Vijay Vedula

Contact Information

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Research Interests

Cardiovascular biomechanics, cardiac multiphysics modeling, computational fluid dynamics, fluid-structure interaction

Education

Ph.D., Mechanical Engineering, Johns Hopkins University — Jan 2015
Dissertation: *Image-based computational modeling of intracardiac flows*
Advisor: Prof. Rajat Mittal

M.Tech., Aerospace Engineering, Indian Institute of Technology Kanpur, India — Jun 2009

B.Tech., Mechanical Engineering, National Institute of Technology Trichy, India — May 2007

Employment

Columbia University, Mechanical Engineering, New York, NY
Assistant Professor, Jan 2020 - present

Stanford University, Pediatrics, Stanford, CA
Postdoctoral research associate, Jun 2015 - Dec 2019

UC San Diego, Mechanical and Aerospace Engineering, San Diego, CA
Postdoctoral research associate, Feb 2015 - June 2015

Johns Hopkins University, Mechanical Engineering, Baltimore, MD
Graduate research assistant, Aug 2010 - Feb 2015

GE India Technology Center, Bangalore, India
Engineer, Dec 2009 - Aug 2010

Tridiagonal Solutions Pvt. Ltd., Pune, India
CFD Engineer, Aug 2009 - Dec 2009

Awards and Honors

Theodore von Kármán Fellowship, RWTH Aachen University, 2018.

Child Health Research Institute Grant & Postdoctoral Fellowship, Stanford University Medical School, 2016-2017.

NSF-sponsored Young Investigator & Travel Award, 5^{th} Engineering Frontiers Conference on Pediatrics and Congenital Heart Disease, Orlando, Florida 2016.

Gordon L. and Beatrice C. Bowles Fellowship, Johns Hopkins University, 2010.

I.I.T. Kanpur Academic Excellence Award, Indian Institute of Technology Kanpur, 2009.

General Electric (GE) Foundation Scholar-Leader 2008.

Publications (since Jan 2020)

Manuscripts in preparation:

Chen, Y., Anzai, I., Bacha, E., **Vedula, V.***, and Kalfa, D.*, "A predictive personalized computational model for patients with borderline left ventricles". *in preparation for Journal of Thoracic and Cardiovascular Surgery, .* (***co-corresponding authors**).

Chen, Y., Anzai, I., Kalfa, D., and **Vedula, V.**, "Uncertainty quantification in predictive virtual surgery hemodynamic models for patients with borderline left ventricles". *in preparation for International Journal of Numerical Methods in Biomedical Engineering.*

Chen, Y., Zhai, H., Ni, Y., Takayama, H., and **Vedula, V.**, "Effect of myocardial motion on coronary hemodynamics using multiscale modeling". *in preparation for Annals of Biomedical Engineering.*

Shi, L., Chen, I.Y., Takayama, H., and **Vedula, V.**, "An optimization framework to quantify passive biventricular myocardial parameters from time-dependent image data". *in preparation for Journal of Computational Physics.*

Shi, L., Chen, Y., and **Vedula, V.**, "A rotation-free Kirchhoff-Love thin shell formulation for cardiovascular applications". *in preparation for Computer Methods in Applied Mechanics and Engineering.*

Shi, L., Takayama, H., and **Vedula, V.**, "A graph neural networks (GNNs)-based surrogate model for personalized biventricular cardiac mechanics". *in preparation for Computer Methods in Applied Mechanics and Engineering.*

Publications by trainees (underlined) and from collaborations at Columbia:

Watson, C., Saaid, H., **Vedula, V.**, Cardenas, J.C., Henke, P.K., Nicoud, F., Xu, X.Y., Hunt, B.J. and Manning, K.B., 2023. Venous Thromboembolism: Review of Clinical Challenges, Biology, Assessment, Treatment, and Modeling. *Annals of Biomedical Engineering*, **52**, pp.467-486.

Hayashi, H., Singh, S.K., Hahn, R.T., Akita, K., Kurlansky, P., Sun, J., **Vedula, V.**, Leb, J.S., Shimada, Y.J., Weiner, S.D. and Takayama, H., 2024. Mitral regurgitation mechanisms related to systolic anterior motion in hypertrophic cardiomyopathy. *Journal of Thoracic Disease*, **16**(1), p.27.

Li, R.L., Russ, J.B., Pierre-Louis, P., Kossar, A.P., Gibson, I., Paschalides, C., Herschmann, A.R., Ferrari, G., Bacha, E., Waisman, H., **Vedula, V.**, Kysar, J.W. and Kalfa, D., 2023. In vitro proof of concept of a first-generation growth-accommodating heart valved conduit for pediatric use. *Macromolecular Bioscience*, 2300011.

