SSRCTS

SCANDINAVIAN SOCIETY FOR RESEARCH IN CARDIOTHORACIC SURGERY

28th Annual Meeting

Program
&
Abstracts

February 8 - 10, 2018
Geilo, Norway

www.ssrcts.org

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Welcome!

Dear Colleagues and friends,

The organising committee welcomes you to the 28th Annual Scientific Meeting of The Scandinavian Society for Research in Cardio-Thoracic Surgery (SSRCTS) from February 8 to 10, 2018 at Hotel Bardøla in Geilo, Norway.

This meeting is an excellent opportunity to be introduced to the field, learn from the experts, interact in the Scandinavian scientific network, and train surgical skills in the wet lab. This year we have a new wet lab sponsored by Ethicon. There will be 10 stations equipped for aortic/aortic root surgery.

International capacities will lecture and provide a knowledge base from which we can all benefit. The program covers cardiac and thoracic surgery including how to disseminate knowledge through presentations and publications. Entwined with invited lectures, the program offers 21 oral and 12 poster presentations, combining basic science and clinical research. As usual, we have a special focus on nurturing the scientist of tomorrow, by dedicating time and training to the young scientists.

At the Guðbjartsson Award session on Friday, the six best abstracts have been elected and an international award committee will select the presenter who handled the presentation and the following discussion to the highest scientific level. The best presentation will be acknowledged at the presidential dinner together with the announcement of the best oral and the best poster presentation.

In order to encourage and stimulate researchers to participate and interact, we have appointed young scientists to co-chair sessions with more experienced scientists. Furthermore, young scientists have been appointed to act as a discussant for each of the Award papers posing questions, before the paper is open for discussion by the audience.

On behalf of the organising committee, we welcome you all to SSRCTS 2018!

Vibeke E. Hjortdal
President of SSRCTS

Committee

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We acknowledge the help from the following colleagues:

Marcell Tjørnild: Upgrading the webpage abstract submission page

Sebastian Udholm: Scientific Committee

Søren Skov: Abstract book

Award Committee

Gudbjartsson Award

Mari-Liis Kaljusto
Oslo University Hospital, Norway

Eeva Moilanen
University of Tampere, Finland

Jens Erik Nielsen-Kudsk
Aarhus University Hospital, Denmark

Oral Session Award

Anders Jeppsson
Sahlgrenska University Hospital, Sweden

Peter Johansen
Aarhus University, Denmark

Ari Mennander
Tampere University Hospital, Finland

Poster Session Award

Johan Heiberg
Aarhus University Hospital, Denmark

Ingvar Berg
Haaglanden Medical Center, The Netherlands

Eva A. Nielsen
Aarhus University Hospital, Denmark

Thursday, February 8		Friday, February 9		Saturday, February 10	
14:00	Arrival and registration	**14:00**	Guðbjartsson Award Session 1	**14:00**	Oral Session 3
14:30	Vibeke Hjortdal: Welcome to SSRCTS				
14:45	Oral Session 1	**14:45**	Invited Lecture: Johan Heiberg	**14:45**	Invited Lecture: Anders Jeppsson
		15:15	Coffee Break	**15:15**	Coffee Break
		15:30	Guðbjartsson Award Session 2	**15:30**	Oral Session 4
15:45	Coffee Break				
16:00	Poster Session 1	**16:15**	Invited Lecture: Ingvar Berg		
16:30	Invited Lecture Eeva Moilanen			**16:30**	Poster Session 3
		16:45	Coffee Break		
17:00	Coffee Break	**17:00**	Aorta/Aortic Root Lab Ethicon - Wetlab	**17:00**	Coffee Break
17:15	Oral Session 2			**17:15**	Invited Lecture: Jarle Vaage Award-committee meeting
				17:45	Awards
18:00	Poster Session 2			**18:00**	Evaluation Beer & Business
18:30	Coffee Break			**18:30**	Jeopardy
18:45	Invited Lecture: Jens Erik Nielsen-Kudsk				
19:15	Break			**19:15**	Break Dress to impress!
		19:30	Break		
20:00	Dinner	**20:00**	Dinner with hosts	**20:00**	Presidential Dinner with pompous speeches

Scientific Program

Thursday, February 8

14:00 - 14:30 **Arrival and registration**

14:30 - 14:45 **Welcome to SSRCTS**
Vibeke Hjortdal, Aarhus, Denmark

14:45 - 15:45 **Oral Session 1**
Chairmen: Jahangir Khan, Mine Onat
8+5 minutes for each presentation

Page 25 **Circulating mitochondrial and nuclear DNA during heart surgery: release kinetics and relation to extra-cellular vesicles**
A Baysa, A Fedorov, K Kondratov, A Ruusalepp, S Minasian, M Galagudza, M Popov, D Kurapeev, G Valen, A Kostareva, KO Stensløkken, J Vaage

Page 27 **Neurohormonal and inflammatory activity in adult patients with atrial septal defect**
AS Ovesen, C Nyboe, S Udholm, V Hjortdal

Page 28 **Aprotinin impacts 8-isoprostane after coronary artery bypass grafting**
V Toikkanen, T Rinne, R Nieminen, E Moilanen, J Laurikka, H Porkkala, M Tarkka, A Mennander

Page 30 **Concentration of circulating PAD2 in relation to CCABG**
A Vejlstrup, D Damgaard, CH Nielsen

15:45 - 16:00 **Coffee Break**

16:00 - 16:30	**Poster Session 1** Chairmen: Jarle Vaage, Anne Vejlstrup 3+3 minutes for each presentation
Page 47	**Impact of congenital heart disease on brain development** *B Asschenfeldt, J Heiberg, S Eskildsen, L Østergaard, V Hjortdal*
Page 48	**Posterior mitral leaflet augmentation using porcine extracellular matrix: A chronic porcine evaluation with extensive histologic and immunehistochemical characterization** *LC Hanse, MJ Tjørnild, KB Poulsen, J Hedensted, DM Røpcke, SL Nielsen, JM Hasenkam*
Page 50	**A new intelligent stocking for quantification of edema in the lower limb** *AE Kaspersen, OB Petersen, JM Hasenkam*
Page 51	**Effect of warm versus cold ischaemia in protection against pulmonary graft thrombosis in lung donation after cardiac death** *US Lorenzen, M Hebsgaard, R Chemtob, PS Olsen, C Møller, P Johansson*
16:30 - 17:00	**Inflammation during cardiac surgery** (Invited Lecture) Eeva Moilanen, University of Tampere, Finland Chairman: Ari Mennander
17:00 - 17:15	**Coffee Break**
17:15 - 18:00	**Oral Session 2** Chairmen: Johan Heiberg, Benjamin Asschenfeldt 8+5 minutes for each presentation
Page 31	**Comparison of valve-sparing aortic root repair techniques with single and double annuloplasty rings** *JH Hedensted, LL Benhassen, T Bechsgaard, P Johansen, SL Nielsen, JM Hasenkam*
Page 33	**Surgical strategy using a rapid deployment aortic valve** *A Mennander, O Järvinen*

Page 34 **Total mitral valve reconstruction using 2-ply porcine extracellular matrix: In-vitro evaluation**
LC Hanse, MJ Tjørnild, SN Skov, DM Røpcke, SL Nielsen, JM Hasenkam

Page 35 **Total mitral valve reconstruction using 2-ply porcine extracellular matrix: A chronic porcine evaluation**
MJ Tjørnild, LC Hanse, KB Poulsen, J Hedensted, DM Røpcke, SL Nielsen, JM Hasenkam

18:00 - 18:30 **Poster Session 2**
Chairmen: Mathilde Hebsgaard, Christa Huuskonen
3+3 minutes for each presentation

Page 52 **FEM methods for identification of constitutive parameters of the aortic root through reverse engineering**
L Marelli, E Votta, M Selmi, S Ringgaard, LL Benhassen, WY Kim, P Johansen

Page 54 **Compromised sinus of valsalva flow and transcatheter aortic valve thrombosis**
MH Nielsen-Kudsk, FJ Ralfs, WY Kim, S Ringgaard, JE Nielsen-Kudsk, P Johansen

Page 55 **Biomechanical characterization of thoracic aortic aneurysms**
MA Noor, SN Skov, LL Benhassen, P Johansen, JM Hasenkam

Page 56 **The functional effect of left atrial appendage occlusion**
FJ Ralfs, MH Nielsen-Kudsk, JE Nielsen-Kudsk, P Johansen

18:30 - 18:45 **Coffee Break**

18:45 - 19:15 **Transcatheter interventions in structural and valvular heart disease** (Invited Lecture)
Jens Erik Nielsen-Kudsk, Aarhus University Hospital, Denmark
Chairman: Peter Johansen

19:15 - 20:00 **Break**

20:00 **Dinner**

Friday, February 9

14:00 - 14:45	**Guðbjartsson Award Session 1** Chairman: Mari-Liis Kaljusto 8+5 minutes for each presentation
Page 15	**An extended chest tube drainage protocol reduces the incidence of late postoperative pericardial tamponade after cardiac surgery** *J Khan, N Khan, A Mennander* Discussant: Benjamin Asschenfeldt
Page 17	**The lymphatic contractility and anatomy in patients with a Fontan-Kreutzer circulation** *S Mohanakumar, N Telinius, B Kelly, M Pedersen, V Hjortdal* Discussant: Jacob Hedensted
Page 19	**Concomitant ablation for atrial fibrillation in patients undergoing cardiac surgery** *M Onat, V Hjortdal, E Moss, H Jensen* Discussant: Eva A. Nielsen
14:45 - 15:15	**Long-term follow-up after closure of a ventricular septal defect** (Invited Lecture) Johan Heiberg, Aarhus University Hospital, Aarhus, Denmark Chairman: Vibeke Hjortdal
15:15 - 15:30	**Coffee Break**
15:30 - 16:15	**Guðbjartsson Award Session 2** Chairman: Eeva Moilanen 8+5 minutes for each presentation
Page 20	**Insights and outcome of surgically treated type A aortic dissection patients with preoperative cardiac arrest – a NORCAAD study** *E Pan, A Wallinder, E Peterström, A Geirsson, C Olsson, A Ahlsson, S Fuglsang, J Gunn, EC Hansson, V Hjortdal, A Mennander, S Nozohoor, A Wickbom, I Zindovic, T Gudbjartsson, A Jeppsson* Discussant: Marcell Tjørnild

