Reconstructive surgery of the aortic root

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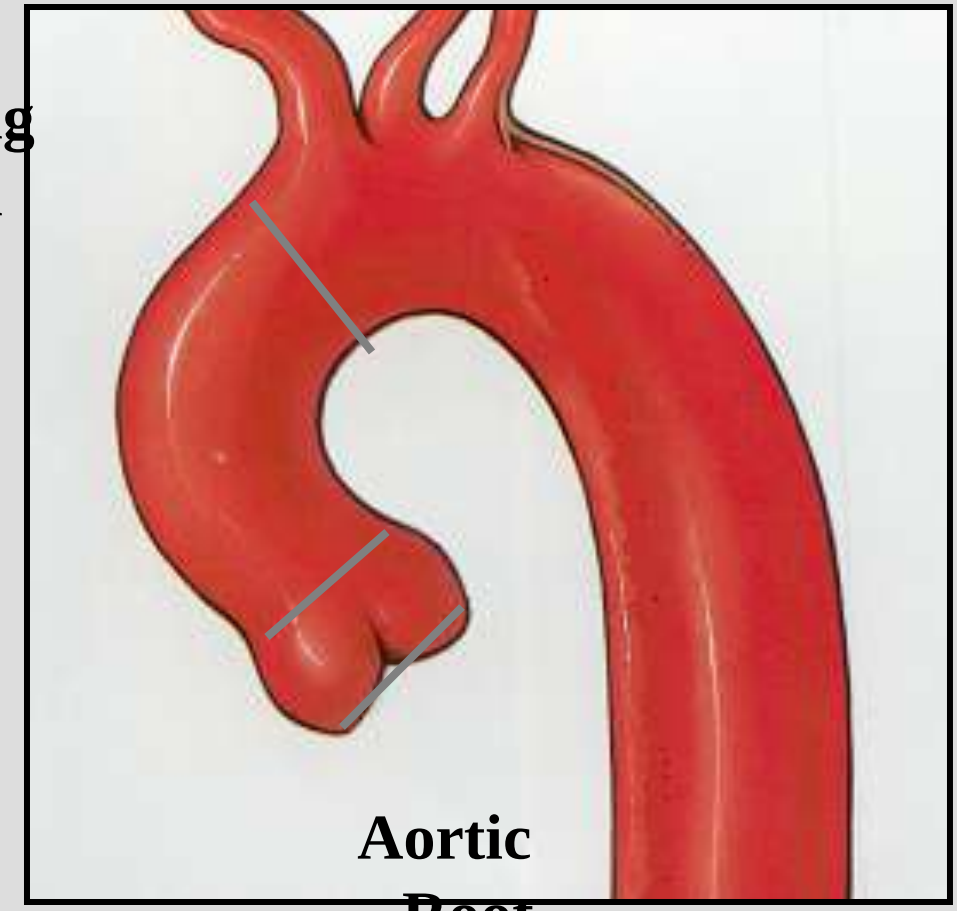
Reconstructive surgery of the aortic root

"Aortic valve repair: still a dream?" -*1997 M. Antunes*

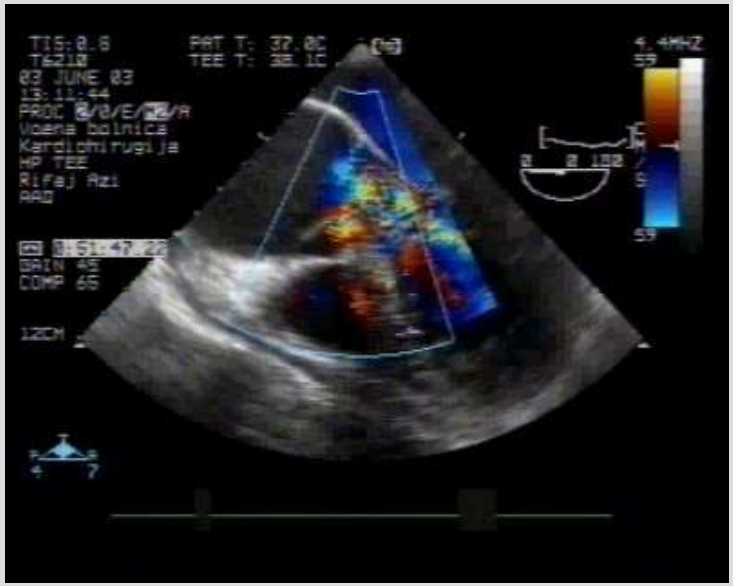
Ascending Aorta



Aortic Root

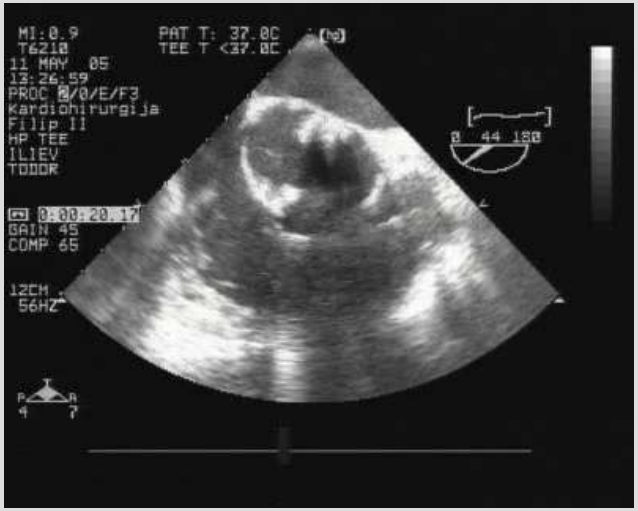
Reconstructive surgery of the aortic root

In insufficiency-established last few years



Acute aortic insuff due to dissection of the ascenidng aorta

In stenosis still is ?????



Aortic stenosis- calcification of the leaflets

Reconstructive surgery of the aortic root – mortality

Aortic regurgitation -

Asymptomatic

Normal LV function (good prognosis)

- 75% 5 years survival

- Sudden death 0,2%

Abnormal LV function

- 50% - 5 year survival

- Sudden death 2%

Symptomatic (bad prognosis)

- 15% - 5 year survival

- Sudden death> 10%

Therapy: Conservative treatment

Surgical treatment before LV dysfunction occurs.

