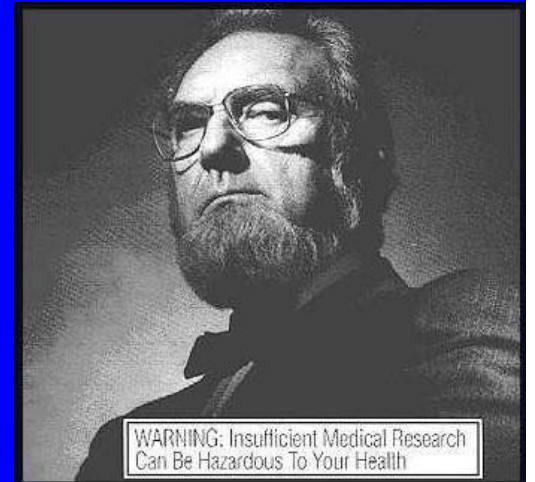


BME 301

Lecture Eighteen

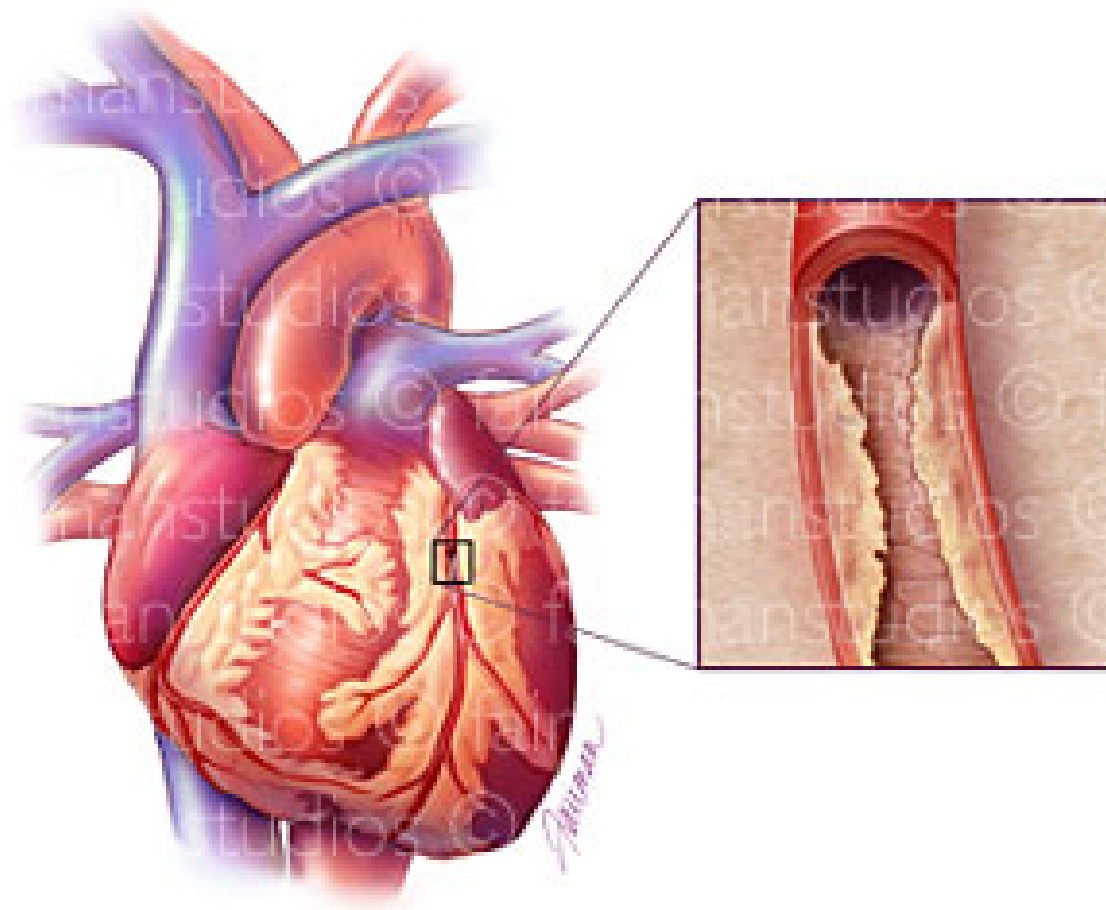


Outline

- The burden of heart disease
- The cardiovascular system
- How do heart attacks happen?
- How do we treat atherosclerosis?
 - Open heart surgery
 - Angioplasty
 - Stents
- What is heart failure?
- How do we treat heart failure?
 - Heart transplant
 - Left ventricular assist devices
 - Artificial heart