Page 22 **Comparison of Dacron ring and suture annuloplasty for aortic root repair – an in vitro evaluation**
M Sharghbin, LL Benhassen, T Lading, T Bechsgaard, SN Skov, DM Røpcke, SL Nielsen, P Johansen, JM Hasenkam
Discussant: Anne Sif Ovesen

Page 24 **Inhibition of aortic valve calcification in vitro**
A Zabirnyk, M Bogdanova, MD Ferrer, MM Pérez, ML Kaljusto, KO Stensløkken, C Salcedo, J Vaage
Discussant: Christa Huuskonen

16:15 - 16:45 **Drowning Resuscitation** (Invited Lecture)
Ingvar Berg, Haaglanden Medical Center, Den Haag, The Netherlands
Chairman: Vibeke Hjortdal

16:45 - 17:00 **Coffee Break**

17:00 - 19:30 **Aortic Root Lab Ethicon – Wetlab – 10 stations**
Introduction: Mari-Liis Kaljusto

19:30 - 20:00 **Break**

20:00 **Dinner with hosts**

Saturday, February 10

14:00 - 14:45	**Oral Session 3** Chairmen: Sheyanth Mohanakumar, Lisa C. Hanse 8+5 minutes for each presentation
Page 37	**Reversibility of early histological changes after experimental acute cardiac volume-overload** *C Huuskonen, M Hämäläinen, T Paavonen, E Moilanen, A Mennander*
Page 38	**Lymphangiogenesis is increased in aortitis** *E Niinimäki, A Mennander, T Paavonen, I Kholova*
Page 39	**Complement system is activated by ischaemia-reperfusion injury following resuscitation after out-of-hospital cardiac arrest and is associated with cerebral outcome** *V Chaban, ER Nakstad, H Stær-Jensen, C Schjalm, I Seljeflot, C Lundqvist, K Sunde, TE Mollnes, GØ Andersen, SE Pischke*
14:45 - 15:15	**Randomized controlled trials** (Invited Lecture) **Anders Jeppsson, Sahlgrenska University Hospital, Gothenburg, Sweden** Chairman: Theis Tønnesen
15:15 - 15:30	**Coffee Break**
15:30 - 16:30	**Oral Session 4** Chairmen: Emily Pan, Peter Johansen 8+5 minutes for each presentation
Page 41	**Lung donation after circulatory death. An experimental model to investigate reconditioning of donor lungs with ex vivo lung perfusion after exposure to warm ischemia** *MMB Hebsgaard, US Lorenzen, R Chemtob, TNB Lilleør, H Kissow, CH Møller, PS Olsen*
Page 43	**Long-term prognosis and causes of death after pleural infections** *J Khan, A Lehtomäki, V Toikkanen, M Ukkonen, R Nevalainen, J Laurikka*

Page 45 **Trends in the incidence, etiology, treatment, and outcomes of pleural infections**
A Lehtomäki, R Nevalainen, V Toikkanen, M Ukkonen, E Pohja, J Nieminen, J Laurikka, J Khan

16:30 - 17:00 **Poster Session 3**
Chairmen: Jacob Hedensted, Viktoriia Chaban
3+3 minutes for each presentation

Page 57 **Biomechanical in vitro assessment of the porcine aortic root**
CD Salvig, LL Benhassen, JV Nygaard, P Johansen, SN Skov, JM Hasenkam

Page 58 **Vitamin D deficiency and nutritional status among rheumatic heart disease patients in Pokhara, Western Nepal**
L Thorup, P Kallestrup, B Koirala, B Gyawali, D Neupane, B Karmacharya, SA Hamann, V Hjortdal

Page 59 **Assessment of left ventricular outflow tract and aortic annulus by conventional (2D) and advanced (3D) echocardiography in patients with open heart-surgery**
L Visby, R Møgelvang, F Grund, CB Kristensen

Page 61 **Balloon over-pressurizing caused by inflator gauge dynamic response**
P Johansen, LS Brodersen, LS Larsen, J Lindhardt, H Engholt, JE Nielsen-Kudsk

17:00 - 17:15 **Coffee Break**

17:15 - 17:45 **How to write a scientific article – and get it accepted** (Invited Lecture)
Jarle Vaage, Oslo University Hospital, Oslo, Norway
Chairman: Johan Heiberg

17:15 - 17:45 **Award-committee meetings**
The members of the 3 award committees (page 5) meet in the bar during the above lecture to decide on awards

17:45 - 18:00 **Awards**

18:00 - 18:30 **Evaluation**
Beer & Business

18:30 - 19:15 **Jeopardy**
Hosts: Sheyanth Mohanakumar & Anne Sif Ovesen

19:15 - 20:00 **Break**
Dress to Impress!

20:00 **Presidential Dinner with Pompous Speeches**

Abstracts - Gudbjartsson Award

An extended chest tube drainage protocol reduces the incidence of late postoperative pericardial tamponade after cardiac surgery

J Khan[1], N Khan[2], A Mennander[1]
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Discussant: Benjamin Asschenfeldt

[1]Department of Cardio-Thoracic Surgery, TAYS Heart Hospital, Tampere University Hospital, Tampere, Finland. - [2]Department of Vascular Surgery, Tampere University Hospital, Tampere, Finland.

Background
Pericardial effusions are present in most patients after cardiac surgery. While usually inconsequential, in some cases these effusions do not spontaneously resolve and may progress to cause life threatening cardiac tamponade. Incompletely drained residual effusions, and those still accumulating after the removal of mediastinal chest tubes, may predispose to the development of late tamponade. The aim of the present study was to ascertain whether longer chest tube drainage decreases the incidence of late cardiac tamponade.

Material and Methods
All patients undergoing cardiac surgery at the Heart Hospital, Tampere University Hospital, Tampere, Finland, between the 23rd October 2015 and the 17th August 2016 were included in the study. The patients operated until and including the 10th of April 2016, altogether 260 consecutive cases, were treated by a short drainage protocol, in which the mediastinal chest tubes were removed during the morning following surgery unless producing >50ml/h. The patients operated on or after the 11th of April 2016, 224 consecutive cases, were treated according to an extended drainage protocol, in which the mediastinal chest tubes were kept at least until the morning of the second postoperative day and thereafter if producing >50ml/4h. The length and course of postoperative hospitalization, including the occurrence of complications, and the incidence of late cardiac tamponade within three months was compared between the cohorts.

Results
The occurrence of late cardiac tamponade was 8.8% following the short drainage protocol and 3.6% after the extended drainage protocol, p=0.018. There were no statistically significant differences in the demographics, medical history, or the procedures performed between the study groups. The overall in-hospital mortality rate was 3.5%, the stroke rate was 2.1%, and the deep sternal wound infection rate was 1.7%, with no statistically significant differences between the study groups. Similarly, there were no differences in the need for early reoperations

for bleeding, overall infection rate, need for pleurocentesis, occurrence of atrial fibrillation, or the length of hospitalization between the cohorts.

Conclusion

Longer mediastinal chest tube drainage after cardiac surgery is associated with a significantly lower incidence of late cardiac tamponade after cardiac surgery.

The lymphatic contractility and anatomy in patients with a Fontan-Kreutzer circulation

S Mohanakumar[1], N Telinius[1], B Kelly[1], M Pedersen[2], V Hjortdal[1]
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Discussant: Jacob Hedensted

[1]Department of Cardiothoracic and Vascular Surgery, Aarhus University Hospital, Denmark. - [2]Comparative Medicine Lab, Aarhus University Hospital, Denmark.

Background

The lymphatics regulate the interstitial fluid by removing excessive fluid. It represents an extremely important step in the prevention of edema. The Fontan-Kreutzer procedure has revolutionized the treatment of univentricular hearts. However, it is associated with severe complications such as protein-losing enteropathy (PLE) and peripheral edema that may involve the lymphatic circulation.
Hypothesis: Patients with a univentricular circulation have a reduced functionality of the lymphatic vasculature, which predisposes them to developing complications such as edema and PLE.

Material and Methods

The functional state of lymphatics is investigated using near infrared fluorescence imaging, NIRF. The anatomy is described using non-contrast MRI and the capillary filtration rate is measured using plethysmography. The study population is patients with Fontan-Kreutzer circulation operated at Aarhus University hospital. Exclusion criteria is BMI>30 and age (years) < 18. The Fontan-Kreutzer group will be compared with an age, gender and weight matched control group of healthy volunteers.

Results

The results (Fontan-Kreutzer n=10, Control n=10) show that Fontan-Kreutzer patients with clinical edema have a vast abnormal network of lymphatic collaterization. We also find a dilated and 10 % elongated thoracic duct with an abnormal course compared to normal. Baseline values found in the control group using NIRF, show that the lymphatic vessels have a contraction frequency: 0.5(0.1) min-1, propulsion velocity: 1.9(0.3) cm/s and are able to generate a pumping pressure: 60(2.8) mmHg. These values correlates with values found earlier in ex-vivo experiments. In comparison lymphatic function in the Fontan-Kreutzer group using NIRF, shows a significant higher contraction frequency: 0.8(0.1) min-1, $p<0.05$, propulsion velocity: 2.1(0.2) cm/s and a significant almost 20 % lowering of pumping pressure: 50(3.1) mmHg, $p<0.05$. No significant differences were found in the capillary filtration rate between the two groups.

Conclusion

The results show that lymphatics in Fontan-Kreutzer patients are abnormal with respect to both morphology and function.

Concomitant ablation for atrial fibrillation in patients undergoing cardiac surgery

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Discussant: Eva A. Nielsen

[1]Department of Cardiothoracic & Vascular Surgery, Aarhus University Hospital, Denmark. - [2]Division of cardiac surgery Jewish General Hospital, & McGill University, Montreal, Quebec.

Background
Atrial fibrillation is the most common cardiac arrhythmia, and a major cause of ischemic stroke. Concomitant surgical ablation to treat atrial fibrillation is indicated in patients undergoing open heart surgery. The choice of ablation procedure between biatrial ablation and pulmonary vein isolation (PVI) balances the efficacy of each type of ablation procedure to obtain sinus rhythm, with the associated risk of needing a permanent pacemaker.
Purpose: To investigate the twelve months postoperative rhythm outcome and pacemaker implantation rates after cardiac surgery and concomitant surgical ablation for paroxysmal and non-paroxysmal atrial fibrillation, respectively

Material and Methods
From February 2004 to May 2016, 497 patients underwent concomitant surgical ablation to treat atrial fibrillation, using biatrial ablation or PVI. Postoperative rhythm status was assessed by electrocardiogram twelve months postoperatively.

