

## Arash Kheradvar, M.D., Ph.D.

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### Research Interests

- Cardiovascular Imaging
- Modeling Congenital Heart Disease
- Heart Valve & Stent Engineering
- Technologies for Minimally Invasive Procedures
- Cardiac Mechanics & Biofluid Dynamics
- Artificial Organs

### Education

- Ph.D. (Bioengineering), *California Institute of Technology, Pasadena, California* – defended on November 1, 2006. Thesis title: The role of vortex ring formation and pressure drop on dynamics of the left ventricle during diastole. Academic advisor: Prof. Mory (Morteza) Gharib
- M.D., *Tehran University of Medical Sciences, Tehran, Iran* – degree received on August 22, 2000. Thesis title: Measurement of the astigmatic changes after frown small incision cataract surgery. Thesis advisor: Prof. Mahmoud Jabbarvand

### Professional Employment

*University of South Carolina, Columbia, South Carolina*

*10/2007-present*

- 10/2007 – Present: Assistant Professor of Mechanical Engineering
- 12/2007 – Present: Adjunct Assistant Professor of Internal Medicine
- 11/2007 – Present: Adjunct Assistant Professor of Cell Biology and Anatomy

*California Institute of Technology, Pasadena, California*

*03/2002-10/2007*

- 01/2007 – 10/2007: Postdoctoral Scholar, Cardiovascular and Biofluid Dynamics Laboratory
- 01/2005 – 10/2007: Project instructor, *Applications of helically actuating pump mechanism in Ventricular Assist devices*
- 12/2004 – 10/2007: Project instructor, *Percutaneous heart valve design*
- 03/2002 – 11/2006: Graduate research assistant, Cardiovascular and Biofluid Dynamics Laboratory

*Tehran University of Medical Sciences, Tehran, Iran*

*01/2000-03/2002*

- 01/2000 - 03/2002: Research Fellow: Immunogenetics Laboratory, Department of Immunology

### Refereed Journal Publications

1. **Kheradvar A**, Houle H, Pedrizzetti G, Tonti G, Belcik T, Ashraf M, Linder JR, Gharib M, Sahn DJ. Echocardiographic Particle Image Velocimetry: A Novel Technique for Quantification of Left Ventricular Blood Vorticity Pattern, *Journal of American Society of Echocardiography (JASE)*, in press.
2. Grosberg A, Gharib M, **Kheradvar A**. The Effect of Fiber Geometry on Pulsatile Pumping and Energy Expenditure, *Bulletin of Mathematical Biology*, 2009, 71: 1580–1598.
3. **Kheradvar A**, Gharib M. On Mitral Valve Dynamics and its connection to Early Diastolic Flow, *Annals of Biomedical Engineering*, 2009 Jan, 37(1):1-13.
4. **Kheradvar A**, Gharib M. Influence of ventricular pressure-drop on mitral annulus dynamics through the process of vortex ring formation, *Annals of Biomedical Engineering* 2007, 35 (12):2050-2064.
5. **Kheradvar A**, Milano M, Gharib M. Correlation between vortex ring formation and mitral annulus dynamics during ventricular rapid filling, *ASAIO Journal (Journal of American Society of Artificial Internal Organs)*, Jan-Feb 2007 53(1): 8-16.
6. **Kheradvar A**, Milano M, Gorman RC, Gorman III JH, Gharib M. Assessment of left ventricular viscoelastic components based on ventricular harmonic behavior; *Cardiovascular Engineering*, 2006 March 6(1): 30-39
7. Gharib M, Rambod E, **Kheradvar A**, Sahn D, Dabiri JO. A global index for heart failure based on optimal vortex formation in the left ventricle. *Proceedings of National Academy of Sciences (PNAS)* 2006, 103 (16): 6305-6308.
8. **Kheradvar A**, Kasalko J, Johnson D, Gharib M. An *in-vitro* study of changing profile heights in mitral bioprostheses and their influence on flow. *ASAIO Journal* 2006 Jan-Feb 52(1):34-38