Anzai, I., Hayashi, H., Nguyen, S., **Vedula, V.**, Leb, J.S., Shimada, Y.J., Weiner, S.D., Takayama, H., 2022. The septal band: how imaging and 3-dimensional printing guides septal myectomy. *Innovations: Technology and Techniques in Cardiothoracic and Vascular Surgery*, p.15569845221120039.

Yamabe, T., Ginns, J., **Vedula, V.**, Leb, J.S., Shimada, Y.J., Weiner, S.D. and Takayama, H., 2022. Left ventricular remodeling following septal myectomy in hypertrophic obstructive cardiomyopathy. *JTCVS Open*, **11**, pp.105-115.

Russ, J.B., Li, R.L., Herschman, A.R., Waisman, H., **Vedula, V.**, Kysar, J.W. and Kalfa, D., 2021. Design optimization of a cardiovascular stent with application to a balloon expandable prosthetic heart valve. *Materials & Design*, **209**, p.109977.

Publications from professional service (open-source software contribution):

Bazzi, M.S., Balouchzadeh, R., Pavey, S.N., Quirk, J.D., Yanagisawa, H., **Vedula, V.**, Wagenseil, J.E. and Barocas, V.H., 2022. Experimental and mouse-specific computational models of the Fbln4^{SMKO} mouse to identify potential biomarkers for ascending thoracic aortic aneurysm. *Cardiovascular Engineering and Technology*, pp.1-15.

Wang, H., Uhlmann, K., **Vedula, V.**, Balzani, D. and Varnik, F., 2022. Fluid-structure interaction simulation of tissue degradation and its effects on intra-aneurysm hemodynamics. *Biomechanics and Modeling in Mechanobiology*, **21**, pp.671-683.

Wang, H., Balzani, D., **Vedula, V.**, Uhlmann, K. and Varnik, F., 2021. On the potential self-amplification of aneurysms due to tissue degradation and blood flow revealed from FSI simulations. *Frontiers in Physiology*, p.2164.

Publications from postdoc-faculty transition:

Motonaga, K.S.†, **Vedula, V.**†, Marsden, A., Chubb, H., Goodyer, W., Ceresnak, S., Feinstein, J. and Dubin, A., Is there a role for cardiac resynchronization therapy in pediatric idiopathic pulmonary hypertension?: A study of the electrical activation patterns utilizing 3D mapping, *manuscript under preparation.* ($\dagger$ **equal contribution**).

Brown, A.L., Salvador, M., Shi, L., Pfaller, M.R., Hu, Z., Harold, K.E., **Vedula, V.**†, and Marsden, A.†, A modular framework for implicit 3D-0D coupling in cardiac mechanics, *Computer Methods in Applied Mechanics and Engineering*, **421**, p.116764. († **co-corresponding author**).

Zhu, C.†, **Vedula, V.**†, Parker, D., Wilson, N., Shadden, S. and Marsden, A., 2022. *svFSI*: A multiphysics package for integrated cardiac modeling, *Journal of Open Source Software*, **7**(78), p.4118. († **equal contribution**).

Roustaei, M., Baek, K.I., Wang, Z., Cavallero, S., Satta, S., Lai, A., O'Donnell, R., **Vedula, V.**, Ding, Y., Marsden, A.L. and Hsiai, T., 2022. Computational simulations of the 4-D microcirculatory network in zebrafish tail amputation and regeneration. *Journal of the Royal Society Interface*, **19**, p.20210898.

Chen, I.†, **Vedula, V.**†, Malik, S., Liang, T., Chung, K., Nguyen, P., Sayed, N., Tsao, P., Giacomini, J., Marsden, A.* and Wu, J.*, 2021. Preoperative computed tomography angiography reveals leaflet-specific contribution to aortic stenosis influenced by local coronary factors, *Circulation: Cardiovascular Imaging*, **14**(12), pp.1122-1132. († **equal contribution**).

Publications (before Jan 2020)

Bäumler, K., **Vedula, V.**, Sailer, A.M., Seo, J., Chiu, P., Mistelbauer, G., Chan, F.P., Fischbein, M.P., Marsden, A.L. and Fleischmann, D., 2020. Fluid-structure interaction simulations of patient-specific aortic dissection. *Biomechanics and Modeling in Mechanobiology*, **19**(5), pp.1607-1628.

Hsu, J.J., **Vedula, V.**, Baek, K.I., Chen, C., Chen, J., Chou, M.I., Lam, J., Subhedar, S., Wang, J., Ding, Y. and Chang, C.C., 2019. Contractile and hemodynamic forces coordinate Notch1b-mediated outflow tract valve formation. *Journal of Clinical Investigation Insight*, **4**(10).

Lee, J.†, **Vedula, V.**†, Baek, K.I., Chen, J., Hsu, J.J., Ding, Y., Chang, C.C., Kang, H., Small, A., Fei, P. and Chuong, C.M., 2018. Spatial and temporal variations in hemodynamic forces initiate cardiac trabeculation. *Journal of Clinical Investigation Insight*, **3**(13). († **equal contribution**).

