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Rupture Prediction in Aneurysms using CFD

MANCHESTER 1824
The University of Manchester

01 Aneurysms

- Swelling in the wall of a blood vessel, commonly develop along the aorta and brain
- Their **irregular size, shape, and growth** make predicting an aneurysm rupture challenging

EVERY **18** MINUTES a brain aneurysm ruptures [1]

1 IN **50** PEOPLE have an unruptured brain aneurysm [2]

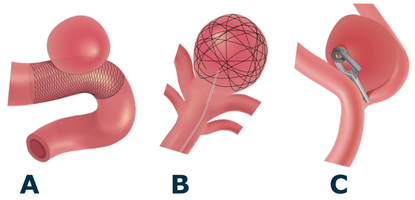
3% of adults in the UK have a brain aneurysm [2]

50% of ruptured aneurysms prove FATAL [1]

02 Background

Treatment Options:

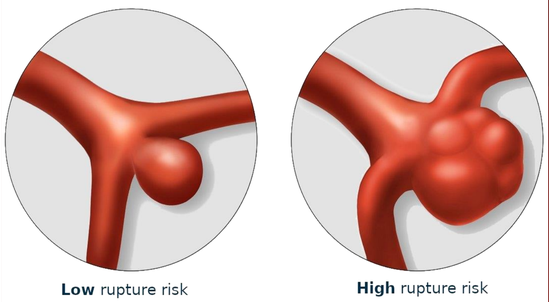
A. Flow Diversion Stent
B. Endovascular Coiling
C. Clipping



This study will cover the use of stents and coiling in intracranial (brain) aneurysms

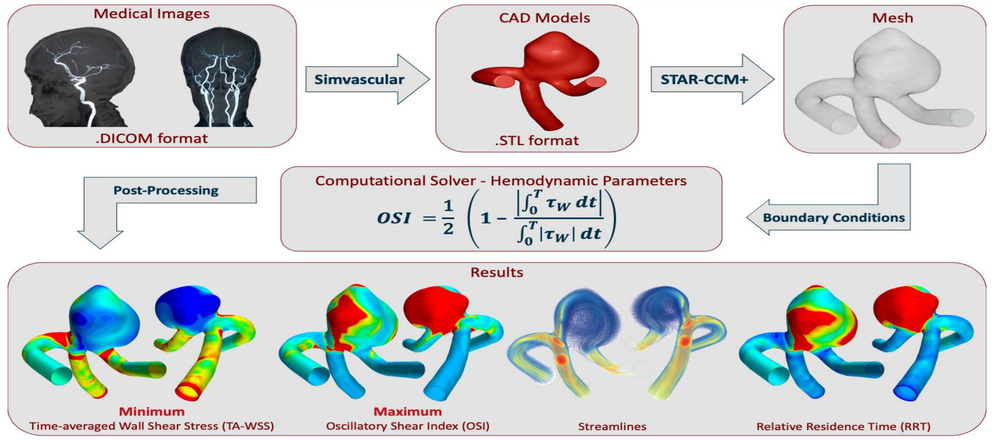
03 Aims

- Improve patient management systems used by the NHS, by **prioritizing high risk** aneurysms for surgery
- Accurately **calculate the chance** of an aneurysm **rupture**
- Personalised and tailored treatment for each unique aneurysm



04 Methodology

1. Patient specific medical images (MRI / X-RAY / Angiograms) are generated
2. Converted to a CAD model using **SimVascular**
3. Mesh generated on **STAR-CCM+**
4. Computational solver set to implicit unsteady, with **varying velocity profile**
5. Simulation of WSS, TA-WSS, OSI, and Streamlines
6. **Minimum** TA-WSS and **Maximum** OSI are pointers towards the rupture location
7. Post-processing of results to produce in-silico data
8. Verification of results using in-vitro tests



05 Results

	TA-WSS	OSI	Streamlines
Case 1	Case 1 minimum TA-WSS is **double** that of Case 2 TA-WSS (Pa) < 0.485 — 1.014 — > 1.543	Case 1 maximum OSI is **half** that of Case 2 OSI < 0 — 0.0035 — > 0.007	
Case 2	Actual Rupture Location TA-WSS (Pa) < 0.2 — 6.7 — > 13.2	OSI < 0 — 0.0073 — > 0.0146	
Case 2 with stent	Stents increased minimum TA-WSS by a factor of **3** TA-WSS (Pa) < 0.67 — 11.02 — > 21.37	Stents decreased maximum OSI by a factor of **5** OSI < 0 — 0.00063 — > 0.00126	
Case 2 with coil	Coils increased minimum TA-WSS by a factor of **6** TA-WSS (Pa) < 1.32 — 13.16 — > 25	Coils decreased maximum OSI by a factor of **10** OSI < 0 — 0.0006 — > 0.0012	

06 Conclusions

- Designed and simulated coils and stents inside an aneurysm
- Correctly predicted rupture location of an aneurysm
- Reduced the need for an angiogram post-surgery

07 Future Work

- Develop more accurate endovascular coil simulations
- Verify in-silico simulations with in-vitro data
- Develop Machine Learning algorithm for classification of aneurysms and rupture risk

08 References

[1] The most often employed current cerebral aneurysm treatment methods', *ResearchGate*. Available at: https://www.researchgate.net/figure/The-most-often-employed-current-cerebral-aneurysm-treatment-methods-Source-several_fig3_274637399
[2] Brain Aneurysm Foundation (n.d.) 'Statistics and facts', *Brain Aneurysm Foundation*. Available at: https://www.bafound.org/statistics-and-facts/