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9. Amirzargar AA, Tabassi A, Khosravi F, **Kheradvar A**, Rezaei N, Naroueynejad M, Ansari-pour B, Moradi B, Nikbin B. Optic neuritis, multiple sclerosis and human leukocyte antigen: results of a 4-year follow-up study. *European Journal of Neurology* 2005 Jan;12(1):25-30.
  10. **Kheradvar A**, Tabassi AR, Nikbin B, Khosravi F, Naroueynejad M, Moradi B, Amirzargar AA. Influence of HLA on progression of optic neuritis to multiple sclerosis: results of a four-year follow-up study. *Multiple Sclerosis*. 2004 Oct;10(5):526-31.
  11. Rad AS, Jabbarvand M, Farahvash MM, **Kheradvar A**. Laser in situ keratomileusis and diode thermal keratoplasty for correction of hyperopia from +5.00 to +10.00 diopters. *Journal of Refractive Surgery*. 2002 May-Jun;18(3 Suppl):S318-20.
  12. Rad AS, **Kheradvar A**. Juvenile xanthogranuloma: concurrent involvement of skin and eye. *Cornea, The Journal of Cornea and External disease*. 2001 Oct;20(7):760-2.
  13. Behnia H, **Kheradvar A**, Shahrokhi M. An anatomic study of the lingual nerve in the third molar region. *Journal of Oral & Maxillofacial Surgery*. 2000 Jun;58(6):649-51.

### Books and Journal Papers submitted/in preparation

1. **Kheradvar A**, Assadi R. Vortex Formation Time Index: A Novel Marker to grade Diastolic Dysfunction, under review by *Journal of American College of Cardiology (JACC)*.
2. **Kheradvar A**, Gorman RC, Gorman III JH, Zeeshan A, Gharib M. Effect of isovolumic relaxation phase on diastolic rapid filling during post infarction cardiac remodeling, in preparation.
3. **Kheradvar A** and Pedrizzetti G. Vortex Formation in the Cardiovascular System. Book title under preparation for Springer UK.

### Patents

1. **Kheradvar A**, Ravichandran G, Gharib M. Implantable small percutaneous valves and the method of delivery, US Patent# 7331991.
2. **Kheradvar A**, Ravichandran G, Gharib M. Implantable small percutaneous valves and the method of delivery, World Intellectual Property Organization Patent# 2006/110228.
3. **Kheradvar A**, Gharib M. Monolithic in situ forming valve system. US 20080161909
4. **Kheradvar A**, Gharib M, Hickerson A. Helically actuating positive-displacement pump US20060216173.
5. **Kheradvar A**, Gharib M, In-situ formation of a valve. US20080195199
6. **Kheradvar A**. Implantable Prosthetic Valves and Methods Relating to Same, US20090164003.
7. **Kheradvar A**, Gharib M. Helically twisting cardiac-apex assist device. *patent pending*
8. **Kheradvar A**, Gharib M. Deployable forming heart valve system and its percutaneous method of delivery. *patent pending*
9. Grosberg A, **Kheradvar A**, Gharib M. Method for reinforcing the cardiac pumping function. *patent pending*.
10. **Kheradvar A**, Grosberg A, Gharib M. Cardiac assist system using helical arrangement of contractile bands and helically-twisting cardiac assist device, *patent pending*
11. **Kheradvar A**. Wireless lab-on-a-chip apparatus for implantable cardiac devices, *patent pending*.
12. **Kheradvar A**, DeLegge MH. Expandable gastric device and its method of implantation, *patent pending*
13. **Kheradvar A**, Karmaus W. Nursing bottle apparatus for improvement of suckling, *patent pending*
14. **Kheradvar A**, Sutton MA, Membrane-deformation mapping technique for evaluation of bioprosthetic heart valves, *patent pending*
15. **Kheradvar A**. Hybrid tissue for heart valve leaflet and other applications, *patent pending*