Abiri, A., Ding, Y., Abiri, P., Packard, R.R.S., **Vedula, V.**, Marsden, A., Kuo, C.C.J. and Hsiai, T.K., 2018. Simulating developmental cardiac morphology in virtual reality using a deformable image registration approach. *Annals of Biomedical Engineering*, **46**(12), pp.2177-2188.

Vedula, V., Lee, J., Xu, H., Kuo, C.C.J., Hsiai, T.K. and Marsden, A.L., 2017. A method to quantify mechanobiological forces during zebrafish cardiac development using 4-D light sheet imaging and computational modeling. *PLoS Computational Biology*, **13**(10), p.e1005828.

Mittal, R., Seo, J.H., **Vedula, V.**, Choi, Y.J., Liu, H., Huang, H.H., Jain, S., Younes, L., Abraham, T. and George, R.T., 2016. Computational modeling of cardiac hemodynamics: current status and future outlook. *Journal of Computational Physics*, **305**, pp.1065-1082.

Vedula, V., Seo, J.H., Lardo, A.C. and Mittal, R., 2016. Effect of trabeculae and papillary muscles on the hemodynamics of the left ventricle. *Theoretical and Computational Fluid Dynamics*, **30**(1), pp.3-21. *Special issue paper on "Recent Developments in Multiphysics Computational Models of Physiological Flows".*

Vedula, V., George, R., Younes, L. and Mittal, R., 2015. Hemodynamics in the left atrium and its effect on ventricular flow patterns. *Journal of Biomechanical Engineering*, **137**(11).

Choi, Y.J., Constantino, J., **Vedula, V.**, Trayanova, N. and Mittal, R., 2015. A new MRI-based model of heart function with coupled hemodynamics and application to normal and diseased canine left ventricles. *Frontiers in Bioengineering and Biotechnology*, **3**, p.140.

Seo, J.H., **Vedula, V.**, Abraham, T., Lardo, A.C., Dawoud, F., Luo, H. and Mittal, R., 2014. Effect of the mitral valve on diastolic flow patterns. *Physics of Fluids*, **26**(12), p.121901.

Vedula, V., Fortini, S., Seo, J.H., Querzoli, G. and Mittal, R., 2014. Computational modeling and validation of intraventricular flow in a simple model of the left ventricle. *Theoretical and Computational Fluid Dynamics*, **28**(6), pp.589-604.

Choi, Y.J., **Vedula, V.** and Mittal, R., 2014. Computational study of the dynamics of a bileaflet mechanical heart valve in the mitral position. *Annals of Biomedical Engineering*, **42**(8), pp.1668-1680.

Seo, J.H., **Vedula, V.**, Abraham, T. and Mittal, R., 2013. Multiphysics computational models for cardiac flow and virtual cardiography. *International Journal for Numerical Methods in Biomedical Engineering*, **29**(8), pp.850-869. *Special issue paper on "Numerical Methods and Applications of Multi-Physics in Biomechanical Modeling".*

Zheng, X., Seo, J.H., **Vedula, V.**, Abraham, T. and Mittal, R., 2012. Computational modeling and analysis of intracardiac flows in simple models of the left ventricle. *European Journal of Mechanics-B/Fluids*, **35**, pp.31-39.

Sengupta, T.K., **Vijay, V.V.S.N.** and Singh, N., 2011. Universal instability modes in internal and external flows. *Computers & Fluids*, **40**(1), pp.221-235.

Sengupta, T.K., Rajpoot, M.K., Saurabh, S. and **Vijay, V.V.S.N.**, 2011. Analysis of anisotropy of numerical wave solutions by high accuracy finite difference methods. *Journal of Computational Physics*, **230**(1), pp.27-60.

Sengupta, T.K., **Vijay, V.V.S.N.** and Bhaumik, S., 2009. Further improvement and analysis of CCD scheme: dissipation discretization and de-aliasing properties. *Journal of Computational Physics*, **228**(17), pp.6150-6168.

Sengupta, T.K., Lakshmanan, V. and **Vijay, V.V.S.N.**, 2009. A new combined stable and dispersion relation preserving compact scheme for non-periodic problems. *Journal of Computational Physics*, **228**(8), pp.3048-3071.

Invited Talks

Syracuse University, "Computational modeling of cardiac biomechanics for clinical decision-making and support", 2022.

University of Pretoria, "Towards personalized models of cardiac function in disease and development", 2021.

Columbia University Initiative for Computational Science and Engineering Research Day, "Cyberinfrastructure for patient-specific modeling of cardiovascular disease", 2021.

Indian Institute of Technology Bhubaneswar, "Towards personalized models of cardiac function in disease and development", 2021.

