



“Heart Valve Replacements From the Old to the New”

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Disclosures and Conflicts of Interest

My only disclosure is that I have nothing to disclose

A scenic landscape of a mountain valley. In the foreground, a dense forest of evergreen trees covers the slopes. A turquoise lake is visible in the lower left, with a small waterfall cascading into it. The middle ground shows a wide valley with more forest and a winding road. In the background, majestic mountains with snow-capped peaks rise against a blue sky with scattered white clouds. The overall scene is a beautiful representation of a wilderness area.

**If I have seen further than others,
it is by standing upon the
shoulders of giants.**

Isaac Newton

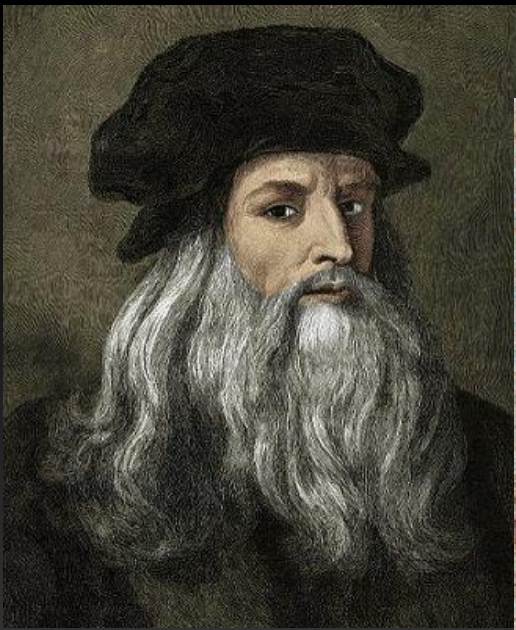


Human Machine

Valves are never resting

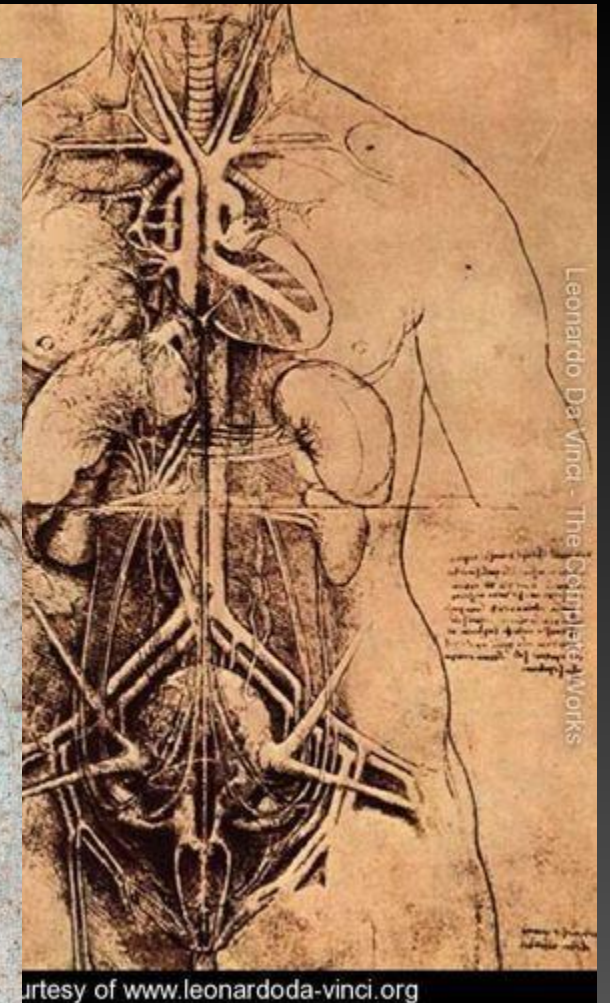
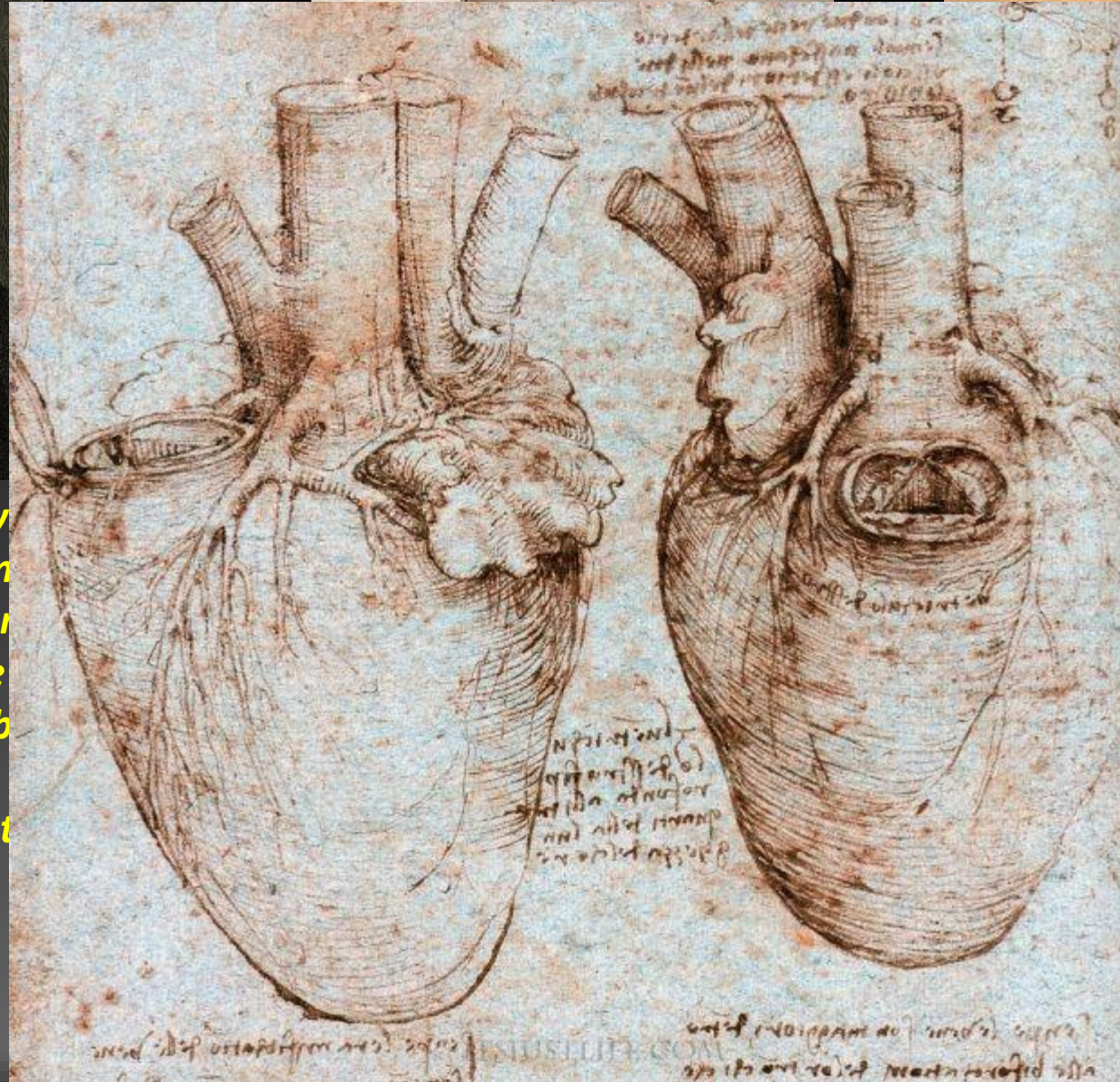
*Over the course of a lifetime, valves will open
and close over 2,800,000,000 times*

*Per Annum, in the United States,
80,000 operations on valve related problems*



Late 15th, early 16th Century

- Concentrated on anatomy
- 240 sketches, 13,000 words
- 1st depiction of the spine
- Described 4 heart chambers
- AV synchronization
- 1st to describe heart beat
- Described all 4 valves



courtesy of www.leonardoda-vinci.org

William Harvey (1578-1657),



William Harvey was the first who provided a true picture of blood circulation. In 1628, he published his pioneering work "**Anatomical Treatise on the Movement of the Heart and Blood in Animals**". This brilliant work proved the continuous circulation of blood within vessels and provided a classic example of the scientific investigation. The controversy over the circulation of the blood raged for 20 years until other anatomists finally repeated Harvey's experiments and confirmed his observations.

WILLIAM HARVEY

A HISTORY OF

*THE DISCOVERY OF THE CIRCULATION OF
THE BLOOD*

BY

R. WILLIS, M.D.

LECTURER IN "THE LIFE AND CIRCULATION OF BLOOD," "ANATOMY AND PHYSIOLOGY," &c., &c.

WITH A PORTRAIT OF HARVEY, AFTER FAITHORNE

LONDON:

C. REGAN PAUL & CO., 1, PATERNOSTER SQUARE

1888

The Early Days of Surgery

(Around 800 BC) Sushruta Samhita was an ancient Indian surgeon and is the author of the book Sushruta Samhita, in which he describes over 300 surgical procedures and 120 surgical instruments and classifies human surgery in 8 categories.

Anesthesia and Pain Control

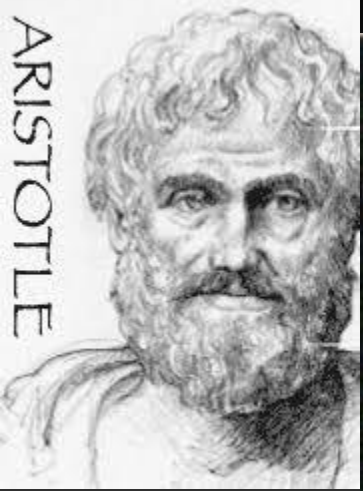
1846. On October 16, William T. G. Morton (1819-1868) made history by being first in the world to publicly and successfully demonstrate the use of ether anesthesia for surgery. This occurred at what came to be called "The Ether Dome," at Massachusetts General Hospital on patient Edward Gilbert Abbott.

Infection Control

Joseph Lister did not discover a new drug but he did make the link between lack of cleanliness in hospitals and deaths after operations. For this reason, he is known as the 'Father of Antiseptic Surgery'. Lister was born in 1827 and died in 1912.



ARISTOTLE



"The heart alone of the viscera cannot withstand injury"

CARDIAC PERISTALSIS: ITS NATURE AND EFFECTS.

By D. W. SAMWAYS, M.A., M.D., B.C. CANTAB.,
M.D. PARIS, D.Sc. LOND.,

LATE FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE.

cases defends the orifice, and I anticipate that with the progress of cardiac surgery some of the severest cases of mitral stenosis will be relieved by slightly notching the mitral orifice and trusting to the auricle to continue its defence.

Mentone, France.

*"has reached the
No new method
ome the natural
the heart"*



Dr. Theodor Billroth

"Any man who would attempt to operate on the heart should lose the respect of his colleagues"

20th CENTURY

HISTORY OF TRANSFUSION

- Important dates:
- 1665: first recorded transfusion; between dogs
- In 1667, blood transfusion from sheep to male
- 1705 first human-to-human transfusion
- 19
- W
- 19
- anti





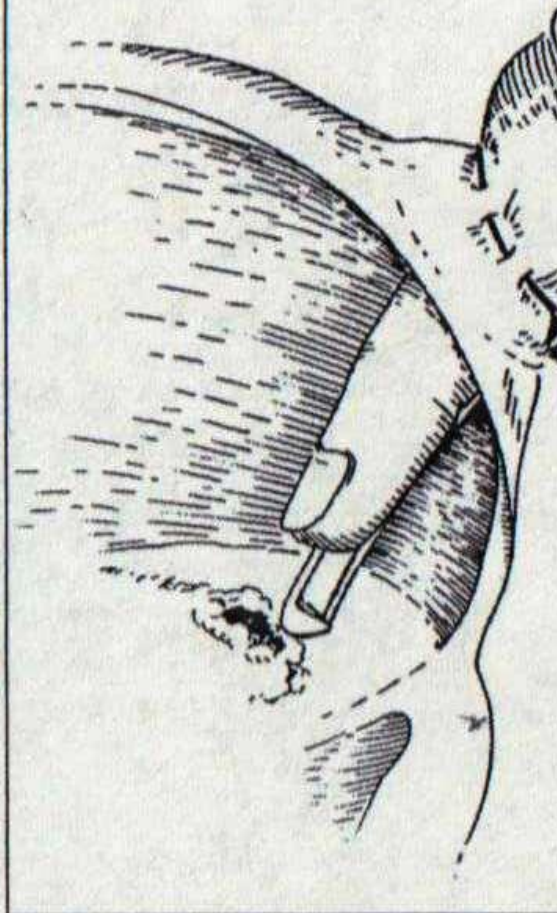
Théodore-Marin Tuffier, known as

And in 1912 –

***was the first to operate on aortic valve stenosis,
attempting to widen the valve***



- ***born at Bellême in Orne in 1857***
- ***FIRST TO PERFORM A LOBECTOMY***
- ***FIRST TO OPERATE ON AN ANEURYSM***



From Sir Henry Souttar
*30, York Terrace,
Regent's Park, N.W.1. 22 9 61
Telbeck 9617.*

Dear Dr Harken,

Thank you so much for your very kind letter.

I did not repeat the operation because I could not get another case. Although my patient made an uninterrupted recovery the Physicians declared that it was all nonsense and in fact that the operation was unjustifiable.