Aortic stenosis

Symptom/Sign

Live expectancy

Angina	5 years
Syncope	2-3 years
Congestive Heart Failure	1-2 years

Therapy: Valve replacement for severe aortic stenosis

Operative mortality (elderly) 4-24%/

Morbidity 3-11%

Event rate in asymptomatic severe AS ~ 1%/year

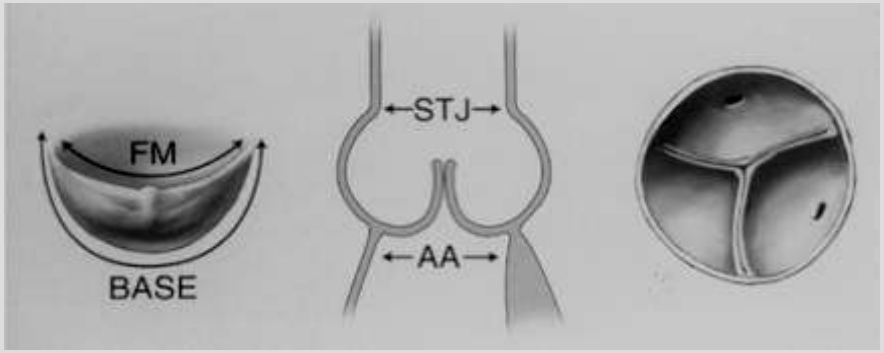
www.escardio.org

Reconstructive surgery of the aortic root

Aortic insuficiency

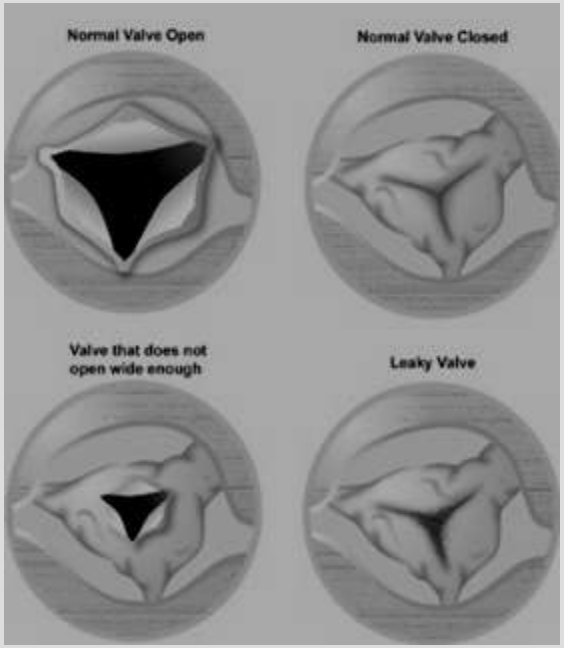
Different techniques depending on the assessment mode of the functional aortic annulus.

Functional aortic annulus (aortic root) FAA = internal part (aortic ventricular junction) + external part (sinotubular junction)



Aortic stenosis

Still there is no approach !!!



Reconstructive surgery of the aortic root

Types of aortic regurgitation according to the pathoanatomical changes of the functional aortic annulus FAA

Type I. Normal cusps with FAA dilatation

Ia: Distal ascending aorta dilation (sino-tubular junction) – aterosclerotic ethiology

Ib: Proximal (Valsalva sinuses) and sino-tubular junction dilation- Marfan Sy, sinus Valsalva ectasia…

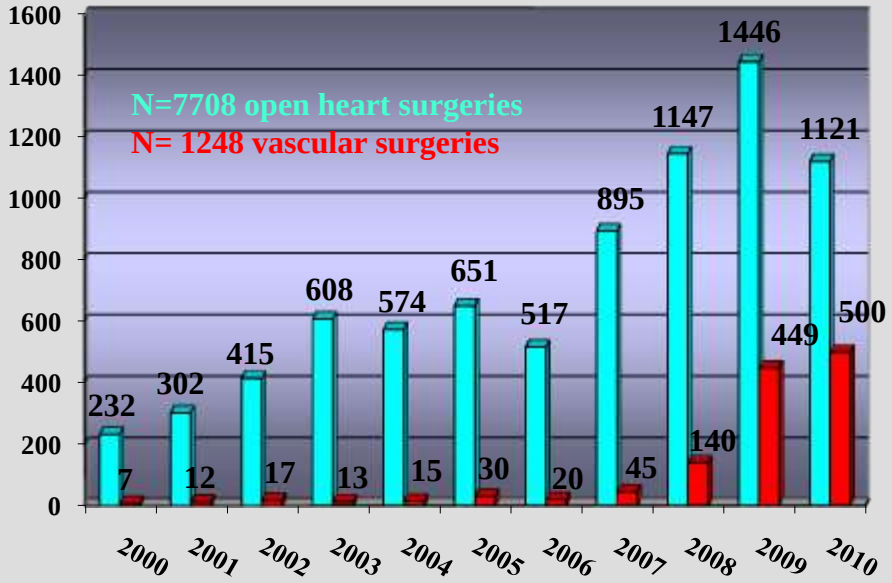
Ic: Isolated FAA dilation --- aortic ectasia

Id: Cusp perforation and FAA dilation

Type II. Cusp prolapsed: excess of cuspal tissue or commissural disruption,dissection

Type III. Cusp retraction, thickening and calcification.

Reconstructive surgery of the aortic root- 11 years experience

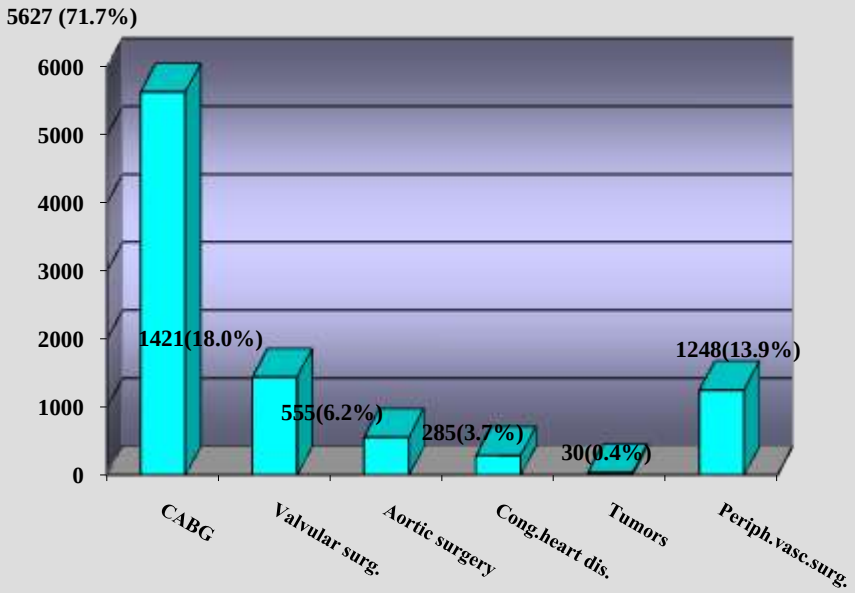


Number of operations per year

N=9156pts.

Type of surgery (08.12.2010)

