Marta Varela

Research Fellow

Computational Modelling & MRI of the Heart

National Heart and Lung Institute
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Work Experience

Jan 2020 – **Research Fellow**, *National Heart and Lung Institute*, Imperial College London, UK.

- Characterise mechanical deformations of left atrium in health and atrial arrhythmias using MRI.
- Explore atrial deformation-based biomarkers of outcome in atrial arrhythmias.
- Create mechano-electrical computational models of atrial arrhythmias.

2018 – 2019 **Research Fellow**, *School of Biomedical Engineering & Imaging Sciences*, King's College London, UK (50% FTE until Aug 2019).

- Created novel high-resolution acquisition protocol to image atrial deformations using CINE-MRI.
- Created automatic tools to estimate atrial strains from CINE-MRI.
- Investigated the impact of mechano-electric feedback on arrhythmia mechanisms *in silico*.

2012 – 2018 **Research Associate**, *School of Biomedical Engineering & Imaging Sciences*, King's College London, UK (50% FTE after Aug 2017).

- Created detailed 3D electrophysiology models of atrial fibrillation to investigate disease mechanisms and test treatments *in silico* (Varela *et al*, 2016; Roy *et al*, 2018; Colman *et al*, 2014).
- Developed MRI acquisition protocols to measure atrial wall thickness *in vivo* (Varela *et al*, 2017a).
- Analysed left atrial shape in AF patients to create novel shape-based biomarkers of outcome (Varela *et al*, 2017b).

2011 – 2012 **Research Associate**, *Dept Medical Physics & Biomedical Engineering*, University College London, UK.

- Acquired and developed methods to reconstruct cotside functional images in neonates using a novel near-infrared tomography scanner (Cooper *et al.*, 2014).

Jun – Aug 2010 **Research Fellow**, *Japan Society for the Promotion of Science*, Nara Medical University, Japan.

- Developed non-invasive MRI acquisition and analysis techniques to measure cerebral perfusion and transit time in patients with chronic arterial occlusion (moya-moya disease) (Taoka *et al*, 2011).

Teaching

2017 – 2019 **Senior Teaching Fellow (50% FTE)**, *School of Biomedical Engineering & Imaging Sciences*, King's College London, UK.

- **Module lead** in two modules of the Biomedical Engineering BEng: *Computational Applied Biomathematics* and *Mechanics for Biomedical Engineering*.
- **Lecturer** in several courses of the Biomedical Engineering BEng, Imaging Sciences Intercalated BSc and Imaging Sciences MRes: *Computational Modelling, Advanced Imaging & Computational Methods, Imaging with Ionising Radiation, Imaging with Non-Ionising Radiation, Physics Laboratories, Advanced Mechanics*.

2014/15 **Associate Lecturer**, *Birkbeck College*, University of London, UK.

- Lecturer in the (evening) *Physics* module of the *Physics and Maths Certificate in Higher Education* Programme.
  - Both course and teaching highly rated by students.

2012 – 2016 **Graduate Teaching Assistant**, *School of Biomedical Engineering & Imaging Sciences*, King's College London, UK.

2005/06 **Teaching Assistant**, *Department of Physics*, Instituto Superior Tecnico, Lisbon, Portugal.

Industry

2011 **Imaging Scientist**, *IXICO Ltd - www.ixico.com*, London, UK.
- Optimised medical image analysis pipelines used in pharmaceutical clinical trials.

Education

2016/17 **Postgraduate Certificate in Academic Practice (PGCAP)**, *King's College London*, UK.
- Successfully completed courses in: Optimising Teaching Practice, Curriculum Design and Postgraduate Student Supervision.

2007 – 2011 **PhD in Magnetic Resonance Imaging (MRI) Physics**, *Imaging Sciences Dept*, Imperial College London, UK.

Thesis: Quantitative Methods for Assessing Perfusion in the Neonatal Brain
Supervisor: Prof. Jo Hajnal

- Developed two MRI methods to measure cerebral perfusion in neonates (Varela *et al*, 2015; Varela *et al*, 2012).
- Designed and implemented a technique to rapidly measure *in vivo* an MR relaxation parameter (T_1) of blood in adults and neonates, as a calibration step for perfusion studies (Varela *et al*, 2011).

2001 – 2006 **Licenciatura (5-year BSc+MSc) in Physics**, *Instituto Superior Tecnico, University of Lisbon*, Portugal.
- **Classification:** First Class Honours (17 points out of 20)
- **Final year project:** Use of EEG techniques to investigate cerebral response to auditory stimuli
- 4^{th}-year (MSc) courses taken in the Niels Bohr Institute, University of Copenhagen, Denmark as an exchange student.