The tear of the appendage had no real bearing on the case but I thought that I ought to mention it as it was a detail to avoid. It is wonderful to think of the immense series you have built up and it is a pleasure to think that my little attempt should have opened the way. Cardiac Surgery has reached levels of which we never dreamt, and it is a privilege to have contact with one who has done so much towards it as yourself.

With very kind regards

Sincerely yours

Henry Souttar

at the presentation of the case aroused, appear advisable to us to detail as exact inary report as is possible at the present to far as we can determine, this is the e on record of such a surgical attack mitral stenosis being completed. Doyen¹ ly attempted a similar case, but his pa- d not survive the operation. since Sir Lauder Branton² in 1902 sug- he possibility of the surgical treatment lar disease of the heart, investigators udied the experimental creation of ' lesions. Papers by McCallum,³ Cush- l Branch,⁴ Bernheim,⁵ Schepelmann,⁶ rrel and Tuffier⁷ from 1906 to 1914 de- ully the experimental methods in use. these methods were only successful in : defective valves resulting in regurgi- The most successful methods consisted ting a knife-hook (valvulotome) into the down the aorta and cutting or tearing ve cusps. Carrel and Tuffier added a thod of creating an insufficiency by the n endothelial transplant over the region s, the ring at the base of the valve then ut, thus permitting a bulging at that In 1922 Allen and Graham⁸ reported in- ions of a similar nature with the addi- at they used a cardioscope in which a nife was carried, and by inserting the ent *via* the left auricular appendage

to be carried out on a structure in only, that no interference what- must take place. The first is not unds, for it is possible to fix the rt which is under operation, but possibilities of repair. In animals y sometimes be ignored, and the ped for as much as two minutes. r be justifiable in a human being, anger to the brain from even the od supply. Any manipulations t therefore be executed in the full , and they must not perceptibly ctions of the heart. lesion for surgical interference is ves, and of these the mitral valve sible. I have been interested for ment of a suitable technique for I owe to Dr. Otto Leyton the the following case for putting my ription of the case itself will give the method of approach I adopted h I devised.

ription of Case.
mitted to the London Hospital in on chorea and mitral stenosis. Her e of many relapses, with steadily

And in fact, of the eleven operations performed on stenotic valves from 1912 to 1929, only two patients survived.



Honolulu Star-Bulletin 1st EXTRA

8 PAGES—HONOLULU, TERRITORY OF HAWAII, DECEMBER 7, 1941—FIVE PAGES

THE PRICE FIVE CENTS

Associated Press by Transpacific Telephone

Dec. 7.—Pres-
announced this
nese planes had

Dwight Harken, MD, operated on 134 soldiers with bullets in their chest, 13 in a heart chamber, without one fatality

SIX KNOWN DEAD,
Attack Made
On Island's
Defense Areas



CIVILIANS ORDERED OFF STREETS

The army has ordered that all civilians be off the streets and highways and not to

Evacuate that the Japanese attack has caused some hits with planes to their killing of people in the East

ANTI-AIRCRAFT GUNS IN ACTION

The anti-aircraft guns of the island were steadily be

Evacuate that the Japanese attack has caused some hits with planes to their killing of people in the East

EMERGENCY HOSPITAL
Hundreds See
City Bombed
Names of

DR. DWIGHT E. HARKEN

“Father of Heart Surgery”

The first surgeon to
have repeated success
with heart surgery.

*“We discovered that the heart
wasn’t such a mysterious and
untouchable thing after all.”*



The New England Journal of Medicine

Copyright, 1948, by the Massachusetts Medical Society

Volume 239

NOVEMBER 25, 1948

Number 22

THE SURGICAL TREATMENT OF MITRAL STENOSIS*

I. Valvuloplasty

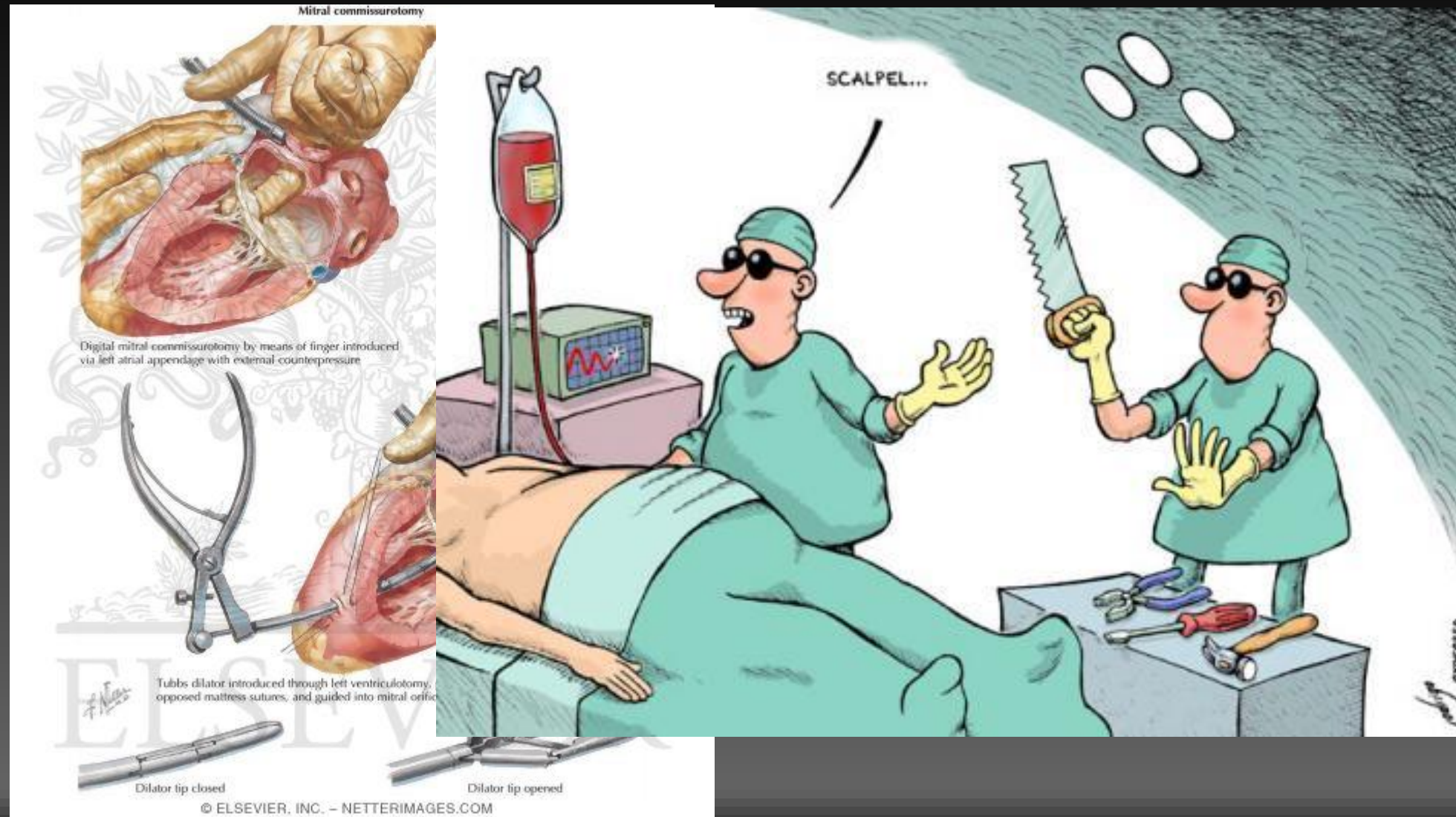
DWIGHT E. HARKEN, M.D.,† LAURENCE B. ELLIS, M.D.,‡ PAUL F. WARE, M.D.,§
AND LEONA R. NORMAN, M.D.¶

BOSTON



**Father and co-founder of
Mended Hearts, Inc.,
Dwight Emary Harken, M.D.,
1910-1993**

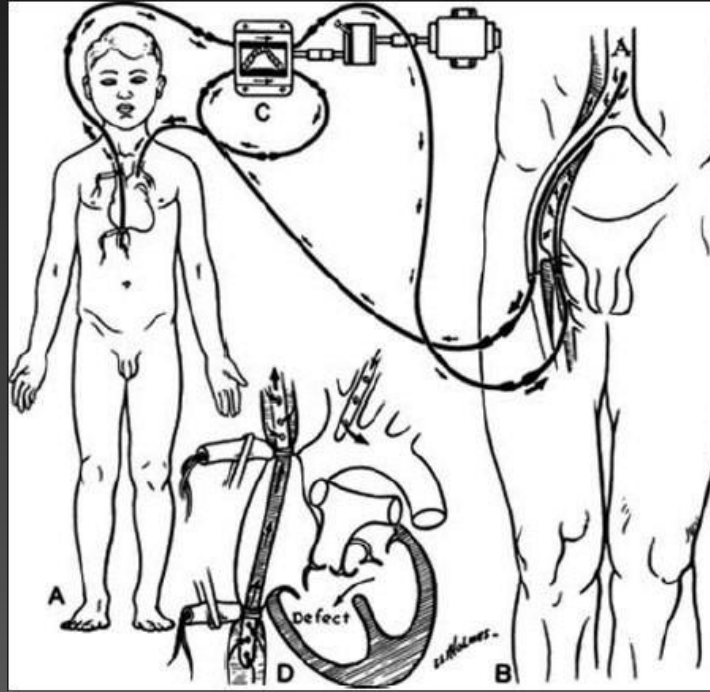
Closed Mitral Commissurotomy



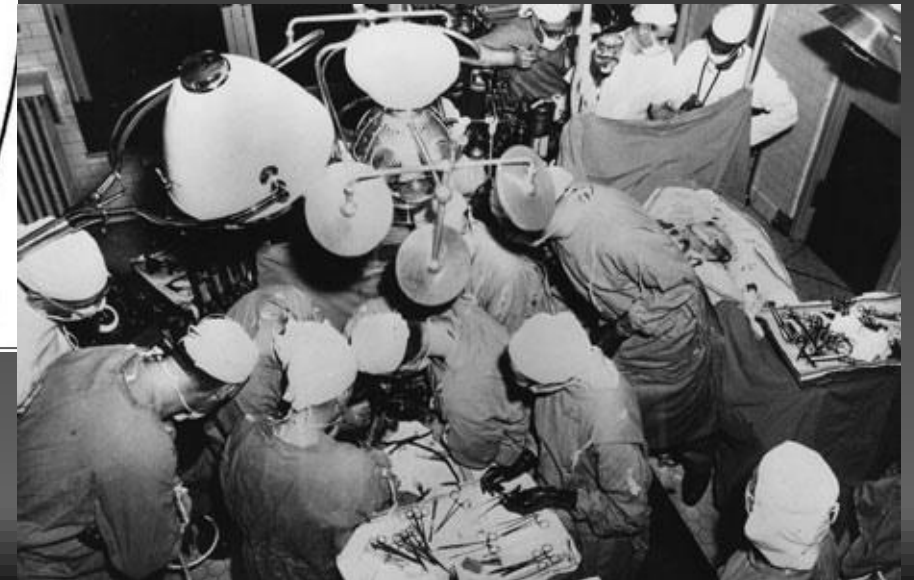
How can you operate on a heart that continues to beat and circulate blood?



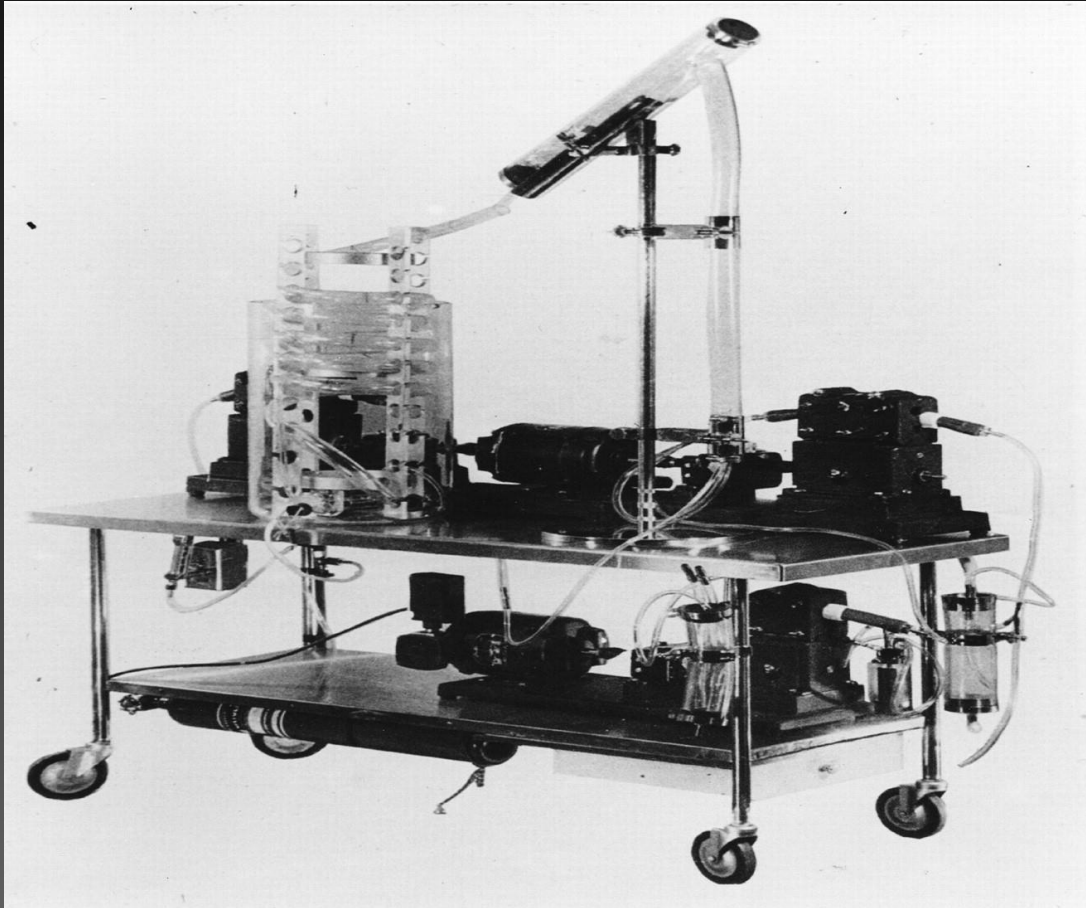
*Packed in ice until temp 26 degrees
Blood flow to the heart stopped
Time of Operation 8-10 minutes
Floyd Lewis, MD - Minnesota*



