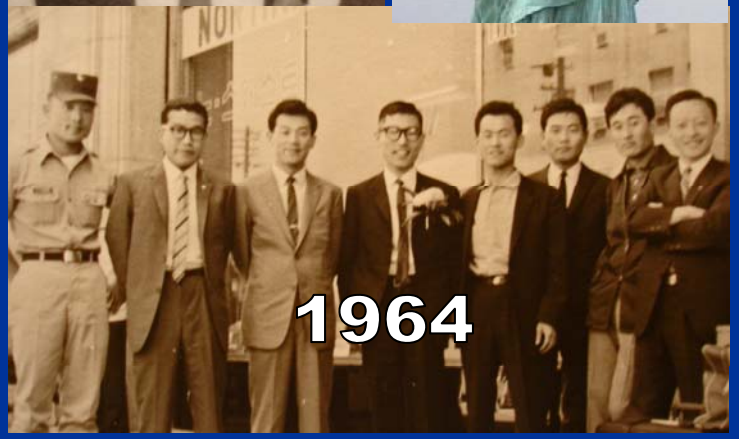
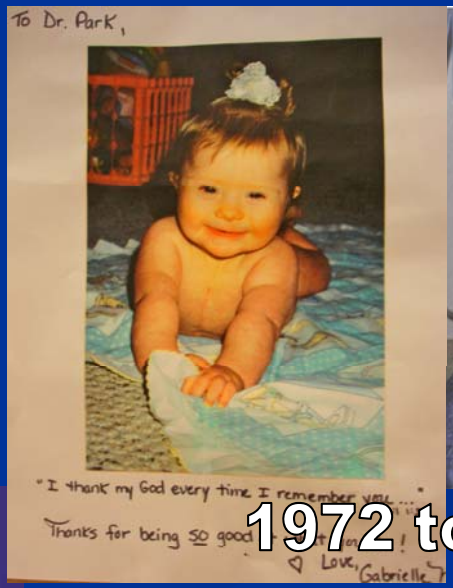
Pediatric Cardiology
Past, Present, and Future
My Journey

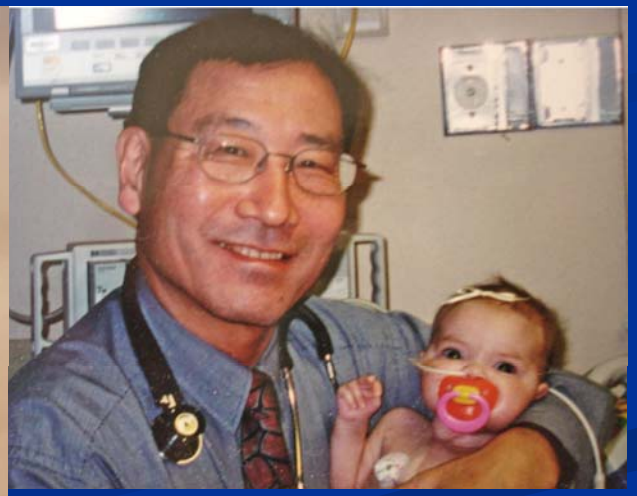
Korean Society of Circulation
51st Annual Scientific Meeting
October 11th -13th 2007
Seoul, Korea

Sang C. Park, M.D.
Professor of Pediatrics
University of Pittsburgh School of Medicine

Time Flies!







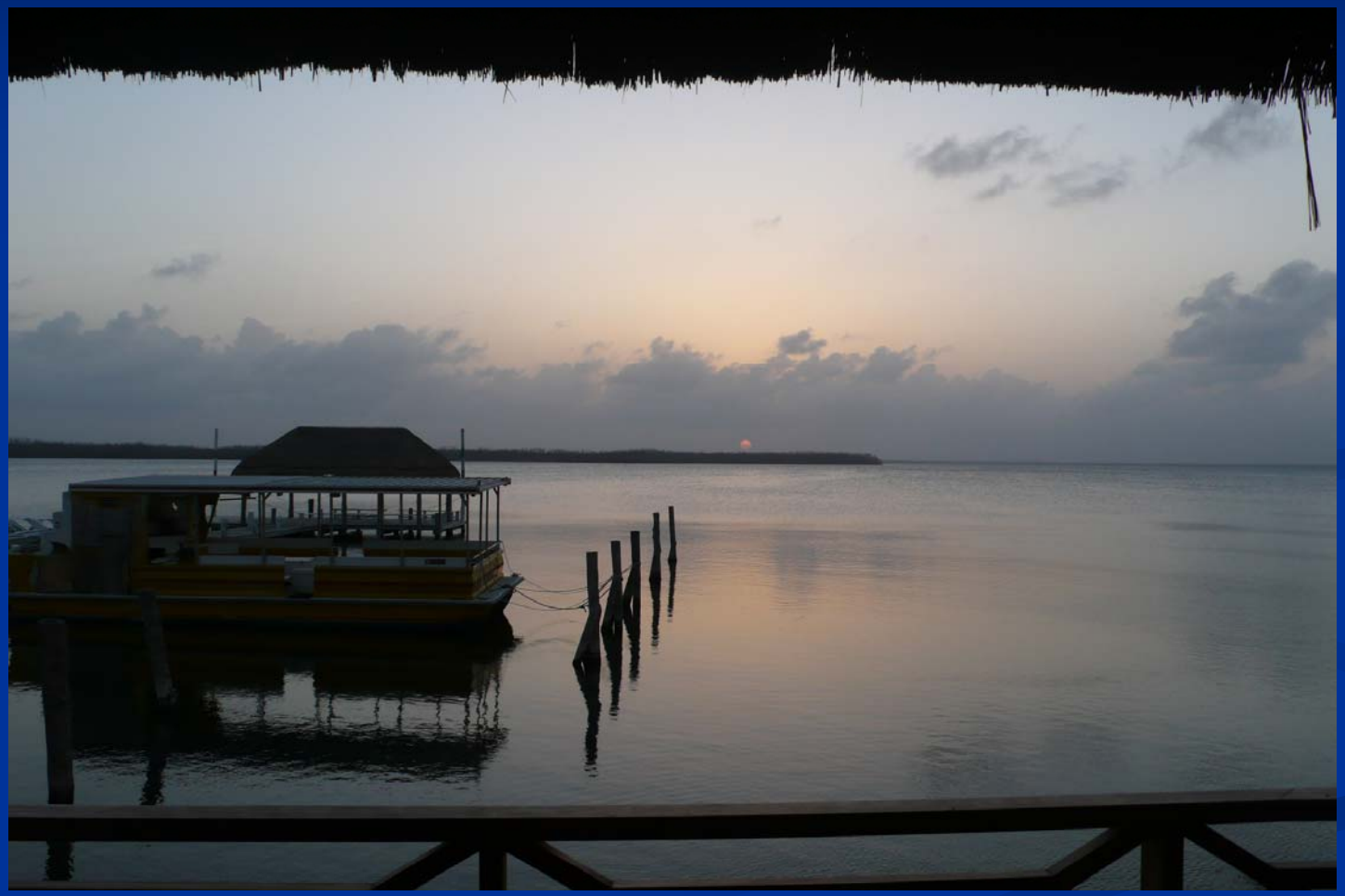
1972 to Present

35 years

Children's Hospital of Pittsburgh


1992

The Beginning of Pediatric Cardiology



Surgical Progress in Pediatric Cardiology 1

- 1939 PDA Ligation (Gross)
- 1945 Coarctation Resection (Crawford)
- **1945** ***Blalock-Taussig Shunt***
- 1950 Surgical Septectomy (Blalock - Hanlon)
- 1954 Pump Oxygenator (Gibbon)
- 1955 Open Bypass Heart Surgery (Lillihie)
- 1959 Senning Procedure
- 1964 Mustard Procedure

Surgical Progress in Pediatric Cardiology 2

- 1968 Human Heart Transplant (Barnard)
- 1971 Fontan Procedure
- 1975 Damus-Kaye-Stansel Procedure
- 1976 Arterial Switch Procedure (Jatene)
- 1976 Rastan-Konno Procedure
- 1981 Norwood Procedure
- 1981 Pediatric Heart Transplant

Blalock – Taussig Procedure

Dr. Albert Blalock (now deceased) and Dr. Taussig at a conference in 1949.

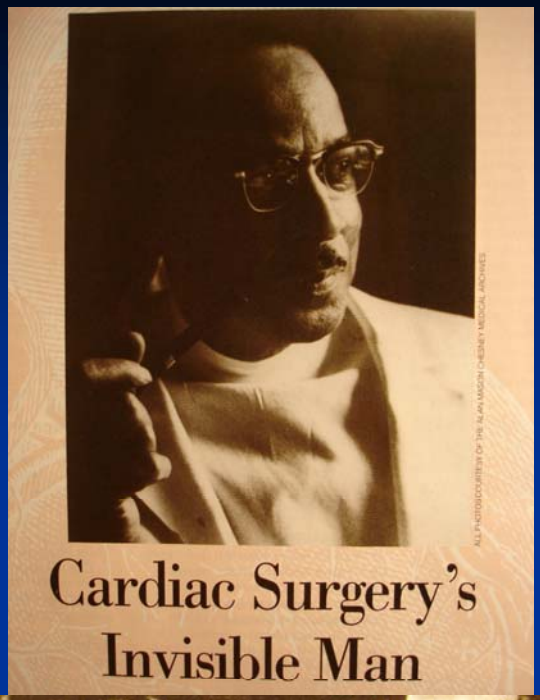
Dr Blalock and Dr Taussig

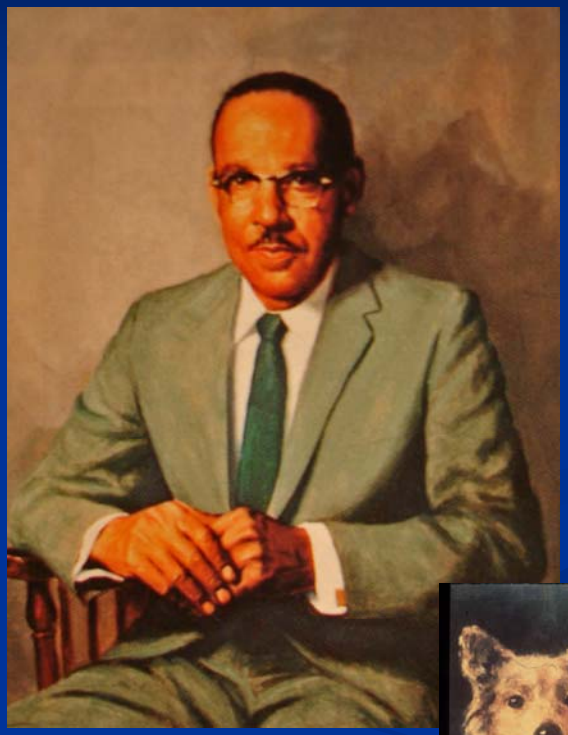
At the news conference in 1949

- Dr Helen Taussig conceived an idea of creating PDA for cyanotic patients with TOF.
- Initially contacted Dr Robert Gross at Harvard but he rebuked her.
- Dr Afred Blalock reluctantly accepted the challenge and persuasion by Dr Taussig.