Results
Significantly more patients in the biatrial group were in sinus rhythm 12 month-postoperatively, compared with the PVI group (paroxysmal (91% vs. 84%, P<0,01 and non-paroxysmal atrial fibrillation; 74% vs. 60%, p<0,001). The need for permanent pacemaker implantations was significantly higher in the biatrial group (16,7% vs. 8,4%, P<0,05).

Conclusion
The rate of freedom from atrial fibrillation at twelve moths postoperatively was significantly higher after biatrial ablation, compared with PVI. This difference is most evident in non-paroxysmal atrial fibrillation. Meanwhile, the risk of needing a permanent pacemaker was twice as high in patients undergoing biatrial ablation, compared with PVI.

Insights and outcome of surgically treated type A aortic dissection patients with preoperative cardiac arrest – a NORCAAD study

E Pan, A Wallinder, E Peterström, A Geirsson, C Olsson, A Ahlsson, S Fuglsang, J Gunn, EC Hansson, V Hjortdal, A Mennander, S Nozohoor, A Wickbom, I Zindovic, T Gudbjartsson, A Jeppsson
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Discussant: Marcell Tjørnild

Department of Molecular and Clinical Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden. - Heart Center, Turku University Hospital and University of Turku, Turku, Finland. – [2]Landspitali University Hospital and Faculty of Medicine, University of Iceland, Reykjavik Iceland. - [3]Department Cardiothoracic and Vascular Surgery, Örebro University Hospital and School of Health and Medicine, Orebro University, Orebro, Sweden. - [4]Department of Thoracic and Cardiovascular Surgery, Aarhus University Hospital, Skejby, Denmark- [6]Heart Center Tampere University Hospital and University of Tampere, Tampere, Finland. - [7]Department of Cardiothoracic Surgery, Skane University Hospital, Clinical Sciences, Lund University, Lund, Sweden. - [8]Department of Thoracic and Cardiovascular Surgery, Karolinska University Hospital, Stockholm, Sweden.

Background

Outcome after type A aortic dissection (TAAD) surgery has improved over time but the mortality is still high. Those who in addition to TAAD experience cardiac arrest before surgery are considered to have very poor prognosis but there is limited data in the literature. We used a large, contemporary database to evaluate the characteristics and outcome of TAAD patients with cardiac arrest within 24 hours before surgery.

Material and Methods

The data is based on the Nordic Consortium for Acute Type A Aortic Dissection (NORCAAD) registry and consists of 1159 consecutive patients who underwent surgical repair for type A aortic dissection from January 1st 2005 to Dec 31st 2014 in eight Nordic centers. We compared patients with and without cardiac arrest and identified variables univariately associated with mortality in the cardiac arrest group. A Kaplan-Meyer curve was used to estimate survival. Median follow-up time was 2.7 years (range 0-10).

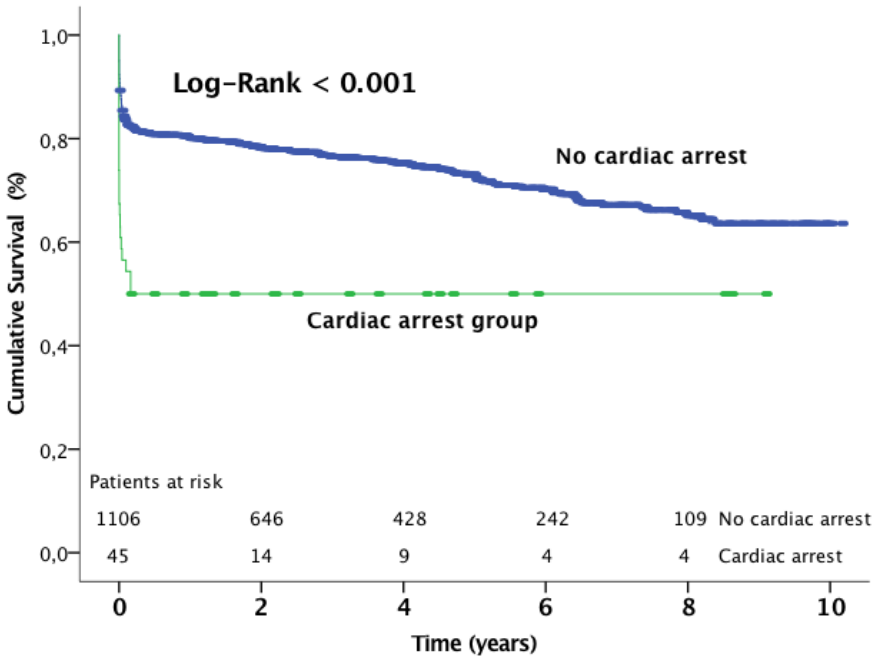
Results

Forty-six of 1159 patients (4.0%) had cardiac arrest before surgery – 25 patients out-of-hospital and 21 in-hospital. Thirty-day mortality was 45.7% in the arrest group and 16.5% in the no arrest group (HR 3.45, CI 2.20-5.43, $p<0.001$). No patient died after the first 63 postoperative days (Figure 1). Preoperatively, the arrest group had significantly more frequent hypotensive shock (56.5% vs 22.1%) and cardiac malperfusion (28.3% vs 7.4%), higher lactate concentration (7.8±4.1 vs 2.2±2.2 mmol/l) and more frequent pericardial tamponade (57.8%

vs. 15.9%). Perioperative myocardial infarction (23.7% vs 5.7%) and postoperative stroke (39.5% vs. 18.1%) occurred more often in arrest patients. Non-survivors in the arrest group had more often DeBakey type I dissection (90% vs 47.8%), cardiac tamponade (77.3% vs 39.1%), cardiac malperfusion (43.5% vs 13.0%) and higher lactate concentration (9.3±2.2 vs 5.6±9.8 mmol/l) (all $p<0.05$).

Conclusion

Early mortality and complication rate after TAAD surgery in patients with preoperative cardiac arrest is high but mid-term outcome in patients surviving the initial period is excellent.
Preoperative cardiac arrest should not be considered a contraindication for surgical treatment.



Comparison of Dacron ring and suture annuloplasty for aortic root repair – an in vitro evaluation

M Sharghbin[1,2,3], LL Benhassen[1,2], T Lading[1,2], T Bechsgaard[1,2,3], SN Skov[1,2], DM Røpcke[1,2], SL Nielsen[1,2], P Johansen[1,2,3], JM Hasenkam[1,2]
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Discussant: Anne Sif Ovesen

[1]Department of Cardiothoracic and Vascular Surgery, Aarhus University Hospital, Aarhus, Denmark. - [2]Department of Clinical Medicine, Aarhus University Hospital, Denmark. - [3]Department of Engineering, Faculty of Science and Technology, Aarhus University, Denmark.

Background
Increasing evidence show that annular stabilization is essential in most aortic valve repair procedures. However, a standardized comparison of the two commonly used annuloplasty procedures is lacking. We hypothesized that the Dacron ring is more rigid than the polytetraflouroethylene suture while both procedures decrease annular dimensions. The aim was to compare the biomechanical properties of the ring and suture techniques with native aortic roots in vitro.

Material and Methods
Eighteen aortic roots explanted from 80 kg pigs were randomized into a Dacron ring, suture annuloplasty, or native control group. Each sample was tested in a pulsatile in vitro model with a force transducer attached to the aortic annulus to obtain radial force measurements, and annular dynamics were evaluated with 2D echocardiography.

Results
The annuloplasty procedures downsized the annular diameter compared with the native group, although only significantly by the Dacron ring. Both interventions significantly reduced the geometric orifice area, tenting area and sinus diameter while increasing the coaptation length compared with the native group. Systolic annular distension was retained between groups, nevertheless, the total radial forces were significantly reduced in the procedure groups compared with native (ring 1.07 $\pm$ 0.45 N; suture 1.13 $\pm$ 0.39 N; native 3.55 $\pm$ 1.34 N, $p < 0.001$).

Discussion
Both annuloplasty procedures downsized the aortic annulus, increased the coaptation length, and decreased the geometric orifice area. The systolic annular distension retained similarly to the native aortic root, while the radial annular forces were evenly decreased by the annuloplasty procedures. These findings indicate that both annuloplasty techniques preserve the flexibility of the aortic annulus while providing external support as intended. The acute effect of the

procedures is comparable; hence, long-term studies are needed to clarify the impact of the annuloplasty procedures over time.

Inhibition of aortic valve calcification in vitro

A Zabirnyk[1], M Bogdanova[1], MD Ferrer[2,3], MM Pérez[2], ML Kaljusto[4,5], KO Stensløkken[1], C Salcedo[2], J Vaage[4,5]
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Discussant: Christa Huuskonen

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Background

Calcific aortic valve disease is an irreversible disease and the 2nd most frequent cause of open heart surgery. The valvular interstitial cells (VIC) are suggested to be crucial for calcification via osteogenic differentiation. A derivative of phytic acid, SNF472, has been shown to inhibit vascular calcification in several preclinical models and it is in clinical development for the treatment of cardiovascular calcifications. In the present study we wanted to investigate whether SNF472 could inhibit calcification in an in vitro model of aortic valve calcification using cultures of human VIC.

Material and Methods

Calcified aortic valves were obtained from patients undergoing aortic valve replacement due to calcific valve disease. VIC were isolated and stored in VIC cell bank until used. The following series of studies were performed: 1. VIC were cultured for three weeks with and without osteogenic medium n=6; 2. VIC were cultured for three weeks in osteogenic medium with 0, 3, 30, or 100 μM SNF472 (n=3-4); 3. VIC from calcified valves were cultured for three weeks in osteogenic medium. After 1 or 2 weeks either 30 or 100 μM SNF472 was added to the cultures n=5. Calcification was measured by Alzarin Red staining and quantified spectrophotometrically.

Results

Compared to calcification without inhibitor (0.52±0.17 (relative absorbance of Alzarin Red)), 3, 30 and 100 μM of SNF472 inhibited calcification by 39% (p=0.089), 73% (relative absorbance 0.14±0.17, p< 0.006) and 96% (0.02±0.01, p<0.0001) respectively). When added after 1 or 2 weeks, SNF472 inhibited the ongoing calcification.

Conclusion

SNF472 is able to inhibit the development and progression of VIC calcification in the present in vitro model. Therefore, SNF472 might represent a promising new therapy to treat heart valve calcification.

