THE GEILO MEETING

ON CARDIOVASCULAR AND THORACIC RESEARCH

32nd Annual Geilo Meeting

on Cardiovascular and Thoracic Research

February 8-10, 2024

Dr. Holms Hotel, Geilo, Norway

Program & Abstracts

www.geilomeeting.com

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CONTENTS

WELCOME

Dear colleagues and friends,

Once again, we are thrilled to welcome you to the 32nd Annual Geilo Meeting on Cardiovascular and Thoracic Research – now simply rebranded as "The Geilo Meeting".

We are extending our invitation to researchers across various fields engaged in cardiac, vascular, and thoracic research. The interdisciplinarity is the cornerstone of the Geilo Meeting. As we assess this year's program, we attribute our success in achieving this objective to your valuable support. In return for your participation, we promise you a meeting with fruitful scientific discussions in a relaxed atmosphere, and excellent opportunities for networking and interdisciplinary collaboration.

This year, we have changed the conference venue to Dr. Holms Hotel as our previous location could no longer accommodate our meeting. However, we are confident that the surroundings and atmosphere at this new site will still provide the perfect setting for discussions of scientific matters, extending beyond the scheduled hours.

We therefore look forward to welcoming you in person in Geilo for some enriching and productive days.

On behalf of the organizing committee,

Peter Johansen
President

PROGRAMME

THURSDAY, 8 FEBRUARY 2024	DAY 1
2:00 PM – 2:30 PM	**Arrival and Registration**
2:30 PM – 2:45 PM	**Welcome** Peter Johansen, MSc PhD, President of the Organizing Committee
2:45 PM – 3:30 PM	**Workshop part I: Artificial intelligence in a medical context** Moderator: Peter Johansen *How to get started with artificial intelligence* Kaare Mikkelsen, MSc PhD Dept. of Electrical and Computer Engineering, Aarhus University, Denmark
3:30 PM – 3:45 PM	**Introductory Lecture** Moderator: Peter Johansen *Advancing cardiovascular research: combining in-silico simulations, flow-loop in-vitro analysis, and 4D-flow MRI validation* Monika Colombo, MSc PhD Dept. of Mechanical & Production Engineering, Aarhus University, Denmark
3:45 PM – 4:00 PM	**Refreshments**

4:00 PM – 5:30 PM	**Poster Presentations**

Chairs: Mari-Liis Kaljusto & Rasmus Kraghede

1) Benedikte Haldrup: Effect of butyrate treatment on post-infarction left ventricular remodeling and function in an in-vivo rat model
2) Doruk Bor: Effect of butyrate treatment on myocardial ischemia in a rat model
3) Aleksi Kuuva: Evaluation framework for cardiac patches for use in cardiac micrograft therapy
4) Vilbert Sikorski: Autologous right atrial appendage micrografts transplanted at coronary artery bypass surgery: A randomized trial design
5) Mads Harthimmer: Resorbable Sutures or Not? A Comparative Study in Strength of Vascular End-to-End Anastomoses
6) Rasmus Gebauer Dalsgaard: New detection of cardiac allograft vasculopathy (chronic rejection) by Cardiac CT-scanning in heart transplanted patients
7) Andreas Kabel: Validation of Super-Resolution Coronary Magnetic Resonance Angiography
8) Villads Juul Bruun: Evolution of Porcine Small Intestinal Submucosal Extracellular Matrix in Cardiovascular Surgery Across the last Decade
9) Lasse Juul Christensen: Effects of butyrate on cardiac hemodynamics - a porcine model

5:30 PM – 5:45 PM	**Break**

5:45 PM – 6:45 PM	**Podium Presentations** Chairs: Won Yong Kim & Lene Thorup 1) Caroline Damsgaard Jensen: Effects of BMP10 and palovarotene in pressure overload induced right ventricular failure 2) Mette Wørmer Poulsen: Effects of oxygen therapy on pulmonary perfusion and ventilation in a porcine model of acute pulmonary embolism 3) Lasse Hubertus Tiroke: Long-term Cardiac CT Follow-Up after Left Atrial Appendage Occlusion 4) Johannes Jedrzejczyk: Posterior mitral valve reconstruction with 2-ply vacuum-pressed small intestinal submucosal extracellular matrix: An in vitro evaluation
6:45 PM – 7:30 PM	**Keynote Talks** Moderator: Peter Johansen *Catheter-based interventions in acute pulmonary embolism* Jacob Gammelgaard Schultz, MD PhD Dept. of Cardiology, Aarhus University Hospital, Denmark
8:00 PM	**Dinner**

FRIDAY, 9 FEBRUARY 2024	DAY 2
2:00 PM – 2:30 PM	**Workshop part II: Artificial intelligence in a medical context** Moderator: Won Yong Kim *Introduction to the AI pipeline – a case from cardiac MRI* Kaare Mikkelsen, MSc PhD Dept. of Electrical and Computer Engineering, Aarhus University, Denmark
2:30 PM – 2:45 PM	**Break**
2:45 PM – 4:30 PM	**Podium Presentations** Chairs: Niamh Hynes & Johannes Jedrzejczyk 1) Anna Ramella: In-vitro 4D flow MRI data to validate FSI simulations of the TEVAR procedure 2) Benedetta Grossi: integration of immunological data with patient-specific fluid-structure interaction simulations for transcatheter aortic valve implantation prognostic assessment 3) Peter Johansen: In vitro modelling of the left atrium 4) Sebastian Sartipy: 24 years of pericardiectomy for constrictive pericarditis in Sweden; short- and long-term outcomes 5) Lene Thorup: Effects of Positive Pressure Ventilation on Peripheral Lymphatic Function (LYMPH-UP) 6) Mary Rezk: Atrial fibrillation recurrence in patients with and without complicated postoperative atrial fibrillation after cardiac surgery 7) Anna Maria Dehn: Atrial Septal Defects: Echocardiographic and Electrocardiographic Characteristics in Neonates
4:30 PM – 4:45 PM	**Refreshments**

4:45 PM – 5:30 PM	**Keynote Talk** Moderator: Monika Colombo *Personalised digital twins to understand the functionality and impact of cardiovascular devices to predict responses to therapeutic actions* Professor Francesco Migliavacca, MSc PhD Politecnico Milano, Italy
5:30 PM – 7:30 PM	**Wet Lab** Instructors: Johannes Jedrzejczyk, Tanita Drejer Jeppesen, & Mari-Liis Kaljusto
8:00 PM	**Dinner and Entertainment**

SATURDAY, 10 FEBRUARY 2024	DAY 3

2:00 PM – 2:45 PM	**Workshop part III: Artificial intelligence in a medical context** Modrator: Peter Johansen *ChatGPT – extended use in medical research* Kaare Mikkelsen, MSc PhD Dept. of Electrical and Computer Engineering, Aarhus University, Denmark
2:45 PM – 3:30 PM	**Keynote Talk** Moderator: Jacob Gammelgaard Schultz *The Dynamic Aortic Environment: Challenges for Current Therapies and Future Perspectives* Niamh Hynes, MD PhD University of Galway, Ireland
3:30 PM – 3:45 PM	**Refreshments**
3:45 PM – 5:15 PM	**Podium Presentations** Chairs: Vibeke Hjortdal & Caroline Damsgaard Jensen 1) Rasmus Kraghede: Feasibility of intratracheal tracheostomy sealing 2) Hedda Marie Kjølberg Hauge: Surgical Treatment of Acute Type A Aortic Dissection in Norway 3) Luca Bontempi: Aortic Annuloplasty: Integration of Experimental Ex-vivo Porcine Data, In-silico Analysis and 4D-flow MRI Validation 4) Sidsel Loft Nagel: Explaining the Unexplainable Death by Introducing Ex-vivo Cardiac Imaging in Forensic Autopsies 5) Louise Winding Nielsen: Intratracheal tracheostomy sealing – a clinical feasibility study 6) Maren Ravndal: Lung function in Fontan patients over a ten-year period; is the Fontan circulation impairing lung development?
5:15 PM – 5:20 PM	**Break**

5:20 PM – 6:10 PM	**Poster Presentations** Chairs: Jacob Gammelgaard Schultz & Mary Rezk 1) Tanita Drejer Jeppesen: A novel expansible aortic annuloplasty ring for aortic valve repair 2) Sara Lau-Jensen: Mental Health in children and adolescents with Fontan circulation in Denmark 3) Signe Gram Sand: Optical Measurement of Pulse Wave Velocity 4) C. Noah Nilsson: Peripheral lymphatic flow during non-invasive negative intrathoracic pressure with biphasic cuirass ventilation 5) Jacob Petersen: Quantitative analysis of ICG fluorescence imaging prolongs visualization time when determining lung segment during segmentectomies
6:10 PM – 6:40 PM	**Award Committee Meeting** Peter Johansen (Chairman), Won Yong Kim, Vibeke Hjortdal, Jacob Gammelgaard Schultz, Mari-Liis Kaljusto, Niamh Hynes, Jarle Vaage
6:40 PM – 6:50 PM	**Awards**
6:50 PM – 7:20 PM	**Evaluation**
8:00 PM	**Presidential Dinner**

ABSTRACTS

PODIUM PRESENTATIONS

O1 *Effects of BMP10 and palovarotene in pressure overload induced right ventricular failure*
Caroline Damsgaard et al.

O2 *Effects of oxygen therapy on pulmonary perfusion and ventilation in a porcine model of acute pulmonary embolism*
Mette Wørmer et al.

O3 *Long-term Cardiac CT Follow-Up after Left Atrial Appendage Occlusion*
Lasse Hubertus Tiroke et al.

