SSRCTS

SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY

Program & Abstracts

February 6 - 8, 2020

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SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY

SSRCTS

THURSDAY
February 6, 2020

CARDIAC & VASCULAR BIOMECHANICS

14.00
Arrival and registration

14.45
Welcome
Peter Johansen

15.00
Keynote talks
Emiliano Votta
Marcell Juan Tjørnild

15.40
Joint discussion

16.00
Refreshments

16.15
Podium presentations

17.15
Refreshments

17.30
Poster presentations

18.30
Keynote talk
Helena Brisby

20.00
Dinner

FRIDAY
February 7, 2020

PCI & CABG

14.00
Keynote talk
Vesa Anttila

14.20
Discussion

14.30
Refreshments

14.45
Gudbjartsson Award

16.00
Refreshments

16.15
Podium presentations

17.00
Poster presentations

17.30
Wetlab with multiple themes

20.00
Dinner & entertainment

SATURDAY
February 8, 2020

HEMODYNAMICS & FLOW MEASUREMENTS

14.00
Keynote talks
Jørgen Arendt Jensen
Steffen Ringgaard

14.40
Joint discussion

15.00
Refreshments

15.15
Podium presentations

16.00
Poster viewing with authors

16.45
Podium presentations

17.30
Anniversary address
Jarle Vaage

17.50
Award Committee Meeting

18.15
Awards

18.30
Evaluation

20.00
Presidential Dinner

Contents

Welcome!

Dear colleagues and friends,

Welcome to the 30th Anniversary SSRCTS Meeting on Cardiac, Vascular and Thoracic Research taking place from February 6th to 8th, 2020 at the Hotel Bardøla in Geilo, Norway.

This meeting has throughout its history established a unique platform for young scientist to present their research and engage in fruitful discussion in a very encouraging atmosphere, in which to learn and practice while having a great time. And we continue in doing so!

This year, each day has a theme which is addressed during the keynote talks and a good portion of the free papers. Moreover, a special session is scheduled each day, including a wet lab with expert guided aortic valve implantation and introduction to PCI.

Like previous years, we also have an award session, where nominated abstracts are presented.

The focus of the meeting is on Cardiac, Vascular and Thoracic Research. This indeed facilitates an interdisciplinary meeting, which is also witnessed and reflected by the attendees counting medical doctors from different clinical specialties, engineers, and physicists.

On behalf of the organizing committee, we are very excited and welcome you all to SSRCTS 2020!

Peter Johansen
President of SSRCTS

Organizing committee

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Cardiac & Vascular Biomechanics

Thursday, February 6

14.00 - 14.45	Arrival and registration
14.45 - 15.00	Welcome Peter Johansen
15.00 - 15.40	**Keynote talks** Emiliano Votta Marcell Juan Tjørnild
15:40 - 16.00	**Joint discussion** Chairmen: Marie Sand Traberg & Alexander Emil Kaspersen *20+20+20 minutes*
16.00 - 16.15	Refreshments
16.15 - 17.15	**Podium Presentations** Chairmen: Emiliano Votta & Siiri Niittynen *8+5 minutes for each presentation*
O1	Validation of pressure drop measurement using ultrasound vector flow imaging and fluid-structure interaction models *Marie Sand Traberg*
O2	In vitro phantom for evaluation of catheter-based therapies for removal of acute pulmonary emboli *Karen Eich Hammer*
O3	Deep Sternal Wound Infections after Median Sternotomies in Iceland: Incidence, Treatment and Mortality. Preliminary Results. *Astridur Petursdottir*
O4	Reducing postoperative morbidity after cardiac surgery *Torben Hoffmann*
17.15 - 17.30	Refreshments
17.30 - 18.30	**Poster presentations** Chairmen: Marcell Juan Tjørnild & Erla Liu Ting Gunnarsdóttir *3+3 minutes for each presentation*
P1	Simulation and Growth of Tissue Engineered Heart Valve *Jonathan Mirpourian*
P2	Performance evaluation of temporary epicardial pace wire with integrated sensor for pacing, sensing, and continuous postoperative monitoring of myocardial function *Malene S. Enevoldsen*

P3	How much stress is the native anterior mitral valve leaflet exposed to after mitral valve-in-valve replacement? *Johannes H. Jedrzejczyk*
P4	TAVI-OP – Transcatheter Aortic Valve Implantation and Design Optimization *Martin Lindvald Pedersen*
P5	Replacement of the Posterior Mitral Valve Leaflet Using 2-ply Porcine Extracellular Matrix: A Chronic Porcine Evaluation *Johannes H. Jedrzejczyk*
P6	Pulmonary cusp repair: In vivo evaluation *Lisa Carlson Hanse*
18.30 - 18.50	**Keynote talk: ”How to combine clinical work, research, and life - traps and tricks”** *Helena Brisby*
18.50-19.00	**Discussion** Chairmen: Mari-Liis Kaljusto *20+10 minutes*
20.00	Dinner

PCI & CABG

FRIDAY, FEBRUARY 7

14.00 - 14.20	**Keynote talk** *Vesa Anttila*
14.20-14.30	**Discussion** Chairmen: Tomas Gudbjartsson & Andreas Lind Johannessen *20+10 minutes*
14.30 - 14.45	Refreshments
14.45 - 16.00	**Guðbjartsson Award Session** Chairmen: Ari Mennander & Helena Brisby *8+5 minutes for each presentation*
G1	Adenosine bolus with initial cardioplegia may be beneficial to myocardial recovery in coronary artery bypass surgery *Mikko Mattila*
G2	Administration of interferon-ß-1a attenuates ischemia-reperfusion injury in acute myocardial infarct in pigs *Siiri Niittynen*
G3	The use of Intra Aortic Balloon Pump in Coronary Artery Bypass Graft Surgery *Sunna Lu Xi Gunnarsdóttir*
G4	Long-term outcome of patients with DSWI following cardiac surgery – results from the SWEDEHEART registry *Alexander Emil Kaspersen*
G5	Incidence and predictors of prolonged intensive care unit stay after coronary artery bypass in Iceland *Erla Liu Ting Gunnarsdóttir*
16.00 - 16.15	Refreshments
16.15 - 17.00	**Podium Presentations** Chairmen: Vesa Anttila & Niels Moeslund *8+5 minutes for each presentation*
O5	Contemporary incidence and treatment of new-onset postoperative atrial fibrillation after cardiac surgery *Mary Rezk*
O6	A bench model evaluation of coronary bifurcation lesions *Kimmie Lisborg Frydenberg*

O7	Optical Coherence Tomography Optimized Bifurcation Event Reduction – The OCTOBER Trial *Omeed Neghabat*
17.00 - 17.15	**Poster presentations** Chairmen: Vesa Anttila & Niels Moeslund *3+3 minutes for each presentation*
P7	Preventing thromboembolism in patients undergoing curative surgery for oesophageal cancer *Tua Gyldenholm*
P8	Veno-occlusive mechanical preload reduction (VOMPR) of the left ventricle to reduce ischemia reperfusion injury in acute myocardial infarction *Tobias Lynge Madsen*
17.30 - 19.30	**Wetlab with multiple themes**
20.00	Dinner

Hemodynamics & Flow Measurements

Saturday, February 8

14.00 - 14.40	**Keynote talks** *Jørgen Arendt Jensen* *Steffen Ringgaard*
14.40 - 15.00	**Joint discussion** Chairmen: Anders Jeppsson & Mary Rezk *20+20+20 minutes*
15.00 - 15.15	Refreshments
15.15 - 16.00	**Podium Presentations** Chairmen: Jørgen Arendt Jensen & Sunna Lu Xi Gunnarsdóttir *8+5 minutes for each presentation*
O8	Automated seizure detection for epilepsy patients using wearable electrocardiogram device *Jesper Jeppesen*
O9	Ex-vivo assessment of donor priming effects on heart graft viability using hyperpolarized 13C magnetic resonance imaging *Sabrina Kahina Bech*
O10	Oxygenation during normothermic regional perfusion after circulatory death for cardiac transplantation in a porcine model *Niels Moeslund*
16.00 - 16.45	**Poster viewing with authors**
16.45 - 17.30	**Podium Presentations** Chairmen: Steffen Ringgaard & Mikko Mattila *8+5 minutes for each presentation*
O11	Cardiac reversibility after acute volume-overload; an experimental study *Ari Mennander*
O12	Lymphatic Function and Morphology in the arms of Breast Cancer Treated Women – A follow-up study *Andreas Lind Johannessen*
O13	Ischemic postconditioning has no effects on postoperative hemodynamics or cardomyocyte injure in elective cardiac surgery. A prostective, randomized, multicentre study *Mari-Liis Kaljusto*

17.30 - 17.50	**Anniversary address** *Jarle Vaage* Chairman: Peter Johansen
17.50 - 18.15	Award Committee Meeting
18.15 - 18.30	Awards
18.30	Evaluation
20.00	Presidential Dinner

Validation of pressure drop measurement using ultrasound vector flow imaging and fluid-structure interaction models

Marie Sand Traberg[1], Tin-Quoc Nguyen[2], Jacob Bjerring Olesen[3], Ramin Moshavegh[3], Kristoffer Lindskov Hansen[2], Jørgen Arendt Jensen[1]

1 Center for Fast Ultrasound Imaging, Dept. of Health Technology,Technical University of Denmark, Kongens Lyngby, Denmark
2 Department of Radiology, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark
3 BK Medical ApS, Herlev, Denmark

Background: Pressure catheters are gold standard for measuring pressure drop (PD) across atherosclerotic plaques, but suffers from drawbacks; exact position of the catheter tip is unknown, it is insensitive to small PDs, and too risky to use in the carotid artery where plaques are common. Vector flow imaging (VFI) quantifies the entire velocity field with high precision and can be used for estimation of PD. Prior to clinical use the technique must be validated. This is challenging in the carotid bifurcation due to flow complexity. No imaging modality can deliver the precision and accuracy needed, thus we have used fluid-structure interaction (FSI) models for this validation.