Abstracts - Oral Presentations

Circulating mitochondrial and nuclear DNA during heart surgery: release kinetics and relation to extra-cellular vesicles

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Background

Mitochondrial DNA (mtDNA) initiates inflammation and has been shown to be released after reperfusion in acute myocardial infarction. It is also released during shock and trauma. Extracellular vesicles originating from different types of cells, are present in the circulation and contain a multitude of biologically active substances. During open heart surgery we investigated the release kinetics of mtDNA and nuclear DNA (nDNA), as well as association of DNAs to extracellular vesicles.

Material and Methods

Blood was sampled before, during, and after surgery from peripheral artery, pulmonary artery, and coronary sinus from patients (n=12) undergoing coronary artery bypass grafting (CABG). An external standard was added to all samples to measure mtDNA and nDNA by qPCR. In another series of CABG patients (n=12) blood was drawn before surgery and after 30 minutes of reperfusion of the heart. In these samples, plasma was processed to yield three fractions: microvesicles (diameter 100-1000 nm, pelleted at 16 000g), exosomes (diameter $<$ 100 nm, pelleted at 100 000g), and supernatant.

Results

Surgery increased plasma levels of DNAs levels before start of cardiopulmonary bypass (CPB) ($p<0.01$, compared to preoperative levels) followed by further increase during CPB ($p<0.001$). There was no net release or disappearance of DNAs across the systemic, the pulmonary, or the coronary vascular bed. Before surgery mtDNA was predominantly localized to the microvesicles whereas nDNA was predominantly in the supernatant fraction. However, mtDNA released during operation was mainly free in the plasma, not associated with the extracellular vesicles. Released nDNA during surgery was predominantly in the exosomal fraction. Total levels of

mtDNA copy number in plasma were approximately 1000 times higher than nDNA.

Discussion

Surgery and CPB released DNAs to the circulation. Levels of mtDNA were far higher than that of nDNA. mtDNA and the extracellular vesicles may be important for the whole body inflammation induced by surgery, CPB and trauma.

Neurohormonal and inflammatory activity in adult patients with atrial septal defect

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Background

Atrial septal defect (ASD) is treated conservatively or by surgical/percutaneous closure. Small and hemodynamically insignificant defects are left unrepaired. Patients with small, unrepaired defects are expected to be as healthy as the background population. Nevertheless, our previous studies showed a shorter life expectancy and a higher prevalence of atrial fibrillation, pneumonia and stroke in adult patients with an unrepaired ASD when compared to both the general population and to patients with a repaired ASD. The underlying pathological mechanisms are unknown, however increased levels of inflammatory and neurohormonal biomarkers are known to be associated with heart failure, atrial fibrillation and pneumonia. The aim of this present study is to determine if neurohormonal and inflammatory activity is increased in adult patients with unrepaired ASD.

Material and Methods

We included 125 Danish patients with unrepaired ASD between 18-65 years of age. Based on echocardiography findings, patients were divided into open ASD (n=24) and spontaneously closed ASD (n=101). Furthermore, 22 patients with a repaired ASD and 22 healthy, age- and gender-matched controls subjects were included.
Plasma concentration of inflammatory and neurohormonal biomarker were assessed, including: Interleukin (IL)-6, pro-atrial natriuretic peptide(proANP) and pro-b-type natriuretic peptide(proBNP).

Results

Levels of proBNP and IL-6 in patients were elevated in small, open ASD patients when compared with controls. Open ASD patients had higher levels of proANP, proBNP and IL-6 than patients with spontaneously closed ASD.
Levels of proANP and proBNP were higher in patients with repaired ASD compared with controls ($p<0.01$). ProANP was strongly correlated with age at closure ($p<0.01$

Conclusion

There is a tendency of increased neurohormonal and inflammatory activity in patients with small, unrepaired ASD when compared with healthy controls. Further studies are needed to understand the underlying pathological mechanisms related to the complications of small, unrepaired ASD patients.

Aprotinin impacts 8-isoprostane after coronary artery bypass grafting

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Background

The lungs participate in the modulation of the circulating inflammatory factors induced by coronary artery bypass grafting (CABG). We investigated whether aprotinin- which has been suggested to interact with inflammation- influences lung passage of key inflammatory factors after coronary artery bypass grafting (CABG).

Material and Methods

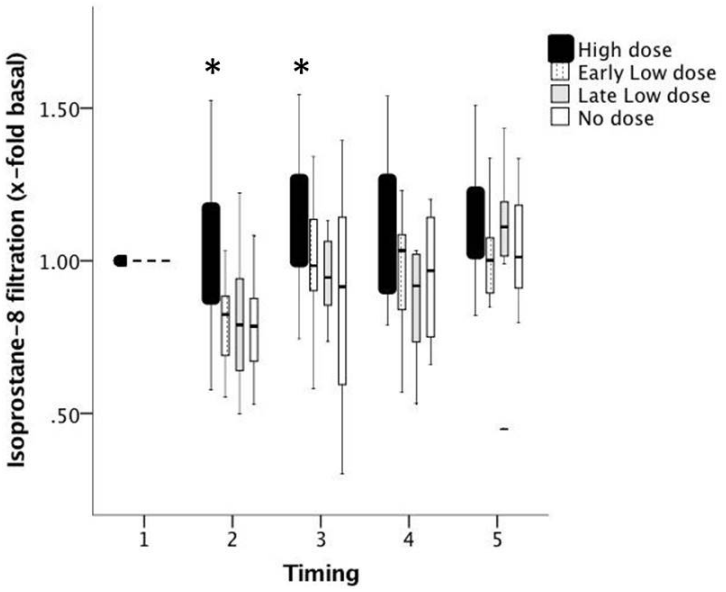
A total of 40 patients undergoing CABG were randomized into four groups according to aprotinin dose: 1) high dose, 2) early low dose, 3) late low dose, 4) without aprotinin. Pulmonary (PA) and radial artery (RA) blood samples were collected for the evaluation of calculated lung passage (PA/RA) of the pro-inflammatory factors interleukin (IL) 6 and IL8, 8-isoprostane, myeloperoxidase and the anti-inflammatory IL10 immediately after induction of anesthesia (T1), 1 min after releasing aortic cross clamp (T2), 15 min after releasing aortic cross clamp (T3), 1 hour after releasing aortic cross clamp (T4), and 20 hours after releasing aortic cross clamp (T5).

Results

PA/RA 8-isoprostane increased in patients with high aprotinin dose as compared with lower doses (1.1 range 0.97 vs 0.9 range 1.39, p= 0.001). The main effect comparing high aprotinin dose with lower doses was significant ($F(1, 38) = 7.338$, $p = 0.01$, partial eta squared = 0.16) further supporting difference in the effectiveness of high aprotinin dose for PA/RA 8-isoprostane.

Conclusion

According to the PA/RA equation, the impact of aprotinin on 8-isoprostane after CABG is dose-dependent. Aprotinin may aid the lung passage of circulating factors towards a beneficial anti-inflammatory milieu.


High dose
Early Low dose
Late Low dose
No dose
Isoprostane-8 filtration (x-fold basal)
1.50
1.00
.50
*
*
1
2
3
4
5
Timing

Concentration of circulating PAD2 in relation to CCABG

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Background

Peptidylarginine deiminase (PAD) is an enzyme that modifies peptidyl-arginine into peptidyl-citrulline, which may alter the structure, function or antigenicity of proteins. PAD2 is found in the synovium of patients with rheumatoid arthritis, but also in other tissues in relation to inflammation in general. Expression levels of PAD2 correlates with the intensity of inflammation in tissues. It remains unknown whether circulating PAD2 is elevated during systemic inflammation.
Coronary artery bypass surgery with cardiopulmonary bypass (CCABG) can result in severe postoperative complications and mortality. CCABG is known to induce systemic inflammation response in patients. Several studies have proved that CCABG leads to endothelial activation, which, among numerous other causes, arises when the blood comes in contact with the artificial surface of the pump. Several studies have shown significantly higher levels of systemic inflammation in CCABG compared with CABG off-pump.

Material and Methods

In this study, 40 patients who were scheduled for elective CCABG surgery were included. Venous blood samples were collected at two time points; 2 h preoperatively and 2h postoperatively. Concentration of circulating PAD2 was measured in serum using a specific ELISA, and levels of inflammatory cytokines and markers were analysed using Luminex technology.

Results

Circulating PAD2 was found significantly elevated postoperatively. Median serum concentration before surgery was 0.3 ng/mL (10-90 percentile range 0.1-1 ng/mL) and after surgery was 1.15 ng/mL (10-90 percentile range 0.3-5.12 ng/mL) ($p<0.0001$). Analysis of circulating inflammatory cytokines is still in progress.

Conclusion

CCABG surgery causes a complex systemic inflammation. PAD2 was elevated after CCABG, most likely because of systemic inflammation during CCABG. To examine whether elevated PAD2 concentration plays a role in the complications after CCABG, further investigation of PAD2 pathology is needed.

Comparison of valve-sparing aortic root repair techniques with single and double rings

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Background

Aortic valve sparing techniques with ring annuloplasty have become a valuable alternative to conventional aortic valve replacement for patients with isolated aortic insufficiency (AI). Lansac et al have reported a tendency of reduced recurrent AI postoperatively with double ring annuloplasty addressing the annulus and sinotubular junction (STJ) compared to single annular annuloplasty. However, studies characterizing aortic ring annuloplasties are lacking. The aim of this project is to investigate the functional and biomechanical properties of single and double ring annuloplasty in vitro.

Material and Methods

18 porcine aortic roots (80 kg) were prepared and randomized to three groups: Native aortic root, single ring annuloplasty and double ring annuloplasty. Echography was used to evaluate valve dynamics, and two dedicated force transducers were implanted at the aortic annulus and STJ for force measurements. The aortic roots were mounted in an in vitro model and tested at aortic pressures of 60, 90, 120 and 150 mmHg. These data will be used for comparison between single and double ring annuloplasty and to a native control group.

Results

We observed a significant downsizing effect in both the single ring and double ring group at annular level (20 ±1 mm and 21 ±2 mm) compared to native (23 ±2mm). Coaptation height increased significantly (8.5 ±0.9 mm from 6.7 ±0.8 mm, respectively) in the single ring group compared to native, and further increased when adding a STJ ring (and 9.8 ±0.8 mm). Forces at annular level decreased significantly in both the single ring and double ring group (0.4 ±0.2 N vs. 0.3 ±0.1 N, respectively) compared to the native group (0.8 ±0.3 N). At STJ we observed a significant decline in forces between all three groups (2.6 ±0.9 N vs. 1.7 ±0.2 N vs. 1.0 ±0.6 N) for native, single ring and double ring, respectively.
All results are presented at aortic pressure of 120 mmHg. However, our findings were consistent at all four pressures.