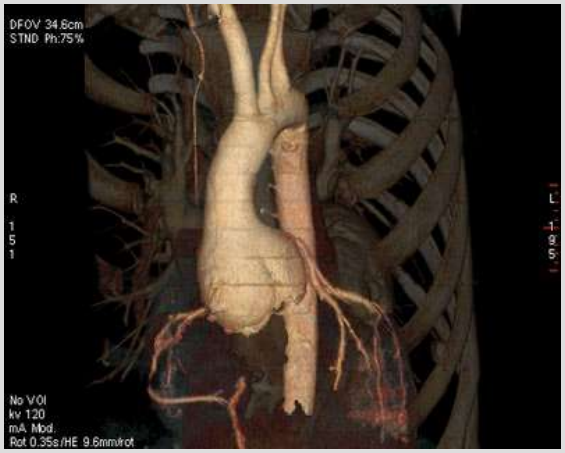
N = 9156pts

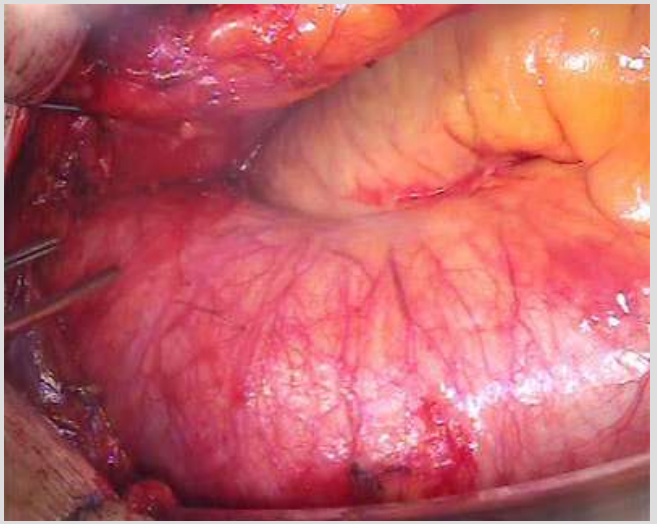


Reconstructive surgery of the aortic root

Type I. Normal cusps with FAA dilatation

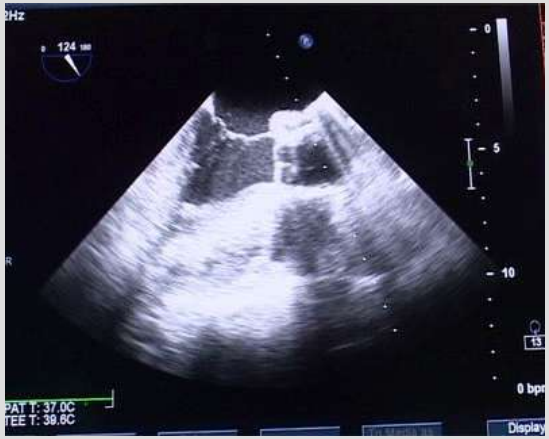
Surgery-Tirone David





Pre-operative

Post-operative



64 MSCT scan

transoesophageal echo 2D/3D

Surgical treatment:

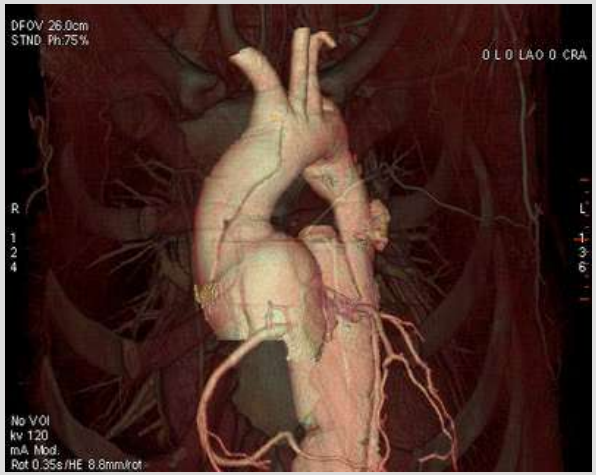
- sino-tubular junction remodelling**;**
- replacement of the ascending aorta with a tube graft
- sub-commissural annuloplasty
- Yacoub, David operation
- FAA anuloplasty

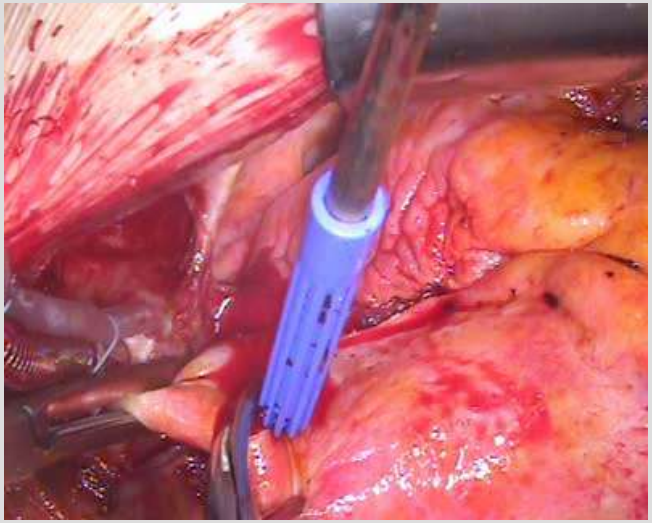
Cardiosurgery-Skopje

Reconstructive surgery of the aortic root

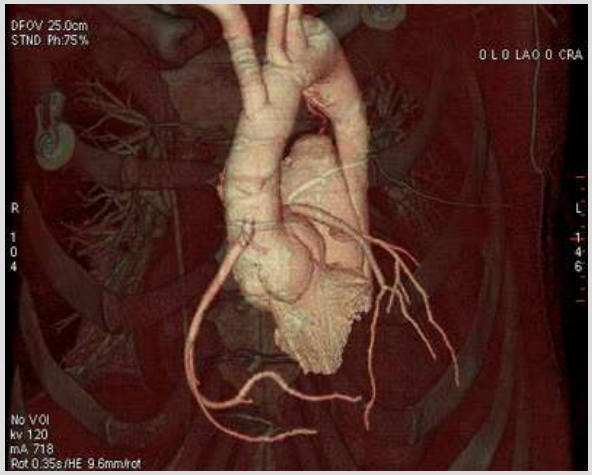
Type II. Cusp prolapse: excess of cuspal tissue or commissural disruption

Surgery- reinforcement of the free leaflet margine





Pre-operative **Post-operative**



64 MSCT scan **transoesophageal echo 2D/3D**

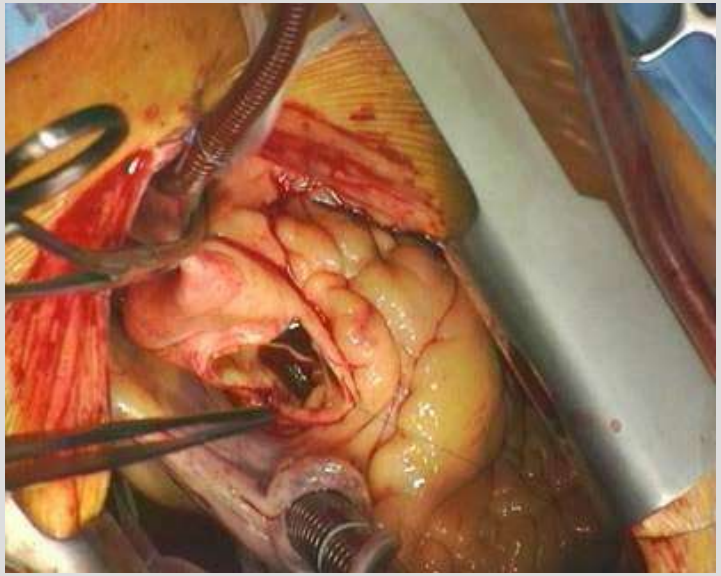
Surgical treatment:

- Free margin plication
- triangular resection
- implantation of stentless valve
- tuging (sparing) surgery
- reinforcement of the free leaflet margin

Cardiosurgery-Skopje

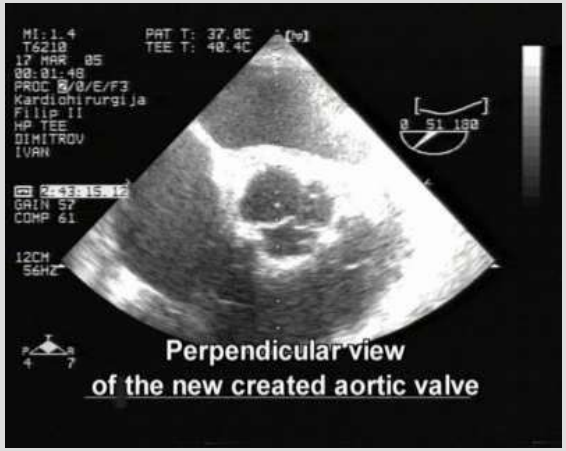
Reconstructive surgery of the aortic root

Type III. Cusp retraction, thickening and calcification.



