EACTS Daily News
European Association For Cardio-Thoracic Surgery
The official newspaper of the 28th EACTS Annual Meeting 2014
Saturday 11 October

## In this issue



# Welcome to Milan

## The 28th Annual Meeting of the EACTS

**Welcome to the 28th Annual Meeting of the EACTS in Milan. This year's programme covers the many different aspects of cardio-thoracic surgery, emphasizing areas that are important in our daily clinical work. As ever, we are hoping to create an interactive meeting with the exchange of knowledge and ideas, facilitating discussions and debates between delegates.**

With a wide range of educational formats presenting the latest and the best information on new technologies and techniques in cardio-thoracic surgery, the presentations will be of interest to all cardio-thoracic surgeons and allied health professionals.

### Techno-College

The meeting begins with the Techno-College and the Acquired Cardiac Disease programme will examine the latest developments in transcatheter aortic valve implantation, aortic surgery, mitral valve, ablation, imaging and heart failure, and will include live surgery and live-in-a box video presentations. This year's Congenital Disease programme will focus on valve and conduits for the right ventricular outflow tract, reconstruction and repair of the pulmonary arteries, and pulmonary artery reconstruction beyond central pulmonary arteries. The Thoracic Disease programme will look at the latest developments and research concerning chest wall deformities, trauma and tumours.

### PostGraduate Course

Sunday's PostGraduate Course will begin with a plenary session how we can 'Deliver value in healthcare' with a focus on innovation. There will also be two sessions on the Quality Improvement Programme with an update from the EuroMACS and QUIP databases and registries.

The Acquired Cardiac Disease programme is entitled 'Better decisions, better outcome' and will examine coronary, aortic and mitral valve repair. The Vascular Disease Domain sessions will focus on the different patterns of bicuspid aortic valve associated proximal aortopathy (RESECT or RESPECT?) and two joint EACTS/STS sessions will discuss aortic disease and examine the controversies in treating the distal aorta with and without previous proximal repair and how to treat type B aortic dissection. The Thoracic programme will discuss oligometastatic diseases and intraoperative complications, and the Congenital programme will look at complex venous anomalies, re-operation techniques and include a surgical film session.

In addition, there will be several nurses' sessions, a session on antimicrobial peptides and tissue engineering, improving perfusion session, a session on mitral disease in Latin America (repair vs. replacement) and a 'Teach the Teacher' session, to name but a few.

As ever, Monday and Tuesday's programme has numerous Abstract sessions, Professional Challenges and Focus Sessions, encompassing the whole spectrum of cardio-thoracic surgery, and we are sure there is something for every cardio-thoracic specialist and allied healthcare professional to learn, discuss and take home from the meeting.

### Keynote lectures

This year's Presidential Address by Paul van Schil, is entitled, 'The versatile beauty of the hand: mysterious, powerful and ingenious' and will be presented on Monday afternoon. We are also delighted to welcome Professor Bart Loeys, Edegem, Antwerp, Belgium, to Milan who I am sure will provide us with a fascinating insight into the 'Genetics of aortic disease', during his Honoured Guest Lecture on Tuesday afternoon.

### EACTS

If you appreciate what the EACTS presents during this event and you want to support the work of the Association, I encourage you to visit the EACTS booth and become a member. Membership fee is low and you will receive the European Journal of Cardio-Thoracic Surgery and the Interactive CardioVascular and Thoracic Surgery Journal, as well as a reduced rate for the Annual Meeting. This application can be done through the website of the EACTS (ww.eacts.org) or at the EACTS booth in the exhibition area.

At the booth you will also find information on our new courses that we are going to organize throughout 2015.

We thank our industry partners for their continued support of the meeting, and all the presenters who have taken the time to contribute to this year's *EACTS Daily News* newspaper.

It is a great pleasure to welcome you in Milan and we are honoured and delighted with your presence at this conference. We hope the information and techniques presented to you here will be of great interest. Milan is a city with a wonderful cultural heritage, I hope you enjoy the meeting and all this wonderful city has to offer.

***Pieter Kappetein*** *EACTS General Secretary*

**Techno-College Acquired Cardiac Disease Domain** Gold Room

# Apical closure device

## Modified ventricular septal occluder for full percutaneous transapical transcatheter procedures

***Enrico Ferrari***
*University Hospital of Lausanne, Switzerland*


Enrico Ferrari

Transapical aortic valve replacement is still a valid approach in patients at high surgical risk with concomitant stenotic aortic valve disease and peripheral vascular disease. Moreover, several new generation TAVI devices have been developed at first with coupled transapical delivery systems and then, in a second time, with transfemoral delivery system.

The transapical access is also used for the minimal invasive repair of mitral chordae (NeoChordae device) and has been use for the development and the implantation of the first transcatheter mitral valves in humans. Therefore, the transapical approach is still an important easy-to-use way to safely deliver valves and other devices into the heart.

Nevertheless, the apical approach requires a mini-thoracotomy of about 7–10cm on the fifth intercostals space and the exposure of the left ventricular apex. Then, the apex is prepared with reinforced double purse-string suture that will guarantee the sealing of the apical breach at the end of the procedure. This approach can be painful and can expose the patient to major bleedings and infections.

Since a year, in our institution we worked in the development of a new prototype of apical ventricular occlude device that will allow true-percutaneous transcatheter transapical procedures without opening the chest and without risks of major bleedings. This new occluder device (Figure 1a) is made of nitinol and is produced by Comed under our specifics. The final design of this apical occlude derives from the standard Comed ventricular septal defect occuder with a new design of the waist and a new inner membrane to assure immediate sealing after the sheath removal. The waist is much smaller and results in a more adaptable device that accepts muscular movement and contractions during the systole and the diastole (Figure 1b).

The animal experience. Six pigs were prepared following the standard protocol

*Continued on page 2*

# Heartmate III

## A novel 3rd Generation LVAD

### Live-in-a-box implantation in 3D!!!

***Jan D. Schmitto and Axel Haverich***
*Hannover Medical School, Hannover, Germany*


Jan Schmitto


Axel Haverich

On June, 25th 2014 the worldwide first human implantation of a Heartmate III LVAD-implantation was performed at Hannover Medical School under the direction of surgeon Jan D. Schmitto and his Chief, Axel Haverich, Dept. of Cardiac, Thoracic, Transplantation and Vascular Surgery, Hannover, Germany. This implant marked the first patient enrolled in the HeartMate III CE Mark Clinical Trial, which will enroll up to 50 patients at nine sites in Europe, Australia, and Canada. The study includes a primary endpoint of six-month survival compared with estimated mortality based on the Seattle Heart Failure Model. The novel LVAD "HM III" (Thoratec Corp.), which is developed to advance the field of mechanical circulatory support, is designed as a third-generation LVAD with a fully-magnetically levitated rotor with no mechanical bearings. As a consequence of

*Continued on page 2*

The novel Heartmate III LVAD – a 3rd generation centrifugal pump

## Saturday 11 October

### Techno College

07:00–17:00 **Registration**

### Cardiac

08:00 **Session 1: Transcatheter Aortic Valve Implantation**
*Gold Room*
*Moderators: Neil Moat, Hendrik Treede, Francesco Maisano, Anson Cheung*
Live-in-a-box
Live surgery

10:30 **Session 2: Aortic Surgery**
*Moderators: Malakh Shrestha, Martin Grabenwoger, Enrico Ferrari*
Live-in-a-box
Live surgery

12:25 **Lunch**

13:35 **Session 3: Mitral Valve**
*Joseph Bavaria, Joerg Seeburger, Thomas De Kroon, Volkmar Falk*
Live surgery

15:50 **Session 4: Ablation/Imaging/Heart Failure**
*Thierry Folliguet, Mattia Glauber, Jan Gummert*
Live-in-a-box

17:30 **Session ends**

### Thoracic

09:00 **Session 1: Chest wall deformities, trauma and tumours: Part 1**
*Amber 1 & 2*
*Ralph Schmid, Kalliopi Athanassiadi, Jose Ribas de Campos, Gaetano Rocco*

13:30 **Session 2: Chest wall deformities, trauma and tumours: Part 2**
*Amber 1 & 2*
*Ralph Schmid, Kalliopi Athanassiadi, Jose Ribas de Campos, Gaetano Rocco*
Live surgery

18:00 **Session ends**

### Congenital

13:00 **Valve and conduits for the right ventricular outflow tract. Reconstruction and repair of the pulmonary arteries Session 1: Conduits and valves**
*Amber 5*
*Felix Berger, Christian Schreiber, Giovanni Stellin*

15:30 **Session 2: Pulmonary artery reconstruction beyond central pulmonary arteries**

EACTS is grateful to the following organisations for their educational grants in respect of this year's Techno College:

Admedus GmbH
Aesculap AG
AtriCure Europe bv
Boston Scientific
CorAssist Cardiovascular
CorMatrix Cardiovascular
Edwards Lifesciences
Heartware Inc
JenaValve Technology GmbH
Jotec GmbH
LSI Solutions
Medtronic International Trading Sàrl
Philips Healthcare
St Jude Medical
Sorin Group Italia SRL
Symetis SA
Thoratec Corporation
Valtech Cardio
Vascutek Ltd

**Techno-College Acquired Cardiac Disease Domain** Gold Room

# Apical closure device

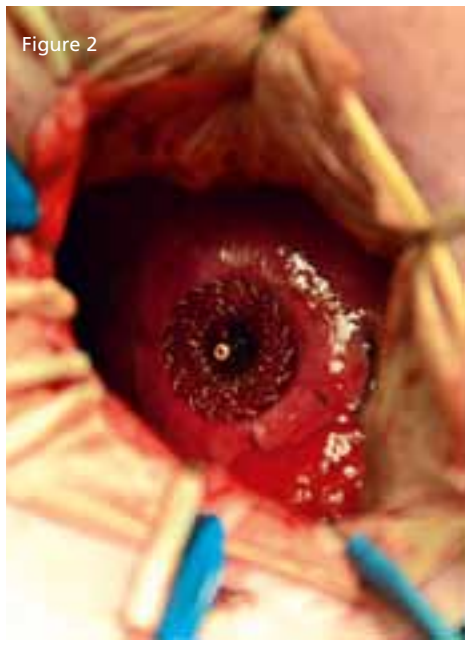
*Continued from page 1*

for animal use in laboratories. Then, through a left mini-thoracotomy, a 21 French Edwards Ascendra sheath was introduced in the apex to mimic an apical valve procedure. At that moment, we started to measure the full blood loss through the thoracotomy. Then, we introduced the apical occlude that was partially deployed (inner disk) in the left ventricle. Then, the Ascendra sheath and the delivery system were gently pulled out and the device was placed against the inner apical wall. After the removal of the Ascendra sheath, the apical occluded was full deployed (external disk) with absence of active bleeding (Figure 2). Blood loss measurements were performed for one hour after the deployment of the occluder and it resulted in just non-measurable traces.

In conclusion, the device is ready for further clinical tests in animals (full percutaneous transcatheter procedures) and in humans. This device cannot be used with sheathless transcatheter devices but will allow the full-percutaneous transapical transcatheter valve repair or replacement when devices with sheaths are employed (to date, sheaths of 18F and 21F inner diameter were tested).

Figure 1

Figure 2



# Heartmate III
## A novel 3rd Generation LVAD

*Continued from page 1*

this, the pump allows wide blood flow gaps, which lead to a lowered shear stress, and also enable sharp speed changes which hemodynamically allow the creation of an artificial pulse.

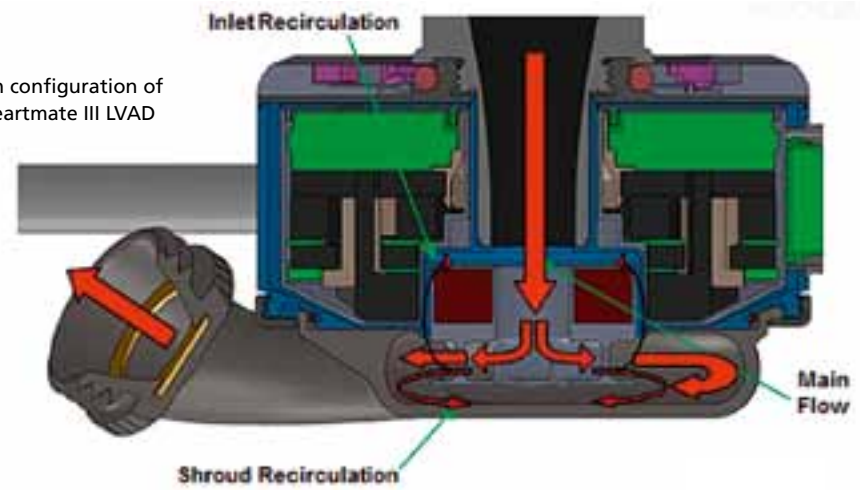
Within the HeartMate III CE Mark Clinical Trial the participating centres investigate wether the technical and hemodynamic advantages of this miniaturized centrifugal pump will result in reduced adverse events and improved outcomes.

The novel developed design benefits of this centrifugal pump are listed as followed:

- 3rd generation LVAD
- Centrifugal pump
- Fully-magnetically levitated rotor
- no mechanical bearings, wide blood flow gaps
- no mechanical friction, lowered shear stress
- smaller size
- artificial pulse capability
- novel apical sewing ring allowing quick mechanical connection to the LV apex
- textured, sintered surfaces
- modular driveline, etc.

***Heartmate illustrations are kindly provided and approved for priting by Thoratec Corp.***

Design configuration of the Heartmate III LVAD




**Techno-College Acquired Cardiac Disease Domain** Gold Room

# Chasing the gold standard
## Combining advanced technologies in thoracoscopic atrial fibrillation ablation

***N. Doll[1]; M. Misfeld[2]; T. Schroeter[2]; S. Kircher[3]; A. Bollmann[3]*** *1 Sana Herzchirurgie Stuttgart; 2 Heart Center Leipzig, Dept. of Cardiac Surgery; 3 Heart Center Leipzig, Dept. of Electrophysiology*

### General aspects

Catheter ablation is an established treatment option for patients with symptomatic atrial fibrillation (AF). Pulmonary vein isolation (PVI) is performed in the vast majority of ablation procedures. In a substantial proportion of patients a more extended left atrial (LA) substrate modification and repeated ablation procedures are necessary to achieve an acceptable success rate. This especially applies to patients with non-paroxysmal forms of AF and/or with a diseased atrial myocardium. Treatment failure is commonly related to gaps in ablation lines and lack of transmurality. Surgical ablation of AF has evolved from the original open heart, "cut and sew" Cox MAZE procedure towards a minimally invasive, thoracoscopic procedure using modern devices that apply radiofrequency (RF) energy to ablate on a beating heart. The potential advantage of epicardial ablation over catheter-based approaches is the placement of continuous, more durable ablation lines. At our institution, we have established a co-operation between cardiac surgeons and electrophysiologists to combine the strengths of endocardial and epicardial ablation and to individualize ablation concepts considering previous ablations, electroanatomical information and tachycardia mechanisms aiming at improving outcome in challenging cases. This "hybrid" approach includes description of individual LA substrate, planning of a personalized ablation concept, epicardial ablation, resection of the LA appendage, intra-operative verification of conduction block across ablations line, and – if necessary – additional endocardial ablation.

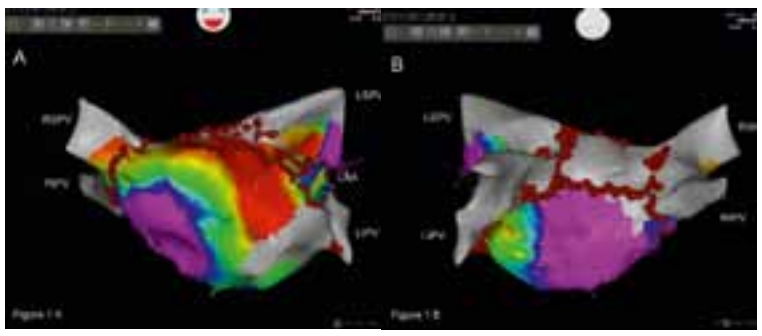


Figure 1. 3D electroanatomic map of the left atrium and the pulmonary veins showing the lesion set (red dots) applied during the second catheter ablation procedure in the anterior-posterior (A) and the posterior-anterior view (B). The lesion concept consisted of circumferential ablation lines around ipsilateral pulmonary vein pairs, a box lesion, a posterior mitral isthmus line, an anterior mitral isthmus line, and ablation around the left atrial appendage (Abbreviations: LAA = left atrial appendage; LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein).

### Case report

A 60-year-old female patient underwent thoracoscopic surgical ablation in September 2014. The patient had symptomatic persistent AF since 2003. Clinical evaluation revealed no evidence of significant structural heart disease with the LA diameter (PLAX) measuring 44mm. Antiarrhythmic drug therapy including amiodarone failed to relieve symptoms. A first catheter ablation was performed in March 2011 consisting of circumferential PVI plus additional substrate modification including a box lesion, a posterior mitral isthmus line, and ablation of the cavotricuspid isthmus. At the end of the procedure AF, was still inducible necessetating electrical cardioversion to restore sinus rhythm. Due to symptomatic AF recurrences a second catheter ablation was performed in June 2011. Intra-procedural mapping revealed re-conduction of all four pulmonary veins (PVs) and of the box lesion.

Figure 2. AtriCure bipolar RF Synergy clamp

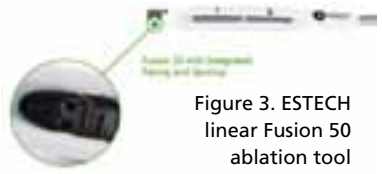


Figure 3. ESTECH linear Fusion 50 ablation tool

Therefore, PVs and the LA posterior wall were re-isolated. Subsequently, an atrial tachycardia (AT) with unstable cycle length was induced followed by extensive LA substrate modification. Finally, an AT was still inducible. Due to early recurrences of AF/AT amiodarone was re-started. After 12 months of amiodarone treatment, highly symptomatic AF/AT episodes recurred. Taking into account the complex catheter ablation procedures the decision was made to propose a thoracoscopic bilateral ablation. During that procedure, epicardial mapping revealed re-conduction of the right inferior PV, of the left PVs, and of the box lesion. The line concept consisted of epicardial PV re-isolation and completion of the box by applying bipolar RF energy using the AtriCure Synergy clamps and the ESTECH Fusion 50mm bipolar linear ablation device. Additionally, the LA appendage was resected with the use of a stapler device. The procedure was started during a sustained AT that terminated shortly after starting RF delivery at the inferior portion of the box lesion. Subsequently, no AT/AF recurred and bidirectional conduction block could be demonstrated for all lesions. The patient left the OR in stable SR.

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# Teleproctoring EACTS 2014

***Mattia Glauber***
*Fondazione Toscana G. Monasterio Massa, Italy*

Surgical telementoring was first described in the 1960s, when Dr DeBakey pioneered the field of telemedicine with the first videoconference demonstration of an open heart surgery to be transmitted overseas by satellite.

Surgical telementoring or teleproctoring today represents an advanced form of telemedicine, whereby an experienced surgeon can guide and teach practicing surgeons new operative techniques, utilizing current information technology.

Recent global focus and increasing numbers of publications on telementoring shows a growing interest from researchers on poorly-explored remote surgical mentoring techniques.

Telementoring can be considered an advanced form of telemedicine and telehealth, which is used to accomplish the dual role of educating trainee surgeons and delivering healthcare, both remotely. Over the last decade, telementoring has been proven to give effective guidance and instruction to trainee surgeons in rural hospitals. This is specially accentuated in rural areas, where the availability of surgeons with the appropriate surgical training expertise is lacking.

This is true for low-complexity surgery but principally in high complexity surgery and above all in all innovative techniques as minimally invasive cardiac surgery (MICS).

According to a recent statement from the American Heart Association, the term "minimally invasive cardiac surgery" refers to a small chest wall incision that does not include a full sternotomy that is the traditional, most used approach to the heart. Many cultural, technical and technological needs are mandatory in minimally invasive surgery (MIS), but, as patients now demand less-invasive procedures with equivalent safety, efficacy and durability, MICS is increasingly performed, and nowadays, is an alternative to the standard sternotomy. The rationale of MIS is to improve postoperative respiratory function; reduce pain and recovery; provide a cosmetically superior incision; reduce tissues dissection with expected lower blood loss; facilitate a reoperation at a later date, as the lower part of the pericardium remains closed; allow a more rapid return to functional activity with less rehabilitation resources; and a possible reduction of costs. These beneficial effects have been actually proved in elderly and in high risk patients.

Proponents and supporters of MICS are now able to comfortably perform the majority of the cardiac operations with comparable clinical outcomes. We can state that the efficacy of a surgical procedure is independent from the adoption rate. Surely, among other limitations such as costs, organization, and principally cultural reasons, the adoptability depends on the complexity. Many debates, controversies and aprioristic reluctancies raised in this field, especially focus on the general complexity and the weight of the learning curve of personnel.

Actually, minimally invasive mitral valve surgery (MIMVS), for example, is being increasingly performed. In the last few years, MIMVS has increased by 60% and it is expected that by 2016, there would be a 400% increase. But for now the total number of MIMVS procedures remains under 20%.

From our experience we can state that cardiothoracic surgery is changing due to a strong interaction between medical community and industry, and the competition between different therapeutic solutions offered by surgery, different surgical techniques and interventional percutaneous procedures.

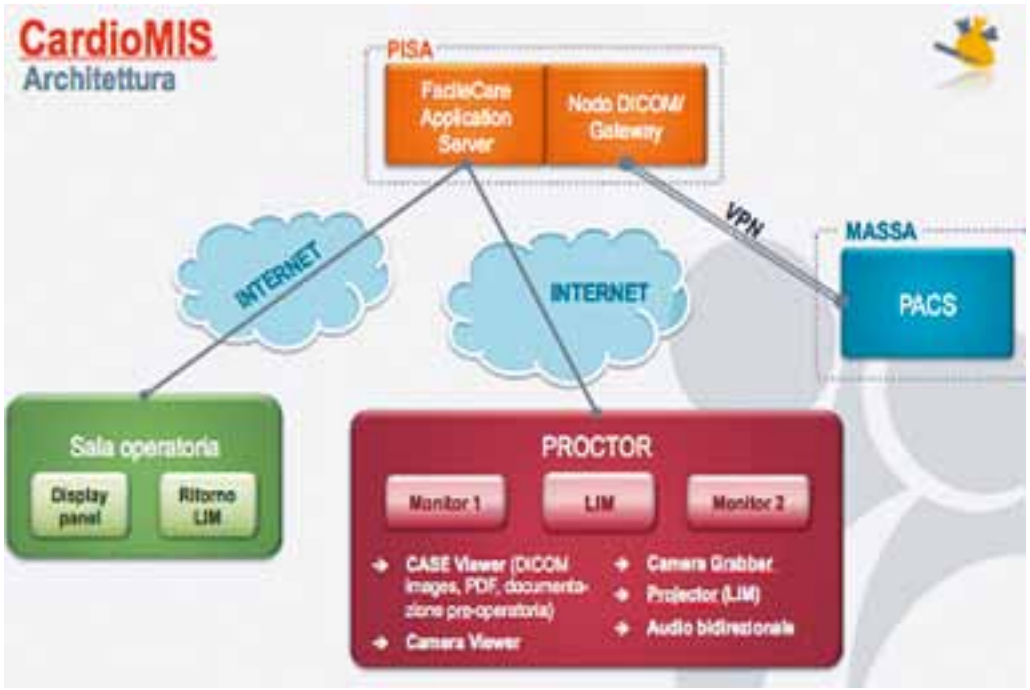
We can face the changes of our speciality only by means of improving internal and external educational programmes. One of the most important and demanding recent activities is proctoring in the field of new techniques and new medical devices.

On the basis of this background, we approached this ambitious adventure to realise a system for telementoring in MICS.

CardioMIS is a project co-founded by Regione Toscana with European funds that started in 2012 and is now in the conclusion phase.

It involves a consortium of four local ICT companies and three public research organizations. The latter are:

- **Fondazione G. Monasterio**, committed to driving requirements, consulting and testing services;
- **Scuola Superiore Sant Anna,** committed to test educational effects of the project, in the II Level Master in Minimally Invasive Heart Surgery
- **Università di Firenze**, committed to study new techniques for DICOM images transmission and elaboration




The direction of the information flow is schematically represented

Above: The 90-inch interactive dashboard and two 40-inch monitors

The project vision is mainly addressed to the transfer of knowledge from excellence centres for both educational and mentoring purposes.

