BENDING STIFFNESS OF STENT GRAFT BY 4-POINT BENDING TEST

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ABSTRACT

This paper aims to clarify the mechanism of stent graft migration. To discuss biomechanical mechanism of stent graft migration, we identified the bending stiffness of the stent graft by 4-point bending test. We measure reaction force to forced load in 0 to 90 degrees in several types of stent graft. In addition to The results showed the bending properties of stent graft depend on the structure of stent graft. By using the elucidated mechanical properties of stent graft, we developed finite element models of stent graft and validate the models. Those validated model will be used for stent graft migration simulation to clarify the criteria to avoid stent graft migration after EVAR.

1. INTRODUCTION

Endovascular abdominal aortic aneurysm repair (hereafter refered to as EVAR) is less invasive and has brought good short-term outcomes. In EVAR, a stent graft is guided and placed in abdominal aortic aneurysms (hereafter refered to as AAA) using catheter, and spread out to create an internal bypass in the AAA. However, the distal end of stent graft sometimes migrates upward and occurs an endoleak especially in case of AAA with severe angulation. This means that aneurysm rupture after EVAR. It is assumed that AAA flexion have effect on such an endoleak. In this study, we conducted 4-point bending test for several stent grafts and clarify the mechanical properties of stent grafts to discuss the mechanism of endleak at the distal end of the stent graft for AAA.

2. EXPERIMENT

2.1 Experimental Apparatus

Stent graft set in acryl pipe and fixing tape; therefore, run 4-point bending test. Experimental apparatus indicated in Figure 1. The two inner supporting points moves upward to apply bending force to a specimen. The indenter pushed the specimen upward until the bending angle reaches to 90 degrees. The load was measured by the loadcell connected with the indenter. We evaluated three types of specimens as shown in Figure 3; Zenith type (Zenith-A with 20mm-length including one-stented segment, and Zenith-B with 25mm-length including two stented segments), and Excluder type (30mm-length). Acryl pipes with Teflon tape were inserted into the stent grafts to extend the length and attached on the experimental apparatus as shown in Figure 2. The displacement of the center of the specimen was measured by a laser displacement meter. Also we checked the behavior of the specimen by recording video and image processing.

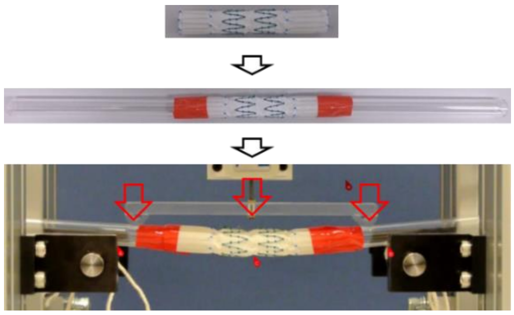

Fig. 1 Experiment Apparatus

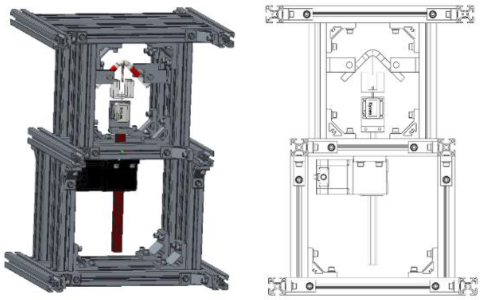

Fig. 2 Set up for stent graft 4-point bending test

Fig. 3 Stent graft

3. RESULTS

Figure 4 shows the reaction force-displacement curves of three types of specimens. Zenith-A showed significant nonlinearity due to the local buckling at the both ends of the stented segment. On the other hand, force-displacement curves of Zenith-B and Excluder were able to be assumed linear properties because the multiple stented segments make the stent graft deformed gradually.

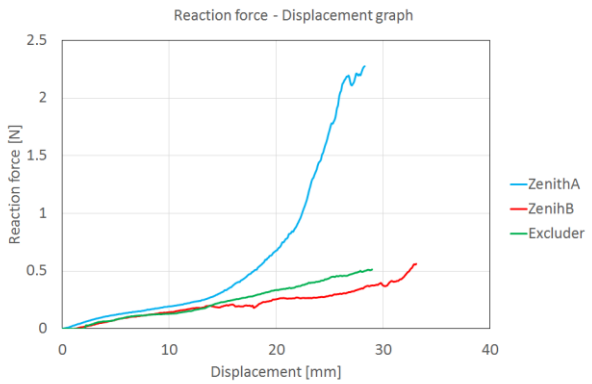

Fig. 4 Force-displacement curves of stent grafts

4. CONCLUSION

Mechanical properties of stent grafts were evaluated by 4-point bending test. The results showed linear force-deformation curves for stent grafts which have multiple stented segments, while a single stented segment model was nonlinear properties. Such a nonlinearity can be caused by local buckling on the boundary of the stented segment.

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