Vivien Thomas

Dr Blalock's Lab assistant





Johns Hopkins Hospital

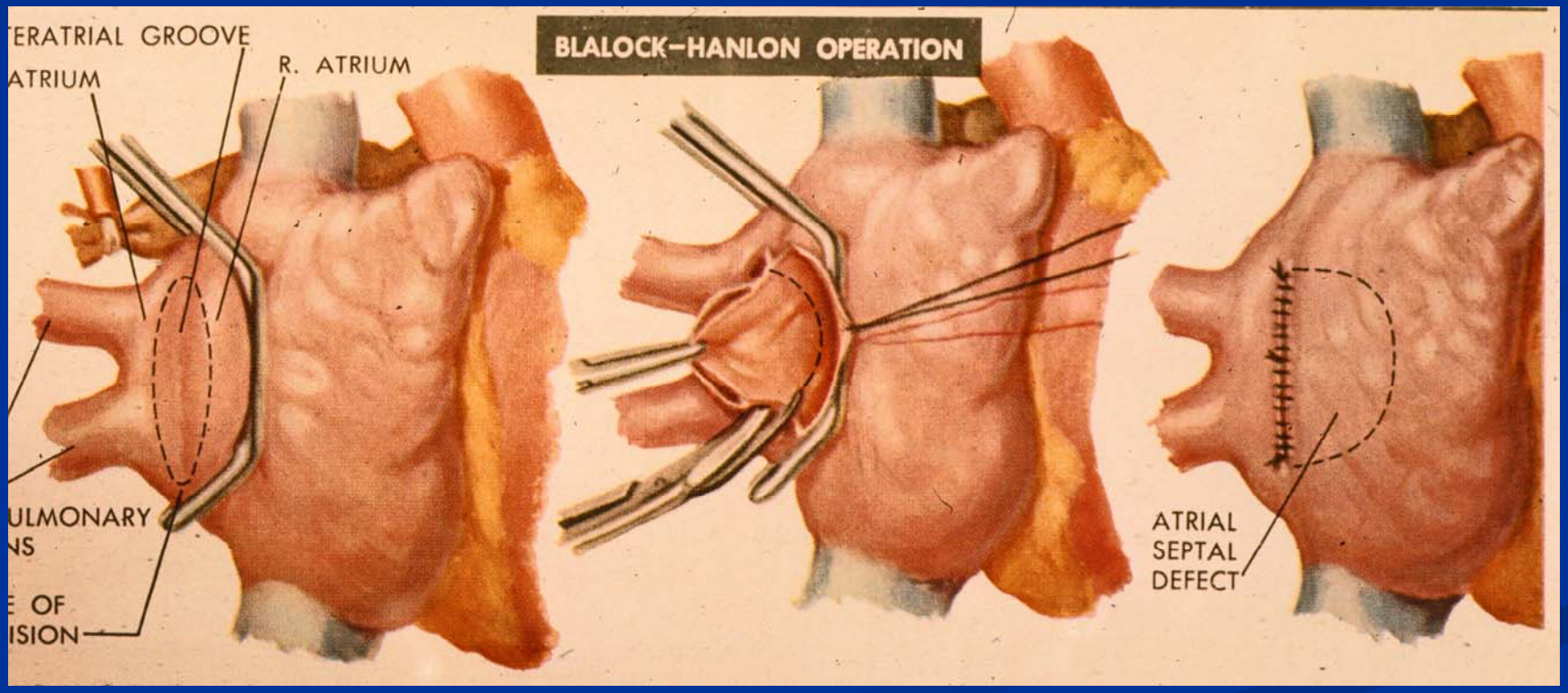
Mother of Pediatric Cardiology

Hopkins Reunion in 1976

Historical Management of TGA

- 1950 Blalock-Hanlon - surgical septectomy
- 1956 Baffes - partial venous routing
- 1959 Senning - atrial switch
- 1964 Mustard - atrial switch
- 1966 Rashkind - balloon atrial septostomy
- 1976 Jatene – arterial switch

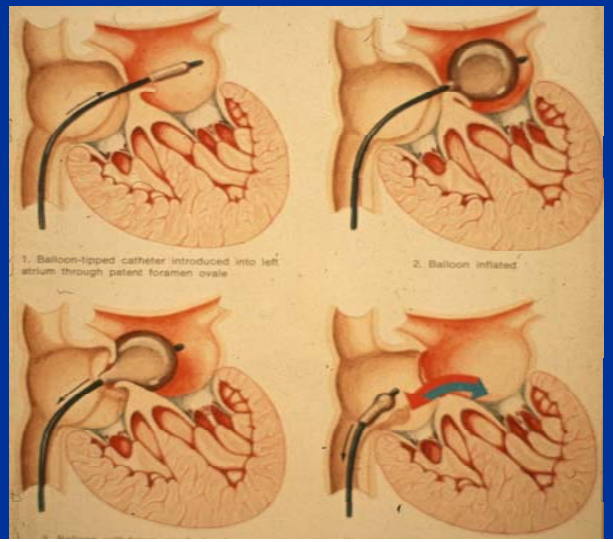
Blalock-Hanlon Operation



Surgical Atrial Septectomy Mortality

Authors	Year	Mortality
Blalock & Hanlon	1950	75%
Cornell et al	1966	53%
Deverall et al	1969	45%
Baker et al	1971	40%
Clarkson et al	1972	29%
Behrendt et al	1975	21%
Herman at al	1975	15%

Introduction of Pediatric Interventional Cardiac Catheterization

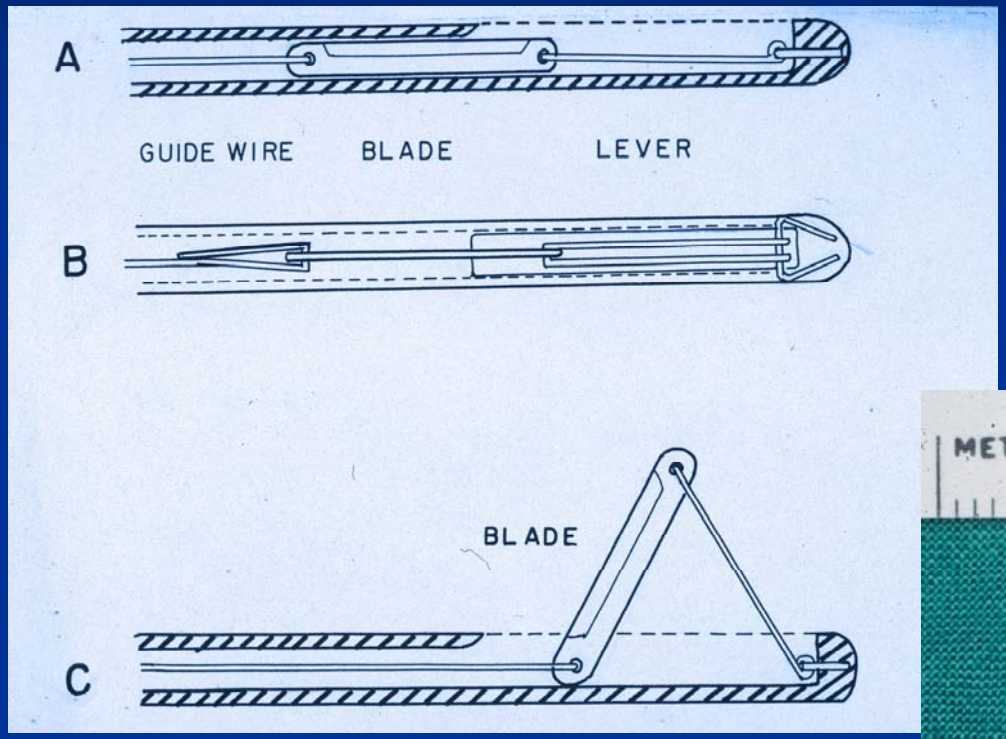


- Balloon Atrial Septostomy by Dr William Rashkind
- Revolutionary change in management of infants with TGA
- Dramatic improvement in morbidity and mortality

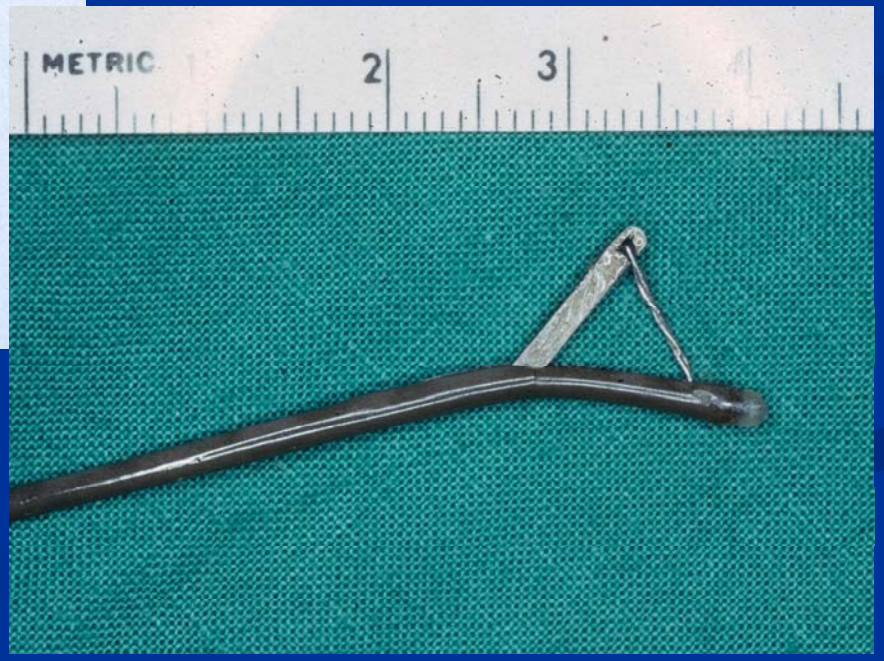
Results of Balloon Atrial Septostomy (Rashkind Procedure)

Author	Year	Success	Compl /mortality
Venables et al	1970	73%	15%
Rashkind et al	1971	84%	-
Baker et al	1971	71%	9%
Neches et al	1973	89%	2%
Hawke et al	1974	62%	-
Rashkind et al	1974	87%	3%
	Average	78%	