### The main objectives are:

- To reduce the 'knowledge gap' between excellence centres and general hospitals
- To enhance the cost-effectiveness of MIS expansion due to the lower travelling costs of specialists and trainees involved in onsite mentoring process and even lower costs for patients transfer
- To offer the MIS clinical benefits to patients who will be obtaining consultation and supportive care from highly experienced surgical specialists, while remaining within the care of their local surgeons and hospitals

The architecture of the system is basically composed by the connection, via the internet, of the principal device – positioned in the operative room and the elements positioned in the mentor room – to a server now in Pisa, in which the hospital patient documentation is also collected by means of a virtual network.

The CardioMIS infrastructure is represented by:

- A trolley in the operating room supporting a Pan Tilt Zoom (PTZ) camera, remotely driven by the proctor
- 1 wireless audio set
- 1 monitor receiving feedback from the interactive dashboard at the Competence Centre
- 2 lines for video flows from endoscope and ultrasound machine
- 1 line for signals arriving from the Competence Centre
- 1 storing device where the whole mentoring session (audio, video, instrumental) will be stored
- A dedicated room at the competence centre with one workstation connected to internet, receiving all the flows from remote OR
- 1 90-inch Interactive dashboard
- 2 40-inch monitors
- 1 audio set for proctor
- 1 joystick to drive PTZ camera
- A software platform for video conferencing and information sharing
- Web services to connect to patient file
- Internet Connection
- The configuration of the CardioMIS with the trolley positioned in the operative theatre and the remote mentor room

### How the system works

- The local surgeon asks for support, looking at the remote Competence Centre agenda
- The proctor accepts to schedule the activity
- The proctor collects a patient folder, querying to the local system what he needs to prepare for the mentoring session (e.g. patient file and DICOM Images)
- The proctor can open the folder and view the documents, asking for more documents or for a preparatory video conference session with the surgeon
- When confirmed, a date and time are selected and the proctoring session starts
- The trolley/robot in the OR collects and syncronises the video signals from the endoscope and ultrasound devices, together with the audio signal from surgeon's headset and the PTZ camera view of the entire room
- Audio/video and instrumental signals are sent to the immersive room, where the proctor can position them in the three monitors, direct the PTZ camera to look at specific sectors, or zoom in on the operating field, also looking at DICOM images or text information from the patient folder
- The proctor uses his interactive dashboard to elaborate the signal he wants, to highlight evidence. He can suggest surgical manoeuvers or send warnings both via audio and using snapshots from the dashboard shared on a monitor positioned over the trolley, and by also talking with the surgeon in OR
- When the local surgeon ends the intervention, asks for closing session

The entire dialogue between surgeon and proctor and all the video and instrumental flows sent and received by the trolley robot can be stored in a voice and data recorder.

The project is now in the phase of system tests and validation. There is currently a review of additional steps in the evolution of CardioMIS system, principally oriented to:

1. 3D optics (3D camera, 3D endoscope) to give the proctor an augmented reality vision
2. Haptic interactions, to give the proctor a return of force specular to the surgeon's one
3. Devices replicating proctor's hands movements, to show maneuvres, movements, etc.
4. Video flows compression
5. Network infrastructure required (low bandwith)


Mattia Glauber

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**Techno-College Thoracic Disease Domain** Amber 1 & 2

# Nightmare in chest wall deformities and reconstructions

***André Hebra*** *Medical University of South Carolina, Charleston, US*

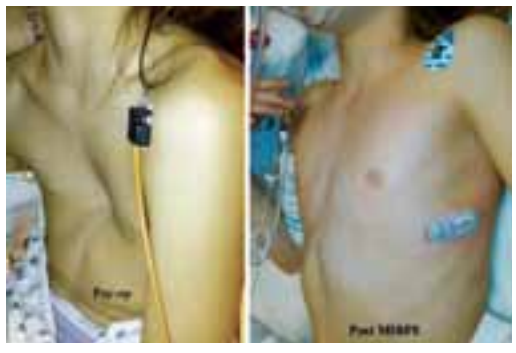
The minimally invasive repair of pectus excavatum (MIRPE), also known as the Nuss operation, has gained significant popularity since its introduction in 1998. The procedure has been universally accepted and, in many countries today, it is considered the procedure of choice for correction of pectus excavatum. Numerous reports have demonstrated its effectiveness and safety with overall excellent short and long-term outcomes. However, a few centres have reported on the occurrence of rare but significant complications and adverse outcomes related to the procedure. Serendipitous reports by many surgeons have highlighted the fact that catastrophic complications can develop. Not surprisingly, most cases with adverse outcomes have never been published.

Unpublished patient data related to life-threatening complications of pectus excavatum patients was obtained from a survey of pectus surgeons members of the international congenital chest wall interest group (CWIG). This was combined with information obtained from medico-legal cases reviewed in United States. The data was collated with a systematic review of the literature related to major complications post open and MIRPE. Major complications are considered very rare and include the following: injury to the heart & pericardium, tamponade, major vascular injury, injury to lung, injury to diaphragm, visceral injury, anesthesia related events, GI complications, and massive hemothorax.

The following is a list of published and unreported life-threatening complications post MIRPE:

- Reported in the literature (as of 2014): 19 (11 cardiac injury cases)
- Unreported life threatening complications: 32 (14 cardiac injury cases)
- Total number of cases with mortality: 9
- Major complications with bar removal: 5 (1 mortality)

Our observations revealed that major adverse events after MIRPE are rare but correlate with a significant risk of mortality (overall estimated incidence of less than 0.1%). Mortality has also been reported with pectus bar removal surgery. The majority of life-threatening complications related to MIRPE are underreported in the medical literature. Careful attention to technical details is extremely important in order to avoid the occurrence of such complications. Risk factors include the surgeon's learning curve and patients with previous chest surgery. Another important observation is the fact that major adverse outcomes and mortality have also been identified after open repair of pectus excavatum at an estimated similar incidence. Awareness by all surgeons treating patients with congenital chest wall malformations is essential in order to minimize the risk of major and potentially fatal complications.



10 year old female patient with severe pectus excavatum (pre-operative Haller index of 5.5) successfully treated with minimally invasive repair of pectus excavatum (MIRPE)

# How to do it: 3D Live in box 'beating heart' aortic arch replacement

***Malakh Shrestha, Andreas Martens and Joe Coselli***
*Hanover Medical School, Germany*

## Objective

Aortic arch replacements are a surgical and a technical challenge, involving circulatory arrest as well as organ ischaemia. Cerebral and organ protection are realized by the use of hypothermia and cerebral perfusion techniques. Cardiac protection with cardioplegia during these complex time consuming aortic arch surgery may be inadequate, resulting in post-operative myocardial insufficiency. Continuous cardiac perfusion (CCP) may limit cardiac injury during complex aortic arch repair.

## Method.

Myocardial perfusion techniques to reduce myocardial ischemia during aortic arch repair have been described for pediatric patient populations and selected adult cases but have not been employed on a routine basis during aortic arch repair in adults.

We developed a simple perfusion technique to add the continuous myocardial perfusion (CMP) method to a standard extracorporeal circulation (ECC) setup.

### Surgical technique

We have standardised the surgical technique as far as possible. After a standard median sternotomy, extra-corporeal circulation is initiated. During the time the patient is cooled to a nasopharyngeal temperature of 25 °C, the aortic root/ ascending aortic procedure or other concomitant procedures (e.g. Coronary artery bypass graft (CABG)) are performed as necessary. Blood cardioplegia has been our preferred method of myocardial protection. Cardioplegia is repeated approximately every 30 minutes.

### Establishing continuous myocardial perfusion (CMP)

After completing all cardiac procedures an aortic root cannula (7F, Medtronic, Germany, "perfusion cannula") is positioned into the ascending aortic graft or the native aorta, respectively, and is connected to the arterial ECC line. The heart is deaired, the aortic graft/ aorta is clamped distal to the perfusion cannula, and perfusion is commenced. Myocardial perfusion is performed with cooled blood from the main arterial line. A pressure monitoring line is connected to the aortic root cannula to monitor myocardial perfusion pressures. The left ventricle is meticulously vented to prevent left ventricular distension.

### Monitoring and adjusting myocardial perfusion

Myocardial perfusion pressure (MPP), myocardial flow (MPF) and temperature are continuously monitored. Myocardial perfusion pressure is maintained at 80-100mmHg.

We divided the arterial line near the ECC pump into two 3/8 inch lines via a Y connector. Silicone tubing allowed sideclamping of both lines to enable individual flow adjustments for lower body and myocardial



# Triple stage approach for treatment of chronic type B aortic dissection

***Martin Grabenwoger*** *Hospital Hietzing, Vienna, Austria*

## Background

Treatment of chronic type B aortic dissections with a dilated thoraco-abdominal aorta of more than 6cm requires one of the most complex, extensive surgical procedures in cardiovascular surgery. In most of these patients the anatomy of the dissection with the primary entry tear located at the offspring of the left subclavian artery precludes proximal aortic clamping and the use of the left heart bypass technique. Consequently, these patients have to be operated in profound hypothermic circulatory arrest. The replacement of the thoraco-abdominal aorta in deep hypothermia implies some disadvantages such as extensive operation times (cooling-rewarming), difficult hemostasis (temperature- full heparinization), lung bleeding complications and renal failure. The goal of the presented triple stage approach is to facilitate thoraco-abdominal replacement by enabling clamping of the descending aorta, thus making the use of the left heart bypass technique possible.

The elephant trunk procedure introduced by Hans Borst in 1983 was created to facilitate consecutive surgical procedures of the descending aorta using a Dacron graft. This floating prosthesis in the proximal descending aorta has the purpose to enable aortic clamping and to facilitate accomplishment of the proximal anastomosis. An advancement of this technique was the evolution of the frozen elephant trunk operation. In contrast to the "floating" trunk, which represents only a prerequisite for future operations, the 'frozen' trunk additionally provides an endovascular treatment of the proximal part of the descending aorta per se. Furthermore, due to the length of the endovascular graft consecutive operations can be commenced in the mid-portion of the descending aorta. In patients with a deep chest realization of the distal anastomosis in total arch repair can be challenging. Therefore, bringing this anastomosis from zone 3 (distal left subclavian artery) to zone 2 (between left common carotid artery and left subclavian artery) significantly reduces the risk of total arch replacement.

Based on these considerations we suggest a three-stage approach for surgical treatment of chronic type B aortic dissection.

## Operative Strategy

### Stage 1:

The first step implies the performance of a Dacron bypass (8mm diameter) from the left common carotid artery to the left subclavian artery, followed by central ligation of the left subclavian artery proximal to the offspring of the vertebral artery.

Figure 1: The Dacron prosthesis for replacement of the thoraco-abdominal aorta is directly anastomosed to the distal end of the endovascular prosthesis.

### Stage 2 (interval five days):

Aortic Arch replacement with simultaneous endovascular treatment of the true lumen of the descending aorta (frozen elephant trunk technique) is performed in moderate hypothermia (270°C) and circulatory arrest with bilateral antegrade cerebral perfusion. The distal anastomosis is conducted in zone 2 of the aortic arch, which allows easy accomplishment of the anastomosis and safe hemostasis.

### Stage 3 (interval six weeks):

Replacement of the thoraco-abdominal aorta is carried out by clamping of the endovascular prosthesis in the mid-portion of the descending aorta using the left heart bypass technique with selective visceral perfusion (300ml/min) and cold renal protection. The proximal anastomosis is directly done with the distal end of the endovascular graft (Figure 1). Prior to the operation cerebrospinal fluid drainage was placed.

The risk of thoraco-abdominal replacement in chronic type B aortic dissection may be reduced by the concept of a three-stage approach. The aim of the individual steps is to facilitate the final step of this concept, which is the replacement of the thoraco-abdominal aorta (Figure 2).

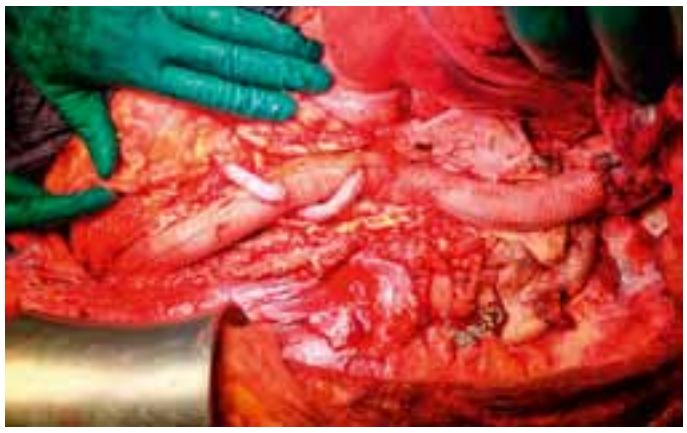


Figure 2. The aorta is replaced from the mid-portion of the descending aorta to the iliac bifurcation. The renal arteries are re-implanted with extra grafts. The proximal part of the descending aorta is treated by the endovascular prosthesis.



# Transfemoral tricuspid valve-in-valve implantation in a radio-translucent bioprosthesis

***Lenard Conradi*** *University Heart Center Hamburg, Germany*

While transcatheter aortic valve implantation (TAVI) has rapidly become routine therapy for selected high-risk patients with severe, symptomatic aortic stenosis, valve replacement options for mitral or tricuspid valves are still in early investigative stages. However, in cases of structural valve deterioration after previous surgical valve replacement, valve-in-valve (ViV) therapy offers the option of transcatheter valve implantation in all four anatomical positions.

Presently, most data has been accumulated regarding aortic ViV procedures which seem to be a viable alternative to redo surgical aortic valve replacement in selected patients. Here, small sized degenerated bioprostheses remain problematic as they are associated with elevated post-ViV transvalvular gradients and decreased one-year survival according to the Valve-in-Valve International Data (VIVID) Registry (Dvir D, JAMA 2014).

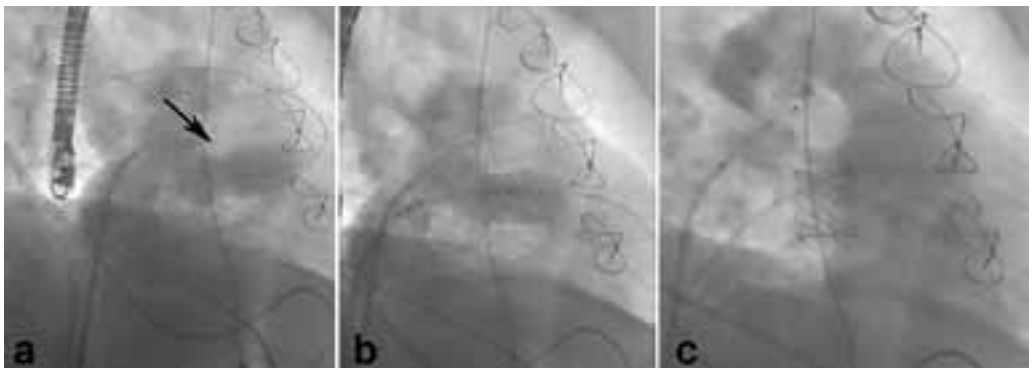



Figure 1: Transfemoral, transvenous tricuspid valve-in-valve implantation. Balloon waist formation (a, arrow) during balloon-valvuloplasty served as a reference landmark for subsequent Edwards Sapien 3 valve deployment (b). Final right ventricular angiography (c) confirmed adequate implantation height without any paravalvular leakage.

Experience with mitral or tricuspid ViV therapy is limited to case reports and small single-centre series at present. However, conceptually transcatheter mitral and tricuspid ViV or valve-in-ring procedures should prove well feasible in larger patient numbers also, especially since bioprosthetic size restrictions generally do not apply in the mitral or tricuspid position. In fact, owing to a considerable trend towards use of bioprostheses for mitral or tricuspid valve replacement a marked increase in patients presenting with structural valve deterioration can be anticipated.

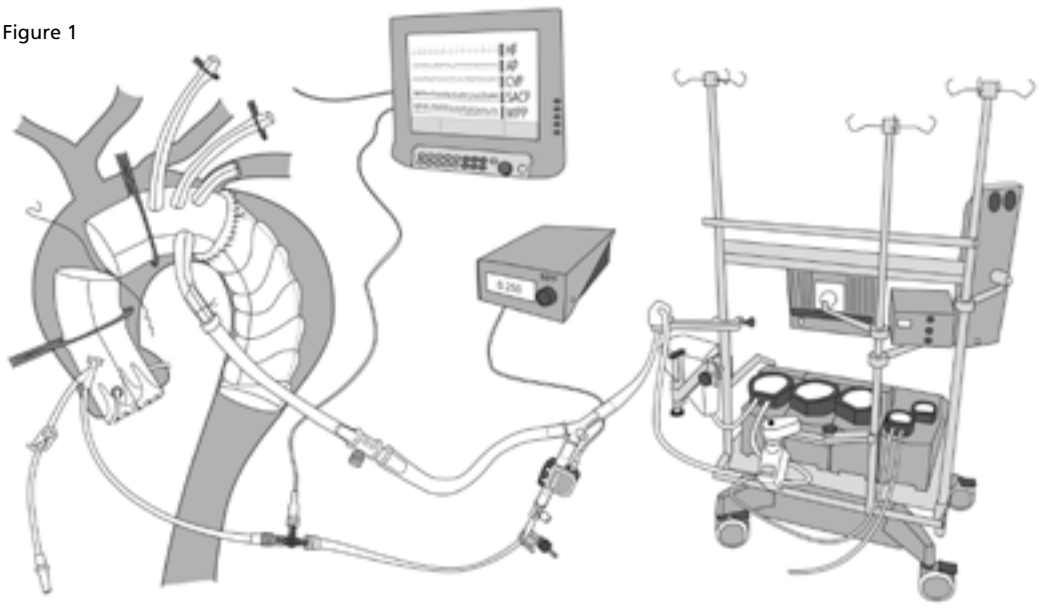
At this year´s EACTS TechnoCollege (Saturday, October 11, 13:00–15:45, Gold Room), we present a live-in-a-box video case of a tricuspid valve-in-valve implantation in a completely radio-translucent bioprosthesis. Diagnostic work-up included transthoracic and transesophageal (TEE) echocardiography revealing a combined tricuspid valve dysfunction with severe regurgitation of a degenerated 31mm Shelhigh NR900A bioprosthesis. Prosthetic valve dimensions as well as optimal c-arm angulation were calculated by reconstruction of a contrast-enhanced, ecg-gated multi-slice planning CT. The intervention was performed via a transfemoral transvenous approach using a 26mm Edwards Sapien 3 transcatheter heart valve (THV; Edwards Lifesciences, Inc., Irvince, CA, USA). Rapid ventricular pacing (RVP) was perfomed via the coronary sinus since the right ventricle was naturally not accessible. As the tricuspid bioprosthesis did not exhibit any fluoroscopic markers, pre-implant balloon valvuloplasty was performed in order to provide a fluoroscopid landing zone for THV deployement (figure 1a) which was subsequently performed under RVP via the coronary sinus (figure 1b). Final right ventricular angiography demonstrated adequate THV function without any paravalvular leakage and a transvalvular gradient of 5 / 1mmHg as measured by TEE. The patient was extubated in the hybrid OR immediately following the procedure and had an uneventful postoperative course with discharge on day 7.

This case demonstrated safety and feasibility of tricuspid ViV implantation using a latest generation balloon-expandable THV. For the future, ViV therapy can be expected to be increasingly performed in elderly patients presenting with structural valve deterioration.

perfusion. Flow through the myocardial perfusion line is monitored using an ultrasonic flow meter (Novaflow, Novalung, Heilbronn, Germany) (Figure 1). With this setup we are able to achieve a fully monitored separate perfusion system for cerebral, lower body, and myocardial perfusion that does not need additional ECC roller pumps and uses the same temperature for lower body and myocardial perfusion while SACP is kept 2-4°C lower. After reaching the desired temperature (25°C), the systemic circulation is arrested and the aorta opened.

After the aortic arch replacement is performed, the proximal end of the graft is anastomosed, either to the native ascending aorta or the ascending aortic graft.

Figure 1



## Conclusion

Continuous cardiac perfusion during complex aortic arch repair is a valuable concept to keep the myocardial ischaemia time to a minimum.

Further evaluation and larger patient cohort is warranted to establish this novel technique.

**Techno-College Acquired Cardiac Disease Domain** Gold Room

# Natural user interfaces: touchless management of information in sterile environments

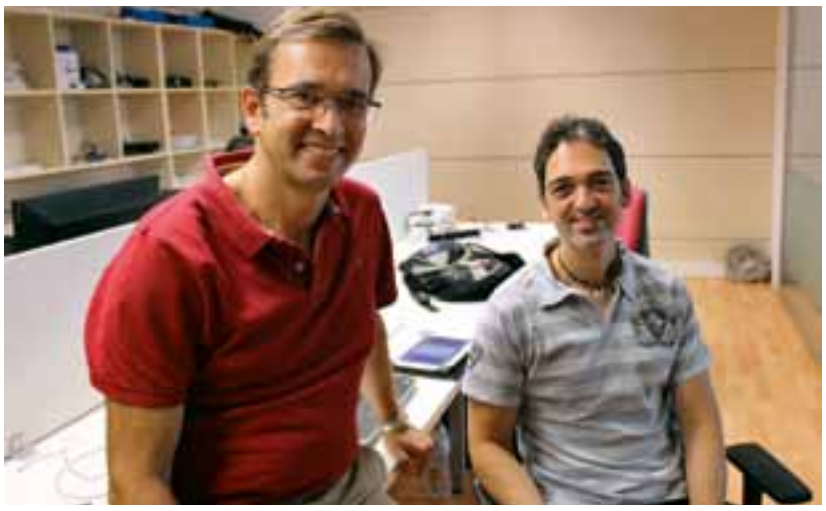
***Rafa Sadaba***
*Hospital de Navarra, Pamplona, Spain*

There are occasions in the operating room (OR), cath-lab, or hybrid room, in which the scrubbed-up operator, sometimes a surgeon, sometimes an interventionalist, needs to have access to diagnostic images obtained before the procedure or to other type of information in electronic format, for instance from medical records. When this is the case, the operator has to either unscrub or ask somebody else, who is not scrubbed, to look into the computer and obtain the information and control the images required. This is most of the times cumbersome, takes time, and the result may not be ideal. In other occasions, the scrubbed-up operator may need to manipulate imaging equipment during the procedure. Similarly, he or she needs to ask somebody else to do this. Again, this process may be complex and time consuming.

Natural user interfaces allow for touchless (either with natural gestures or voice commands) direct communication between the operator and the imaging equipment without the need of intermediaries. Thanks to TedCas (Pamplona, Spain) and its innovative "plug and play" device known as the "TedCube", it is possible to control medical equipment and imaging devices through natural gestures and voice commands.

The TedCube acts as a gateway, which recognizes predefined and customized gestures (or voice commands), processes the information, and translates it into a protocol that the computer understands. As it does not require software installation in the medical equipment, it is a perfect solution for including gesture control in the OR without further modifications in its existing equipment. Although it makes the mouse and keyboard redundant, it is fully compatible with these devices, which could be used as back-up plan.

TedCube is not only compatible with current OR equipment, but it also offers different interfaces for the gesture-voice control, in order to provide the user with the right sensor for his needs. These sensors include some of the state-of-the-art technologies such as the Microsoft Kinect (V2), the Leap Motion or the Myo bracelet.



Rafa Sadaba and Jesus Perez

The Microsoft Kinect 2.0 sensor relies upon a novel image sensor that indirectly measures the time it takes for pulses of laser light to travel from a laser projector, to a target surface, and then back to an image sensor. It's suited for specialists who need to control their computers or equipment from a distance.

The Leap Motion has a stereoscopic camera (i.e. two twin calibrated cameras), which allows simulation of the human binocular vision, and therefore gives it the ability to capture three-dimensional images. It is ideal for executing highly accurate commands, such as performing measurements.

The function of the Myo bracelet is based on electromyography which detects the electrical activity produced by skeletal muscles in the forearm. It also contains an accelerometer and a gyroscope. It is ideal for specialists who are required not to take their hands off the patient during the procedure.