### Peer Reviewed Conference Proceeding

1. **Kheradvar A**. Development and Testing a Dynamic Bi-leaflet Mitral Prosthesis. *American Heart Association Scientific Sessions 2009*, Orlando, FL
2. **Kheradvar A**, Houle H, Pedrizzetti G, Tonti G, Belcik T, Ashraf M, Linder JR, Gharib M, Sahn DJ. Quantification of Left Ventricular Blood Vorticity Pattern by the novel method of Echocardiographic Particle Image Velocimetry. 2009 Society for Experimental Mechanics Fall Symposium and Workshop, Columbia, SC.
3. Biechler SV, Weidner J, Goodwin R, **Kheradvar A**. The Morphogenesis of Atrioventricular Valves Due to Flow-Induced Forces. *BMES 2009 Annual Fall Meeting*, Pittsburgh, PA, October 2009.

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4. **Kheradvar A** and Gharib M. Formation of a Bioprosthetic Heart Valve within the Ventricle: A Percutaneous approach. *BMES 2009 Annual Fall Meeting*, Pittsburgh, PA, October 2009.
5. Mangual J, Jung B and **Kheradvar A**. Modeling Radial Viscoelastic Behavior of the Left Ventricle in a Cardiac Cycle. *BMES 2009 Annual Fall Meeting*, Pittsburgh, PA, October 2009.
6. Falahatpisheh A and **Kheradvar A**. Computational Modeling of repaired Tetralogy of Fallot. *BMES 2009 Annual Fall Meeting*, Pittsburgh, PA, October 2009.
7. Burnside J and **Kheradvar A**. Progress on Design and Development of a Bi-leaflet Mitral Bioprosthetic Valve. *ASAIO Journal*. 55(2):144, March/April 2009.
8. **Kheradvar A** and Gharib M. Vortex formation time in progression of Cardiac dysfunction. Bulletin of American Physical Society, DFD08 meeting, 35(15) p76, San Antonio, TX.
9. Grosberg A, **Kheradvar A**, Gharib M. Helical contraction: an efficient mean for pulsatile ventricular assist devices. *ASAIO Journal*. 54(2):44A, March/April 2008.
10. Saber NR, Wood JC, **Kheradvar A**. A computational methodology for stent-leaflet interactions in minimally-invasive heart valves. *ASAIO Journal*. 54(2):3A, March/April 2008.
11. **Kheradvar A**, Assadi R, Jutzy KR, Bansal R. Transmitral Vortex Formation: A Reliable Indicator for Pseudonormal Diastolic Dysfunction. *Journal of the American College of Cardiology* 51(10) supplement A: A104, March 2008.
12. **Kheradvar A** and Gharib M. How ventricular pressure drop can affect the mitral valve dynamics. *BMES 2007 Annual Fall Meeting*, Los Angeles, CA, September 2007.
13. **Kheradvar A**, Milano M, Gharib M. Assessment of myocardial global viscoelastic behavior by MR imaging. *BMES 2006 Annual Fall Meeting*, Chicago, IL, October 2006.
14. **Kheradvar A**, Milano M, Gorman RC, Gorman III JH, Gharib M. Estimation of elastic and viscous properties of the left ventricle based on annulus plane harmonic behavior. Proceedings of 28th Annual International Conference of the IEEE-EMBS, Aug. 2006 Pages:616 - 619
15. **Kheradvar A**, Milano M, Gorman RC, Gorman III JH, Gharib M. LV dynamical model with time-varying coefficients resulted from annular plane displacement and LVP. *BMES 2005 Annual Fall Meeting*, Baltimore, MD, September 2005
16. **Kheradvar A**, Johnson D, Kasalko J, Gharib M. Changing profile heights in perimount™ mitral valve: An in-vitro quantitative flow visualization study. *ASAIO Journal*. 51(2):32A, March/April 2005.
17. **Kheradvar A**, Gorman RC, Gorman III, JH, Zeeshan A, Gharib M. Evaluation of Isovolumic Relaxation Phase in the process of Ventricular Remodeling following Myocardial Infarction. Proceedings of 26th Annual International Conference of the IEEE-EMBS, Volume: 2 , 1-5 Sept. 2004 Pages:3654-7
18. Gharib M, Rambod E, **Kheradvar A**, Sahn D. On the Issue of Optimal Trans-Mitral Flow. *XXI International Congress of Theoretical and Applied Mechanics* Warsaw, Poland, August 15-21, 2004
19. **Kheradvar A**, Gorman RC, Gorman III JH, Zeeshan A, Gharib M. Assessment of variations in Isovolumic Relaxation Phase during post MI cardiac remodeling, *BMES 2004 Annual Fall Meeting*, Philadelphia, PA, October 2004
20. **Kheradvar A**, Gharib M. Correlation between Vortex Formation Number and the rate of change of left ventricular pressure in Diastole. *BMES 2003 Annual Fall Meeting*, Nashville, TN.
21. Amirzargar AA, Abodolreza T, Farideh K, **Kheradvar A**, et al. Human leukocyte antigen association in optic neuritis and progression to multiple sclerosis: The results of a four-year follow up study. *Tissue Antigens* 64 (4): 368-368 Oct 2004
22. Nikbin B, Tabasi AR, **Kheradvar A**, Khosravi F, Naroueynejad M, Danesh A, Amirzargar AA. Optic neuritis and HLA association in Iranian patients. *Tissue Antigens* 59: 71-71 Suppl. 2, 2002
23. Sadighi A, **Kheradvar A**. Gubernaculopexy; A novel technique for placement of the undescended testis in the scrotum. *3<sup>rd</sup> International Conference of the Egyptian Association of Pediatric Surgeons* (May 5-7, 1999).