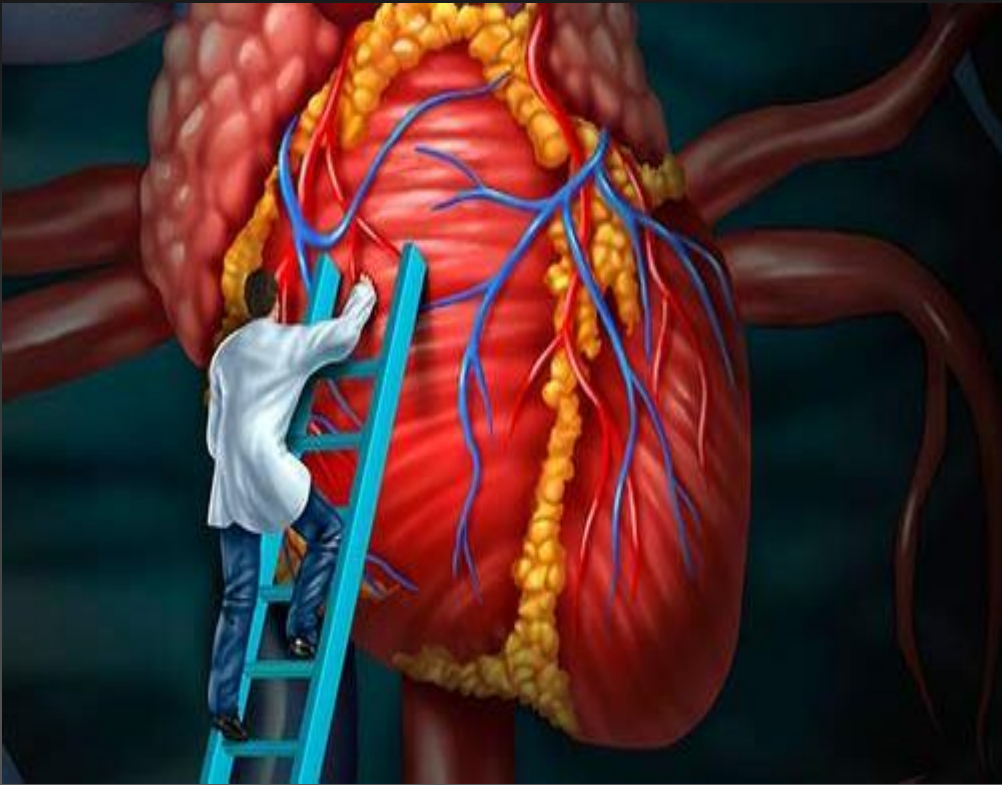
C. Walton Lillihei, MD



Development of the Heart Lung Bypass Pump



From the Dawn of Man to 1950.....



***Anatomy and Physiology
Surgery and Surgical techniques
Anesthesia and Pain Control
Blood typing and Blood Banking
Overcoming Fears and the Unknown
Surgical Instrumentation
Out-of Body circulation***

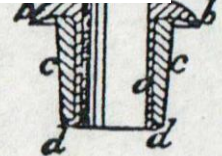


Charles Hufnagel, MD and Justin Chesterman (England)

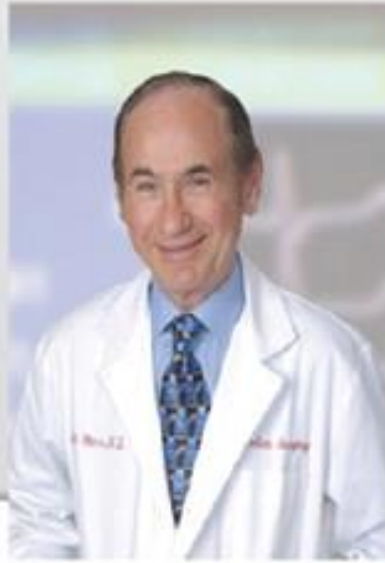
*1954 re
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descend*



*c position
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***Oregon
Health and
Science
University***



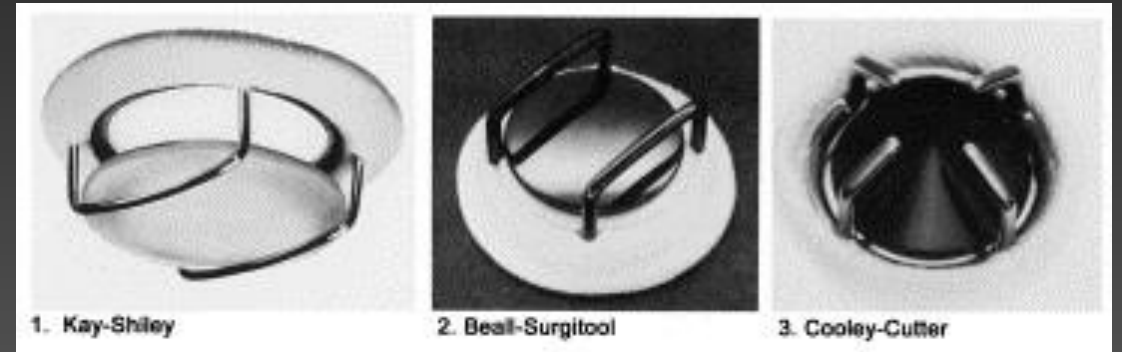
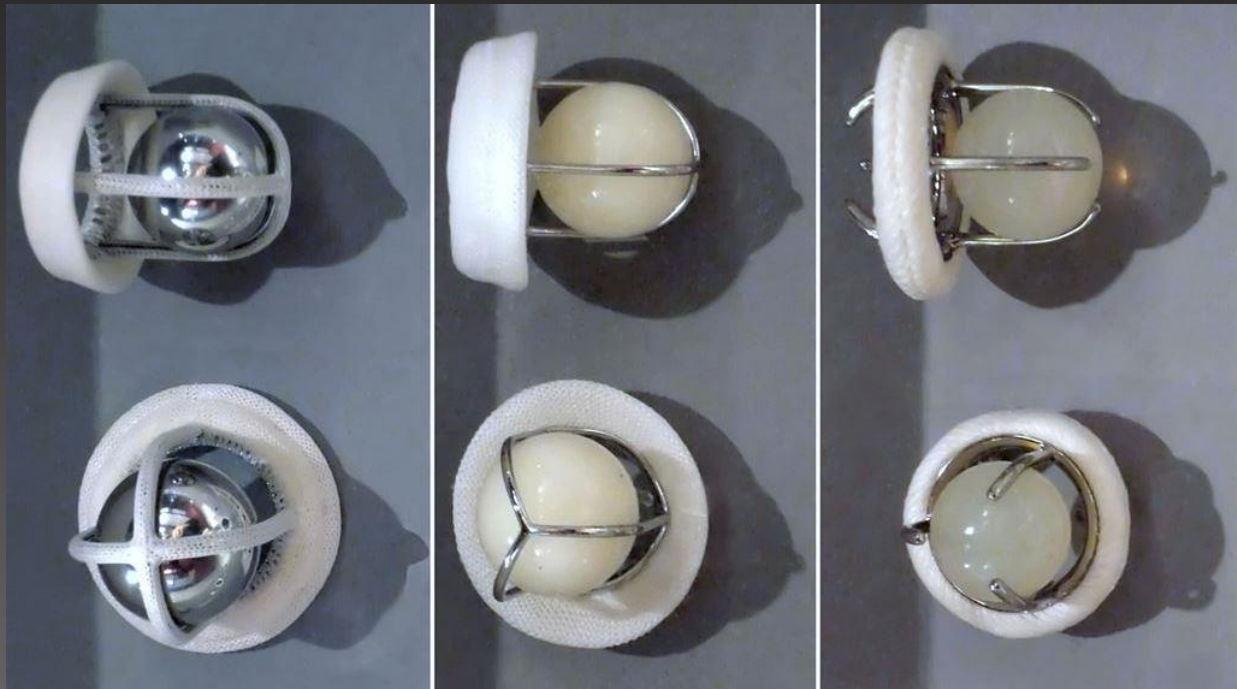
Albert Starr, a physician, the caged ball valve and Lowell Edwards

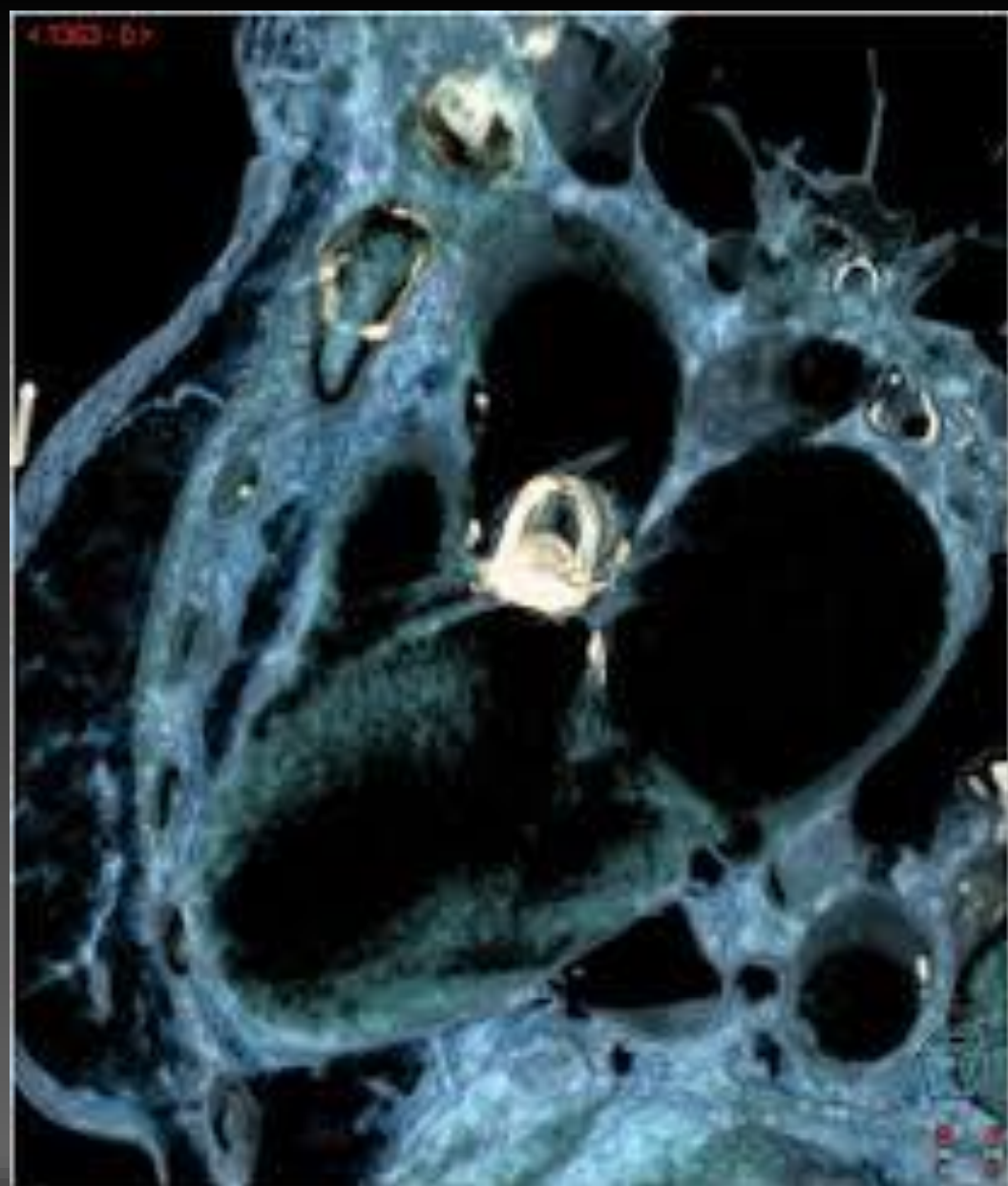
***September 21, 1960- first successful MVR
Soon thereafter
Harken performed the first AVR***



Philip Admundson

*After the Starr-Edwards valve was established, several other design variations were created such as **Magovern–Cromie**, **DeBakey–Surgitool**, and **Smeloff–Cutter** ball valves. A variation of the ball valve utilizes a metal cage to contain the ball which allows a smaller ball to be used.*