Surgery:

- shaving of the nodes and free margin,
- cusp extension with pericardium and calcium enucleation,
- cusps replacement
- **Reconstruction of aortic leaflets**



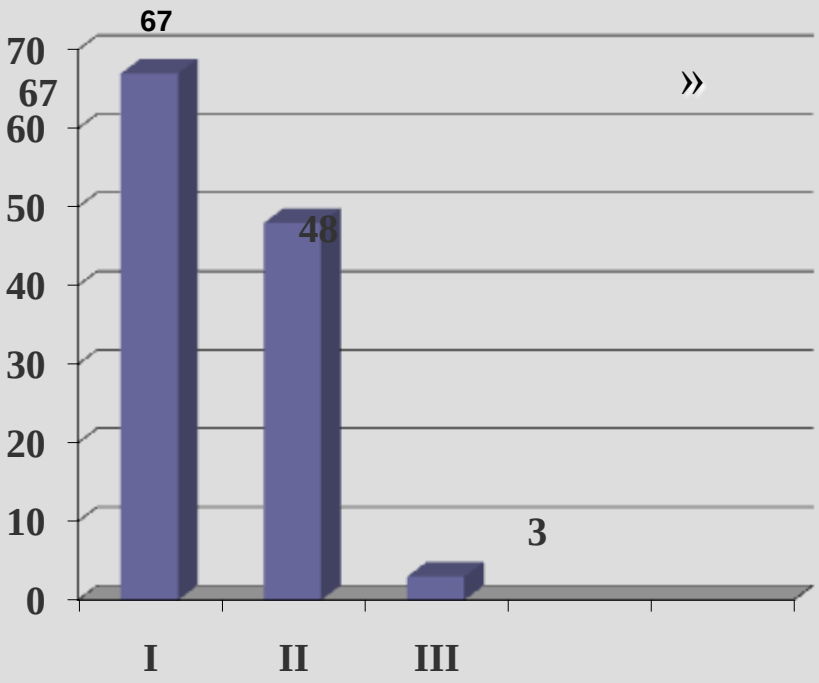
Aortic reconstructive surgery N=276patients

Type of surgery	Normal root	Aortic dissection	Aortic aneurysm
Tyrone David		32	34
Suspension of the aortic annulus		34	27
Reinforcement of the free margine of the semilunar leaflet	20	4	10
Replacement one of the semilunar aortic leaflet	3	/	/
Replacement two of the semilunar aortic leaflet	5		
RECONSTRUCTIVE SURGERY IN AORTIC STENOSIS Replacement of three aortic leaflets- a type of aortic root reconstructive surgery	100	3	5

Aortic insuficiency

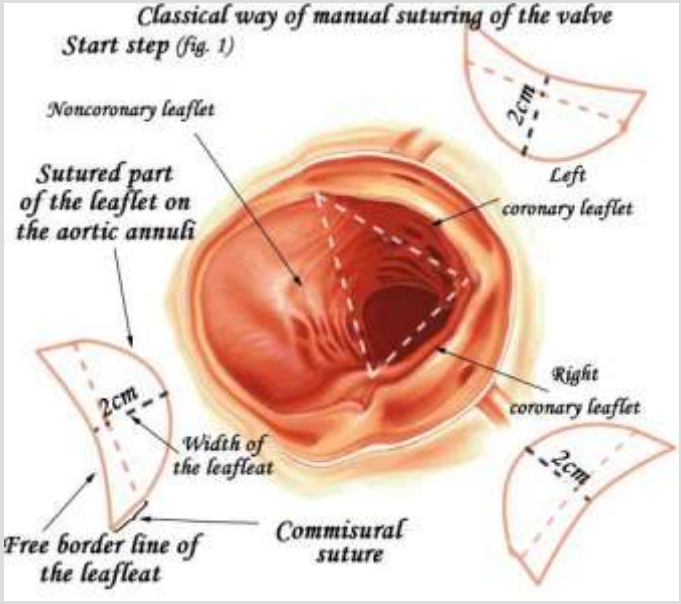
Aortic root reconstructive surgery for aortic stenosis - clinical approaches

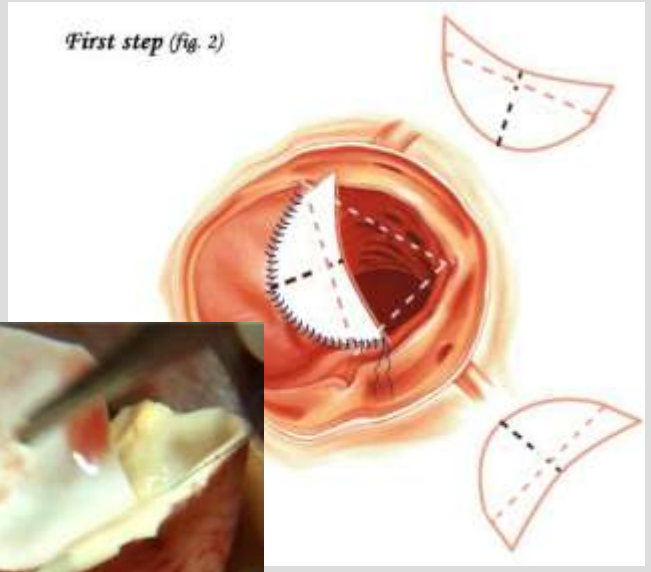
- **Prospective study N = 118 pts Age (years) 56 ± 7.6y**
- **Sex (f/m) 24 / 64**
- **The oldest patient – 72y**

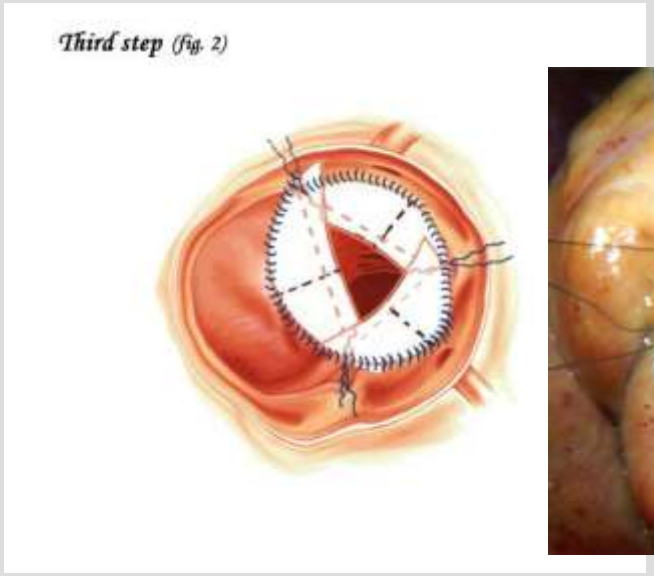


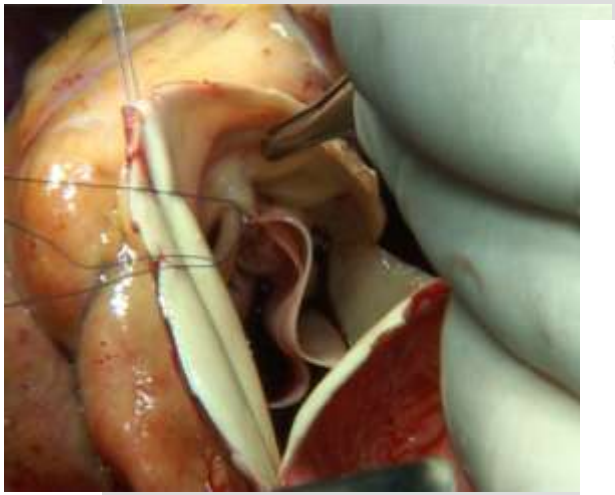
I=atherosclerotic ethyology
II=rheumatic ethyology
III=subacute endocarditis in patients on chronic haemodyalysis

