

# Comparison of Flow Patterns of Different Stents within a Simulated Disease Model

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## Introduction

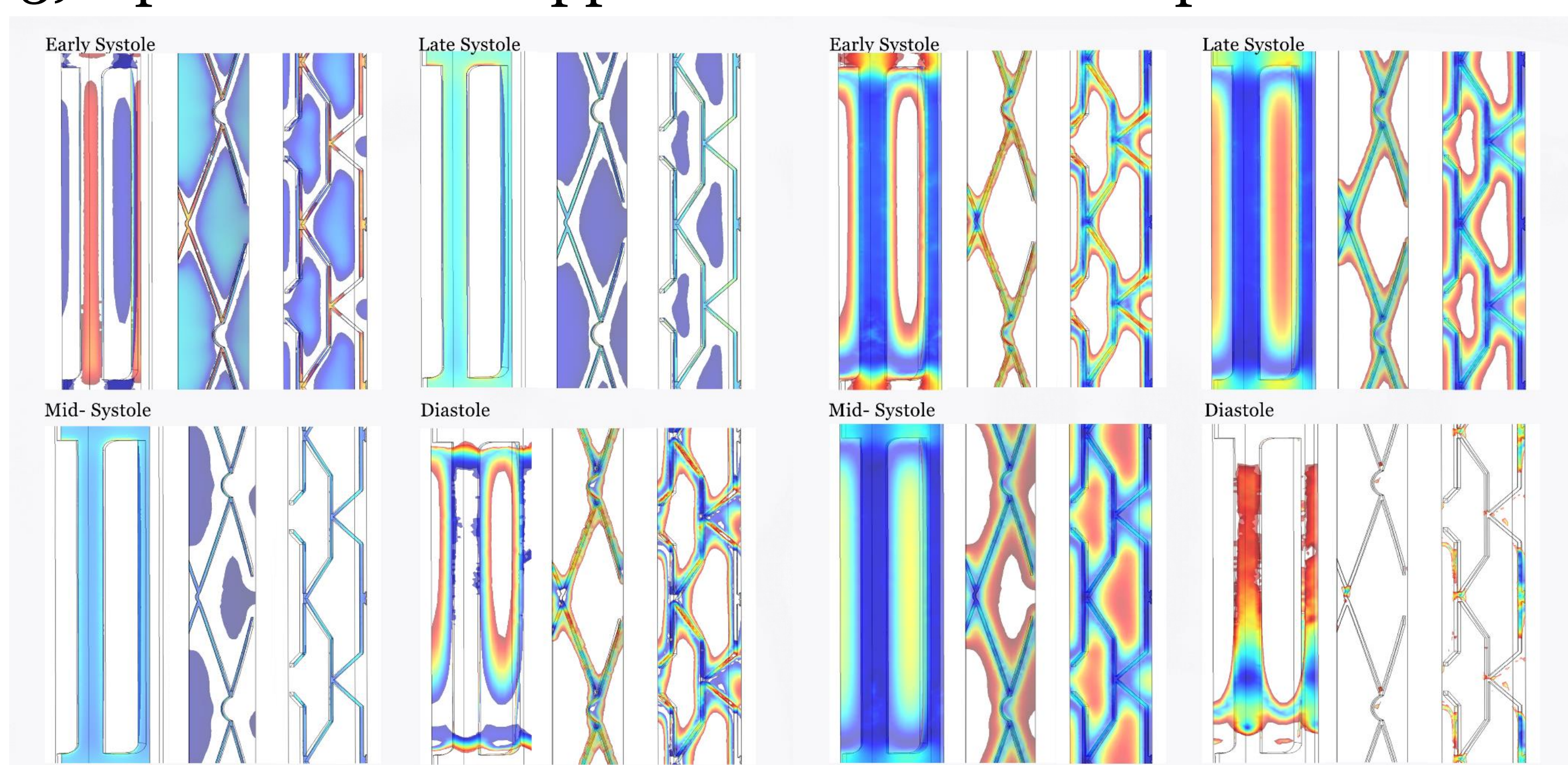
- Cardiovascular Disease is a prevalent health problem among Singaporeans, a rising number of PCI procedures has been highlighted from years 2007-2012[1].
- This also means more PCI patients would undergo restenosis procedures in the near future as their stents cease functioning due to restenosis rates.
- One possibility is current stent simulation studies are inept in predicting success rates of PCI treatment. Current studies have set current restenosis criteria based on velocity flow and conventional testing of stent performance in a straight vessel might not be accurate[2,3].
- Aim is to perform a CFD study to compare the performance of 3 different stents under varying geometrical, velocity and pressure conditions to investigate the WSS change.

## Methodology

- 3 Different stents were put into 2 geometry models, one straight tube & the other a curved entrance vessel.
- The stents included an Open-cell stent, one Closed-cell stent and a Palmaz- Schatz stent model.
- Geometry models were run in COMSOL Multiphysics with a normal mesh used.
- Flow is taken as be non-Newtonian Carreau model as suggested in a study of aortic aneurysm.
- Areas of Wall Shear Stress and potential deposition areas were also identified in the results.

