Morphology and Biomechanical Index Predict the Rupture Location and Rupture Risk of Abdominal Aortic Aneurysm

Wei Wang, PhD, Central South University, Changsha, Hunan, China

Objective:

The objective of this study is to evaluate the predictive value of biomechanical and morphological indices in assessing the rupture location and rupture risk of abdominal aortic aneurysms (AAA), and to develop a nomogram that incorporates these indices to improve the accuracy of predicting AAA rupture risk.

Methods:

Patient groups with RAAA and IAAA were matched based on diameter, age, and sex. AAA morphology was analyzed from CT model segmentation, and biomechanical indices were determined using FSI. We conducted paired t-tests or Wilcoxon rank sum tests for statistical comparison. Multivariate and LASSO regression identified predictive factors, and a nomogram was developed. The model's accuracy was evaluated using the area under the curve (AUC).

Results:

In our study with 66 RAAA and 66 IAAA patients, the Aortic Neck Length (ANL) of the IAAAs was 1.23 times that of the RAAAs ($P = 0.0015$), and the tortuosity of the RAAAs was 1.4 times that of the IAAAs ($P = 0.0005$). The Wall Shear Stress (WSS) of the IAAAs was 1.22 times that of the RAAAs ($P = 0.0424$). The Peak Wall Stress (PWS), Maximum Deformation (MD) and Peak Wall Rupture Index (PWRI) of the RAAAs was 1.18, 1.32 and 1.27 times that of the IAAAs ($P = 0.0158, 0.0036, 0.0071$). The MD position closely matched RAAA rupture locations (94.12%). Four variables were selected for a nomogram, predicting AAA rupture with an AUC of 0.7604 (95% CI, 0.6653 0.8556) and an internal validation AUC of 0.8051 (95% CI, 0.6400 0.9703).

Conclusion:

In this study, we found that the location of MD may be of value in predicting the rupture location of AAA, and a nomogram including four morphological and biomechanical indexes is constructed, which may be useful in predicting abdominal aortic rupture risk.