2000/01 **First Year of Licenciatura in Medicine**, *University of Lisbon*, Portugal.
- Passed all 1^{st} year examinations with an average classification of 15 points (out of 20), equivalent to First Class Honours.

Funding & Awards

2019 **Research Fellowship**, *Wellcome-EPSRC Centre for Medical Engineering*, Predicting the Outcome of Atrial Fibrillation Patients using CINE-MRI and Convolutional Neural Networks, **£99,569**.

2018 **Knowledge Exchange Fellowship**, *EPSRC Medical Imaging Network (MedIAN) Knowledge Exchange Programme*, 3D Atrial Deformations Using CINE-MRI to Predict Outcome of Atrial Fibrillation, **£28,921**.

2018 **Imaging Grant, as PI**, *Wellcome-EPSRC Centre of Medical Engineering*, Creation of 3D Maps of Atrial Mechanics Using High-Resolution Free-Breathing CINE-CMR, **£5,500**.

2018 **Public Engagement Grant, as PI**, *Institute of Physics*, The Physics of Heart Beats, **£1,600**.

2018 **Advancing Impact Award (KCL), as Co-I**, *EPSRC*, Image-Based Computational System for Guiding Ablation of Atrial Arrhythmias, (*PI: Aslanidi*), **£20,000**.

2018 **RISE Connector Support**, *EPSRC*, Funds to facilitate engagement with the media, **£500**.

2016 **Parenting Leave Fund, as PI**, *King's College London*, Measurements of Atrial Wall Thickness Using Magnetic Resonance Imaging, **£9,861**.

2014 **Cardiovascular Healthcare Technology Support Grant, as Co-I**, *NIHS*, Imaging and Computational Tools for Optimising Catheter Ablation Treatment of Atrial Fibrillation, (*PI: Aslanidi)*, **£15,000**.

2013/14 **Research Excellence Travel Award**, *British Heart Foundation*, **£750** $\times$ **2**.

2010 **Summer Research Fellowship**, *Japan Society for the Promotion of Science & British Council*, Advanced MRI Techniques to Investigate Cerebral Haemodynamics in Moya-Moya Disease, **£6,100**.

2009 **Hounsfield Research Poster Prize**, *Shortlisted*, Non-Invasive Measurements of Cerebral Perfusion in Neonates using MRI, Imperial College London, UK.

2006 **4-Year PhD Stipend Award**, *Portuguese Foundation for Science and Technology*, **€88,500**.

2007 **Research Project Prize**, *British Chapter of the ISMRM*, Rapid Blood T1 Measurements in Neonates, Birmingham, UK.

2004 3^{rd} **Best Physics *Licenciatura* Student**, *Instituto Superior Tecnico*, University of Lisbon, Portugal.

2004 ***Science in the Summer* Outreach Award**, *Portuguese Foundation for Science and Technology*, **€1,000**.

2000 5^{th} **place, Portuguese National Physics Olympiad**, *Coimbra*, Portugal.

2000 **Represented Portugal in the 31^{st} International Physics Olympiads (link)**, *Leicester*, UK.

Other Scientific Roles

2020 – **Review Editor and Member of the Editorial Board**, Computational Physiology and Medicine, Frontiers in Physiology and Frontiers in Bioengineering & Biotechnology, link to journal webpage.

Oct 2018 **Invited Speaker**, *Developments in Healthcare Imaging - Connecting with Industry Seminar*, Isaac Newton Institute, Cambridge, UK.
(link to presentation)

2011 – **Student Supervision**.

- Successfully co-supervised the 1 Smart Imaging CDT PhD student (Aditi Roy), who investigated the role of fibrosis and atrial wall thickness on the mechanisms of atrial fibrillation.
  - Student passed *viva* with minor corrections.
  - Student published 2 peer-reviewed manuscripts and presented her work at several international conferences.
- Successfully supervised the final year research projects of **3 iBSc medical students, 2 Physics MSc students and 3 Biomedical Engineering BEng students**.
  - The outcomes of 2 of these projects were successfully presented at international conferences (e.g. Soor *et al*, 2016).
- Academic tutor to 6 Medical Physics BSc students: all successfully passed all their examinations.

2013 – **Academic Committees**.

- Committee member of the School's **Development, Diversity and Inclusion (DDI, formerly Athena SWAN)** steering group.

2011 – **Peer Reviewer**.

- PLoS Computational Biology; Journal of Cardiac Magnetic Resonance; Journal of Cerebral Blood Flow and Metabolism; Journal of Magnetic Resonance Imaging; Neuroimage; Neuroimage Clinical; European Journal of Radiology; Biomedical Optics Express; Medical Image Computing & Computer Assisted Intervention Conference; Frontiers in Physiology.

2007 – **Membership of Professional Bodies**.

- Institute of Physics, Institution of Engineering and Technology, Biophysical Society, IEEE Engineering in Medicine and Biology Society, AdvanceHE (formerly: Higher Education Academy).

