



# 6th World Congress of Biomechanics

## *Abstracts*

In conjunction with

14th International Conference on Biomedical Engineering (ICBME)

&

5th Asian Pacific Conference on Biomechanics (APBiomech)

**1 - 6 August 2010**

**Singapore Suntec Convention Centre**

Jointly Organised by



Biomedical Engineering Society  
(Singapore)

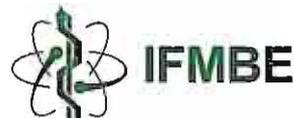


Global Enterprise for Micromechanics  
and Molecular Medicine



National University of  
Singapore

Endorsed By



International Federation for Medical  
and Biological Engineering

# **6<sup>th</sup> World Congress of Biomechanics**

in conjunction with

**14<sup>th</sup> International Conference on Biomedical Engineering (ICBME)  
&  
5<sup>th</sup> Asia Pacific Conference on Biomechanics (APBiomech)**

**1 – 6 August 2010  
Singapore Suntec Convention Centre**

**Abstracts**

## ABOUT 6<sup>th</sup> WORLD CONGRESS OF BIOMECHANICS

The 6th World Congress of Biomechanics is hosted by Biomedical Engineering Society of Singapore (BES) together with the Global Enterprise for Micromechanics and Molecular Medicine (GEM4) and the National University of Singapore (NUS), in conjunction with the 14th International Conference on Biomechanical Engineering (ICBME) and the 5th Asian Pacific Conference on Biomechanics (APBiomech). With over 2,000 delegates from all over the World, especially from the Asia Pacific region, to attend this congress, this Biomechanics conference explores a wide field such as organ mechanics, tissue mechanics, cell mechanics to molecular mechanics.

At the 6th World Congress of Biomechanics, authors would be presenting the largest experimental studies, technologies and equipment. Special emphasis will be placed on state-of-the-art technology and medical applications, for example in areas of sports medicine and crash injuries.

Abstracts

Abstracts

Abstracts

Abstracts

Abstracts

Published by

**6<sup>th</sup> World Congress of Biomechanics**  
1 – 6 August 2010  
SINGAPORE

Copyright © 2010

All rights reserved. This book, or parts thereof, may not be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage and retrieval system now known or to be invented, without prior written permission from the organizers.



side, 9%-case). However, good correlation ( $R = 0.97$ ) between US- and FSI-values was obtained for all distension degrees, suggesting correction of the severe underestimation might be feasible for the simulated flow conditions.

**CONCLUSION:** We developed a simulation environment to optimize ultrasonic vascular imaging, coupling FSI- and US-simulations. The simulation tool was demonstrated with clinically relevant imaging modalities: wall distension and shear rate assessment. Results showed our FSI-US simulation environment provides realistic RF-signals which can be processed into ultrasound-derived medical images and measurements. Further research will focus on applications for ultrasonic investigation of the carotid bifurcation.

WCB-A00747-01647

**PDMS Anatomical Realistic Models for Hemodynamic Studies Using Rapid Prototyping Technology**

Luis QUEIJO<sup>1,2</sup>; Rui LIMA<sup>1,2,3</sup>

1. *Departamento de Tecnologia Mecanica, Instituto Politecnico de Braganca, Braganca, Portugal*
2. *cibeR - Centro de Investigacion en Biomechanica y Ergonomia, Universidad de Valladolid, Valladolid, Spain*
3. *CEFT - Centro de Estudos de Fenomenos de Transporte, FEUP - Faculdade de Engenharia da Universidade do Porto, Porto, Portugal*

The main purpose of this work is to investigate a simple way of making polydimethylsiloxane (PDMS) anatomically artery models such as a carotid arteries with and without aneurysm. By using a human carotid computerized tomography (TC) it was possible to develop 3D anatomical models through the application of a rapid prototyping (RP) technique, known as tridimensional printing (TDP). By combining the TDP with a PDMS casting technique we were able to obtain at the end an anatomically transparent model of a human carotid artery made by a silicon elastomer, i.e. PDMS. We believe that this combination is a promising technique to perform more realistic in vitro blood studies through anatomical models and consequently improve our current understanding of the origin and development of cardiovascular diseases.

WCB-A00750-01239

**Study on Cardiovascular System**

Giuseppe VERMIGLIO<sup>1</sup>; Giovanni PALLOTTI<sup>2,3</sup>; Maria Giulia TRIPEPI<sup>1</sup>; Giuseppe ACRI<sup>1</sup>

1. *Department of Environmental, Sanitary, Social and Industrial Protection, University of Messina, Messina, Italy*
2. *Faculty of Medicine and Surgery, University of Bologna "Alma Mater Studiorum", Bologna, Italy*
3. *Clare Hall, Cambridge, United Kingdom*

This haemodynamic investigation concerns the problems connected to the study of the blood flow in the cardiovascular system, where artificial organs and prostheses inserted in human body provide patients a better quality of survival also in presence of pathological conditions. In fact, when we have the implant of an organ inside a human body, blood constitutes the first element involved by the extraneous insertion, and circulatory behaviour becomes meaningful and relevant. Consequently, the biomechanical characteristics of the human tissues and the properties of the prostheses are determinant for the patient life. The possible haemolytic mechanical effects so arising include inflammation at the shunt site which must be treated with antibiotics, and stenosis, both within the shunt and downstream in the arteries. Therefore, several typical shunt were studied to determine whether flow disturbance within the shunt can give rise to these complications.