Blade Atrial Septostomy Catheter

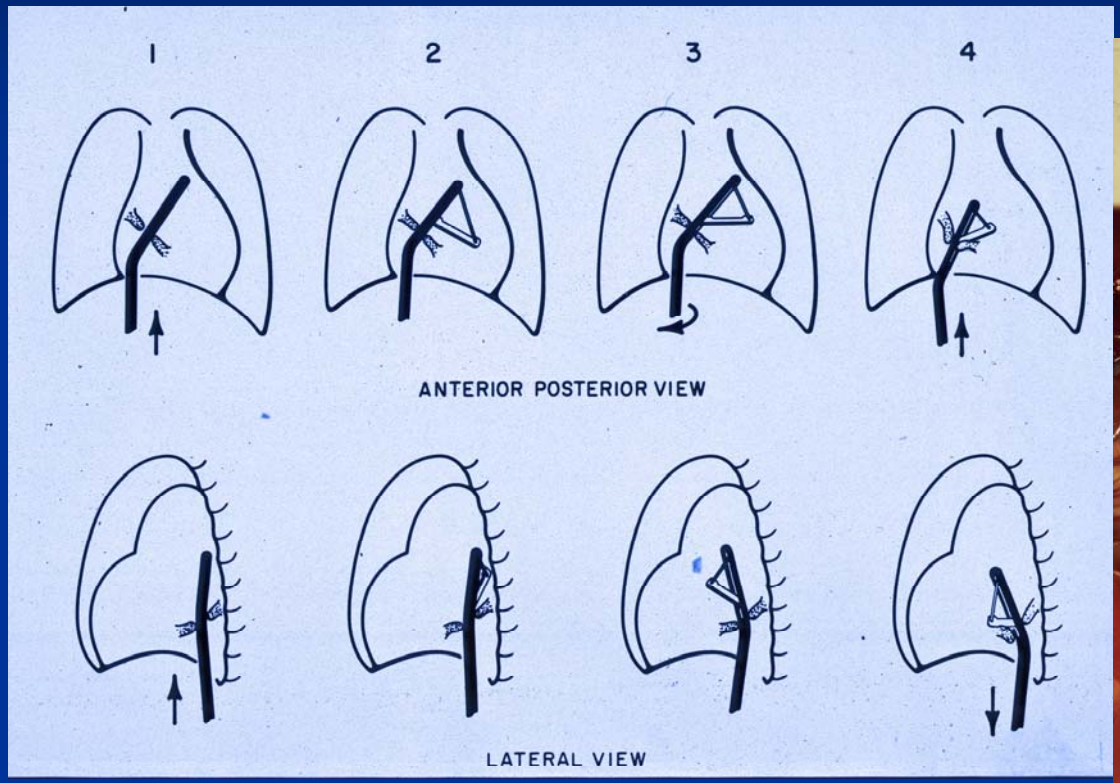


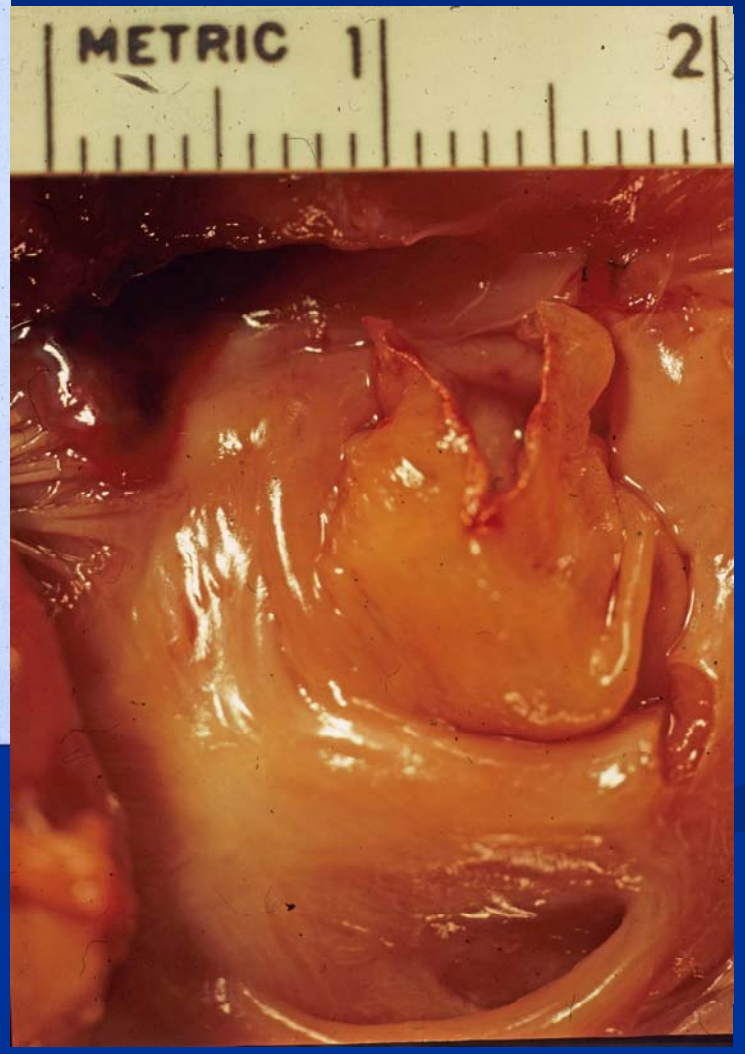
Conceived the idea
in early 1970



Hand Made Model

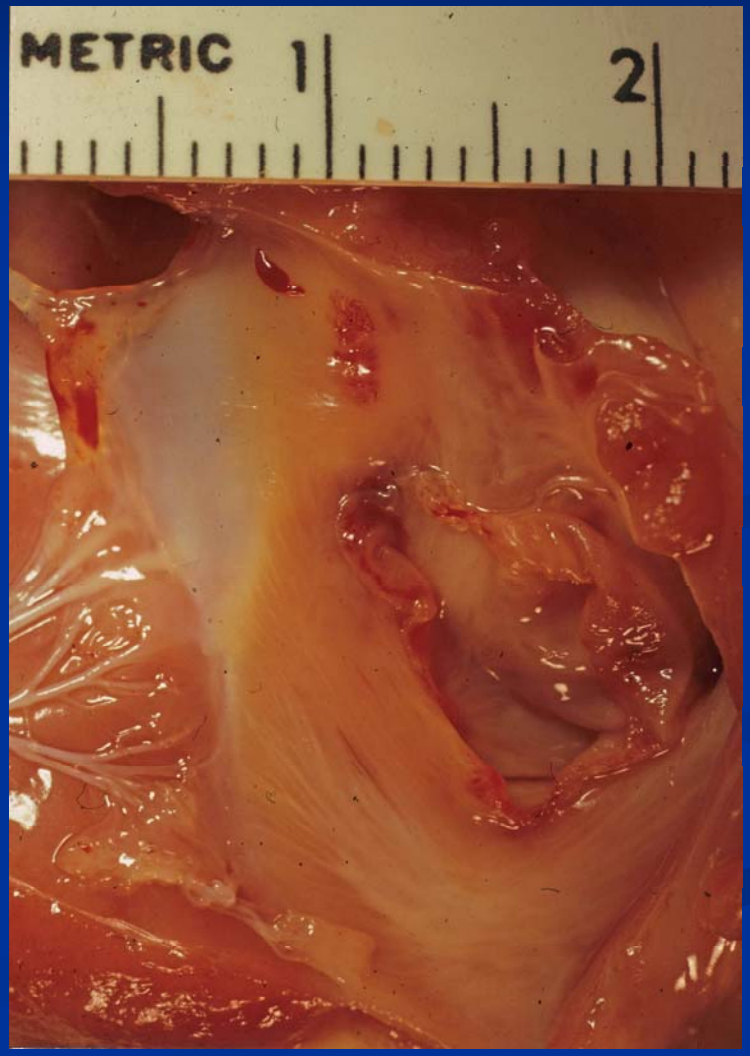
Animal Experiment



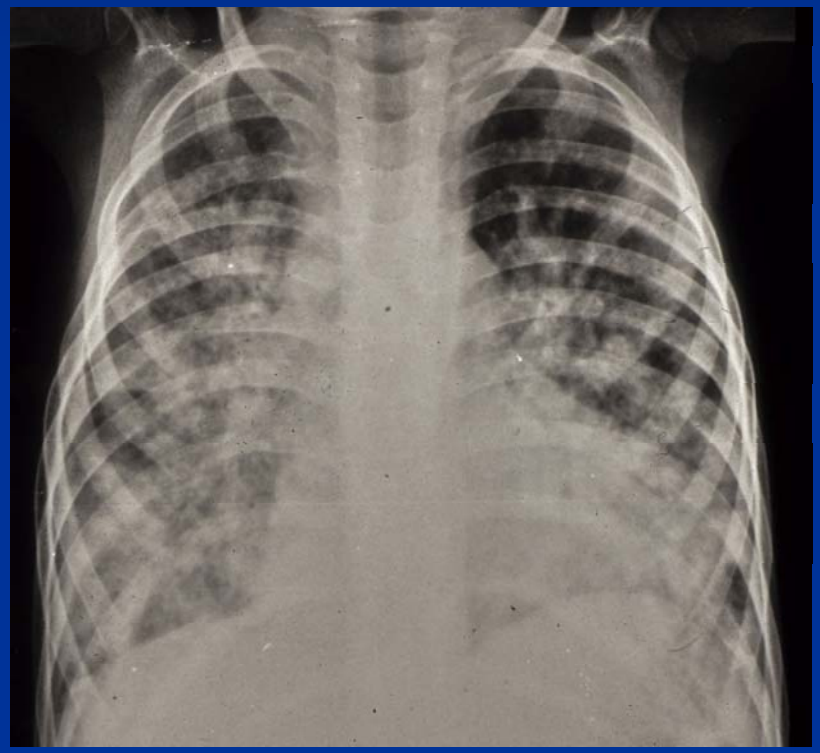


Blade Septostomy only

Blade Balloon Septostomy

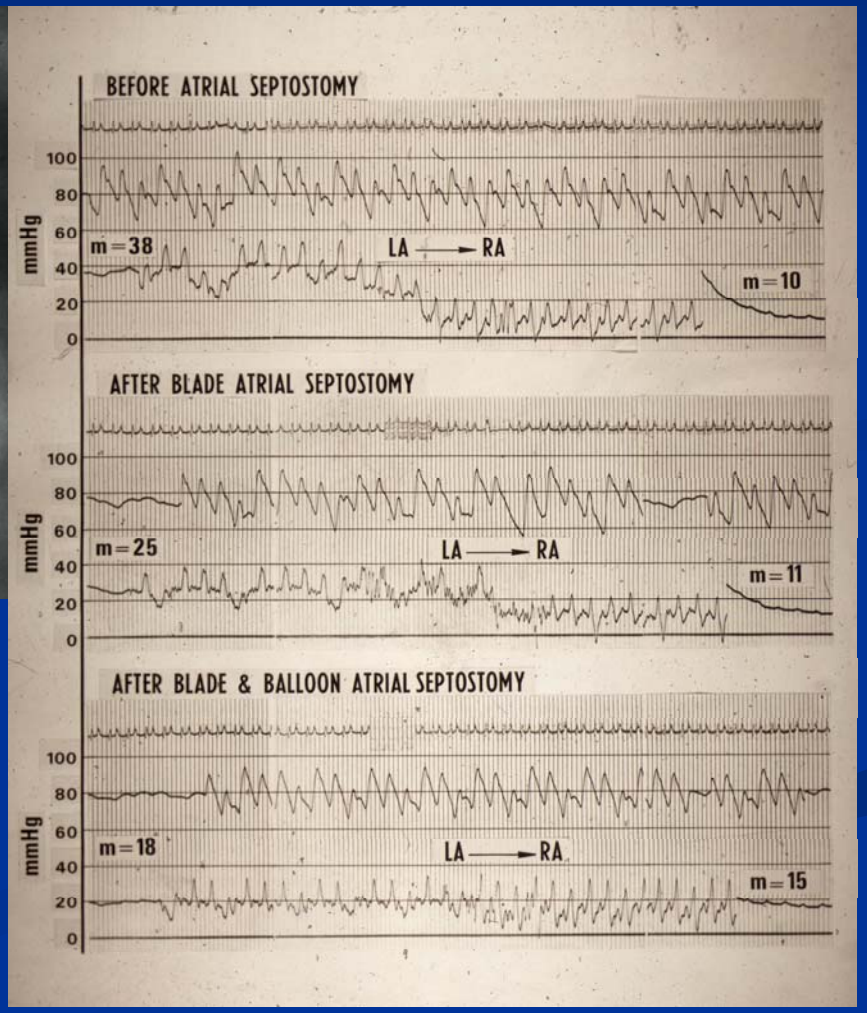


Clinical Case – Indianapolis, IN



- 3.5 yr old boy with DORV mitral atresia with PS, post Waterston shunt
- Restrictive inter-atrial opening with pulmonary edema and high fever
- Anesthesiologist and Surgeon were reluctant to perform surgery.

Clinical Trial of the Blade Catheter



Interatrial Mean Gradient

- Before 28 mmHg
- After 3 mmHg

Radiographic Change after the Blade Atrial Septostomy

within 24 hours

A X-mas Gift

Pittsburgh Press January 30, 1977

Tiny Knife Inserted Through Vein Repairs Boy's Heart

By DOLORES FREDERICK
Press Science Writer

A Selma, Ind., child is home playing with his fire truck today because of a new surgical instrument developed at Children's Hospital.

The instrument is used to open up damaged hearts.

"It was a wonderful Christmas present to see Brian, bright-eyed, after surgery. He was so ill when I took him to the hospital," said his mother, Deborah Chafin, 21, of Selma.

Brian, 3½, was a "blue baby." He was also born without a mitral valve — a major heart valve between the upper and lower left chambers of his heart. His lower left chamber remains filled with heavy muscle and isn't working normally to supply blood to his body.