Discussion

Both single and double ring techniques downsize the aortic annulus and increase coaptation height, as expected. The aortic root as a functional unit is supported by the observed increase

in coaptation height from single to double ring and the decrease in STJ forces when adding an annular ring. Thus, addressing both the annulus and STJ simultaneously seems necessary for proper aortic root stabilization.

Surgical strategy using a rapid deployment aortic valve

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Background

Rapid deployment aortic valve replacement (RAVR) may facilitate cardiac surgery in patients with aortic valve stenosis. We adopted a surgical strategy using primarily RAVR operated through hemisternotomy. Traditional biological aortic valve replacement (AVR) via hemisternotomy was performed whenever the aortic valve was asymmetrical, during annulus enlargement and during a bioBentall operation. Sternotomy was utilized whenever a concomitant cardiac procedure was necessary.

Material and Methods

We report our initial experience on 34 consecutive patients treated with a RAVR operated either via hemisternotomy (n=13) or sternotomy (n=13), and AVR via hemisternotomy (n=8). Concomitant surgery included tricuspid valve annuloplasty, coronary artery bypass grafting and septal myectomy.

Results

Altogether, 32 patients recovered. One patient with RAVR and one with AVR had a paravalvular leak perioperatively. One patient with RAVR and tricuspid valve surgery underwent hemostasis. Two patients with AVR and intended hemisternotomy underwent sternotomy and concomitant coronary bypass grafting. Two patients (one with RAVR and one with AVR) received a pacemaker. Two patients died at hospital; an emergent comorbid patient with end-stage chronic obstructive pulmonary disease doomed initially inoperable underwent RAVR and hemisternotomy died after suffering from mediastinitis. Another patient with RAVR via hemisternotomy underwent hemostasis through sternotomy, but died unexpectedly due to cardiac failure.

Conclusion

A tailored surgical approach using RAVR aids surgery in patients with aortic valve stenosis. Follow-up of patients with RAVR and AVR is mandatory.

Total mitral valve reconstruction using 2-ply porcine extracellular matrix: In-vitro evaluation

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Background

Extensive defects on the mitral valve often require total valve replacement using either a mechanical or a biologic prosthetic valve. However, both options have severe disadvantages which can lead to serious complications for the patients. Decellularized extracellular matrix (ECM), CorMatrix®, has emerged as a promising alternative to conventional mitral valve replacement. The sheet of ECM allows the surgeon to construct a valve to fit the individual patient. We sought to test if a mitral valve tube graft reconstruction is feasible. Our aim was to investigate both the functional and biomechanical consequences of a mitral valve tube graft replacement using 2-ply CorMatrix® in an in-vitro setup.

Material and Methods

Hearts were obtained from 80-kilogram swine (n=7), of which the mitral apparatus was explanted. A sheet of 125 mm x 35 mm was sewn into a tube. The valves were tested using a modified version of a left heart simulator. The annulus of the mitral valve was fastened to the annulus holding plate. Valves were photographed digitally in high resolution from an atrial point of view at pressures of 0, 20, 40, 60 and 80 mmHg, along with continues papillary muscles force measurement (each valve was its own control).

Results

We found that the valve closed without signs of regurgitation at increased pressure. The anterior leaflet area decreased (440±55 mm2 vs. 482±78 mm2), whereas the posterior leaflet area increased (556±35 mm2 ± 483±56 mm2) in the tube compared to the native. A significant difference was observed in papillary muscle forces and a redistribution of force between the native valve and the tube from the anterior papillary muscle (3.4±0.4 N vs. 2.8±0.4 N*) to the posterior papillary muscle (2.9±0.6 N vs. 3.5±0.9 N) was recorded. *: $p<0.05$.

Discussion

A 2-ply CorMatrix® tube graft is conceivable without regurgitation. An anatomical shift in leaflet area from a dominating anterior leaflet area, in the native leaflet, to a dominating posterior leaflet area, in the tube, occurs. Emphasis should be put on the shift in force distribution of the papillary muscles, which might have an impact in an in-vivo setting.

Total mitral valve reconstruction using 2-ply porcine extracellular matrix: A chronic porcine evaluation

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Background

Today, replacement of the entire mitral valve involves the use of a mechanical or biological valve, which is often associated with complications for the patients. However, CorMatrix® has shown promising results for valve reconstruction. Implanted, it acts as a scaffold and will be recellularized with the patient's own cells and eventually provide the patients with a new mitral valve. The aim of this study was to assess total mitral valve reconstruction using this patch material after nine months in a chronic model.

Material and Methods

A 2-ply CorMatrix® sheet of 11.3x3.5 cm was used to make a tube graft, with 15 mm arcs cut outs at A2 and P2, and double folded layers at the annular and papillary muscle attachments points. An open chest chronic porcine model (80 kg) was used (n=5). The new mitral valve was attached at the annular level and at two points on each papillary muscle. After surgery, the pig was observed for 24 hours and transferred to a farming facility for experimental animals. The mitral valve was assessed by epicardial echocardiography at baseline and after implantation of the tube graft.

Results

Representative echocardiographic images of a reconstructed mitral valve are shown in Figure 1. There were no signs of systolic anterior motion or insufficiency. The mean gradient across the reconstructed valve was 2.2±0.8 mmHg. Valve reconstruction downsized the septal-lateral annular diameter compared to the native valve (systole: 21.1±2.3 mm vs 27.0±2.0 mm*; diastole: 23.3±3.3 mm vs 29.9±2.1 mm*). The tenting area and tenting height were significantly reduced (53.5±19.8 mm2 vs 142.9±16.0 mm2* and 5.8±2.3 mm vs 8.1±1.3 mm*. The coaptation length increased (8.9±3.7 vs 6.0±0.6). *: $p<0.05$.
All the pigs were euthanized before time. One due to reactive pericarditis and four due to acute mitral insufficiency caused by the CorMatrix® breaking at the new chordae structure to the posterior papillary muscle. The longest survival time was one and a half months.

Discussion

Total mitral valve reconstruction is not possible using the current version of 2-ply CorMatrix® and the used design. It seems that there is a mismatch between the degeneration and re-

generation of the patch material, which leaves the valve vulnerable between day 14 to 45 after reconstruction, especially near the posterior papillary muscle.

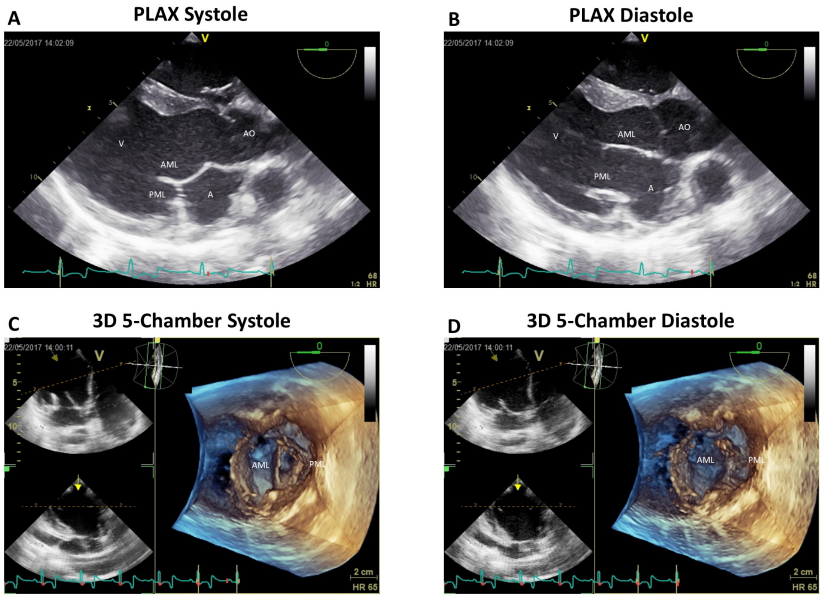

Figure 1. *Echocardiographic images of the mitral valve reconstruction in both systole and diastole. PLAX: Parasternal long axis; AO: Aorta; A: Left atrium; V: Left ventricle; AML: Anterior mitral leaflet; PML: Posterior mitral leaflet.*

Reversibility of early histological changes after experimental acute cardiac volume-overload

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Background

Acute cardiac volume-overload (AVO) may occur after rupture of the ascending aortic root into the right atrium. AVO induces early ischemic-like myocardial changes, and a left ventricular assist device may be applied for hemodynamic aid. We experimentally investigated whether a non-working state of the heart impacts on these ischemic myocardial changes after AVO.

Material and Methods

Thirty-two syngeneic Fisher 344 rats underwent surgery for abdominal arterial-venous fistula to induce AVO. Seven hearts were heterotopically transplanted one day after AVO for non-working state of the left ventricle (AVO+Tx). For control, five rats each underwent clamping of the aorta (Clamp) and only sham surgery (Sham), respectively. Myocardial recovery was studied using histology and immunohistochemistry for chitinase-3-like protein (YKL-40).

Results

At three days, the relative number of edematic myocardial arterial nuclei of the left ventricle decreased in AVO as compared with Sham (0.01±0.01 and 0.08±0.07, PSUs, point score units [PSUs], p=0.009). At one day, the relative number of edematic myocardial arterial nuclei of the left ventricle increased in AVO+Tx as compared with AVO, Sham and Clamp (0.30±0.12 vs. 0.12±0.25, 0.09±0.07 and 0.04±0.03, PSUs, p=0.002, p=0.01 and p=0.03). The relative number of ischemic myocardial arterial nuclei of the septum decreased in AVO+Tx as compared with AVO and Clamp (0.04±0.03 vs. 0.16±0.10 and 0.13±0.06, p=0.008 and p=0.014), in the right ventricle as compared with AVO (0.03±0.03 vs. 0.09±0.08, p=0.04), and in the left ventricle as compared with Sham (0.34±0.14 vs. 0.20±0.14, p=0.044). The number of YKL-40- positivity was increased in AVO+Tx as compared with AVO (8.80±2.68 vs. 5.91±1.86, $p<0.04$).

Conclusion

The experimental setting of AVO+Tx simulated the implantation of a left ventricular assist device during AVO. A non-working state reverses acute ischemic myocardial injury after AVO. The protective impact of edema and increased YKL-40 remains to be explored.

Lymphangiogenesis is increased in aortitis

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Background

Inflammation-associated lymphangiogenesis (IAL) is associated with various inflammatory states. Sparse data exist on lymphatics during aortitis. We aimed at delineating whether IAL impacts on the ascending aorta during inflammation.

