

- **Hybrid ML-mechanics framework:** Novel integration of deep learning with computational solid mechanics for real-time aortic biomechanics prediction.
- **Patient-specific dataset pipeline:** Automated generation methodology incorporating individualised geometries, material properties, and haemodynamic data.
- **Stress-strain surrogate model:** Neural network architecture trained to predict spatial distributions of Second Piola-Kirchhoff stress and Right Cauchy-Green strain tensors across heterogeneous patient anatomies.
- **Clinical translation efficiency:** Demonstrates orders-of-magnitude computational acceleration compared to conventional finite element analysis, enabling point-of-care clinical applicability.