Brian Chafin is back with his toys after 'dramatic' recovery.

Because of Brian's illness, Dr. Sang C. Park, a children's heart specialist at Children's was flown to Indianapolis to perform surgery on Christmas Eve.

It was the second time ever Park's new instrument — a tiny surgical knife similar to a razor blade sliver — was used to open the right and left heart chambers of a young child.

Because Park can't find a manufacturer for his new instrument, he had to be called to do the surgery.

"Without surgery, Brian could have died. He was a very sick child and we needed to find a way to get the blood mixed between his right and left chambers," said Dr. Donald Girod, a pediatric heart specialist at Indiana University's Medical Center in Indianapolis.

Brian was hospitalized Nov. 23 and was very weak, with a high fever and severely congested lungs because blood wasn't being properly supplied to the lungs.

During surgery, Park inserted his knife, which was collapsed and housed in a long tube (catheter) through a vein in Brian's groin. Once the tube reached the heart, Park pulled a wire and opened the knife, following the progress of surgery on a "televised" fluoroscope that allowed doctors to see into the inner chambers of the heart.

In the one-hour procedure, Park cut a hole — about the size of a nickel — between the upper right and left chambers to mix the blood flowing to Brian's body.

Once the hole was cut, he retracted the blade and pulled the catheter from Brian's vein.

Brian was spared open-chest surgery — which poses a serious risk to children already suffering serious heart problems.

Park's instrument is a variation of a "balloon" instrument developed by William Rashkind of Children's Hospital in Philadelphia in 1966.

The death rate from open-chest surgery among children with conditions similar to Brian's at one time was 40 per cent.

The Rashkind "balloon" — which opens once it is inside the heart to pry open a hole to mix blood — cut the death rate to "less than 1 per cent," according to Dr. James Zuberbuhler, director of cardiology at Children's Hospital here.

But Park said the Rashkind instrument doesn't always work in permanently opening the heart chambers. They would often close up again, requiring additional operations.

Babies are normally born with a hole in their hearts but it closes after birth, Zuberbuhler explained. It's because their blood has to be mixed and their lungs aren't working yet.

With children such as Brian, he said, "we try to reopen that hole. It's usually temporary until they are strong enough for more extensive corrective surgery."

But for some children, including Brian, there isn't any corrective surgery yet developed to permanently correct the heart defect. However, there are several patients, some in their 20s, who don't have repairable conditions but are "doing well" after undergoing the Rashkind procedure.

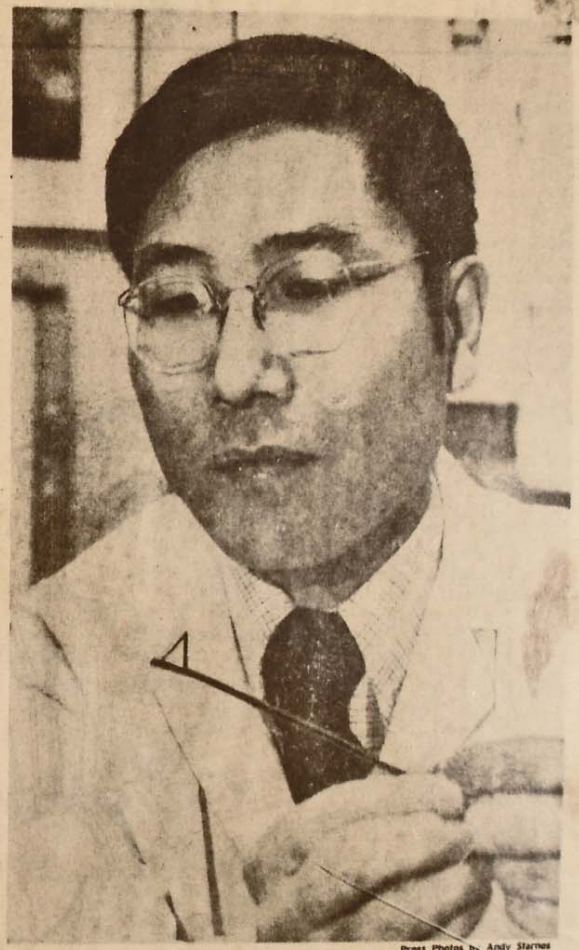
Over the last eight years, Zuberbuhler said, 150 "balloon" procedures have been performed at Children's Hospital. He estimates about 10 to 20 per cent of future cases may require the Park "knife" because of problems in opening up their chambers with the "balloon."

Park first used his new instrument on a 7-month-old child. He said the procedure was successful but the child later died of an unrelated illness.

Brian first underwent surgery when he was three months old. He started turning blue and had difficulty breathing. Consequently, surgeons performed a Waterson shunt that hooked his aorta to his pulmonary artery to get more blood to his lungs.

The Park cathether was used to mix the blood inside his heart chambers. Brian was discharged Jan. 7 and when he went back for tests last Tuesday, everything was "reported just fine."

His recovery after Park's procedure was described by Girod as "dramatic." He said his fever went down, his lungs gradually improved over 10 days and he is home playing with his toys.

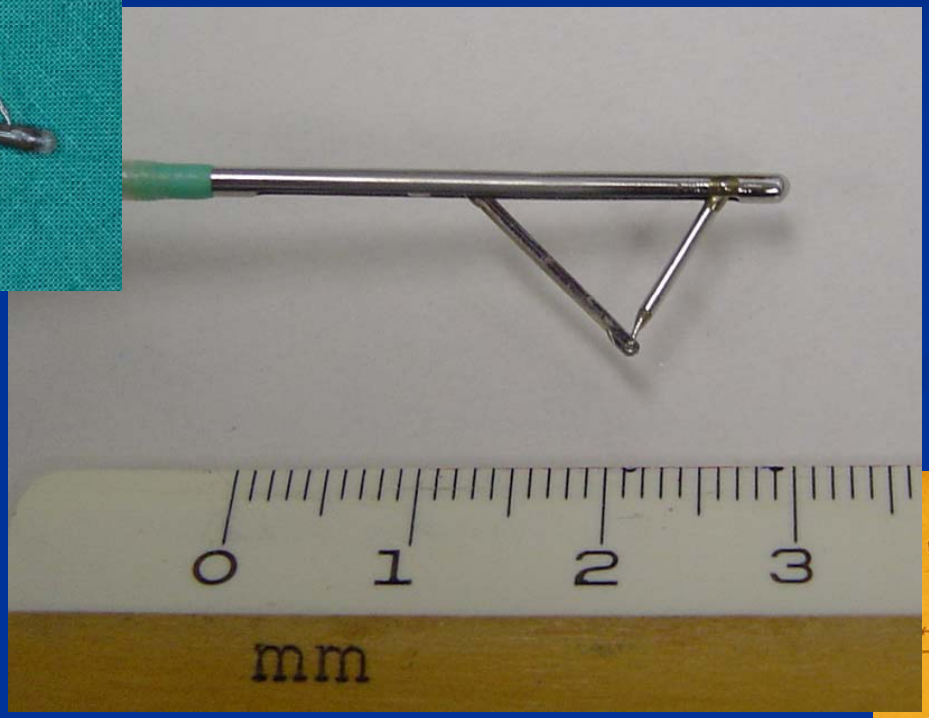


Press Photos by Andy Starnes

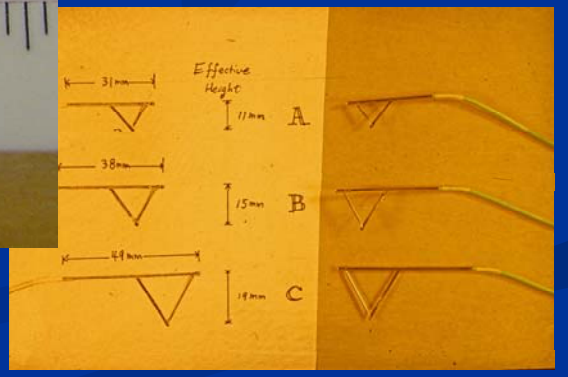
Dr. Sang Park and his tiny knife that repairs hearts.

Development of the Blade Catheters

Hand Made



Professionally Made



3 Sizes

Blade Atrial Septostomy

Historic Progress

Studies	Initiated	Reported
Animal Experiments	1973	1975
Clinical Trial	1975	1978
Collaborative Clinical Study	1977	1982

Collaborative Study

Dr Charles E Mullins
Texas Children's Hospital

- Bakulev Institute, Moscow
- Hospital for Sick Children, Toronto
- Indiana University Hospital
- Texas Children's Hospital, Houston, Texas
- Children's Hospital of Pittsburgh

Blade Atrial Septostomy
Current Trend

- Less used for congenital heart disease as early infant surgery becomes routine.

- Other indications :

  Primary pulmonary hypertension to help the systemic output.

  To relieve pulmonary edema in patients on **ECMO** support.

  To relieve protein-losing enteropathy (**PLE**)

Complications following Atrial Switch Procedures (Senning or Mustard procedure)

- Systemic or pulmonary venous obstruction
- Atrial arrhythmia
- Tricuspid regurgitation
- Right ventricular dysfunction