Material and Methods

Thirty patients with surgically resected ascending aortas including 8 aortitis, 6 dissection, 7 atherosclerotic aortas, 5 with cystic media necrosis and 4 controls were investigated. Lymphatics were detected by podoplanin antibody immunohistochemistry and morphometric analysis of the aortic wall was performed.

Results

The lymphatic density of aortitis (22752.2, SD 64321.4, range 0-181934.1) was increased ($p = 0.037$) as compared with dissection (8.4, SD 4.4, range 0-13.7), atherosclerotic aortas (7.4, SD 3.8, range 0-9.6), cystic media necrosis (6.0, SD 4.5, range 0-11.8) and controls (2.9, SD 2.5, range 0-5.8).

Conclusion

IAL is increased in aortitis as compared with aortas without inflammation. Novel means targeted against lymphangiogenesis may facilitate treatment of aortitis.

Complement system is activated by ischaemia-reperfusion injury following resuscitation after out-of-hospital cardiac arrest and is associated with cerebral outcome

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Background

Cardiopulmonary resuscitation after cardiac arrest initiates a whole-body ischaemia-reperfusion injury. Complement system activation has been suggested to be a part of the reperfusion injury pathophysiology, but the association to long-term cerebral outcome is unclear. We hypothesized that complement is activated after resuscitation and associated with multiorgan failure, cerebral outcome and death.

Material and Methods

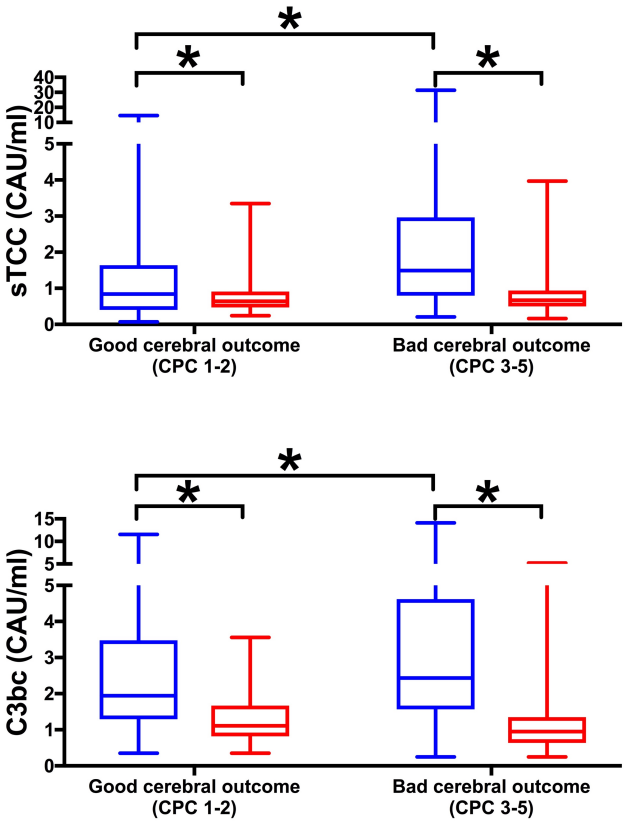
EDTA blood samples obtained at admission and at day 3 from patients enrolled in the NORwegian Cardiac ArreST trial (NCT01239420) were analyzed by ELISA for complement activation products C3bc and the soluble terminal complement complex (sTCC). Patients were comatose, treated with mild hypothermia (32-34ºC) for 24 hours and followed-up for up to 6 months. Cerebral outcome was defined by cerebral performance category scale (CPC, 1-2 good outcome, 3-5 bad outcome). Data are presented as median and interquartile range (box) with minimum/maximum values (whiskers) and compared with non-parametric tests and post-hoc Sidak correction if multiple comparisons were performed.

Results

During the observation period, of the 257 patients, 119 died. Among the survivors, 10 patients had bad cerebral outcome (CPC 3) resulting in 128 patients with good outcome (49,8% of total patients in study). C3bc and sTCC were higher on admission as compared to day 3 ($p<.001$ for both). There was a significant correlation between complement activation and time to resuscitation after cardiac arrest for sTCC at admission ($R^2=0.299$, $p<.001$). Death due to cerebral causes had significantly higher sTCC on admission compared to patients who were alive ($p<.001$). sTCC and C3bc at admission were significantly higher in patients with bad outcome (CPC 3-5) compared to patients with good outcome (CPC 1-2; $p<.001$ and $p=0.041$, respectively) (figure 1, admission day in blue, day 3 in red).

Conclusion

The complement system was strongly activated after successful cardiopulmonary resuscitation in patients with out-of-hospital cardiac arrest. High blood levels of sTCC and C3bc upon admission, but not on day 3, were associated with bad cerebral outcome and death from cerebral causes. Patients with kidney failure in need of dialysis were not associated with complement activation.



Lung donation after circulatory death. An experimental model to investigate reconditioning of donor lungs with ex vivo lung perfusion after exposure to warm ischemia

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Background

Lung transplantation is an accepted treatment for patients with end-stage lung disease. Acceptable donor lungs are the limiting factor for transplantation. However, the use of ex vivo lung perfusion (EVLP) has made it possible to recondition and evaluate marginal donor lungs. Because donor lungs from Donation after Circulatory Death (DCD) suffer from warm ischemia at circulatory arrest, there has been reluctance using these for donation. The aim of this project is to investigate, through a DCD pig model, if it is possible to recondition donor lungs exposed to one or two hours of warm ischemia with EVLP.

Material and Methods

Danish domestic pigs (N=17) were put down by ventricular fibrillation after blood sampling and bronchoalveolar lavage (BAL) and left untouched for 0, 1 or 2 hours of warm ischemia. Lungs were surgically removed, weighed, ventilated and perfused on EVLP system with Steens solution and autologous red blood cells. When connected to the EVLP a biopsy was taken from the middle lobe and perfusion samples were collected. After reconditioning in the system (83±38 min) lungs were evaluated at FiO2 100% and 21%. Blood samples and biopsies were collected and weight was recorded. Endpoints were physiological parameters (PaO2, compliance and pulmonary vascular resistance (PVR)), Δweight and myeloperoxidase (MPO) activity in bronchial lavage fluid, tissue homogenates and perfusion buffer. A histopathologic assessment score wall was performed.

Results

There was a significant difference between the three groups in PaO2 ($p=0.0008$). Opposite to 0 and 1 h warm ischemia lungs, lungs exposed to 2 h of warm ischemia did not meet the criteria: PaO2>14 kPa that is required for donation. No significant difference was seen in compliance or PVR between the three groups. Surprisingly, the histopatological scores were highest in the biopsies harvested in the control group before EVLP, however this score decreased during EVLP. Activity of MPO in tissue increased during EVLP. However, this was only significant in the 1 h group ($p<0.05$), still there was no significant difference between groups either before or after EVLP.

Conclusion

Our results show that lungs from DCD pigs can be successfully reconditioned by EVLP after 0 and 1 h warm ischemia. Lungs exposed to 2 h warm ischemia tend not to meet the criteria for transplantation despite EVLP reconditioning.

Long-term prognosis and causes of death after pleural infections

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Background

Most patients with risk factors for pleural infections, such as pneumonia or thoracic trauma, do not acquire the disease. The development of pleural infections may imply a worse state of health and a worse prognosis for these patients. The aim of this study was to ascertain the long-term survival and the causes of death after pleural infections and to compare them to those of matched controls.

Material and Methods

Altogether 191 consecutive patients treated for pleural infections at a single University Hospital between January 2000 and December 2008 and 1910 controls matched for age, gender, and the location of residence were included in the study. All etiologies for pleural infections were included in the study, as were patients treated conservatively and those undergoing surgery. Survival data and the causes of death for non-surviving study subjects were obtained from national databases and compared between the groups.

Results

The etiology of pleural infection was pulmonary infection in 70%, procedural complication in 9%, trauma in 5%, malignancy in 4%, other in 7%, and unknown in 5% of included patients. The median follow-up time was 11 years. Mortality rates were 8.4% vs. 0.8% during the first 90 days, $p<0.001$, and 46.6% vs. 24.5% overall, $p<0.001$, in patients and controls, respectively. Mortality was significantly higher in patients with pulmonary infection, procedural complication, or malignancy as the cause of pleural infection. In multivariable analysis, advanced age, previous malignancies, institutional care, alcoholism, and malignant etiology for the infection were associated with inferior survival. The most frequent causes of death during follow-up were due to malignancies, respiratory diseases, neurological diseases, cardiovascular diseases, and digestive diseases, together accounting for approximately 85% of all deaths. Of these, deaths associated with malignancies, respiratory diseases, and digestive diseases were significantly more common in patients than in controls.

Discussion

Long-term survival in patients with pleural infections is significantly inferior to that of age- and gender-matched controls. Deaths caused by malignancies, respiratory diseases and digestive diseases were significantly more frequent in patients than in controls.

Trends in the incidence, etiology, treatment, and outcomes of pleural infections

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Background

Pleural infection is a severe disease associated with significant morbidity, mortality, and healthcare costs. The disease often requires invasive treatment. The aim of the study was to define possible changes in the incidence, etiology, treatment, and outcomes of pleural infections over a decade in Finland.

Material and Methods

The study included all patients treated for pleural infections in Tampere University Hospital between January 2000 and December 2008 (Group 1) as well as those treated between January 2012 and December 2016 (Group 2). Epidemiologic data, medical history, treatment trends, and outcomes were reviewed for each case and the groups were compared. The incidence rates were calculated for both time periods. The 30-day mortality rates for the study patients were obtained from the national registries.

Results

The incidence of pleural infections increased significantly and was 4.4/100.000 between 2000-2008 and 9.9/100.000 between 2012-2016, $p<0.001$. There were no differences in the distribution of the most frequent causes of pleural infections between the study groups and the most common etiology for pleural infection was pneumonia, accounting for approximately 70% of all cases. The patients in group 2 were slightly older, 63 vs 57 years, $p=0.001$, and the prevalence of chronic lung disease, hypertension, heart failure, dyslipidemia, and immunosuppressive medication were higher in group 2. The detection and identification rate for the microbe pathogens increased from 49% in group 1 to 64% in group 2, $p=0.002$. The overall distribution of the identified pathogens was similar in both groups. More patients were treated operatively, 88.3 vs. 80.9%, $p=0.005$, and the delay to operative treatment was shorter, 6 vs. 9 days, $p=0.003$, in group 2. Both the rate of video-assisted thoracic surgery and the need for reoperations increased, 57.4 vs 8.0%, $p<0.001$, and 21.9 vs. 10.9%, $p=0.002$, respectively, during the study period. The overall 30-day mortality rate was 3.1% in group 1 and 5.1% in group 2, $p=0.293$.