Methods: MRI data from a healthy volunteer were obtained and used to replicate a wall-less phantom model of the carotid artery. Carotid lumen was segmented from the MRI data, 3-D printed, and casted in PVA-cryogel. The phantom was scanned using VFI implemented on a commercial ultrasound scanner with a 5.5 MHz linear probe. The FSI model was made in SolidWorks and COMSOL Multiphysics with geometry and material properties complying with the phantom, see fig. 1A. Inlet velocity for FSI was obtained from the VFI data. Zero pressure was applied on the outlets. A stream line for PD estimation using the unsteady Bernoulli equation was extracted from the FSI model. PD was calculated likewise along a similar stream line in the VFI data using an in-house program, see fig. 1B.

Results: Fig. 2 shows PD averaged over 15 cycles with VFI compared to PD from the FSI model. Measured systolic PD is 27.9 Pa +/- 16%, and diastolic PD is 5.8 Pa +/-23%. Systolic PD in the FSI model is 31.6 Pa. PD from simulation demonstrate strong coherence to measured PD. Accuracy of the FSI model is 6.88%, obtained from mesh convergence studies. Discrepancy stem from FSI
boundary conditions, as peripheral resistance is not included. Compared to catheter
measurements, having very low accuracy, VFI-based PD is precise and accurate. FSI models apply
for validation of VFI-based PD estimation.
Conclusion and perspective: This new PD method overcomes current issues related to pressurecatheters. The non-invasive PD measurement can be used on any

artery, data are available
anywhere in the image, and PD can be evaluated in known position. The new PD method applies
to larger patient groups allowing better diagnosis.

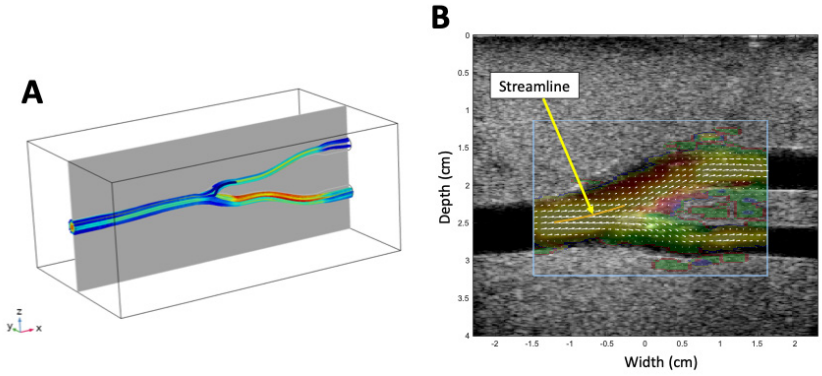

Figure 1
Fluid-structure interaction model geometry and velocity field of the carotid artery phantom is shown in A. In B the stream line along which the pressure drop is calculated is shown in orange.

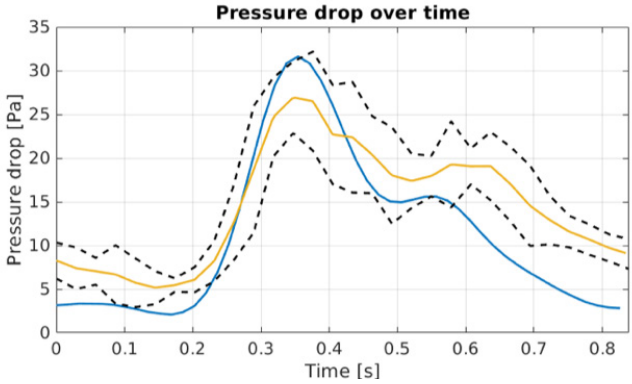

Figure 2
Pressure drop over the cardiac cycle. VFI-based estimation is shown in yellow. The dashed lines in black indicate the standard deviation of the measurements. The pressure drop obtained from the FSI model is shown in blue.

In vitro phantom for evaluation of catheter-based therapies for removal of acute pulmonary emboli

Karen Eich Hammer[1,3], Jesper Alrup Ellegaard[1,3], Per Lyngs Hansen[1], Marcelo Azevedo Dias[3], Asger Andersen[2], Jens Erik Nielsen-Kudsk[2] & Peter Johansen[3]

1 Aarhus School of Engineering, Aarhus University, Denmark
2 Department of Cardiology, Aarhus University Hospital, Denmark
3 Department of Engineering, Aarhus University, Denmark

Background: Acute pulmonary embolism (PE) is a life threating disease responsible for more than 500,000 deaths per year in Europe. Current therapy is by thrombolysis and anticoagulation. A novel approach to the treatment, is catheter-based thrombus removal. Catheters with different thrombus removal techniques are available. The aim of this study is to establish an in vitro setup for test and evaluation of catheter devices designed to remove thrombus material from the pulmonary circulation.

Materials & Methods: An in vitro model will be designed based on a 3D-printed patient specific pulmonary artery will be installed in a pulsatile flow-loop system. The set-up will include a mimic of the catheter way from the femoral vein to the pulmonary artery through the inferior vena cava, right atrium and right ventricle.
An embolus of porcine blood mimicking an embolus originating from deep vein thrombosis, will be introduced into the model and become lodged in the arteries as a PE. A catheter will be advanced through a gateway along a geometric pathway mimicking the route from the femoral vein to the pulmonary artery in the human body. To ensure visual examination and evaluation of the procedure, all parts of the in vitro loop will be transparent. Pressure and flow will be monitored continuously and recorded to assess hemodynamics and effects of the catheter intervention.
The 3D-printed pulmonary artery is based on a CT-scan, and printed in flexible material on a SLA 3D-printer.
To optimize the match between the mechanical properties of the 3D-printed model and the pulmonary artery uniaxial testing of 3D print elements will be performed. The mechanical properties of the pulmonary artery will be approximated through literature review and mathematical models. Further testing of the compliance properties of the 3D print will be performed, to better evaluate the difference in behavior between the 3D-printed model of the pulmonary artery and the human pulmonary artery.

Expected Results: The in vitro model will provide a platform for examining different catheter-based approaches and novel device designs for thrombus removal, and thereby introduce a valuable framework for preclinical evaluation of catheter-based therapies in treating patients suffering from acute PE.

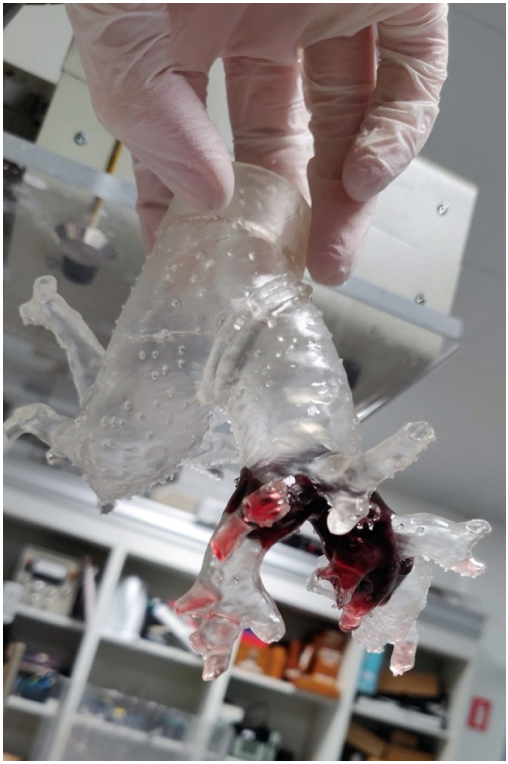

Figure text 1
An embolus placed in the 3D-printed pulmonary artery model

Deep Sternal Wound Infections after Median Sternotomies in Iceland: Incidence, Treatment and Mortality. Preliminary Results

Ástríður Pétursdóttir[1] MD, Steinn Steingrímsson[2] MD, PhD, Tómas Guðbjartsson[1,3] MD, PhD

1 Department of Cardiothoracic Surgery, Landspitali University Hospital
2 Department of Psychiatry, Sahlgrenska University Hospital
3 aculty of Medicine, University of Iceland

Background: Deep sternal wound infections (DSWI) as a complication of a median sternotomy can result in increased morbidity and mortality of patients undergoing open cardiac surgery. We studied the trends in incidence and outcome of DSWI a well-defined population over a 17-year period.

Materials and Methods: A retrospective study, including all adult patients treated for DSWI following a median sternotomy for cardiac disease in Iceland 2000-2017. Information was gathered from medical records and cases of DSWI confirmed based on the Center of Disease Control and Prevention (CDC) criteria from 2018. Mean follow-up was 75 months (January 2018).

Results: A total of 55 patients (mean age 69 years) were included in the study, 41 men (75%) and 14 women. The DSWI rate was 1.7% out of 3771 open heart surgery patients and did not change significantly during the study-period; or from 1.8% during 2000-2010. Most patients had undergone CABG (85%), 65% of them isolated CABG and 4% isolated AVR. DSWI was diagnosed within 30 days in 46 patients (84%) and was treated with negative-pressure wound therapy (NPWT) in 33 patients (60%), or all patients after 2005. The most common pathogens were coagulase-negative staphylococci (49%) and Staphylococcus Aureus (36%). 30-day post-op mortality was 0% but 7 patients (12,7%) fell within the 1-year mortality rate.

Conclusions: The rate of DSWI after open heart surgeries in Iceland has not changed significantly over the course of 17 years. All patients diagnosed after 2005 were treated with NPWT and has therefore been considered as a first-line treatment for DSWI.

Reducing postoperative morbidity after cardiac surgery

Torben Hoffmann[1], Christine Ilkjær[1], Johan Heiberg[1], Vibeke Hjortdal[1]

1 Dept. of Cardiothoracic and Vascular Research, Aarhus University Hospital, Denmark

Background: Thirty-day mortality following cardiac surgery has decreased during the last decade. However, nearly every fifth patient was readmitted to hospital during the first 30 days after surgery, mainly due to suboptimal medical treatment, infection or pleural effusion. We aim to improve early outcome with intensified follow-up with potential for early intervention.