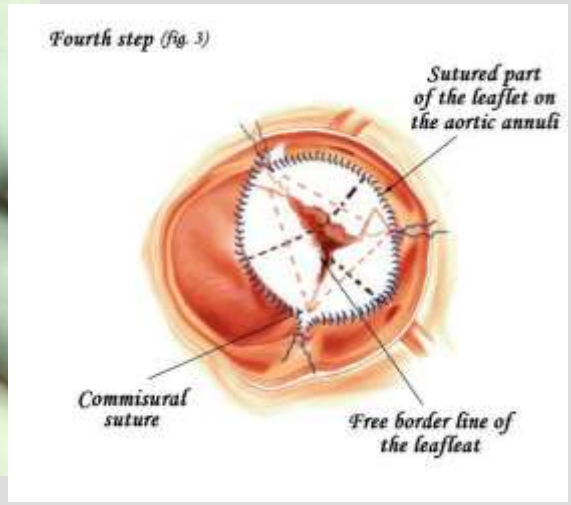
How to do it


Classical way of manual suturing of the valve
Start step (fig. 1)
Noncoronary leaflet
Sutured part of the leaflet on the aortic annuli
2cm
Left coronary leaflet
Right coronary leaflet
2cm
Width of the leafleat
2cm
Free border line of the leafleat
Commisural suture

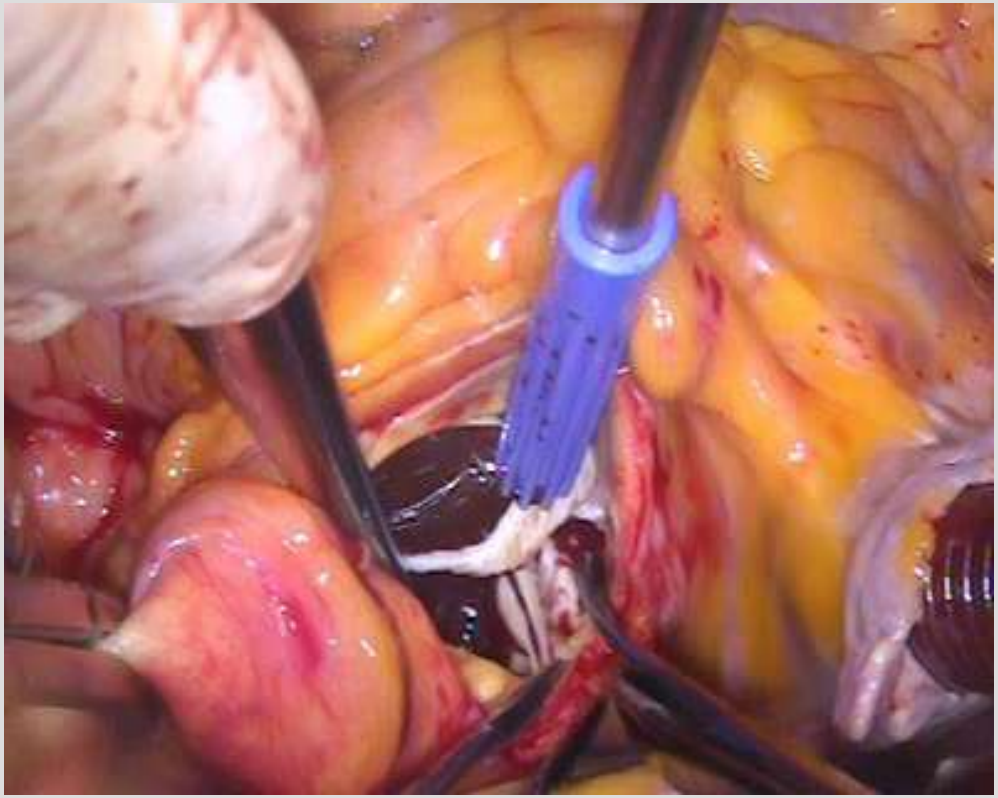

First step (fig. 2)


Third step (fig. 2)




Fourth step (fig. 3)
Sutured part of the leaflet on the aortic annuli
Commisural suture
Free border line of the leafleat

Aortic root reconstructive surgery for aortic stenosis
Reconstruction of aortic leaflets N= 118 pts.



surgery

Preop.echo 2D TEE

Postop.echo 2D TEE

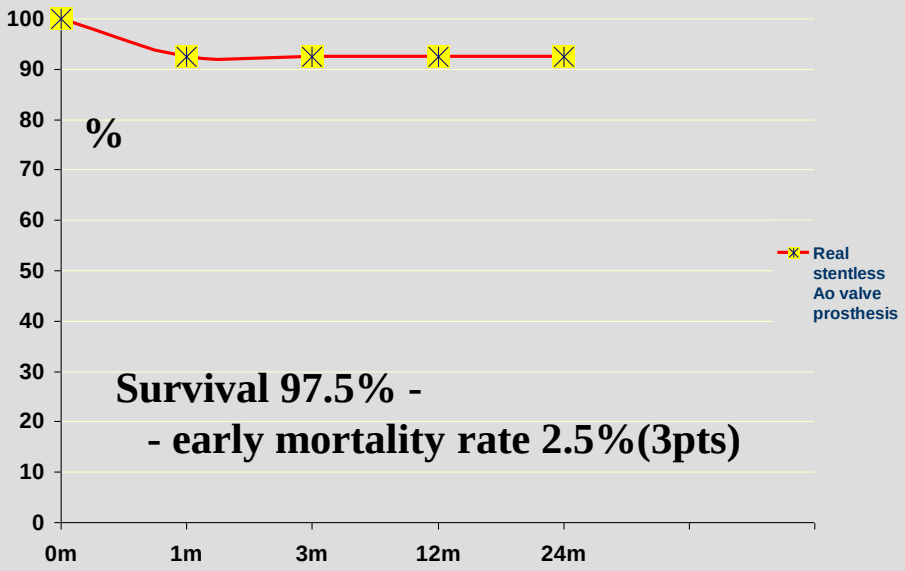
Results N= 118 pat

- **Early survival (30 days) 97.5 %(3pts)**
- **Other main complication:**
- **Bleeding 5 pat (3 surg.ethyology)**
- **Ventilation time 6.8h 2.2**
- **Stroke 2 (1 with left side hemiparesis)**
- **3pts (with preoperative terminal renal failure) with CAVH 5 days in combination with bicarbonate haemodyalisis**
- **Length of ICU stay 4.1d 2.1**
- **Hospital stay 12.4 3.2**
- **Follow up period 1-108 months**