Scientific Outreach

Jan 2020 **Public & Patient Involvement Event**, *St Thomas' Hospital*, London, UK.

- Presented an overview of current and planned research projects to 8 arrhythmia patients.
- Gathered patient views on the use of computational simulations and artificial intelligence for arrhythmia treatment selection.

Aug 2019 **in2Science UK Mentor (link)**.

- Supervised and mentored two A-level students interested in a career in science.

Dec 2018 – **EPSRC RISE Fellow**.

- Receive training and funding to engage with policy makers and the media.

2017 – **STEM Ambassador (link)**.

- Visit UK primary and secondary schools (6 to date) to introduce students to careers in science and to raise awareness and interest in science and scientific research.
- Created an interactive Android app (link) that simulates virtual cardiac ablations and a microprocessor-controlled 3D-printed heart model to demonstrate activation sequences in arrhythmias (link to KCL Imaging Blog).

2017 – **Speaker with Native Scientists (link)**.

- Give talks in Portuguese explaining my research to UK school children.

Mar 2017 **Runner-Up in I'm a Scientist - Get Me Out of Here (link)**.

- Online competition in which scientists answer questions from UK school children.

2015 **Article in Popular Science Publication**, *Physics World, Institute of Physics*.

- **Title:** Bringing the Quantum to Life *(link)* (April 2015 issue, pages 40-41)

2003/04 **Secretary of the Astronomy Student Club**, *Technical University of Lisbon*, Portugal. (link, in Portuguese)

- Organised and delivered night-sky observations and planetarium sessions in schools and in community events for the general public.

2003/04 **A-Level Physics Tutor**, *Centro Universitario Padre Antonio Vieira*, Lisbon, Portugal.

- Gave one-to-one tuition in A-level Physics to immigrant students, as a volunteer.

Social Involvement

2010 – 2014 **Coordinator of the Amnesty International Camden Group**, *London*, UK.

- Wrote letters and petitions about Human Rights violations.
- Organised group meetings, fundraising and public events including debates with MPs in the House of Commons.

2001 – 2013 **Volunteer with several NGOs promoting Human Rights and Social Equality**, *Amnesty International, Oxfam, Fairtrade Foundation*.

- Set up and co-managed the only Fairtrade shop in Lisbon.
- Ran Human Rights-themed holiday camps for children.
- Organised fundraising activities such as pub quizzes and market stalls.

Other Skills

Programming

- C (including MPI), Python (including Pytorch), Matlab, Mathematica, Bash, Java, Assembly, HTML

Languages

- Portuguese (native); English (fluent); French, German and Spanish (good); Danish and Gujarati (beginner)

Selected Peer-Reviewed Publications

For further details, see my Google Scholar page (link).

- Roy A, Varela M, Aslanidi OV, **Image-Based Computational Evaluation of the Effects of Atrial Wall Thickness and Fibrosis on Re-entrant Drivers for Atrial Fibrillation**, *Frontiers Physiol 2018*, DOI: 10.3389/fphys.2018.01352

  We show that regions of atrial fibrosis and gradients in atrial wall thickness can both act as anchoring sites for the re-entrant electrical circuits that drive atrial fibrillation.

- Varela M, Morgan R, Theron A, Dillon-Murphy D, Chubb H, Whitaker J, Henningsson M, Aljabar P, Schaeffter T, Kolbitsch C, Aslanidi OV, **Novel MRI Technique Enables Non-Invasive Measurement of Atrial Wall Thickness**, *IEEE T Med Imaging 2017*, 36(8): 1607-1614

  We create the first MRI protocol for the acquisition and calculation of atrial wall thickness (AWT) maps. We acquire proof-of-principle data in 2 atrial fibrillation patients and 10 healthy volunteers. This data is used to create the first atlas of atrial wall thickness.

- Varela M, Bisbal F, Zacur E, Berruezo A, Aslanidi OV, Mont L, Lamata P, **Novel computational analysis of left atrial anatomy improves prediction of atrial fibrillation recurrence after ablation**, *Frontiers Physiol 2017*, 8: 68

  We perform a detailed analysis of left atrial morphology in atrial fibrillation patients. Vertical asymmetry, a novel atrial shape-based predictor of post-treatment outcome in these patients is presented based on this analysis.

- Varela M, Colman MA, Hancox JC, Aslanidi OV, **Atrial heterogeneity generates reentrant substrate during atrial fibrillation and anti-arrhythmic drug action: mechanistic insights from canine atrial models**, *PLoS Comp Bio 2016*, 12: e1005245

  We create a novel electrophysiology (EP) computational model for four regions of the canine atria. Using a realistic 3D atrial anatomy and myofibre architecture, we create an in silico model of atrial fibrillation.