Methods: We established a student-led surgical outpatient clinic, with postoperative patient follow-up at two and four weeks after surgery in addition to routine patient follow-up in cardiology out-patient clinic. Patients are monitored by six-minutes walking test, direct spirometry, electrocardiogram, blood pressure measurement, focus assessed transthoracic echo scanning, wound inspection, control of subscribed medicine. Outcome will be compared to a control group consisting of all patients discharged on days where medical students were not available. The control group gets regular follow-up up in cardiology out-patient clinic. Both groups are given quality of life questionnaires one, six and twelve months after cardiac surgery. Endpoints include number and reason for readmission, total length of all hospitalization, death up to one year after surgery. In addition, we register the degree of heart failure and functional level.

Results: We have enrolled 175 patients into the intensified follow-up group and 400 patients into the control group. Preliminary results from the control group show, that 43.6 % (n=172) was readmitted the first year after cardiac surgery, and the average number of readmissions per patient was 2.2 times among the ones who were readmitted. 55.7 % of the readmissions occurred within the first two months after surgery.
In the interventional group preliminary results show that 63.6 % (n=44) was readmitted at least once. On average patients was readmitted 1.9 times among the ones who were readmitted the first year. 55.8 % of the readmissions occurred within the first two months after surgery.

Perspectives: We believe that closer postoperative follow-up after heart surgery will provide us with knowledge that will enable us to reduce the overall morbidity. We expect more preliminary results from both the control and intervention group to be available at SSRCTS meeting.

Simulation and Growth of Tissue Engineered Heart Valve

Jonathan Mirpourian[1], Peter Johansen[2], Jens Vinge Nygaard[3], Menglin Chen[4], John Michael Hasenkam[5], Hermanus Johannes Marco Eijken[6]

1 Master Mechanical Engineering Student Aarhus University, Aarhus, Denmark
2 Associate Professor Aarhus University, Aarhus, Denmark
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4 Associate Professor Aarhus University, Aarhus, Denmark
5 Professor Aarhus University, Aarhus, Denmark
6 Assistant Professor Aarhus University, Aarhus, Denmark

The following is an application for presenting an upcoming PhD project, formulated by the authors named above. The project would be presented by the Master Student Jonathan Mirpourian. The main objective of this presentation is to collect relevant feedback by experts in the field of cardiac biomechanics and hemodynamics and flow measurement. The feedback will then be included in the realization of the project to ensure a relevant and impactfull contribution to the field of Tissue Engineering. Since the project is in its infancy, Results and Conclusion will not be described in this abstract.

Background: Tissue Engineering aims at synthesising functional tissues and organs for implantation. This is achieved by a combination of biomaterials, cells and guiding cues. Applying these concepts towards the development of a tissue engineered heart valve(TEHV) could eliminate current drawbacks existing solutions suffer from like life long medication and follow up operations.

Material and Methods: An overview of the project is given in figure 1. In its essence the project consist of three continously loops: (1) Computational Loop: Topology optimization will be applied to a virtual heart valve geometry to present the right cell guiding parameters so that the right extracellular matrix (ECM) structure will be produced. Afterwards the virtual geometry will be manufactured with the help of electrospinning and a biodegradebale polymer. (2) Experimental Loop: Fibroblasts are seeded onto computationally optimized biodegradable scaffolds and placed into a bioreactor mimicking the physiological in situ conditions in order to enhance ECM production. The fibroblasts will redevelop the degrading polymer into their own native ECM structure. (3) Cultivation Loop: Fibroblast are proliferated into the right quantities in order to use them in the experimental loop.

Each iteration of TEHV will produce data on the fibroblast interaction with the scaffold.The aquired data will be fed into a machine learning algorithm improving the next iteration of TEHV.

Perspectives: The main goals is to bring TEHV's closer to a clinical reality, exploiting fundamental interactions between cells and biomaterials and provide a systematic approach towards regenerating damages tissue with "traditional" tissue engineering and modern optimization methods.

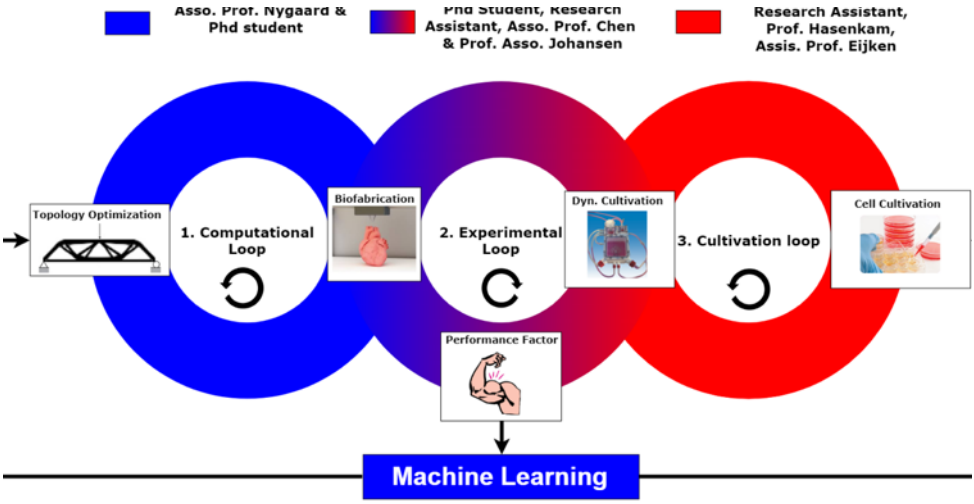

Figure 1
Overview of the project approach. Colouring indicates primarily responsible of the given loops. Connected to the project are Jonathan Mirpourian, enrolled as a Phd student, the remaning authors and a research assistant as evident from the figure.

Performance evaluation of temporary epicardial pace wire with integrated sensor for pacing, sensing, and continuous postoperative monitoring of myocardial function

Malene Enevoldsen, Kim Terp, Per Steinar Halvorsen, Helge Skulstad, Johannes Bjørnstad, Jonas Tyssø, J. Michael Hasenkam

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Department of Cardiothoracic Research at Aarhus University Hospital
The Intervention Centre at Oslo University Hospital (Cardiaccs shareholder)
Section of Cardiac Ultrasound at Oslo University Hospital
Department of Cardiothoracic Surgery at Oslo University Hospital, Cardiaccs AS,
Department of Clinical Medicine at Aarhus University
Department of Cardiothoracic Surgery at Aarhus University Hospital

Background: Echocardiography is the golden standard for assessment of cardiac function after open-heart surgery. It is sufficiently reliable to assess all stages of cardiovascular diseases. Hence, it can be used before, during, and after surgery. However, one limitation is the missing ability of ultrasound to provide continuous cardiac monitoring.
This study introduces a new direct measurement of epicardial velocity using a temporary pacemaker electrode (TME) containing an accelerometer. This device allows continuous measurement and monitoring of cardiac function during the surgical and postoperative period. Our hypothesis is that the accelerometer-based monitoring of myocardial velocity is equal to cardiac monitoring by echography; additionally, it provides data continuously and is less user-dependent. The aim of this study therefore is to compare this new technology with current ultrasound measurements.

Material and Methods: In this multicenter, international, open, non-controlled investigation, 15 patients undergoing open-heart surgery at Aarhus University Hospital, Denmark, will be equipped with the accelerometer containing temporary pacemaker electrode. The accelerometer provides specific data of the myocardium's velocity during heart contractions, and this will be compared to intermittent echocardiography examinations. From implantation and until removal, the accelerometer detects, transmits, and stores continuous heart contractility data. For the best possible estimate of device feasibility, the following values will be noted: time, sensing and pacing threshold, arterial and venous pressure, ECG heart rate, and adverse

events. Contractility data will later be paired with a time schedule of events perioperatively and postoperatively, and with the ultrasound examinations (transesophageal and transthoracic) performed during and after surgery.

Results: Results pending.

Expected outcome: We expect a consistency of changes in myocardial velocity compared to intermitted echocardiography, and in relation to this, consistency of relative changes in velocity in the event of myocardial dysfunction.

Perspectives: Continuous monitoring of ventricular contractility has the potential to be used for postoperative decision support for optimization of inotropic support and allow early detection of onset of complications such as ischemia and myocardial dysfunction.

How much stress is the native anterior mitral valve leaflet exposed to after mitral valve-in-valve replacement?

Johannes H. Jedrzejczyk, Jonas Rasmussen, Lisa Carlson-Hanse, Søren N. Skov, Farhad Waziri, Marcell J. Tjørnild, Sten L. Nielsen.

Department of Cardiothoracic and Vascular Surgery, Aarhus University Hospital, Denmark
Institute of Clinical Medicine, Aarhus University Hospital, Denmark

Background: Obstruction of the left ventricular outflow tract (LVOT) is one of the most significant post-operative complications after mitral valve-in-valve replacement (ViVR). The interaction between the mitral valve prosthesis, the septal wall, and the anterior leaflet results in the formation of a neo-LVOT with reduced cross-sectional area. We will examine changes in geometry and describe how pressure gradients are affected by mitral ViVR. Furthermore, we will examine how force applied to the native anterior mitral valve leaflet influences the dynamic change of the neo-LVOT and if it correlates to a higher risk of obstruction of the LVOT due to systolic anterior motion.

Materials and methods: 80 kg Danish landrace pigs (N = 9) underwent surgical mitral valve-in-valve replacement using a size 31 Carbomedics OptiformTM mechanical mitral valve prosthesis. Baseline echocardiography and pressure measurements were performed. The force transducer was placed with felt-pledgets on the central part of the anterior mitral valve leaflet. A suture to the force transducer was subsequently externalized through the left ventricle. The prosthesis was inserted above the native mitral valve and sutured to the annulus. After closure of the left atriotomy, reperfusion, and off cardio-pulmonary bypass, interventional measurements were performed.

Results: Pending.