Complications following Atrial Switch Procedures

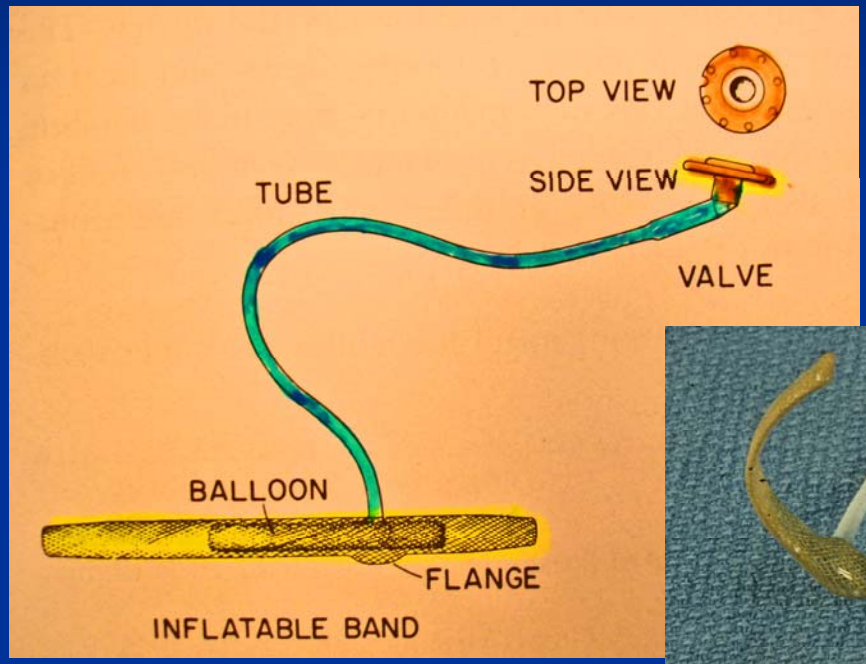
- **Right ventricular dysfunction**

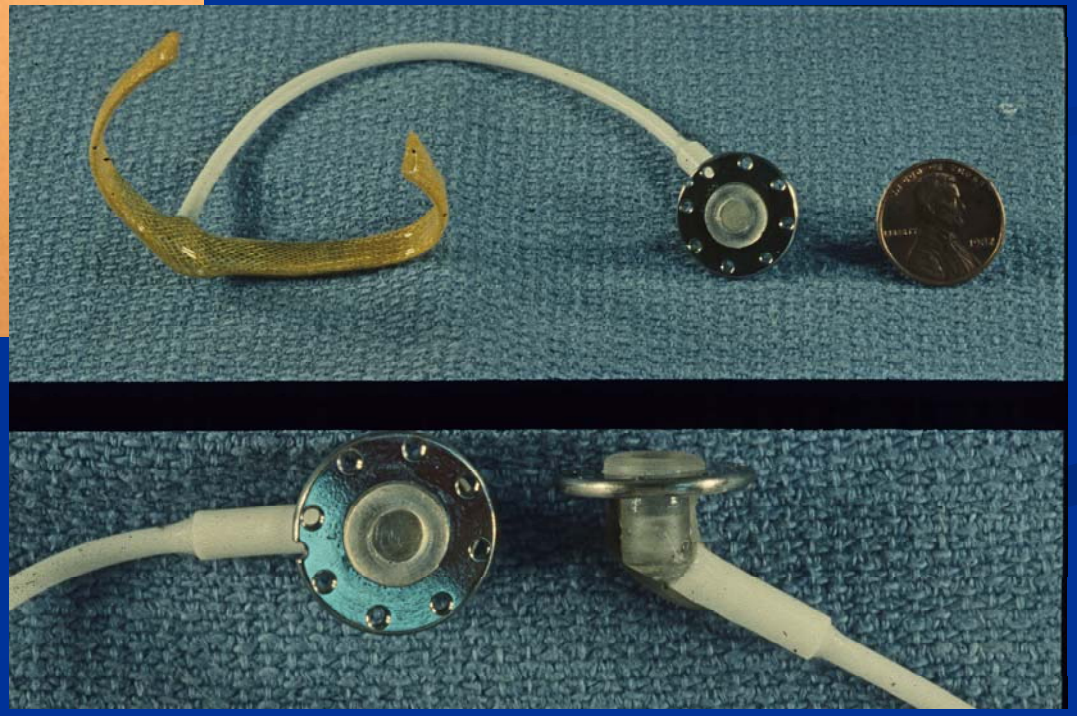
  Option : Heart transplant or

  Conversion to Arterial Switch candidate that requires serial pulmonary artery banding procedures to train the left ventricle to serve as a systemic ventricle.

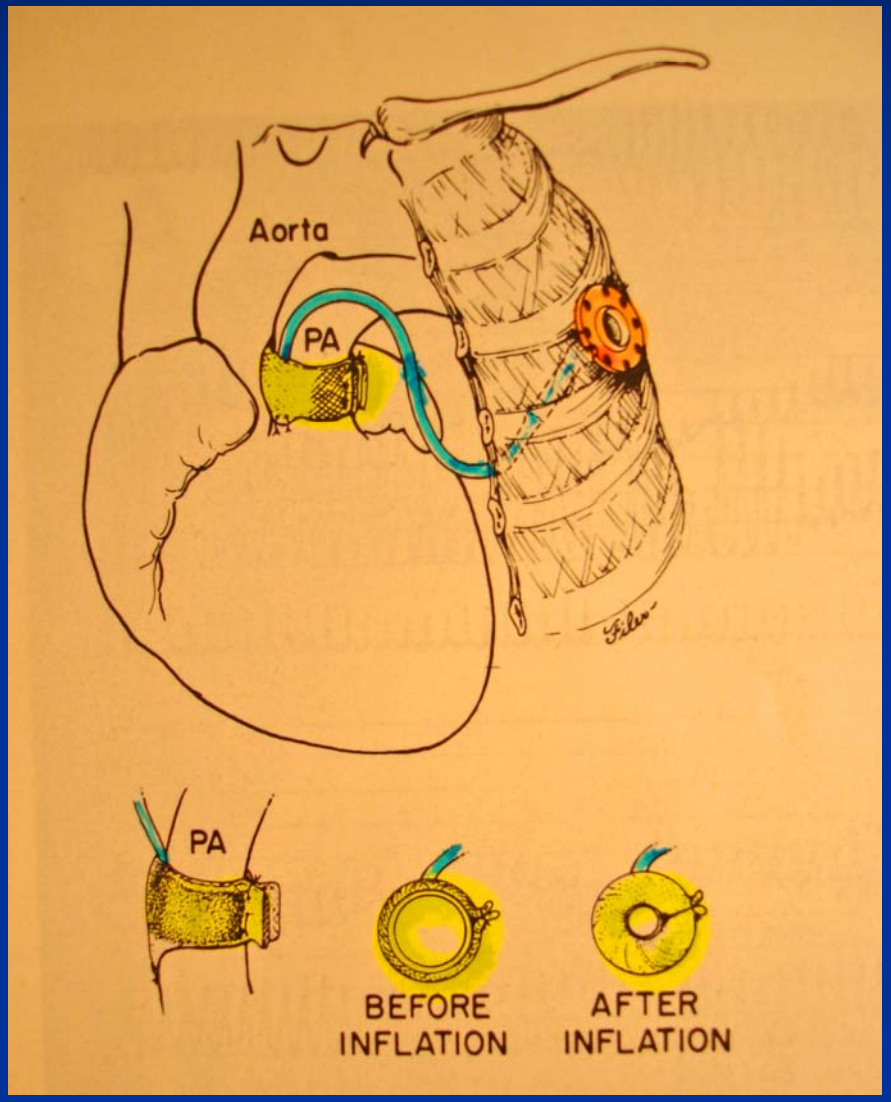
  Requiring multiple open chest procedures

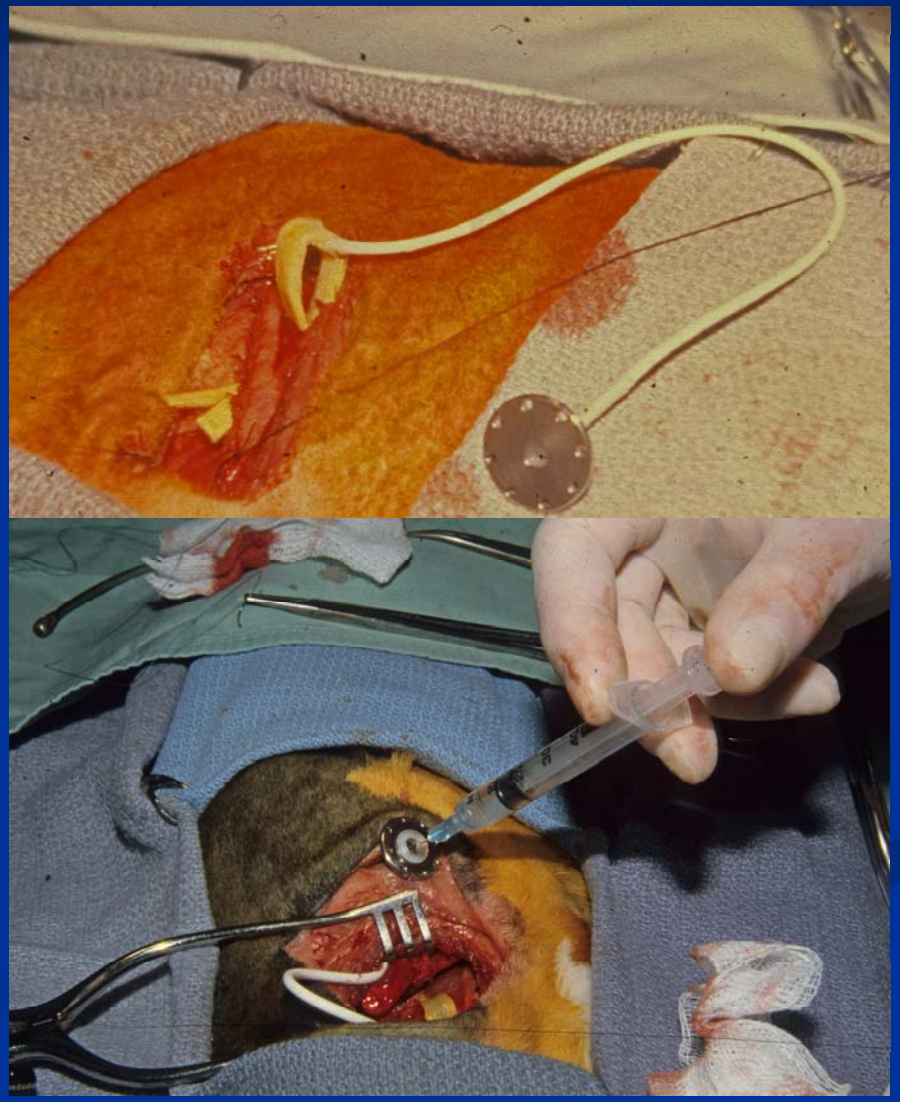
Percutaneously Adjustable Pulmonary artery Banding Device