O4 *Posterior Mitral Valve Leaflet Reconstruction with 2-Ply Vacuum-Pressed Small Intestinal Submucosal Extracellular Matrix: An in Vitro Evaluation*
Johannes Jedrzejczyk et al.

O5 *In-vitro 4D flow MRI data to validate FSI simulations of the TEVAR procedure*
Anna Ramella et al.

O6 *Integration of immunological data with patient-specific fluid-structure interaction simulations for transcatheter aortic valve implantation prognostic assessment*
Benedatta Grossi et al.

O7 *In vitro modelling of the left atrium*
Peter Johansen et al.

O8 *24 years of pericardiectomy for constrictive pericarditis in Sweden; short- and long-term outcomes*
Sebastian Sartipy et al.

O9 *Effects of Positive Pressure Ventilation on Peripheral Lymphatic Function (LYMPH-UP)*
Lene Thorup et al.

O10 *Atrial fibrillation recurrence in patients with and without complicated postoperative atrial fibrillation after cardiac surgery*
Mary Rezk et al.

O11 *Atrial Septal Defects: Echocardiographic and Electrocardiographic Characteristics in Neonates*
Anna Maria Dehn et al.

O12 *Feasibility of intratracheal tracheostomy sealing*
Rasmus Kraghede et al.

O13 *Surgical Treatment of Acute Type A Aortic Dissection in Norway*
Hedda Marie Kjølberg Hauge et al.

O14 *Aortic Annuloplasty: Integration of Experimental Ex-vivo Porcine Data, In-silico Analysis and 4D-flow MRI Validation*
Luca Bontempi et al.

O15 *Explaining the Unexplainable Death by Introducing Ex-vivo Cardiac Imaging in Forensic Autopsies*
Sidsel Loft Nagel et al.

O16 *Intratracheal tracheostomy sealing – a clinical feasibility study*
Louise Winding Nielsen et al.

O17 *Lung function in Fontan patients over a ten-year period; is the Fontan circulation impairing lung development?*
Maren Ravndal et al.

O1

Effects of BMP10 and palovarotene in pressure overload induced right ventricular failure

Caroline Damsgaard Jensen[1], Julie Sørensen Axelsen[1], Stine Andersen[1], Asger Andersen[1], Frances Handoko de Man[2]

1. Department of Cardiology, Aarhus University Hospital, Aarhus, Denmark 2. Department of Physiology and Pulmonology, Amsterdam University Medical Centers, Amsterdam, The Netherlands

BACKGROUND
Right ventricular (RV) failure is the predominant cause of death in patients with pulmonary arterial hypertension (PAH), leaving an unmet need for new treatment strategies to support the failing RV. Bone morphogenetic protein (BMP) signaling is disturbed in patients with PAH, and injection with BMP10 improved left ventricular function in an experimental model of myocardial infarction. The direct effects of BMP10 on the RV remain unknown. We aimed to investigate whether administration of exogenous BMP10 or increasing endogenous BMP10 by administration of palovarotene could attenuate the development of RV failure in an animal model of isolated RV failure.

MATERIALS AND METHODS
Wistar rat weanlings underwent sham (n=4) or PTB surgery where a titanium ligating clip constricts the pulmonary trunk. One week after surgery, PTB rats were allocated to the treatment groups after a baseline echocardiography (PTB controlBMP n=12, PTBBMP n=11, PTB-controlpalovarotene n=11, PTB palovarotene n=11). After four weeks of treatment, the echocardiography was repeated, followed by a cardiac MRI scan and right heart catheterization. Cardiac tissue was harvested for histological and molecular analyses.

RESULTS
Rats with PTB had a three-fold increase in RV end-systolic pressure compared with sham. The increased RV pressure led to RV dilation with increased RV end-systolic volume and RV hypertrophy in PTB rats. There were no differences in RV endsystolic pressure, volume, or hypertrophy between both control and treatment groups. The gene expression of BMP10 was increased in control compared with sham. However, the expression was not further increased by exogenous BMP10 or palovarotene treatment. Neither administration of BMP10 nor administration of palovarotene had an impact on RV function or RV remodeling in rats with pressure overload-induced RV failure from PTB.

CONCLUSION
The PTB surgery increased endogenous expression of BMP10, however, the two treatments did not further increase the gene expression. The study found no toxic or adverse effects on the failing heart from treatment with BMP10 or palovarotene.

O2

Effects of oxygen therapy on pulmonary perfusion and ventilation in a porcine model of acute pulmonary embolism

Mette Wørmer Poulsen[1,2], Jacob Valentin Hansen[1,2], Lasse Tiroke[1,2], Mads Dam Lyhne[2,3], Christopher Kabrhel[4], Mannudeep K. Kalra[5], Asger Andersen[1,2]

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BACKGROUND

Every year, 300.000 people die of acute pulmonary embolism (PE) in Europe alone. Oxygen is a key element of acute PE treatment, although knowledge about the exact mechanism is sparse, and the amount of oxygen given is not agreed upon. Dual Energy CT (DECT) is a useful tool for assessing lung perfusion changes before and after acute PE. It offers quantitative values for perfusion in areas of the lung while also providing images for the evaluation of ventilation, and traditional CT pulmonary angiogram. The aim of this study is to evaluate pulmonary perfusion changes at different fractions of inhaled O2 (FiO2) in acute PE by utilizing novel software for the DECT technology.

MATERIALS AND METHODS

Female pigs (n=6) underwent five DECT-scans at four different levels of FiO2, with 15-minute intervals between scans, before and after acute pulmonary emboli (PE). Autologous PE were given one at a time until mean arterial pressure (MAP) was reduced by ≥ 50 %, mean pulmonary arterial pressure (mPAP) was doubled, cardiac output was decreased by ≥ 20 %, or if administration of vasopressors was needed. Images were uploaded into post-processing software and quantitative measures were obtained from regions of interests in each of the 6 lobes. The results from these analyses were compared to invasive pulmonary pressures, systemic pressures and blood gases obtained at the same timepoints as the scan.

RESULTS

Introduction of the PE resulted in an increase in mPAP (18 ± 2 vs. 34 ± 4, p = 0.0016) and PVR (180 ± 32 vs. 362 ± 77, p = 0.0351). mPAP decreased when comparing FiO2 21 % vs. 40 % (34 ± 4 vs. 27 ± 5, p = 0.0016). FiO2 higher than 40 % did not significantly decrease mPAP further. No changes were found in perfusion when altering FiO2.

CONCLUSION

In a porcine model of acute PE, FiO2 of 40 % or higher decreases mPAP, with effects similar to other known vasodilating drugs. Further investigation is needed to examine the effects of oxygen on pulmonary perfusion before and after acute PE. Perspectives The beneficial effects of oxygen on the RV afterload support earlier studies, and currently clinical trials are being performed to confirm the same effects in humans. This might help change guidelines for future treatment of patients with acute PE.

O3

Long-term Cardiac CT Follow-Up after Left Atrial Appendage Occlusion

Lasse Hubertus Tiroke[1], Anders Kramer[1], Mette Wørmer Poulsen[1], Caroline Dam Jensen[1], Jesper Møller Jensen[1], Bjarne Linde Nørgaard[1], Kasper Korsholm[1], Jens Erik Nielsen-Kudsk[1]

1. Department of Cardiology, Aarhus University Hospital, Aarhus, Denmark

BACKGROUND

Atrial fibrillation is associated with a five times increased risk of ischemic stroke. Oral anticoagulation (OAC) is the current first line treatment. However, bleeding complications and insufficient compliance challenge the safety and efficacy of this strategy. Left atrial appendage occlusion (LAAO) is a non-inferior alternative in patients unsuited for anticoagulants. Long-term follow-up imaging data on safety and durability are missing. We aimed to evaluate safety and durability of the Amplatzer Amulet device >4 years after LAAO.

MATERIAL AND METHODS

This study included a prospective observational cohort study with a total of 52 patients implanted with the Amplatzer Amulet (Abbott, Chicago, Illinois) at Aarhus University Hospital, Denmark. A late (>4 years) follow-up cardiac CT-scan after LAAO was performed and compared with results from two-month, and twelve-month scans, when available. The primary outcome was left atrial appendage (LAA) sealing based on distal LAA contrast patency and peridevice leak (PDL) stratified into complete occlusion and grade 1-3 leakage (G1-3). Secondary outcomes were low- and high-grade hypoattenuated thickening (HAT), device-related thrombosis (DRT) and device durability.

RESULTS

At two-month (n=52), twelve-month (n=27) and >4-year follow-up CT (n=52), rates of both complete occlusion (33%/37%/35%) and G2 leaks (52%/52%/48%) remained stable. Rates of G1 leaks varied (14%/4%/6%) and G3 leaks rose (2%/7%/12%) from earliest to latest follow-up Median left atrial volume increased from 127 ml (96; 176) to 144 ml (108; 182) and 147 ml (107; 193). No DRT was found. The structural device integrity was preserved.

CONCLUSION

This study indicates a stable LAA sealing status throughout the follow-up period, emphasizing the importance of the procedural result to avoid PDL. Few patients displayed PDL progression which might partly be related to LA remodeling with increasing volume. The long-term device durability appears excellent. Larger studies are warranted to confirm these findings.

O4

Posterior Mitral Valve Leaflet Reconstruction with 2-Ply Vacuum-Pressed Small Intestinal Submucosal Extracellular Matrix: An in Vitro Evaluation

Johannes H. Jedrzejczyk[1,2], Frederik T. Andersen[1,2], Jacob Petersen[1,2], Alexander E. Kaspersen[1,2], Søren N. Skov[1,2], Jens T. Væsel[1,2], J. Michael Hasenkam[1,2,3], Marcell J. Tjørnild[1,2]

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BACKGROUND

Different iterations of small intestinal submucosal extracellular matrix (SIS-ECM) were evaluated to assess the mechanical properties. Based on these results, the optimal iteration was chosen for posterior mitral valve reconstruction in vitro.

