The aim of the study was to detect inter-relations between the mechanical conditions and material properties of abdominal aortic aneurysm (AAA) wall and the underlying local gene expression of destabilizing inflammatory, proteolytic, and structural factors. During open surgery, 51 tissue samples from 31 AAA patients were harvested. Gene expression of collagen types I and III, inflammatory factors CD45 and MSR1, proteolytic enzymes matrix metalloproteinases 2 and 9, and tissue inhibitor of matrix metalloproteinase 1 was analyzed by reverse transcription-polymerase chain reaction. Material properties of corresponding AAA tissue samples were assessed by cyclic sinusoidal and destructive testing. Local mechanical conditions of stress and strain were determined by advanced nonlinear finite element analysis based on patient-specific three-dimensional AAA models derived from preoperative computed tomography data. In the AAA wall, all parameters analyzed were significantly expressed at the messenger RNA level. With respect to mechanical properties of the aneurysmatic wall, expression of collagen III correlated with the stiffness parameter $\sigma$ ($r = -0.348; P = 0.017$), and matrix metalloprotease 2 correlated with the stiffness parameter $\sigma$ and wall strength ($r = -0.438$ and -0.593; $P = .005$ and $P< .001$).
Furthermore, significant relationships were observed between local AAA diameter and the expression of CD45, MSR1, and tissue inhibitor of matrix metalloproteinase 1 (r = 0.285, 0.551, 0.328; P< .05). However, we found no inter-relation of local calculated wall stresses and strains with gene expression. Our results show for the first time that gene expressions of destabilizing factors within AAA tissue might be correlated to geometric and mechanical properties of the AAA wall. However, we found no influence of local mechanical conditions on gene expression of these factors. Therefore, these preliminary results are still ambiguous.