Life Science

Medical-Engineering Collaboration for Therapeutic Support and Medical Device Evaluation Using Numerical Simulation and AI

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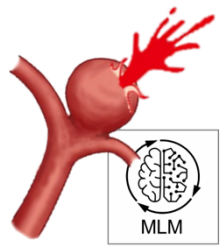
Purpose of Research

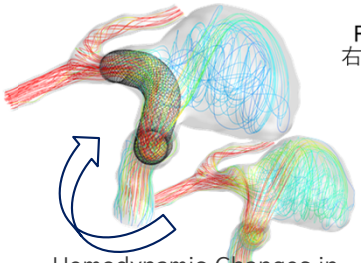
In cardiovascular, cerebrovascular, and respiratory diseases, blood flow and airflow play critical roles in disease progression and treatment outcomes. However, conventional medical devices alone cannot directly capture these details. This research aims to analyze hemodynamic and aerodynamic conditions using numerical simulations and to integrate the results with conventional medical information for further analysis through statistical methods and AI techniques. The goal is not only to deepen the understanding of pathophysiology but also to enable risk assessment and optimization of treatment strategies. Furthermore, these approaches are applied to the performance evaluation and design support of medical devices, thereby contributing both to clinical decision-making and to the development of new technologies through medical–engineering collaboration.

Summary of Research

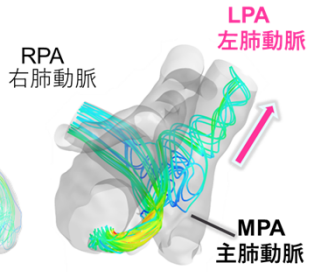
In the field of intracranial aneurysms, we are working on rupture risk prediction using AI, treatment outcome prediction based on hemodynamic changes through Flow Diverter Stent (FDS) and Woven EndoBridge (WEB) deployment simulations, as well as the software implementation of these methods. In the field of cardiology, we analyze postoperative circulation and predict outcomes following central shunt procedures for pediatric heart disease. In the field of rhinology, we are conducting quantitative evaluations of treatment effects using vibrating nebulizers.



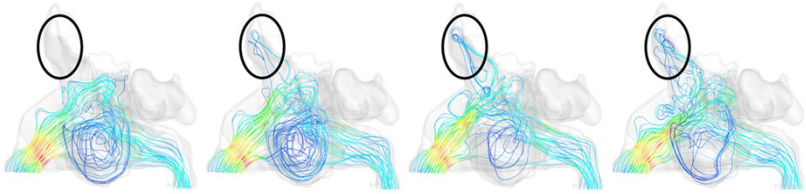
AI-Based Rupture Risk Prediction of Intracranial Aneurysms



Hemodynamic Changes in Flow Diverter Stent (FDS) Deployment Simulation



Hemodynamics After Central Shunt Surgery



Airflow Changes with Varying Inlet Frequencies of Vibrating Nebulizer

Comparison with Conventional or Competitive Technologies

- Quantifying treatments once based on clinical intuition
- Simulation enables safer and more effective therapies

Expected Applications

- Effective treatment planning and device development enabled by simulation
- Reducing reliance on physician intuition to standardize care and bridge regional gaps

Challenges in Implementation

- More clinical data needed to validate analyses and prediction accuracy
- Stronger systems for software development and regulatory readiness needed

Points

- Medical–engineering collaboration based on numerical simulation and AI analysis
- Broad applications spanning intracranial aneurysms, cardiac, and respiratory diseases
- Direct translation from clinical support to medical device design and evaluation

What We Expect from Companies

We are actively seeking collaborative research on the development and evaluation of medical devices. With multiple successful collaborations already achieved, we look forward to further expanding industry–academia partnerships.

Future Developments

We are advancing large-scale data analysis through multi-institutional collaboration and promoting the software implementation of simulation technologies, aiming for integration into clinical practice and medical device development. We are actively seeking partnerships with medical institutions and device manufacturers for collaborative research.

- Associated System: NEDO, AMED, BRIDGE, etc.
- Awards: JSPS Ikushi prize, EMBS Paper Competition, and others (15 in total)
- Intellectual Property: JP Patent Application No. 2022-035086, 2021-155882
- Prototype: Prototype Software of WEB and FDS Deployment Simulation
- Sample: 3D-printed models of various organs

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