METHODS

Four different versions of SIS-ECM were subjected to uniaxial testing. A customizable patch using MRI scans of healthy 80 kg pigs (n = 5) was created. Patch reconstruction of the entire posterior mitral valve using the 2-ply vacuum-pressed small intestinal submucosal extracellular matrix was performed in vitro (n = 7).

RESULTS

The vacuum-pressed iterations had superior mechanical robustness compared to the lyophilized (7.87 ± 0.64 vs 17.39 ± 3.68 MPA, P < 0.001). Competence was achieved for all reconstructions and total leaflet area was preserved. However, the area of the individual leaflet segments had been redistributed.

CONCLUSIONS

It was feasible to reconstruct the entire posterior mitral valve in vitro with our customizable patch design with the 2-ply vacuum-pressed SIS-ECM. Further in vivo studies in an 80 kg porcine model for which the patch was designed will be necessary to evaluate it further.

O5

In-vitro 4D flow MRI data to validate FSI simulations of the TEVAR procedure

Anna Ramella[1], Giulia Luraghi[1], Luca Bontempi[1], Arianna Callera[1], Francesco De Gaetano[1], Steffen Ringgaard[2,3], Won Yong Kim[2,4], Santi Trimarchi[5], Peter Johansen[6], Monika Colombo[7], Francesco Migliavacca[1]

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OBJECTIVE

Thoracic Endovascular Aortic Repair(TEVAR) involves the deployment of a self-expandable stent-graft(SG) into a pathological aortic region to restore physiological hemodynamics. Given the need of investigating complications to TEVAR, reliable computational models may play a role in pre-operative planning and prediction of post-operative results. The best numerical approach to replicate the pre-/post-TEVAR scenarios is the Fluid-Structure Interaction(FSI) modeling, which couples hemodynamics and structural mechanics. This study aims to validate the pre- and post-TEVAR hemodynamics with FSI simulations using in-vitro 4D flow MRI data.

MATERIALS AND METHODS

Patient-specific aortic anatomy was reconstructed from clinical images and 3D-printed with a compliant polymer with known material properties. Two conditions were studied: the pre-TEVAR pathological aorta and the post-TEVAR with SG. These phantoms were connected to a pulsatile flow loop circuit mimicking the systemic circulation. Inlet and outlet pressure and inlet flow rate data were recorded. Strongly coupled, two-way and boundary-fitted FSI simulations were conducted. Velocity and pressure waveforms extracted from the flow loop were imposed as boundary conditions. In the post-TEVAR, the SG was modeled as an embedded body into the fluid mesh volume. The entire flow loop was MRI-compatible, allowing the acquisition of full cardiac cycle velocity field data inside the scanner. After post-processing, the velocity values obtained from 4D-MRI were compared to those from numerical simulations.

RESULTS

Fig.1 shows the experimental loop and depicts pre-operative FSI simulation results regarding velocity contours at the systolic peak. Simulation data will be compared with the corresponding velocity fields extracted from 4D-MRI acquisitions.

CONCLUSION

The validation of numerical simulations is crucial to ensure their reliability when dealing with clinical applications. The proposed methodology allows for experimentally recreating the aortic circulation in a controlled environment (3D-printed aorta, measurable pressures and flow rate) and extracting data for FSI simulations. The combination with the 4D flow MRI data allows for validating the developed FSI simulations modelling pre- and post-TEVAR. This novel FSI approach can be useful for investigating TEVAR complications or supporting clinical decisions.

O6

Integration of immunological data with patient-specific fluid-structure interaction simulations for transcatheter aortic valve implantation prognostic assessment

Benedetta Grossi[1,2], Giulia Luraghi[2], Sara Bridio[2], Riccardo Terzi[1], Matteo Sturla[1], Alessandro Villaschi[1], Ottavia Cozzi[1], Anna Ramella[2], Marinos Kallikourdis[1], Josè Felix Rodriguez Matas[2], Gianluigi Condorelli[1], Giulio Stefanini[1], Francesco Migliavacca[2]

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BACKGROUND

A close link between inflammatory status and degenerative aortic stenosis (AS) has been established. However, in vivo evidence about the benefit of transcatheter aortic valve implantation (TAVI) on the inflammatory background via amelioration of the hemodynamic environment is still lacking. Thanks to Fluid-Structure Interaction (FSI) patient-specific simulations, such cause/effect link may be proved. The aim of this study is to evaluate the inflammatory response after TAVI in patients whose aortic fluid dynamics conditions have been studied through FSI simulations.

METHODS

For twenty-four patients, detailed anatomical and physiological data were collected from pre-procedural CTs and intra-procedural pressure acquisitions. Patients' hemodynamic conditions were subsequentially reproduced with FSI models (Figure 1), validated with post-procedural imaging techniques. The in silico model simulates the implantation, the interaction of the device with the patient-specific domain and the hemodynamics after TAVI, allowing the quantification of potential aortic regurgitation due to paravalvular leak. To preliminarily evaluate this cause/effect link, for six patients the neutrophil-to-lymphocyte ratio (NLR) was measured in the pre-operative, acute and post-operative phases (Figure 2).

RESULTS

Mean baseline NLR was 2.27 ± 0.89, which increased to 3.82 ± 2.09 in the acute phase. One month after the procedure, mean NLR was 1.97 ± 0.85, with an average decrease from baseline of 18% ($p=0.027$). In five patients, mild aortic regurgitation post TAVI was noted, while in one patient moderate regurgitation was observed, accurately quantified by the FSI simulations. Of interest, in this latter patient a lower decrease of NLR (9%) with respect to the pre-operative data was found (red curve). More specific results about the simulations will be presented at the conference.

CONCLUSIONS

A decrease of the inflammatory response after the restoration of physiological hemodynamic conditions was found in a small subset of patients undergoing TAVI. Further analysis will delve deeper into this correlation with the aim of creating a patient-specific profiling for AS treatment. In particular, 50 patients will be enrolled and for all of them specific inflammatory markers (e.g., IL-1β and IL-12) will be extracted from blood samples for further immunological profiling.

O7

In vitro modelling of the left atrium

Peter Johansen[1], Masoud Meskin[1,2], Philip Alexander Starkey[1], Alexander Emil Kaspersen[3], Steffen Ringgaard[4], Signe Gram Sand[1], Jens Vinge Nygaard[5], Jørgen Arendt Jensen[6], Marie Sand Traberg[2,6]

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BACKGROUND

The left atrium has an important role in the normal functioning of the heart, serving as both a reservoir, a conduit and pump during the cardiac cycle. However, various conditions can affect this. In patients with atrial fibrillation the normal hemodynamic function is compromised and in patients with mitral valvular dysfunction alteration of the left atrium occurs. Moreover, the general interplay between the left ventricle and left atrium may be affected under various heart failure conditions. To improve the hemodynamic understanding and provide a platform for test and development of interventions in conditions involving the left atrium, an experimental model can be an important asset. Alternatives to animal in vivo models are in vitro models. The aim of this study is therefore to establish an in vitro flow loop introducing a realistic left atrial model.

METHODS

An existing left heart model was extended by applying a left atrial model casted in silicone. The material was matched to provide similar expansion as seen in porcine hearts. Three left atrial models with low, normal, and high compliance were tested. Fluid dynamic measures included pulmonary venous flow, mitral valve flow, left atrial pressure, and left ventricular pressure. The timing and action of the left atrial and ventricular diastole and systole was controlled through a piston pump and a pneumatic system.

RESULTS

The model demonstrated realistic hemodynamic behavior. A decrease of left atrial compliance reflected changes in the left atrial pressure (a-wave increased from 12 to 19 mmHg and v-wave increased from 22 – 26 mmHg) and the S/D ratio of the pulmonary venous flow was reduced from 1.5 to 0.3.

CONCLUSIONS

The in vitro model provides realistic fluid dynamics and responds in a physiological manner. It serves a platform for development and investigation of left heart procedures and interventions.

O8

24 years of pericardiectomy for constrictive pericarditis in Sweden; short- and long-term outcomes

Sebastian Sartipy[1,2], Susanne J. Nielsen[1,2], Carl Johan Malm[1], Göran Dellgren[1,3], Emma C. Hansson[1,2]

1. Department of Cardiothoracic Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden; 2. Department of Molecular and Clinical Medicine, University of Gothenburg, Sweden; 3. Department of Surgery, University of Gothenburg, Sweden.

BACKGROUND

Constrictive pericarditis, a rare cause of heart failure, results from restricted diastolic relaxation due to fibrotic changes to the pericardium. Pericardiectomy is the only curative treatment. However, factors contributing to variation in outcome remain poorly understood. Therefore, we explored short- and long-term outcomes, both readmission because of heart failure and mortality, in patients undergoing pericardiectomy for constrictive pericarditis.

METHODS

This retrospective, nation-wide study included all pericardiectomy procedures for constrictive pericarditis in Sweden between the years 1997-2020 (n=175, mean age 59 ± 15 years). In addition, controls from the Swedish general population matched on age and sex were included (n=630). The log-rank test was used to compare survival and Fisher's exact test or Mann-Whitney U-test were used for two-group comparisons. Data were collected from the SWEDEHEART registry and two other mandatory registries. The median follow-up time was 5.8 (IQR 2.5-10.1) years.