Moreover, TedCas includes some other custom solutions such as eye-tracking or smart glasses compatibility.

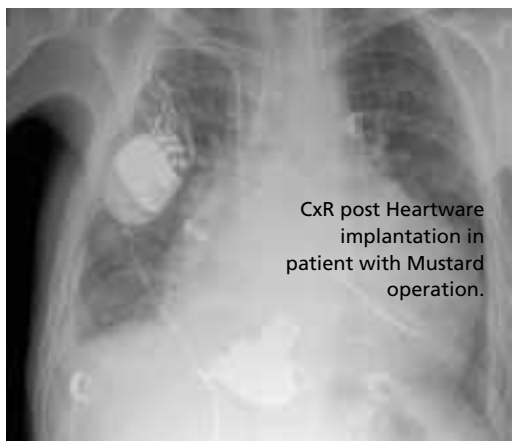
In summary, this technology which can be readily applicable in any OR, allows the operator to manage and have access to images and information during surgical or interventional procedures without the need to move away from the operating table.

**Techno-College Acquired Cardiac Disease Domain** Gold Room

# Durable ventricular assist device support in failing systemic right ventricle

***Massimo Griselli***
*Freeman Hospital, Newcastle upon Tyne, UK*

The systemic morphological right ventricle (mRV) in congenitally-corrected transposition (ccTGA) or following atrial switch (Senning or Mustard procedure) is associated with late failure as the mRV is not designed as a durable support for systemic circulation and transplantation becomes the only treatment option. Although the role of using left ventricular assist device (LVAD) to support failing left ventricle is well established, the indications and outcomes of using LVAD in systemic mRV remains unclear. The experience is largely confined to sporadic reports of successful cases and publication bias cannot be altogether ruled out.
We are describing here our complete institutional experience of using third-generation LVAD to support failing systemic-RV. Eight patients received third generation LVAD (HVAD, HeartWare International Inc., Framingham, MA) for systemic mRV failure (1 ccTGA, 7 post atrial switch). Concomitant severe sub-pulmonic ventricular failure was present in six of them. The indications of VAD were bridge to transplant (BTT) in three patients and in another five patients we made an attempt to reduce high trans-pulmonary gradient (TPG) prior to listing them for transplantation. All patients (except 1 with prosthetic tricuspid valve) had at least moderate systemic atrio-ventricular valve (AVV) regurgitation, but systemic AVV was not routinely repaired or replaced concomitantly during VAD insertion. Valve surgery was only undertaken in one patient who presented with acute post-partum decompensation and was deemed to be potentially recoverable from mechanical support. No patient had more than mild aortic regurgitation before VAD, and therefore none required concomitant aortic valve replacement. Our institutional policy would require all patients with biventricular failure needing mechanical circulatory support to receive aggressive dehydration with diuretics or combination with inotrope (most commonly Milrinone) to achieve a central venous pressure (CVP) <10mmHg prior to implantation. If necessary, further elective haemofiltration would be used (none required in this cohort). We aim to unload and optimise the sub-pulmonic ventricle to achieve mechanical circulatory support for systemic ventricle alone. LVAD support for systemic-RV alone was achieved in all patients with no early mortality (<30 days). Our results show that 3(38%) were transplanted successfully and are well at follow-up, 2(25%) died from non-cardiac cause and 3(38%) have on-going VAD. Three patients suffered from cerebrovascular events but they regained neurological recovery. Repeat catheterization in four patients showed improved TPG in three patients. Two developed de novo aortic regurgitation (one required valve replacement). In conclusion, third-generation VAD provides a durable support for systemic-RV failure, both as a bridge to transplant and strategy to reduce pulmonary vascular resistance. Although concomitant sub-pulmonic ventricular failure is common, systemic mRV support alone has been adequate in these patients.



CxR post Heartware implantation in patient with Mustard operation.

**Techno-College Acquired Cardiac Disease Domain** Gold Room

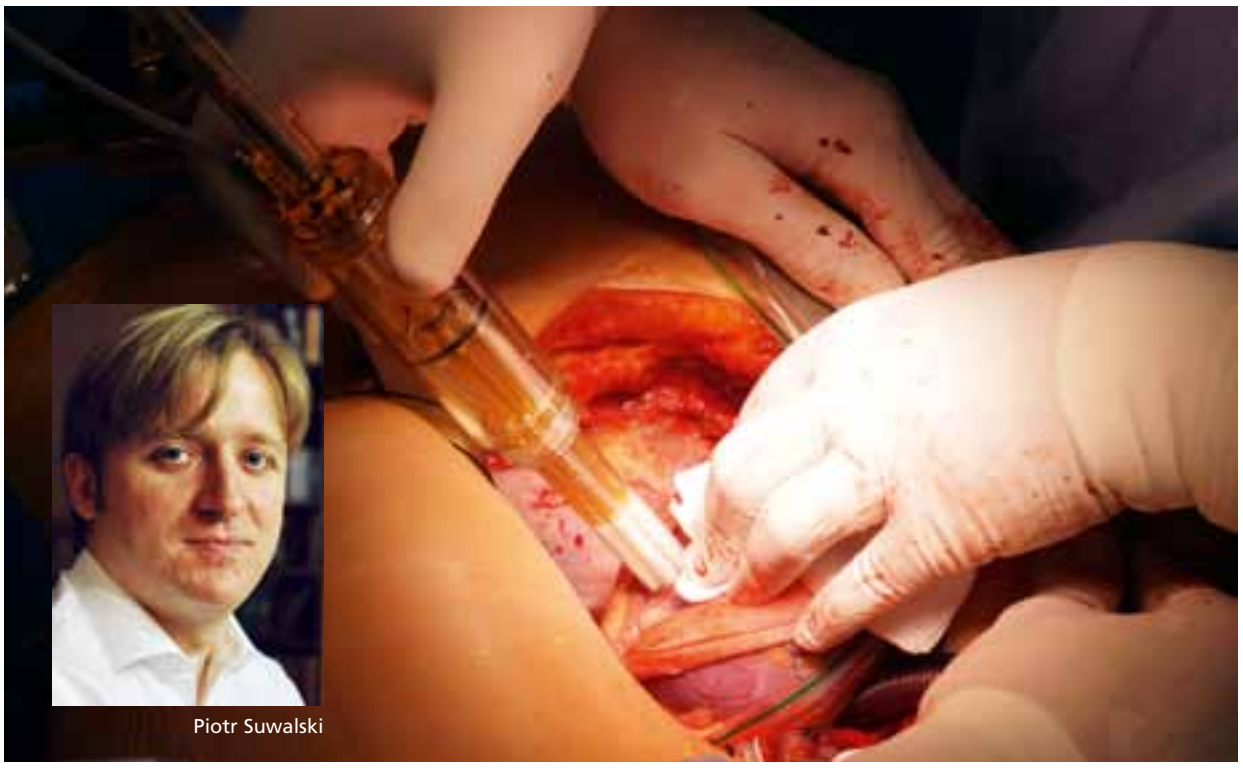
# Intramyocardial application of extracellular matrix

***Piotr Suwalski*** *Central Clinical Hospital of the Ministry of Interior, Warsaw, Poland*

Heart failure (HF) represents one of the largest unsolved medical problems today and may be the only cardiovascular disease whose prevalence and incidence are thought to be increasing. Globally, the incidence of HF is increasing with over one million new cases diagnosed annually. Current treatment options for HF are limited to pharmacological therapy, cardiac resynchronization, mechanical circulatory support devices, and heart transplant. In advanced HF, transplant offers the best opportunity for long-term survival, but is restricted to select patients and the number of donor organs is severely limited and cannot meet the growing demand. These circumstances have promoted mechanical circulatory support devices as a treatment option aimed at restoring cardiac output.

The RESTORE Study is evaluating the safety of CorMatrix ECM delivered trans-epicardially with a proprietary delivery system to patients with left ventricular ejection fraction (LVEF) 25 to 40% during coronary artery bypass grafting (CABG). The RESTORE Study is being conducted at the Central Clinical Hospital of the Ministry of Interior in Warsaw, Poland under the direction of Study Investigator Dr. Piotr Suwalski, Chief of the Department of Cardiac Surgery. The endpoints of the study include device related safety and improvement in global ventricular function. Echocardiography and MRI data will be evaluated by Yale Cardiovascular Research under the direction of Dr. Alexandra Lansky. Patients will be followed for 18 months for safety and efficacy, with interim assessments being conducted at six months and 12 months post treatment.

The CorMatrix extracellular matrix (ECM), the tissue depth measurement system, and an intra-myocardial delivery device are parts of an integrated system that enables implantation of the ECM directly into damaged cardiac tissue. Intra-myocardial delivery of the ECM to mechanically stabilize, repair and recover infarcted regions of the heart could provide myocardial recovery for these heart failure patients. The ECM is an implantable material derived from porcine small intestine submucosa (SIS) that has been shown to provide a biologically and mechanically favorable scaffold for cell incorporation, differentiation, and proliferation.



Piotr Suwalski

Extracellular matrix implantation

We treated a total of nine patients in the RESTORE Study in June and July 2014 presenting with an EF of 34.5% (28.4% to 39%) and receiving 2.7 bypasses (1 to 4). The device was delivered with 100% success. There were no device related adverse events through 90 days and there was one patient death resulting from duodenal bleeding. Patients received 47% of injections with the 3mm and 53% with the 5mm needle injectors. The average volume injected per patient was 4.0ml (2.8 to 5.6ml) in infarct areas of 35.12cm$^2$ (6.45 to 51.61cm$^2$).

Early results of the RESTORE Study demonstrated the safety and feasibility of treating patients with an LVEF of 25 to 40% during coronary artery bypass grafting (CABG). Further follow-up will be conducted to assess the efficacy of the treatment.

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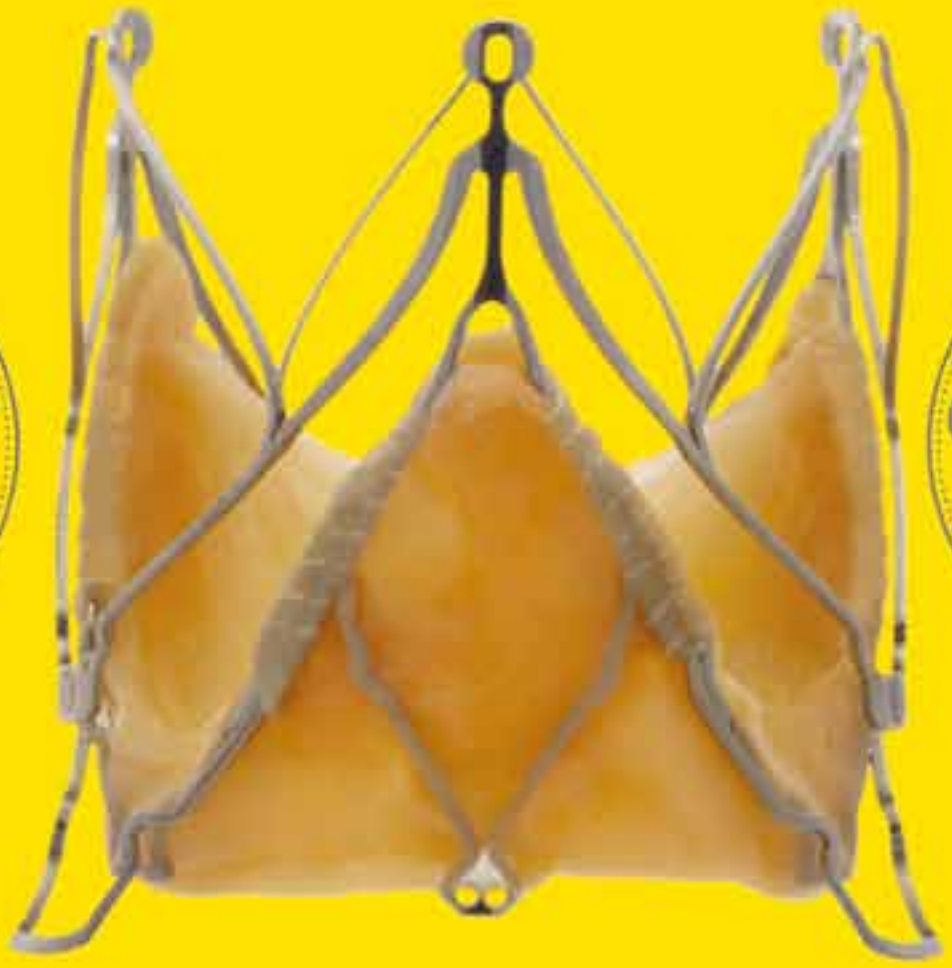

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**Techno-College Thoracic Disease Domain** Amber 1 & 2

# Operative option in the management of cleft sternum with a PSW (posterior sternal wall) with 30 years of experience

***Jose Ribas Milanez de Campos, Manoel Carlos Prieto Velhote*** *University of São Paulo, Brazil*
***Antonio Messineo***
*Pediatric Surgery Department, Florence Italy*

Since the 1850's, fascination with cleft of the manubrium has been evident because the heart and great vessels visibly beat under the skin. This produces an alternate protrusion and retraction movement upon respiration, specifically during coughing or the Valsalva manoeuver. In this challenging anomaly, the underlying mediastinal structures (heart and great vessels) may easily be injured by external trauma. In addition, it is an unpleasant cosmetic deformity and quite alarming to the young patient's family. Sternal cleft (SC) is a rare congenital anomaly, it consists of a defect, of variable degree, arising from the incomplete fusion of the sternal bars in embryonic life.

Diagnostic work-ups include computed tomography scans or MRI evaluation of the chest and abdomen, focusing on those rare but complex associated anomalies. They are quite helpful in prognosticating the extent of the lesion, and directing the appropriate surgical therapy. There is a tendency to recommend performing the surgical correction of sternal clefts in the first days or weeks of life. At this age structures are less ossified, more flexible, the size of the defect is small and easier to close. The only reason to postpone the procedure is when there are major cardiac malformations or clinic contraindication. However, in the reality of the developing countries this never happens, we almost always receive all the patients or were asked for a second opinion after months or years after the neonatal period.

In these situations, in adolescents or young adults, foreign material can be or is usually utilised as titanium bars, prolene mesh, stainless steel mesh, acrylic, silicone and Teflon associated to autologus costal cartilages or tibial periosteum. We like the possibility to work and usually make it possible to close primarily the defect utilizing only or mainly autologus tissues. (Figure 1, see top of opposite page)

In our preference the SC is accessed through a midline skin incision, the pectoralis major muscle is freed from its insertions in the sternum. With the defect completely exposed the periosteum of the sternal bars are raised antero-medially all along the "U" or "V" defect. To build a PSW, the periosteum of each bar was incised on its lateral border and elevated from its anterior and medial surfaces. Both flaps were then turned upside down and sutured together in the midline with 3–0 absorbable sutures. The bars of the sternum are approximated with three or four unabsorbable stitches close to the midline. If there is tension in the suture line, two to four chondrotomies can be made bilaterally until the base of the "U" or "V" defect, bending the upper double sternum bars together. When the sternum cannot be approximated without tension a cartilage graft, harvested from the near rib, is embedded in the middle of the defect. It can be stabilized with a small sheet of Marlex or preference for absorbable mesh. The pectoralis muscle is ressutured over the defect.

Jose Ribas Milanez de Campos

The periosteal flaps bridge confers an anatomic substract for osteogenesis allowing a neosternum remodeling. Our proposal is based on two concepts: a) the use of autogenous tissue without the use of synthetic material; b) allows approximation of the sternal bars. In some patients, the inferior fusion between the sternal bars was divided and further mobilization was carried out from both sides. Then all the perichondrial sheets after the chondrotomies were closed on both sides. (Figure 2)

We reviewed 22 of our patients from May 1979 to May 2014 in which 18 were operated with this technique, 18 females and four males, aged from 1.5 to 19 years (mean of 8.9y). Twenty had the diagnosis of SC, one associated with pectus excavatum and one had Cantrell's pentalogy.

Whether dealing with older children or young adults, the rigidity of the chest wall and the lack of new space for accommodation of the intrathoracic organs must be considered, especially when the defect is too large to be closed directly. The heart is the least tolerant organ to reduced space inside the thoracic cage. Enlargement of the thoracic cage diameter is the main reason for our decision to use the PSW, apart from the fact that in older groups approximation of the sternal bars is almost physically and anatomically impossible. Our procedure of building a PSW with periosteal flaps raised from the sternal bars, together with the chondral grafts, prepares a natural bed for new bone formation which, despite their absorption of the grafts, will provide a genuine bone to build a new sternum to protect the mediastinal structures.

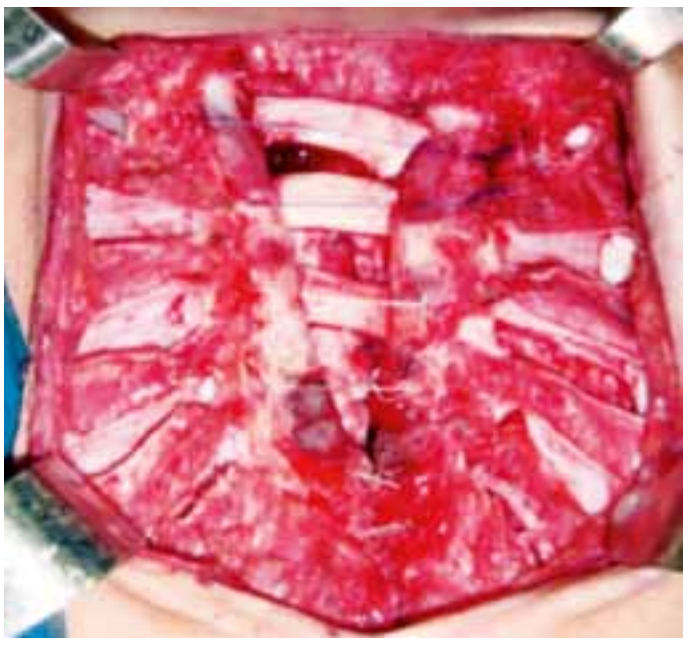


Figure 2: Surgical technique before the perichondrial sheets were closed.

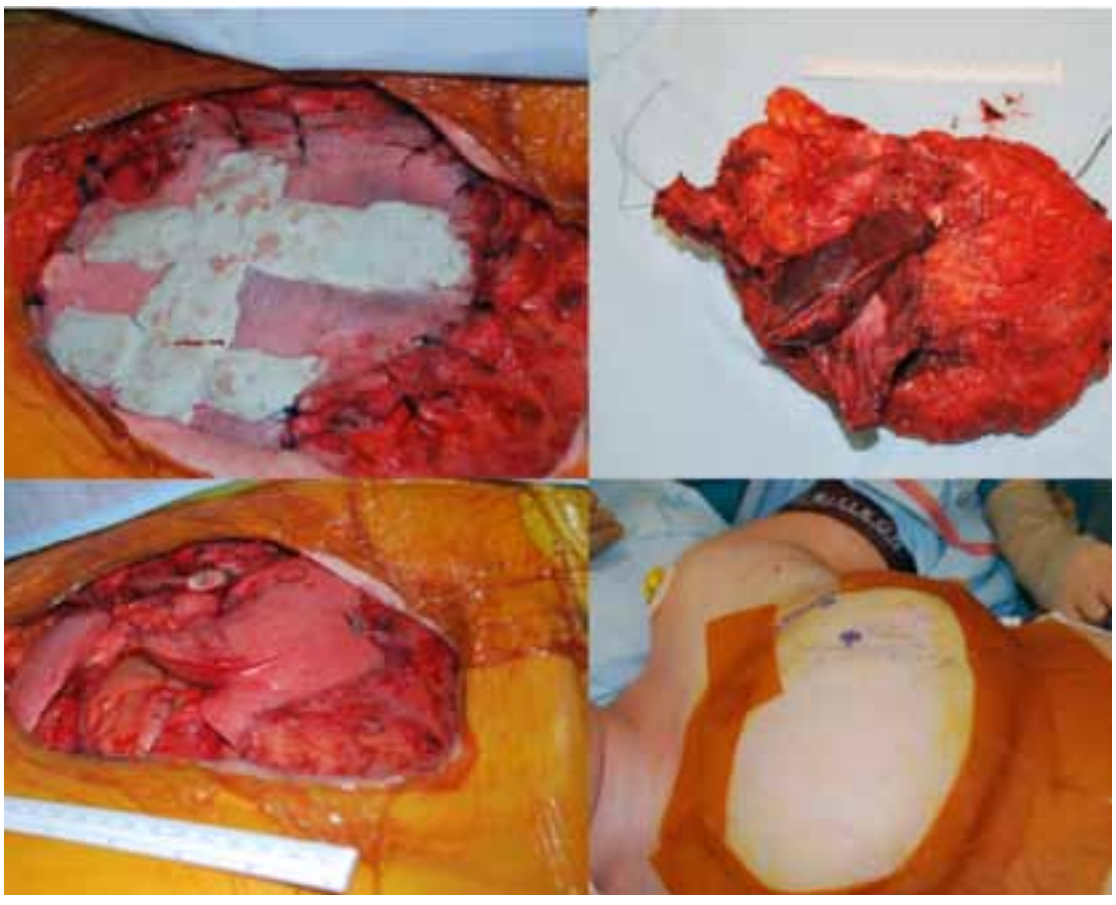
**Techno-College Thoracic Disease Domain** Amber 1 & 2

# Chest wall Resection and Reconstruction

***Maninder S Kalkat***
*Heartlands Hospital, Birmingham, UK*

The most common indications for chest wall resection include tumours (primary, invasive lung, thymic or breast cancers and metastasis), radiation induced necrosis and trauma. The primary chest wall tumours include soft tissue and bone sarcomas and are usually extensive involving various parts of bony cage, including ribs, sternum, vertebra and overlying muscles and skin. The management of such tumours involves resection of involved chest wall with wide margins. This results in large defects in the chest wall, which not only interferes with the respiratory mechanics resulting in respiratory problems, but exposes the vital structures to risk of injury. The decision to perform skeletal reconstruction with prosthetic material and further soft tissue coverage of the defect is crucial to the successful management of these lesions. In addition the reconstruction is important to achieve good cosmetic outcome.

The various prosthetic material used over the period of time has included meshes, in conjunction with or without firmer material like methylmetahcrylate cement or recently introduced titanium or steel bars. This bony reconstruction helps to maintain the stability of the chest wall. However, these prosthetic materials need to be covered with appropriate viable soft tissue. To achieve this various muscle and/or skin flaps are harvested from areas remote from the primary pathology, transferred to the chest defect and laid on the prosthetic material. At times microvascular anastomosis is performed to maintain the blood supply to the flap. The commonly used flaps include latissimus dorsi, rectus abdominis, pectoralis major and serratus anterior muscle. In view of complexity associated with harvesting these flaps, the onco-plastic surgeons are usually involved with the conduct of the operation.


Caption

The patients afflicted with these tumours not only have poor survival if left untreated, but suffer significant pain and discomfort. Because these tumours usually grow to large size they can interfere with sitting and lying down. These tumours usually do not respond to other treatment modalities like radiotherapy and chemotherapy and hence surgical resection remains the only hope for the patients. The success of the resection depends on wide resection with clear margins and avoidance of respiratory complications. With complete resections patients have good outcome with long-term survival and improved quality of life.