WCB-A00753-01201

**An In Vitro Investigation of Mitral Valve Coaptation in Healthy, Pathological, and Repaired States**

John ADAMS; Malachy O'ROURKE  
*School of Electrical, Electronic and Mechanical Engineering, University College Dublin, Dublin, Ireland*

**INTRODUCTION:** The healthy Mitral Valve (MV) is a complex structure whose operation relies upon each element of its apparatus working in harmony. When this balance is disturbed, the result is a sub optimal coaptation of the mitral leaflets and the formation of a regurgitant orifice through which Mitral Regurgitation (MR) occurs.

**EXPERIMENTAL METHODS:** An in vitro facility designed for the purpose of studying an isolated natural porcine MV has been developed. This facility provides a transparent plexiglass chamber in which the MV is sutured onto saddle shaped annulus. Each papillary muscle is attached to adjustable arms with inbuilt three-axis force sensors for measurement of papillary muscle tethering forces. A computer controlled pulsatile pump provides

flow. Two electromagnetic flow meters measure volume flow rates at mitral inflow and aortic outflow locations.

The MV coaptation force is measured at three locations along the line of coaptation using a novel, purpose built probe. The probe is made up of a very thin, narrow and flat sensor approx. 1mm x 2mm x 15mm that is inserted between the leaflets of a MV and the force exerted on the probe from each leaflet is measured.

**EXPERIMENTAL PROCEDURE:** Ten Fresh (<3hrs old) native porcine MVs were first examined in the whole isolated porcine heart. A trans-mitral pressure difference was achieved by inflating the left ventricle using saline solution and clamping the aorta closed. Coaptation force versus pressure for a range of trans-mitral pressures was recorded. The MV was then dissected and inserted in the in vitro environment and static trans-mitral pressures were reproduced across it. The coaptation forces were again measured.

The MV was then subjected to physiologically realistic flow conditions and the dynamic coaptation forces were recorded. Ischemic MV regurgitation was then simulated by altering the papillary muscle position. The coaptation forces were again measured. Mitral annuloplasty was attempted in an effort to repair the MR and the coaptation forces were again measured. Following Mitral annuloplasty, chordal cutting was then carried out and mitral coaptation was again measured.

**RESULTS:** During loading of the healthy MV it was observed that the mitral coaptation force increased rapidly with pressure difference across the MV up to a limit, after which the coaptation forces increased very slowly. The pathological valve showed an altered coaptation force profile throughout the dynamic cycle, even during stages of functional operation. After MV annuloplasty of the pathological valve, mitral coaptation geometry and forces were altered but MR was no longer present. After chordal cutting the mitral coaptation forces were seen to be closer to the healthy valve but were still altered.

**CONCLUSION:** The results described by this work highlight the delicate balance of forces required for healthy MV operation. The pathological MV simulation showed that each repair technique, although mending the MR did not fully restore MV coaptation forces.

This work is, to this author's knowledge, a first ever direct evaluation of the strength with which mitral leaflets meet. This information should prove valuable in the development of implantable repair devices and prognostic strategies.

WCB-A00753-02881

**Evaluation of a Blood Equivalent Fluid for In Vitro Modelling of Mitral Valve Haemodynamics**

John ADAMS; Malachy O'ROURKE  
*School of Electrical, Electronic and Mechanical Engineering, University College Dublin, Dublin, Ireland*

**Introduction:** Many of the next generation of percutaneously delivered repair devices are being designed for implantation within an intact mitral valve apparatus. To properly evaluate the performance of these devices within an in vitro setting it is necessary to model both the operation of the natural mitral heart valve and also replicate the haemodynamics of atrio-ventricular blood flow.

To do this, a blood equivalent fluid that has physical properties e.g. viscosity and specific gravity similar to those of blood is required. This fluid must also be transparent and must not degrade the natural mitral valve prematurely during testing.

**Experimental methods:** A solution of Xanthan Gum (Xg) and Phosphate Buffer Solution (PBS) was proposed as a suitable blood equivalent fluid as it has been shown not to alter tissue cell properties and matches both the viscous and elastic components of the 2 Hz complex viscosity of blood. Viscosity measurements were conducted using a Brookfield R/S Rheometer at 37°C and for a range of shear rates from 100-2000 S<sup>-1</sup>.

A mock flow loop was developed for evaluation of the fluid dynamic performance of both the Xg-PBS and also of a pure PBS solution. Two orifice plates, selected from the BS EN ISO 5840:2009 standard, were installed in the flow loop, one to model forward flow through an open valve and one to model regurgitant flow through a leaking valve. Initially, static pressure differences were applied across each orifice plate. Following this, physiologically representative pulsatile flow velocities were generated across the orifice plates. Volume flow rates, velocity profiles and flow visualisation data were recorded using electromagnetic flow meters, LDV and high speed imaging.