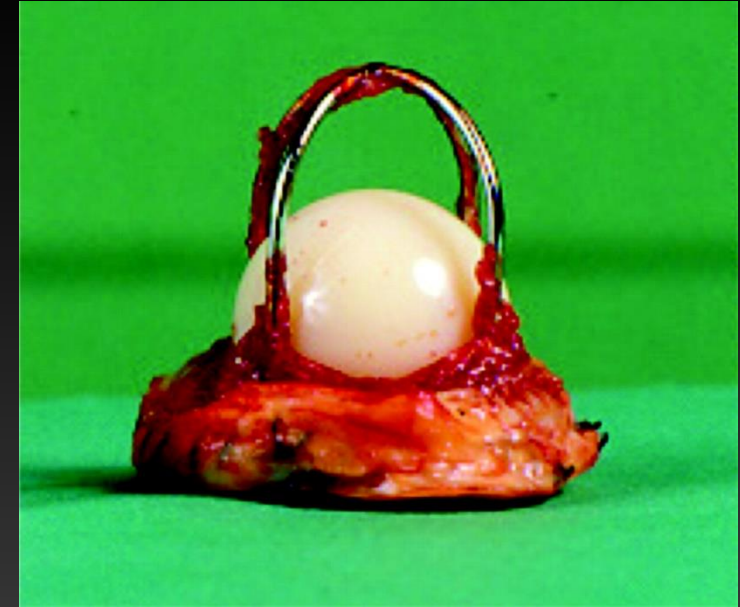
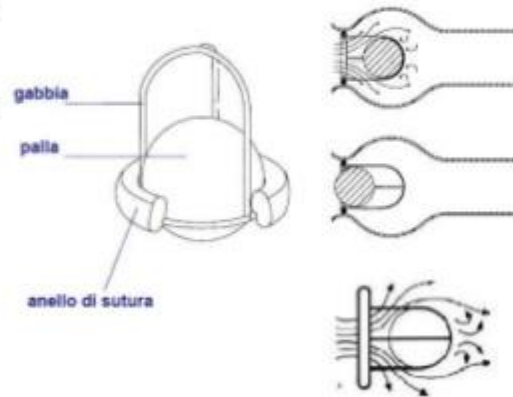
Mechanical Valves: Ball Valves

This design uses a spherical occluder, or blocking device, held in place by a welded metal cage

Problem and Why failed: Natural heart valves allow blood to flow straight through the center of the valve (central flow)

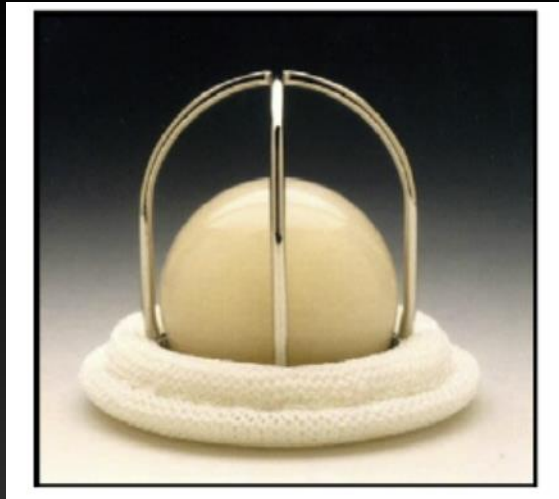
Caged-ball valves completely blocked central flow and collisions with the occluder ball caused damage to blood cells

Finally, these valves stimulated thrombosis, or formation of blood clots

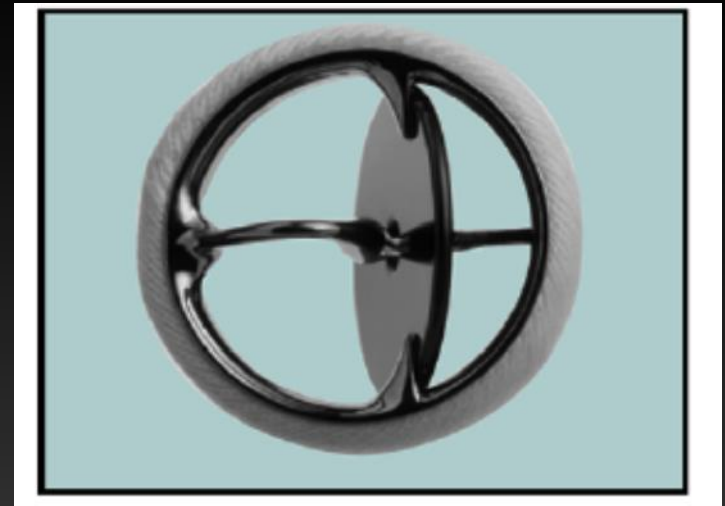


Butprogress never stops



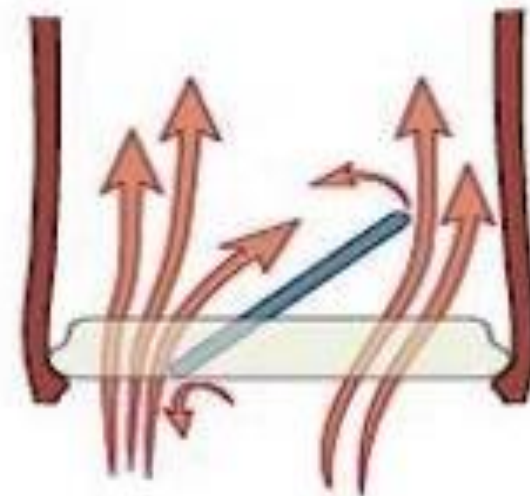
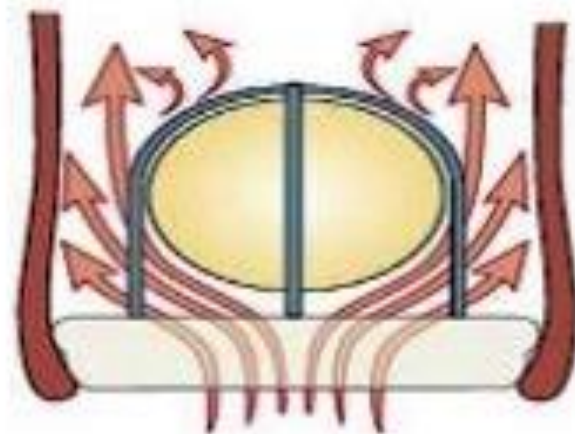
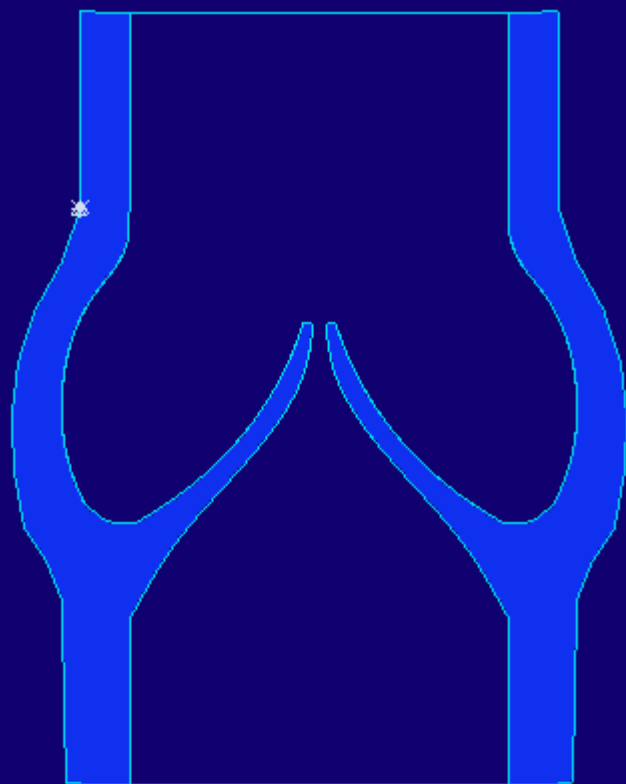


Starr Edwards



Bjork-Shiley (1969-1986)	Sorin monodisco (1977-2001)	Omniscience (1978-2001)	Medtronic-Hall (1977-Presente)	Bicer (1980-1994)
60° o 70° según modelo	60°	60°	Mi 70° - Ao. 75°	75°

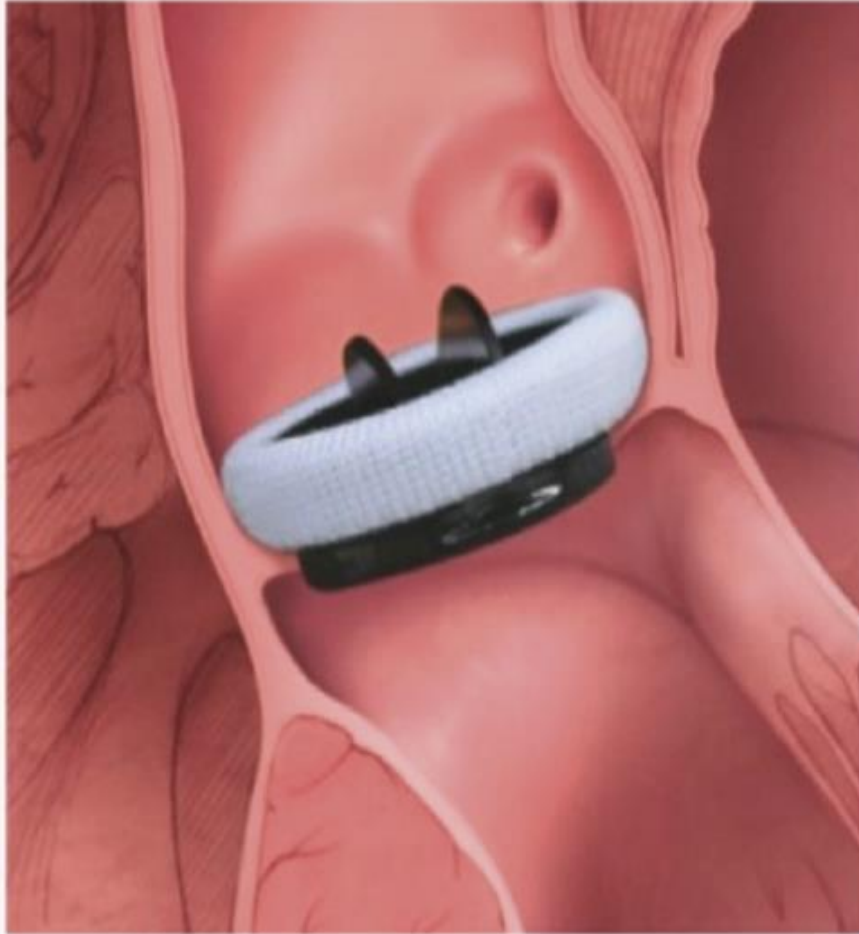
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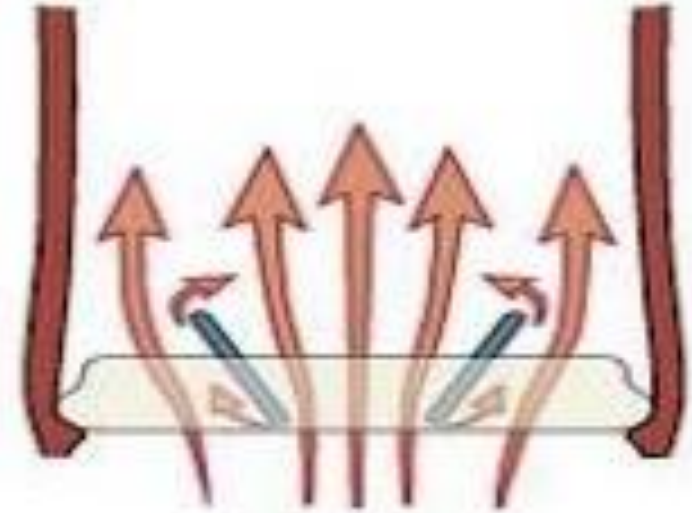
(B)