Columbia University, 4^{th} Annual Engineering in Medicine Symposium, "Computational modeling of cardiovascular biomechanics in disease and development", 2020.

Columbia University, "Multiphysics model of cardiac function", 2019.

Michigan Technological University, "Towards personalized models of heart function in disease and development", 2019.

RWTH Aachen, "Ventricular hemodynamics in disease and development", 2018.

University of Washington, Seattle, "Ventricular hemodynamics in disease and development", 2018.

Seattle Children's Hospital,"Ventricular hemodynamics in disease and development", 2018.

University of California, Los Angeles, "Ventricular hemodynamics in disease and development", 2018.

University of Utah, Salt Lake City, "Ventricular hemodynamics in disease and development", 2018.

Stanford Biomechanics Seminar, "Ventricular hemodynamics in disease and development", 2017.

Stanford Institute for Computational and Mathematical Engineering (ICME) Seminar Series,"Computational modeling of cardiac hemodynamics", 2017.

Purdue University, "Computational modeling of cardiac hemodynamics: from canonical to patient-specific models", 2017.

University of California Berkeley, "Computational modeling of cardiac hemodynamics: from simplified canonical models to patient-specific", 2016.

Convergent Science, "Image-based flow modeling in a two-chamber model of the left heart", 2014.

Conference Proceedings & Abstracts

Presentations by trainees are highlighted

Shi, L., and **Vedula, V.**, "A graph neural networks (GNNs)-based surrogate model for personalized biventricular cardiac mechanics". *to be presented at the* 17^{th} *U.S. National Congress on Computational Mechanics (USNCCM)*, Albuquerque NM, USA, Jun 23-27, 2023.

Chen, Y., Anzai, I., Tran, J., Kalfa, D., and **Vedula, V.**, "Predicting hemodynamic outcomes in patients with borderline left ventricles under uncertainty". *to be presented at the 2023 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, Vail CO, USA, Jun 4-8, 2023.

Shi, L., Chen, Y., and **Vedula, V.**, "A three-node rotation-free Kirchhoff-Love shell formulation for cardiovascular applications". *poster accepted for the 2023 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, Vail CO, USA, Jun 4-8, 2023.

Vedula, V., Chen, Y., Shi, L., Anzai, I., Kalfa, D., and Takayama, H., "Towards planning cardiac surgery using personalized computational modeling". *International Mechanical Engineering Congress and Exposition (IMECE)*, Columbus OH, USA, Oct 30 - Nov 3, 2022.

Vedula, V.*, Chen, Y.†, Anzai, I.†, Tran, J., and Kalfa, D.*, "Initial validation of a predictive personalized computational model for patients with borderline left ventricles". *Single Ventricle Investigator Meeting*, Baltimore MD, USA, Oct 6-9, 2022.

Shi, L., Takayama, H., and **Vedula, V.**, "Modeling ventricular mechanics in patients with obstructive hypertrophic cardiomyopathy". *oral presentation for the 2022 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, Jun 20-23, 2022.

Chen, Y.†, Anzai, I.†, Bacha, E., **Vedula, V.***, and Kalfa, D.*, "Early validation of predictive personalized computational model for patients with borderline left ventricles". *poster at* 102^{nd} *Annual Meeting of the American Association for Thoracic Surgery (AATS)*, May 14-17, 2022.

Chen, Y., Anzai, I., Kalfa, D., and **Vedula, V.**, "Computational modeling of borderline left ventricular circulation for clinical decision-making". *2021 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, (virtual) Jun 14-18, 2021.

Shim, J.J., Mass, S.A., **Vedula, V.**, Hung, C.T., Weiss, J.A., and Ateshian, G.A., "A computational fluid dynamics formulation with solute transport derived from mixture theory and its finite element implementation in FEBio". *2021 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, (virtual) Jun 14-18, 2021.

Yamabe, T., Ginns, J., **Vedula, V.**, Leb, J.S., Shimada, Y.J., Weiner, S.D., and Takayama, H., "Left ventricular remodeling following septal myectomy in hypertrophic obstructive cardiomyopathy". 101^{st} *Annual Meeting of American Association for Thoracic Surgeons (AATS)*, (virtual) Apr 30 - May 2, 2021.

Tikenogullari, O.Z., Peirlinck, M., **Vedula, V.**, Kuhl, E., and Marsden, A., "Patient-specific characterization of hypoplastic left heart mechanics". 16^{th} *U.S. National Congress on Computational Mechanics (USCNCCM16)*, (virtual) Jul 25-29, 2021.

Zhu, C., **Vedula, V.**, Liu, J., Marsden, A.L., and Shadden, S.C., "Cardiac contraction modeling using a variational multiscale approach". *2020 Summer Biomechanics, Bioengineering and Biotransport (SB*^{3}*C)*, (virtual) Jun 17-20, 2020.