Discussion/Perspective: We will assess how mitral valve-in-valve replacement affects the geometry of the mitral valvular and subvalvular apparatus of the left ventricle. Furthermore, we will describe the function of the native anterior mitral valve leaflet after mitral ViVR. Lastly, we will examine how a force applied to the native anterior mitral valve may affect the dynamic changes of the neo-LVOT and thereby cause obstruction. This knowledge is crucial to understand the pathology behind LVOT obstruction after mitral valve-in-valve surgery and may be useful to reduce the mortality after mitral ViVR.

TAVI-OP – Transcatheter Aortic Valve Implantation and Design Optimization

Martin Lindvald Pedersen[1], Steffen Ringgard[2], Won Yong Kim[3] & Peter Johansen[1]

1 Department of Engineering, Aarhus University, 8000 Aarhus C, Denmark
2 MR Centre, Aarhus University Hospital, 8000 Aarhus C, Denmark

Background: Aortic stenosis treatment with the insertion of a prosthetic valve is shifting from surgically implanted valves towards an increased number of transcatheter aortic valve implantations (TAVI). Several short-term studies have demonstrated that TAVI valves perform comparable to surgically implanted heart valves, but adverse effects have also been registered relating to the hemodynamic performance such as valve leaflet thrombosis. Studies have shown that the presence and position of the stent may induce areas where conditions for thrombosis formation is increased such as blood stagnation and low flow velocity.
This study aims towards establishing a magnetic resonance (MR) compatible in vitro model which is capable of providing 3D flow fields using an MR compatible TAVI replica. Based on this model detailed investigation on the local flow patterns will be examined which will define the optimal TAVI valve position relative to the aortic annulus and the rotational in-plane position.

Material and Methods: An MR compatible in vitro model will be made where a bioprosthetic valve will be installed anatomically in a realistic dimensioned sinus of Valsalva conduit. The flow conditions will be a cardiac output of 5 l/min, a mean arterial pressure of 100 mmHg, and a heart rate of 72 BPM. The MR compatible stent will be positioned over the bioprosthetic valve and afterwards the stent + valve will be moved with three 3 mm progressive steps of supra-annular advancement. This is repeated but with the valve rotated 60 degrees of the anti-anatomical position.

MR 4D flow measurement will be obtained and the MR sequence will provide a 3D spatially isotropic measurement of the velocity flow field, assessing all three velocity components. The measured velocity field will be visualized with streamlines and the vorticity will be quantified.

Results: Pending.

Conclusion: The study will provide a platform for detailed flow measurements and examination of optimal implantation position of a TAVI valve relative to the aortic annulus and in-plane rotational orientation, which will yield minimal disturbance of the blood flow vorticity in the sinus of Valsalva.

Perspectives: In vivo investigation on how patients with TAVI valves implanted present reduced washout time and blood stagnation in the sinus of Valsalva.

Replacement of the Posterior Mitral Valve Leaflet Using 2-ply Porcine Extracellular Matrix: A Chronic Porcine Evaluation

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Background: Repair is widely accepted as the preferential method to treat mitral regurgitation. The classic technique used for correction of posterior leaflet prolapse is based on partial or complete resection of P2 and reconstitution of the leaflet continuity by direct suture, as popularized by Carpentier. Total mitral valve reconstruction using a tube graft made from the first generation of 2-ply from CorMatrix® has been tested in a chronic model. Implanted, the CorMatrix® patch (SIS-ECM) is supposed to act as a scaffold and become recellularized with the patient's cells. However, total mitral valve reconstruction using a 2-ply CorMatrix® tube graft has not proven was not possible as there was a mismatch between degeneration and regeneration of patch material. We propose that the new generation of 2-ply CorMatrix® can be used for reconstruction of the posterior mitral leaflet (PML) in patients with PML prolapse. The aim of this study is to assess PML reconstruction using the new generation of CorMatrix® in a 12 months chronic porcine animal model.

Materials and methods: The new generation of 2-ply CorMatrix® will be made into a PML-patch measuring 6x4 cm. 80 kg Danish Landrace pigs (N = 10) will be used as an open chest chronic in vivo model. Prior to surgery, a baseline MRI and echocardiography will be performed. On cardiac bypass, through the left atrium, the native posterior mitral valve leaflet will be excised and the PML-patch will be attached. Off cardiac bypass, the PML-patch will be assessed by epicardial echocardiography and compared with baseline. The chest will be closed conventionally and the pigs will be observed for 24 hours before sending them to a farming facility for experimental animals. After 14 days, an interventional MRI will be performed and compared to baseline MRI. The animals will be euthanized after a total of 12 months follow-up and histological and immunohistological analysis of explanted valve tissue will be performed.

Results: Pending.

Perspective: If reconstruction of the PML is possible using SIS-ECM, reconstructive heart valve surgery, in general, might benefit from this novel reconstructive method in both adult and pediatric heart surgery.

Pulmonary cusp repair: In vivo evaluation

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Background: Congenital abnormalities of the pulmonary valve are commonly treated surgically. Often entire valve replacement -usually with a biologic valve- is performed in the teenage years or early adulthood. Timing for this surgery is debatable as; on the one hand, the child should be fully grown to avoid under sizing, but, on the other hand, prolonging surgery increase the risk for severe cardiac complications. A new surgical pulmonary cusp repair technique has the potential to grow with the recipient. Our aim was to evaluate the functionality of this new surgical pulmonary cusp repair technique in vivo.

Methods: The pulmonary cusp repair was performed in an acute 60-kg porcine model (N=7), each pig acting as its own control. Three cusps, individualized for each pig and made from 0.6% glutaraldehyde-treated homologous pericardium, were subsequently implanted. Before and after pulmonary cusp repair; echocardiography was used to assess pulmonary regurgitation, pulmonary stenosis, right ventricular outflow tract obstruction and pulmonary valve geometry; invasive pressure measurements were used to assess right ventricular pressure and pulmonary artery pressure.

Results: Pending

Perspective: With potential promising results, this method of pulmonary cusp repair should be investigated in a chronic in vivo setup, which examines the durability of the new surgical technique long term and its potential to grow with the recipient. In the future, children with congenital pulmonary abnormalities might receive this surgical and could avoid complications that comes with a biologic valve replacement.

Adenosine bolus with initial cardioplegia may be beneficial to myocardial recovery in coronary artery bypass surgery

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Background: Cardioprotection is an essential part of any surgical procedure of the heart. Although cardioplegic strategies perform well, cardiac surgeons sometimes encounter low output syndrome, right ventricular failure and other signs of myocardial damage. We hypothesized to further develop cardioprotection by injecting adenosine to aortic root during initial cardioplegia and compared it to routine cardioplegia. In this randomized controlled trial (RCT) we study adenosine's potential benefits to myocardial performance (Cardiac Index) when given with initial cardioplegia.

Material and methods: 43 elective coronary artery bypass grafting (CABG) patients were recruited to RCT. Subjects were randomized 1:1 to receive 4 ml (20mg) adenosine or 4 ml saline to aortic root right after aortic clamping. Both groups received cold blood cardioplegia in identical dosing. Hemodynamic measurements were recorded from radial and pulmonary catheters at given time points. All subjects received internal thoracic artery graft. 47 % of subjects received radial artery graft and vein graft was used in 84% of the cases. All operations were performed using cardiopulmonary bypass (CPB). Cardiac index was the main hemodynamic performance outcome parameter and was compared between groups.

Results: Mean age of the subjects was 68 (sd 9.2). 41 of the 43 subjects were male. Mean preoperative ejection fraction was 54 % (sd 9.8). Main finding of the study was marginally better cardiac index in adenosine group immediately after weaning from cardiopulmonary bypass (2.33 l/min/m2, sd 0.37 vs 2.10 L/min/m2, sd 0.26, P=0.022). There was no statistically significant difference in overall cardiac index. Final results with detailed findings will be presented at the conference.

Conclusion: Adenosine induced cardioplegic arrest improved initial myocardial function recovery in this small series and was not inferior to traditional cardioplegic arrest when evaluated by hemodynamic performance and other markers after perfusion.

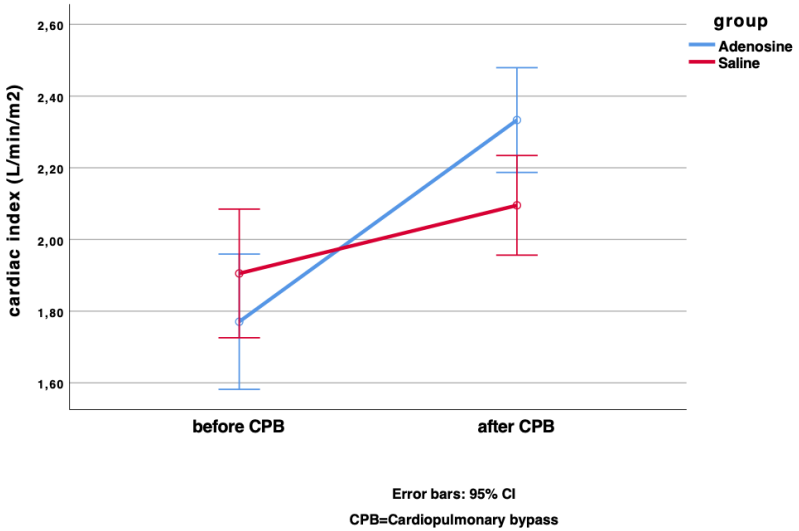

Figure 1
Cardiac index before CPB and after CPB in saline- and adenosine groups.

Administration of interferon-ß-1a attenuates ischemia-reperfusion injury in acute myocardial infarct in pigs

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Background: Acute myocardial ischemia-reperfusion (IR) injury seriously impairs the myocardial function. In this study, we studied the potential of porcine recombinant interferon-beta-1a (IFN-ß-1a) in myocardial protection during acute IR injury in an experimental animal model.