Aortic



Mitral

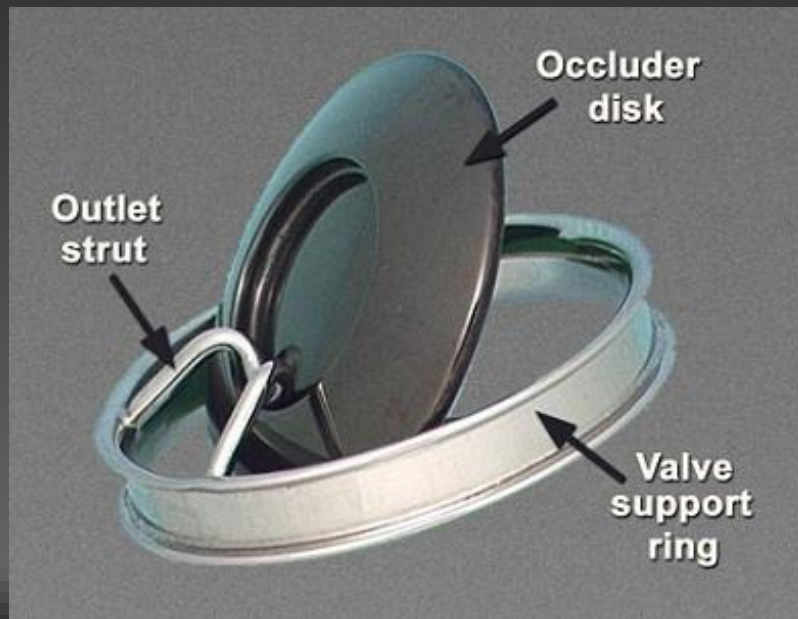


The Bileaflet Valve

The Bjork –Shiley Disaster



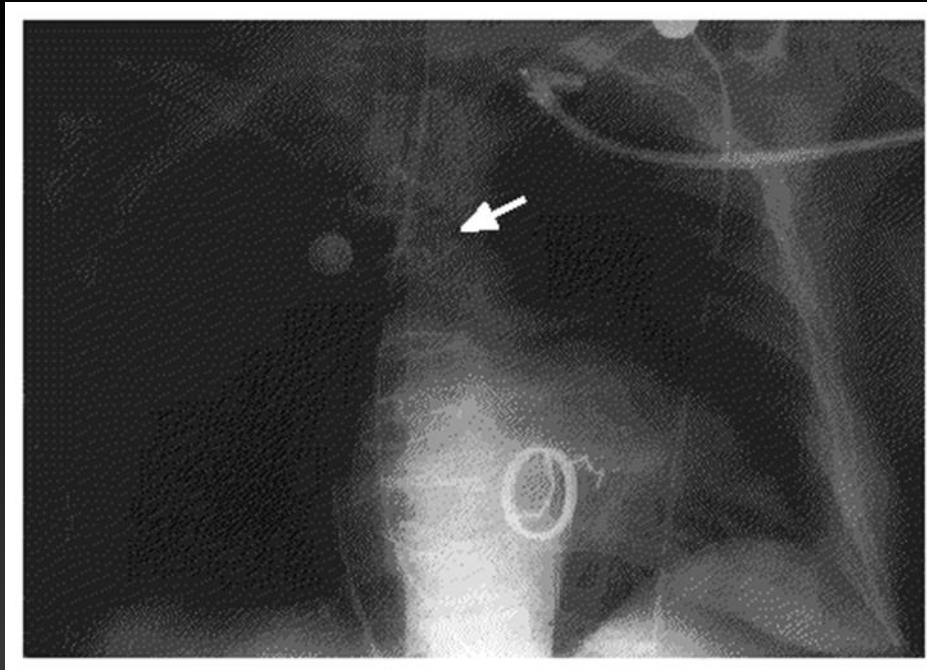
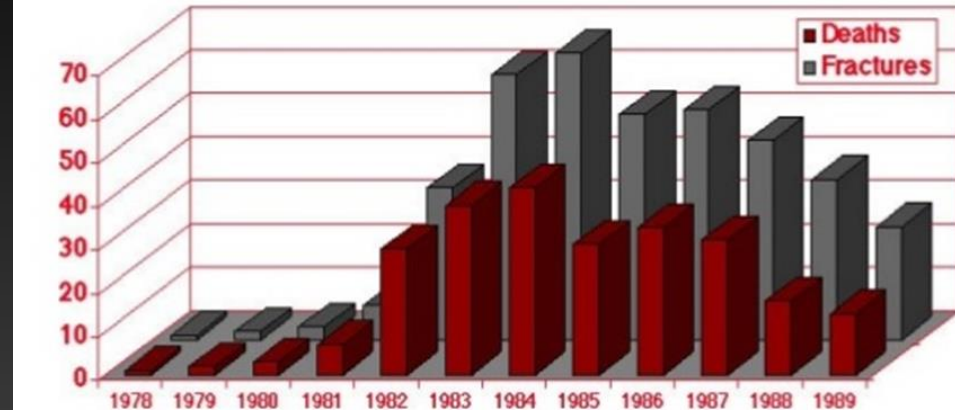
***Initial valve from the late 1960s
improved hemodynamics
But had a high incidence of
thrombosis and embolization***



***1979 the valve was redesigned and
reconstructed
Became the most popular valve in the
world
86,000 valve were implanted world-
wide, 31k in USA***

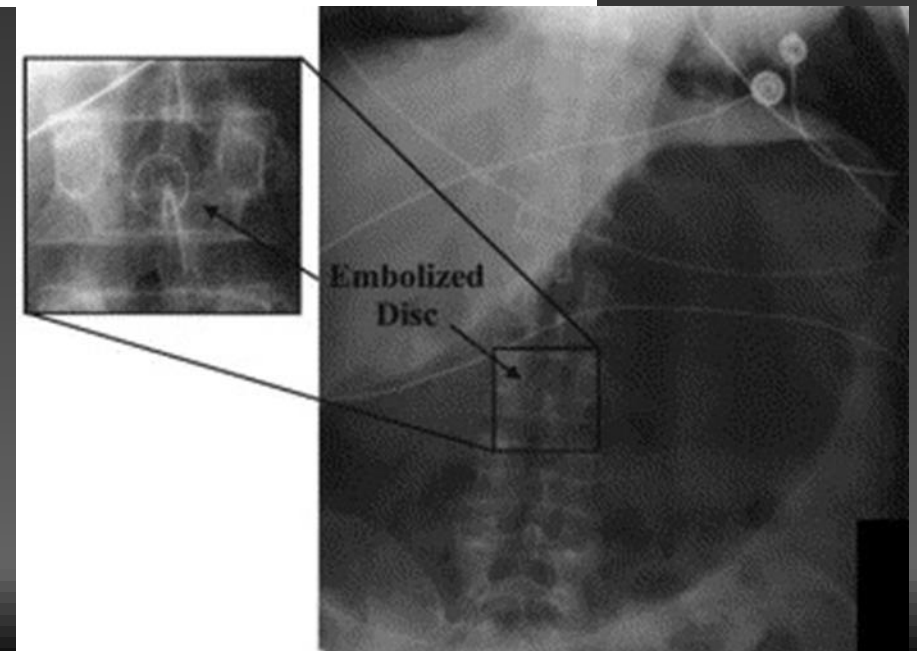
Björk-Shiley Convexo-Concave valve: The (Really) Bad News

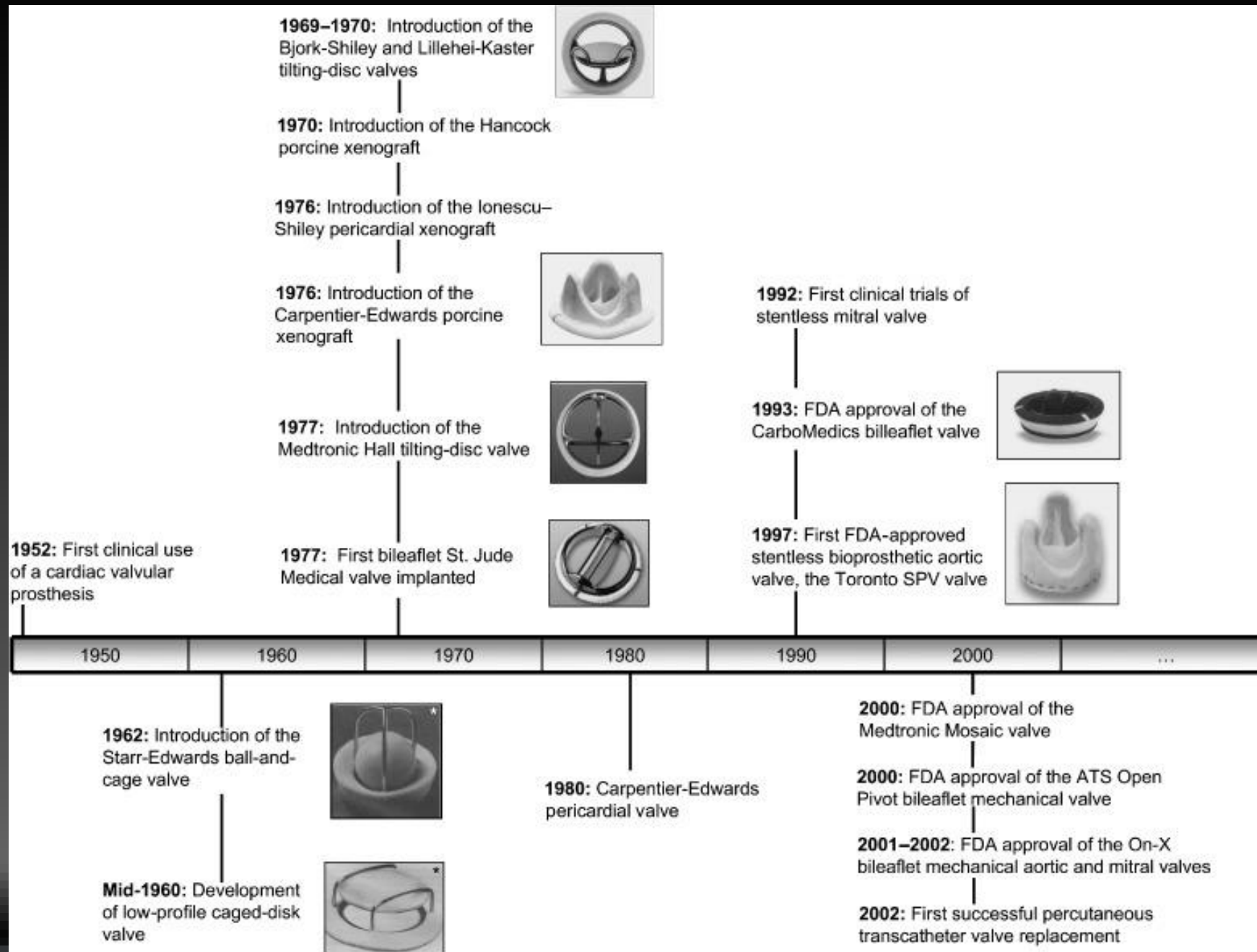
- First outlet strut fracture in 1978 during clinical trials



***Beame apparent that the valve had
an unacceptable failure rate
Valve was recalled***

***All told – 633 deaths
Fracture rate 0.1% per year***





Bioprosthetic Valve Types

1960s

Tissue valve investigated in an attempt to overcome
lives

essful

ograft

preserved

rafts for

ility with

preservation

➤ Xenografts

✓ Tissue

➤ Allografts

✓ Tissue

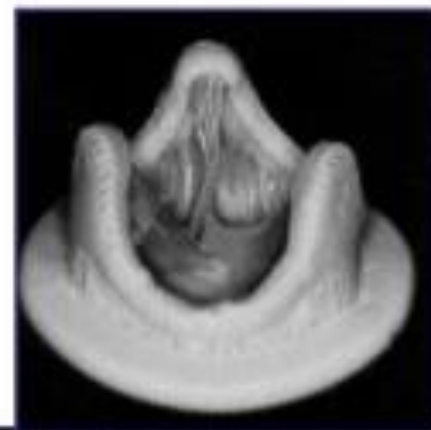
➤ Autografts

✓ Tissue



1970'S

- ✓ Continued development of tissue valves including stented products
 - **Early 70's:** Kaiser & Hancock developed first successful porcine bioprosthesis - metal stent - then plastic
 - **1976:** Carpentier & Edwards developed porcine valve with an Elgiloy stent
 - **1976:** Ionescu & Shiley introduced bovine pericardial valve with polyester-covered flexible stent.