**Further reading:**

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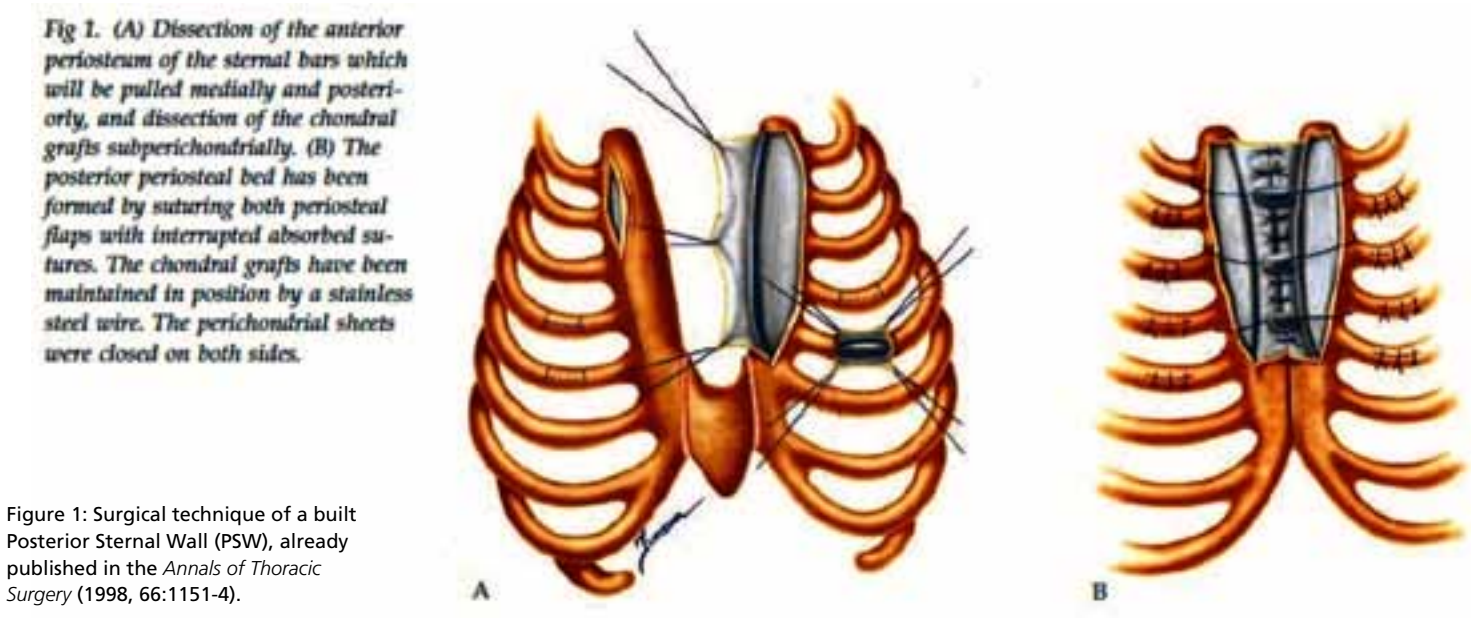



*Fig 1. (A) Dissection of the anterior periosteum of the sternal bars which will be pulled medially and posteriorly, and dissection of the chondral grafts subperichondrially. (B) The posterior periosteal bed has been formed by suturing both periosteal flaps with interrupted absorbed sutures. The chondral grafts have been maintained in position by a stainless steel wire. The perichondrial sheets were closed on both sides.*

Figure 1: Surgical technique of a built Posterior Sternal Wall (PSW), already published in the *Annals of Thoracic Surgery* (1998, 66:1151-4).



SORIN GROUP

# Improving patient outcomes with a Goal

Patient outcomes are the clinicians' main goal and, in cardiac surgery, they are influenced by several factors: surgery, anesthesia and perfusion management all play a significant role.

The extra-corporeal circulation is a significant contributor and specific strategies can be introduced to make it as effective and controlled as possible.

The choice of the heart-lung machine, designing the extracorporeal circuit, selecting the right oxygenator, using a perfusion electronic medical record and, more important, using dedicated strategies to provide an adequate perfusion, all contribute to patient outcomes.

Goal-Directed Perfusion is one of these strategies, with the main goal of guaranteeing an adequate oxygen delivery to the patient by keeping it above threshold levels. In the literature this has been associated with a reduction of post-operative Acute Kidney Injury (AKI) occurrence and with a shortening of the hospital and ICU length of stay (LOS)1.

To ensure that the patient receives enough oxygen to adequately perfuse all the organs, the perfusionist has two alternatives: managing arterial flow or hematocrit. More specifically: limiting hemodilution to raise the hematocrit, and increasing the pump flow to compensate for a low hematocrit are the more effective actions.

The choice of an oxygenator which minimizes impact on hemodilution is crucial to maintain a higher hematocrit, thus facilitating remaining above the oxygen delivery threshold. It is also important to closely monitor the variations in oxygen delivery and consumption, and carbon dioxide production, directly related to the patient's metabolism, by using a perfusion management system.

The Sorin HeartLink system, consisting of INSPIRE, the new Sorin adult oxygenators, CONNECT, the new perfusion management system, S5 HLM and the XTRA autotransfusion system, offer all these functionalities:

- INSPIRE has a low dynamic operating volume (DOV), and is proven to help maintain a high hematocrit along the case;
- CONNECT allows to trend and record all the relevant parameters and includes a key functionality, to facilitate the implementation of a Goal-Directed Perfusion strategy. It is called GDP™ MONITOR, and monitors all the parameters related to the metabolism of the patient in real time. Continuously monitoring the value of oxygen delivery, by adapting pump flow or hematocrit management, is the easiest and more effective way to ensure the oxygen delivery goal is reached.

When the parameter to be corrected is hematocrit, Goal-Directed Perfusion also is a valuable addition to make the red blood cell transfusion decisions more effective, by suggesting a transfusion trigger that takes oxygen and carbon dioxide exchange parameters into account, rather than only on hemoglobin. Transfusions can then be performed only when they are really more likely to be effective in increasing oxygen delivery and venous saturation.

When RBC transfusion is needed to increase oxygen delivery, then the Xtra autotransfusion system offers a valuable alternative to homologous transfusion in addition to a potential cost saving.

AKI and LOS reduction are just two of the benefits offered by HeartLink system in terms of patient outcomes. Find out more at Sorin booth #112.

**1** O2 DELIVERY AND CO2 PRODUCTION DURING CARDIOPULMONARY BYPASS AS DETERMINANTS OF ACUTE KIDNEY INJURY: TIME FOR A GOAL-DIRECTED PERFUSION MANAGEMENT?, De Somer F,Mulholland JW, Bryan MR, Aloisio T, Van Nooten GJ, Ranucci M., Crit Care. 2011 Aug 10;15(4):R192.

**Techno-College Thoracic Disease Domain** Amber 1 & 2

# The vacuum bell experience for pectus excavatum

***Sergio B Sesia, Frank-Martin Haecker*** *University Children's Hospital of Basel (UKBB), Switzerland*

Sergio Sesia

In the 19th century, the treatment of pectus excavatum (PE) was purely conservative and limited to "fresh air, breathing exercises, aerobics activities, and lateral pressure". With the development of thoracic surgery at the beginning of the 20th century, the surgical correction of PE, popularized by Ravitch during 50 years and modified subsequently, consisted of long skin incision, costal cartilage resection and sternal osteotomy. Even very young children were operated. Probably due to the extensive cartilage resection, some patients developed an acquired asphyxiating chondrodystrophy. Thus, the time point of surgery was shifted to after the puberty and the surgery became less radical. In 1998, Nuss et al. published their 10-year experience with the minimally invasive repair of PE (MIRPE), avoiding cartilage resection and sternal osteotomy and requiring only small skin incisions. This procedure became very popular all over the world. However, knowing that PE may worsen during puberty when untreated, what could be offered to patients who are afraid of the well-known risks of MIRPE, who are reluctant about the post-operative pain or an unsatisfactory cosmetic outcome, or who refuse surgery? One alternative to surgery represents the vacuum bell of Klobe (VB), first described by Lange in 1906, that elevates the sternum by rotation of the sterno-costal joints. Three different sizes (16cm, 19cm and 26cm in diameter) of the VB and one female model exist. An application twice per day 30 minutes each is recommended. Minor side effects may include hematoma, petechial bleeding, back pain and temporary paresthesia of the upper extremities. The VB is contra-indicated in case of vasculopathy (e.g. Marfan syndrome, aneurysm), coagulopathy, and skeletal disorder (e.g. osteogenesis imperfect). To exclude those conditions, a physical examination and an echocardiography before starting the VB therapy are performed. On first presentation, the depth of PE and the required pressure to correct the PE are measured. The chest wall is photographed. After a short instruction how to apply the VB, the patients have follow-up at 3 month intervals. All patients are recommended to do physiotherapy, to improve body control and posture, an important factor in outcome.

The length of treatment depends on patient's age, the depth of PE, and the compliance of the patient. In general, the younger the patient, the higher is the chest flexibility and the shorter is the treatment duration. In a cohort study of 109 patients, 56% successfully terminated the therapy (median follow-up 27.6 months, range 0-73), 21% are still under treatment and 23% dropped out of the treatment (decreasing compliance, unsatisfied result).

The indications to use the VB are manifold: preoperatively before MIRPE in order to increase the chest flexibility, intraoperatively during MIRPE in order to facilitate the advancement of the introducer and the bar flipping, and postoperatively after bar removal in case of unsatisfactory result.

In carefully selected patients with flexible chest and symmetric PE, the VB may replace the surgery.

A multi-centre study regarding the long-term efficacy of the VB is currently planned.

***All images © UKBB***

Different types of vacuum bell, on the right the female model

VB application

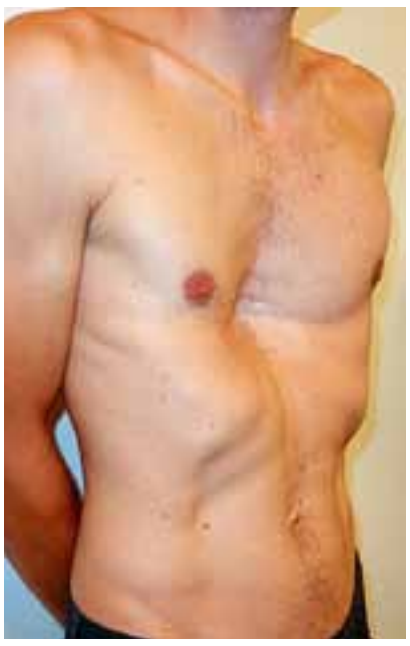
**Techno-College Thoracic Disease Domain** Amber 1 & 2

# Technical modifications of the Nuss procedure

***Hans Pilegaard***
*Aarhus University Hospital, Denmark*

Pectus excavatum (PE) was first described in 1594 by Bauhinus. The modern era of correction started in 1949 where Ravitch published a paper about resections of the cartilages for correction. Since were several modifications evolved and published, but many surgeons omitted to use the operation because it was considered to be a difficult one to use. In 1998 D. Nuss published the first paper of minimal invasive correction, which now in most surgeons hands, who correct PE has been the preferred technique. This technique was very soon modified by using shorter bars to get a more stable system[1, 2]. The presentation will go through the technique using a short bar and highlight the important steps to get a safe, stable and cosmetic good correction. The technique was previously only thought to be used in children and teenagers but with the growing experience it has been shown that it might even be used in adults and 'old adults'[3, 4]. The patients then often need more than one bar.

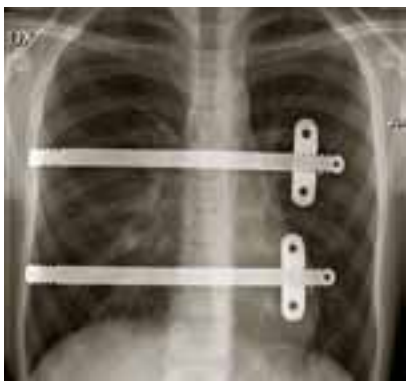
Hans Pilegaard



Pectus excavatum

Previously the correction was thought only to be of cosmetic importance but new knowledge has shown that it also improve the cardiac performance[5], and normalize the chest wall motion[6].

In experienced hands, mean operation time is around 30 minutes. The postoperative hospital stay is around three days and the patients may afterwards resume their physical activity only avoiding really heavy contact sport such as icehockey, American football and self defence sports.



Pectus bars

Complications such as bleeding, infection, pneumothorax[7], and bar displacement are few and can easily be managed in a hospital setting.

The recreation time after surgery is one to two weeks for patients with non physical work and it may be up to 12 weeks for craftsmen.

The bar(s) should stay for three years and may then be removed as an outpatient procedure[8]

The recurrence rate is very low, less than 2% and more than 95% obtain a good cosmetic result[9]

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**Techno-College Thoracic Disease Domain** Amber 1 & 2

# Experimenting new materials in how to treat pectus excavatum

***Antonio Messineo*** *University of Florence, Italy*

Pectus excavatum (PE) is the most common anterior chest wall deformity (1:300) leading to cosmetic and, in severe cases, cardiovascular problems. In the past, the surgical approach entailed a wide incision, abnormal cartilages removal followed by sternal elevation and stabilization. In 1998, Nuss described an innovative mininvasive repair of PE (MIRPE) based on the concept of internal bracing: a curved metal bar is inserted through two lateral chest incisions under thoracoscopic view, avoiding cartilage resection. This approach was designed to improve both functional and cosmetic outcomes in comparison with the previous repair.

In the last decade, the Nuss procedure has been worldwide popularized: considering only three Centers (Norfolk-USA, Seoul-South Korea, and Aarhus-Denmark), more than 4000 MIRPE procedures (with different variations) have been performed.

However, we have to consider that this operation is still far from being ideal.

The first limit of MIRPE is that the technique is applied to patients with different types of PE (i.e. with symmetric or asymmetric forms, severe or moderate defects, more o less flexibility of chest wall, etc). Such differences should require that data concerning forces at work when the bar is inserted should be well known, but this is not the case and therefore bars are empirically curved and kept in place for a predetermined period of time (three years).

Another important issue arises from leaving a stainless steel implant in the chest: during the implant period, there is evidence of metallic ion diffusion, which may have an impact on health, (i.e. metallic ions allergy, systemic toxicity), being most of the treated patients adolescents with a long life expectancy. Moreover, long-term stainless steel implants determine an important interaction between biological tissues and metal device: this often results in an excessive fibrotic reaction. For these reasons the treatment should be limited to the time necessary to achieve a stable correction of the defect.

To overcome all these issues, at the Meyer Children Hospital in Florence, we have been studying, thanks to a fruitful collaboration with the BioRobotics Institute at Scuola Superiore Sant'Anna of Pisa, the possibility to develop new bar models.

In particular our study was finalized to study two new bars models, a first with sensors (to quantify forces intensity on the chest wall and time of their action) and a second using a composite metal/polymer material.

**Techno-College Thoracic Disease Domain** Amber 1 & 2

# The management of complex infections of the sternum

***Maria Pia Tocco*** *Filippo Neri Hospital, Rome, Italy*

The deep infection of the sternal wound is one of the most serious complications which can occur following open-heart surgery.

Among the several factors responsible for the deep sternal wound infection (DSWI), the most important one is the sternal ischemia due to mammary artery harvesting for coronary bypass grafting. This aspect plays a very important role in the pathogenesis of the infection and can be responsible for the failure of treatments.

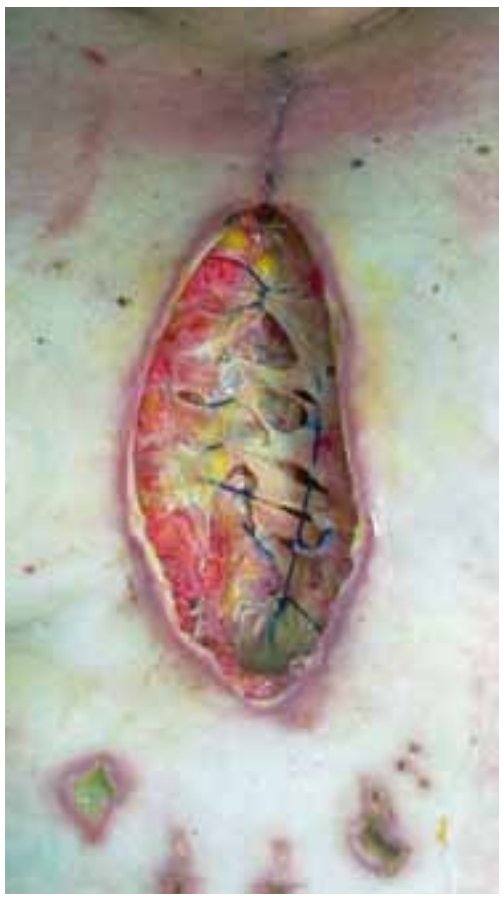
The use of Vacuum Assisted Closure (VAC) is definitely the most useful technique to clean the entire wound following the surgical debridement, provided the sponge is positioned between the sternal edges, after removing all the steel wires and following the debridement of the ischemic sternum. The advantage of the VAC treatment is the application of a continuous negative pressure thus causing perfect wound drainage and arteriolar dilatation; this allows a decrease of bacteria levels and a faster tissue granulation.

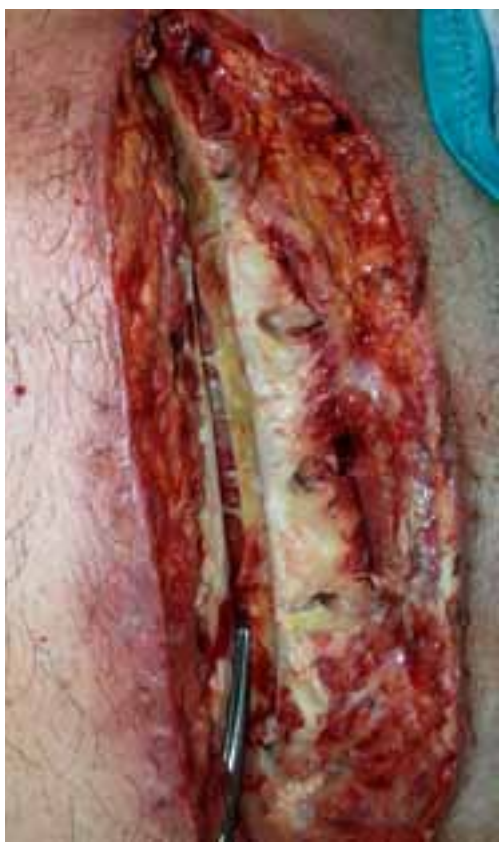
Maria Pia Tocco

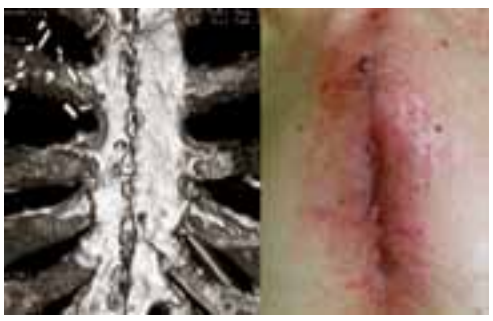
Furthermore, wound depth reduction following the use of the VAC, allows the use of the pectoralis major muscles without the need to harvest other flaps such as the rectus abdominis or the greater omentum. Once bacteria eradication has been reached, the use of the major pectoralis flaps to close the chest remains one of the safest technique when the sternum is in bad condition due to surgical debridement. It is, however, important that every empty space is filled by the muscles to avoid potential relapses of the wound dehiscences.

The only criteria for choosing the type of sternal closure technique is the condition of the sternum.

If the bone is in good condition, the Nitinol clips are a good solution for closing the sternum as these are not invasive; in fact, in order to insert the clips it is not necessary to free the posterior face of the sternum from the mediastinal structures.







The incomplete eradication of the bacteria from the spongiosa of the sternum can be responsible of a chronic infection of the bone which is the chronic sterno-cutaneous fistula.

It can be single or multiple, situated in the midline, along the post-sternotomy scar. The images of a 3-D CT-scan reconstruction, which is performed in all the patients presenting fistulas, show the presence of osteolysis along the line of the sternotomy, in correspondence of the fistula. These findings suggest that the chronic fistulas are due to sternal osteomyelitis and it could be a relapse of a previous low virulence and a long-standing wound infection caused probably by a nidus of bacteria within the spongy bone and not a primary infection of the steel wires. In fact, the steel wires are most probably involved in the infection only at a second time rather than being the direct cause of the primary infection itself.

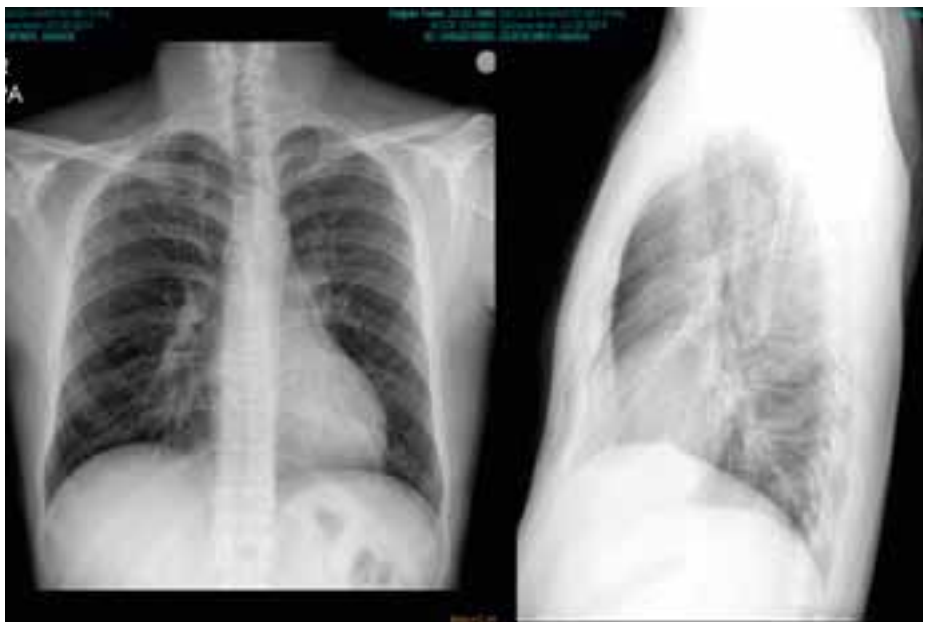
In conclusion, wound debridement, removal of all foreign materials and complete eradication of the bacteria are essential steps to achieve a good result after flaps sternal reconstruction or if any other technique of wound sternal closure is used.

**Techno-College Thoracic Disease Domain** Amber 1 & 2

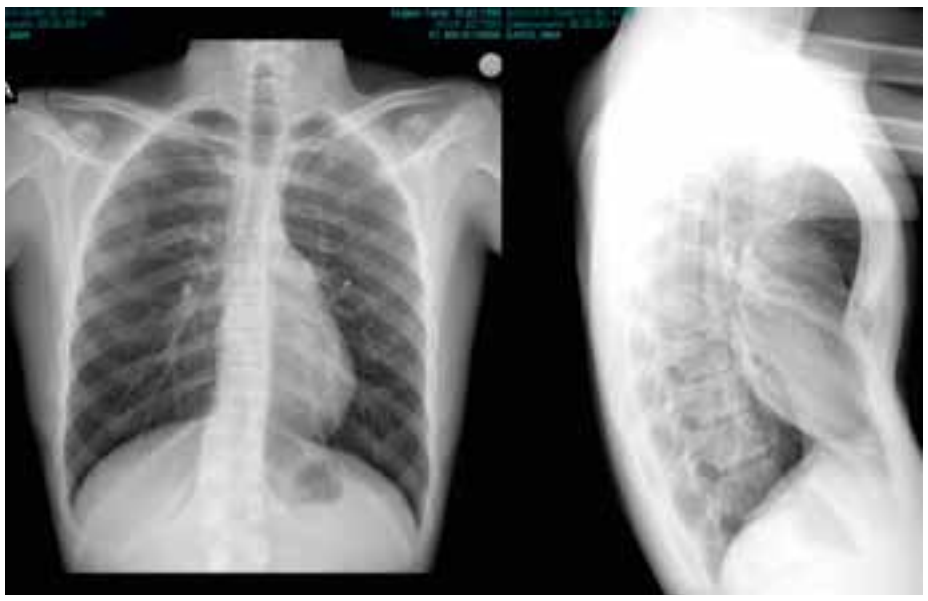
# Chest wall deformities, trauma and tumors

***Mustapha Yuksel***
*Marmara University Faculty of Medicine, Istanbul, Turkey*

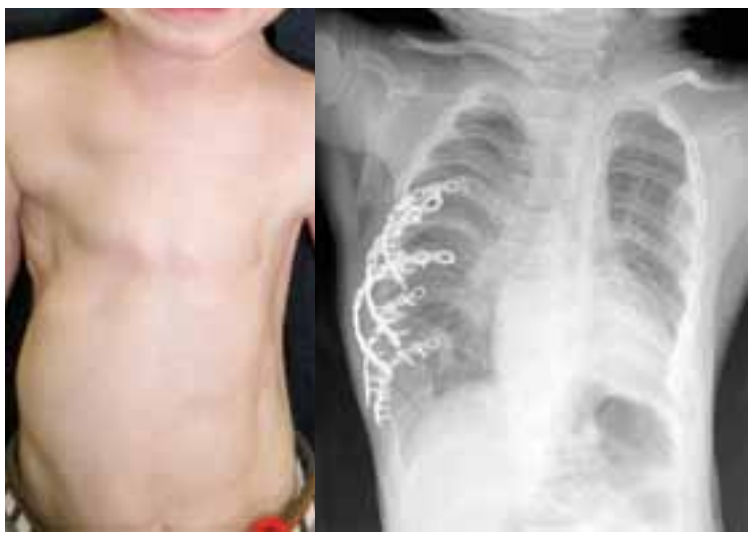
Techno-College of the Thoracic Domain will take place on Saturday, 11 October 2014. This year's main topic is 'Chest Wall Deformities, Trauma and Tumors'. Live surgical procedures will be transmitted from the Marmara University Hospital in Istanbul, Turkey. The scheduled cases for this occasion are as follows:



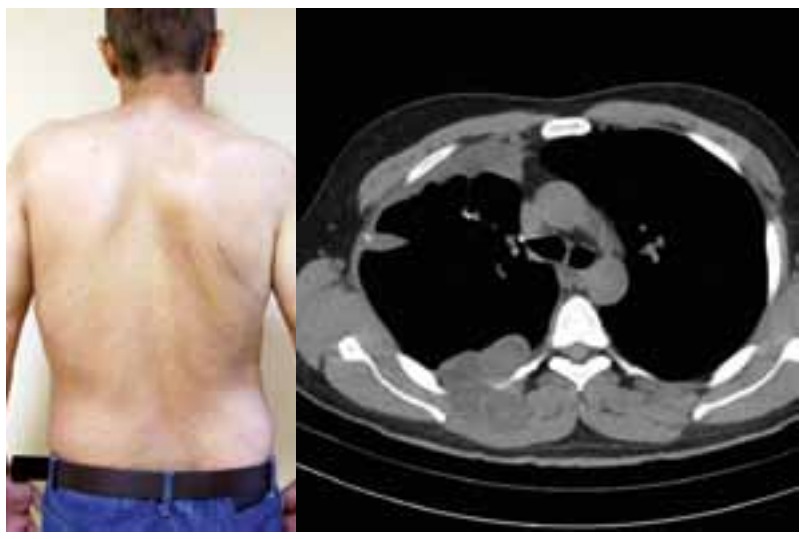
1. HG is a 26-year-old male with a symmetric pectus excavatum (PE) deformity. Minimally invasive repair of PE (Nuss Procedure) using one or two bars is planned to correct this.