This model is used to test the efficacy of multi-channel anti-arrhymthmic drugs in silico and link their efficacy to measured electrophysiological properties.

- Soor N, Morgan R, Varela M, Aslanidi OV, **Towards patient-specific modelling of lesion formation during radiofrequency catheter ablation for atrial fibrillation**, *EMBC 2016*, 489-492

  We model the localised delivery of energy in atrial catheter ablation procedures and determine effect of atrial geometry and thickness on the optimal ablation power.

- Whitaker J, Rajani R, Chubb H, Gabrawi M, Varela M, Wright M, Niederer S, O'Neill MD, **The role of myocardial wall thickness in atrial arrhythmogenesis**, *Europace 2016*, 15: 809-812

  We perform a review of the literature methods and values of atrial wall thickness (AWT) and of the role of AWT in atrial arrhythmias.

- Varela M, Petersen ET, Golay X, Hajnal JV, **Cerebral Blood Flow Measurements in Infants using Look-Locker Arterial Spin Labelling**, *J Magn Res Imag 2015*, 41: 1591-1600

  We create accurate detailed 3D maps of cerebral perfusion in neonates using arterial spin labelling, a contrast agent-free MRI technique.

- Colman MA, Varela M, Hancox JC, Zhang H, Aslanidi OV, **Evolution and pharmacological modulation of the arrhythmogenic wave dynamics in canine pulmonary vein model**, *Europace 2014*, 16: 416-423

  We show how the electrical and structural remodelling of the atrial tissue near the pulmonary veins aids the formation of the re-entrant electrical circuits that cause atrial fibrillation.

- Cooper RJ, Magee E, Everdell N, Magazov S, Varela M, Airantzis D, Gibson AP, Hebden JC, **MONSTIR II: A 32-channel, multispectral, time-resolved optical tomography system for neonatal brain imaging**, *Rev Sci Instrum 2014*, 85: 053105

  We build a novel, portable 32-channel near-infrared optical tomography machine. We demonstrate its application by acquiring and reconstructing cot-side functional images in 2 neonates.

- Aslanidi OV, Colman MA, Varela M, Zhao J, Smaill BH, Hancox JC, Boyett MR, Zhang H, **Heterogeneous and anisotropic integrative model of pulmonary veins: computational study of arrhythmogenic substrate for atrial fibrillation**, *Interface Focus 2013*, 3: 20120069

  We show how the heterogeneity and anisotropy of the atrial tissue near the pulmonary veins allows spontaneous (ectopic) electrical activity to lead to atrial fibrillation.

- Varela M, Zhao J, Aslanidi OV, **Determination of atrial myofibre orientation using structure tensor analysis for biophysical modelling**, *Lecture Notes Comp Science 2013*, 425-432

  We create a novel structure-tensor analysis protocol to identify myofibre architecture in iodine-stained microCT images of the atria.

- Arichi T, Fagiolo G, Varela M, Melendez-Calderon A, Allievi A, Merchant N, Tusor N, Counsell SJ, Burdet E, Beckmann CF, Edwards AD, **Development of BOLD signal hemodynamic responses in the human brain**, *Neuroimage 2012*, 63: 663-673

  We image, for the first time, the BOLD haemodynamic response functions of neonates undergoing a simple motor task.

- Varela M, Groves AM, Arichi T, Hajnal JV, **Mean Cerebral Blood Flow Estimates using Phase Contrast MRI in the First Year of Life**, *NMR in Biomed 2012*, 25: 1063-1072

  We present a novel fast protocol to estimate global cerebral perfusion in neonates non-invasively using standard MR imaging. We then determine how blood flow to the brain, as well as global cerebral perfusion, vary with age in the first year of life.

- Taoka T, Varela M, Sakamoto M, Akashi T, Miyasaka T, Ochi T, Wada T, Kichikawa K, Evaluation of perfusion following STA-MCA bypass surgery using multi-TI arterial spin labeling, 39^{th} *Meeting of Japanese ISMRM*, 2011, Kokura, Japan

  Using conventional perfusion MRI techniques, delayed arterial transit times (ATT) can be confused with low cerebral perfusion in moya-moya patients. We present a dedicated, time-resolved contrast-free perfusion MRI protocol that resolves this issue by simultaneous estimating of ATT and perfusion in these patients.

- Varela M, Hajnal JV, Petersen ET, Golay X, Merchant N, Larkman DJ, **A Method for Rapid in Vivo Measurement of Blood T_1**, *NMR in Biomed 2011*, 24: 80-88

  We create a novel very rapid protocol to image blood T_1 (one of the main MR imaging parameters) in vivo. We show, for the first time, how blood T_1 depends strongly on the hematocrit in vivo and is thus highly variable in neonates.