RESULTS

Extracorporeal circulation was utilized in 47% of cases and 26% of patients underwent concomitant cardiac surgery. In the pericardiectomy cohort, 30-day mortality rate was 5.1% and associated with older age at surgery (p=0.008). At latest follow-up, mortality rate was 35% and associated with older age, reduced ejection fraction, diabetes, atrial fibrillation, and renal failure at baseline. During follow-up, 22% of patients were readmitted because of heart failure, with preoperative atrial fibrillation as a predicting factor (p<0.001). Additionally, a trend towards improved survival for patients operated between 2010-2020 compared to 1997-2009 was observed (p=0.066). Pericardiectomy patients had more baseline comorbidities and poorer survival compared to the Swedish population controls.

CONCLUSIONS

Constrictive pericarditis is a rare disease, and patients often suffer from comorbidites which affect outcomes after surgery. Advancements in overall treatment of these patients over the last decade may have contributed to a trend of improvement in survival rates.

O9

Effects of Positive Pressure Ventilation on Peripheral Lymphatic Function (LYMPH-UP)

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BACKGROUND

The lymphatic system plays an important role in immune response, uptake of dietary fats, and maintaining fluid homeostasis. Most of the lymphatic fluid returning from the body runs through the thoracic cavity via the thoracic duct, before draining into the subclavian vein. This transport is unidirectional and dependent on contraction forces of peripheral and central lymphatic vessels, venous pressure at the thoracic duct outlet, and pressure in the thoracic cavity. Even though positive pressure ventilation (PPV) is known to increase central venous pressure it is not known if it also affects the peripheral lymphatic vessels and thus the drainage of lymphatic fluid. We aim to investigate the impact of positive pressure ventilation on peripheral lymphatic contractility.

METHODS

Inclusion of 20 cardiopulmonary healthy patients 18 ≤ 35 years old undergoing surgery for malformations in the jaw requiring general anesthesia and PPV. Lymphatic contractility is investigated using Near-Infrared Fluorescence Imaging of the lower limb. Outcomes are lymphatic contraction frequency and velocity. Investigations are performed for 1) 30 minutes at standard ventilation pressure (PEEP 4-7 cmH2O), 2) 30 minutes at elevated ventilation pressures (PEEP 10 cmH2O > standard), 3) during breath-hold, 4) immediate post-op, and 5) during spontaneous respiration (baseline). Results Data collection and analysis is ongoing. Inclusion is expected completed by March 2024.

RESULTS

Preliminary results from the first 11 patients show a median lymphatic contraction frequency at baseline of 1.8 (IQR 1. 3 - 2.5) contractions min-1. Standard pressure PPV decreased contraction frequency with 61% (median 0.7 (IQR 0.3 - 1.0) remaining here at elevated pressure ventilation (median 0.5 (IQR 0.3 - 1.1) and breath-hold (median 0.7 (IQR 0.0 - 0.8)). Immediate post-op median frequency was 0.8 (IQR 0.5 - 1.4) contractions min-1.

CONCLUSIONS

These preliminary results suggest that peripheral lymphatic contractility is affected by PPV. If so, it could support initiatives to reduce fluid retention after prolonged exposures to PPV in e.g. intensive care patients, as well as help improve our understanding of especially patients with a Fontan circulation who either have or are at risk of developing lymphatic complications.

O10

Atrial fibrillation recurrence in patients with and without complicated postoperative atrial fibrillation after cardiac surgery

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BACKGROUND

New-onset postoperative atrial fibrillation (POAF) is the most common adverse event after cardiac surgery. The clinical course of the POAF event varies markedly in real life. Atrial fibrillation (AF) recurrence after POAF is common and associated with a higher long-term risk for heart failure hospitalization. We aimed to explore potential associations between the clinical course of POAF and long-term risk for recurrent AF requiring hospitalization.

METHODS

A retrospective, observational study including all patients who underwent coronary artery bypass grafting, valve surgery, or a combination thereof, from 2010 to 2018 at Sahlgrenska University hospital (n=6435). Information on the clinical course of POAF was collected on all POAF patients using patient records. POAF patients were grouped into uncomplicated (spontaneous/pharmacological conversion to sinus rhythm) and complicated (necessitating electrical cardioversion to regain sinus rhythm). Multivariable Cox regression models adjusted for age, sex, type of surgery, comorbidities, and early initiated oral anticoagulation were utilized to compare the risk for AF recurrence in patients with and without complicated POAF. Median follow-up time was 3.8 years (range, 0-8.3).

RESULTS

POAF occurred in 2172 patients (33.8%). Among POAF patients, 2011/2172 (94.9%) converted to sinus rhythm before discharge. Out of these, a total of 1481 (73.6%) had an uncomplicated POAF and 530 (26.4%) had a complicated POAF. AF recurrence occurred in 318 (21.5%) of the patients with uncomplicated and in 189 (35.7%) of the patients with complicated POAF (Log rank test $p<0.001$). After multivariable adjustment, a complicated POAF course was independently associated with AF recurrence (adjusted hazard ratio 1.54 (95% CI 1.29-1.84), $p<0.001$), and heart failure hospitalization (aHR 1.28 (95% CI 1.00-1.65), $p=0.049$).

CONCLUSIONS

A more complicated course of POAF is associated with increased long-term risk for recurrent AF and heart failure requiring hospitalization.

O11

Atrial Septal Defects: Echocardiographic and Electrocardiographic Characteristics in Neonates

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BACKGROUND

Atrial septal defect (ASD) is often considered a relatively benign congenital heart defect. ASDs typically only cause subtle symptoms or might even be asymptomatic. Small defects are mostly left untreated and without regular follow-up. Nevertheless, patients with ASDs have increased mortality and morbidity. Diagnosis frequently does not occur until late childhood or even adulthood and some defects are probably never diagnosed. The pathophysiology and etiology of ASDs remain somewhat unknown and little is known about complications early in the life of patients with ASDs.

METHODS

We investigated cardiac morphology, function, and electrical activity in a large, population-based cohort of neonates from the Copenhagen Baby Heart Study (CBHS). Neonates (n=12,388; mean age 11 days) were examined by transthoracic echocardiography within 30 days of birth and systematically assessed for ASDs using an algorithm for the classification of interatrial communications that has been developed and validated within the CBHS. We compared echocardiographic and electrocardiographic characteristics between neonates with ASDs and matched controls from the same birth cohort.

RESULTS

On echocardiography, neonates with ASDs (n=716) had larger right ventricular (RV) dimensions than neonates without ASDs: RV longitudinal dimension 27.7mm vs. 26.7mm, p<0.001; RV basal dimension 14.9mm vs. 13.8mm, p<0.001; and RV outflow tract diameter 13.6mm vs. 12.4mm, p<0.001. Also, atrial volumes were larger in neonates with ASDs compared to controls: right atrial end-systolic volume 2.9ml vs. 2.1ml, p<0.001; and left atrial end-systolic volume 2.0ml vs. 1.8ml, p<0.001. On electrocardiography, neonates with ASDs (n=438) had longer P-wave durations (58 vs. 56 ms, p<0.001) and PR intervals (100 vs. 96 ms, p<0.001) than neonates without ASDs, and the QRS axis was more rightwards shifted in neonates with ASDs when compared to controls (116 vs. 114 degrees, p=0.032).

CONCLUSIONS

As early as in the first month after birth we find the same morphological and electrophysiological alterations that repeatedly have been described in patients with ASD later in life. This contributes with new knowledge on the pathophysiological understanding of ASDs. It is questionable if the alterations can be considered secondary to the shunt or are part of a more complex disease mechanism in ASD.

O12

Feasibility of intratracheal tracheostomy sealing

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BACKGROUND

Tracheostomy decannulation after prolonged mechanical ventilation therapy leaves the patient with an open upper airways channel. Improper tracheostomy wound sealing leads to pulmonary dysfunction and reduced voice quality. The prevailing tracheostomy wound sealing method involves using a bandage to seal the tracheostoma, but this approach often proves ineffective as it can be easily dislodged during coughing. In response to this challenge, we have recently introduced an innovative concept for intratracheal tracheotomy sealing. This study aims to investigate the feasibility and tissue compatibility of a new prototype in a porcine model.

METHODS

A silicone disc capable of intratracheally sealing a tracheostomy wound was prototyped in collaboration with Technolution A/S. 17 pigs (60 kg) were divided into 3 groups in this controlled study; 7 pigs in group A, 5 in group B and 5 in the control group. In the intervention groups a silicone disc was inserted under the skin (in intervention A the silicone disc was placed intratracheally through a tracheostomy, sealing the tracheostomy from the inside; in intervention B the disc was placed in the pretracheal connective tissue). The control group had a sham procedure performed. After 7 days, tissue samples were collected and analyzed for inflammation and compatibility with the sealing disc.

RESULTS

Results are yet to be analyzed, but in general group B showed macroscopic inflammation consistent with normal healing (as seen in the controls) and no necrotic tissue was found. In group A the seal was sufficient in all pigs and only minimal subcutaneous emphysema was found though hyperinflammation and necrotic tissue was found in several tissue samples, consistent with contamination of the tracheostomy wound. Histologic analysis of the tissue is yet to be evaluated.

CONCLUSIONS

This feasibility study showed tissue compatibility between the silicone disc and pigs physiology, though contamination through the airways gives rise to increased inflammation and infection. To further investigate this concept using a porcine model, our method needs further development in attempt to assess the properties of our prototype for intratracheal tracheostomy sealing. Further research will seek to investigate the effect of intratracheal tracheostomy sealing compared with conventional treatment.