2. MB is an 18-year-old male with a pectus arquatum (PA) deformity. Open surgical repair is planned to correct this.



3. AC is a four-year-old male with Jeune Syndrome. Augmentation procedure on the left hemithorax (operated on the right a year ago) is planned.



4. HA is a 43-year-old male with a tumor (metastatic leiomyosarcoma) on the right posterior chest wall. Chest wall resection and resonstruction is planned.

**Techno-College Congenital Disease Domain** Amber 5

# Transcatheter interventions for right ventricular outflow tract and pulmonary arteries

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***Mario Carminati*** *Policlinico San Donato IRCCS, Milan, Italy*

Transcatheter treatment of pulmonary branches stenosis is well recognized and widely spread. Stents implantation is the first choice procedure in the majority of cases with pulmonary arteries stenosis following surgical repair of a variety of cono-truncal malformations, as Tetralogy of Fallot, Pulmonary Atresia and Ventricular septal defect, Truncus Arteriosus, Complex Transpositions.

In a minority of particularly complex cases, usually in infancy, stent implantation in pulmonary arteries can be performed by means of cooperation of cardiologist and surgeon in a hybrid setting. Rare cases of "resistant" pulmonary branches stenosis/hypoplasia the use of cutting balloons is an additional option, possibly followed by stent.

Transcatheter pulmonary valve implantation, was originally used for the treatment of dysfuntioning right ventricle to pulmonary artery conduits (homografts, contegra or other biological conduits) by implanting the "Melody"(Medtronic) consisting in a tract of bovine jugular vein valve sutured on a CP stent, crimped on a balloon and reexpanded in the right ventricular outflow tract position. More than 6, 000 cases have been performer worldwide with a success rate of 95% and limited number of complications. More recently the "Sapien" (Edwards) valve, originally created for the aortic valve replacement, has been implanted in pulmonary position with satisfactory results. Transcatheter pulmonary valve implantation is also possible in selected patients with "native" right ventricular ouflow tracts, if the anatomy allows a safe and stable stent implantation. The cases with very large right ventricular out flow and severe pulmonary regurgitation are still surgical candidates; however development of dedicated devices (large self expandable stents with valve inside) are under way.

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# Creation of a pulmonary valve and valved conduit

## Multi-centre study of fan-shaped ePTFE valve and ePTFE conduit with bulging sinuses in Japan

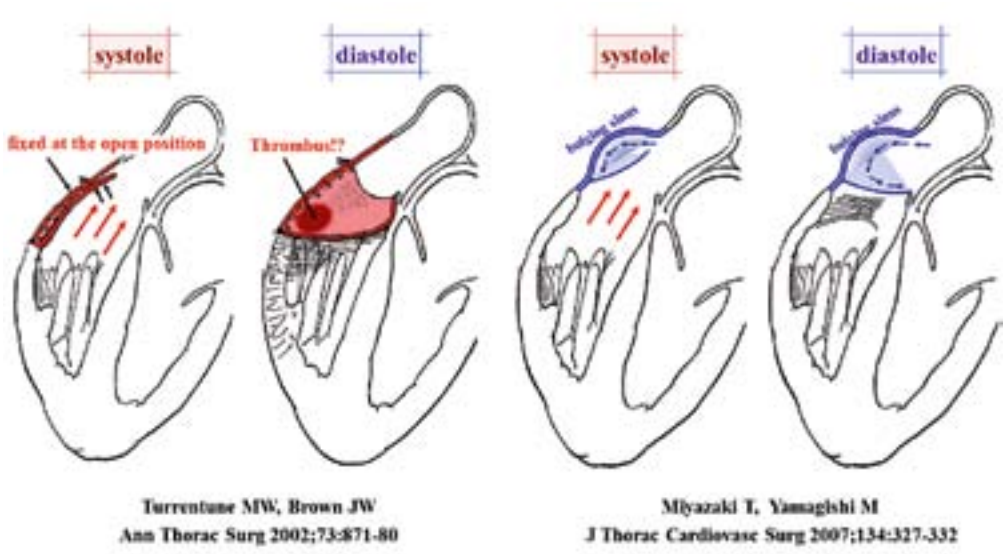


Figure 1: Fan shaped ePTFE (Gore-Tex) membrane valve


Figure 2: Fan-shaped ePTFE Valve & ePTFE Conduit with Bulging Sinuses

***Shunji Sano[1], Masaaki Yamagishi[2] and Takako Miyazaki[2]*** *1 Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Science; 2 Kyoto Prefectural University of Medicine*

There are various techniques and materials to reconstruct right ventricular outflow tract (RVOT), however, ideal technique and material are not found yet. Long-term availability and durability of commercially available materials in pulmonary position are unsatisfactory or unknown.

Homograft is not commercially available in Japan and bovine jugular vein graft (Contegra) were accepted in 2013.

Therefore, either hand-made ePTFE (Gore-Tex) membrane monocusp valve or valved conduit have been most commonly used in Japan.

Recently, we have developed a fan-shaped Gore-Tex membrane valve.

Its design concept is based on the configuration of the natural semilunar valve.

Compare to other Gore-Tex valve, Our valve is positioned at the natural pulmonary annulus (Figure 1). The hydrodynamic vortex flow along the inner surface of bulging sinus may improve the closing motion of the Gore-Tex valve and flush away stagnating blood in the bulging sinus.

New ePTFE conduit with bulging sinuses (non cut-open type) has been used since 2010 (Figure 2).

A total of 794 patients underwent RVOT reconstruction using fan-shaped ePTFE valves either ePTFE valved conduits or patches with bulging sinuses in 52 Japanese institutions. 325 patients required valved conduits and 469 patients required patches.

Mean follow-up timewas 4.7 years with longest follow-up period of 10.0 years.

Freedom from reoperation was 100% at five years and 95.3% at 10 years for the patients with conduits. For the patients with patches, freedom from reoperation was 99% at five years and 93% at 10 years (Figure 3).

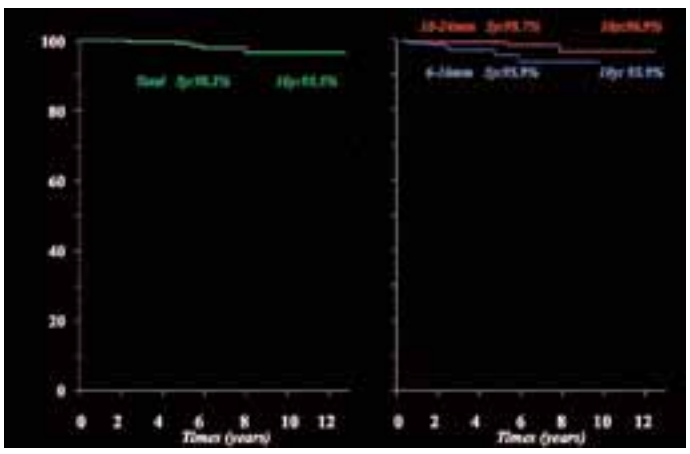


Figure 3: Freedom from reRVOTR (patch)

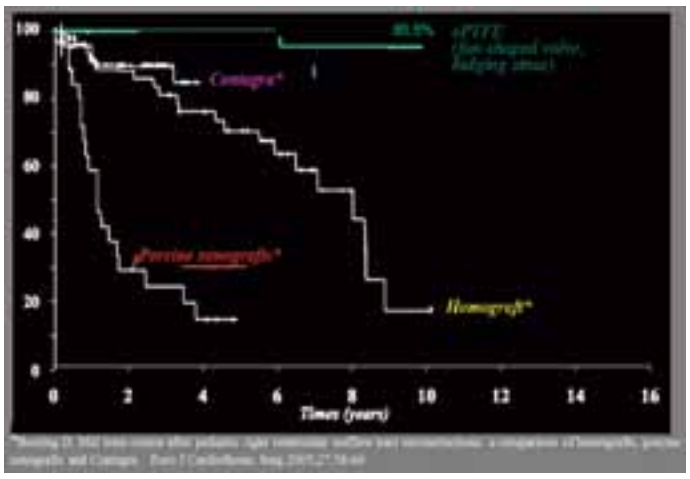


Figure 4: Freedom from Reoperation: Compare to other conduits

This figure shows the freedom from reoperation compared with other conduits and it is obvious that ePTFE valved conduits demonstrated excellent midterm results (Figure 4.)

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# Development of a single endovascular device for aortic valve replacement and ascending aortic repair

***Bartosz Rylski*** *Hospital of the University of Pennsylvania, Philadelphia, USA; Heart Centre Freiburg University, Freiburg, Germany*

Currently, no established endovascular treatment is available for high-risk patients with aortic valve disease and concomitant ascending aneurysm. Transcatheter aortic valve implantation (TAVI) without therapeutic intervention on the dilated aorta may lead to catastrophic lethal complications such as aortic dissection or rupture. Therefore, high-risk patients are usually denied TAVI and undergo open surgery or continue medical treatment only.

Last year we presented design of a single device for minimal invasive treatment of both aortic valve and ascending aortic disease. Shortly, this device enables a novel one-stage endovascular Wheat procedure: aortic valve and ascending aortic replacement with preservation of the sinus of Valsalva and free diastolic blood flow to the coronary arteries. The novel composite prosthesis comprised aortic valve prosthesis coupled to the stent graft with proximal uncovered and distal covered graft portion (Figure 1). Design of this device is based on the following 5 integrated concepts published recently in J Card Surg 2014 (Rylski et al, Development of a single endovascular device for aortic valve replacement and ascending aortic repair):

1. **Individualization** – size of both device components, the prosthetic aortic valve and the tubular graft, are individually defined according to imaging studies
2. **Frame-to-frame connection** – the prosthetic aortic valve and the tubular graft are coupled to each other in the operating room using clips or single sutures
3. **Free diastolic coronary blood flow** – the tubular graft in the proximal portion is uncovered to facilitate the free diastolic coronary perfusion
4. **Three landing regions** – the aortic annulus, the sinotubular junction and the distal ascending aorta
5. **Single-stage implantation** – the endovascular composite valved graft can be implanted from a central or peripheral location (transapical or transfemoral route) in a single stage procedure.

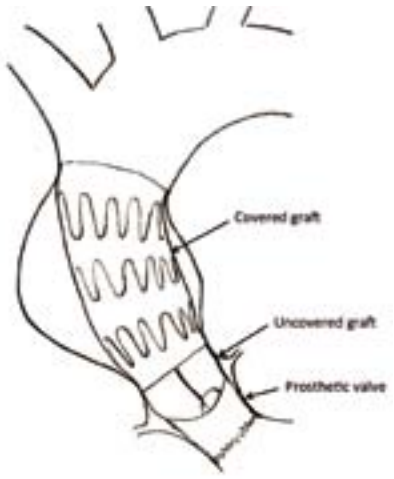


Figure 1. Single device for transcatheter aortic valve replacement and ascending aortic repair.

The first CT-feasibility study determining the post-stenotic proximal aortic anatomy in relation to the device design has been conducted according to the population of 1,196 patients with severe aortic stenosis screened for TAVI at The Hospital of the University of Pennsylvania in Philadelphia between 2007 and 2013 and published in above-mentioned report. In this manuscript we concluded that developing a single unit endovascular Wheat procedure device is a question of time. This device will extend the application of transcatheter techniques to patients denied TAVI due to a concomitant ascending aneurysm. The short distance between coronary artery ostia and the sinotubular junction will be most challenging in the designing process of this single unit endovascular composite valved graft. We strongly believe that endovascular treatment of ascending aortic aneurysm can be safely performed only using presented endovascular composite valved graft, since the Achilles tendon of endovascular approach to the ascending aorta, namely lack of appropriate proximal landing zone, can be solved only placing the prosthesis in the aortic annulus given the stability of the frame-to-calcified annulus fixation.

This project is being realized via cooperation between Hospital of the University of Pennsylvania in Philadelphia and Heart Centre Freiburg University.

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# A new computer-assisted device for digital test chest drain systems: Redax DrenTech Palm EVO

***Rita Daniela Marasco***
*Basilicata Regional Cancer Institute, Rionero in Vulture, Italy*

A prolonged air leak is still the most common complication after pulmonary resections and the leading condition influencing both the chest tube removal time and the length of post-operative hospital stay.

The main advantage taken from the digital management of chest drainages is the decrease of inter-observer variability of the air leak assessment.

In general, a digital drain system should provide: 1) the identification of significant air flows, or active air leaks; 2) the recognition of prolonged air leaks; 3) the prediction of late air leak; 4) the differentiation of an active air leaks from a pleural space effect; 5) hopefully, the best management of the above mentioned conditions.

DrenTech Palm EVO is an innovative, exclusive digital vacuum unit equipped with a water seal chamber allowing an immediate comparison with a traditional analogue chest drain, which could be helpful in ambiguous cases in identifying a significant air flow; moreover, its software provides a real "no suction" mode, consisting in the deactivation of the suction pump.

The control unit, based on MEMS (micro-electronic-mechanical-system) technology, ensures, on board up to 99 hours: a real time assessment of intrapleural pressures span (from +15 to -30cm$H_2O$) and air flows (ml· min $^{-1}$) every 60 seconds; an air leak mean hourly value (AVG 1 h history); a graphic form of intrapleural pressures, air volumes and applied suction levels.

An active air leak (Figure 1) can be graphically recognized by a modal value of instantaneous air flow spikes higher than 150ml/min and high differential pleural pressures ($\Delta p \geq 10cmH_2O$), which is the expression of a pleural space constantly and actively feeded by a mean air flow ≥ 50ml/min. A prolonged air leak (Figure 2) consists in the persistence of an air flow ≥ 50ml/min and a $\Delta p \geq 10cmH_2O$ over the 4th post-operative day. A late air leak, defined as an active air flow arising over the third p.o. day, can be predicted by a progressive pressure curves divergence (corresponding to an increase of $\Delta p \geq 5cmH_2O$ in the previous 24-48 hours), anticipating the appearance of a significant air flow.

It's been previously showed that a digital chest drain system ensuring a continuous air flow and pleural pressures measurement could clearly identify a pleural space effect, helping the frequent misinterpretation with an active air leak; this drainage recognizes a pleural space effect as characterized by a mean air flow $\Delta\varphi < 10ml/min$; a $\Delta p$ value: $15 < \Delta p < 25cmH_2O$, and a minimum inspiratory pressure: $-17 < pi_{MIN} < -30cmH_2O$ (Figure 3).

DrenTech Palm EVO has all the requested characteristics to recognize active, prolonged, late air leaks and pleural space effect, and to effectively treat them applying the right suction levels.

Figure 1

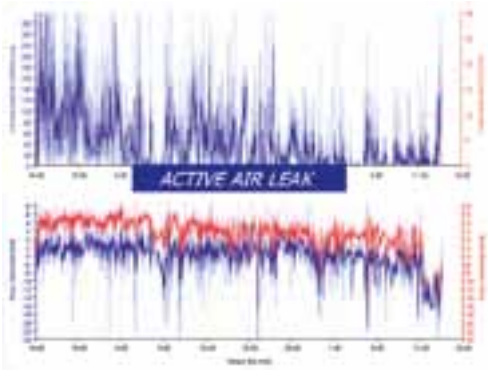



Figure 2

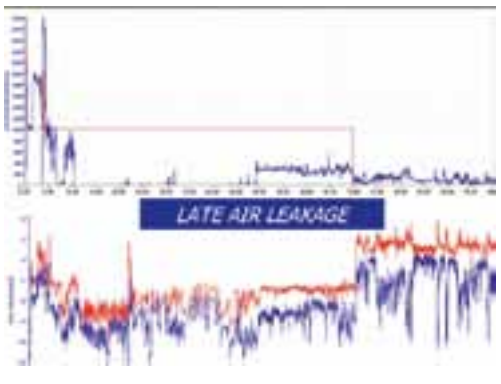
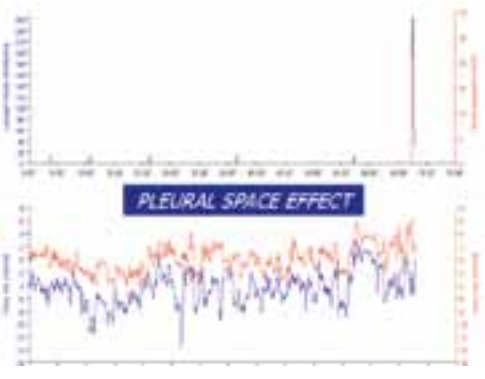



Figure 3



# Use of untreated fresh autologous pericardium for reconstruction of prosthetic valve: Is it the best material?

***Shantanu Pande[1], Amitabh Arya[2], Surendra K Agarwal[1], SC Kheruka[2], Sanjay Gambhir[2], Aditya Kapoor[3], Sunil Kumar[4]*** *1. Department of Cardiovascular and Thoracic Surgery, 2. Department of Nuclear Medicine, 3. Department of Cardiology, 4. Department of Radiology*

## Background

Advances in tissue valves has improved hemodynamics making it superior to a mechanical option but issues with durability remains. Heterologous tissue has unresolved challenge of antigenicity and homologous tissue of scarcity. Moreover, material used to create a tissue valve in both is rendered non-living. Autologous untreated pericardium was the first material used for reconstruction in cardiac surgery but fell out of repute because in studies it was shown to disappear after few months to a year. But, its easily availability, toughness and suppleness still uphold the promise for use as a material for reconstruction of valve. This material when used to create or reconstruct a valve that can evenly distribute the stress of closing pressure can enhance its longevity. If pericardium used in this fashion retains its living characteristic inside the heart by direct utilization of substrate, durability may be enhanced. We planned to observe whether a piece of pericardium used to reconstruct a valve at pulmonary position retains its life *in vivo*?

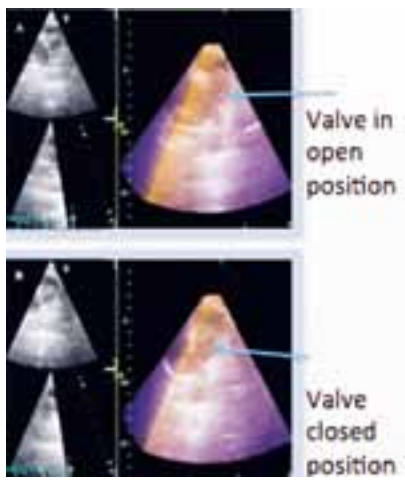



Figure 1. Single device for transcatheter aortic valve replacement and ascending aortic repair.

## Method

Study includes 70 patients undergoing TOF correction between December 2006 and 2010 divided into two groups based on requirement of TAP. Group I, requiring (n=50) and group II avoiding TAP (n=20). TAP utilized autologous untreated pericardium. A piece of similar pericardium was sutured to the undersurface of TAP at the level of native annulus to create an annulus of desired size and a competent PV with native leaflets. The efficiency of this procedure was assessed functionally by PI and RVOT gradient and anatomically by leaflet thickening and motion.

Two patients were investigated for uptake of 18 fluoro FDG by FAP used for reconstruction of pulmonary valve in both. Gated PET CT is performed at 1 and 6 months to show the uptake of 18 FDG as a marker of life by the FAP.

## Result

The median age is 11 years (1–38), 56 were males with no difference in both the groups. The clinical follow-up is 88% for 57.5 months (33–84) while echocardiographic follow-up is 80% for36 months (6–72). There was no significant difference in two groups in occurrence of PI (Group I, none 31, mild 12, moderate 6 and severe 1 vs Group II, none 16, moderate 2, severe 2, p= 0.59) and RVOT gradient. There was no thickening and calcification in constructed valve (Figure 1 & Figure 2).

Both the reconstructed valves are competent with trivial pulmonary regurgitation. FAP is observed as thin, supple and without calcification. CT scan confirmed the structural observation of echocardiography. Uptake of FDG is observed in FAP in both the cases similar to native pericardium (Figure 3).

Conclusion: FAP used as material for reconstruction of pulmonary valve shows capability to take up FDG at one as well as six months. This confirms the living nature of pericardium used in this manner. This finding can promise durability of material for valve leaflet with possibility of growth as shown in mid-term result of 50 patients in this study. A study for evaluation of uptake of 18 Fluoro FDG by the pericardium used for reconstruction of pulmonary valve is planned and initiated to study this observation in larger population.

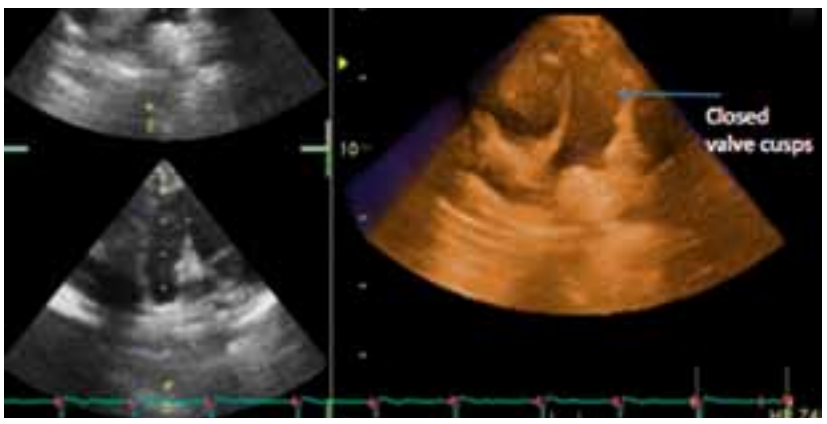



Figure 2: Anatomy of reconstructed pulmonary valve at five v year. (Image produced by 3D echocardiography).

