, has a highly complex and unsteady fluid structure. In this work, we therefore present a novel experimental setup which allows 3D volume reconstruction of the flow field in a transparent LV membrane model.

2. MATERIALS AND METHODS

2.1 Stereoscopic scanning PIV

The developed multiplane scanning Stereo PIV system, consisting of two CCD cameras, is capable of acquiring the 3D velocity field within a volume of 80*70*80 mm^3 by assembling the velocity data from several parallel measurement planes. The cameras, the pulsed Nd:YAG laser and the external housing have been rigidly connected to a traversing mechanism equipped with a stepper motor. To eliminate the need to perform the complex and time consuming calibration in each measurement plane separately, the LV membrane is mounted inside the internal fixed transparent tank. This proposed system, partly based on the work of Yagi and co-workers [3], is further referred to as the 'Double Windows Prism' system.

2.2 Working fluid and cardiac cycle

A cardiovascular simulator was used to impose different physiological pressure and flow conditions. Mechanical bileaflet valves were mounted in the aortic and mitral position. A three component fluid consisting of sodium iodide, glycerol and distilled water (volume fraction 79:20:1) was used as a blood mimicking fluid.

3. RESULTS AND DISCUSSION

The aim of this work was to develop an experimental PIV system that would allow us to reconstruct the 3D LV flow field in different controllable and repeatable conditions. Figure 1 shows a preliminary reconstruction of the flow in the LV, obtained after interpolating the velocity data from several parallel planes (distance 2 mm). The images were obtained in a phase-locked manner through 100 pulsatile cycles during late diastole. We believe that this experimental setup will facilitate the interpretation of the complex LV flow and serve as a reference for *in vivo* and numerical studies.

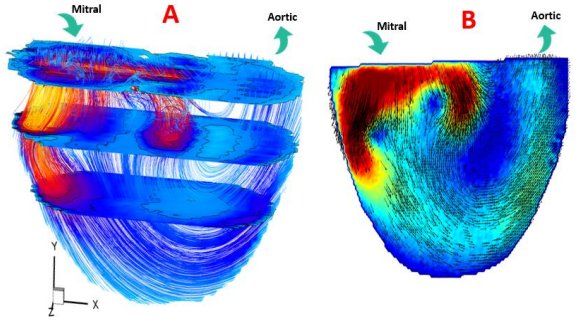

Figure 1: 3D streamlines in LV sac during the early diastole (A). The velocity vector field in one plane (B); the vectors (in black) represent the velocity magnitude, and the out-of-plane velocity component is color coded.

References

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