Early Warning Signs of Heart Attack

- Many heart attacks start slowly; symptoms may come and go
- Chest discomfort
 - Most heart attacks involve discomfort in the center of the chest that lasts for more than a few minutes, or goes away and comes back. The discomfort can feel like uncomfortable pressure, squeezing, fullness, or pain
- Discomfort in other areas of the upper body
 - Can include pain or discomfort in one or both arms, the back, neck, jaw, or stomach
- Shortness of breath
 - Often comes along with chest discomfort. But it also can occur before chest discomfort
- Other symptoms
 - May include breaking out in a cold sweat, nausea, or light-headedness



Heart Attack Video

- <http://www.heart1.com/attack/guidant.cfm>

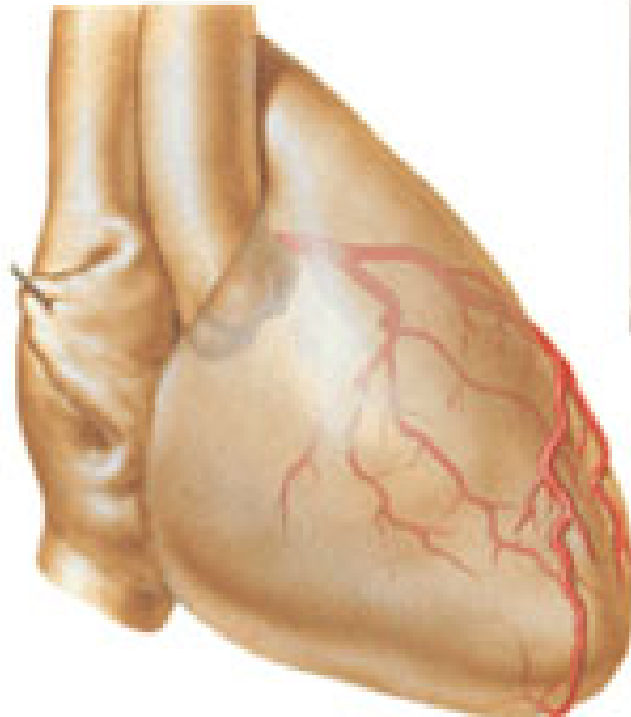
Heart Attacks

Diagnosis of Atherosclerosis

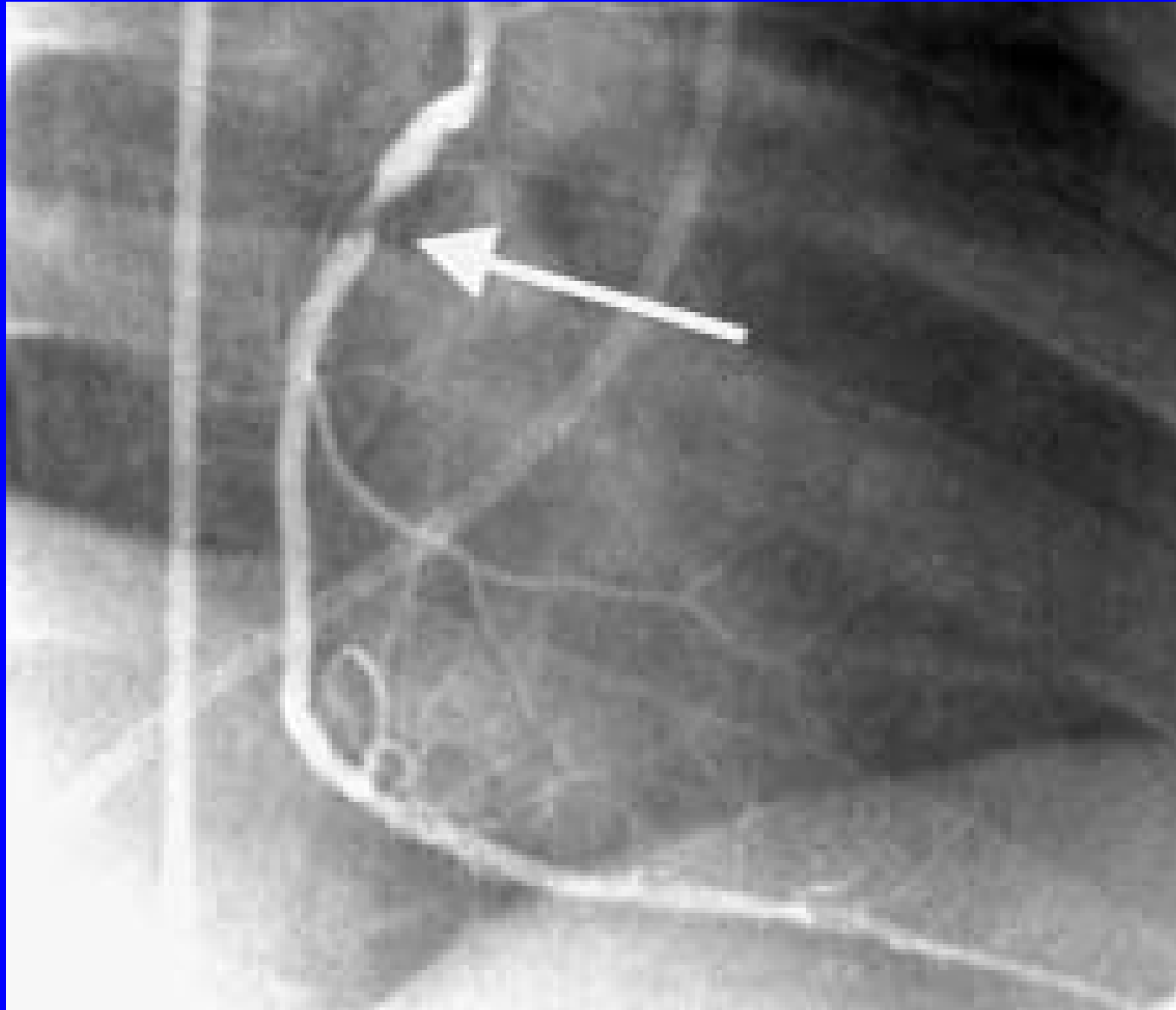
Detection of Atherosclerosis