## Grants

1. PI for NIH-R21: "Modeling Development of Tetralogy of Fallot in-vivo and in-silica", co-PI: Richard Goodwin (USC), pending.
2. PI for NSF-DMS-NIGMS: "Riemannian Geometry of Remodeling in Biological Tissues", co-PI: Arash Yavari (Georgia Tech) pending.

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3. PI for SC EPSCoR/IDeA GEAR: Biofabrication of a Hybrid Percutaneous Valve System inspired by DNA Helical Structure; co-PI: Tom Borg (MUSC), pending.
  4. PI for NSF CAREER: "Predictive Modeling of Coupled Fluid-Structure Interaction in a Growing Heart", NSF pending.
  5. PI for CBET-BME: "A comprehensive approach to assess defect propagation in living cardiac tissue", co-PI: Arash Yavari (Georgia Tech) pending.
  6. PI for NSF-BISH: "Development of 3D Echocardiographic Particle Image Velocimetry (PIV) for Assessment of Right Ventricular Flow Pattern, pending
  7. PI for AHA Scientist Development Grant proposal: "Predictive Modeling for Tetralogy of Fallot", pending.
  8. PI for DOE Early Career Research Proposal: "ASCR Early Career: Multiscale Computational Modeling of Cardiac Growth and Development", pending.
  9. Co-PI for NIH-RC-3 challenge grant: "Technology for Real Time Detection of Thrombus Formation in Atrial Fibrillation-Flutter", pending.
  10. PI for CMMI-NBM: "Developing a Heart Valve Damage Model based on 3D Dynamic Deformation Mapping of Leaflet Membranes", co-PI: Michael Sutton (USC), NSF pending.

### Professional Service

- Grant proposal reviewer,
  - National Institute of Health (NIH)
  - National Science Foundation (NSF)
  - National Medical Research Council, Ministry of Health, Singapore.
  - American Heart Association
- Editorial Board member,
  - ASAIO Journal (Journal of American Society of Artificial Internal Organs)
  - International Journal of Medical Engineering and Informatics
  - International Journal of Biomedical Engineering and Consumer Health Informatics
- Reviewer:
  - The Annals of Thoracic Surgery
  - Journal of American Society of Echocardiography
  - Annals of Biomedical Engineering
  - The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology
  - Microscopy and Microanalysis
  - IEEE Transactions on Biomedical Engineering
  - Applications and Applied Mathematics: An International Journal (AAM)
- University Service:
  - Advisor for National Society of Black Engineers, Chapter for University of South Carolina
  - Member for NSF-RII and NSF-FEI Faculty Search committees
- Consultant and Advisory Boards
  - *Ultrawave Labs* (2009- present)
  - *Siemens Healthcare* (2008-present)
  - *Evalve Inc* (2008)
  - *Edwards Lifesciences*, (2004 and 2005)