Zhu, C., **Vedula, V.**, and Shadden, S., "A Row and Column Scaling Preconditioner for Efficient Fluid-Structure Modeling in Cardiovascular System". 73^{rd} *Meeting of the American Physical Society Division of Fluid Dynamics*, (virtual) Nov. 22-24, 2020.

Chen, I.Y., **Vedula, V.**, Malik, S.B., Liang, T., Chung, K.S., Sayed, N., Tsao, P.S., Giacomini, J.C., Marsden, A.L. and Wu, J.C., "Preoperative computed tomography angiography reveals leaflet-specific contribution to aortic stenosis influenced by local coronary factors". Circulation, **142**(Suppl_3), pp.A16300-A16300.

Marsden, A. L., **Vedula, V.**, Tikenogullari, O., and Kuhl, E., "Towards patient-specific multi-physics modeling of cardiac function", 56^{th} *Annual Technical Meeting of the Society of Engineering Sciences (SES2019)*, St Louis MO, USA, Oct. 13-15, 2019.

Vedula, V., Liu, J., Tikenogullari, O., Kuhl, E., and Marsden, A. L., "A multiphysics model of cardiac function - methods and verification", 16^{th} *International Symposium on Computer*

Methods in Biomechanics and Biomedical Engineering (CMBBE2019), New York NY, USA, Aug. 14-16, 2019.

Hsu, J., **Vedula, V.**, Baek, K. I., Chen, C., Ding, Y., Tintut, Y., Marsden, A., and Hsiai, T., "Contractile and hemodynamic forces promote cardiac valve development via Notch1b-mediated endothelial-to-mesenchymal transition", *Circulation*, **138**(Suppl_1), A14393-A14393, 2018.

Vedula, V., and Marsden, A., "Patient specific modeling of intraventricular hemodynamics", 69^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Denver CO, USA, Nov. 19-21, 2017.

Lee, J., **Vedula, V.**, Ding, Y., Chen, J., Marsden, A., and Hsiai, T., "Spatiotemporal variations in intracardiac shear stress differentially modulate trabeculation for developmental contractile function. *Circulation*, **136**(Suppl_1), A19511-A19511, 2017.

Hsu, J., Chen, J.,**Vedula, V.**, Lee, J., Ding, Y., Marsden, A., and Hsiai, T., "4-D light-sheet imaging and moving-domain computation reveal that oscillatory shear index mediates endocardial notch1b signaling and valve development", *Poster accepted for The American Heart Association (AHA) Scientific Sessions 2017*, Anaheim CA, USA, Nov. 11-15, 2017.

Hsu, J., Chen, J.,**Vedula, V.**, Lee, J., Ding, Y., Marsden, A., and Hsiai, T., "Light-sheet microscopy and computational fluid dynamics to evaluate the effects of intracardiac hemodynamic modulation on cardiac valve development", *2017 Biomedical Engineering Society (BMES) Annual Meeting*, Phoenix AZ, USA, Oct. 11-14, 2017.

Vedula, V., Lee, J., Xu, H., Kuo, C.-C., Hsiai, T., and Marsden, A., "A 4-D computational study of developmental cardiac mechanics in zebrafish embryos", *2017 Summer Biomechanics, Bioengineering and Biotransport (SB^3C)*, Tucson AZ, USA, Jun. 21-24, 2017.

Bäumler, K., **Vedula, V.**, Sailer, A., Marsden, A., and Fleischmann, D., "Computer simulations of blood flow in aortic dissections with fluid structure interaction (fsi)", *2017 Summer Biomechanics, Bioengineering and Biotransport (SB^3C)*, Tucson AZ, USA, Jun. 21-24, 2017.

Vedula, V., Feinstein, J., and Marsden, A., "Patient-specific modeling of intraventricular hemodynamics in single ventricle physiology", 5^{th} *International Conference on Computational and Mathematical Biomedical Engineering (CMBE)*, Pittsburgh PA, USA, Apr. 10-12, 2017.

Liu, J., **Vedula, V.**, and Marsden, A., "Variational multiscale formulation for incompressible solid dynamics with particular references to patient-specific modeling in biological tissues", 5^{th} *International Conference on Computational and Mathematical Biomedical Engineering (CMBE)*, Pittsburgh PA, USA, Apr. 10-12, 2017.

Zhu, C., Seo, J., **Vedula, V.**, and Mittal, R., "A highly scalable sharp-interface immersed boundary method for large-scale parallel computers", *In 23rd AIAA Computational Fluid Dynamics Conference* (p. 3622), 2017.

Vedula, V., Feinstein, J., and Marsden, A., "Patient-specific modeling of intraventricular hemodynamics in single ventricle physiology", 69^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Portland OR, USA, Nov. 20-22, 2016.