O13

Surgical Treatment of Acute Type A Aortic Dissection in Norway

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BACKGROUND

Acute type A aortic dissection (ATAAD) requires prompt surgery to prevent death and fatal complications. If untreated, mortality increases by 1-2% per hour from the onset of symptoms. The lifesaving implantation of a supracoronary graft (SCG) has been the standard surgical approach in Norway. A resection of the proximal aorta with hemiarch often eliminates the entry tear, in most cases found in the ascending aorta or at the minor curvature of the arch. However, in line with increasing evidence and disease understanding, guidelines now recommend a more customized approach for complex dissections. In case of a distal entry-tear or malperfusion, emergency arch surgery with frozen elephant trunk (FET) should be considered. This technically more advanced strategy has shown better long-term outcomes for complex ATAADs especially when handled by aortic teams in large centres.

PERSPECTIVES

Implementing guidelines based on evidence from urban areas might be challenging given the Nordic geography. May the conservative strategy of SCG + hemiarch still be appropriate as a safe standard where geography affects time to diagnosis and surgery, and the surgical volume remains considerably lower than in Central Europe? We seek data in order to evaluate which approach can offer the most favourable outcome for Norwegian ATAAD patients.

METHODS

We aim to investigate the outcome of ATAAD-surgery by assembling retrospective data from the four cardiothoracic surgery centres in Norway. It is initiated a chart-review of data from Oslo University Hospital (OUS) of approximately 330 patients who underwent ATAAD surgery from 2018-2022, identified by ICD-10-code I71.0 and non-elective urgency. Endpoints are short- (30 d) and long-term survival, and rates of complications and reoperations. Demographics, symptoms, diagnostics, perioperative data and risk scores/classifications (GERAADAscore, TEM) are registered. The patient material from OUS covers >50% of the population. However our aim is to gather all the national ATAAD-data.

RESULTS

Preliminary results from the OUS analysis will be available by Feb 2024.

CONCLUSIONS

Few studies exist in the field of ATAAD-surgery in Norway, and published national data is lacking. In order to assess which guideline elements that can improve Norwegian outcomes, we need data describing current practice and results.

O14

Aortic Annuloplasty: Integration of Experimental Ex-vivo Porcine Data, In-silico Analysis and 4D-flow MRI Validation

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BACKGROUND

Aortic annuloplasty involves the implantation of a ring external to the aortic root, aiming to reduce annular dimensions in conditions such as aortic valve regurgitation. This project introduces an innovative computational fluid-structure interaction (FSI) model, simulating the entire aortic root under physio-pathologic and post-annuloplasty conditions. The model couples the deformable aortic wall domain with hemodynamic behaviors. The primary objective is to create a tool to assist clinicians in pre-surgical planning: specifically, to aid in selecting the optimal device geometry and mechanical properties, ensuring an optimal STJ-annulus ratio in post-operative conditions.

METHODS

In the pursuit of a validated patient-specific simulation, the initial steps involved the analysis of both an idealized reference model and subsequently an ex-vivo porcine-specific geometry. To gather essential boundary conditions for the computational model, both the reference model and the ex-vivo porcine-specific geometry were incorporated into an experimental flow-loop setup (Fig. 1), where pulsatile flow was maintained. This setup facilitated the collection of data from pressure and flow-rate sensors, ensuring the integration of accurate parameters into the computational model. The reference model was constructed through CAD-modeling and subsequently 3D-printed using an elastic resin with known material properties. The porcine-specific geometry was derived through segmentation of µ-CT scans of ex-vivo porcine aortic roots. To validate the simulation, 4D-flow MRI scans of the experimental flow-loop were employed to collect fluid-field velocity data (Fig. 2).

RESULTS

Both the reference model and the ex-vivo porcine aortic roots were integrated into the experimental mock circuit. Experimental sensor-based data were collected and implemented with the in-silico simulation. 4D-flow MRI data were compared with the velocities obtained through the FSI simulation.

CONCLUSIONS

In order to create an in-silico patient-specific simulation of aortic annuloplasty, reducing the time-consuming in-vitro testing, preliminary steps are necessary to ensure reliability of the results obtained. Integration of experimental studies, in-silico analysis and imaging data is fundamental to predict results of surgical procedures and to help surgeons with surgical planning.

O15

Explaining the Unexplainable Death by Introducing Ex-vivo Cardiac Imaging in Forensic Autopsies

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BACKGROUND
In forensic medicine sudden death in presumed healthy individuals are in many cases believed to have an underlying cardiac cause. Today, the forensic heart autopsy is based on a microscopic examination guided by visual, gross anatomical inspection with an inherent risk of overlooking localized pathology and thereby missing the cause of death. We aim at introducing post-mortem imaging of ex-vivo whole hearts as an add-on to the forensic autopsy to improve the likelihood if determining a cardiac cause of death and provide a better understanding of the underlying diseases.

METHODS
A CT contrast agent dissolved in gelatin will be injected, at physiological pressure, into the coronary arteries of ex-vivo whole hearts explanted during forensic autopsies. After hardening of the gelatin, a computed tomography angiography will be performed allowing for visualization and quantitative measurements of the coronary arteries. We apply techniques routinely used by cardiologists in clinical practice to evaluate the presence and extent of stenoses and calcification of the coronary arteries. Areas of potential pathological interest can subsequently be subjected to thorough conventional histological examination.

RESULTS
Results are pending. We expect to be able to include 20 cases. Preliminary results are expected to be presented at the conference.

PERSPECTIVES
By introducing the application of existing state-of-the-art imaging techniques in the setting of the forensic autopsy, we expect to be able to provide hitherto inaccessible knowledge on quantitative measurement of the coronary arteries post-mortem. This will aid the forensic scientist in locating sites of pathology, thereby increasing the chance of explaining a death that would previously have remained unexplained.

O16

Intratracheal tracheostomy sealing – a clinical feasibility study

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BACKGROUND

Tracheostomy is a commonly performed procedure in patients admitted to the intensive care unit. Decannulation is performed once the mechanical ventilation is no longer necessary. During the period between the decannulation and full healing of the tracheostomy, the loss of air through the tracheostomy inhibits sufficient pulmonary rehabilitation and the patient risks developing pneumonia and compromised lung function. In the spring of 2022, we finished a feasibility study with a preliminary prototype to seal the tracheostomy and have since further improved our method.

METHODS

This feasibility study will enroll 10 patients from the intensive care unit of Aarhus University Hospital between January 1st, 2023, and January 1st, 2025. Following decannulation a silicone sealing device will be inserted into their trachea to achieve an airtight sealing of the tracheostomy wound. The device remains in situ for a period of seven days, which corresponds to the expected healing time for the tracheostomy opening. Lung function is assessed through spirometries measuring FVC, FEV1 and PEF.

RESULTS

Based on the spirometry tests conducted so far, the spirometries from patients with sealed stoma on day 0 shows an increased FVC (0.055 ± 0.03 L, p=0.271), FEV1 (0.31 ± 0.32 L, p=0.406) and PEF (35 ± 32.5 L/min, p=0.370) compared to the pre-intervention condition with an open stoma on the same day. Spirometries conducted on day 1 after the intervention for sealed patients shows a further increase in FVC (0.67 ± 0.52 L, p=0.321) and FEV1 (0.202 ± 0.0 L, p=0.007) and a decline in PEF (4.5 ± 4.9 L/min, p=0.420) compared to the sealed condition on day 0.

CONCLUSIONS

The preliminary results indicate that the cough mechanism, lung function and lung rehabilitation improve with an airtight sealing of the tracheostomy implemented after the removal of the tracheostomy tube. However, the feasibility study is currently ongoing, and the initial results appear to be promising.

O17

Lung function in Fontan patients over a ten-year period; is the Fontan circulation impairing lung development?

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BACKGROUND
Few studies have investigated how the Fontan circulation affects lung function and no studies have investigated the evolution of lung function over time in these patients. We aimed to describe the evolution of lung function in Fontan patients over a ten-year period

METHODS
Pulmonary function tests (PFT), including spirometry and diffusion capacity for Carbon Monoxide (DLCO) and Nitric Oxide (DLNO), were conducted in a Danish Fontan cohort in 2011 (PFT-I). In 2021, re-investigations were performed (PFT-II). We investigated changes in percent predicted (%pred) lung function from PFT-I to PFT-II. Patients were categorized into a pediatric group (age under 18 at PFT-I) and an adult group (age 18 or older at PFT-I). In addition, cross-sectional PFT-I results from the pediatric group were compared with a Danish reference material from healthy children.

RESULTS
Out of the 81 patients completing PFT-I, 48 completed PFT-II. In the pediatric group, (32 patients), there were significant declines in %pred forced expiratory volume in 1 second (FEV1) (99.7 (92.4, 104.4) - 89.3 (84.9,97.2), p<0,001), forced vital capacity (FVC) (98.3 (87.8,106.1) - 96.7 (86.7,100.6), p=0.008), and alveolar volume (VA) (95.5 (89.5,101.6) - 89.5 (79.7,93.2), p<0.001). The corresponding measurements remained stable in the adult group. However, the median %pred DLNO significantly declined in the adult group (58.4 (53.3, 63.5) – 53.7 (44.1, 57.3), p=0.005). Longitudinal DLNO results were not analyzed in the pediatric group due to the lack of suitable reference material. Interaction analyses using linear regression found that DLCO10s, DLNO, and the membrane diffusing capacity of DLNO (Dm), increased significantly less with age in the pediatric Fontan group compared to healthy children. FEV1, FVC, and VA showed a similar trend, although not significant.