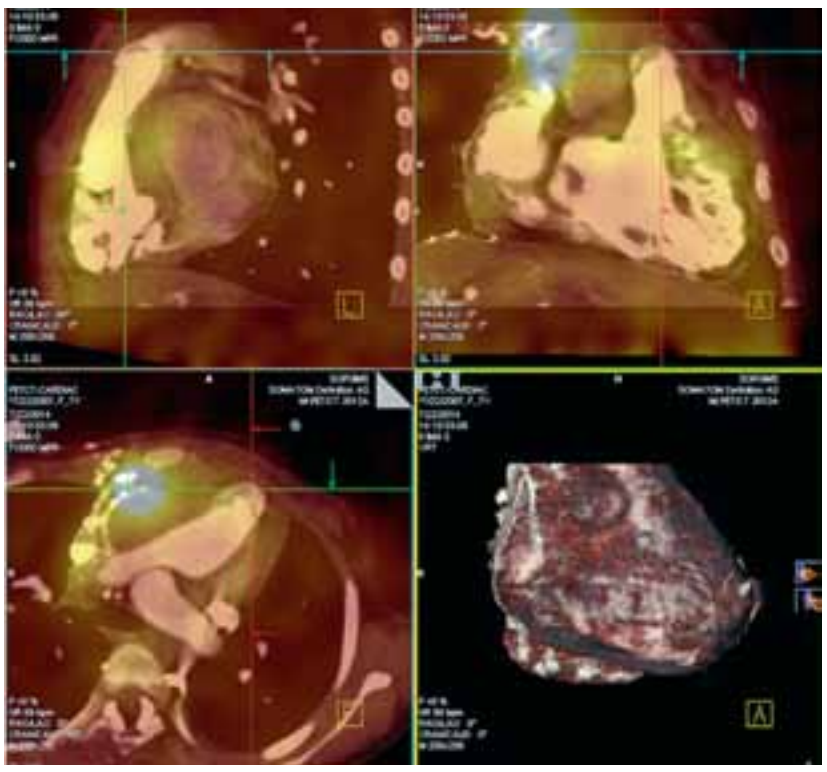


Figure 3: 18 Fluoro FDG uptake by fresh autologous pericardium used for pulmonary valve reconstruction at six months.

# Intraventricular flow accelerator LVFA

***W. Mohl[1], M. Gföhler[2], C. Janaczek[2], A. Karabegovic[2], R. Willinger[2].*** *1 Medical University Vienna, 2 Technical University Vienna*

## On behalf of the Assistocor Project

Permanent Left ventricular assistance is normally achieved by an implantable pump unloading the left ventricle and supplying the blood into major arteries. With the complete unloading of the ventricle the patient can be bridged for transplantation or destiny and seldom to recovery. One problem is that physiologic periodicity is lost due to the continuous form of the operation of these pumps. Rotary blood pumps achieve a permanent flow and pulse wave forms are seldom achieved.

In our concept we assist the failing ventricle by accelerating the flow during systole within the heart allowing a maximum of achievable ejection. The assistive device is placed through the ventricular wall into the apex of the heart and basically consists of a micro pump that is driven by a brushless micro-electric motor. The device is fixed in the ventricular wall at tip of the heart so that the motor unit stays outside the heart and the pump is inside the ventricle pointing towards the aortic valve.

LVFA is the first concept in left ventricular assist potentially able to correct heart failure with a completely new pathophysiologic understanding, to be applied minimal invasive transapical and might be considered a game changer in device development for permanent heart failure therapy

## Detailed Description

### The innovation and the potential clinical impact

Our innovative concept is based on the notion that the normal heart accelerates the blood volume during the ejection phase caused by the contractile force of the ventricle. In the failing heart this mechanism is insufficient so that the majority of the blood volume remains within the left ventricular cavity.

To correct this crippling and on the long run deadly malfunction we designed a concept that supports the heart and uses as much of remaining power of the failing heart. The so called Left ventricular flow accelerator LVFA propels the volume otherwise unable to be ejected into the direction of the patient's aortic valve during systole. The improved unloading of the left ventricle puts the heart in a better contractile status since it moves the Frank Starling curves to the left and upwards indicating higher cardiac output. In addition the patient's own contractile forces are supported allowing the heart to remodel itself. The schematic use of the device which can be implanted minimal invasive transapically is depicted in Figure 1.

The motor is activated through a burst of electrical stimuli during the early systolic phase (determined by the ECG signal) rotating a propeller to maximal speed. Bursts are organized in a way that the propeller starts with low rotation and with increasing energy speeds up rotation maximizing blood acceleration. During the ejection phase blood is propelled through the pump and ejected into the outflow tract of the left ventricle, causing a pressure increase towards the aortic valve that facilitates complete opening of the valve and increases blood outflow into the aorta. A magnetic coupling of pump and motor allows hermetical separation between pump and motor unit. The impeller of the pump is supported by a hydrodynamic bearing for minimal contact and friction.

The ECG signal is measured continuously for synchronization of the pump to the periodicity of the heart. Onset trigger for pump is the beginning of the electromechanical period (measured by the ECG signal, begin of systole), offset trigger is closing of the aortic valve (end of systole). The action requires around 250mseconds, heart rate dependent.

As seen in Figure 2 depicting pressures and ECG signals. The rotor of the pump will accelerate intraventricular flow during the ejection time of the ventricle and force and redirect the flow towards the aortic valve.

A special sensor (impedance or volume measurement) helps to optimize pump function and rotational speed of the driver. Modeling of the flow characteristics will also be done to optimize the ejecting volume.

In the failing heart blood flow velocities within the heart are turbulent and undirected according to the lack of contractile force (seen in Figure 3; normal flow pattern and abnormal flow pattern).

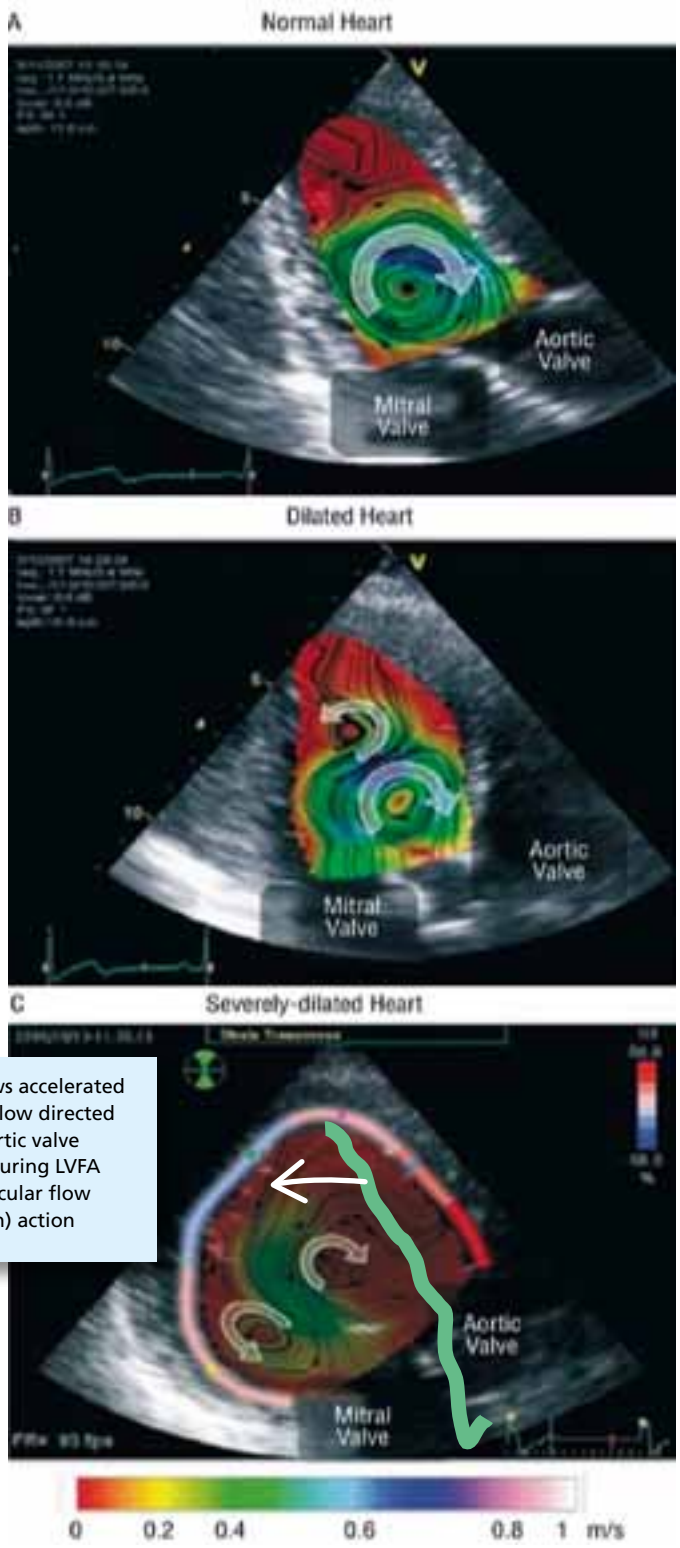
With the present concept we anticipate that the redirection of flow as well as its acceleration will enhance the ejected volume and therefore improve cardiac performance.

## Beyond current concepts

To date there is only one concept of an intraventricular pump (long horn) however with a completely different corrective philosophy and technology used.

## The current Status of the project

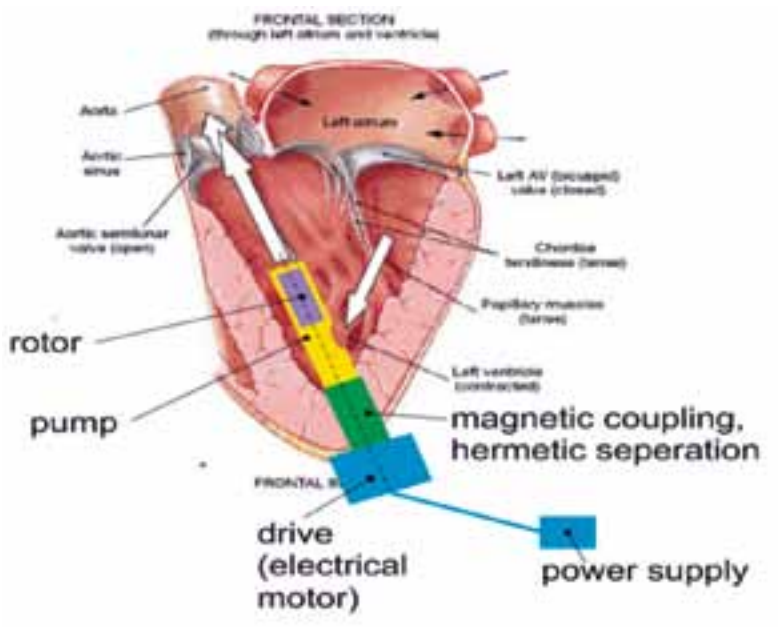
The pump has been realized and was tested in a mock circulation. We are currently planning acute animal studies to test the device as well as the underlying pathophysiologic concept. The concept has been filed in the US patent office (application number 14/324727) and part of the underlying technology in the Austrian patent application(AT 50A50343/2014).




Arrow shows accelerated enhanced Flow directed towards aortic valve propelled during LVFA (Intraventricular flow acceleration) action

Figure 3 document downloaded and modified from http://www.revespcardiol.org. day 11/02/2012 Recent Advances in the Application of Computational Mechanics to the Diagnosis and Treatment of Cardiovascular Disease Juan C. del Álamo,a Alison L. Marsden,a and Juan C. Lasheras,b

Figure 3: Flow pattern in the normal, failing and supported heart



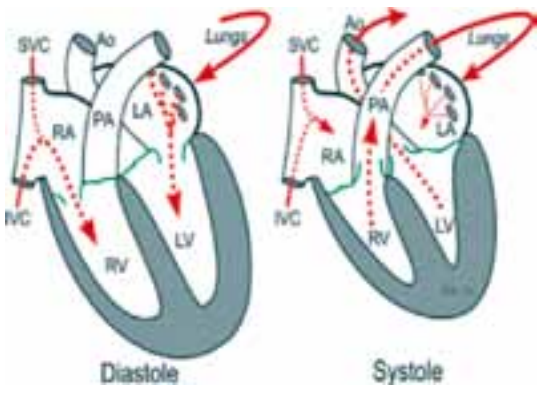




Figure 1: left: Schematic of components of the assistive device and placement in the left ventricle
Above: Flow patterns in the normal heart filling during diastole and ejection during systole. Ejection is facilitated through enforcing and accelerating flow through the pump.

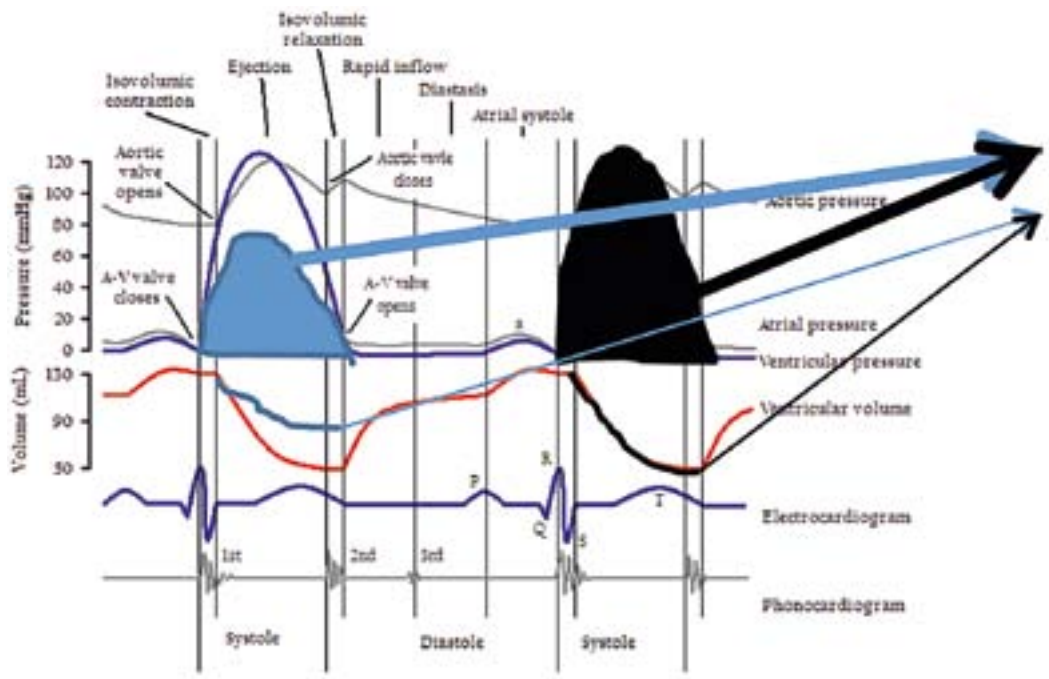



Figure 2: Two cardiac cycles one without (blue) and one with (black) intraventricular flow acceleration;
Note the remaining volume in the ventricle in the failing heart

Figure 2 modified from Wikipedia

## Summary and clinical potential

With this pulsatile flow pump we will achieve several important improvements for the patient. A more physiologic approach to left ventricular assistance will help to eventually recover the failing heart and reduce the sequelae of continuous blood flow). Implantation is achieved in a minimal way only exposing the apex of the heart similar to the implantation of Trans apical Valve implantations (TAVI). The use of an extracorporeal circuit is unnecessary. Follow up care can be done in a similar way as in patients with mechanical valves& pacemakers.

Figure 4: depicts the schematic of the LVFA

Figure 5: first prototype tested in the mock circulation

# New axillary artery cannulation

***Corrado Cavozza and Antonio Campanella*** *University of Torino, Italy*

Type A acute aortic dissection is a life-threating emergency that requires immediate surgical intervention. Few choices remain for the surgeon to make when performing emergency repair; whether to use hypothermic circulatory arrest and, if so, at which body core temperature, and whether to selectively perfuse the brain unilaterally or bilaterally and consequently, which cannulation site to use to establish cardiopulmonary bypass (CPB). Despite and increasing improuvement of the surgical technology, some drawbacks and controversies are still mentioned and discussed throughout the literature.

Cardiopulmonary bypass (CPB) is established using various cannulation sites depending on the anatomy and urgency. Arterial cannulation for antegrade perfusion is accomplished either via the distal aortic arch if not involved, right subclavian/axillary artery, innominate artery, true lumen of the dissected ascending aorta, ventricular apex.

Axillary artery perfusion instead of a femoral one has the benefit of avoiding false lumen perfusion and atheroembolization,caused by retrograde perfusion in acute type A aortic dissection surgery.

Aortic dissection usually does not extend into the right axillary artery, making it a reliable site for arterial cannulation with a low risk of organ malperfusion. Furthermore that allows antegrade perfusion of the brain during the period of hypothermic circulatory arrest.

Complications related to axillary artery cannulation may be reduced by cannulating the artery with a side graft but it's usually time consuming. Morover the axillary artery is rarely injured during side graft anastomosis, and decannulation is simply performed by transecting the side branch and oversewing and clipping its stump.

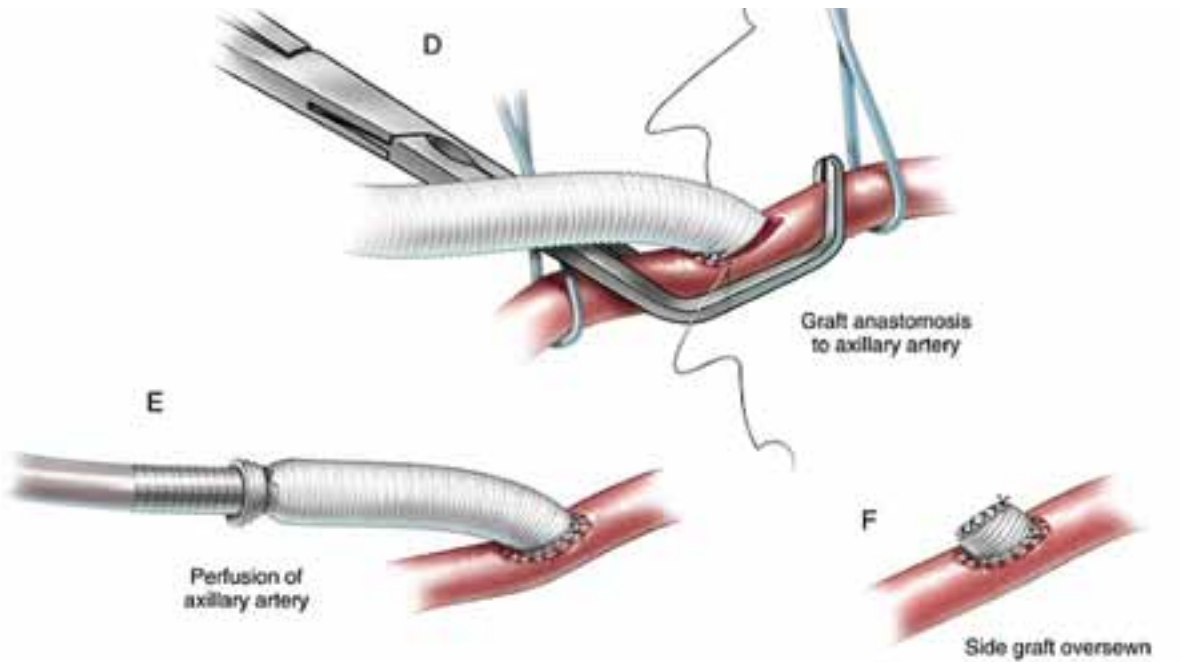
The innovation that I would like to put into practice is a disposable dacron graft device, which allows, thanks to some malleable side arms pre-anchored or a flexible distal ring, made of non trombogenetic material, to fix the prosthetic graft into the arterial wall, ensuring both tightness and bloodlessness (samples of possible devices: figures 1,2,3,4)

Most cannulae being used are primarily designed for femoral or aortic cannulation. A few cannulae designed specifically for axillary artery cannulation simply take into consideration the required angulation without addressing the perfusion limitations. On the other hand, the use of a side graft requires careful hemostasis at the suture line, sometimes adding bioadhesives, as the blood loss can be significant.

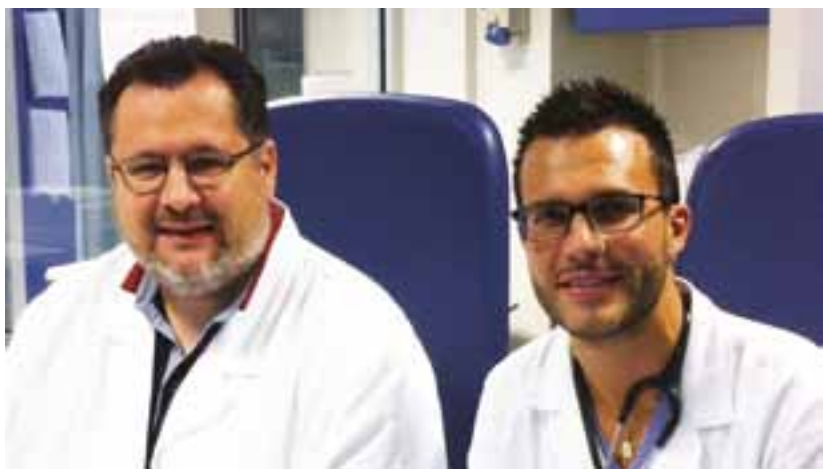
This device allows a sutureless, tightless and bloodless cannulation for arterial perfusion during a challenging emergent cardiac surgery. At the end of CEC is not necessary remove any cannula, but only suture the proximal side graft near the arterial wall as usually (Figure 5).

Figures 1–4

Figure 5. Removing arterial inflow




Corrado Cavozza and Antonio Campanella



# High-fidelity minimally invasive mitral valve repair simulator with interactive feedback system

***Peyman Sardari Nia*** *Maastricht University Medical Center, Maastricht, The Netherlands*

Mitral valve repair is one of the most complicated and difficult procedures in cardiac surgery due to the complexity of the mitral valve and diversity of its pathology. Performing mitral valve repair through minimally invasive techniques (whether endoscopically, through direct vision, or with robotic-assistance) is even more difficult.

Minimally invasive mitral valve repair (MIMVR) has been shown to be effective and beneficial for patients, but the application of this technique has been concentrated in high-volume centers and in the hands of a limited number of surgeons.

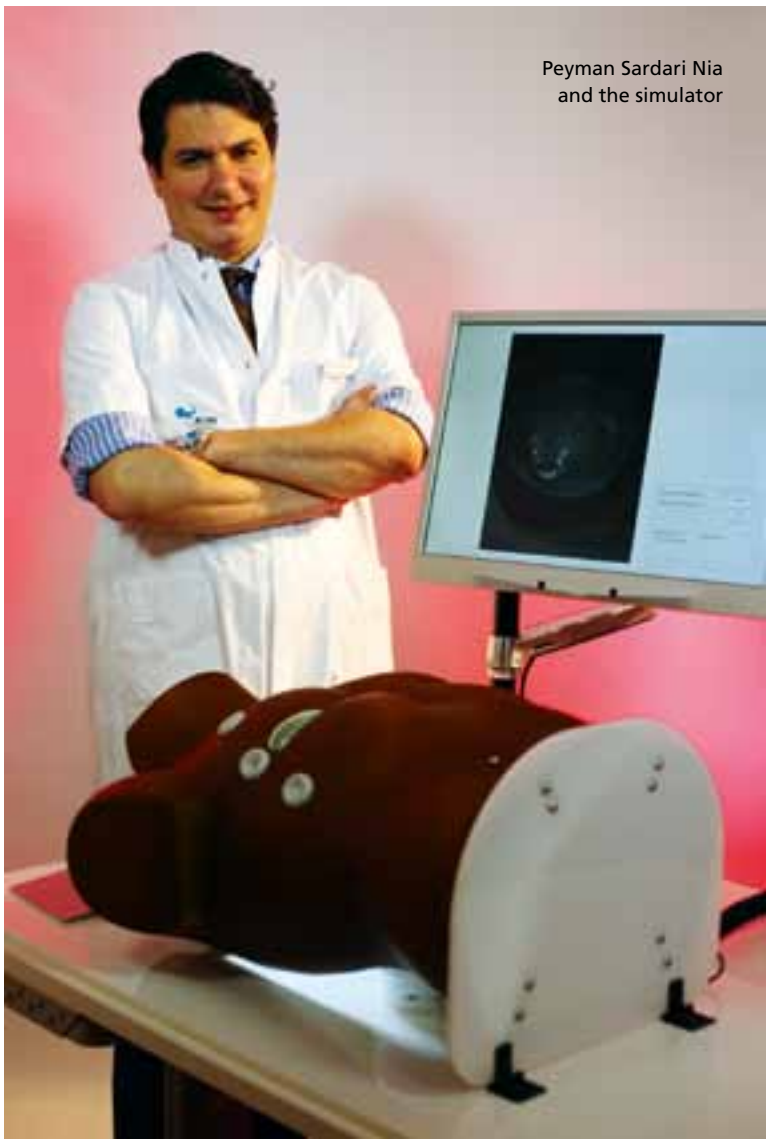
Dexterity in open surgery is insufficient for starting a MIMVR, as a new dexterity must be developed. The most critical technical steps are working with long-shafted instruments endoscopically, placing sutures on the mitral valve annulus and papillary muscles.