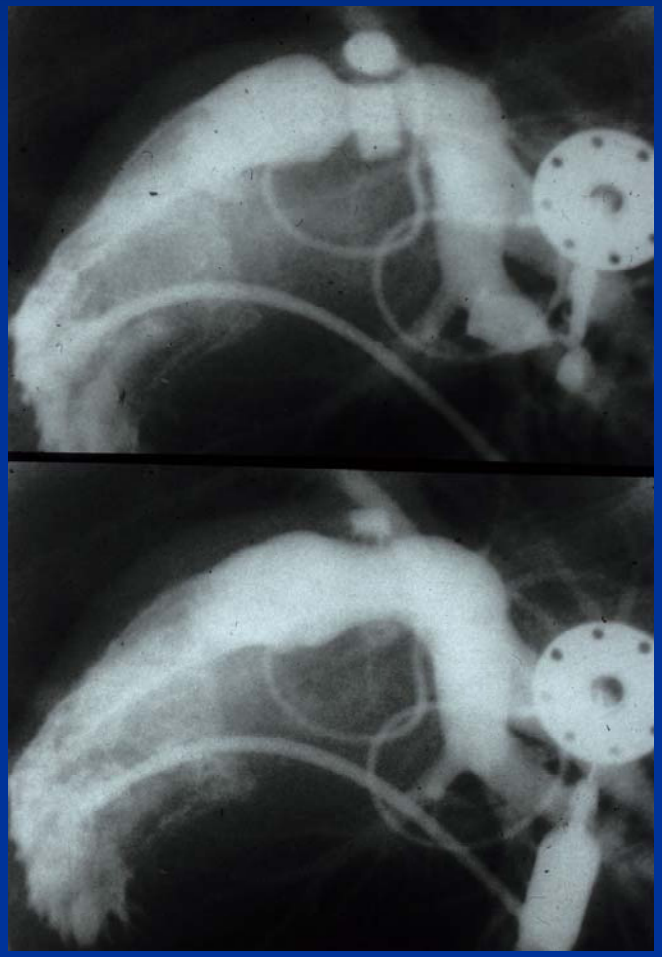


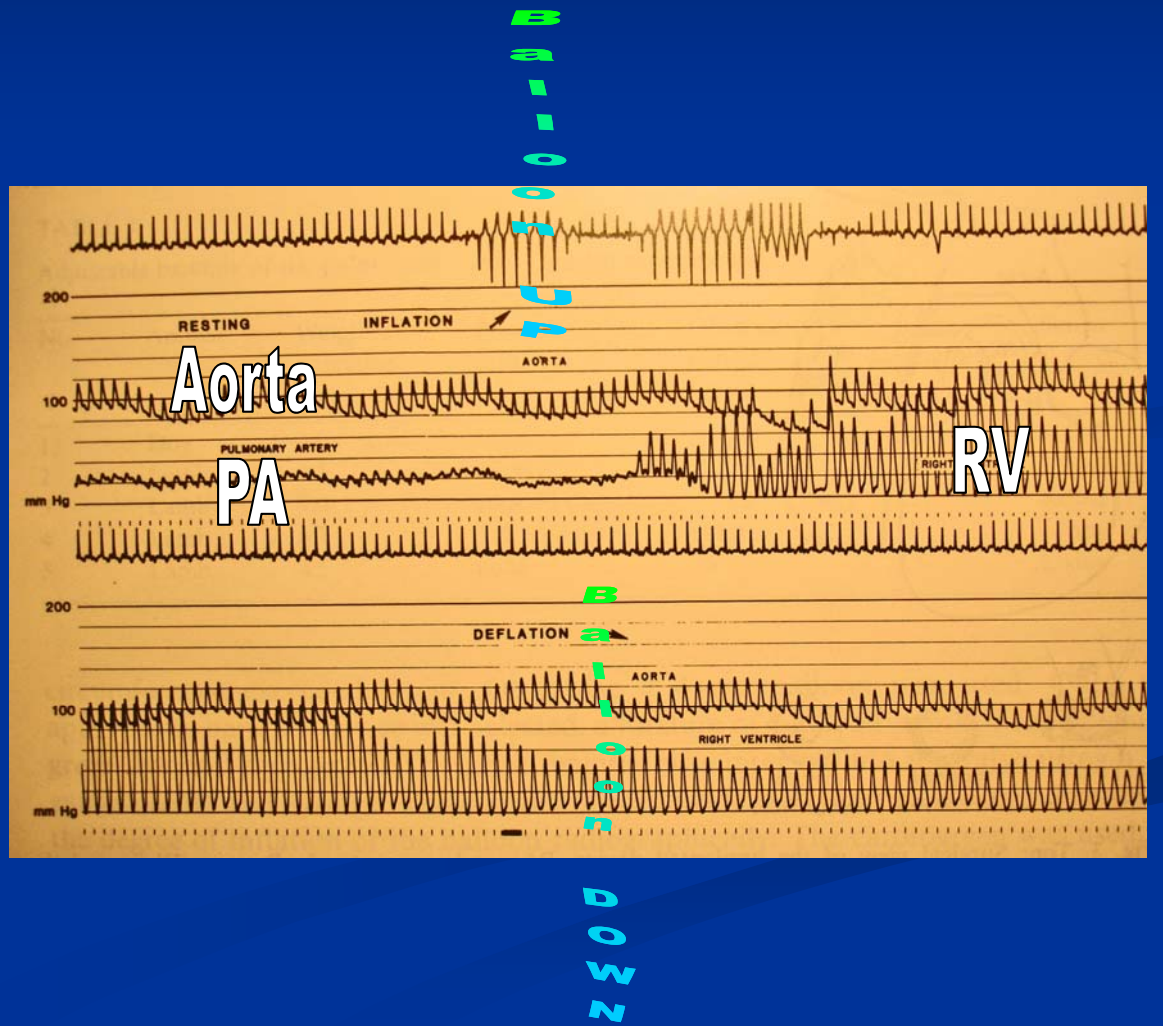
Application of the Percutaneously Adjustable Pulmonary Artery Band





Adjustable Pulmonary Artery Band
Animal Experimentation





Adjustable PA Band
Animal Experimentation

10 months later

Percutaneously Adjustable Pulmonary Artery Banding

LONG TERM FOLLOW-UP

NO	Animal	Weight (kg) at OP	Observation Peroid (mo.)	Weight (kg) at Sacrifice
1	Lamb	4.1	10	50.8
2	Dog	3.2	6	5.4
3	Dog	2.9	23	8.2

Adjustable Pulmonary Artery Band Clinical Case 1

- Simple TGA
- 5 months - Senning Procedure
- 2.5 years - Reoperation for pulmonary venous obstruction
- 3 years - RV dysfunction and tricuspid regurgitation developed
- 4.5 years – Adjustable PA band was applied
- 5 years – Arterial switch procedure was done successfully.

Adjustable Pulmonary Artery Banding
Clinical Case 1

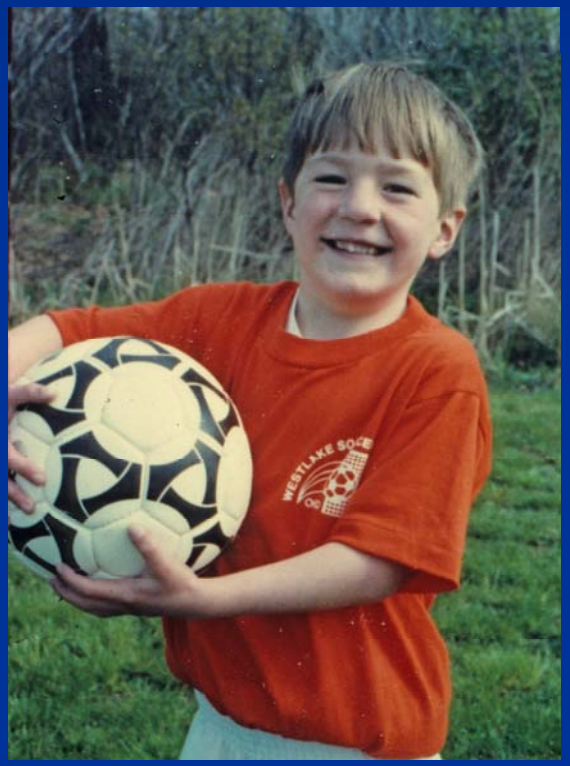
Dr Aldo Casneda performed
At Boston Children's Hospital
On August 12, 1988

Late Result of the Adjustable PA Band

19 years later

Assistant Teacher

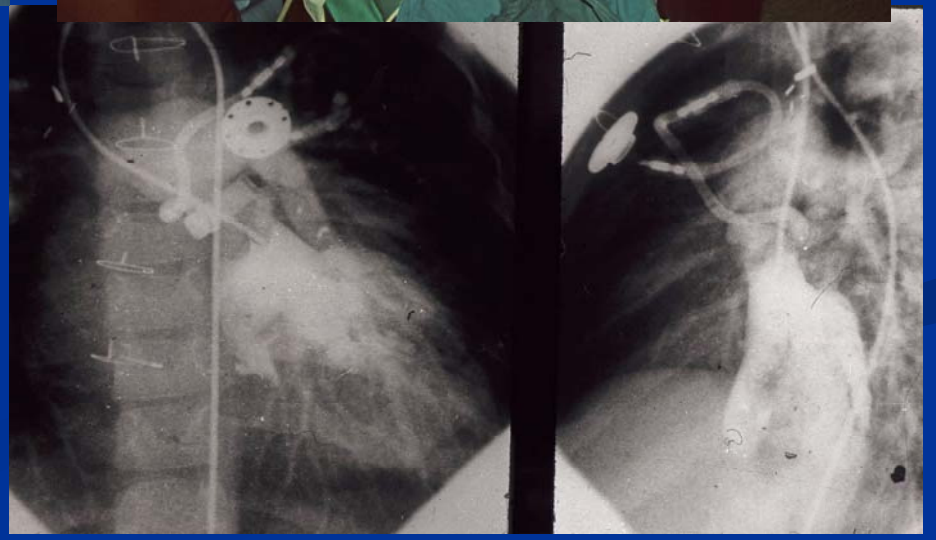
Adjustable Pulmonary Artery Banding
Clinical Case 2



- TGA with small VSD
- 2.5 years – Developed severe RV dysfunction and tricuspid regurgitation
- 3 years – Adjustable PA band was applied
- 3.6 years – Arterial switch was performed successfully.

Adjustable Pulmonary Artery Banding
Clinical Case 2 in Pittsburgh

On January 18, 1989
At the Children's Hospital
of Pittsburgh
By Dr Ralph D Siewers



Adjustable Pulmonary Artery Band

- Animal experimentations and limited clinical trials were successful.

