Interview: Dr. Bryn Martin

Definitions

biomechanics - study of the structure and function of biological systems such as humans, animals, plants, organs, and cells

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

craniospinal - relating to the cranium and the spinal column

cranium - the skull

flow - movement of a fluid like blood or CSF

fluid dynamics - the study of how liquids (or fluids) move through different types of containers; often uses mathematical modeling to simulate the motion

hydrodynamic - relating to the movement of a liquid

neurohydrodynamic- combination of fluid mechanics principles and neuroscience to improve neurological disorder healthcare diagnosis, monitoring and therapy

Mechanical Engineering - a discipline of engineering that applies the principles of physics and materials science for analysis, design, manufacturing, and maintenance of mechanical systems.

MRI - Magnetic Resonance Imaging, non-invasive, diagnostic test which uses a magnetic field to create internal images of a person

pathophysiology - the biological and physical manifestations of disease as they correlate with the underlying abnormalities and physiological disturbances.

pulsatile - not steady; vibrating or beating

syringomyelia - neurological condition where a fluid filled cyst forms in the spinal cord

Dr. Bryn Martin is the director of the Conquer Chiari Research Center at the University of Akron. His research interest is in neurohydrodynamics of craniospinal disorders and biofluid dynamics. He completed his post-doctoral training at the Swiss Federal Institute of Technology in Lausanne, Switzerland from 2009 - 2012. Dr. Martin earned a Ph.D. in Mechanical Engineering from the University of Illinois at Chicago in 2008. His Ph.D. thesis focused on syringomyelia hydrodynamics and was completed under the direction of Prof. Francis Loth. Dr. Martin has been employed in a number of medical device companies and is an active medtech inventor and consultant. He serves on a number of international research committees in the field of cerebrospinal fluid dynamics.

Let's start by introducing you to the community; what is your background?

M: I grew up in the suburbs of Chicago and always liked fixing broken things. I went to the local career center and studied electronics technology in high school so I could learn how to make guitar effect pedals and then went to the College of DuPage to complete an associates degree. I transferred to the University of Illinois at Chicago where I began researching craniospinal disorders as an undergraduate working with Dr. Francis Loth. He was my favorite teacher at the time! My motivation in my work was greatly increased after attending an American Syringomyelia Alliance Project annual patient meeting around the year 2002. The patients helped me realize that research in syringomyelia and Chiari is extremely important. I went back to the laboratory and eventually completed a Ph.D. in Mechanical Engineering focused on a biomechanical analysis of syringomyelia. After this I was able to study as a post-doc at the Swiss Federal Institute of Technology and fortunately received a grant to help continue my research in craniospinal disorders.

What were your first thoughts when you were approached about being the Director of the CCRC?

M: It was extremely humbling for me to be considered for a position leading the world's first center in Chiari and syringomyelia research. I had several work opportunities, but when CCRC approached me, this job became my top priority. For many years I have worked to make the kind of impact in Chiari and syringomyelia research that reaches patients. Working with CCRC gives me the perfect opportunity to make a difference for patients.

What do you bring to the CCRC in terms of strengths and experience?

M: I think my greatest strengths are thinking "outside of the box" and team building. It sounds cliché, but in order to leap forward in our understanding of Chiari and syringomyelia we must think differently about the past research and future directions. This can't be accomplished alone and requires a team of experts that crosses many disciplines, from genetics to fluid mechanics to neurosurgery.

What is your long range vision for the CCRC?

M: In the next three years I aim to lead the CCRC to make a major breakthrough in the fundamental understanding of Chiari and syringomyelia pathophysiology. In the long range I expect CCRC to help translate this knowledge to clinical use and improve the standard of care and treatment for patients.

What are some of the initial projects the CCRC will be working on?

M: When I began here at CCRC just over a month ago, we had a brainstorming session and put together about twenty potential project ideas. We have prioritized them and now have four projects in the top tier for the remainder of this year and another handful waiting down the pipeline.

- **Tonsil motion tool:** Pulsatile motion of the cerebellar tonsils has been thought to be elevated in Chiari I (CMI) patients. The aim of this study is to 1) noninvasively quantify the difference between tonsillar motion (TM) in symptomatic CMI patients and age/gender matched healthy controls and 2) further quantify differences in TM pre and post decompression surgery. TM will be assessed by development of a novel tool that utilizes motion sensitive 3D MRI morphology scans. We hypothesize that TM will be greater in Chiari patients than healthy controls and that TM will be reduced post successful decompression surgery. If successful, the TM tool will have potential to help assess CMI disease states and surgical success.
- **Nerve damage tool:** The extent and time course of nerve damage in Chiari I malformation (CMI) and syringomyelia (SM) is difficult to assess. The aim of this study is to 1) develop a nerve damage (ND) tool based on noninvasive MRI diffusion tensor imaging (DTI) and magnetization transfer (MT) and 2) demonstrate the ND tool on SM and CMI patients with clinical symptoms versus age/gender matched healthy controls. We hypothesize that ND will be detectable in patients versus healthy controls due to alterations in the spinal cord properties such as fraction of anisotropy in diffusion. If

syrinx - fluid filled cyst in the spinal cord

ultrasound - diagnostic device which uses sound waves to create internal images of the body

Qualifications

- Director, Conquer Chiari Research Center
- Member, International Hydrocephalus Imaging Working Group
- Reviewer for Neurosurgery, American Journal of Physiology and bioengineering journals
- Consultant for various medical technology companies

Education

- Post-doctoral fellow, Swiss Federal Institute of Technology, Switzerland 2009-12
- Ph.D. Mechanical Engineering, University of Illinois at Chicago 2008
- M.S. Mechanical Engineering, University of Illinois at Chicago 2005
- B.S. Mechanical Engineering, University of Illinois at Chicago 2002

Research Interests

- Neurohydrodynamics of Chiari malformation and syringomyelia
- Hydrocephalus and related craniospinal disorders
- Sleep and Breathing disorders
- Aortic aneurism
- Medical Imaging and Medtech

successful, the ND tool will have potential to help assess SM and CMI disease states and surgical success.