The learning curve of MIMVS is steep and unfortunately still developed in patients. Therefore, there is a need for paradigm shift in cardiothoracic surgery moving from "trial and error" to pre-operative planning and skills development. I have developed a minimally invasive mitral valve repair simulator with the help of the engineering department (IDEE – Instrument Development Engineering and Evaluation) at Maastricht University Medical Center (MUMC), the Netherlands. This simulator is in line with this paradigm shift, providing residents, fellows and surgeons an objective, reproducible way to practice and train skills endlessly instead of developing skills in patients.

These simulators were successfully tested for the first time during the EACTS course, *Minimally Invasive Techniques in Adult Cardiac Surgery*, held in Maastricht during June 2014.

### The main characteristics of the simulator

- The simulator can be used for the following surgical approaches:
  - MIMVR endoscopically
  - MIMVR through direct vision
  - MIMVR with robotic-assistance using the available ports
  - Conventional mitral valve repair by opening the thorax
- The mitral valve component is disposable and developed from special material that mimics the tissue characteristics of the mitral valve so that a true suturing experience can be created.
- The simulator gives feedback about the exact depth and length of each suture.
- The simulator provides a picture of each suture.
- The depth and length of each suture attempts can be pre-setted and the simulator will provide feedback about the suture attempts with regard to pre-setted values.
- The disposable papillary muscles for suturing the neochordae are available.
- The disposable mitral valve can theoretically be replaced by 3D-printed mitral valve of an individual patient for pre-operative practice and pre-planning of complex mitral valve repair.



Peyman Sardari Nia and the simulator

**Techno College** Award Nominee 2014

# New applicator for direct cardiac shockwave treatment during open heart surgery

***Johannes Holfeld*** *Innsbruck University, Austria*

Ischemic heart disease is a prevalent clinical problem and an increasing global socio-economic health burden in industrialized countries. The morphological surrogate of chronic ischemia caused by atherosclerosis of coronary arteries, is mainly due to the loss of myocytes leading to functional deterioration. Regenerative therapies aim to safe hibernating myocytes at ischemic border zones by induction of angiogenesis. Current strategies mainly include gene and (stem) cell based approaches. Both showed promising results in animal studies and partly in clinical application. However, none of

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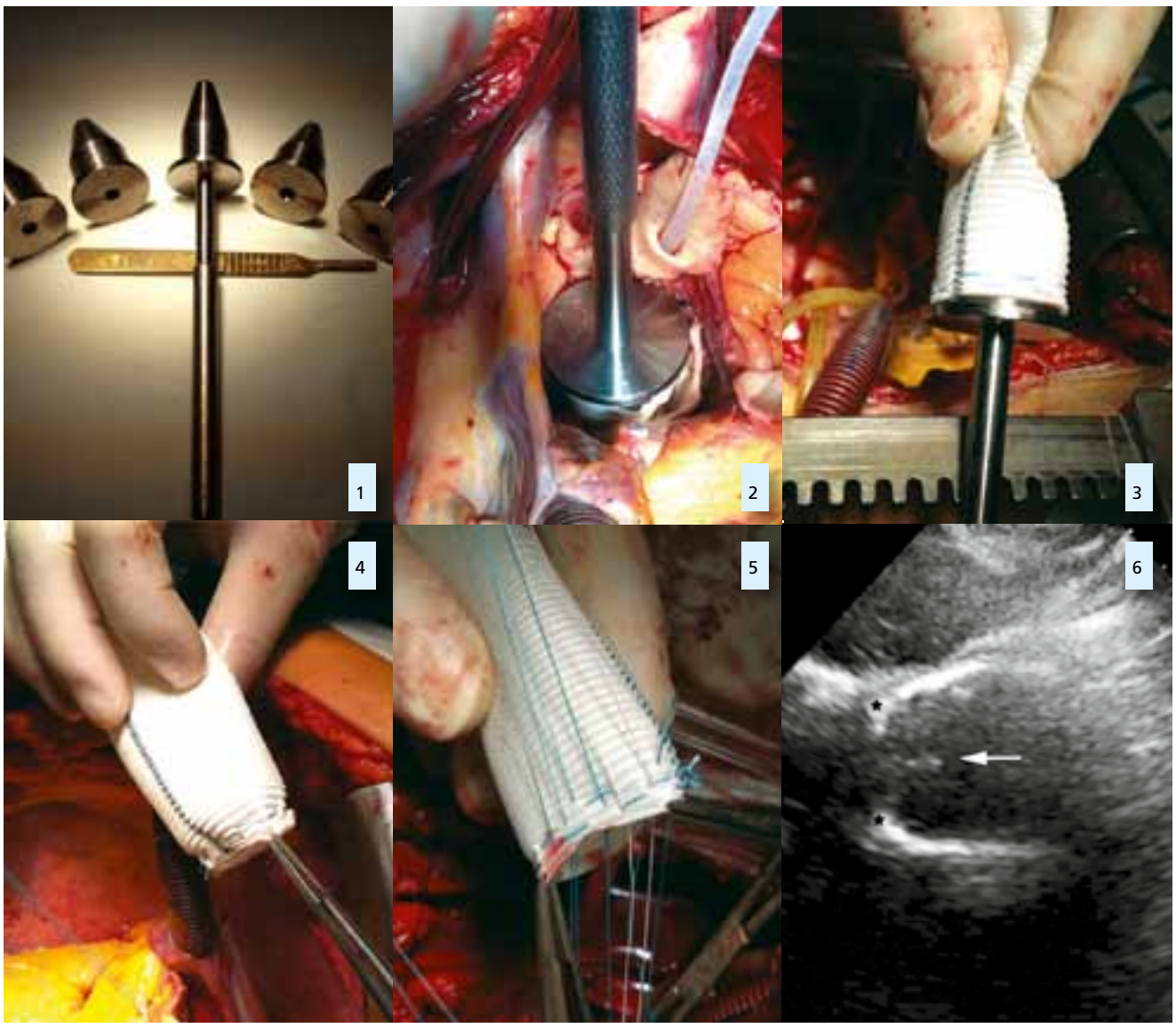
# A novel tool to facilitate crimping suture placement for a modified David V/Miller aortic root replacement

***Sergey Boldyrev, Kirill Barbukhatty, Vladimir Porhanov***
*Regional Clinical Hospital #1, Krasnodar, Russian Federation*

We describe a simple technique for aortic root reconstruction that has been successfully performed for patients with aneurysms of aortic root and ascending aorta with aortic insufficiency. For measuring of aortic annulus and preparing of vascular graft, we created a new, simple, and convenient device (Figure 1). There is a circular stop on the opposite side of the device. Cylinders are changeable and are of different diameters: 21, 23, 25, 27, or 29mm. The working part of each cylinder has streamlined circular grooves 0.2mm deep at a distance of 2mm from each other. The fibrous annulus is measured by inserting the device into the left ventricle through the annulus of the aortic valve (Figure 2). We then prepare the vascular graft for reimplantation. An oversized vascular graft (annulus diameter + device chosen size + 8mm) is necked down proximally to fit an appropriate device using 2-0 horizontal interrupted polyester plication sutures. The assistant introduces the device into the selected prosthesis to the circular stop. The surgeon performs the first proximal suture line. The first line of the suture is located 1-2mm from the proximal edge of the prosthesis. The suture is tightened so that the graft is partially fixed on one of the device's circular grooves.

The second line is located 3-4mm above the first line. The ribs of sutures are located in a chess order, thereby resulting in a border of approximately 5mm (Figures 3 and 4). The proximal suture line is performed by using 2-0 polyester sutures with pledgets that are passed from inside the left ventricular outflow tract to the outside, under the aorta cusps. Then the pledgeted sutures pass through the prosthesis base edge as follows: 1-2mm lower, between, and 1-2mm higher than the lines formed by two horizontal sutures. Then, the graft is anchored in the aortic root by tying the suture. Thus, a zigzag line of fixation is created along the whole circular length (Figure 5).

Once the graft is anchored in the aortic root, the commissures are trimmed by placing the stay sutures at the appropriate height inside the vascular graft. The correct position of the commissures inside the graft is identified by pulling on both the commissure and the vascular graft before stitching the sutures through the graft. The graft should extend by half or two thirds of its maximum length at this segment. When the commissures are trimmed, the tissue remnants of the partially resected sinuses of Valsalva are reimplanted into the vascular graft using 4-0 monofilament running sutures. The aortic root is finally formed by 2-0 polyester-interrupted or plication sutures at the sinotubular ridge level (Figure 6).

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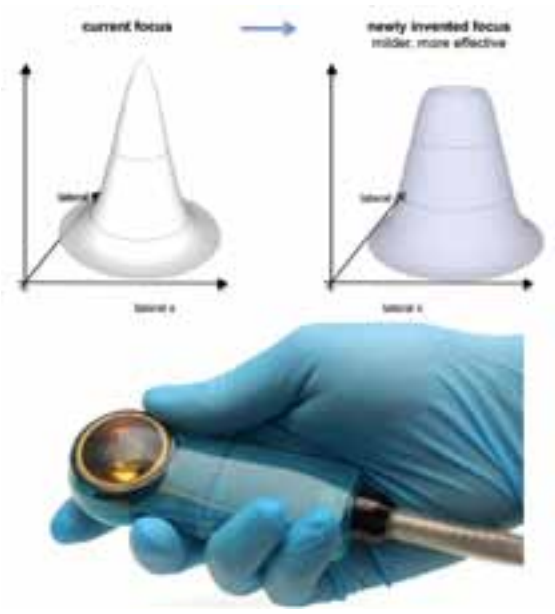
**1.** Boldyrev S, Barbukhatty K, Porhanov V. A Novel Tool to Facilitate Crimping Suture Placement for a Modified David V/Miller Aortic Root Replacement. Aorta 2014;2(4):

them yet gained broad clinical use as of side effects or lack of feasibility and the enormous logistical and regulatory issues. Thus, effective strategies that are clinically easy to implement and have a favorable side effect profile are of high interest.

A new approach to induce angiogenesis in ischemic tissue is low energy shockwave therapy (SWT). It has been shown to cause release of angiogenic growth factors and thereby a subsequent increase in capillary as well as arteriole density in ischemic muscle tissue. Shockwaves represent a specific type of sound pressure waves being used at high energy levels in medicine for over 30 years for lithotripsy.




Due to this long-term clinical application, the safety profile is quite well studied and, hence, SWT is well proven not to cause any severe side-effects or even neoplastic tissue transformation. Moreover, shockwave therapy has been shown to be effective in chronic and acute myocardial ischemia in the experimental as well as clinical setting when applied from extracorporeal.

However, extracorporeal cardiac shockwave treatment shows distinct limitations as small acoustic windows between the rips (just as known from transthoracic echocardiography) allow for the treatment of small areas of the myocardium only. In addition, repeated treatment sessions are required as certain amounts of energy get absorbed while waves are passing the thorax. Still showing promising results in cardiology, shockwave treatment has not been used by cardiac surgeons as no sterile and small-sized applicator has been available. We therefore developed a single-use, sterile applicator that is approximately the size of a common cell phone and therefore can easily reach every area of the heart.

In addition to its markedly smaller size and sterility the applicator features a differently shaped reflector that focuses waves to a larger area and thereby increases the total amount of energy delivered at one time to the myocardium. This physical trick enables milder but at the same time more effective treatment! Therefore, a single direct cardiac shockwave treatment additional to CABG surgery (takes about 5 minutes) reaches the same effects as repeated extracorporeal shockwave treatment does!

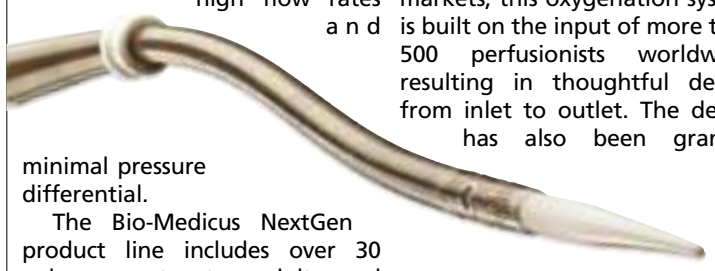
This new treatment modality offers an effective, feasible, easy-to-use and cost-effective alternative to current regenerative approaches, such as (stem) cell or gene therapy. The effectiveness has been proven in numerous experimental trials. The same technology is routinely used in other fields of medicine and can therefore easily be implemented in the field of cardiac surgery as well. The newly developed applicator shall for the first time enable cardiac surgeons to routinely apply a safe and effective biological regenerative treatment approach adjunctive to the surgical treatment. A large-scale European multicentre trial is currently in preparation to gain robust evidence for the efficacy of cardiac shockwave therapy adjunctive to CABG surgery.

Medtronic

# New Bio-Medicus™ NextGen Cannulae and Affinity Fusion™ Oxygenator Set Versatility Trend

Medtronic's commitment to cardiac surgeons and perfusionists is realized once again with the recent launch of Bio-Medicus™ NextGen Cannulae. In October 2014, the company announced

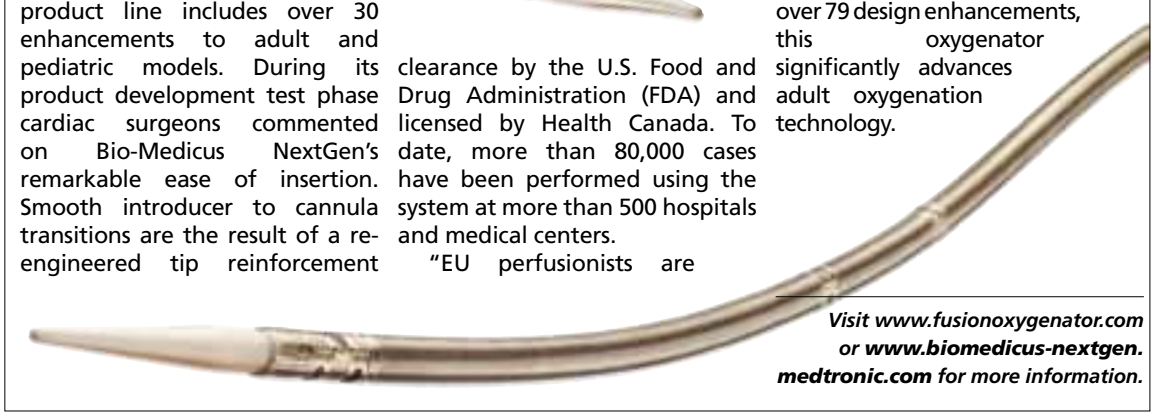
CE-registration of the Bio-Medicus NextGen product line. Versatility was high on the list when Medtronic considered enhancements to the original Bio-Medicus Cannulae products. The new femoral arterial models are also indicated for jugular venous usage and the femoral venous models include bi-caval placement capability.These next generation models offer more solutions for alternative access, high flow rates and minimal pressure differential.



The Bio-Medicus NextGen product line includes over 30 enhancements to adult and pediatric models. During its product development test phase cardiac surgeons commented on Bio-Medicus NextGen's remarkable ease of insertion. Smooth introducer to cannula transitions are the result of a re-engineered tip reinforcement design. New pediatric arterial and venous models boast the same improved insertability and hemostasis management features as adult models. Each pediatric cannula is packaged with a tapered solid core and percutaneous-style non-phthalate PVC introducer to provide new options via traditional or Seldinger technique.

Versatility is also evident in Medtronic's Affinity Fusion™ Oxygenator with Balance Biosurface, as it continues to be a highly sought solution for perfusionists and cardiac surgeons. Today, it is also available with Carmeda® BioActive Surface. Available for over 2 years in CE markets, this oxygenation system is built on the input of more than 500 perfusionists worldwide, resulting in thoughtful design from inlet to outlet. The device has also been granted clearance by the U.S. Food and Drug Administration (FDA) and licensed by Health Canada. To date, more than 80,000 cases have been performed using the system at more than 500 hospitals and medical centers.

"EU perfusionists are enthusiastic about the Affinity Fusion Oxygenator, which is fundamentally different from previous designs," said Christiaan Matheve, Medtronic Training and Education Manager, Perfusion Technology for Europe and Canada. "Once they begin using it, they realize that it is truly the product of collaboration between perfusionists and Medtronic's engineering experts." With over 79 design enhancements, this oxygenator significantly advances adult oxygenation technology.



***Visit www.fusionoxygenator.com or www.biomedicus-nextgen.medtronic.com for more information.***

# A new tissue engineering approach to create a versatile collagen scaffold

***WML Neethling***
*Fremantle Hospital, University of WA, Australia*

Numerous biological substitutes have been used for congenital and adult cardiovascular repair procedures. Most of these substitutes have a limited life span due to degeneration and calcification. Alternative approaches with autologous tissue substitutes and synthetics have shown some improvement but fail due to retraction, surface thickening and calcification.

The primary objective of this innovation was to create a versatile collagen scaffold with outstanding biocompatibility, durability, optimal physical properties and maximum calcification resistance for congenital and adult cardiovascular applications.

Biological substitutes are chemically treated to improve durability and reduce antigenicity. The cytotoxic nature of these chemicals have negative effects on biocompatibility and the physical properties of these substitutes. The reduced biocompatibility becomes evident as a cascade of inflammatory responses after implantation which eventually result in calcification and graft failure.

This problem has been addressed by the development of a multi-step treatment approach whereby pericardium is processed to yield a highly biocompatible cardiovascular scaffold. This novel multi-step tissue treatment is called the ADAPT tissue engineered process. This process utilizes tissue engineering principles such as delipidation, decellularisation and nuclease treatment to eliminate all tissue-related factors responsible for the cascade of inflammatory responses associated with the implantation of bioprosthetic substitutes. Furthermore, the resultant collagen scaffold is cross-linked in a novel way using modified monomeric glutaraldehyde at a significantly lower concentration compared to what is currently being used in the industry. The cross-linked scaffold is then exposed to a detoxification treatment process after crosslinking which addresses unbound and residual glutaraldehyde moieties. The decellularized, detoxified, crosslinked scaffold is then sterilized and stored in a non-glutaraldehyde solution allowing for direct application without any rinsing procedures.

These highly desirable biocompatible properties were demonstrated following multiple in vitro (tensile testing, stem cell interactions, enzymatic degradation studies, residual glutaraldehyde levels, burst testing) and *in vivo* assessments (small and large animal models as well as a Human Clinical Trial).

Pulmonary valve reconstruction


CardioCel

Results to date (*J Cardiovasc Surg*. 2006;47(6):711, *J Heart Valve Dis*. 2008; 17:456, *J Heart Valve Dis*. 2010; 19:778, *Interact Cardiovasc Thorac Surg*. 2013;17(4):698, *Eur J Cardiothorac Surg*. 2014;45(4):e110, *J Thorac Cardiovasc Surg*. 2014 Aug 7-in press, *J Biomed Mater Res* A 2014 Sep 25 – in press) highlight the uniqueness of this collagen scaffold, demonstrating outstanding physical properties and a significantly high resistance to calcification in both pre-clinical and clinical studies.

The CardioCel bioprosthetic scaffold obtained CE mark and FDA clearance for use in Europe and the United States in late 2013 and 2014 respectively.

For the first time all aspects to produce an ideal universal bioprosthetic substitute for cardiovascular application in both pediatric and adult patients were effectively addressed. More than 10 years of pre-clinical as well as clinical evaluations have demonstrated ultimate biocompatibility, durability, outstanding calcification resistance and unique physical properties in simple and complex cardiovascular repair procedures.

**Techno College** Award Nominee 2014 • **Techno College** Award Nominee 2014 • **Techno College** Award Nominee 2014 • **Techno College** Award Nominee

# Supra-sternal innominate artery cannulation

## Safe site to save life when there is risk of aortic injury during resternotomy

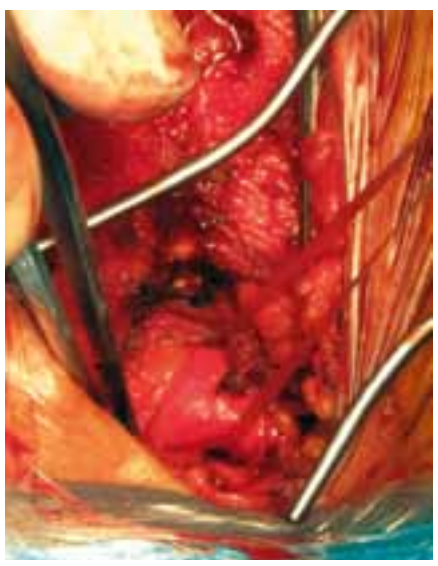
***Saeid Hosseini***
*Rajaei Heart Hospital, Tehran, Iran*

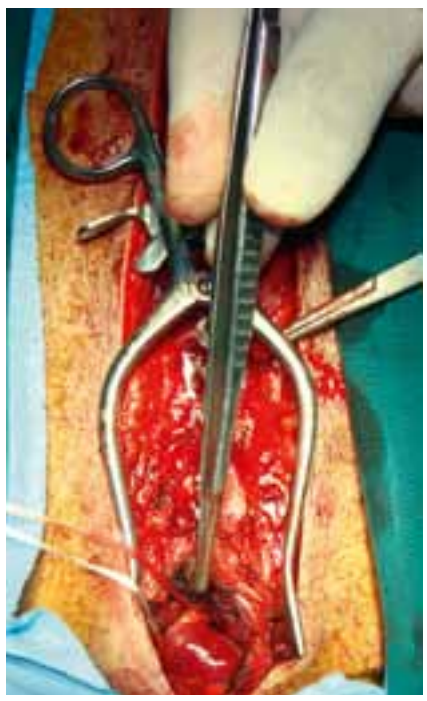
The ascending aorta, innominate vein and cardiac chambers may be damaged during sternal reentry at reoperations with an increased rate of morbidity and mortality. The most catastrophic event is aortic rupture. We here describe our experience with an access to improve safety and outcomes of resternotomy in cases in which aortic injury is likely to occur.

From April 2012 to July 2014, 186 redo cases were operated at our tertiary heart centre. Thoracic CT is routinely performed in all cases before surgery. In case of close proximity (<3mm) of the aorta to the inner table of the sternum or if there is ascending aortic aneurysm, a supra-sternal extension of the skin incision is performed, the innominate artery is dissected and a vascular graft is anastomosed. The aortic cannula is then connected to the side graft. From all of our redo cases, there were nine patients with less than 3mm distance between the ascending aorta and the sternum on thoracic CT scan. At surgery, only the skin and subcutaneous tissues were incised incision over the sternum and the skin incision extended 2-3cm upwards. The innominate artery is dissected and isolated. Then the artery is clamped for two minutes and cerebral oxymetry checked. If there was not significant decrease in cerebral oxymetry we anastomosed a 6-8mm vascular graft to the innominate artery.

The patients with supra-sternal innominate artery cannulation were placed on cardiopulmonary bypass with femoral vein cannulation. Cooling is started and sternotomy is then performed.

There are some possible sites for arterial cannulation in redo cardiac surgery like the femoral or axillary arteries but, in case of aortic blowout injury the chances for an appropriate antegrade cerebral perfusion may be decreased due to the lack of proximal control. With suprasternal innominate artery cannulation, the most important advantage of this method is the possibility of proximal control of innominate artery for safer antegrade cerebral perfusion.