Bäumler, K., **Vedula, V.**, Karmann, A. S., Marsden, A., and Fleischmann, D., "Simulations of blood flow in patient-specific aortic dissections with a deformable wall model", 69^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Portland OR, USA, Nov. 20-22, 2016.

Bäumler, K., Sailer, A. M., **Vedula, V.**, Chiu, P., Fischbein, A., Marsden, A., and Fleischmann, D., "Computer simulation of blood flow in patients with aortic dissection: Validation with Quantitative MR Flow", *ISMRM Workshop on Quantitative MR Flow*, San Francisco CA, USA, Oct. 20-23, 2016.

Vedula, V., Feinstein, J., and Marsden, A., "Patient-specific modeling of intraventricular hemodynamics in single-ventricle physiology", Invited talk and Poster presentation. 5^{th} *Engineering Frontiers Conference in Pediatrics and Congenital Heart Disease*, University of Central Florida, Orlando, USA, June 9-10, 2016. ***(Received NSF-sponsored Young Investigator and Travel Award.)***

Vedula, V., Lee, J., Ding. Y., Marsden, A., and Hsiai, T., "Hemodynamic implications of ventricular trabeculation during cardiac morphogenesis", Poster presentation (first two authors have equal contribution). 5^{th} *Engineering Frontiers Conference in Pediatrics and Congenital Heart Disease*, University of Central Florida, Orlando FL, USA, June 9-10, 2016.

Vedula, V., Feinstein, J., and Marsden, A., "Patient-specific modeling of intraventricular hemodynamics in single-ventricle physiology" *Stanford Annual Bioengineering Research Retreat*, Santa Cruz CA, USA, Apr. 15-17, 2016.

Vedula, V., Lee, J., Hsiai, T., and Marsden, A., "Effect of trabeculae on the hemodynamics of an embryonic left ventricle", 68^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Boston MA, USA, Nov. 22-24, 2015.

Vedula, V., Seo, J. H., Shoele, K., George, R., Younes, L., and Mittal, R., "Image-based flow modeling in a two-chamber model of the left heart" 67^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, San Francisco CA, USA, Nov. 23-25, 2014.

Seo, J. H., K. Shoele, **Vedula, V.**, and Mittal, R., "Simulation of Intraventricular Flows with Physiological Mitral Valve Models", 7^{th} *World Congress of Biomechanics*, Boston MA, USA, Jul. 6-11, 2014.

Vedula, V., and Mittal, R., "Image based modeling of left-ventricular flows" *Johns Hopkins University Center for Environmental and Applied Fluid Mechanics-Burger's Program for Fluid Dynamics Annual Graduate and Postdoc Showcase Symposium*, University of Maryland, College Park MD, USA, May 28, 2014.

Vedula, V., Seo, J. H., and Mittal, R., "Effects of trabeculations on the hemodynamics of the left ventricle: a computational study" 66^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Pittsburgh PA, USA, Nov. 24-26, 2013.

Seo, J. H., **Vedula, V.**, George, R., and Mittal, R., "Coupled hemodynamic-biochemical modeling of thrombus formation in infarcted left ventricles" 66^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Pittsburgh PA, USA, Nov. 24-26, 2013.

Vedula, V., Seo, J. H., Lardo, A., Abraham, T., and Mittal, R., "Modeling of blood flow in normal and diseased left-ventricles" *2013 Society for Industrial and Applied Mechanics Conference on Computational Science and Engineering*, Boston MA, USA, Feb. 25 - Mar. 1, 2013.

Seo, J. H., **Vedula, V.**, and Mittal, R., "Multiphysics computational models for cardiac flow and virtual cardiography" 6^{th} *European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS)*, Vienna, Austria, Sep. 10-14, 2012.

Vedula, V., Seo, J. H., Fortini, S., Querzoli, G., and Mittal, R., "Computational modeling of the effects of myocardial infarction on left ventricular hemodynamics" 65^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, San Diego CA, USA, Nov. 18-20, 2012.

Vedula, V., Seo, J. H., Zheng, X., Abraham, T., and Mittal, R., "Computational modeling and analysis of intracardiac flows in normal and diseased hearts" *Johns Hopkins University Center for Environmental and Applied Fluid Mechanics-Burger's Program for Fluid Dynamics Annual Graduate and Postdoc Showcase Symposium*, University of Maryland, College Park MD, USA, May 22, 2012.

Seo, J. H., **Vedula, V.**, Eslami, P., Mittal, R., and Abraham, T., "Computational fluid dynamics based analysis of cardiovascular flows and implications for diagnosis and surgical planning", *Johns Hopkins Heart and Vascular Institute's* 3^{rd} *Annual Cardiovascular Research Retreat*, June 1, 2012.

Vedula, V., Seo, J. H., and Mittal, R., "Virtual cardiac surgery using CFD: application to septal myectomy in obstructive hypertrophic cardiomyopathy" 64^{th} *Meeting of the American Physical Society Division of Fluid Dynamics*, Baltimore MD, USA, Nov. 20-22, 2011.

