Deformation controlled load application in heart valve tissue-engineering

Citation for published version (APA):
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Introduction
Mechanical behavior of tissue-engineered heart valves still needs improvement when native aortic valves are considered as a benchmark [1]. Although it is known that cyclic straining enhances tissue formation, optimal loading protocols have not been defined yet.

Objective
To develop a bioreactor system for heart valve culture in which leaflet deformation is assessed and controlled in real time and non-invasively.

Materials & Methods
A combined experimental-numerical approach [2] was developed to assess volumetric and local leaflet deformation of the cultured heart valve in diastolic configuration (Fig. 1).

Results & Discussion
Good correspondence between the measured and the prescribed deformation values was found in both experiments (Fig. 4a, b). Mean relative error values of all valves did not exceed 5%. However, controlled load application was not possible for heart valves having leak flows larger than ~10 ml/min (Fig. 4c, d).

Conclusion
This bioreactor system has promising possibilities to systematically elucidate the effects of temporal loading patterns on tissue properties, and to develop an optimal conditioning protocol for tissue-engineering of aortic heart valves.

References
1. Mol A et al., Circulation 2006; 114(19):152-158.
2. Kortsmit et al., Submitted for publication.