Conclusion

The overall incidence of pleural infections has increased significantly while the causes of pleural infections and the distribution of pathogens remain unchanged. Contemporary patients are somewhat older and the prevalence of comorbidities is higher. Most patients are now treated with minimally invasive surgery.

Abstracts - Poster Presentations

Impact of congenital heart disease on brain development

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Background

Survivors of complex congenital heart defect (CHD) surgery live with an involuntary cerebral burden. For what is known, this burden consists of an abnormal brain morphology, demonstrated by magnetic resonance imaging (MRI) and, furthermore, an impairment in neurodevelopment. In general, these alterations are thought to be inflicted in utero and caused by the circulatory pathophysiology. To date, it is unknown to what extend this burden impacts adulthood and, furthermore, whether patients with septal CHD carry a similar burden. Moreover, an increase in cerebral comorbidity remains speculative. The aim of this thesis is to investigate the impact of septal CHD on brain development across the age continuum and into adulthood, to determine the long-term neurodevelopmental outcome.

Material and Methods

The project is designed as a prospective long-term follow-up study on patients diagnosed with septal CHD at Aarhus University Hospital in the period between 1975 to 1995. The study population will consist of 30 unclosed atrial septal defect patients, 30 surgically closed ventricular septal defect patients and 30 matched controls. The study examines; brain macro- and micromorphology with MRI, brain interactions and activity using quantitative functional-MRI (fMRI) and, moreover, assess cognitive domains and abilities using a targeted neuropsychological test.

Results

Pending.

Perspective

This is the first study to investigate the long-term impact of CHD on neurodevelopment. Our results will be a stepping stone towards describing neurodevelopmental outcome in septal CHD and, moreover, clarifying the associated late-life cerebral comorbidities.

Posterior mitral leaflet augmentation using porcine extracellular matrix: A chronic porcine evaluation with extensive histologic and immunehisto-chemical characterization

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Background

Biomaterials, both biologic and synthetic, are often essential for successful reconstructive cardiac surgery. This is particularly the case in mitral valve repair surgery, in which leaflet augmentation or reconstruction is often performed. Yet, the biologic and synthetic biomaterials used today are not always ideal due to associated post-operative complications. Decellularized extracellular matrix (ECM) from porcine small intestinal submucosa, CorMatrix®, has emerged as a promising alternative to conventional biomaterials. It acts as a bioscaffold, of which recellularization after implantation occurs. However, the mechanisms of resorption, remodelling and the immune response of implanted CorMatrix® are not fully understood. The of aim of this study was firstly, to preform posterior mitral leaflet augmentation in a chronic porcine model. Secondly, preform selection of histological stains with extensive histologic and immunohistochemical characterization along with a biomechanical analysis of the implanted 2-ply CorMatrix®. We can thereby assess the long-term feasibility of 2-ply CorMatrix® for mitral valve repair.

Material and Methods

On cardiac bypass and a left atrial approach, danish landracepigs (n=12) have undergone posterior leaflet augmentation with an oval shaped, 4 x 1cm 2-ply CorMatrix®, patch. Weaning from cardiac bypass, the valve was assessed with epicardial echocardiography and compared to baseline. After surgery, the pigs were observed for 24 hours after which they were sent to a farming facility for experimental animals. The pigs will undergo a MR-scan at 2 weeks, six and nine months after surgery. They will be euthanized after the last MR-scan and the tissue will be analysed.

Results

Pending.
Nine of the twelve pigs are still alive, five to seven months after the operation.

Perspective

A chronic porcine setting has the potential to provide a more fundamental understanding of the long-term durability and behavior of CorMatrix®. This study should confirm if 2-ply CorMatrix®, can withstand the hemodynamic environment in the left side of the heart. With

the help of histology and immunohistochemistry we will be able to see leaflet formation and if there are scar tissue formation, activated immune response, calcification or shrinkage. We thereby hope to get a new understanding of the long-term feasibility of 2-ply CorMatrix® for mitral valve repair

A new intelligent stocking for quantification of edema in the lower limb

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Background

The balance of the body fluids is strictly regulated within a narrow range. It is controlled by water movement between the interstitial compartment and the capillaries. An unnatural balance between the two compartments can be seen in several diseases, which leads to a net filtration out of the vascular space, resulting in the formation of edema. Monitoring of edema formation therefore represents a unique way of evaluating the degree of the underlying disease and effect of treatment. This has resulted in the development of Edema Stocking device, which has the potential to quantitate edema.
The aim of the study is to evaluate the Edema Stocking device as a tool for quantification of edema compared to the water displacement method (Archimedes' principle).

Material and Methods

The non-randomised study includes 25 women in the age of 20-30 years, identified at the dept. of Gynaecology and Obstetrics Y, Aarhus University Hospital. For every individual we will obtain a volume of the lower extremity with both Edema Stocking device and with the water displacement method which represents the gold standard. Throughout 3 days, each day one measurement will be performed in the morning and one in the evening. Likewise, a continuous monitoring of the edema formation will be performed in 8 hours each day.

Results

This study examines whether the Edema Stocking device is capable of quantitating edema or not. Currently no results have been obtained.

Conclusion

No conclusions can be drawn, but we hope to find out if the Edema Stocking device has the capability to quantitate edema.

Effect of warm versus cold ischaemia in protection against pulmonary graft thrombosis in lung donation after cardiac death

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Background

To overcome organ shortage, the use of lung donation after cardiac death (DCD) is increasing and the tolerable warm ischemic period after cardiac arrest has been discussed extensively. Several animal studies have shown a substantial effect of lung transplantation after 1 hour of warm ischaemia furthermore, no improved graft function of heparinized DCD lungs. It has previously been suggested that lung donation after cardiac death may be used for transplantation if intrapleural cooling and heparinization is initiated within minutes of irreversible cardiac arrest. However, a recent study found that warm rather than cold ischaemia protected the pulmonary graft from thrombosis in non-heparinized pigs.
Objective: Investigating the protective effect of warm ischaemia versus cold ischaemia at three different temperatures, on thrombotic formation in non-heparinized pulmonary grafts.

Material and Methods

The study is designed as a prospective clinical animal trial (translational science). Twelve pigs are divided in 4 groups: a group exposed to 1 hour of warm ischaemia at 38 ºC (4 pigs) and 1 hour of cold ischaemia at 30-32 ºC (4 pigs), 25 ºC (4 pigs) and 17-18 ºC (4 pigs). Measurements from arterial and venous blood are conducted at a pre-fibrillation baseline; post-fibrillation, at the time of confirmed circulatory arrest; and from the aorta, pulmonary artery and pulmonary vein at 1 hour of ischaemia. Measurements include antitrombin, prostacyclin, Von Willebrand factor, and syndecan-1, and biopsies performed post lung excision. To reach the target temperature, a cold solution of RingerAcetat is supplied to the pleura through an intercostal drain. At 1 hour of ischaemia, the lungs will be harvested en bloc. The pulmonary arterial branches will be opened and studied macroscopically for thrombotic material.

Results and Conclusion

Trial is still ongoing with the last inclusion expected to be before the 31st of January 2016.
Results will be presented at the SSRCTS conference in Geilo.

FEM methods for identification of constitutive parameters of the aortic root through reverse engineering

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Background

The aortic root is the functional-anatomical unit that connects the left ventricle to the thoracic ascending aorta. It is composed of four main elements: the aortic annulus, the interleaflet tringles, the sinuses of Valsava and the sinotubular junction. There are many ex vivo studies that have reconstructed the characteristic material parameters of the aortic root. However, the physiological conditions of ex vivo tissues, once extracted from the body, are altered. The aim of this project is to obtain material characterizations of the aortic root starting from an in vivo geometry.

Material and Methods

Based on computed tomography scans (CT) (short axis images, slice thickness 1 mm, 21 frames/cycle with temporal resolution of 0.065 s), the in vivo threedimensional geometry of the physiological aortic root images of one pig was reconstructed. Through in house software implemented in Matlab® (The Mathworks, Inc.), in each frame and on each relevant image, the aortic root wall was manually traced, traced points were automatically fitted by Fourier functions, and the corresponding profiles were interpolated through cubic splines to yield the 3D geometry of the root, which was discretized into 102,434 triangular elements by means of the freeware software Meshmixer.
For the material characterization, a reverse engineering method is under implementation. The obtained discretized geometry is imported in ABAQUS (SIMULIA, Dessault Systèmes) and pressurized accordingly with the in vivo pressure recorded during image acquisition. Aortic wall tissue is assumed hyperelastic and anisotropic. Through an optimization algorithm written in Matlab and Python, the constitutive parameters of the mechanical model are iteratively adjusted so that the model response matches the in vivo one: given two consecutive time frames ti and ti+1, a set of variants of the model at frame ti is generated, each variant being characterized by a different combination of constitutive parameters. The variant that, following partial inflation from p(ti) to p(ti+1), best matches the in vivo configuration at time ti+1 is selected as first guess for the next iteration.

Results

Pending results.

Perspective

From this work, it is expected to obtain an optimization algorithm able to identify the material characteristics that best approximate the in vivo behavior of the aortic root.

Compromised sinus of valsalva flow and transcatheter aortic valve thrombosis

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Background

Transcatheter aortic valve implantation (TAVI) in patients with severe aortic stenosis has become a safe routine procedure. Recently, the transcatheter valves have also been employed in treating degenerated bioprosthetic heart valves using the valve-in-valve technique. However, for the TAV an incidence of leaflet thrombosis of 7% has been observed. The mechanism has not been identified but compromising the flow and vortices in the Sinus of Valsalva may be an important factor. This may be evoked when the native leaflets are pushed into the Sinus of Valsalva along with the implantation of the TAV frame. The aim of this study is therefore to investigate how the TAV structure affects the valve leaflet dynamics along with the flow patterns in the Sinus of Valsalva.

Material and Methods

Part 1: In a pulsatile in vitro flow loop a TAV prepared with a detachable metal frame will be inserted into a test section with intact sinus of Valsalva. The valve leaflet dynamics along with the flow pattern in the Sinus of Valsalva will be assessed using high speed imaging, ultrasound, and dye flow visualization. Part 2: In vivo, an MR compatible replica of a commercial TAV frame will be manufactured and inserted into an 80 kg pig during anaesthesia. The Sinus of Valsalva flow will be evaluated using MR 4D flow measurements before and after the stent frame insertion.