Vedula, V., Zheng, X., Abraham, T., and Mittal, R., "Computational modeling and analysis of intracardiac flows in normal and diseased hearts" *2011 Biomedical Engineering Society Annual Meeting*, Hartford CT, USA, Oct. 12-15, 2011.

Vijay, V. V. S. N., Singh, N., and Sengupta, T. K., "Computing internal and external flows undergoing instability and bifurcations" *5th M.I.T. Conference on Computational Fluid and Solid Mechanics, Focus: Advances in CFD*, Massachusetts Institute of Technology, Cambridge MA, USA, Jun. 17-19, 2009.

Teaching Experience

Mechanics of Fluids (MECE E4100), Columbia University. Intermediate fluid mechanics course for graduate students. Adapted course content from Prof. Karen Kasza.
Spring 2020; Enrollment: 5 grad, 1 undergrad; Evaluation: 3.5/5 (course), 4.5/5 (instructor);
Spring 2022; Enrollment: 7 grad, 2 undergrad; Evaluation: 4.3/5 (course), 5/5 (instructor);

Computational Heat Transfer and Fluid Flow (MECE E6102), Columbia University. Graduate-level course on applying finite differences and finite element methods for fluid flow and heat transfer applications. Developed the course material.
Spring 2021; Enrollment: 5 graduate students; Evaluation: 4.0/5 (course), 4.5/5 (instructor);
Spring 2023; Enrollment: 6 graduate students; Evaluation: 4.0/5 (course), 4.0/5 (instructor);;

Finite Element Method for Fluid Flow and Fluid-Structure Interactions (MECE E6106), Columbia University. Graduate-level course on applying finite element methods for fluid flow and fluid-structure interaction applications. Introduced and developed the course material.
Fall 2021; Enrollment: 4 graduate students; Evaluation: 4.0/5 (course), 3.5/5 (instructor);

Introduction to Mechanics of Fluids (MECE E3100), Columbia University. Introductory fluid mechanics course for undergraduate students (juniors).
Fall 2022; Enrollment: 87 undergraduates; Evaluation: 3.5/5 (course), 3.5/5 (instructor);

Guest Lectures

Columbia University (MECE E3100)	Oct 2020
Stanford University (CME 285)	2019, 2017
RWTH Aachen	Oct 2018

Advising Experience

Postdocs

Kewei Li	Spring 2021 - present
Lei Shi	Fall 2021 - 2023

Ph.D. Students

Yurui Chen	Fall 2020 - present
Hannah Haider	Fall 2023
Hannah Zhai	Fall 2023

M.S. Students

Chen Shirley Zhang	Fall 2023
Yeqing Ni	Fall 2023
Haoyang Chen	Summer 2022
Xinyi Lu	Summer 2022
Yurui Chen	Summer 2020

B.S. Students

Elise Yang - *Bonomi Scholar*	Summer 2022
Prince Kagunyi	Fall 2023

Ph.D. Dissertation / Proposal Committee

Dissertation Committee

Jay Shim, Mechanical Engineering (defended Apr 2021; primary advisor: Gerard Ateshian)

Lei Shi, Mechanical Engineering (defended Jun 2021; primary advisor: Kristin Myers)
Richard Li, Mechanical Engineering (defended Sep 2021; primary advisor: Jeffrey Kysar)
Nicole Lee, Mechanical Engineering (defended Aug 2022; primary advisor: Kristin Myers)
Caryl LaGrotta, Mechanical Engineering (defended Feb 2023; primary advisor: Michael Burke)

Proposal Committee

Richard Li, Mechanical Engineering (proposed Feb 2021; primary advisor: Jeffrey Kysar)
Caryl LaGrotta, Mechanical Engineering (proposed Sep 2021; primary advisor: Michael Burke)
Erin Louwagie, Mechanical Engineering (proposed May 2023; primary advisor: Kristin Myers)

Grants

Pending Research Support

NIH R21 R21AG090065, *application submitted Oct 2023*
Contact PI, 12.5% effort; Multi PI (Takayama, H.)
"Hemodynamic and biomechanical characterization of aortic root aneurysms"

NIH R21 R21LM014481, *application submitted Nov 2023*
Contact PI, 12.5% effort; Multi PI (Kalfa, D.)
"Personalized computational modeling for predicting hemodynamics in borderline left ventricles"

AHA Career Development Award, *application submitted Dec 2023*
PI, 12.5% effort
"Hemodynamic characterization of the aortic root and deep veins"

AHA Second Century Early Faculty Independence Award, *application submitted Jan 2024*
PI, 12.5% effort
"AI-enabled personalized computational modeling of cardiac electromechanics"