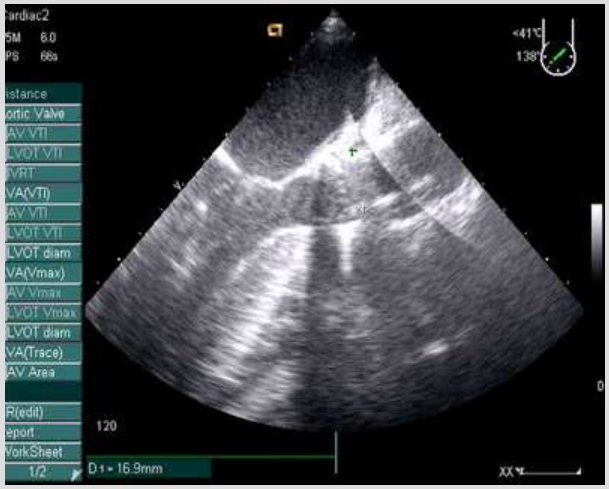
Intra-operative TEE data

- *Dp/dt = 0.07 0,015; SS= 22±3.2*
- *EAO cm2=3.6±0,8; CO = 6,5±2.9l*
- *Average systolic valve gradient 14±6.8mmHg*
- *Average mean valve gradient 7±5.6mmHg*

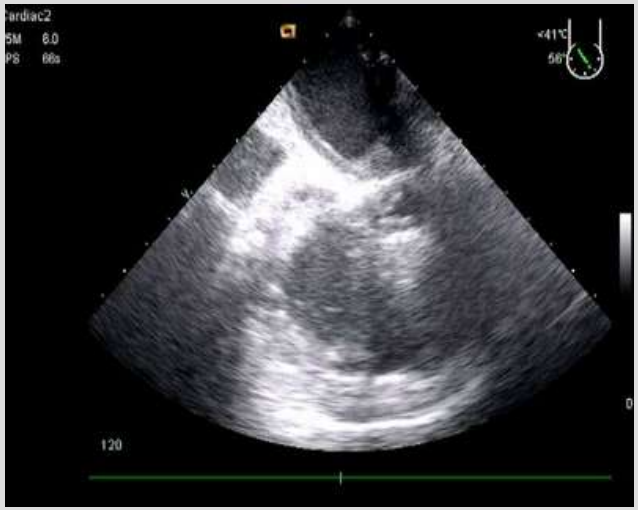
Actuarial survival



Replacement Aortic Valve Leaflets in a patient with a small roth aorta – case report



Pre-operative echocardiography

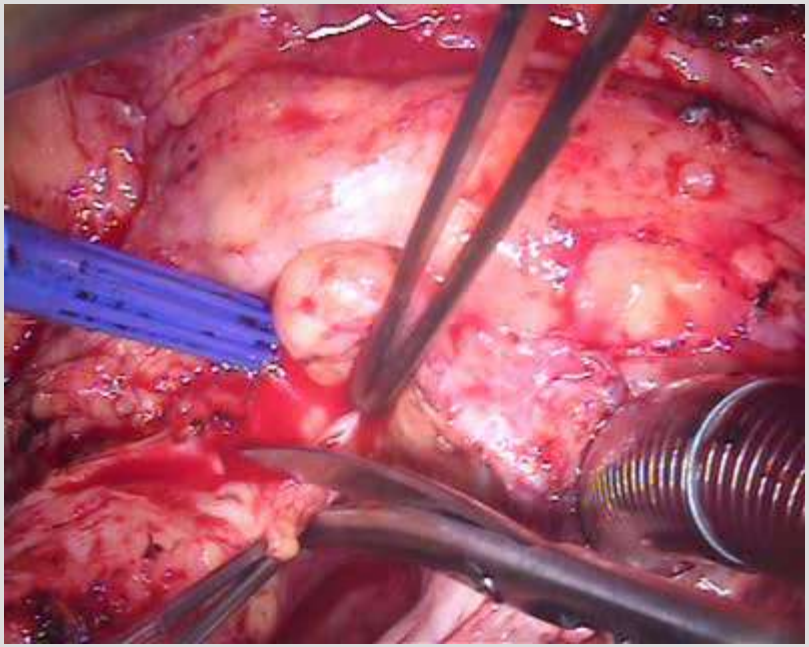


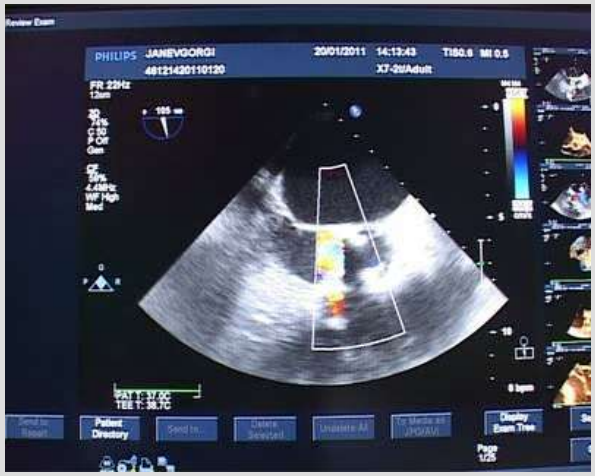
Post-operative echocardiography

68y.old women
Severe symptomatic aortic stenosis
Small aortic roth – 16,9mm
Severe calcificated ascending aorta up to aortic arch
Once delated operation- because of her condition

Cardiosurgery-Skopje

Re-operation-replacement Aortic Valve Leaflets in a patient with prosthetic endocarditis – case report





Pre-operative echocardiography

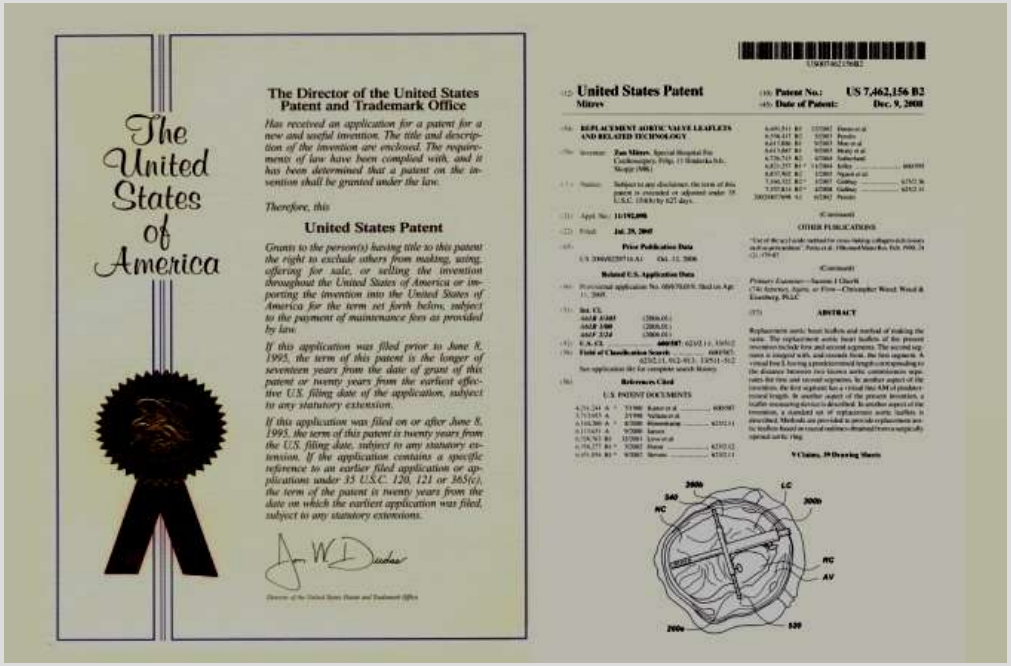
64y.old men; 04/2007 biologic aortic valve prosthesis
09/2010 Pseudomonas pneumonia with severe symptomatic prosthetic endocarditis
Peri-annular abscess
Positive haemoculture- Pseudomonas aurogenosa
ICV- aphasio
3mounths after ICV re-operation