STENTED

to the Present Day

SORIN | PERCEVAL



Extra Large

SIZE NOW AVAILABLE



Large

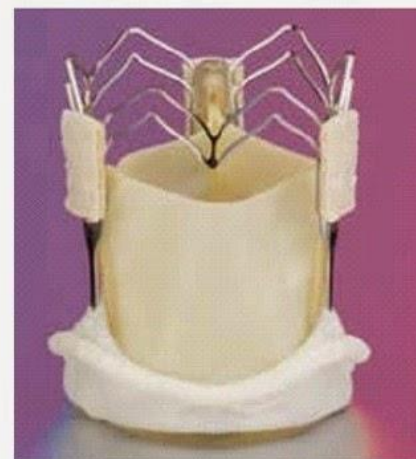


Medium



Small

3F Enable model 6000



Perceval S



Sutureless valve

ced

stent

pericardial

Me

**A HOSPITAL BED IS A
PARKED TAXI WITH
THE METER RUNNING.**



ima Plus



: Freestyle



onto SPV



Cardiac Cath

Werner Forssman

August 29,
1904 – June 1, 1972

First Cardiac
Catheterization
in 1929 received
The Nobel Prize
Medicine
1956

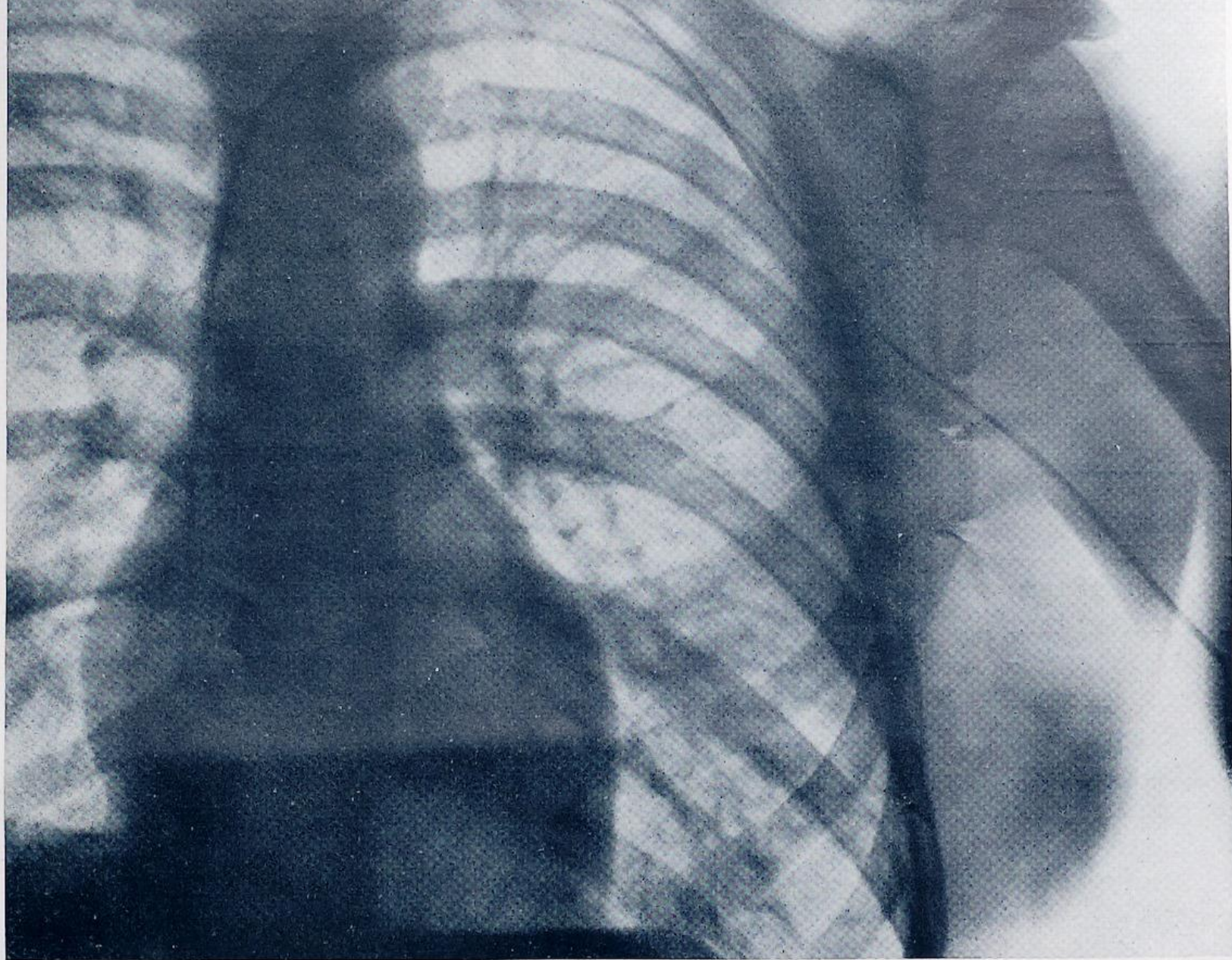
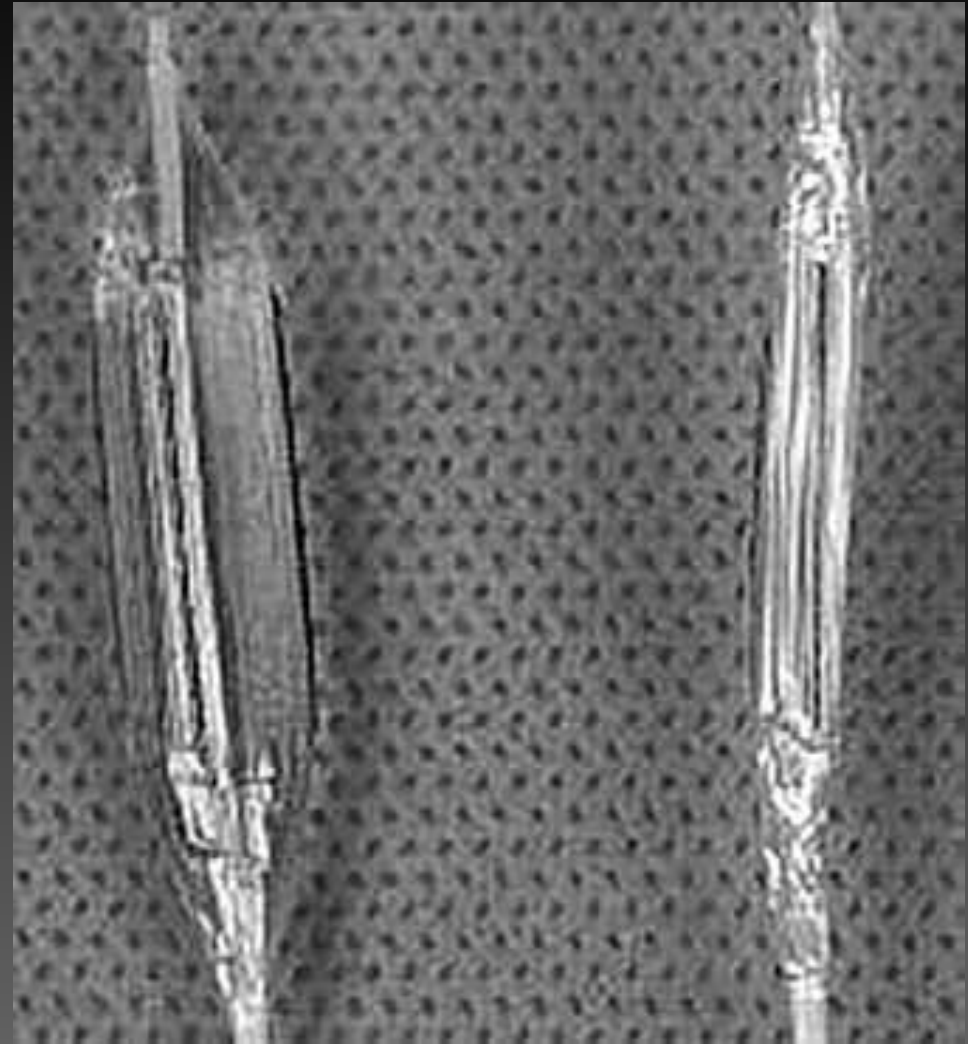
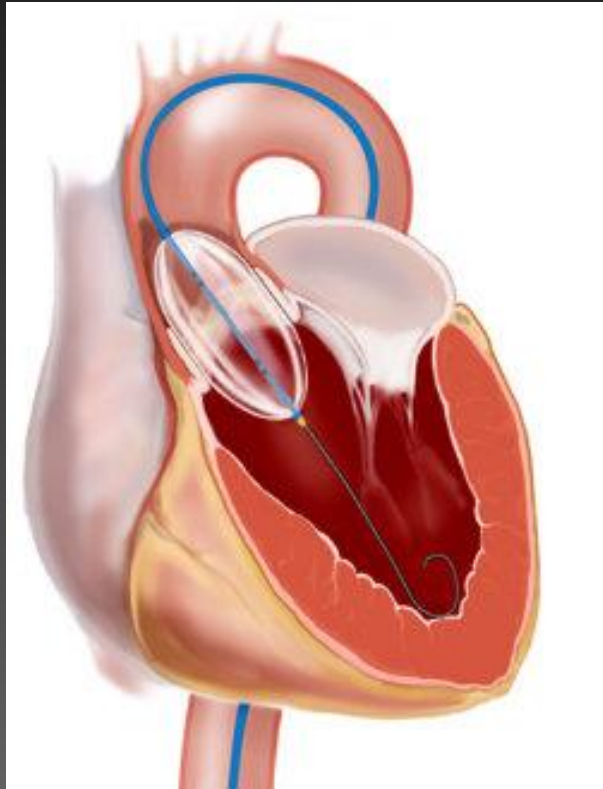


Abb. 2. Der Katheter reicht von der linken Vena cephalica herabkommend bis in die rechte Vorkammer.