## Result

- In straight tube geometry:
  - 1) Observed deposition area along the stent proximity persists throughout cardiac cycle
  - 2) Size of strut is a factor in deposition area
  - 3) Open Cell Stent appears to have the best performance

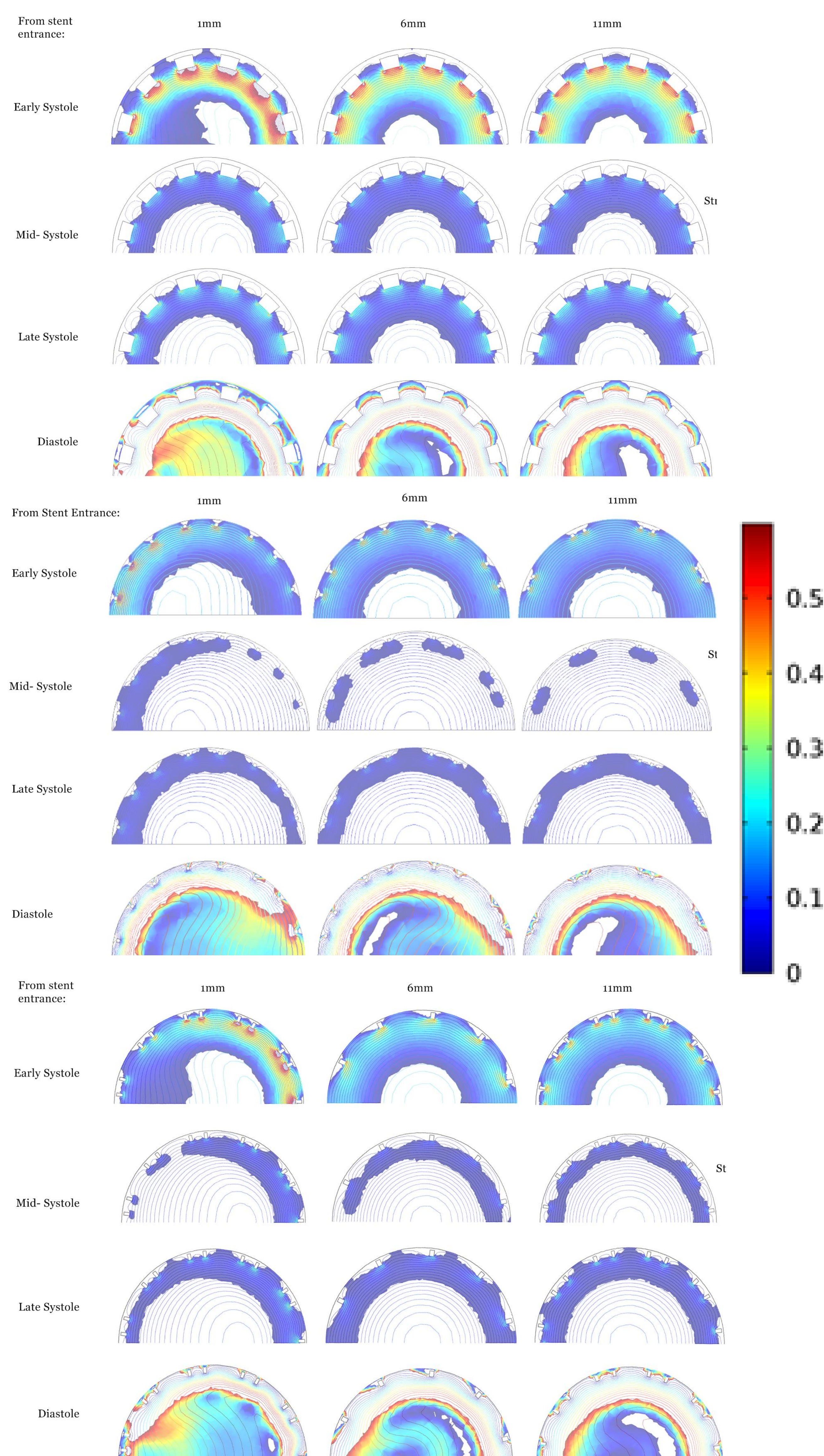


Close up of Wall shear Stress (0.5-2.5Pa, Left) and Deposition area (<0.5Pa, right) at 4 time points in a cardiac cycle.

## Reference

- [1] "PCI Clinical Outcomes," <https://www.nhcs.com.sg/patientcare/clinicaloutcomes/pci/Pages/Home.aspx>. [Accessed 29 Nov 2016].
- [2] M. Damon S. Pierce and M. Eric B Rosero, "Open-Cell Stent vs Closed-cell stent design differences in blood flow velocities after carotid stenting," *Journal of Vascular Surgery*, vol. Mar 2009, pp. 602-606, 5 Oct 2008.
- [3] C. Chiastra, F. Migliavacca, M. A. Martinex and M. Malve, "On the necessity of modeling fluid-structure interaction for stent coronary arteries," *Journal of the Mechanical Behaviour of Biomedical Materials*, 12 Feb 2014.

## Result



Wall Shear Stress (WSS), Pa

- In curved Entrance geometry:
  - 1) Size of struts affect deposition seen in cross sections
  - 2) Layout of struts affect the Low WSS formation at proximal end of stent
  - 3) Centre of the vessel marked with low wall shear stress areas due to more consistent velocity flow

## Conclusion

From this study, we can conclude vessel geometry and stent structure will affect low WSS areas distribution, which would lead to plaque formation in those areas in the future. Patient vessel morphology and intended stent information must be present before a conclusive hypothesis of PCI success can be made.