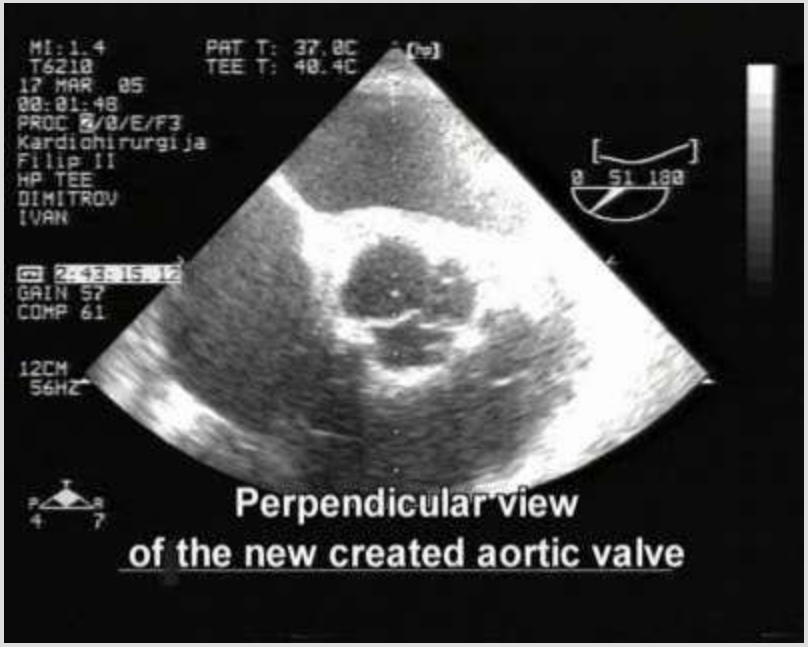
Post-operative echocardiography

Cardiosurgery-Skopje

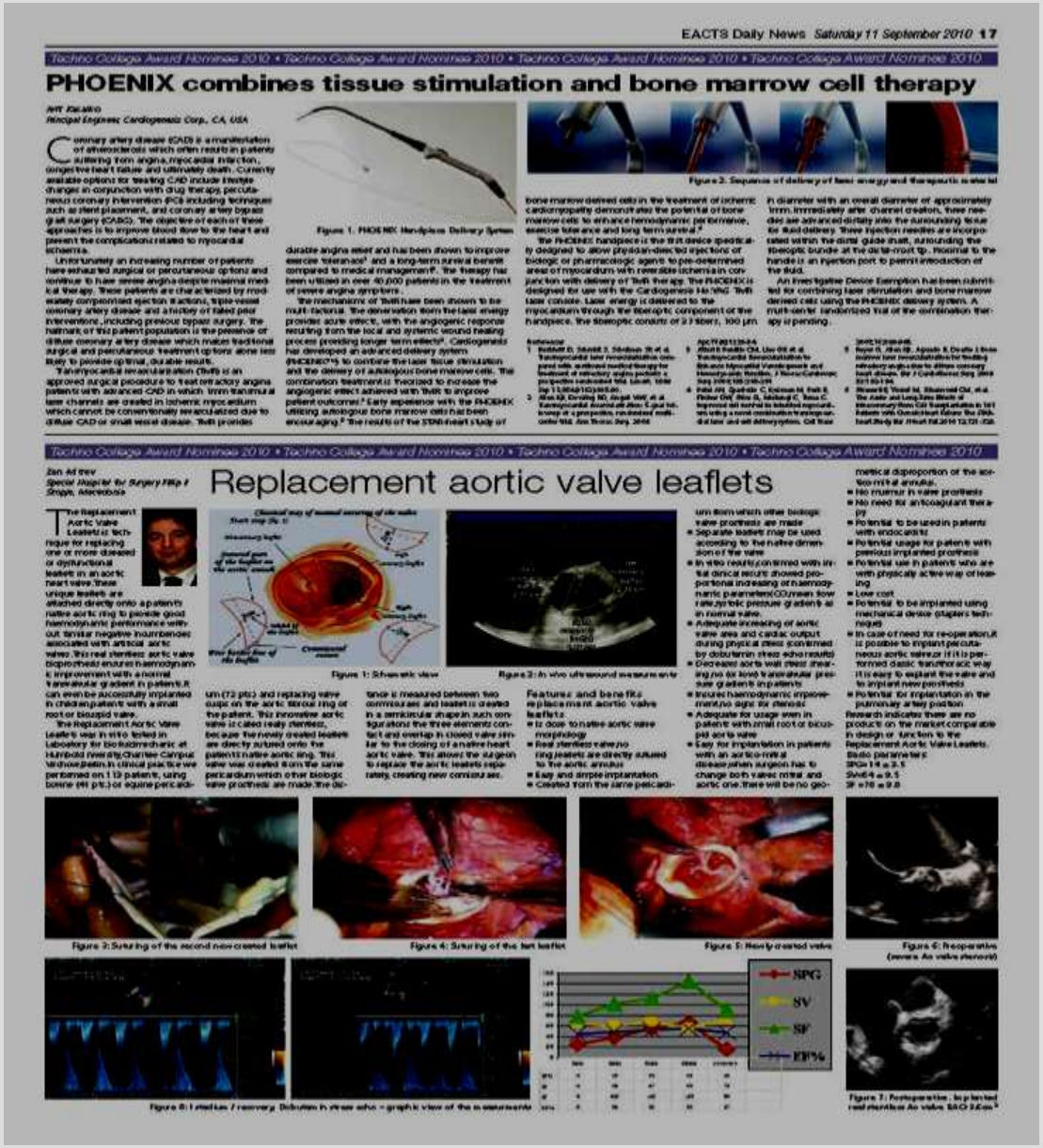
Aortic root reconstructive surgery for aortic stenosis
Reconstruction of aortic leaflets

Accepted as a patent in USA 09.12.2008





Post-operative echo



EACTS Daily News *Saturday 11 September 2010* 17

Techno College Award Nominee 2010 • Techno College Award Nominee 2010 • Techno College Award Nominee 2010 • Techno College Award Nominee 2010

PHOENIX combines tissue stimulation and bone marrow cell therapy

Art Kaukko
Principal Engineer, Cardiogenesis Corp., CA, USA

Coronary artery disease (CAD) is a manifestation of atherosclerosis which often results in patients suffering from angina, myocardial infarction, congestive heart failure and ultimately death. Currently available options for treating CAD include lifestyle changes in conjunction with drug therapy, percutaneous coronary intervention (PCI) including techniques such as stent placement, and coronary artery bypass graft surgery (CABG). The objective of each of these approaches is to improve blood flow to the heart and prevent the complications related to myocardial ischaemia.

Unfortunately an increasing number of patients have exhausted surgical or percutaneous options and continue to have severe angina despite maximal medical therapy. These patients are characterized by moderately compromised ejection fractions, triple-vessel coronary artery disease and a history of failed prior interventions, including previous bypass surgery, the hallmark of this patient population is the presence of diffuse coronary artery disease which makes traditional surgical and percutaneous treatment options alone less likely to provide optimal, durable results.