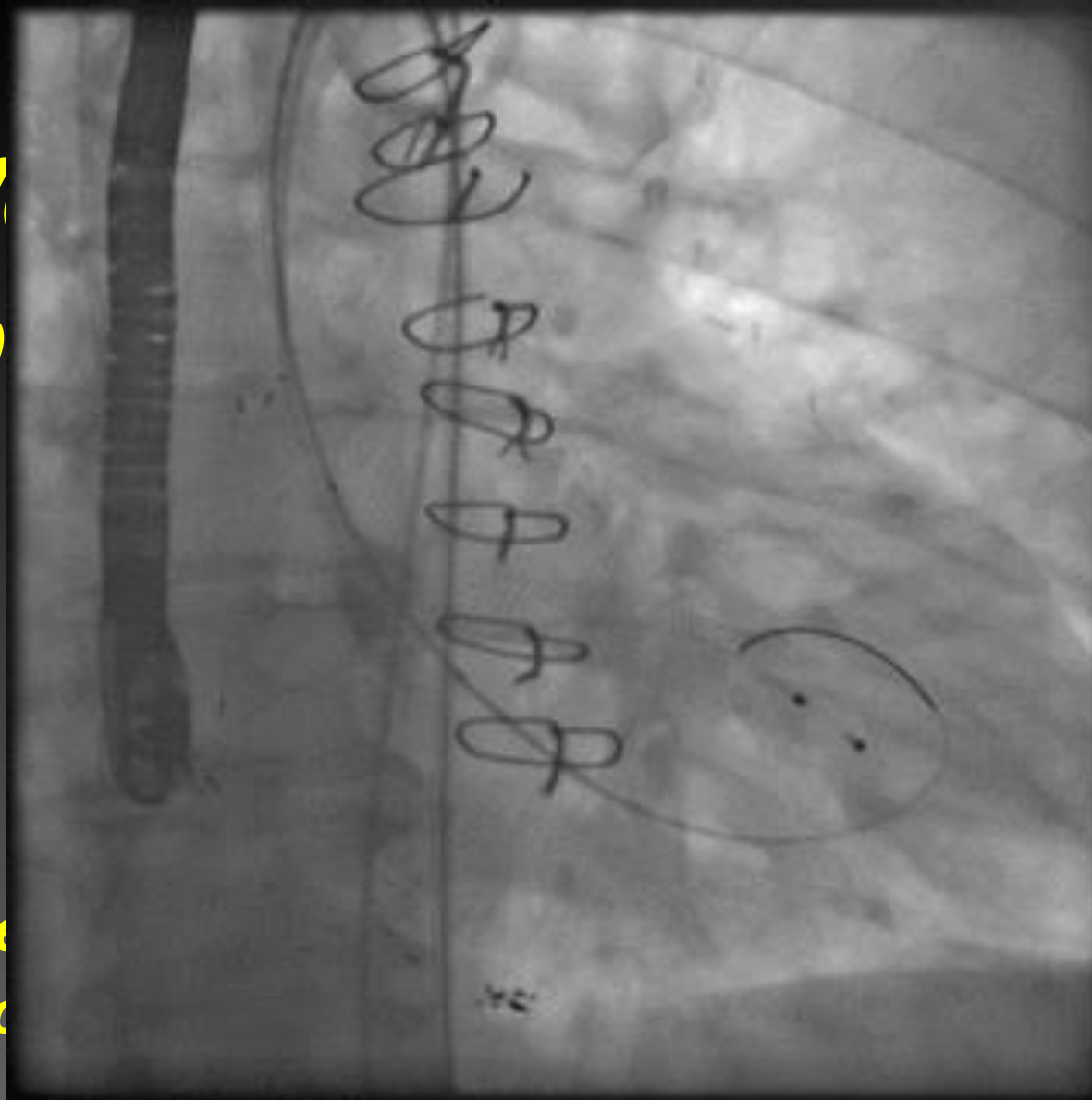


Aortic Valve Valvuloplasty



Aortic Valve Valvulopathy

1985 performed
33% of



er, MD

Address the
y

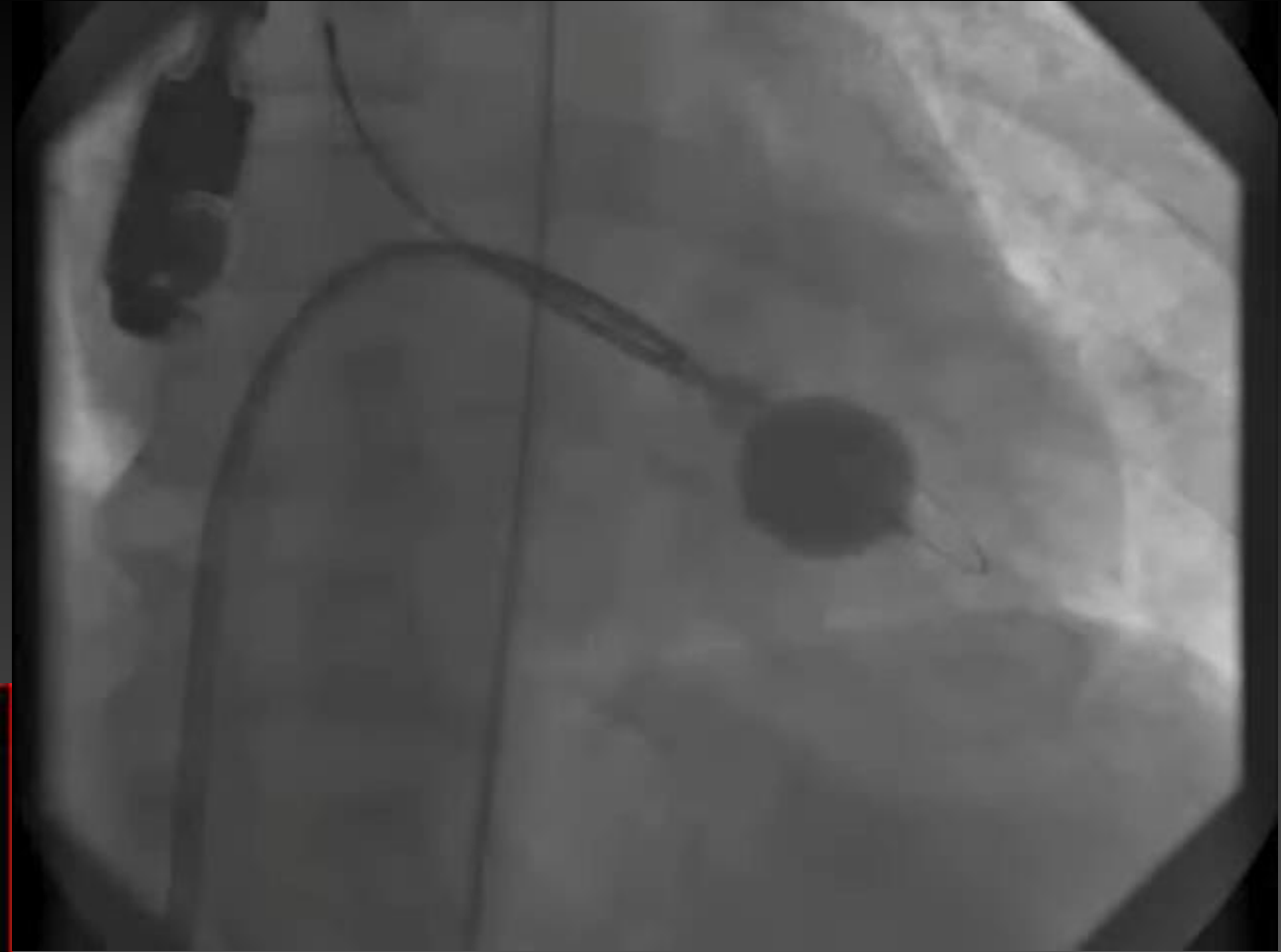
Mitral Valve balloon Valvuloplasty

Kanji Inoue, MD



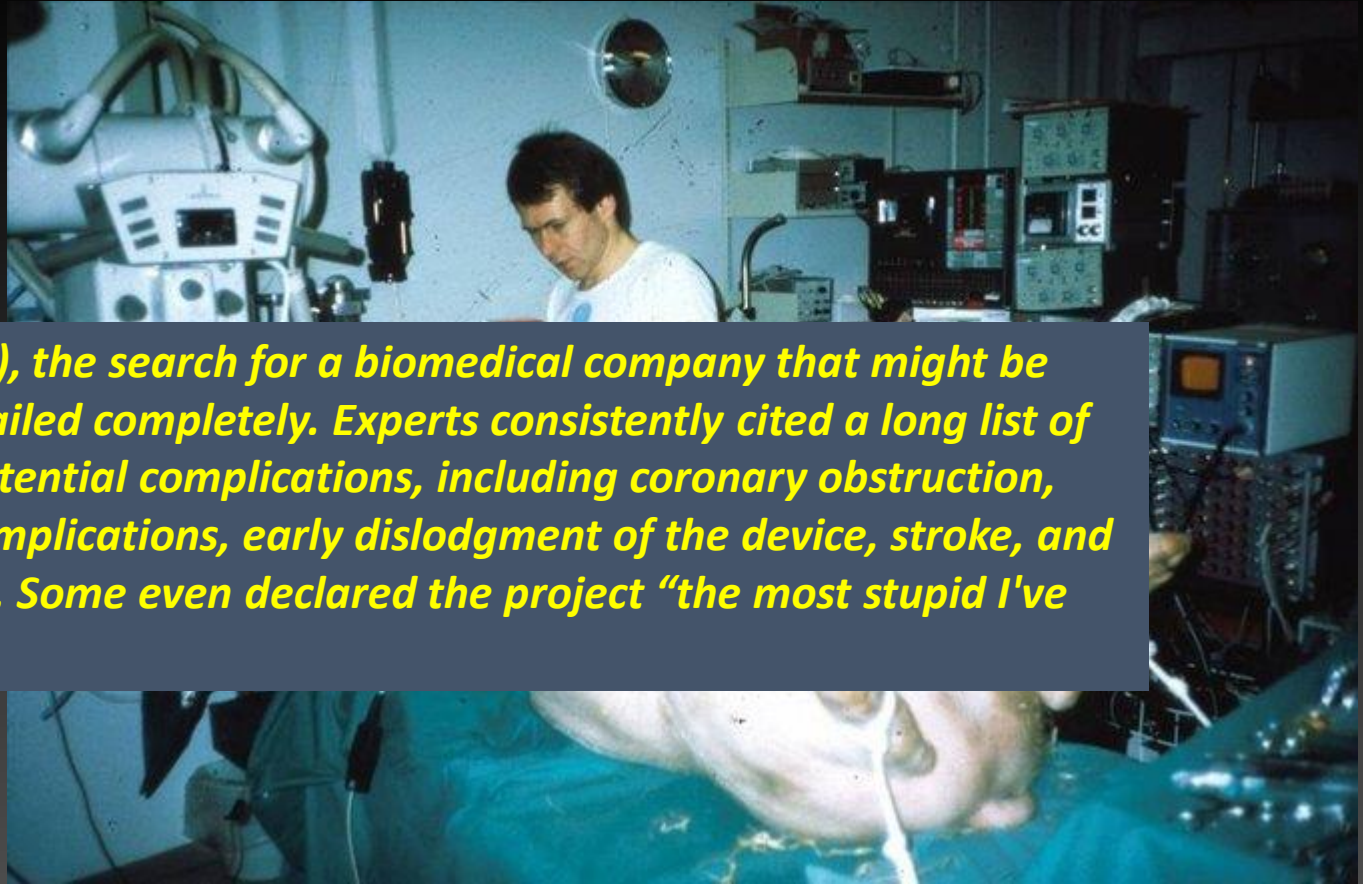
***1984 - Dr Inoue performed the first mitral valve balloon dilation of mitral stenosis.
The technique, and the balloon, the “Inoue balloon” is still in use today***

Mitral Valve Valvuloplasty



***If only we had
something better
than a balloon?***





4-year period (1995–1999), the search for a biomedical company that might be interested in the project failed completely. Experts consistently cited a long list of engineering issues and potential complications, including coronary obstruction, aortic and mitral valve complications, early dislodgment of the device, stroke, and mechanical complications. Some even declared the project “the most stupid I’ve ever heard.”