CONCLUSIONS
Over a ten-year period, several lung function parameters declined significantly in the younger Fontan patients, suggesting possible impairments in lung development during growth. The decline in %pred DLNO in the adult patient group indicates deterioration of the membrane component of diffusion capacity, implying that the Fontan circulation might negatively affect the alveolar membrane over time.

POSTER PRESENTATIONS

P1 *Effect of butyrate treatment on post-infarction left ventricular remodeling and function in an in-vivo rat model*
Benedikte Haldrup et al.

P2 *Effect of butyrate treatment on myocardial ischemia in a rat model*
Doruk Bor et al.

P3 *Evaluation framework for cardiac patches for use in cardiac micrograft therapy*
Aleksi Kuuva et al.

P4 *Autologous right atrial appendage micrografts transplanted at coronary artery bypass surgery: A randomized trial design*
Vilbert Sikorski et al.

P5 *Resorbable Sutures or Not? A Comparative Study in Strength of Vascular End-to-End Anastomoses*
Mads Harthimmer et al.

P6 *New detection of cardiac allograft vasculopathy (chronic rejection) by Cardiac CT-scanning in heart transplanted patients*
Rasmus Gebauer Dalsgaard et al.

P7 *Validation of Super-Resolution Coronary Magnetic Resonance Angiography*
Andreas Kabel et al.

P8 *Evolution of Porcine Small Intestinal Submucosal Extracellular Matrix in Cardiovascular Surgery Across the last Decade*
Villads Juul Bruun et al.

P1

Effect of butyrate treatment on post-infarction left ventricular remodeling and function in an in-vivo rat model

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BACKGROUND

Congestive heart failure (CHF), most commonly caused by myocardial infarction (MI) is a leading cause of morbidity and mortality worldwide. The pathophysiology of post-MI heart failure is intricate and multifactorial resulting in left ventricular remodeling and a decline in contractile function that may lead to clinical heart failure. While the healthy heart primarily generates energy from ß-oxidation of long-chain fatty acids, the metabolism of the failing heart is replaced by a compensatory metabolism driven by glucose. This metabolic adaptation is believed to contribute to myocardial energy depletion and the progression of heart failure. Butyrate, a short chain fatty acid, is an alternate energy source for the heart. Our research group has observed increased myocardial contractility, elevated cardiac output, reduced peripheral resistance decreased and stable blood pressure in rats treated with butyrate (unpublished data). These observations were consistent in both healthy hearts and during the reperfusion phase after myocardial ischemia. We hypothesize that butyrate improves left ventricular- and mitochondrial function in rats with chronic ischemic heart failure. We aim to investigate the effect of oral butyrate supplement in an in vivo rat model of CHF.

MATERIAL AND METHODS

Heart failure is induced in male Sprague Dawley rats (8 weeks) by ligation of the left anterior descending coronary artery for 30 minutes and subsequent reperfusion. At baseline and after 28 days of reperfusion, an echocardiography will be performed, and a blood sample drawn to evaluate left ventricular function and plasma levels of butyrate. Immediately after reperfusion and for the remaining 28 days, the rats will receive standard chow enriched with the butyrate ester, tributyrin. Control animals will receive isocaloric chow. Effects of tributyrin on left ventricular function is evaluated by echocardiographic assessment of left ventricular volumes, ejection fraction and cardiac output. Mitochondrial function is evaluated by high resolution respirometry. Myocyte hypertrophy will be evaluated by hematoxylin-eosin stained left ventricular sections.

RESULTS

Pending results.

PERSPECTIVES

This project may spark further investigations into butyrate as a potential treatment for heart failure and pave the way for human trials.

P2

Effect of butyrate treatment on myocardial ischemia in a rat model

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BACKGROUND

β-hydroxybutyric acid exhibits favorable effects on cardiac function, including enhancements in left ventricular performance, peripheral vasodilation, and cardioprotective benefits during ischemic conditions. The administration of ß-hydroxybutyric acid, however necessitates coadministration of sodium, resulting in a substantial sodium load, which is a contradictory practice in several cardiac conditions. Therefore, the clinical use of ß-hydroxybutyric acid is not practical. Consequently, there is a pressing need for the development of novel compounds with similar properties but greater potency. We believe that the candidate compound might be butyrate. We expect that butyrate could provide similar hemodynamic benefits as ß-hydroxybutyric acid, but with the advantage of needing only one-tenth of the drug dose and thereby serving as a therapeutic approach for heart failure patients. The aim of this study is to investigate the effect of Tributyrin and butyrate as a treatment strategy in the isolated perfused rat heart model.

METHODS AND MATERIALS

The isolated ex-vivo Langendorff heart model together with an in-vivo rat model will be employed. In the Langendorff model the heart is effectively isolated from the the rat's body and induction of ischemia becomes feasible. In accordance with the outlined protocol, ischemia is initiated for a duration of 30 minutes, succeeded by a subsequent reperfusion period lasting 30 minutes. During the reperfusion phase, the perfusate is supplemented with the intervention butyrate. In our in-vivo model, MI is induced by ligating the left anterior descending coronary artery for 30 minutes. Reperfusion is then initiated with tributyrin or butyrate. Pre-ischemic administration of tributyrin and butyrate is also employed to evaluate potential preemptive effects.

RESULTS

This research year study is ongoing since 1st of September 2023. Perspective: Our study attempts to shed light on the feasibility of employing tributyrin and butyrate as viable treatment strategies for patients with heart failure. The findings from the study could potentially be the first step to pave the way for forthcoming clinical trials involving butyrate and tributyrin.

P3

Evaluation framework for cardiac patches for use in cardiac micrograft therapy

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OBJECTIVE

Cardiac micrograft therapy (CMT) has been developed to enhance the healing of myocardial scarring and prevent heart failure after ischemic damage, such as myocardial infarction. In CMT, patient's own cardiac tissue, harvested from atrial appendage, is mechanically processed into smaller micrografts and transplanted epicardially onto the damaged heart muscle. The micrografts are applied onto the heart with a cardiac scaffold (patch), which has many functions. Hence, the mechanical, biological, physical and economical parameters of the patch need to be considered.

METHODS

This work is based on observations and empirical experience on patch selection processes, which have ended up in varied selections. This experience led to systematic identification and analysis of relevant factors affecting the selection.

RESULTS

We are presenting a LIFESS principle, standing for Long-term and Independent impact, Fixation, Environment, Shunting and Surgical feasibility to evaluate the suitability of cardiac patch for CMT procedure. Long-term impact is considering the resorption and calcification of the patch over time and the individual impact regards the foreign body effect caused by the patch. The parameters are not completely unequivocal, as limited inflammatory effects could even be considered to promote the healing. Fixation is a parameter of the patch's capability to hold the micrografts in place on the heart at the transplantation and after reperfusion. Environment for the cells is a crucial parameter containing the gas and nutrient permeability of the patch. The patch should not have a negative impact on the pH or chemical environment of the treated area. The last parameters of the LIFESS feasibility principle consider the targeting of the paracrine effect to the treated area and the physical applicability of the patch for the CMT procedure. To take health economics and regulatory aspects into consideration, the principle can be expanded with Pricing, Reimbursement, Regulation and Availability (LIFESS-PRRA).

PERSPECTIVES

The proposed LIFESS-PRRA model can be used as a simple framework in patch selection. Future work may contain quantitative test method development and systematic patch evaluations. Patch evaluation studies will also contribute to understanding the mechanisms of action in epicardial micrograft transplantation.

P4

Autologous right atrial appendage micrografts transplanted at coronary artery bypass surgery: A randomized trial design

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BACKGROUND

Achieving functional recovery of myocardium jeopardized by ischemia, hallmarked by cardiomyocyte loss, fibrosis, and pumping deficit, presents as the paramount treatment gap in the present-day-care of ischemic heart disease (IHD) continuum, the burden of which has shifted towards its late sequalae, such as ischemic heart failure with reduced ejection fraction (iHFrEF). With six treated iHFrEF patients (open label), we have reported intraoperative setup and epicardial delivery of autologous right atrial appendage micrografts (AAMs) during coronary artery bypass grafting (CABG) to be safe. Late gadolinium enhancement cardiac magnetic resonance imaging (LGE-CMRI) showed a significant ($p = 0.009$) change in myocardial thickness in AAMs-patch group (+1.0 mm [0.2–1.3 mm]) compared to control group (−1.4 mm [−1.7 to 0.0 mm]), alongside a trend for reduced scar mass and N-terminal pro–B-type natriuretic peptide (NT-proBNP) levels. These results warrant further study.

MATERIAL AND METHODS

This double-blinded AAMS2 trial assesses the efficacy of AAMs in a collagen-based patch (AAMs-patch) when epicardially transplanted at the end of CABG in 50 iHFrEF patients. Based on randomization, the patients receive either the AAMs-patch or only the patch. To standardize the transplantation site, failure to visualize any ischemic injury (scar or dyskinesia) in the preoperative LGE-CMRI, repeated 6–8 months after CABG, leads to screening failure. To standardize the iHFrEF pathophysiology, recent myocardial infarction (< 1 month) is an exclusion criterion. To restrict micrograft apoptosis ex vivo, a cooling plate (+6 – +8oC) is used. On the cooling plate, to prevent the patch wetting, the AAMs are first allowed to gel with fibrinogen and thrombin into AAMs-fibrin hydrogel-patch prior placement onto the patch (done only just before transplantation). The primary endpoints are the LGE-CMRI-assessed change on the scar mass and change in NT-pro-BNP levels. The secondary endpoints center on feasibility, safety, echocardiography, and 6-minute walk test.