Transmyocardial revascularization (TMR) is an approved surgical procedure to treat refractory angina patients with advanced CAD in which 1mm transmural laser channels are created in ischemic myocardium which cannot be conventionally revascularized due to diffuse CAD or small vessel disease. TMR provides durable angina relief and has been shown to improve exercise tolerance[1] and a long-term survival benefit compared to medical management[2]. The therapy has been utilized in over 40,000 patients in the treatment of severe angina symptoms.

The mechanisms of TMR have been shown to be multi-factorial. The denervation from the laser energy patient acute effects, with the angiogenic response resulting from the local and systemic wound healing process providing longer term effects[3]. Cardiogenesis has developed an advanced delivery system (PHOENIX™) to combine the laser tissue stimulation and the delivery of autologous bone marrow cells. The combination treatment is theorized to increase the angiogenic effect achieved with TMR to improve patient outcomes[4]. Early experience with the PHOENIX utilizing autologous bone marrow cells has been encouraging[5]. The results of the STAR-heart study of bone marrow derived cells in the treatment of ischemic cardiomyopathy demonstrated the potential of bone marrow cells to enhance hemodynamic performance, exercise tolerance and long term survival.[6]

The PHOENIX handpiece is the first device specifically designed to allow physician-directed injections of biologic or pharmacologic agents to pre-determined areas of myocardium with reversible ischemia in conjunction with delivery of TMR therapy. The PHOENIX is designed for use with the Cardiogenesis HeartLinq™ TMR laser console. Laser energy is delivered to the myocardium through the fiberoptic component of the handpiece. The fiberoptic consists of a 2.3 fiber, 100 µm in diameter with an overall diameter of approximately 1mm. Immediately after channel creation, three needles are advanced distally into the surrounding tissue for fluid delivery. These injection needles are incorporated within the distal guide shaft, surrounding the fiberoptic bundle at the distal-most tip. Proximal to the handle is an injection port to permit introduction of the fluid.

An Investigative Device Exemption has been submitted for combining laser stimulation and bone marrow derived cells using the PHOENIX delivery system. A multi-center randomized trial of the combination therapy is pending.

Figure 1. PHOENIX Handpiece Delivery System

Figure 2. Sequence of delivery of laser energy and therapeutic material

1. Burkhoff D, Oldenburg O, Sabbah HN et al. Transmyocardial laser revascularization: comparison with optimized medical therapy for treatment of refractory angina pectoris: a prospective randomized trial. Lancet. 1999 Sep 11;354(9182):885-90.
2. Allen KB, Dowling RD, Argall WM, et al. Transmyocardial revascularization update. J Card Surg. 2000 Jan-Feb;15(1):1-8.
3. Aktan AB, Chekanov VS, Mikhaylov EN, et al. Human pilot trial of injection myocardial angiogenesis gene therapy for stable and unstable incurable ischemia. Int J Cardiol. 2001 Jan;77(1):37-46.
4. Aktan AB, Chekanov VS, Mikhaylov EN, et al. Human pilot trial of injection myocardial angiogenesis gene therapy for stable and unstable incurable ischemia. Int J Cardiol. 2001 Jan;77(1):37-46.
5. Patel AN, Geffner L, Vina RF, et al. Surgical treatment for congestive heart failure with autologous adipose-derived regenerative cells. J Heart Lung Transplant. 2005 Dec;24(12):1943-9.
6. Perin EC, Dohmann HF, Borojevic R, et al. Transendocardial, autologous bone marrow cell transplantation for severe, chronic ischemic heart failure. Circulation. 2003 Jun 24;107(24):2294-302.

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Zan Ad trev
Special Hospital for Surgery Filip I Skopje, Macedonia

Replacement aortic valve leaflets

The Replacement Aortic Valve Leaflet is a technique for replacing one or more diseased or dysfunctional leaflet in an aortic heart valve. These unique leaflets are attached directly onto a patient's native aortic ring to provide good haemodynamic performance without annular negative incurrences associated with artificial aortic valves. This real stentless aortic valve bioprosthesis ensures haemodynamic improvement with a normal transvalvular gradient in patients. It can even be successfully implanted in child-patients with a small root or bicuspid valve.

The Replacement Aortic Valve Leaflet was initially tested in Laboratory for biomechanics at Humboldt University Charite Campus Virchow-Klinikum. Clinical practice was performed on 113 patients, using bovine (48 pts.) or equine pericardium (72 pts.) and replacing valve cusps on the aortic fibrosa ring of the patient. This innovative aortic valve is called really stentless, because the newly created leaflets are directly sutured onto the patient's native aortic ring. This valve was created from the same pericardium which other biologic valve prothesis are made. The distance is measured between two commissures and leaflet is created in a semicircular shape in such configuration the three elements contact and overlap in closed valve similar to the closing of a native heart aortic valve. This allows the surgeon to replace the aortic leaflets separately, creating new commissures.

Figure 1: Schematic view

Figure 2: In vivo ultrasound measurements

Features and benefits replace mant aortic valve leaflets:
- Is close to native aortic valve morphology
- Real stentless valve no ring,leaflets are directly sutured to the aortic annulus
- Easy and simple implantation
- Created from the same pericardium from which other biologic valve prothesis are made
- Separate leaflet may be used according to the native dimension of the valve
- In vitro results confirmed with initial clinical results showed proportional increasing of haemodynamic parameters(CO,mean low rate,systolic pressure gradient) as in normal valve.
- Adequate increasing of aortic valve area and cardiac output during physical stress (confirmed by dobutamin stress echo results)
- Decreased aorta wall mass/ diameter ratio no or low transvalvular pressure gradient in patients
- Insured haemodynamic improvement,no signs for stenosis
- Adequate for usage even in patients with small root or bicuspid aorta valve
- Easy for implantation in patients with an aortic-mitral disease,when surgeon has to change both valves: mitral and aortic one,there will be no geometrical disproportion of the aortic-mitral annulus.
- No murmur in valve prothesis
- No need for anticoagulant therapy
- Potential to be used in patients with endocarditis
- Potential usage for patients with previous implanted prothesis
- Potential use in patients who are with physicaly active way of leaving
- Low cost
- Potential to be implanted using mechanical device (staplers technique)
- In case of need for re-operation,it is possible to implant percutaneous aortic valve,or it is performed classic transthoracic way. It is easy to explant the valve and to implant new prothesis
- Potential for implantation in the pulmonary artery position

Research indicates there are no products on the market comparable in design or function to the Replacement Aortic Valve Leaflets.

Basic parameters:
SPG= 14 ± 3.1
SV=64 ± 9.1
SF =70 ± 9.8

Figure 3: Suturing of the second new-created leaflet

Figure 4: Suturing of the last leaflet

Figure 5: Newly-created valve

Figure 6: Preoperative (severe Ao valve stenosis)

Figure 8: Left atrium / recovery. Dobutrin in stress echo + graphic view of the measurements

Figure 7: Postoperative, bioprosthetic root stentless Ao valve, EACG 2.Cas

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Conclusion:

Reconstructive surgery of the aortic root covers many complex surgical techniques, whose application depends on the preoperative functional state of the aortic annulus.

The patients do not need anticoagulation therapy.

Aortic leaflet reconstructive surgery is possible even in aortic stenosis

The past results have shown good clinical outcome, better quality of life and good rate of mid term survival.

I PORED OPERACIJE

PACIJENTU JE IPAK DOBRO

Prof dr.sc. Ino Husedžinović, dr.med.