Materials and Methods: 22 Finnish land race pigs (26.7 ± 1.65 kg) were divided into control group (n = 10) and treatment group (n = 12). Acute IR injury was induced by ligating the distal portion of left descending coronary artery (LAD) for 30 minutes. After reperfusion (6 hours), the experiment was terminated. In treatment group, the animals received 12,5 micrograms IFN-ß-1a intravenously 8 hours prior to infarction, and the dose was repeated right before ligation of LAD. In control group, the animals received saline solution.
The levels of IL-6 and TnI were measured from blood samples, and the amount of myocardial damage was quantified analysing myocardial apoptosis (TUNEL) and the mean fluorescent intensity (MFI) of methylin-blue dyed myocardium.

Results: The postoperative levels of IL-6 and TnI did not differ significantly between the study groups. In infarcted myocardium, there were more apoptotic myocardial cells than in healthy myocardium (0.98 ± 0.75 % vs. 0.32 ± 0.18 %, p= 0.0004), but there was no significant difference between groups. In treatment group, the MFI from apex of the heart was significantly lower compared to control group (96.02 ± 2.73 % vs. 90.75 ± 4.90 %, p = 0.01).

Conclusion: In this acute IR injury animal model, IFN-ß-1a added on the magnitude of IR injury.

Perspectives: The dose and timing of administration of IFN-ß-1a must be evaluated in dose-response study as well as potential cardioprotective qualities of IFN-ß-1a with longer follow-up period.

The use of Intra Aortic Balloon Pump in Coronary Artery By-pass Graft Surgery

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Introduction: Intra-aortic balloon pump (IABP) is a mechanical device that increases cardiac output by increasing diastolic blood flow to the coronary arteries and lowers the afterload of the left ventricle in systole. IABP is primarily used in acute heart failure, that includes patients that have to undergo coronary artery bypass grafting (CABG), but its usage in cardiac surgery has been declining with ongoing controversy regarding its benefits. The aim of this study was to assess the use and indications and outcome of IABP related to CABG surgery.

Material and Methods: The study was retrospective and included 2177 patients that underwent CABG at Landspítali during 2001-2018. We compared those who received an IABP with controls, using uni- and multivariate analysis. Long term survival and complications (major adverse cardiovascular and cerebral events, MACCE) was estimated with Kaplan-Meier method.

Results: A total of 99 (4.5%) patients received an IABP. The incidence was highest in 2006 (8.9%) and lowest in 2001 (1.7%), but the incidence did not change during the study period (p =0.90). Most patients received the pump before (58.6%) or during (34.3%) CABG, but only 6.1% after surgery. Complication rate was 14.1%, with bleeding from the insertion site in the groin being the most common complication. Thirty day mortality was higher in the IABP group compared with controls (22.2% vs 1.3%, p<0.001) and both 5-year survival (56.4% vs 91.5%, 95% CI: 0.47-0.67) and 5-year MACCE-free survival (46.9% vs 83.0%, 95% CI: 0.38-0.58) were inferior.

Conclusions: Less than 5% of patients received IABP in relation to CABG in Iceland and the rate hasn't changed much for the last 18 years. As expected, the complication rate and 30-day mortality was higher in patients in IABP group and both the long term and MACCE-free survival was much worse.

SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY SSRCTS

Long-term outcome of patients with DSWI following cardiac surgery – results from the SWEDEHEART registry

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Background: Deep sternal wound infection (DSWI) is a major complication following open heart surgery with increased mortality and morbidity for the patient. The incidence is usually 1-4% and 90-days mortality 0-16%. Numerous studies have analyzed short-term outcome of DSWI and defined risk factors. However, less is known about long-term survival and complications of these patients. We therefore studied long-term outcome of DSWI patients in a large nation-wide cohort of heart surgery patients.

Methods: This retrospective cohort study included 114,869 patients from the SWEDEHEART registry who underwent CABG (70.6%), valve repair or replacement (18.6%) or both (10.8%) between 1997 to 2015. DSWI patients were identified by surgical intervention codes in the Swedish Patient Registry (reoperation for deep infection), and DSWI cases were compared to surgical patients not developing DSWI. Median follow-up was 5.5 years for the DSWI cases and 8.0 years for the non-infected patients.

Results: Altogether, 1,516 patients (1.3%) developed DSWI, most of them after CABG (69.7%). Median time from surgery to surgical intervention was 15 days (range 0-90 days). DSWI patients were older and had significantly higher BMI than those without. They had more often diabetes, hypertension, heart failure, previous stroke, renal failure and more often underwent combined CABG and valve surgery. Ninety-day mortality was 7.9% vs. 3.0% ($p<0.001$) in the DSWI vs. non-infected group, and 1-, 5- and 10-year mortality was 12.8% vs. 4.5%, 28.9% vs. 14.1% and 57.0% vs. 33.1%, respectively (<0.001). DSWI patients had inferior unadjusted mortality compared to the group not developing the infection.

Conclusion: In this nation-wide cohort study, the unadjusted ninety-day mortality was almost threefold higher for DSWI patients than for non-DSWI patients and long-term all-cause mortality was also significantly increased in the DSWI group.

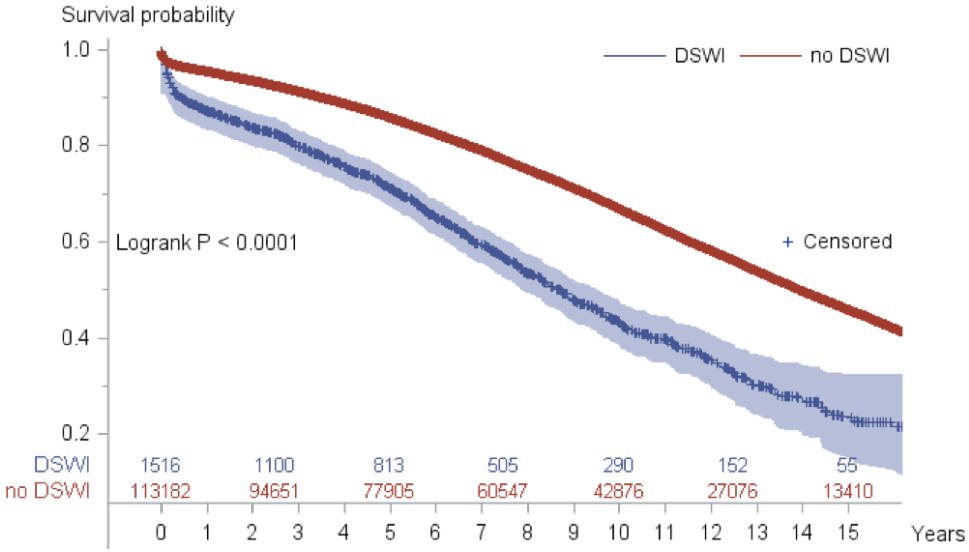

Figure 1
Unadjusted Kaplan-Meier survival curves with 95%-CI bands for patients re-operated for DSWI (blue) and those not developing DSWI (red).

SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY SSRCTS

Incidence and predictors of prolonged intensive care unit stay after coronary artery bypass in Iceland

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Introduction: To maximize the use of intensive care resources, it is important to estimate the prevalence and risk factors for prolonged intensive care unit (ICU) stay after coronary artery bypass grafting (CABG) surgery.

Material and methods: This retrospective cohort study included all patients who underwent primary isolated CABG at Landspitali between 2001 and 2018. Patient information was collected from hospital charts and death registries. Patients who stayed in the ICU for the conventional one night postoperatively were compared with those who needed longer stays in the ICU. Survival rate was estimated with the Kaplan-Meier method. Predictors for prolonged ICU stay were calculated with logistic regression and the outcome used to create a calculator that estimates the probability of prolonged ICU stay.

Results: Out of 2177 patients, 20% required prolonged ICU stay. Patients with prolonged stay were on average two years older ($p<0.001$), more frequently female (23% vs 16%, $p=0.001$), had a higher rate of cardiovascular risk factors and higher EuroSCORE II (4.7 vs. 1.9, $p<0.001$). They also had a higher rate of impaired renal function (14% vs. 4%, $p<0,001$) and emergent surgery (18% vs. 2%, $p<0,001$). Furthermore, these patients had higher rates of both short-term and long-term complications, and lower long-term survival (85% vs 68% five-year survival rate). Independent risk factors for prolonged ICU stay were advanced age, female gender, EuroSCORE II and history of heart diseases. The results were used to design an online calculator to estimate the probability of prolonged ICU stay.

Conclusion: Every fifth patient had a prolonged ICU stay after CABG. Several risk factors predicted prolonged ICU stay after CABG, in particular advanced age and EuroSCORE II. A better understanding of the risk factors for prolonged ICU stay will hopefully aid in scheduling CABG surgeries at Landspitali.

Contemporary incidence and treatment of new-onset postoperative atrial fibrillation after cardiac surgery

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Background: New-onset postoperative atrial fibrillation (POAF) is a common complication after cardiac surgery. In most previous studies POAF is reported as a dichotomous variable (yes/no) but in real-life the clinical characteristics and management during hospitalization may vary considerably. Furthermore, the role of anticoagulation in POAF patients is yet not fully clarified. The aim of the present study was to describe the contemporary incidence of POAF and treatment with anticoagulants at discharge in relation to in-hospital clinical course.

Material and methods: All patients who underwent coronary artery bypass grafting (CABG), valve surgery, or a combination thereof from Sep 2013 to Dec 2018 at Sahlgrenska University Hospital were included (n=4269). Information about clinical course (spontaneous/medical conversion to sinus rhythm, need for DC cardioversion or persistent atrial fibrillation (AF) at discharge), and anticoagulation at discharge, was collected on all POAF patients using patient records from the operating hospital and any direct subsequent hospitalization. Clinical information was collected from the SWEDEHEART registry.

Results: Overall, new onset POAF occurred in 1459 (34.2%) of the patients, 31.3% in CABG patients, 35.3% of valve patients and 39.8% in CABG + valve patients. 94.3 % converted to sinus rhythm before discharge, 79.8% spontaneously or with medical treatment, and 14.5% after DC cardioversion. 5.7% of the patients had persistent AF at discharge. Oral anticoagulation was initiated during hospital stay and remained at discharge in 39.8% of the patients with spontaneous/medical conversion, in 41.0 % of the patients with DC cardioversion and in 97.4% of the patients with sustained AF.