RESULTS

The first patient is set to be recruited in December 2023 and the trial to be completed by mid-2026. Perspectives—If revealed with benefits, this trial warrants an outcome trial equipped with power to even modify clinical practice. Also, the AAMs-patch transplantation holds wider potential as adjuvant therapy in cardiac surgery.

P5

Resorbable Sutures or Not? A Comparative Study in Strength of Vascular End-to-End Anastomoses

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BACKGROUND
Approximately 4,000 cardiac and 3,000 vascular operations are performed annually in Denmark. The current practice employs non-resorbable sutures for anastomosis in cardio and vascular surgery, providing anticipated long-lasting mechanical support. However, concerns about complications such as inflammation, fibrosis, and infection arise from the presence of foreign materials in the body. This study aims to compare non-resorbable and resorbable sutures in carotid end-to-end anastomosis surgery, evaluating their mechanical strength and potential complications.

HYPOTHESIS
Both resorbable and non-resorbable sutures will exhibit supraphysiological tensile strength, with a similar incidence of adverse events such as leakage, stenosis, or stroke. Resorbable suture types are expected to induce a lower degree of inflammation in the tissue surrounding the anastomosis over time.

HYPOTHESIS
Investigate the biomechanical and inflammatory properties over time after carotid artery anastomosis, comparing non-resorbable and resorbable sutures. Provide insights into the long-term effects and significance of suture choice on artery anastomosis.

MATERIAL AND METHODS
In Vitro Testing: Uniaxial mechanical testing of Prolene 5-0 (non-resorbable) and select resorbable sutures, including Poly-P-dioxanone 5-0, to determine tensile strength. Chronic Pig Intervention: End-to-end anastomosis in porcine carotid arteries using Prolene 5-0 (control) and selected resorbable sutures. Monitoring over 3 months with ultrasound, assessing blood flow, and diameter changes. Sample Collection Phase: Macroscopic inspection, ultrasound measurements, and tissue collection for biomechanical, histological, and RNA analysis. Data Acquisition and Analysis: Biomechanical testing using Universal Testing Machine, hydroxyproline quantification for fibrosis, histological examination, and RNA expression profiling. Statistical analysis using STATA to compare outcomes between non-resorbable and resorbable sutures after 3 months.

RESULTS
The study and data collection have not yet initiated; hence, pending results. The first experimental pig will undergo surgery on January 30th, 2024. Expected Outcome: Anticipate both suture types to exhibit supraphysiological tensile strength, with resorbable sutures inducing less inflammation- In the long term, a reduced degree of restenosis.

P6

New detection of cardiac allograft vasculopathy (chronic rejection) by Cardiac CT-scanning in heart transplanted patients

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BACKGROUND

The major limitation for long-term survival after heart transplantation (HTx) is cardiac allograft vasculopathy (CAV). CAV affects approximately 50% of HTx-patients 10 years after transplantation and is the cause of 1 in 8 deaths beyond the first year. Invasive coronary angiography (CAG) is now considered the gold standard for CAV surveillance. Unfortunately, CAG underestimates CAV severity, especially in the early stages, and is associated with risks and patient discomfort. Non-invasive surveillance is desirable, but non-invasive markers of long-term outcome after HTx are lacking. For many years, cardiac computed tomography angiography (CTA) was not considered the optimal imaging modality for CAV surveillance. HTx patients display increased heart rate, especially when CAV is present, which limits the utility of CTA. Furthermore, the anatomical assessment of CAV by CTA does not provide functional or hemodynamic information that could be useful in the clinical management of HTx patients. However, within recent years, increasing evidence support that CTA could serve as a reliable method for non-invasive CAV monitoring despite the aforementioned limitations. In addition, it is now possible to determine noninvasive fractional flow reserve (FFR) derived from standard acquired CTA-datasets (FFR-CT) for the diagnosis of myocardial ischemia in patients with suspected stable coronary artery disease (CAD). FFR-CT has also been shown to perform well in non-invasive detection of milder coronary lesions (>30 %) in patients with diabetes and hypertension. This study aims to investigate the potential for FFR-CT to non-invasively identify CAV in HTx-patients.

MATERIAL AND METHODS

This is an exploratory cohort study. We will include 50 HTx-patients, and they will undergo blood samples, comprehensive echocardiography, coronary angiography, cardiac computed tomography with assessment of FFR-CT, as well as optical coherence tomography and measurement of invasive fractional flow reserve in all 3 major coronary arteries.

RESULTS

Results are pending. Data collection began February 2023. Hopefully, some preliminary results will be presented at the congress.

CONCLUSION

Conclusion is pending.

PERSPECTIVES

We hope to reduce expenses and patient discomfort by replacing invasive CAG with noninvasive cardiac CT in the follow-up of patients after HTx.

P7

Validation of Super-Resolution Coronary Magnetic Resonance Angiography

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BACKGROUND

Coronary magnetic resonance angiography (CMRA) is a rapidly developing, non-invasive diagnostic method to investigate coronary artery disease, that can be performed without use of contrast agents or ionizing radiation. However, at present the image quality remains inferior to Coronary CT angiography CCTA), the current non-invasive gold-standard investigation. Super Resolution (SR) is a new approach to obtaining high-resolution images in a clinically viable time frame. SR uses pairs of high-resolution (HR), but slowly acquired and low-resolution (LR), but rapidly acquired images to train a deep learning (DL) based algorithm. This can then take other LR images, without a HR pair, and enhance this to CMRA of diagnostic quality. In this way, CMRA can be performed much more rapidly, but without compromising on scan duration.

MATERIALS AND METHODS

The DL-model is currently being developed by co-author engineering student Christoffer Overgaard. The model is being trained on CMRA data consisting of 264 individual CMRA scans and is expected to be available for testing by January 2024. The SR images will be clinically validated via assessment of the presence of coronary stenosis. The result of assessment will be compared to the conventionally acquired HR-CMRA. CCTA will also be performed in all participants. All analysis will take place by readers blinded to the participants' clinical information.

RESULTS

Data analysis is anticipated to be complete by June 2024. Due to the deep learning model still undergoing development, only limited results are available. However, qualitative assessment of SR-CMRA compared to HR-CMRA indicates that a good image quality can be obtained. However, whether these images retain the relevant clinical information following SR-CMRA remains to be seen. Conclusion: SR-CMRA using our Deep Learning model is capable of reconstructing LR-CMRA to that of a high image quality. Visual qualitative assessment suggests this is comparable to HR-CMRA. However, further analysis is required to determine whether the DL-model can accurately reconstruct disease in coronary arteries.

PERSPECTIVES

SR-CMRA shows promise as a method to accelerate CMRA, enabling a high image quality within a shortened scanning time. If successful, this could offer an alternative to CCTA that does not use ionising radiation or nephrotoxic contrast agents.

P8

Evolution of Porcine Small Intestinal Submucosal Extracellular Matrix in Cardiovascular Surgery Across the last Decade

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BACKGROUND

Porcine small intestinal submucosal extracellular matrix is a biomaterial that has become increasingly popular in cardiovascular surgery over the past 30 years. The popularity has been due to porcine small intestinal submucosal extracellular matrix demonstrating properties of an ideal biological scaffold; it is easy to use, lacks immunogenicity, is absorbable, possesses potential to promote native tissue growth, and exhibits remodeling properties. Here, we systematically review the literature on its preclinical and clinical use in cardiovascular surgery over the past decade.

MATERIALS AND METHODS

Utilizing a box-search methodology, an extensive survey of the literature on porcine small intestinal submucosal extracellular matrix's application in cardiovascular surgery from 2013 onwards was conducted within both the PubMed and Embase databases. 245 possible articles were identified. Following title screening, abstract screening, and full-text screening, 66 articles were included.

RESULTS

Among nine preclinical studies conducting histological assessments of explants, eight did not report signs of inflammation. Tissue remodeling was documented in six preclinical studies. Among clinical cohort studies, 13 incorporated histological examination of explants, all demonstrating varying intensities of inflammation and no or minimal signs of regeneration and remodeling. The reintervention rates among clinical cohort studies range from 4.5% to 87.5%. 11 studies report a reintervention rate exceeding 15%, while six studies report a reintervention rate below 15%.

PERSPECTIVES

Preclinical studies corroborate the notion that porcine small intestinal submucosal extracellular matrix exhibits properties of an ideal biological scaffold. Yet, these findings lack reproducibility in clinical settings. In combination with observations that several clinical studies present reintervention rates exceeding 15%, questions regarding the clinical application of porcine small intestinal submucosal extracellular matrix are raised. However, uncertainties remain, warranting further research.

P9

Effects of butyrate on cardiac hemodynamics - a porcine model

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BACKGROUND

Heart Failure (HF) is a major public health issue because the disease affects 1-2% of the West-ern population and the lifetime risk of HF is 20%. HF is responsible for 1-2% of all healthcare expenditures and 5% of all hospital admissions. The cornerstone in the medical treatment of chronic HF is a combination of ACE-inhibitors/ATII-receptor antagonists, beta-blockers, mineralocorticoid receptor antagonists, and SGLT2-inhibitors. Despite major improvements in the management and care of patients with HF, the 1-year mortality in patients with HF is 13 % and >50% of HF-patients are admitted within a 2.5 year period. Furthermore, patients with HF have markedly decreased physical capacity and quality of life. Thus, there is a need for new treatment modalities in this group of patients. We have shown in a rodent model, that butyrate improves cardiac output and contractility. We hope to demonstrate same effect in pigs.

HYPOTHESIS

Butyrate improves cardiac output and contractility.