AHA Transformational Project Award, *application submitted Feb 2024*
PI, 6% effort
"Leveraging computational modeling and machine learning for cardiac mechanics in hypertrophic obstructive cardiomyopathy"

Current Research Support

NIH 1R01HL155381 9/1/2020 - 8/31/2024 $2.8M
Co-I, 5% effort (PI: David Kalfa)
"An expandable polymeric valved conduit to repair congenital heart disease"

NIH 1R01HL170188 6/1/2023 - 4/30/2027 $2M
Co-I, 5% effort (PI: Kimara Targoff)
"Mechanisms of outflow tract morphogenesis regulated by extracellular matrix"

Completed

AHA 20TPA35310049 1/1/2020 - 12/31/2022 $300K
Co-I, 5% effort (PI: David Kalfa)
"*In vitro* and *in vivo* mechanical stability and growth of a bio-hybrid heart valve"

Columbia SIRS (Blavatnik) Award 7/1/2022 - 6/30/2023 $85K
"Hemodynamic predictors of aortic root aneurysm progression using computational modeling"

Professional Service

Memberships

American Society of Mechanical Engineers	2016 - present
American Physical Society	2012 - present
American Heart Association	2019 - present

Conference Session Chair

Computer Methods in Biomechanics and Biomedical Engineering (CMBBE) 2019
Summer Biomechanics, Bioengineering and Biotransport Conference (SB^3C), Biofluids, 2022
Summer Biomechanics, Bioengineering and Biotransport Conference (SB^3C), Vascular Mechanics, 2022

Conference Training Workshops

SimVascular Workshop & Training, 2019 (CMBBE).
SimVascular / SimCardio Workshop, 2021 (CMBBE, FIMH, SB^3C)

Grant Review Panel

NSF Fluids	2020
AHA Transformational Project Award (Bioengineering)	2022
NIH NHLBI Catalyze Enabling Technologies	2022
Columbia SIRS	2023

Editorial Board

Review Editor, Frontiers in Physiology	2020 - present

Department

Department Scribe	2020 - 2022
Graduate Committee, *Member*	2020 - present
Diversity, Equity, and Inclusion, *Member*	2023
Colloquium Organizer	2023

Manuscript Reviewer

Annals of Biomedical Engineering (ABME)
Biomechanics and Modeling in Mechanobiology (BMMB)
Biomedical Engineering / Biomedizinische Technik (BMT)
Computers & Fluids
Computer Methods and Programs in Biomedicine (CMPB)
Cardiovascular Engineering and Technology (CVET)
European Journal of MechanicsB Fluids
Fluids
Flow
Frontiers in Bioengineering
Frontiers in Physiology
International Journal of Numerical Methods in Biomedical Engineering (IJNMBE)
Journal of Biomechanics (JB)
J. Biomechanical Engineering (JBME)
Journal of Computational Physics (JCP)
Journal of Fluid Mechanics (JFM)
Journal of the Mechanical Behavior of Biomedical Materials (JMBBM)
Journal of Medical and Biological Engineering (JMBE)
Journal of Mechanics in Medicine and Biology (JMMB)
MDPI Bioengineering
Medical and Biological Engineering and Computing (MBEC)
Medical Imaging and Analysis (MedIA)
Metrology and Measurement Systems (MMS)
Nature Communications Medicine (CM)
Physiological Reports
PLOS Computational Biology
Summer Biomechanics Bioengineering and Biotransport (SB^3C)
Thrombosis Research

Open Source Software Contribution

SimVascular Project (svFSI code, examples, forum)

Outreach Activities

Johns Hopkins Center for Talented Youth (CTY) 2017, 2018.
I enjoyed participating in the Hopkins CTY program hosted by Alison Marsden at Stanford University, motivating mid-high school students about scientific research. In 2017, I conducted experiments on vortex rings and help students understand the effect of vortex rings on physical

systems. In 2018, I used the Stanford Virtual Heart model to explain complex congenital heart disease conditions in an immersive virtual reality (VR) environment.

La Jolla Elementary School, San Diego, 2015.
I participated in the La Jolla Elementary School Family Science Night on March 13, 2015, to demonstrate Bernoulli's principle in fluid mechanics to elementary school children and get them excited about science.

PRAYAS, Indian Institute of Technology (IIT) Kanpur, India, 2008.
PRAYAS is an IIT Kanpur initiative focused on providing education for underprivileged children. I served as a volunteer for tutoring elementary school children during the spring of 2008. My service here has led to the GE Foundation Scholar-Leader scholarship.

Aeromodeling Club, Indian Institute of Technology (IIT) Kanpur, India, 2008.
I was an active volunteer at the Aeromodeling Club, IIT Kanpur, India during the summer of 2008. I was involved in activities including educating high school students and undergraduates on the basics of flight and help them design, build, and fly model airplanes made from paper and wood, some of which are radio-controllable.