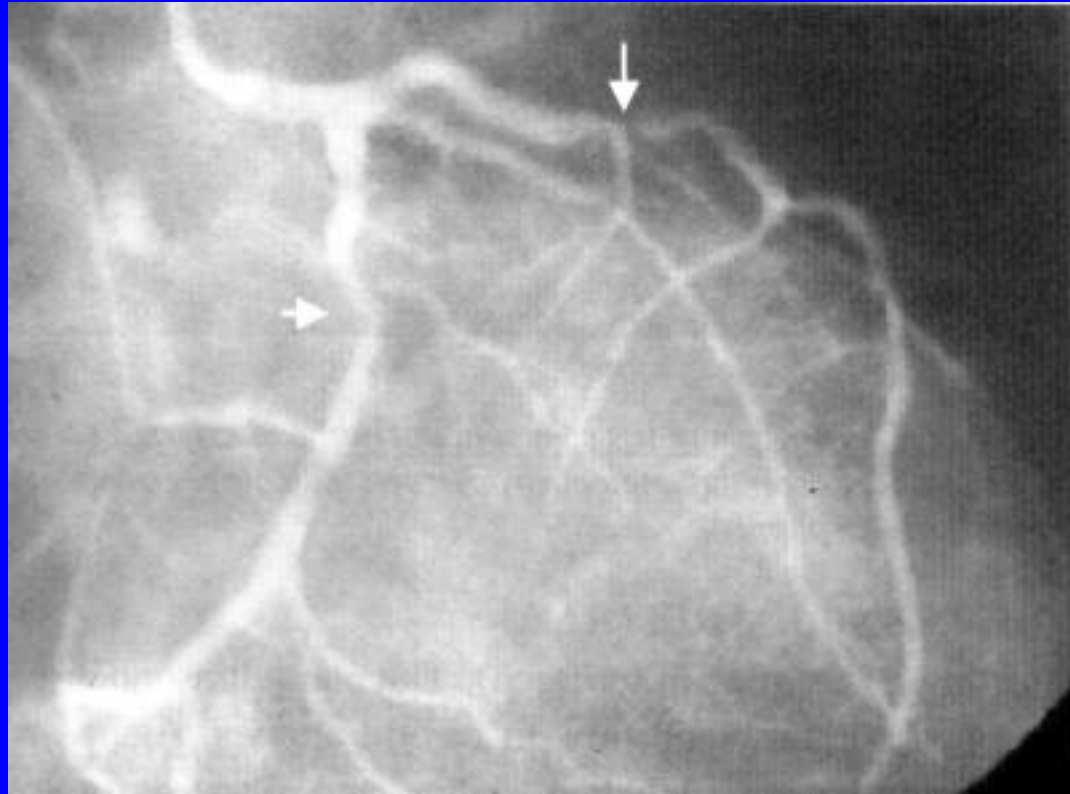


Left Coronary Artery Arteriographic View 2



Handwritten signature
© 2000-10



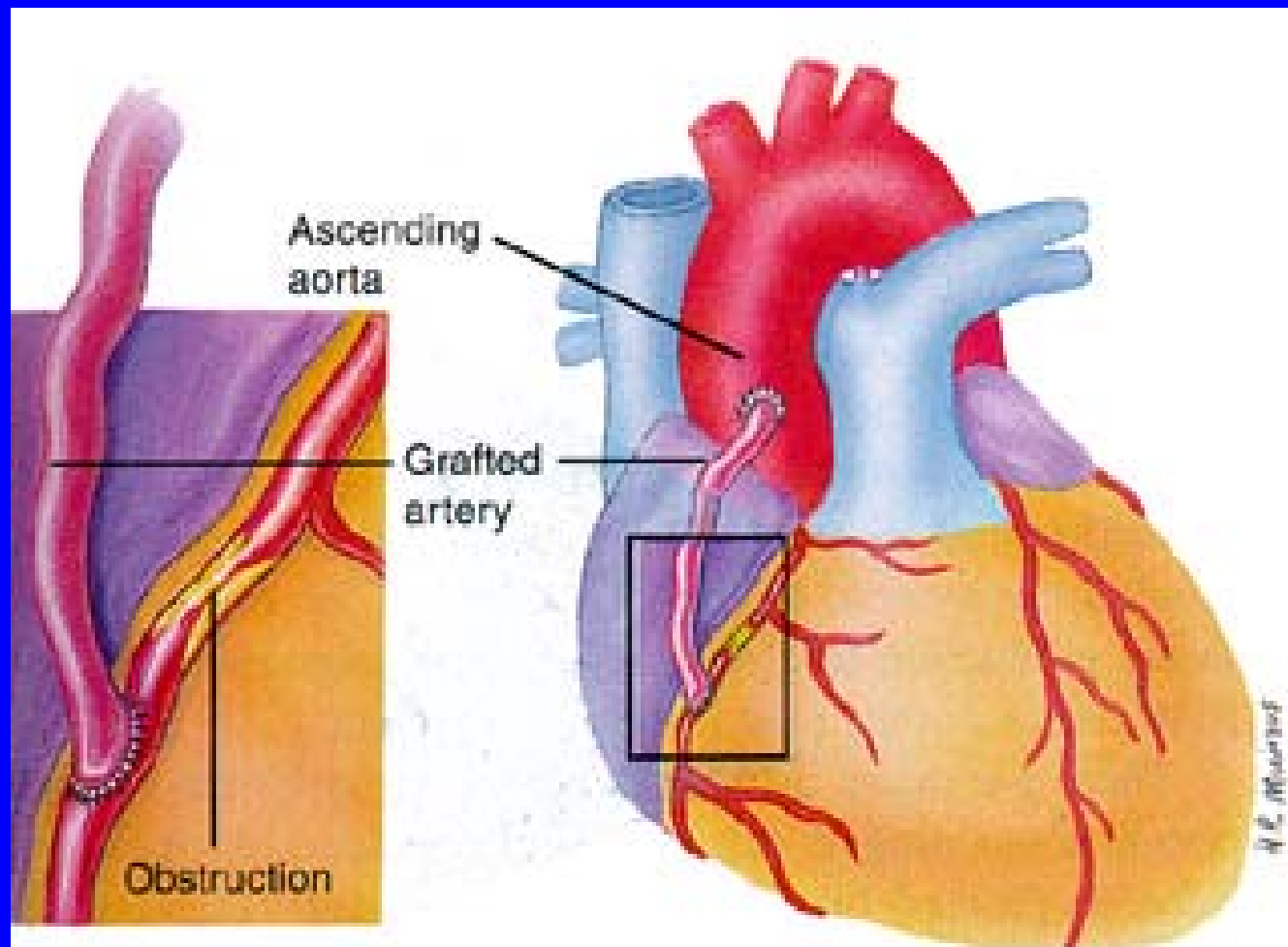


Heart Attacks

Treatment of Atherosclerosis

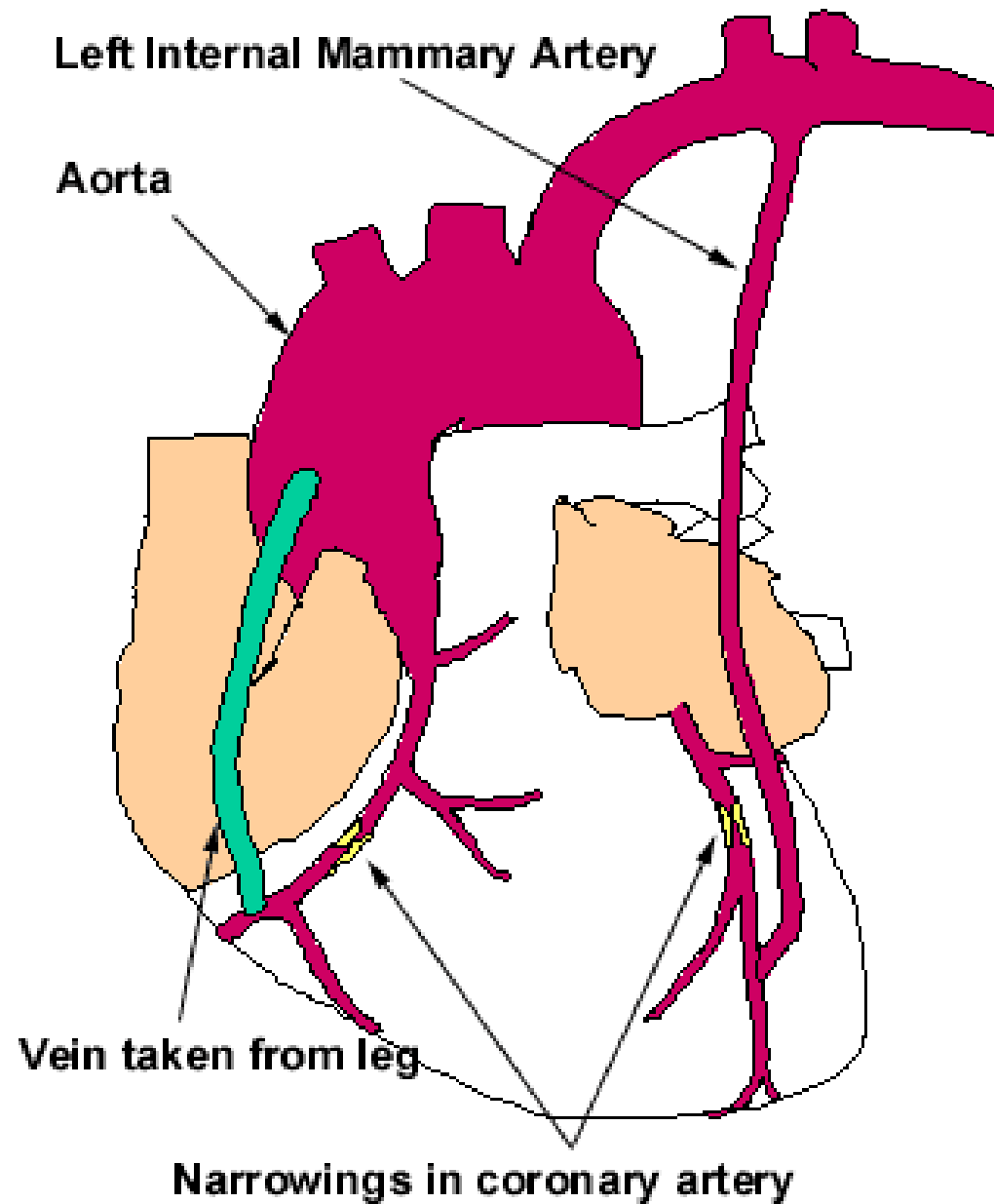
How Do We Treat Atherosclerosis?