### Invited Seminars

- **Fondation Leducq**, the Leducq meeting in Charleston, SC on November 12-13, 2009.
- **Medical University of South Carolina**, Department of Cell Biology and Anatomy (11/05/2008)
- **Carolina Cardiovascular COBRE Conference**, USC School of Medicine (10/16/2008)
- **Arizona State University**, Department of Mechanical & Aerospace Engineering (11/02/2007)
- **Rice University**, Department of Bioengineering (3/21/2007)
- **University of Michigan**, Department of Biomedical Engineering (3/15/2007)
- **University of California, San Diego**, Department of Mechanical & Aerospace Engineering (2/28/2007)

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- **University of Connecticut**, Department of Biomedical Engineering (2/19/2007)
  - **Virginia Tech**, Department of Engineering Science and Mechanics (2/12/2007)
  - **University of Chicago**, Department of Surgery, Section of Cardiothoracic Surgery (12/11/2006)
  - **University of California, San Francisco**, Department of Surgery (07/06/2006)
  - **Illinois Institute of Technology**, Department of Biomedical Engineering (06/27/2006)
  - **University of Minnesota**, Department of Biomedical Engineering (04/10/2006)
  - **University of South Carolina**, Department of Mechanical Engineering (04/03/2006)
  - **ASAIO 51st Annual Conference** scientific session, invited moderator (06/11/2005)

### Honors and Awards

- Vivien Thomas Young Investigator Award Finalist nominated by American Heart Association at the AHA Scientific Sessions 2009 in Orlando, Florida.
- The heart-valve model I made based on Leonardo's manuscript, represents the "first scientific flow visualization of impulsive vortex formation" was featured in the exhibit: Leonardo da Vinci: Experience, Experiment and Design, at the *Victoria and Albert Museum* in London (09/14/06 – 01/07/07).
- *Benjamin M Rosen graduate fellowship* for graduate study toward the Doctor of Philosophy degree in Bioengineering/Engineering science at Caltech
- Winner of the *first prize* of the 6<sup>th</sup> National Iranian Student's Book Competition for the best medical translation for the book Cellular and Molecular Immunology.

### Technical Reports

- **Kheradvar A**, Gharib M. Quantitative In-Vitro Flow Visualization on the Carpentier-Edwards PERIMOUNT Magna, PERIMOUNT plus and SJM BIOCOR mitral prostheses (09/20/2005)
- **Kheradvar A**, Gharib M. Quantitative In-Vitro Flow Visualization of Altered Profile Heights on the Carpentier-Edwards PERIMOUNT Mitral Valve (10/25/2004)
- **Kheradvar A**, Lin B, Gharib A. Flow mapping inside multiple entrance tip catheters (05/14/2004)

### Professional Memberships

- Member, American Heart Association
- Member, American Society for Artificial Internal Organs
- Member, American Society of Biomechanics
- Member, American Society of Mechanical Engineers
- Member, Engineering in Medicine and Biology Society
- Member, Iranian Council of Medicine

### Teaching

- University of South Carolina, Columbia, SC
  - BMEN211: Modeling and Simulation of Biomedical Systems
  - BMEN589a: Introduction to Cardiovascular Engineering
  - EMCH561a: Biofluid Mechanics
- GEM4 Summer School at Caltech, July 21-25
  - Summer 2008: Invited instructor: Mechanics of Heart Failure
- California Institute of Technology, Pasadena, California.
  - Summer 2007: Invited research mentor for Minority Freshman Summer Institute

### Students and Scholars

- Postdoctoral Scholar: Javid Moraveji, PhD.
- PhD student: Ahmad Falahatpisheh, M.Sc.
- Undergraduate Students: Matt Hill, Todd Gandy (graduated currently medical student at USC)
- *Past members*: Jason Burnside (Magellan Scholar), Todd Gandy (graduated currently medical student at USC)