***Henning Rud
Andersen***



16 April 2002

***Alain Cribier and colleagues performed the
first percutaneous valve replacement***

\$10,000

\$168,030,000



Edwards TAVR video

20.7785
0.40 sec

R

Coro SF
cm 16
kV 95
RAO 4° / CAUD 23°

120cm/1111

95.3 kV CARD
369.3 mA 15.0 f/s

A

Coro SF
FL 3040
1029 mGy
10640.4 μGym^2
00:07.40

23%

00:00

720 x 720

EE 22%
Dose 50%

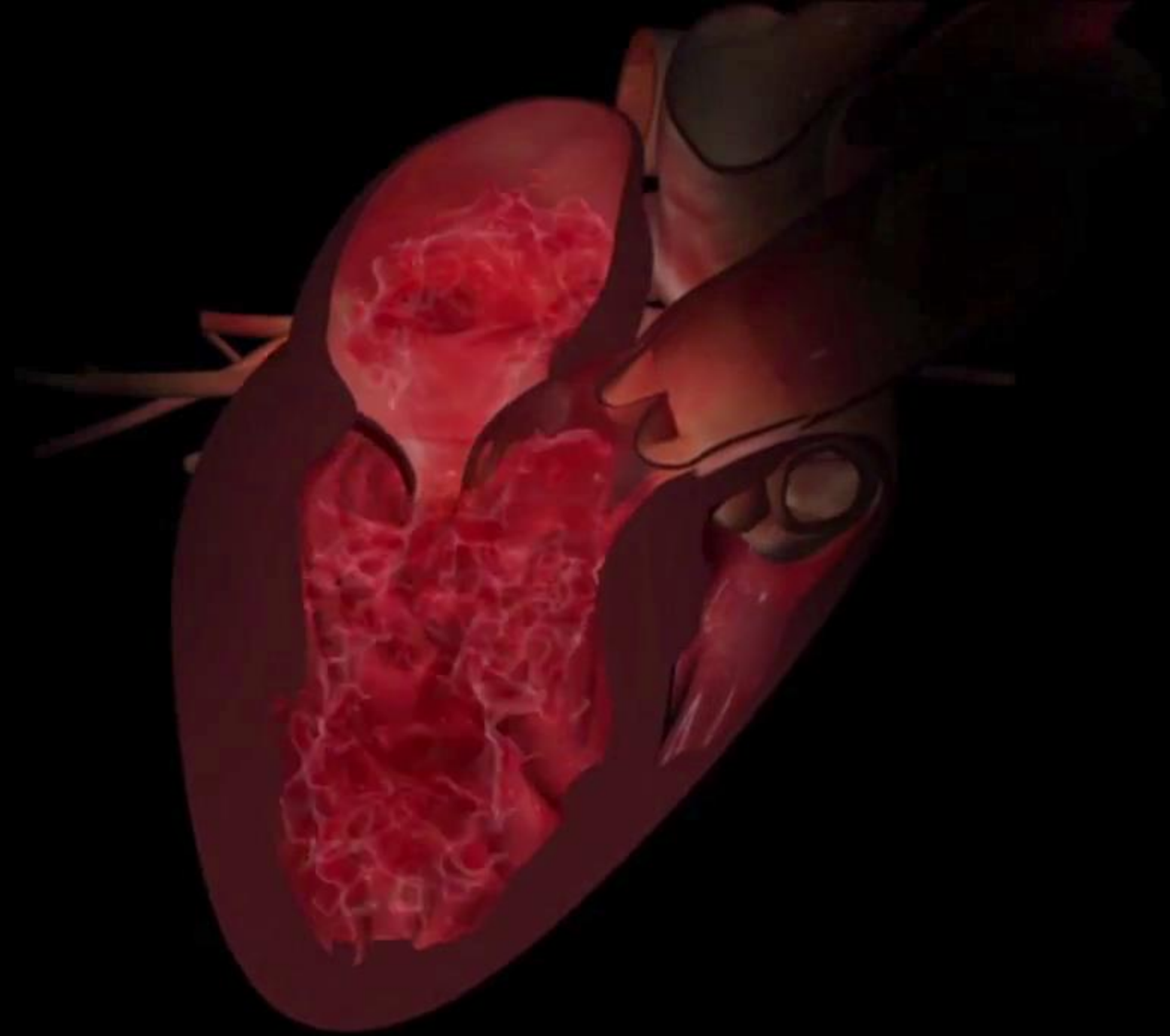
VFD 1976
WV 2200



Review

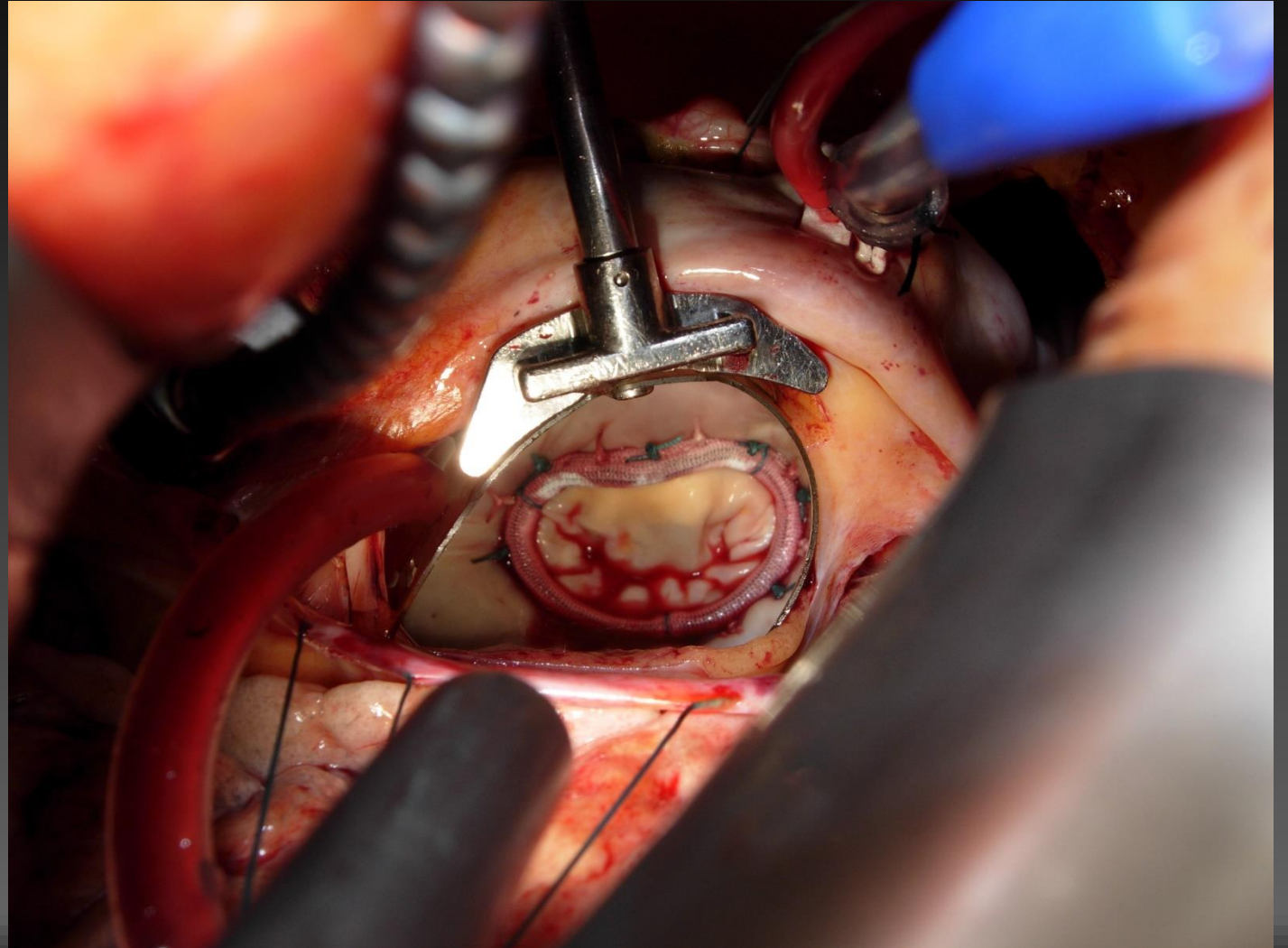


Pointer





Mitral valve repair



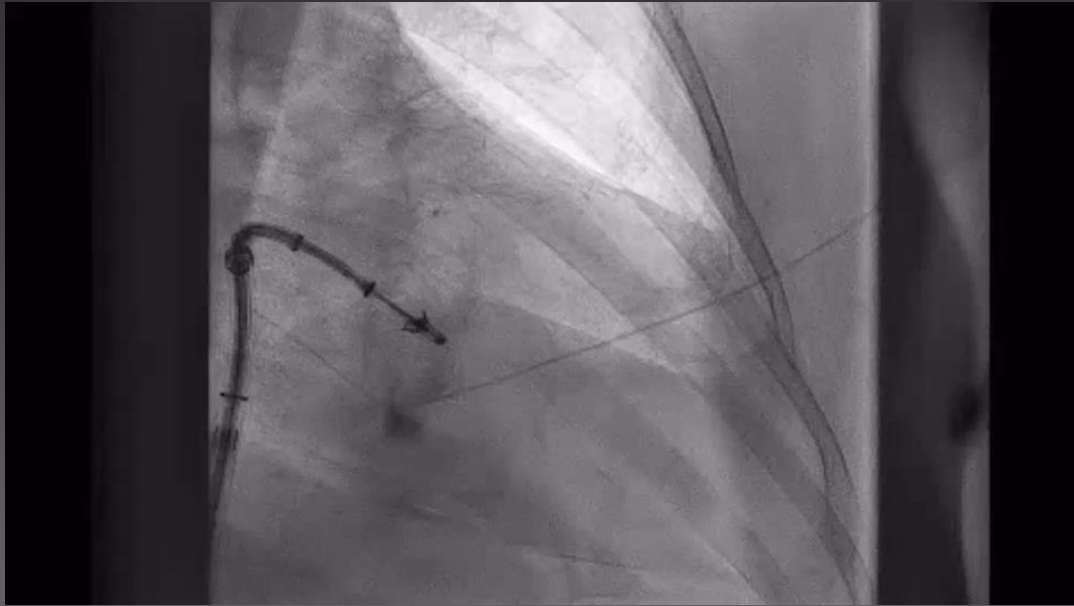
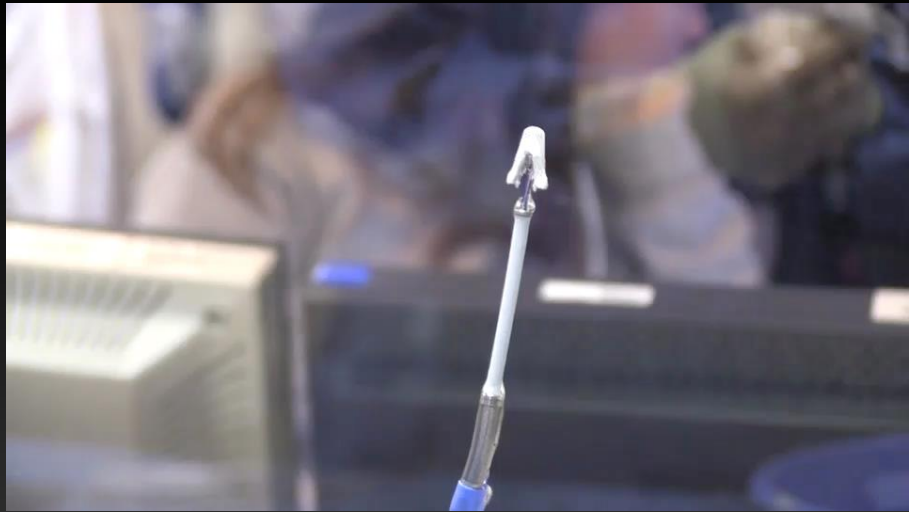
***Alain Carpentier, MD
Delos Cosgrove, MD***

So guess what happened





Abbot MitraClip video





From PVT to Edwards balloon expandable Valves

Edwards Valves

2000: PVT Valve 2003-2004

2005-2009

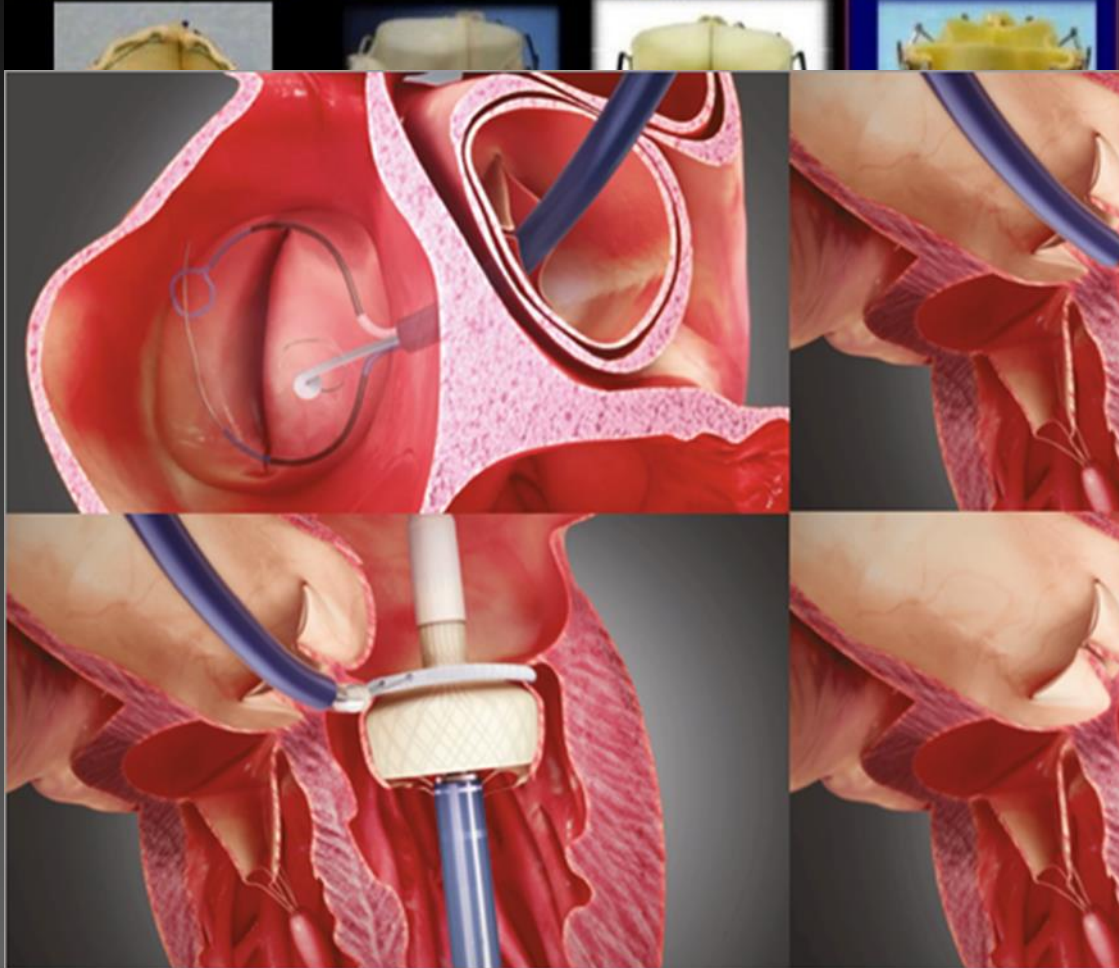
2009

Percutaneous Heart Valve

Cribier Edwards

Edwards Sapien

Edwards Sapien XT



Self expandable Medtronic CoreValve

Generation 1
25F

Generation 2
21F

Generation 3
18F

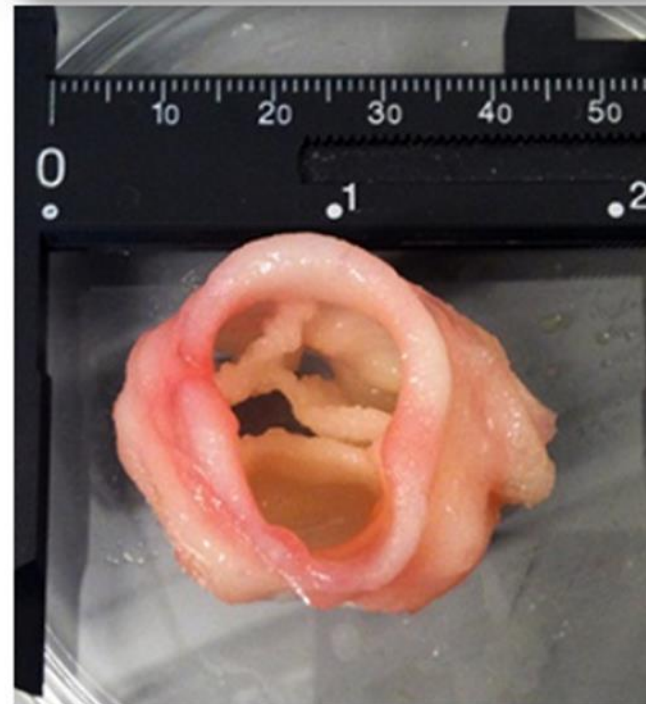
Generation 4
18F

3D TISSUE PRINTING

J Biomed Mater Res A, 2013 May;101(5):1255-64. doi: 10.1002/jbm.a.34420. Epub 2012 Sep 27.

3D bioprinting of heterogeneous aortic valve conduits with alginate/gelatin hydrogels.

Duan B¹, Hockaday LA, Kang KH, Butcher JT.



Micro CT of the
aortic valve and
3D reconstruction



Hydrogel conduit
3D printing



Encapsulation
of cells into
the conduit



A scenic view of a mountain valley. In the foreground, a turquoise lake is nestled among dense evergreen forests. The middle ground shows rolling hills and valleys covered in greenery. In the background, majestic mountains with snow-capped peaks rise against a blue sky with scattered white clouds. The overall atmosphere is serene and majestic.

**If I have seen further than others,
it is by standing upon the
shoulders of giants.**

Isaac Newton

"Discovering truth by building on previous discoveries"



????

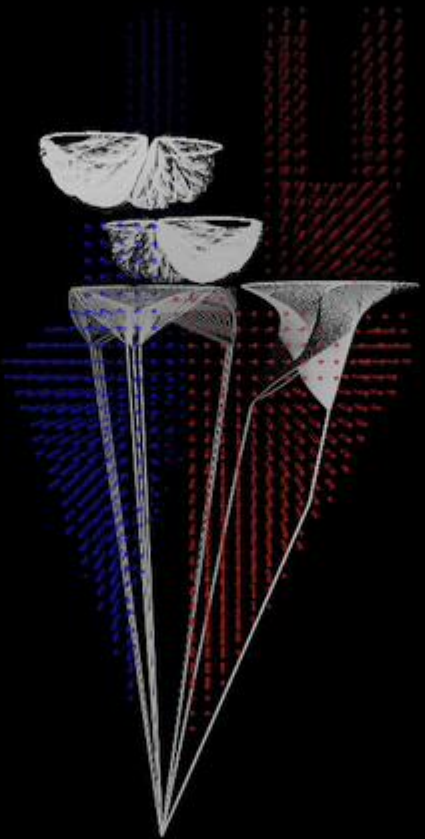
*Cribier /Andersen
Inoue*

*Tuffier
Souttar
Harken*

*Sushrata
DaVinci
Harvey
Lister*



The attribution to **Bernard of Chartres** is due to John of Salisbury. In 1159, John wrote in his *Metalogicon*: "Bernard of Chartres used to compare us to dwarfs perched on the shoulders of giants. He pointed out that we see more and farther than our predecessors, not because we have keener vision or greater height, but because we are lifted up and borne aloft on their gigantic stature."



*Thank You For
Listening*