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# Inno-atrial two-stage venous cannula for on-pump beating CABG: an effective method to decrease postoperative neurocognitive disorders occurrence

***Mathias H. Aazami*** *Kurdistan University of Medical Sciences, Sanandaj, Iran*

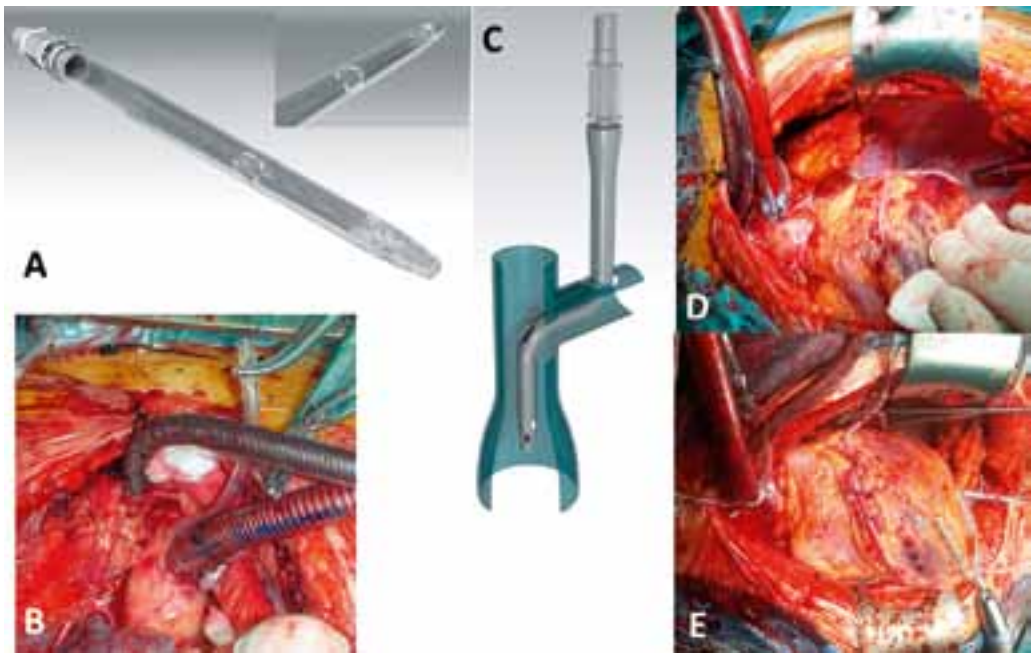
Perioperative stroke and postoperative neurocognitive disorders remains serious complications by CABG. Recent studies have shown increases in central venous pressures causing concomitant decreasing in regional cerebral perfusion, especially by the time of heart displacement. In concert with the latter, hemodynamic disturbances in cerebral perfusion may act synergistically in occurrence of neurologic and neurocognitive disorders. The current innovation consists on a new two-stage Inno-Atrial venous cannula for the purpose of On-Pump Beating CABG aimed at adequately draining the superior vena cava as to avoiding cerebral venous congestion during heart displacement; while maintaining adequate arterial perfusion.

This new flexible Fr 22 venous cannula (20cm length) bears two additional symmetrical oval holes 8cm from its distal atrial end (figure 1-A). The cannula is inserted via the innominate vein by placing a 5/0 monofilament purse (figure 1-B) in a manner to place one of the lateral holes in regard of right jugular vein junction (figure 1-C). These two lateral holes ensures adequate drainage of the superior vena cava. The total length of the cannula is reduced to 20cm

Since 2013 to present. 96 patients underwent isolated On-Pump Beating CABG using this new two-stage Inno-Atrial venous cannula. 70 percent of the patients was operated on an emergent or urgent status. The mean age and calculated Eurscore-II were 60.7 years and 4.03 respectively, with 76 of patients being three-vessel or left main CAD disease. The mean preoperative LVEF was 44.8 percent (ranging from 10 to 60).

The mean number of total, venous, arterial, and composite distal anastomoses per patient were 3.6, 2.2, 1.4, and 2 respectively. Bilateral internal thoracic arteries were used in 30 percent of the patients. The mean pump time was 135 minutes. The mean body surface area and calculated index pump flow were: 1.75 $m^2$ and 4158ml/min (calculated on a 2400ml/min/$m^2$ indexed flow basis) respectively. The mean drained Inno-atrial flow was 2847ml/min corresponding to an indexed Inno-atrial flow of 1624ml/min/$m^2$. The mean ratio of drained Inno-atrial flow to calculated flow was: 67.7 percent (ranging from 50 to 100).

The 30-day mortality was 4.2 percent. The cause of deaths were: perioperative MI, delayed stroke, rhabdomyolisis, and heart failure. One patient need perioperative IABP insertion. 97 percent of the patients did not require inotropic support. Among survivors, the mean postoperative LVEF was 46.5 percent. The rate of perioperative MI was 2 percent. 95.5 percent of the patients were extubated within the first 12 hours following ICU admission. There was none instance of perioperative strokes and 98 % of the survivors were free from any kind of postoperative neurocognitive disorders.




A) The new Inno-Atrial Two-Stage venous cannula with its two lateral oval holes.
B) Operative view of the aortic and inno-atrial cannula insertion.
C) Three-dimensional reconstruction of Inno-arial venous cannula placed via the innominate vein.
D + E) operative view of a two cases of complete arterial CABG using Inno-Atrial two-satge cannulation.

Inno-atrial two-stage venous cannula inserted via the innominate vein is a safe approach for the purpose of On-pump beating CABG providing adequate venous drainage. The current approach seems promising in overall operative outcome of CABG especially by considerably reducing the rate of perioperative strokes and postoperative neurocognitive disorders.

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# Development of a new algorithm to plan a new interventional valve-in-valve procedure

***Stephan Ensminger*** *Ruhr University Bochum, Bad Oeynhausen, Germany*

The number of implanted biological valves for treatment of valvular heart disease is constantly growing and a percentage of these patients will eventually undergo a transcatheter valve in valve (ViV) procedure. However, compared to a standard TAVI, ViV-procedures are relatively rare and experience is comparatively low. Major safety and efficacy concerns include device malposition and patient-prosthesis mismatch, both associated with adverse outcomes as documented in ViV registries. In particular, ViV procedures in new prostheses are challenging, as they are comparable to first-in-man trials which are usually preceded by a significant amount of in-vitro and in-vivo experiments. Therefore, the aim of our study was to develop a feasible algorithm utilizing an extended spectrum of modern imaging, modeling and perfusion modalities to plan and in vitro simulate a new interventional procedure.

This algorithm was developed for a patient with a degenerated 21mm Perceval aortic sutureless prosthesis requiring a ViV procedure, which had not been performed before and therefore several challenges had to be solved. Our algorithm included the following steps:

1 3D printing of the aortic annulus in a 1:1 size ratio according to CT scan.
2 Implantation of the previously implanted valve prosthesis in vitro.
3 Performance of a ViV-procedure with different THV (different devices, different sizes, variation of implantation height) under direct visual control and fluoroscopy to 'know what it looks like intraoperatively'.
4 Assessment of valve performance for the different scenarios under different physiological conditions in a hydrodynamic test model with respect to transvalvular gradients and leakage volumes, orifice areas and position safety.
5 Capturing of leaflet motion with a high-speed motion camera.
6 Decision for the procedure with the best performance and lowest risk based on experimental and clinical diagnostics for the patient.

As the Perceval prosthesis has a distal "outflow" ring - a unique feature of the valve - which ensures prosthesis stabilization, but on the other hand represents a potential mechanical obstacle for transfemoral TAVI. Therefore, a transapical approach with an Edwards Sapien XT seemed the better option for this patient and first, the patients' aortic annulus including the left ventricular outflow tract was 3D printed based on a cardiac CT scan. A Perceval 21mm prosthesis was exactly positioned according to CT scan into this annulus. Two ViV-procedures with an Edwards SAPIEN XT 23mm were performed at different heights (low=position 1 and high=position 2). Both scenarios were checked for stability of the ViV position and were compared in a hydrodynamic test model capturing the following data: transvalvular pressure gradients, effective orifice areas, closure volumes and leakage volumes. During hydrodynamic measurements leaflet motion was compared with help of high speed camera analyses.

Both positions showed good functional results with acceptable transvalvular gradients (10-13mmHg), orifice areas (1.6cm$^2$) and negligibly small leakage volumes. Analysis of high speed camera recordings however showed that in position 1, leaflet motion was impaired compared to position 2. Due to the higher deployment of the valve in position 2, the Perceval leaflets were completely pushed aside by the SAPIEN XT stent, resulting in an unimpaired valve opening in this higher position. Therefore, the higher position was chosen as the best option for this patient and fluoroscopy images of both positions (1+2) were taken in order to have a 'blueprint' for the patient procedure.

The patient procedure went exactly as planned with a very good result for the patient. She had an uneventful recovery and was discharged on day seven with a fully competent Sapien XT aortic valve prosthesis, a mean gradient of 5mmHg and an aortic orifice area of 1.8cm$^2$.

In summary we have developed a new affordable and technically feasible algorithm simulating important aspects of an interventional procedure in advance to optimize procedural success and patient safety, which can be applied to virtually all patients requiring a new interventional procedure.

## EACTS Academy Course preview 28–29 November

# Valve Sparing Aortic Root Replacement and Aortic Valve Repair Course

In 28-29 November this year, the EACTS will host the Valve Sparing Aortic Root Replacement and Aortic Valve Repair Course at EACTS House, Windsor, UK. We talked to one of the course directors, Dr Emmanuel Lansac, about the importance of the course…

"The objective of this highly-focused course is to provide a dedicated teaching platform on surgery for aortic insufficiency and/or aortic root aneurysm, particularly examining the role of valve repair," stated Dr Lansac. "The course will provide a standardised approach to management of these patients from their pre-operative analysis to select good candidates for valve repair, to surgical technique. Aim of the course is that attendees learn a step-by-step, systematic approach to valve sparing root replacement and aortic valve repair surgery, in order to spread diffusion of these techniques to all teams who want to offer it to their patients".

He said that course delegates could include cardiac surgeons and echo cardiographers (cardiologists and anaesthesiologists) who are willing to start or are already part of a valve sparing aortic root replacement and aortic valve repair programme. He added that the appeal of the course reflects the multi-disciplinary aspect of aortic root replacement and aortic valve repair.

The programme will begin with an examination of the functional anatomy of the aortic valve and the rationales of aortic annuloplasty for a standardised aortic valve repair, which will include all the important parameters which need to be taken into account when considering aortic valve repair.

Dr Lansac explained that the course will include presenters from different schools of aortic valve repair such as Diana Aicher (Homburg), Dr Laurent De Kerchove (Brussels) and Alain Berrebi (Paris), among others.

The course will also feature "live on tape" case studies focusing technical detail for valve sparing root replacement, aortic valve repair and ring annuloplasty technique.

"Each video will clearly demonstrate to attendees the various surgical techniques in a step-by-step approach depending on the phenotype of the ascending aorta such as aortic root aneurysm, supra coronary and isolated aortic insufficiency" he added. "The videos will show common cases and more complex cases for both tricuspid and bicuspid aortic valve."

The programme will also include a failure session, in which attendees will discuss the case from echo analysis to surgical repair, and learn how to identify predictors of repair failure and bailout technique in such conditions.

The course will end with a Wetlab bringing together the theoretical knowledge with a practical application. This will include an analysis of the anatomy of the aortic root, valve assessment including measurement of cusp effective height, valve sparing root replacement and annuloplasty technique.

"Right now, the question regarding aortic valve surgery is no longer 'can we do aortic valve repair?', because we know it is feasible with satisfying long-term results thanks to the work of pioneering surgeons such as Magdi Yacoub, Tirone David, Gebrine El Khoury and Joachim Schaffer among others," he added. "Now we are asking, 'how can we standardise the technique in order to ease its widespread use among every team?' Aside the ones who advocate remodelling of the aortic root or who support re-implantation of the aortic valve, we know now that the more physiologic the root reconstruction, the better.

"Moreover, the need of cusp effective height resuspension and aortic annuloplasty are now recognised as key component for a predictable and durable repair. Standardisation of both the root reconstruction and valve repair is the aim of this course. Dr Rafael Sádaba, who is the co-director of the session, and myself are looking forward to the first edition in November where we will discuss and debate all these fascinating aspects of aortic root and valve repair surgery."

## EACTS Course preview 10–14 November

# Heart Failure
## State of the Art and Future Perspectives

In November 2014, the EACTS will host its third Advanced Module: Heart Failure – State of the Art and Future Perspectives course at EACTS House in Windsor, UK. *EACTS News* talked to one of the course directors, Professor Gino Gerosa (Padua, Italy), about the course…

"In the third Heart Failure Course we will again try to incorporate all aspects of heart failure from diagnosis and epidemiology, imaging and biomarkers, to advanced therapies such as LVADs, tissue engineering and the total artificial heart," said Gerosa. "The aim to provide a comprehensive overview of the current status of the available treatments for heart failure patients."

The course, which is aimed at residents and experienced cardiac surgeons with an interest in the heart failure field, will include a world-class faculty of heart failure experts including cardiac and congenital surgeons, cardiologists and scientists.

The course will begin with two presentations by pathologist Professor Angelini (Padua), who will explain the development of heart failure, why certain diseases lead to heart failure and the diagnosis of the condition. Professor Feltrin (Padua) will then examine the role of biomarkers in heart failure and Dr Osswald (Bad Oeynhausen, Germany) will then assess the current alternatives to medical therapy such as implantable cardioverter-defibrillator resynchronisation therapy and biventricular pacemakers.

Dr Schulze (New York) will then discuss optimal medical therapy and provide a cardiologist's point of view by evaluating the current medical therapies available for treating heart failure.

"We will also examine the surgical options for heart failure including mitral valve repair and replacement, as well as myocardial revascularisation," added Gerosa. "It is important that all the current therapies and treatment options are explained, discussed and understood. Heart failure is a highly complex condition and one that has multiple solutions, choosing the right solution is key."

### Case reports

"We will again be presenting some case reports and asking the group for their opinion, allowing the group to discuss different treatment options and take part in the decision-making process," explained Gerosa. "The case reports discussions provide delegates with an opportunity to see how treatments options are evaluated depending on the conditions of the heart failure patient. The discussions from this session are always very interesting."

The course will then discuss heart transplantation and specifically the issues surrounding donor shortage.

In many countries the availability of donor hearts is decreasing as fewer people with healthy hearts are dying early, as a result there is a real concern regarding the shortage of donor hearts, explained Gerosa. One solution could be found in tissue engineering, and during this year's course the 'Organ factory' session will discuss regenerative medicine and the possibilities it can offer the heart failure patient.

"It took almost 40 years from when mankind made the first transatlantic flight to when we took our first step on the moon," said Professor Gerosa. "Now, almost 40 years on from the first heart transplant, we are close to realising a similar dream – the bioengineered heart."

### Wetlab

The course will also include the ever popular wetlab, sponsored by Thoratec. This is a hands-on session that allows attendees to implant Thoratec's HeartMate device.

"The wetlab session gives delegates an opportunity to apply their knowledge in a practical setting," he added. "It gives them the chance to assess and improve their surgical technique, as well as receive one-to-one advice from world renowned experts."

The course will also include a session on mechanical circulatory support with an assessment of short-term assist devices options and total artificial hearts.

The final day of the course is dedicated to industry presentations and allows companies to showcase their devices, giving the attendees the opportunity to see the latest technological advances and ask questions regarding patient selection, implantation and modification techniques.

Gino Gerosa

"Overall, this course provides attendees with the opportunity to spend five days talking directly to heart failure specialists," concluded Gerosa. "I would strongly advocate that colleagues who are part of a heart failure programme attend this course."

***For further information, please visit the EACTS website: www.eacts.org.***

## COURSE Programme

The course will run from 10-14 November 2014

**MONDAY 10 NOVEMBER**

| | |
|---|---|
| 08:00 | **Arrivals and registration** |
| 08:30 | **Epidemiology and pathological substrates of heart failure Part I** *A Angelini, Padua* |
| 09:30 | **Epidemiology and pathological substrates of heart failure Part II** *A Angelini, Padua* |
| 10:30 | **Break** |
| 11:00 | **New diagnostic biomarkers and imaging modalities in heart failure Part I** *G Feltrin, Padua* |
| 12:00 | **Alternative to medical therapy: implantable cardioverter defibrillators resynchronisation** *B Osswald, Bad Oeynhausen* |
| 13:00 | **Lunch** |
| 14:00 | **Optimal medical therapy** *C Schulze, New York* |
| 15:00 | **Post-operative monitoring of the surgical patient – new imaging modalities** *to be announced* |
| 16:00 | **Break** |
| 16:15 | **Management of heart failure patients: outpatients clinic/frequent flyers/ moving towards mechanical circulatory support** *C Schulze, New York & B Osswald, Bad Oeynhausen* |
| 17:15 | **Close** |

**TUESDAY 11 NOVEMBER**

| | |
|---|---|
| 08:30 | **Cardiac Surgery for heart faliure Part I: mitral valve repair/replacement** *A Parolari, Milan & V Spadotto, London* |
| 09:30 | **Cardiac Surgery for heart faliure Part II: myocardial revascularisation** *A Parolari, Milan & V Spadotto, London* |
| 10:30 | **Break** |
| 11:00 | **Heart transplantation Part I: indications and patient selection** *M Morshuis, Bad Oeynhausen* |
| 12:00 | **Lunch** |
| 13:00 | **Heart transplantation Part II: surgical techniques: the donor/the recipient** *M Morshuis, Bad Oeynhausen* |
| 14:00 | **Heart transplantation Part III: long-term results** *S Tsui, Cambridge* |
| 15:00 | **Break** |
| 15:15 | **Heart transplantation Part IV: shortage of organ donors: chasing the marginals (new technologies and future perspectives)** *S Tsui, Cambridge & A Simon, Harefield* |
| 16:15 | **Close** |

**WEDNESDAY 12 NOVEMBER**

| | |
|---|---|
| 08:30 | **Heart transplantation in paediatric population: indications, surgical techniques and results** *M Griselli, Newcastle Upon Tyne* |
| 09:30 | **Mechanical circulatory support in paediatric population: indications, surgical techniques and results** *M Griselli, Newcastle Upon Tyne* |
| 10:30 | **Break** |
| 11:00 | **Regenerative medicine for heart failure: the organs' factory. The bioengineered heart** *L Iop, Padua* |
| 12:00 | **The significance of Euromacs** *T De By, Germany* |
| 12:30 | **Lunch** |
| 13:30 | **Wetlab generously sponsored by Thoratec** *Thoratec* |
| 18:00 | **Close** |

**THURSDAY 13 NOVEMBER**

| | |
|---|---|
| 08:30 | **Mechanical circulatory support: Impella, short term ventricular assist devices, extra corporeal membrane oxygenation** *G Gerosa, Padua* |
| 09:30 | **Mechanical circulatory support: left ventricular assist device, biventricular assist device** *M Struber, Leipzig* |
| 10:30 | **Break** |
| 11:00 | **Mechanical circulatory support: total artifical heart** *G Gerosa, Padua* |
| 11:30 | **Less invasive techniques for left ventricular assist device implantation** *T Bottio, Padua* |
| 12:00 | **Which device for which patients, management of the right ventricle** *G Wieselthaler, San Francisco* |
| 13:00 | **Lunch** |
| 14:00 | **Myocardial recovery: fact, fiction and future directions** *M Slaughter, Louisville* |
| 14:30 | **Post-operative care, out of hospital patient management** *M Morshuis, Bad Oeynhausen & VAD-coordinator: D Roefe* |
| 15:00 | **Heart transplant post-ventricular assist device or without ventricular assist device** *G Wieselthaler, San Francisco* |
| 16:00 | **Break** |
| 16:15 | **Trouble shooting. Case reports: residents have to form groups and solve problems** *All Faculty* |
| 17:15 | **Close** |

**FRIDAY 14 NOVEMBER**

| | |
|---|---|
| 08:30 | **Presentation generously sponsored by Heartware Inc.** *Heartware* |
| 09:00 | **Presentation generously sponsored by Berlin Heart** *Berlin Heart* |
| 09:30 | **Break** |
| 10:00 | **Company presentation** |
| 10:30 | **Left ventricular reconstruction** *G Gerosa, Padua* |
| 12:15 | **Summary and close** |
| 12:30 | **Lunch and Depart** |

EACTS
European Association For Cardio-Thoracic Surgery

| EACTS Academy Programme 2014 | |
|---|---|
| Advanced Module: Congenital Surgery | 27-31 October |
| Advanced Module: Heart Failure: State of the Art and Future Perspectives | 10-14 November |
| Thoracic Surgery: Part II | 2-5 December |
| Extra Corporeal Membrane Oxygenation | 20-21 October |
| Advanced Course on the Mitral and Tricuspid Valve | 19-21 November, Munich, Germany |
| Valve Sparing Aortic Root Replacement and Aortic Valve Repair | 28-29 November |
| 4th EACTS Meeting on Cardiac and Pulmonary Regeneration and Stem Cell Technology | 12-13 December, Bern, Switzerland |

| EACTS Academy Programme 2015 | |
|---|---|
| Fundamentals in Cardiac Surgery: Part I | 2-6 February |
| Advanced Module: Open and Endovascular Aortic Therapy | 17-20 March |
| Thoracic Surgery: Part I | 13-17 April |
| Fundamentals in Cardiac Surgery: Part II | 8-12 June |
| Advanced Module: Congenital Surgery | 26-30 October |
| Advanced Module: Heart Failure: State of the Art and Future Perspectives | 9-13 November |
| Thoracic Surgery: Part II | 7-11 December |
| Functional Mitral and Tricuspid Regurgitation | 20-21 February |
| Transcatheter Aortic Valve Implantation | 25-27 February |
| Ventricular Assist Device Coordinator Educational Course | 26-28 March, Berlin, Germany |
| Modern Perspectives on Atrial Fibrilation Surgery | 7-8 May |
| Perioperative Skills in Cardiac Surgery | 22-23 June |
| Infection in Cardiac Surgery | 2-3 July |
| Advanced Aortic and Mitral Valve Reconstructive Surgery | 10-11 July |
| Heart and Lung Transplantation | 7-8 September |
| Chest Wall Diseases | 2-4 December |

All courses to take place at EACTS House in Windsor, UK, unless stated otherwise.

Foundation Courses  Specialist Courses

Raising Standards Through Education and Training

www.eacts.org

# Floor plan

## Exhibition opening times

Saturday: Closed. **Sunday: 15:00–19:00**. Monday: 09:00–17:00. **Tuesday: 09:00–17:00**. Wenesday: Closed.

| | |
|---|---|
| **47** | A&E Medical |
| **15** | AATS<br>American Association for Thoracic Surgery |
| **6** | Abbott Vascular |
| **123** | Admedus |
| **5** | Advancis Surgical |
| **95** | Andocor |
| **3** | AngioDynamics |
| **10** | Argentum Medical |
| **92, 93** | Asanus Medizintechnik |
| **77** | ATMOS MedizinTechnik |
| **105** | AtriCure |
| **108** | B Braun Surgical |
| **106** | Bard |
| **127–8** | Baxter Healthcare |
| **109** | Berlin Heart |
| **71** | BioCer Entwicklungs |
| **62** | Biointegral Surgical |
| **7** | Cardia Innovation |
| **88, 89** | CardiaMed |
| **21** | Cardio Medical &<br>Sengewald Klinikprodukte |
| **23, 24** | CareFusion International |
| **75, 76** | Carmat |
| **80** | Cook Medical |
| **42** | CorMatrix Cardiovascular |
| **33, 34** | Covidien |
| **104** | Cryolife Europa |
| **12** | CTSNet |
| **61** | CytoSorbents Europe |
| **64** | De Soutter Medical |
| **90, 91** | Delacroix-Chevalier |
| **73** | Dendrite Clinical Systems |
| **18** | DGM/Global Intercepts |
| **124** | EACTS<br>The European Association for Cardio-Thoracic Surgery |
| **101** | Edwards Lifesciences |
| **113** | Eurosets |
| **85, 86** | Fehling Instruments |
| **57** | G+N MEDICAL |
| **126** | gebemed medical systems |
| **81, 82** | Gebrueder Martin &<br>KLS Martin Group |
| **117** | Geister Medizintechnik |
| **35** | Genesee BioMedical |
| **48** | GEOMED Medizin-Technik |
| **52** | GUNZE |
| **125** | Hamamatsu Photonics Deutschland |
| **26** | Heart and Health Foundation |
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