Conclusions: The incidence of POAF remains high after cardiac surgery. The vast majority of patients convert to sinus rhythm before discharge, at which time a minority are on oral anticoagulation. Studies focusing on the short- and long-term effects of anticoagulation in patients with POAF after cardiac surgery are warranted.

A bench model evaluation of coronary bifurcation lesions

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Background: Ischemic heart disease caused by atherosclerosis is one of the most frequent causes of death worldwide. In symptomatic patients, revascularization is often achieved through percutaneous catheter intervention (PCI). However, some procedural challenges exist particular when the PCI is performed at bifurcations. The aim of this project is to develop a patient realistic coronary bifurcation model to improve the PCI procedure.

Material and Method: The diseased coronary artery model (including LM, LAD and LCx) is developed based on CT-scans of patients with coronary left main stenosis. The physical model consists of two materials; an elastic polymer with comparable mechanical properties as the arterial wall and a hard resin imitating the properties of calcified plaque. The model is 3D printed in a silicone-like material where the sites of plaque lesions are hollowed out and filled with resin. Tensile tests are performed according to standards to characterize and compare the materials with real arteries and calcified plaque. This allows adjustment of printed wall thickness within practical range to match the arterial wall properties as close as possible.

Results: Tensile tests revealed that the silicone-like material had non-linear characteristics with tangent-moduli of 1,8-3,7 MPa. The hard resin component had an E-modulus of 1 GPa. The model has been successfully tested with a stenting procedure by PCI (Figure 1).

Discussion: The silicon material did not match the tangent-modulus of coronary arteries within the physiological range (~0,39 MPa). To compensate and to optimize the compliance conditions, the 3D printed wall was printed as thin as possible. The hard resin did not reach the E-modulus of calcific portions which can reach 17 GPa. However, the difference between the silicone and resin is still 1000 orders of magnitude greater.

Conclusion: By applying the methods proposed, a novel 3D-printed patient realistic model with calcified plaque lesions has been created. The method could be further improved through material tweaking, to mimic human-like conditions even more. Three model are developed, representing frequent plaque placement (Figure 2). The models are expected to be applied by interventional cardiologist to investigate optimal stent placement.

Figure 1
The figure shows a printed patient realistic phantom.

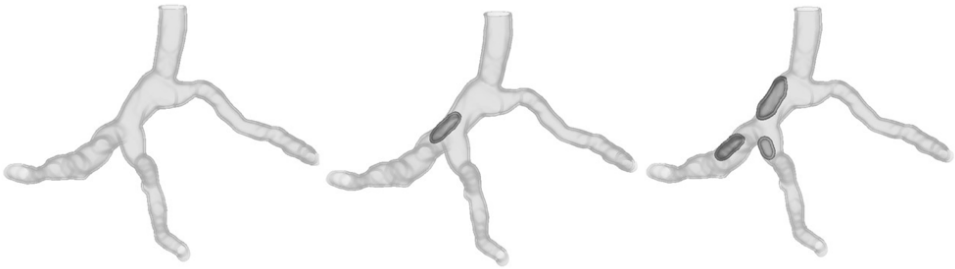

Figure 2
The figure shows the design of three model versions.

Optical Coherence Tomography Optimized Bifurcation Event Reduction – The OCTOBER Trial

Omeed Neghabat[1], Lene Nyhus Andreasen[1], Simon Walsh[2], Olli Kajander[3], Nils Witt[4], Christian Eek[5], Paul Knaapen[6], Lukasz Koltowski[7], Juan Luis Guitérrez-Chico[8], Francesco Burzotta[9], Janusz Kockman[7], John Ormiston[10], Irene Santos-Pardo[4], Peep Laanmets[11], Darren Mylotte[12], Morten Madsen[13], Jakob Hjort[14], Indulis Kumsars[15], Truls Råmunddal[16], Evald Høj Christiansen[1], Niels Ramsing Holm[1]

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Background: Percutaneous coronary intervention (PCI) of bifurcation lesions is challenging with high risk of procedural and long-term complications. High ambiguity of coronary angiography and implantation of stents in vessel branch points constitute important difficulties that treating physicians need to overcome in about 15% of cases. Optical coherence tomography (OCT) is a high definition, intravascular imaging modality that may aid physicians in optimizing treatment results and potentially improve clinical outcomes if used routinely and systematically. We aim to compare the clinical outcome after OCT-guided vs. standard angiography-guided revascularization of patients with coronary bifurcation lesions.

Methods: The OCTOBER trial is a 1:1 randomized, controlled, prospective, superiority trial randomizing 1200 patients with coronary artery disease located at a bifurcation to either standard angiography-guided PCI or OCT-guided PCI. Major inclusion criteria are; stable or unstable angina pectoris, clinically stable non-STEMI, main vessel reference diameter ≥2.75 mm and side branch reference diameter ≥2.5 mm. Major exclusion criteria are; STEMI within 72 hours, renal failure and severe tortuosity of target vessels. The primary endpoint is two-year major adverse cardiovascular events, a composite of cardiac death, target lesion myocardial infarction and ischemic driven target lesion revascularization. Patients are followed until 10 years.

Results & conclusion: The trial is ongoing, and 673 patients have been randomized in 29 sites in Europe. Enrollment is expected to conclude in late 2020.

Perspectives: Intravascular imaging modalities are used in selected, complex cases. This trial will illuminate if a routine use of OCT in patients with bifurcation lesions could emerge as gold standard in the field of PCI.

Preventing thromboembolism in patients undergoing curative surgery for oesophageal cancer

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Background: Oesophageal cancer is an aggressive cancer with an 85% mortality within the first two years. The mainstay of curative treatment is extensive surgery often combined with preoperative radio-chemotherapy. Surgery and cancer are known risk factors for developing venous thromboembolic events (VTE), and currently VTE is the leading cause of death in cancer patients after the cancer itself. In patients with oesophageal cancer, the postoperative period entails a high risk of VTE due to the extensive surgery, and low-molecular weight heparin (LMWH) after the surgery is recommended as thromboprophylaxis. However, no international or national treatment guidelines exist regarding the duration of the treatment. LMWH increases the risk of bleeding events, and thus it is important to determine the optimal treatment length where both the risk of VTE and bleeding events are minimized.

Materials and methods: The study is a randomized, controlled study comparing two thromboprophylactic treatment regimes. Patients will be randomized to receive 5000 IE LMWH daily for either 10 or 30 days. We will include 120 patients diagnosed with oesophageal cancer, who has undergone neoadjuvant chemoradiotherapy (CROSS regimen), and are scheduled to undergo curative surgery for the cancer. The surgery consists of a laparoscopic and a thoracoscopic or thoracotomy procedure. Blood samples will be taken before, during, and after surgery, as well as in the outpatient clinic 30 days after surgery. The analysis will evaluate the primary and secondary haemostasis using platelet function tests, thrombin generation assays and thromboelastometry (ROTEM®), as well as standard coagulation analysis. Fibrinolysis will be investigated using an in-house clot-lysis assay. Post-operatively, screening for VTE will be performed using ultrasound examinations of the lower extremities.

Results: Pending results. The study is a PhD study with patient inclusion planned from November 2020 - November 2022. We have applied for funding and are in the process of applying for permissions to conduct the study.

Conclusion and perspectives: The results of the project will help us determine whether longer thromboembolic prophylactic treatment in oesophageal cancer patients offers better protection against VTE and thereby increase the survival of these patients after they have undergone intended curative surgery.

Veno-occlusive mechanical preload reduction (VOMPR) of the left ventricle to reduce ischemia reperfusion injury in acute myocardial infarction

Tobias Lynge Madsen[1], Won Yong Kim[1], Esben Søvsø Szocska Hansen[1], Hans Erik Bøtker[1], Jørgen Frøkjær[2], Lars Poulsen Toldbod[3], Lars Christian Gormsen[3] and Gregory Wood[1]

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Background: According to earlier research conducted by our research group veno-occlusive mechanical preload reduction (VOMPR) could be a novel approach to limit infarct size further during an acute myocardial infarction (AMI) when combined with percutaneous coronary intervention (PCI) in the future.
A project already conducted by our research group regarding VOMPR showed a reduction in final infarct size during an AMI from 22% of the total heart to 14 % when applying VOMPR during ischemia and reperfusion in a porcine model (unpublished data). We also observed a big variation within our intervention group in the project. Some of the pigs had a very high salvage while other did not differ from the control group. Therefore, the question now is whether we can find the physiological reason why some of the pigs are affected greatly by VOMPR while others are not. We hypothesize that we will be able to find a correlation between reduction in oxygen consumption in the heart during the infarct and the final myocardial salvage. Scanning the pigs using a PET-MR scan will be the main key, as it will provide us with information regarding how the oxygen consumption and perfusion of the heart is affected by our intervention.

Material and methods: 16 pigs will be separated into a control and an intervention group. Myocardial infarction will be induced for an hour with a balloon in all the pigs. The intervention consists of a balloon which will be inflated in the caval vein to reduce the preload to the heart. A PET-MR scan will be conducted before the experiment and 3 hours after reperfusion to measure changes in myocardial perfusion, oxygen consumption and to measure the area at risk within the heart. When the pig is euthanized the hearts will be collected for histology and final infarct size.

Results: Pending results

Conclusion: Studies within the research group regarding VOMPR shows very promising results. Therefore, it is of great interest to clarify the exact mechanism why VOMPR might be cardioprotective and this project aims to increase our knowledge regarding VOMPR.
Perspectives: In the future VOMPR could have the potential to be a method which further reduces final infarct size during an AMI when combined with PCI. Further research is necessary to investigate the potential of VOMPR, how it is best applied and how the method can be translated into clinical trials.

Automated seizure detection for epilepsy patients using wearable electrocardiogram device

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Background: So far, only generalized tonic-clonic seizures can be reliably detected with non-invasive wearable devices. We aimed to develop an automated seizure detection algorithm using a wearable ECG-device for detecting both GTC and focal seizures.