- However, no further clinical trial was possible

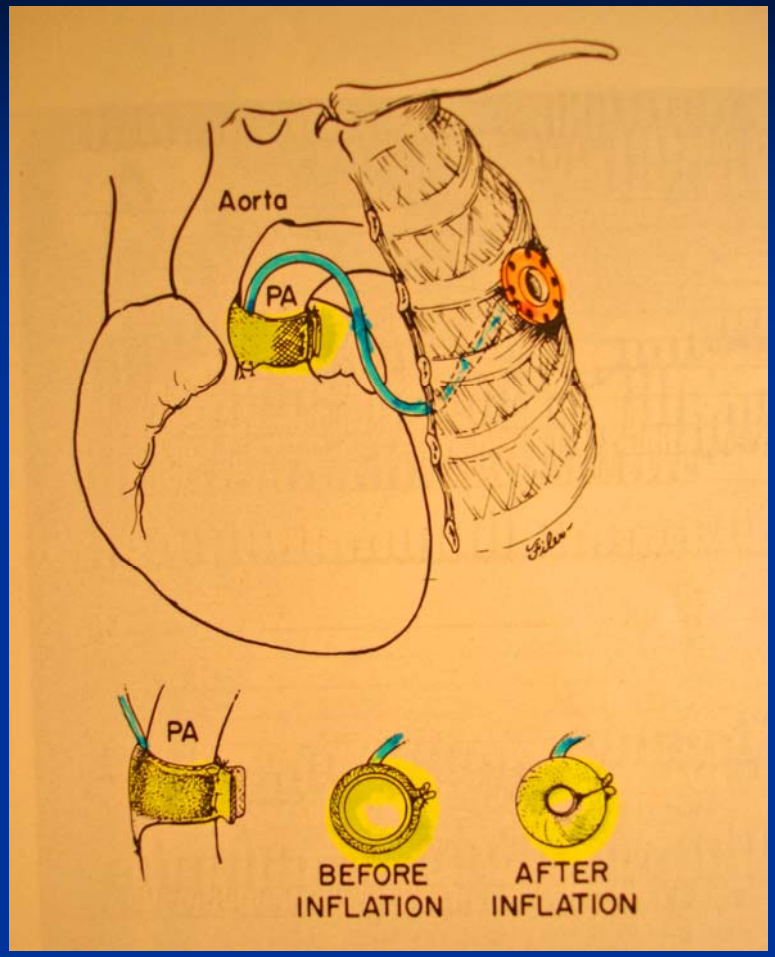
  DUE to

  Limited marketable value

  Stringent FDA regulatory process

  = Huge expenses

  Loss of interest in manufacturing the product



Adjustable PA Band 1985

Lap-Band

With Dr Taussig at AAP meeting in 1985, St Antonio, TX

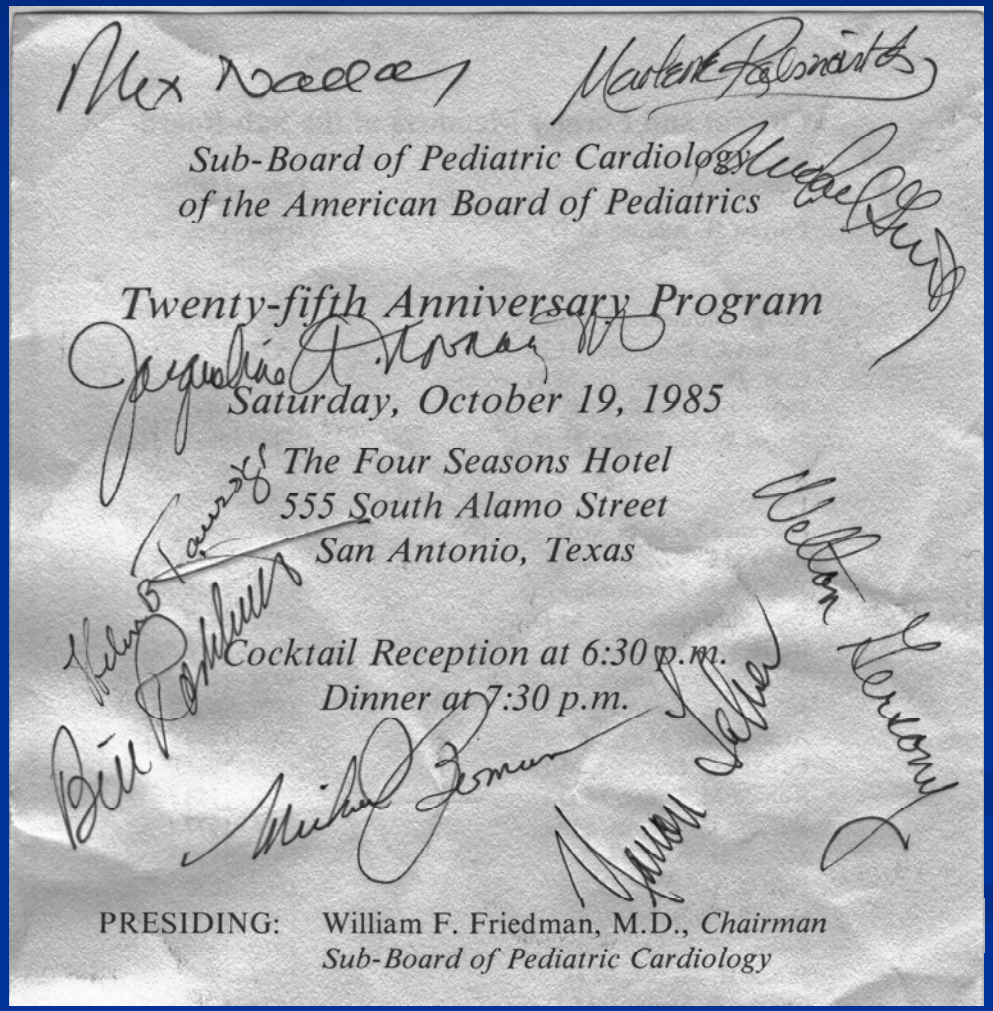
Special Gathering in 1985

Alex Nadas

Jacqueline Noonan

Helen B Taussig

Bill Rashkind



Marlene Rabinovich

Donald Girod

Welton Gersony

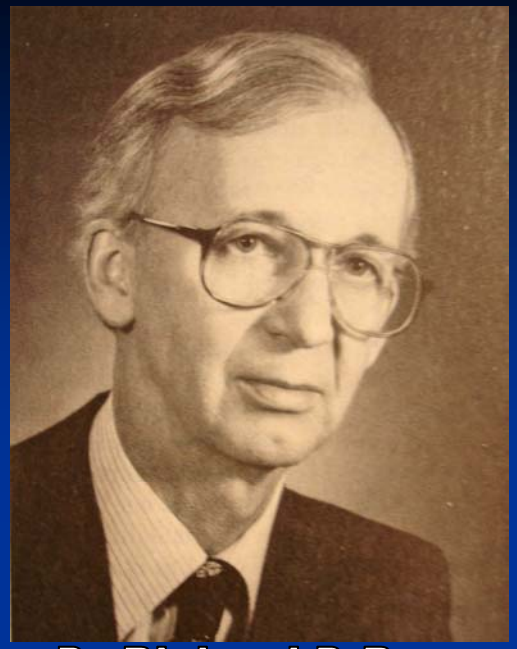
Norman Talner

Two Legends in Pediatric Cardiology

Dr. Helen B Taussig
1898-1986

Dr. William J Rashkind
1922-1986

Some of my mentors and friends



Dr Richard D Rowe

Dr Alex Nadas

Dr Jerry Liebman & Dr Sam Kaplan

Dr Dan McNamara

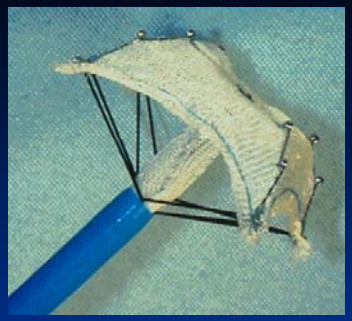
Dr Chuck Mullins

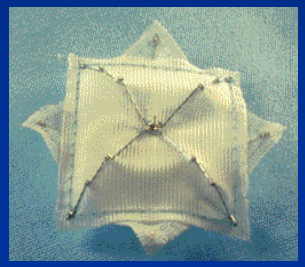
Legends in Cardiac Morphology

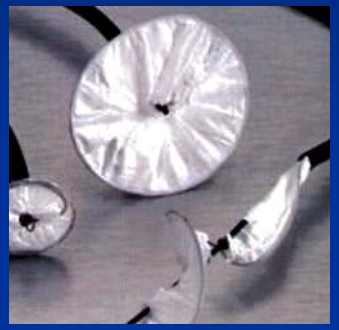
Dr. Richard VanPraagh & Dr. Robert Anderson