- **HydroSpine:** A number of engineering groups have simulated CSF hydrodynamics in the spine under varying levels of complexity. However, none of these simulations have been validated. The aim of this study is to develop a hydrodynamics simulation of the spine (HydroSpine) that includes enough anatomical detail to accurately simulate the spinal hydrodynamics and validate this tool on a subject specific basis with in vivo MRI measurements. We will then use HydroSpine as a platform to assess the impact of anatomical structures such as presence of Chiari malformation, denticulate ligaments, spinal cord nerve roots and arachnoid trabeculae on CSF hydrodynamics. This tool will help to reveal important information about the hydrodynamic environment of the spine that could identify new treatment possibilities. HydroSpine also has potential to help design intrathecal catheters and/or spinal shunts.
- **Chiari Patient database:** We are working with Conquer Chiari and a contractor to design a Chiari patient database where patients can input their own information including medical images. We hope this database will have a vast number of patients and thus help researchers reveal new findings and lead to important discoveries.

The Conquer Chiari Research Center has generated a great deal of excitement in the Chiari community, do you feel pressure to produce results?

M: Yes, absolutely, but it is not something that I would say looms over me in a negative way. Pressure from the Chiari community helps me to be more inspired on a daily basis. It's actually the reason I started down this road from the beginning. When I read an email from a patient I am always thinking, “How can I learn from this,” and, “in what way could I shape a research project around this specific problem?” It’s very motivating.

How will you communicate advances to the Chiari community?

M: We are in process of launching a research webpage, Chiari-research.org, that will contain information on all of our ongoing research projects. This should be running sometime during Fall 2012. I also aim to attend many of the Chiari and syringomyelia research organization events such as the American Syringomyelia Alliance Project, Chiari and Syringomyelia Foundation, Column of Hope and others. All of these organizations are doing an amazing job of supporting research and the CCRC wants to work alongside them towards finding a cure.

Who should patients in the Ohio area contact if they are interested in volunteering for research?

M: Currently, we are not directly recruiting patients for our projects, but rather recruitment will be through our clinical partners on a per project basis. In the future, if we are undertaking a project that involves general recruitment we will announce it on the Conquer Chiari website.
Also, when the Conquer Chiari Patient Database launches later this month, people can participate in research by taking the time to enter information in the database.

Can people visit the CCRC?

M: The lab facility isn’t ready to receive visitors just yet, but we have been talking about having an annual open house to allow people to see what we are working on and talk to the researchers. *Also, in the future, if there is a specific group that would like to arrange a short visit, we ask they notify us in advance so we can set it up.*

Is there anything else you want to say to the Chiari community?

M: I am truly grateful to be working with you to help find a cure. I am thankful for the donations that have made the CCRC possible and will be working my very best to make the greatest impact with every cent.

Selected Publications

- Bryn A. Martin, P. Reymond, J. Novy, O. Balédent, N. Stergiopulos, "A coupled hydrodynamic model of the cardiovascular and cerebrospinal fluid system," *American Journal of Physiology (in press, January 2012).*
- A. Bunck, J. R. Kröger, Bryn A. Martin, et al., "Magnetic resonance velocity mapping of 4D cerebrospinal fluid flow in Chiari I malformation with and without syringomyelia,"
European Journal of Radiology (published, May 2012).
- K. Shahim, J.-M. Drezet, Bryn A. Martin, S. Momjian, "Ventricle equilibrium position in healthy and normal pressure hydrocephalus brains using an analytical model,"
Journal of Biomechanical Engineering (published, April 2012).
- N. Shaffer, Bryn A. Martin, F. Loth, "Cerebrospinal Fluid Hydrodynamics in Type I Chari Malformation,"
Neurological Research (published, April 2011) (1.621).
- Bryn A. Martin, F. Loth, "The Influence of Coughing on Cerebrospinal Fluid Pressure in an In vitro Syringomyelia Model with Spinal Canal Stenosis," *Fluids and Barriers of the CNS (published, 2009).*
- Bryn A. Martin, F. Loth, "Detailed Subarachnoid Space Pressure Measurements in an In vitro Spinal Stenosis Model: Implications on Hydrodynamic Syringomyelia Theories," *Journal of Biomedical Engineering (published, 2009).*

- Bryn A. Martin, W. Kalata, F. Loth, T.J. Royston, J.N. Oshinski, "Syringomyelia hydrodynamics: an in vitro study based on in vivo measurements,"
  Vol. 127, No. 7, pp. 1110-1120, Journal of Biomechanical Engineering, (published, December 2005).