Material and Methods: In this phase-2 study, we prospectively recruited patients admitted to long-term video-EEG monitoring (LTM). ECG was recorded using a dedicated wearable device, hidden under the patients´ clothes. Seizures were automatically detected using HRV-parameters computed off-line. Seizure detection was done blinded to all other data. We compared the performance of twenty-six automated algorithms with the seizure time-points marked by experts who reviewed the LTM recordings. Patients were classified as responders if >66% of their seizures were detected

Results: We recruited 100 patients, and we analyzed 126 seizures (108 non-convulsive and 18 convulsive) from 43 patients who had seizures during monitoring. The best performing HRV-algorithm identified 53.5% of the patients as responders. Among responders, detection sensitivity was 93.1% for all seizures and 90.5% for non-convulsive seizures. FAR was 1.0 / 24 hours (0.11/night). Median seizure detection latency was 30 seconds. Typically, patients with prominent autonomic nervous system changes were responders: an ictal change of >50 heartbeats per minute predicted who would be responder with a positive predictive value of 87% and a negative predictive value of 90%.

Conclusion: The automated HRV-algorithm, using ECG recorded with a wear-able device has high sensitivity for detecting seizures, including non-convulsive seizures. FAR was low during the night. This approach is feasible in patients who have prominent ictal autonomic changes.

Perspectives: A seizure alarm can contribute to a much more secure life with better job-, social- and mobile opportunities for the untreatable epileptic patients. In severe epileptic cases the alarm system may even save lives.

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Ex-vivo assessment of donor priming effects on heart graft viability using hyperpolarized 13C magnetic resonance imaging

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Background: An increasing amount of patients are waiting for new organs on the transplant waiting-list, meanwhile the number of organ donors remains unchanged. Transplantation using organs from marginal donors such as donation after circulatory death holds great potential for alleviating this organ shortage. In order to utilize these organs, new highly sensitive measures for estimation of organ viability are required. Normothermic ex-vivo perfusion in combination with hyperpolarized MRI enables evaluation of the local metabolic status in the heart tissue thus providing a unique opportunity to explore the effects of different priming factors on graft viability pre, per and post transplantation.

Material and Methods: Pigs will be randomized into groups according to priming intervention; saline, glucose or ketone body infusion. Hearts will be obtained from pigs undergoing cardioplegia and transported in cold storage to the imaging facility, where they will be attached to an ex-vivo perfusion system. The hearts will be perfused with fully oxygenated whole-blood, and a catheter in the left ventricle will measure heart rate and ventricular pressure. Heart graft viability will be examined using functional MRI, creating pressure-volume loops for assessment of stroke work and contractility, and hyperpolarized MRI enabling tracking of the myocardial metabolism.

Results: Preliminary results show, that lactate to pyruvate ratio is higher compared with bicarbonate to pyruvate and alanine to pyruvate ratios (as depicted in Figure 1) in grafts without pretreatment. We hypothesize that priming the grafts with energy substrates i.e. glucose and ketone bodies increase all metabolites from pyruvate in the heart tissue. Final results are pending.

Perspectives: The aim is to explore the effects of priming factors on graft viability and investigate if non-invasive measurements from MR hyperpolarization leads to better examination and monitoring of graft quality pre, per and post transplantation, which in time enables the usage of heart grafts from supposedly ineligible donors for transplantation.

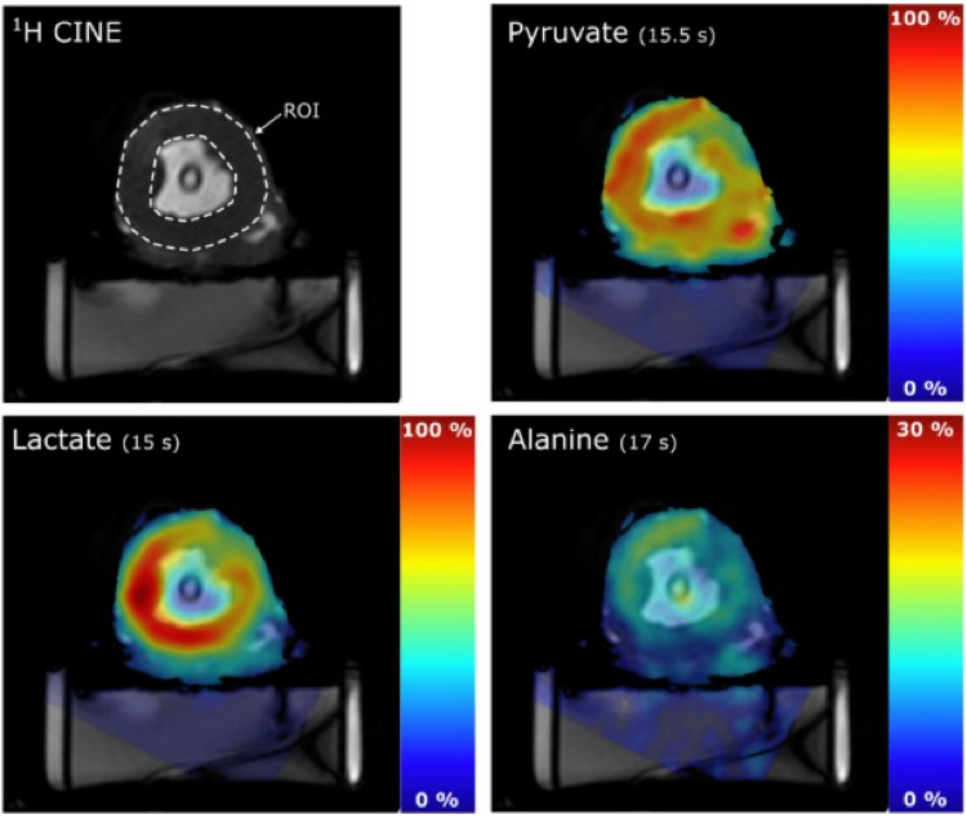

Figure 1
Hyperpolarized [1-13C]pyruvate SPSP cardiac imaging examples. Pictures tracking the metabolism of pyruvate and its breakdown products, lactate and alanine. Data from pilot study by Christian Ø. Mariager[1].

Oxygenation during normothermic regional perfusion after circulatory death for cardiac transplantation in a porcine model

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Background: Organs for transplantation are sparse and every year patients die while on the waiting list for heart transplantation. Organs from circulatory dead donors are now used in many countries to increase the donor pool but not in Denmark. While normothermic regional perfusion (NRP) is an established method to optimize donor organs from circulatory dead donors, on, its use in thoracoabdominal perfusion is debated. Knowledge about the oxygenation levels that are most favourable for thoracoabdominal NRP is needed.

Aim: To find the optimal oxygenation strategy during NRP in a heart transplant setting from circulatory dead donors in a porcine model.

Materials and methods: The study is performed as a randomized intervention-control study with 2 groups (8 pigs in 21% oxygenation group and 8 pigs in the 100% group). The primary endpoint-parameter is cardiac contractility after NRP compared to baseline measured by pressure-volume recordings and by thermodilution with a pulmonary catheter. Baseline measurements are recorded before disconnecting the ventilator (before asphyxia). When mechanical asystole is recorded, NRP is commenced, using a standard heart-lung machine for open-heart surgery after, fifteen minutes no-touch period. The heart is then resuscitated, and NRP is gradually weaned over 35 minutes by protocol. The cardiac contractility is measured at 1, 2 and 3 hours after weaning (see figure 1). Myocardial biopsies are acquired for in vitro assessment of mitochondrial function by oxygraphy.

Preliminary Results: The study is ongoing with eight procedures performed to date; of these, seven successfully weaned from extracorporeal circulation. One animal in the 21% oxygenation group could not be weaned due to continuous low arterial blood pressure and ventricular fibrillation; another animal in the same group could only be weaned after 60 minutes of NRP. At 60 minutes after weaning the cardiac index was 3,5 and 2,8 L/min in the 21% and 100% oxygenation groups. Oxygraphy shows the mitochondrial efficacy decrease after ischemia and reperfusion with an increase 60 minutes after wean (see figure2)

Perspectives: We believe that thoracoabdominal NRP in donors suffering from circulatory death may increase the number of available donor organs, and this study may provide information about the most optimal oxygenation settings.

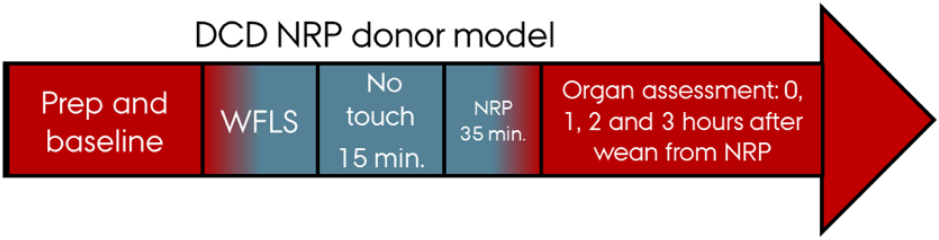

Figure 1
Timeline of the experiment. Red colour represents warm perfusion. Blue: no perfusion

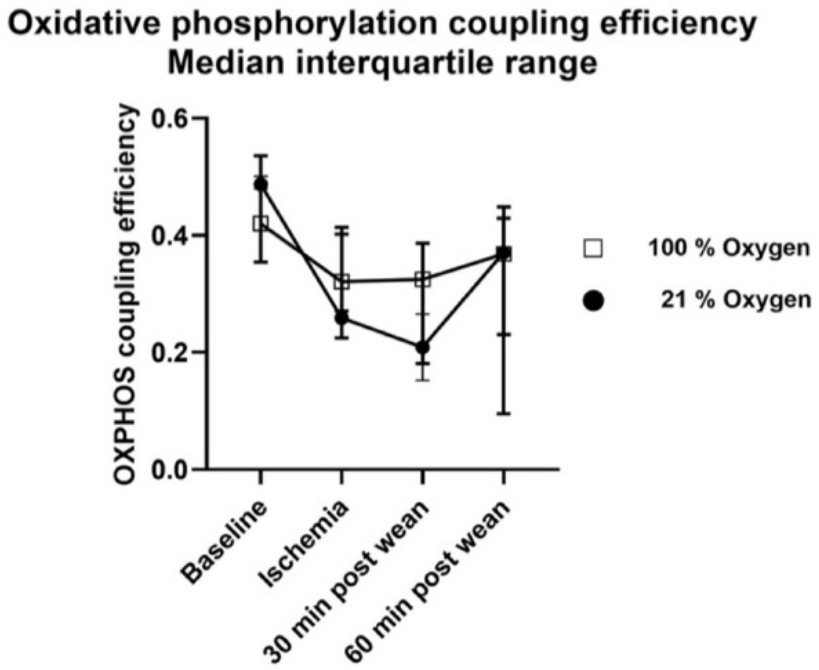

Figure 2
Oxidative phosphorylation coupling efficiency. Ischemia is the timepoint 10 minutes after asystoli. The figure shows the heart getting two hits: an ischemic insult and a reperfusion insult. The coupeling efficiency increases with time after weaning.