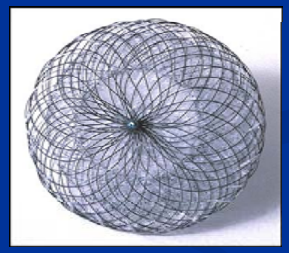
London in 1985

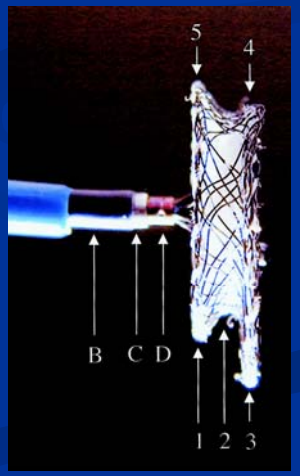
Defect Closure





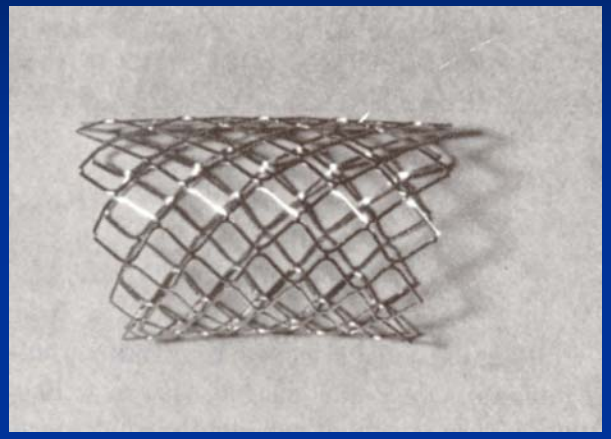




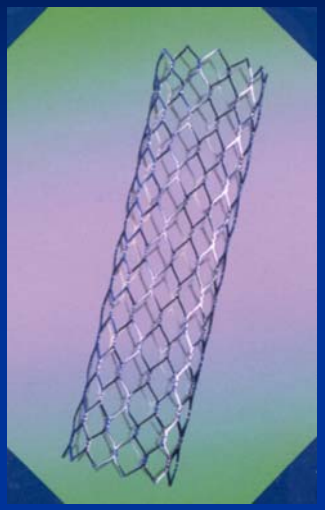


FDA approved

Stents for Congenital Heart Defects

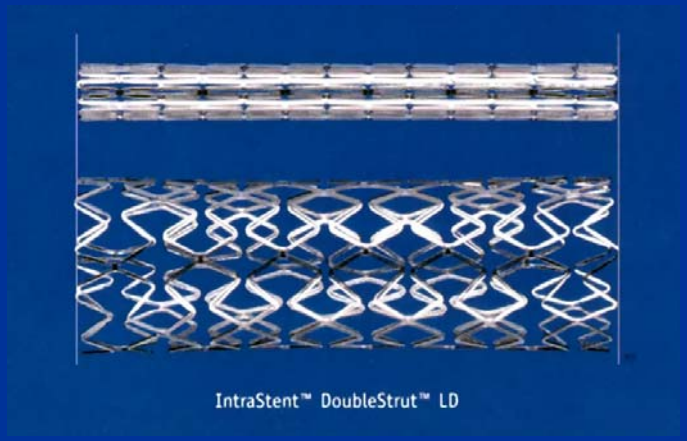


18,30,40,50 mm

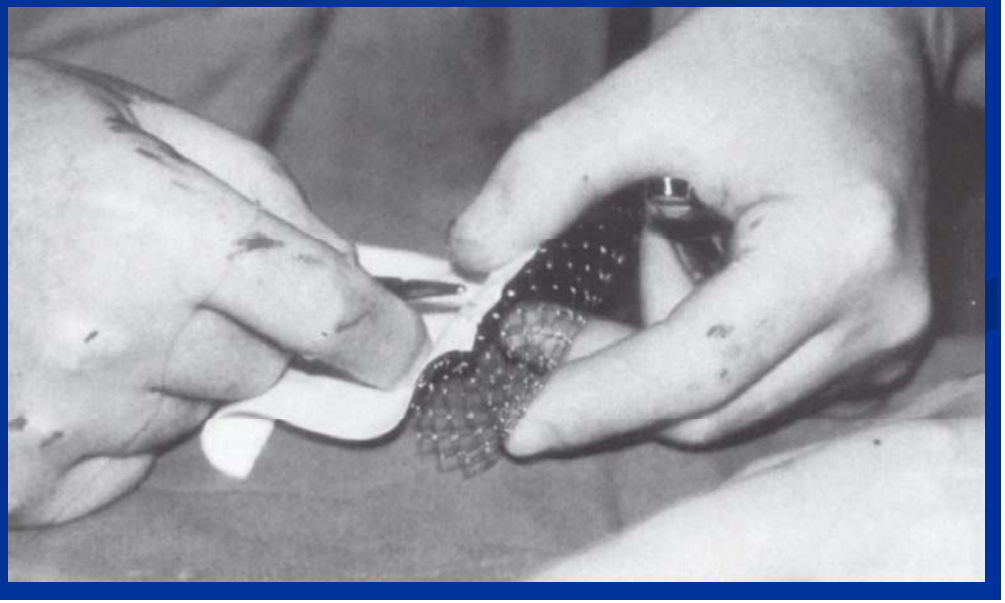


19,25,29,39,59 mm

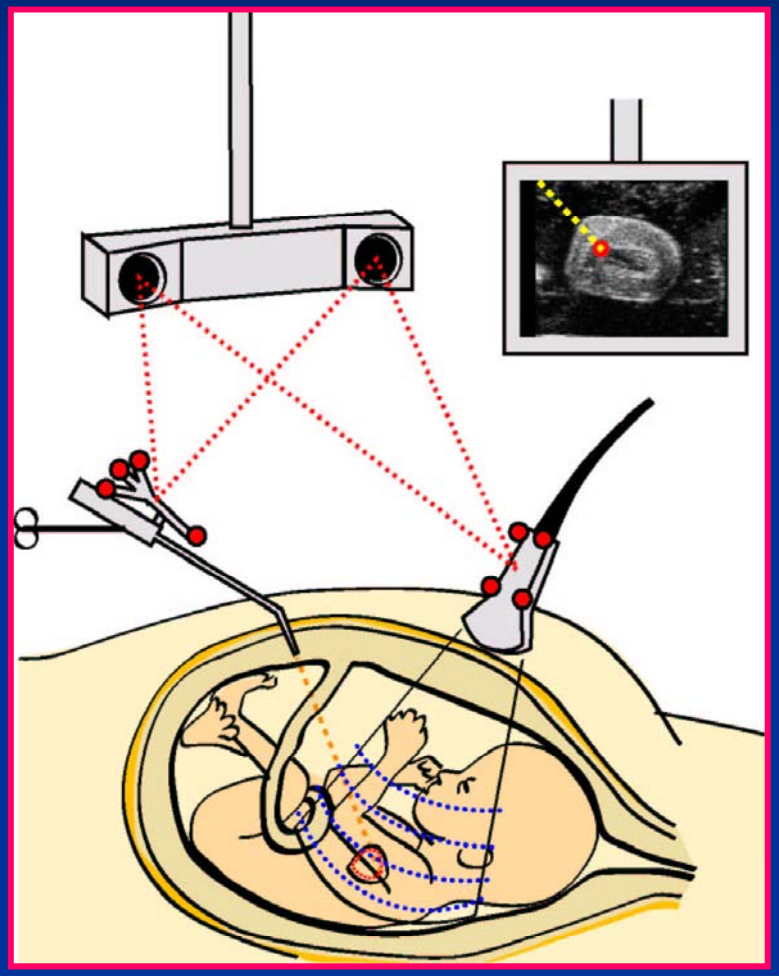
3-10 mm



10,16, 26, 36 mm



Computer Assisted Navigation



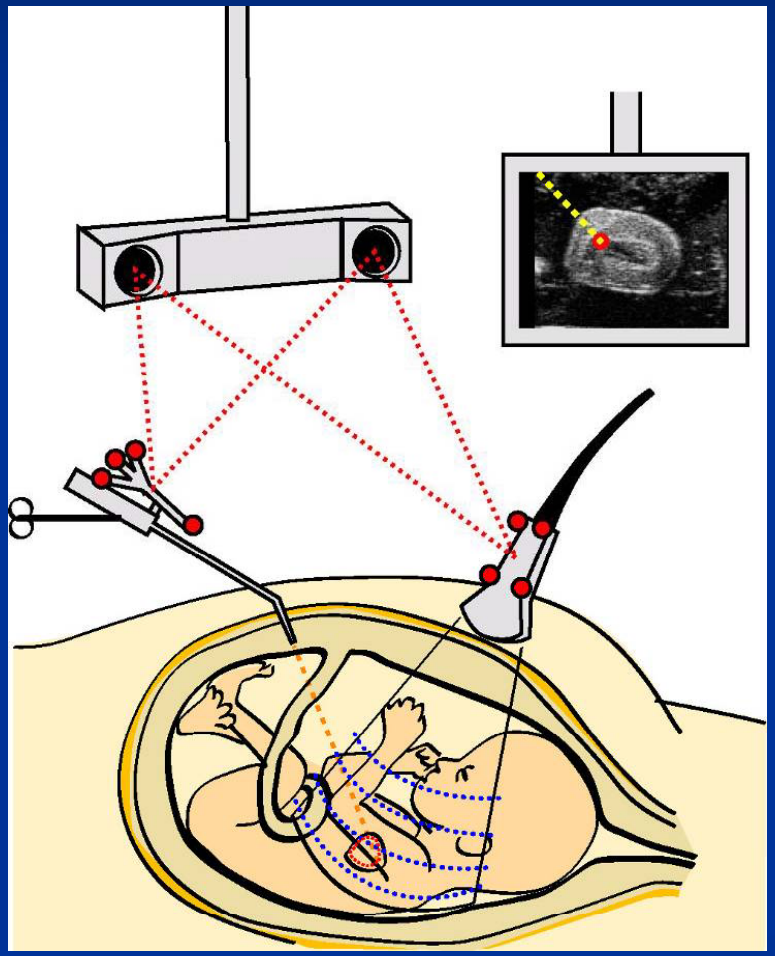
- This CANav was developed to track the trajectory of an EM embedded needle and stylet relative to the position and orientation of 2D ultrasound image.
- It allows accurate and rapid navigation through multiple tissue planes to a 3 mm target.

Computer-Assisted Navigation: Large Animal Validation in Fetal Sheep

Use of the NDI Aurora magnetic generator, ultrasound imaging, and a custom needle containing a 0.4 mm diam NDI magnetic positioning coil (right hand) within the trocar of the needle, with sensor wires attached to the NDI system

NDI: Nothern Digital Inc

Novel Image Guided Technique



- Electromagnetic guided imaging technology
- Enables fetal intervention such as valvuloplasty and septosplasty
- Prevention of HLHS

We can now accurately diagnose congenital heart disease even in the fetus, and can surgically repair or palliate the heart defect in majority of cases.

We can also intervene the residual lesion by non surgical, transcatheter procedures.

Growing Number of Adult with Congenital Heart Disease

Congenitally Corrected TGA
Mom 60 yrs Daughter 32 yrs

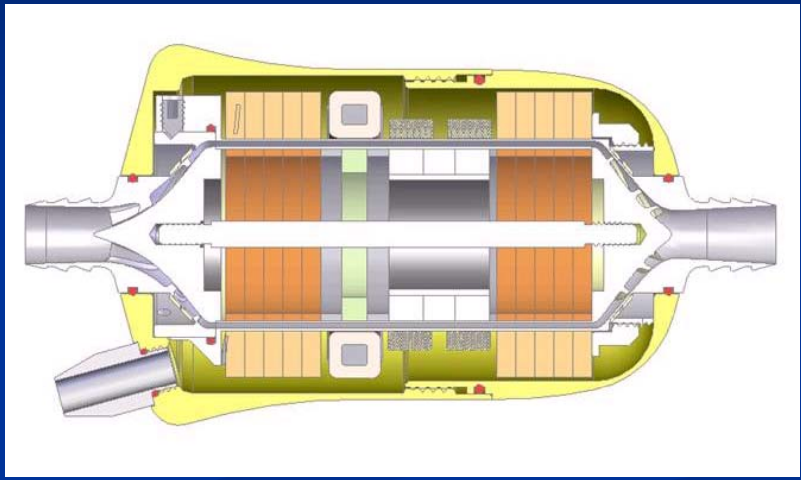
TGA, post Senning
22 yrs

Future Challenges

- Increasing population of adults with residual heart disease – previously palliated
- Close surveillance of high-risk patients (post-Senning & Mustard procedure)
- Uncertain future of post-Fontan patients
- Timely protection of RV in patients with significant pulmonary regurgitation (post-TOF, post-truncus repair, & post-Ross group)

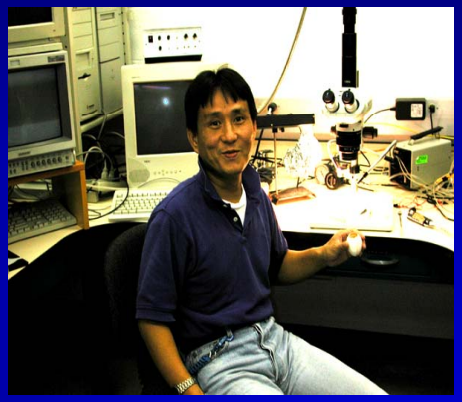
Heart / Lung Transplant

Ventricular Assist Device for Infant



Our Team and Collaborators

Bradley B. Keller, MD



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Ension, Inc., Launch Point Technologies, Inc.

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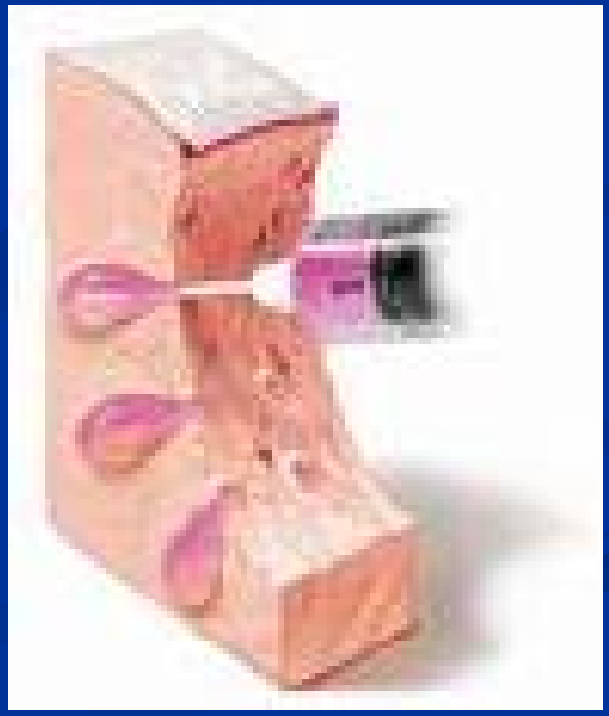
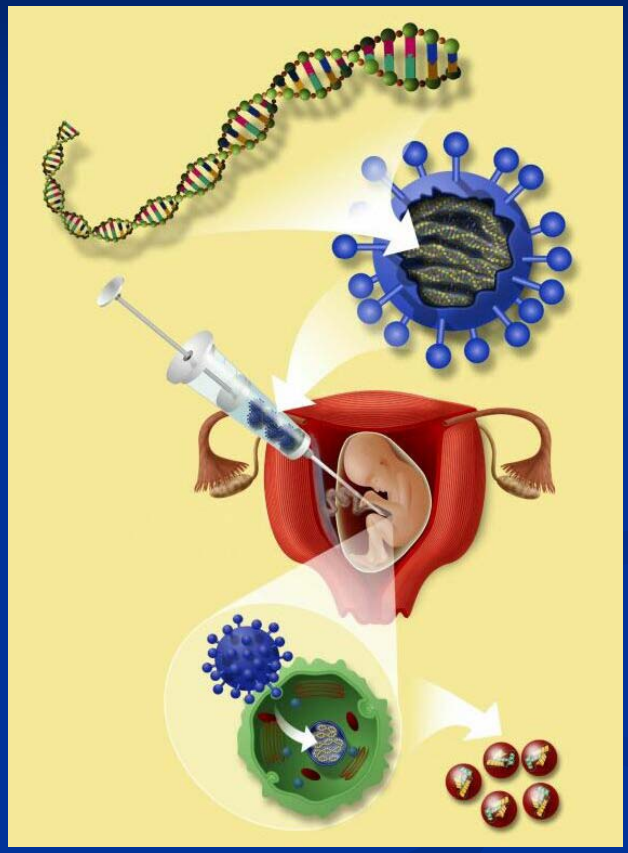
Jim Osborn, M.S.	*Robotics, CMU*

Gene Therapy is already in Clinical Trials



Our Wishes may come True someday!



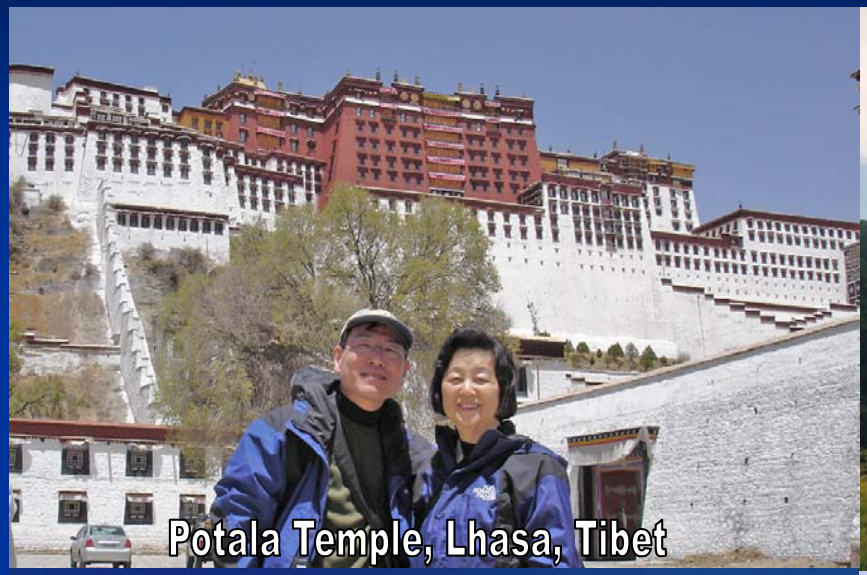
Pediatric Cardiology Staff
At the Children's Hospital of Pittsburgh

Final Plea

- Have an ***Innovative Idea***
- Have a firm ***Commitment*** to Work Hard to Achieve the Goal
- Have steadfast ***Ambition,*** purely for the benefit of the patients
- ***Never*** Give Up

Why are we climbing Mt Everest?

No Pain = No Gain!


Potala Temple, Lhasa, Tibet


Machu Picchu, Peru


Cario, Egypt


Beijing, China

Final Take Home Message

- Innovative Idea
- Commitment
- Ambition
- Never Give Up

Final Take Home Message

- Innovative Idea
- Commitment
- Ambition
- Never Give Up

Yes, you can!

Thank You !

Best Wishes to All !

ALWAYS EXCITING IN PITTSBURGH…