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## **Computer Assisted Annuloplasty Planning**

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Mitral regurgitation is one of the most diagnosed mitral valve diseases. The surgical treatment commonly includes the implantation of an annuloplasty ring onto the patient's mitral annulus to consolidate it. Shape and size of the used ring have an effect on the quality and durability of the performed mitral valve repair and should be chosen according to the patient's annular anatomy. However, in the clinical routine the commonly performed measurement and assessment of the patient's mitral annulus is often restricted to the visual judgment and personal experience of the surgeon.

In this work methods for a computer-assisted annuloplasty planning are proposed based on pre-operative transesophageal ultrasound data acquired in the clinical routine. It includes methods for the generation of 4D mitral annulus models using prior shape and pose knowledge. An average error of  $2.12 (\pm 0.27)$  mm was determined in the generated models, which is close to the average expert's standard deviation ( $1.86 \pm 0.32$  mm). The presented semi-automatic modeling is faster and more accurate than comparable methods, while being robust to low image quality and pathology. Tools for reproducible and comprehensible annular measurements based on the created models are proposed. Interesting findings from an empirical study based on 42 patients are presented, including the observation of a strong variability in the P1-segment of the mitral annulus for severe mitral regurgitation, which is commonly thought to be rarely affected by pathologies. The proposed planning method also includes the simulation of the individual annular deformation caused by annuloplasty rings. It is shown that an adaption of the ring shape according to a general pathological or patient-specific form causes a lower average and maximum tissue deformation throughout the heart cycle, which reduces the risk of ring dehiscence. Design tools and concepts for patient-specific annuloplasty rings are presented and it is shown that the production of patient-specific annuloplasty rings is possible at low costs (approximately € 300) and in acceptable time (about seven days).

The proposed methods and tools for modeling and assessment of the mitral annulus provide a fundament for patient-specific treatment and research on novel annuloplasty concepts.