Cardiac reversibility after acute volume-overload; an experimental study

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Background: Acute volume-overload (AVO) causes life-threatening cardiac insufficiency and may be due to excessive blood flow into the right side of the heart after acute aortic dissection, cardiac wall rupture or tricuspid valve regurgitation. In the attempt to treat unstable hemodynamics, left ventricular assist device is applied to support cardiac function by reducing cardiac workload during AVO. Incongruous evidence suggest that cardiac wall changes may be reversible by reducing cardiac workload after AVO.

Materials and Methods: Altogether, the study included 35 syngeneic Fischer-344 rat hearts. AVO was surgically induced by creating a 5-mm fistula in between the vena cava and the abdominal aorta in 13 rats, and the heart were explanted at one month. Five of these hearts were heterotopically transplanted to reduce cardiac workload and were followed for an additional one-month period. Six hearts without AVO were heterotopically transplanted and procured after one-month. Five hearts without intervention served as controls. Systematic histological quantification of the heart was performed.

Results: Rat hearts with AVO developed cardiac insufficiency with edematous intramyocardial arterial wall cell nuclei, myocardial cells, and the size of the hearts were approximately four times larger than hearts without AVO ($p<0.001$). Periadventitial and epicardial inflammation were present in all transplanted hearts regardless of AVO. However, the size of the hearts with AVO gained back their initial size after transplantation.

Conclusion: Reversibility of the distended heart size due to reduced cardiac workload after AVO and heterotopic transplantation occurs in spite of inflammation related to surgical trauma. The clinical rational of reducing workload in hearts with AVO is associated with inducing reversible cardiac changes.

Lymphatic Function and Morphology in the arms of Breast Cancer Treated Women – A follow-up study

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Background: Axillary surgery and radiation therapy (RT) are significant risk factors for developing breast cancer related lymphedema (BCRL). These interventions may partially obstruct lymph outflow from the ipsilateral arm, chronically raising the afterload of the lymphatic vasculature. Lymphatic contractile function is changed, and distinct pathological lymphatic patterns are described in women diagnosed with BCRL, but it is unknown whether these changes occur before clinical edema is detectable.

Methods: The study population consists of 35 high-risk breast cancer patients examined at baseline a few weeks after ended RT and at follow-up 6-12 months later. Contraction frequency, velocity and pumping pressure of the lymphatic vessels are described using Near-Infrared Fluorescence (NIRF) imaging. Lymphatic stress-test is performed using hyperthermia. Blood is analyzed for endothelial growth factors and pro-fibrotic cytokines.

Results: The preliminary results consist of 14 patients investigated at baseline. Two patients presented with lymphatic abnormalities. A 22% higher pumping pressure was observed in the ipsilateral arm compared to the contralateral in the remaining 12 patients (p=0.0105). The 2 patients with lymphatic abnormalities had reduced maximal pumping pressure in the ipsilateral arm compared to the contralateral. All 35 patients will have baseline examination completed at the end of 2019, and most patients will have their second examination in the early spring of 2020.

Conclusion: The preliminary baseline results indicate that well-functioning lymphatic vessels in the ipsilateral arm are compensating for the cancer treatment related obstruction by raised pressure. However, lymphatic vessels with lymphatic abnormalities generate lower pressures. These lymphatic abnormalities and reduced contractile function could be the initial phase in the development of BCRL.

Perspectives: Studies have shown that early identification and treatment of subclinical lymphedema significantly reduces its development into advanced stages with significant improvement in quality-of-life. NIRF might be a promising method to detect these early changes. Furthermore, these data may elucidate the characteristics of the changes taking place in the lymphatic vessels after breast cancer treatment and thus provide new insight for future treatments medical as well as surgical.

SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY SSRCTS

Ischemic postconditioning has no effects on postoperative hemodynamics or cardiomyocyte injury in elective cardiac surgery. A prospective, randomized, multicentre study

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Background: Ischemic postconditioning is cardioprotective in animal models. In the clinical setting the effect of postconditioning is more controversial. We hypothesized that postconditioning would improve hemodynamics and reduce cardiomyocyte injury in a prospective, multicenter, randomized, controlled trial on patients undergoing elective aortic valve replacement.

Material and Methods: Two-hundred-and-nine adult patients undergoing elective aortic valve replacement in four cardiac centers in Europe were included. Each center employed their standard anesthetic and surgical care including type of cardioplegia. Postconditioning was performed by three cycles of flow/non-flow (two minutes each) of normothermic blood via the cardioplegia line at the end of cardioplegic arrest immediately before the cross-clamp was released. Cardiac index during the first 24 postoperative hours was the primary end point. Secondary end points included additional hemodynamic measurements, biomarkers of cardiomyocyte injury, renal function parameters, intra- and postoperative arrhythmias, chest tube output, and use of inotropic agents.

Results: There was no significant difference between the groups regarding cardiac index (mean between group difference, 95% confidence interval (CI) 0.07 (-0.1 – 0.3), p=0.47). Furthermore, postconditioning had no effect on pulmonary artery pressures, pulmonary artery wedge pressure, central venous pressure, heart rate, or systemic vascular resistance index. There was no between-group difference regarding troponin T (95% CI -68 (-235 - 98), p=0.42) or creatine kinase MB (mean between group difference, 95% CI -1.32 (-7.8 – 5.2), p=0.69). No diffe-

rences were seen in chest tube output, use of inotropes, need of pacing, or renal function parameters. Sub-group analysis showed no effect in patient with/without diabetes or in patient above/below 70 years of age. There was no important inter-group difference of intraoperative ventricular fibrillation or postoperative atrial fibrillation. However, when occurrence of intraoperative ventricular fibrillation and postoperative atrial fibrillation were pooled, postconditioned patients had 45 % less risk of arrhythmias (OR 0.55; 95% CI -1.32 (-7.8 – 5.2), p=0.69).

Conclusion: Ischemic postconditioning has no important cardioprotective effects in low-risk patients undergoing elective cardiac surgery.

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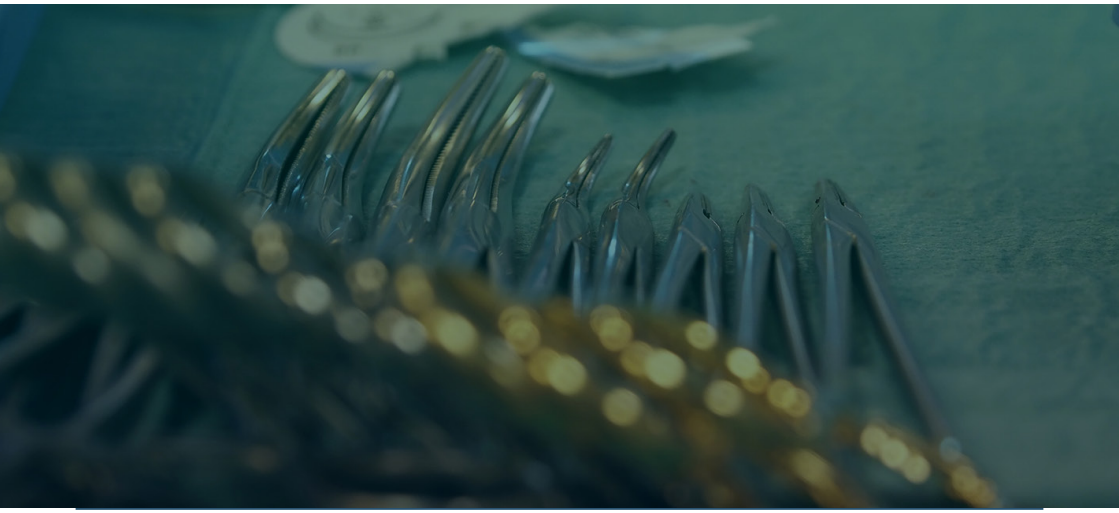

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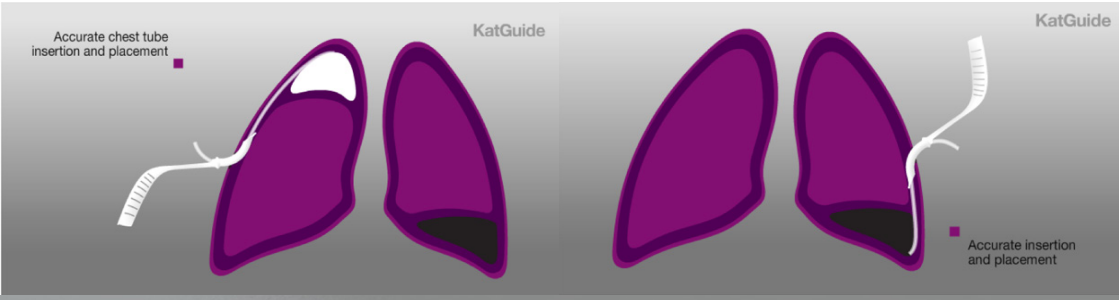
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