STUDY DESIGN

The study is a randomized, double-blinded, cross-over design. All pigs have an approx-imate bodyweight on 60 kg. 8 pigs are studied during 3-hour infusion of Na-butyrate and a 3-hour placebo infusion of equivalent tonicity and volume of saline in a random order.

MATERIALS AND METHODS

The pigs will be examined by simultaneous left ventricular pressure-volume measurements (PV catheter), measurement of CO using thermodilution (right sided heart catheterization), coronary sinus catheterization and blood samples.

PRIMARY ENDPOINT

Difference between the change in cardiac output during the two 3-hour infusion periods.

TIME PLAN

The first experiments have been completed and the last experiments are done by 17th of January 2024. Preliminary results will be presented at the Geilo meeting and published at a later time.

P10

A novel expansible aortic annuloplasty ring for aortic valve repair

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Despite valve-related complications, aortic valve replacement has been the treatment-of-choice for severe aortic valve regurgitation (AR), a common valvular disease that can lead to heart failure. Nonetheless, aortic valve repair with ring annuloplasty is increasingly recognized as a potential superior option for treating aortic valve regurgitation and aortic annulus dilatation. However, current rings on the market have limitations. Therefor we have designed a new annuloplasty ring (A-ring) for aortic valve repair to mitigate the limitations of current rings. We have conducted acute animal studies that have shown promising results and are now planning to conduct long-term studies. We aim to compare the A-rings long-term durability, biocompatibility, and behaviour with standard procedure. We will investigate the A-ring with three substudies in a chronic porcine model with a follow-up period of three months. In substudy 1, we will assess the aortic root dynamics and leaflet characteristics by echocardiography. In substudy 2, we will perform a dynamic evaluation of the aortic annulus in vitro by echography and High-speed images. In substudy 3, we will achieve biomechanical tests and histological and immunohistochemical analysis. We hypothesize that the A-ring will preserve normal biomechanical characteristics, and stabilize the aortic annulus better than current surgical technique. This study represents the final step before testing the A-ring in human trials. The project will have a significant impact on the overall treatment of a severe and common valve disease, as it has the potential to change and standardize the surgical approach to aortic regurgitation.

P11

Mental Health in children and adolescents with Fontan circulation in Denmark

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BACKGROUND

Long-term co-morbidities including neuropsychological co-morbidities are common in children with congenital heart disease. Miles et al found in a registry study, that children and adolescents born with a CHD have a greater risk for psychiatric co-morbidities including anxiety disorder, autism spectrum disorder, and attention hyperactivity disorder. As the registries only include patients with psychiatric diagnoses made by a psychiatrist working in the public service, the results may potentially only reflect the tip of the iceberg. Many children and adolescents with somatic diseases such as epilepsy and mental health difficulties do not receive sufficient help for their mental health problems. We do not know if patients with CHD and mental health problems receive sufficient help.

MATERIALS AND METHODS

This is a questionnaire study of psychiatric comorbidities and received help in children and adolescents (age 5-17y) with complex CHD (Fontan circulation). Children, adolescents, and their families answer the Development and Well-Being Assessment (DAWBA) questionnaire and a questionnaire about receiving help at home. The questionnaires are then rated by three independent raters and controlled by two specialists in children and adolescent psychiatry and a consensus psychiatric diagnosis is made. The results will be compared to the Danish background population. We will evaluate the mental help aid that the children and adolescents with both CHD and a psychiatric diagnosis have received.

RESULTS

Results are pending. 22 of 65 Fontan-operated patients have given informed consent to participate in the study so far. Of these 22 participants, 15 have answered the psychiatric questionnaire. A psychiatric diagnosis was found in 9 of the 15 participants who answered the psychiatric questionnaire.

CONCLUSION

Pending on the results this study will answer the question if children and adolescents with a complex CHD have a larger burden of mental health problems than the background population and if children and adolescents with both a CHD and a mental health problem are receiving adequate mental help aid.

P12

Optical Measurement of Pulse Wave Velocity

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BACKGROUND
The arterial pulse wave velocity depends on the elasticity of the arteries and is therefore a useful biomarker in predicting the risk of cardiovascular events related to changes in the arterial wall. Measuring the arrival of a pulse wave at two points on the body provides a time delay. The pulse wave velocity is calculated as the distance between the two points divided by the time delay. This can be a non-trivial measurement. Therefore, this project aims to create a system to allow for a simplified optical camera-based measurement of this biomarker.

MATERIALS AND METHODS
An in vitro model was designed to provide a reproducible, stable, and controlled measurement setup, allowing for the comparison of an optical measurement system with a tonometry reference. The project consists of the following three parts: 1) Establishment of the in vitro model; 2) Analysis and development of the optical measurement system detecting skin pulsation; 3) Development of a reference system based on tonometry. In addition to measurements in vitro, a few pilot measurements have been conducted in vivo, more specifically on the neck, wrist, and groin.

RESULTS
A pulse wave velocity of 11.4 ± 2.2 m/s (mean ± STD) and 7.5 ± 0.7 m/s for the reference and optical systems, respectively, was measured using the in vitro model. Measuring on the skin provides signals of various qualities. It was only possible to measure a pulse wave on the neck. It was therefore not possible to measure a pulse wave velocity in vivo.

DISCUSSION
The optical system's signal is strongly dependent on the camera angle and the distance at which the measurement is taken. A stable and standardized setup minimizes this dependency. High velocities will need a high frame rate and will potentially be a challenge if a standard consumer mobile camera is to be used. The temporal resolution of the data has a significant effect on the results, and it is, therefore, evident that there is a trade-off between processing time and data quality.

CONCLUSION
An in vitro model has been developed as a platform for further development of the optical system. Under ideal conditions, the optical system can be used to measure pulse wave velocity, although in vivo, it is currently only possible to measure a pulse wave on the neck.

P13

Peripheral lymphatic flow during non-invasive negative intrathoracic pressure with biphasic cuirass ventilation

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BACKGROUND
Single ventricle heart defects have an increased central venous pressure (CVP) and a congested and vulnerable lymphatic system. The CVP is sensitive to the intrathoracic pressure and decreases during inspiration aiding both venous and lymphatic return. In contrast to positive pressure ventilation, biphasic cuirass ventilation (BCV) mimics pressure changes of natural breathing and further decreases the intrathoracic pressure. To improve the understanding of the interplay between lymphatic function and intrathoracic pressure, we plan to evaluate the impact of non-invasive negative biphasic pressure ventilation on the peripheral lymphatic system.

MATERIALS AND METHODS
Cardiopulmonary healthy individuals (N=20) aged 18-40 and with a BMI ≤ 30 are to be included. The non-invasive negative intrathoracic pressure is achieved by BCV. A cuirass placed on the chest, actively controls inspiration and expiration by controlling the pressure environment inside the shell. Lymphatic function is examined using Near-Infrared Fluorescence (NIRF) imaging. NIRF-imaging allows for measurements of contraction frequency and velocity. The microvascular fluid filtration is measured through strain gauge plethysmography, where a venous congestion protocol enables estimation of capillary filtration rate. Fluid filtration and lymphatic function is measured during spontaneous respiration and negative pressure biphasic cuirass ventilation (inspiratory pressure: -30 mmHg; expiratory pressure: +2; respiration frequency: 10-14).

RESULTS
9 study subjects are included at the time of abstract submission. Preliminary results from the first 5 participants are set to be ready for presentation at the conference.

END POINTS
Primary endpoints: Changes in lymphatic vascular contraction frequency and velocity of lymphatic transport during BCV. Secondary endpoint: Changes in SGP-estimated capillary filtration rate during BCV.

CONCLUSION
Normal lymphatic fluid transport is essential for maintaining a healthy fluid balance and for avoiding edema formation. This study aims to describe the interplay between intrathoracic pressure and lymphatic fluid transport from the periphery.

PERSPECTIVES
In the future, BCV may serve as a viable alternative to positive pressure ventilation in individuals with a vulnerable lymphatic vasculature prone to lymphatic complications.

P14

Quantitative analysis of ICG fluorescence imaging prolongs visualization time when determining lung segments during segmentectomies

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BACKGROUND

Indocyanine green (ICG) fluorescence imaging has emerged as a valuable tool for delineating intersegmental planes during pulmonary segmentectomies. This study explores the advantages of employing quantitative analysis, which enables prolonged visualization time and is not constrained by the residual tissue fluorescence following prior ICG administrations, thus eliminating the need to await washout of the initial dose. Additionally, software solutions that provide visualization through heat maps exist and may establish an equally effective method.

MATERIALS AND METHODS

We investigated the feasibility of using quantitative analysis to identify the intersegmental plane in a sample of ten healthy 60 kg pigs. Bilateral thoracotomy was performed, and various segmental arteries were isolated and occluded. An initial dose of 12.5 mg ICG was administered to induce indistinction between the segments during qualitative analysis. Subsequently, quantitative analysis based on 0.008 mg/kg micro-doses was employed to discern the intersegmental plane amidst the remaining segments.

RESULTS

The results demonstrated successful differentiation of lung segments using micro-doses and quantitative fluorescence analysis. When qualitatively interpreted indistinction between lung segments was induced, it was possible to delineate the intersegmental plane using quantitatively derived heat-maps.

CONCLUSION

Quantitative analysis based on high frequency, low dose bolus ICG regimen is technically possible. Heat maps derived from the quantitative analysis allows to perform effective delineation of the intersegmental plane during pulmonary segmentectomies. Additionally, quantitative analysis may provide a better option since its interpretation is not limited by residual fluorescence from surrounding tissues after prior ICG-administration.

THE

GEILO MEETING

ON **CARDIOVASCULAR** AND **THORACIC** RESEARCH