Results

Pending.

Perspective

These results may reveal a comprised and altered flow in the Sinus of Valsalva as a result of the implanted TAV. This may potentially result in flow stagnation that could lead to valve leaflet thrombosis.

Biomechanical characterization of thoracic aortic aneurysms

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Background

Aortic aneurysm is a common pathology with a prevalence of 6–9% in people age 65 and older [1] With an increasing population of elderly this number will only increase. The disease can be asymptomatic but if acute dissection or rupture occurs it is associated with a very high mortality.

The pathophysiologic mechanisms governing aortic aneurysm progression in humans is not fully understood. Currently, aneurysm size (>5,5) cm remains the best criteria for recommending surgery in large aortic aneurysms [2]. This has clear shortcomings, as aneurysm size is not an absolute predictor of aneurysm expansion and risk of rupture. While a detailed description of the structural organization of the human aorta has been reported by a few investigators, none have quantified simultaneously the organization of the collagen and elastin fibres and how the changes corresponds to alterations in the biomechanical function of the aorta. Therefore, further understanding of the mechanisms leading to rupture of aortic aneurysms would enable better selection of patients for endovascular or open surgery repair and identify possible therapeutic targets for the medical measures to minimize the risk of aneurysm rupture.

Material and Methods

Human aortic tissue specimens from 10 patients will be obtained according to the guidelines of the institutional ethical board. Ring-shaped segments of TAA will be obtained fresh from the operating room from patients undergoing surgical repair. The aneurysm diameter will be recorded from patient charts as assessed from computed tomographic scans. Tensile testing will provide data on the elastic modulus of the aortic wall using uniaxial tensile testing in two different areas of the stress–strain relationship: physiological and maximum range of stresses. Experiments will be carried out using a tensile testing machine (Bose ElectroForce 3200). Load and stretch will continuously be recorded by the data acquisition software provided by Bose.® Tissue microstructure will be quantitatively histological assessed using histochemical staining of collagen by sirius red method and Verhoeff-van Gieson Staining of elastic fibers.

Results

Pending.

Perspective

A thorough understanding of the aortic tissue properties, will be crucial for the establishment of preclinical animal models and strategies for evaluating new treatment techniques.

The functional effect of left atrial appendage occlusion

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Background

In Europe, 10%-17% of those aged 80 or older suffer from Atrial Fibrillation (AF). These patients have a 5-fold increased risk of stroke and also an increased risk of major bleeding due to anticoagulation therapy.
The primary site of thrombus formation in the left atrium is the Left Atrial Appendage (LAA). In patients with AF, the LAA is acting as a static pouch, resulting in stagnation of blood potentially leading to thrombosis. Therefore, occlusion of the LAA is an alternative to anticoagulation for prevention of thrombus formation and embolization. LAA occlusion can be accomplished through a transcatheter procedure delivering an occluder device to the LAA thereby sealing it off from the systemic circulation.
Presently, there are no studies examining the effect of LAA occlusion on the volume/pressure relationship of the left atrium. The appendage can have up to 30% of the size of the left atrium and occluding it might therefore have consequences for the physiological function of the left atrium and ultimately filling of the left ventricle.
The aim of this study is therefore to evaluate the effect on left atrial compliance from LAA occlusion.

Material and Methods

Using cardiac CT scans from patients with AF, five patient specific 3D geometries of the left atrium were created. Tensile tests were performed on pig hearts to determine the mechanical properties of the left atrial tissue. Based on the tests and available literature, the 3D models were printed in a material that mimics the tissue and mechanical properties of the left atrium. The test setup consists of a pressure transducer and a data acquisition system. The transducer is inserted into the 3D models. The model will gradually be filled and expanded with fluid while registering the volume along with the resulting change in pressure. Based on the registered data the volume/pressure relationship in the LA will be assessed before and after LAA occlusion.

Results

Pending.

Perspective

If the tests reveal a difference in the pressure/volume relationship before and after occluding the LAA, more research would be needed to explore how this will influence left ventricular filling and pump function.

Biomechanical in vitro assessment of the porcine aortic root

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Background

Aortic aneurysms are defined as localized expansions of the aorta, whereas 20% involve the aortic root. Based on US healthcare data, aortic aneurysms is estimated to the 14th leading cause of death. In order to understand the development of aneurysms it is important to know the biomechanical properties and structural composition of the native aortic root.

Material and Methods

Porcine hearts will be obtained of which the aortic root will be excised. Specimens from the aortic root will be examined in an uniaxial tensile test machine in order to determine the stress-strain relationship and maximum strength. Furthermore, the viscoelastic properties in terms of energy storage and loss capacity will be described using Dynamic Mechanical Analysis (DMA). Finally, the amount of collagen and elastin in the tissue will be measured and related to the biomechanical findings.

Results

Pending.

Perspective

By understanding the tissue composition and the biomechanical properties of the aortic root and later how they are altered in patients with aneurism, essential knowledge may benefit for optimizing the surgical procedure in those patient groups. By improving the surgical procedure, a better postoperative course with longer-lasting repairs, lower numbers of re-operation and improved quality of life for each patient may be achieved

Vitamin D deficiency and nutritional status among rheumatic heart disease patients in Pokhara, Western Nepal

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Background
Although nearly eradicated in high income countries, Rheumatic Heart Disease (RHD) remains the most commonly acquired heart disease in people < 25 years of age globally, with an estimated prevalence of 33 million people. It has been suggested that malnutrition is of great importance for immune responses in general. More specifically, Vitamin D deficiency has recently been linked to autoimmune diseases, Group A Streptococcal pharyngitis, Acute rheumatic fever and RHD. However, research on RHD pathophysiological mechanisms is lacking. The aim of this study is to investigate the association between malnutrition, especially Vitamin D deficiencies, and RHD.

Material and Methods
A case-control study of 140 people in Pokhara, Nepal. The case-group will comprise of 70 patients selected from the Western Regional Hospital's national RHD registry in Nepal. Inclusion criteria are; age > 5 years and currently receiving secondary prophylaxis. The control-group will comprise of healthy individuals selected by echocardiography at community screening camps, and matched on sex and age. Dried Blood Spot testing will be performed to determine serum Vitamin D levels by liquid chromatography-tandem mass spectrometry. Furthermore, data on weight, height, age, middle-upper-arm circumference and socio-economic background will be collected.

Results
Pending.

Perspective
This study will contribute with new knowledge on the association between malnutrition and RHD. Hereby, we hope to elucidate the pathogenic mechanisms involved in RHD progression, in accordance with recent World Health Organization recommendations.

Assessment of left ventricular outflow tract and aortic annulus by conventional (2D) and advanced (3D) echocardiography in patients with open heart-surgery

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Background

Today conventional 2D echocardiography is an important diagnostic method in examining patients with aortic valve-and ischemic heart diseases. Both conventional 2D and advances 3D echocardiography can determine the size of left ventricular outflow tract (LVOT) and the aortic annulus, which are important measures before aortic valve surgery. The aim of this study is to examine if 3D echocardiography is more accurate in measuring LVOT and aortic annulus than 2D echocardiography. If 3D echocardiography shows to be more accurate than 2D, there could be a change in standard methods and the valve size chosen for the surgery can be more precise, which might give a better outcome.

Material and Methods

To examine if 3D echocardiography is more accurate in determining LVOT and aortic annulus three sub studies are designed:
Study 1(anatomy): Examination of 25 patients with 2D and 3D echocardiography compared with heart-CT.
Study 2(flow): Examination of the same 25 patients within 14 days both fasting and after 2L NaCl to change preload and hereby flow and geometry. Examination with 2D echocardiography and 3D cardiography and compared with heart-MRI.
Study 3(clinical validation): Examination, with 2D and 3D echocardiography, of 100 patients that will undergo aortic valve surgery. The 2D and 3D measures will be compared with surgical measure.
The population for study 1 and 2 are patients included from the Echocardiography lab, while the population for study 3 is a subgroupof of the GLP-1 and Hyperoxia for Organ Protection in Heart Surgery (GLORIUS) study (n=1080). The subgroup is patients with ischemic heart disease and/or aortic valve disease, who will have a CABG or aortic valve surgery. 2D and 3D echocardiography will be performed just before the surgery, 4-6 days and 3 months after the surgery.

Results

Trial is still ongoing with the last inclusion ultimo 2018.

Perspective

3D echocardiography being more accurate in determining LVOT than 2D echocardiography in patients before open-heart surgery and a decrease in mortality and complications when the

measure is more accurate can make a change in the pre-surgery-examination where 3D echocardiography may replace 2D echocardiography. This can make the prognosis after open-heart-surgery better for patients.

Balloon over-pressurizing caused by inflator gauge dynamic response

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Background

Objectives: Patients with degraded aortic bioprosthetic heart valves are often treated with surgical valve replacement. However, those who are not eligible for redo surgery can be offered a valve-in-valve procedure. This procedure installs a percutaneous valve within the frame of the degraded surgical bioprosthesis in situ. However, in small sized aortic valves (19 mm and 21 mm) the valve-in-valve procedure results in too narrow a lumen. To circumvent this more space for the percutaneous valve is needed. The restrictive part in the lumen is the frame structure of the installed surgical valve. By fracturing this frame, a more flexible anchoring site will be achieved which can accommodate a larger or a more expanded percutaneous valve. Current research has demonstrated the balloon pressure needed to fracture various types of bioprosthetic valve frames. A fast balloon expansion and deflation is required since the aorta will be totally occluded during the procedure. The required pressure is reached according to the manometer on the inflator. However, it has been observed in vitro with a high responsive reference pressure gauge that the manometer on the gauge is highly overdamped, potentially causing the pressure to be more than 20% higher that the gauge read out during fast inflation.

Material and Methods

An inflator (SIS Medical) is coupled in parallel with a reference pressure gauge system (AKS32, Danfoss) to a closed rigid system that allows pressurization in the range of 10 – 20 atmospheres. Once the system has been pressurized a pressure step response is acquired by an immediate induced line rupture. The pressure gauge deflection of the inflator will be captured using a high-speed camera (Fastcam SA3, Photron) with a frame rate of 1,000 frames per seconds. The analog pressure signal from the reference gauge will be digitized at 1,000 samples per seconds. The system characteristics for the pressure gauge will be deduced and the corresponding responsiveness quantified.

Results

Preliminary results indicate that the pressure gauge can be modelled as an overdamped system resulting in a very slow response towards fast changing pressures.

Perspective

During fast pressurization, the operator must take into account the responsiveness of the inflator device being used.