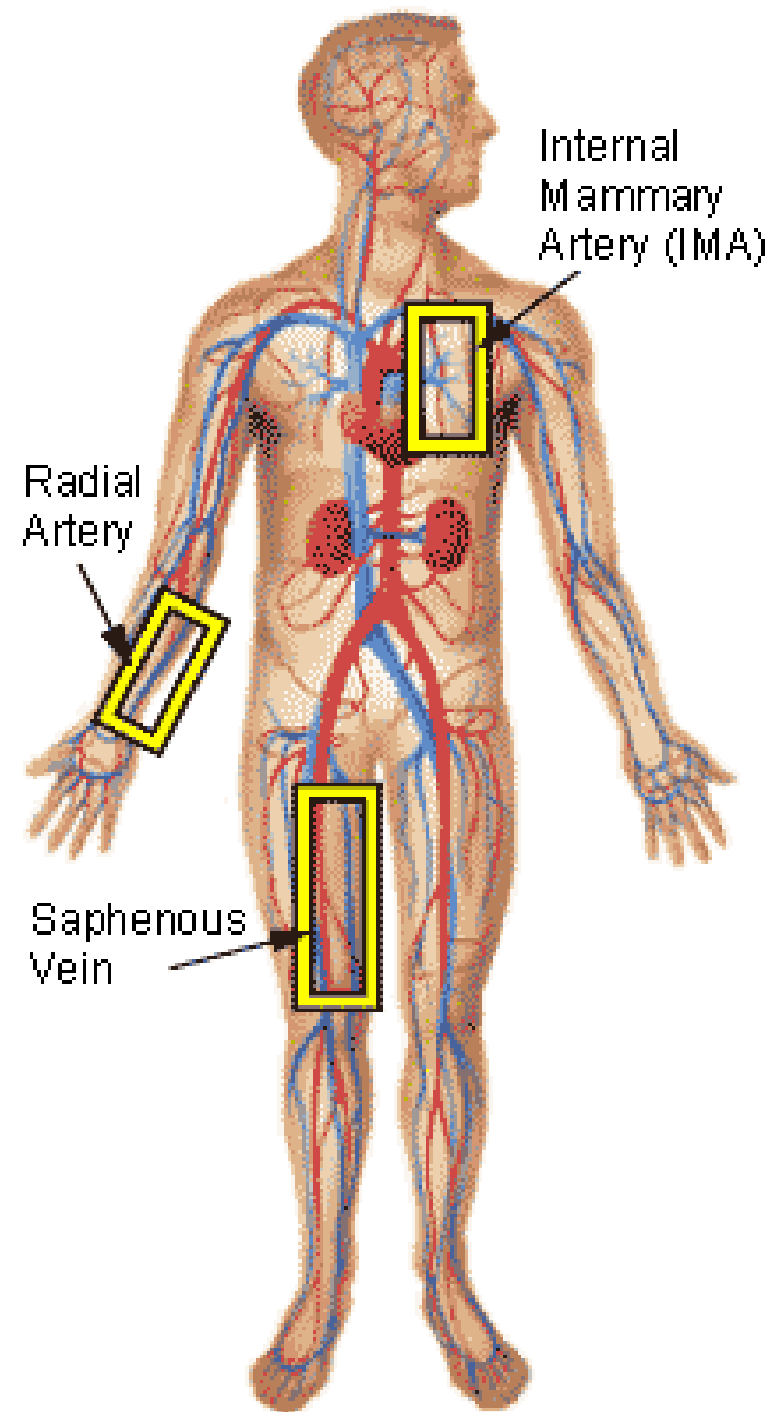
CABG



Coronary artery bypass grafting (CABG)

Coronary Artery Bypass Graft



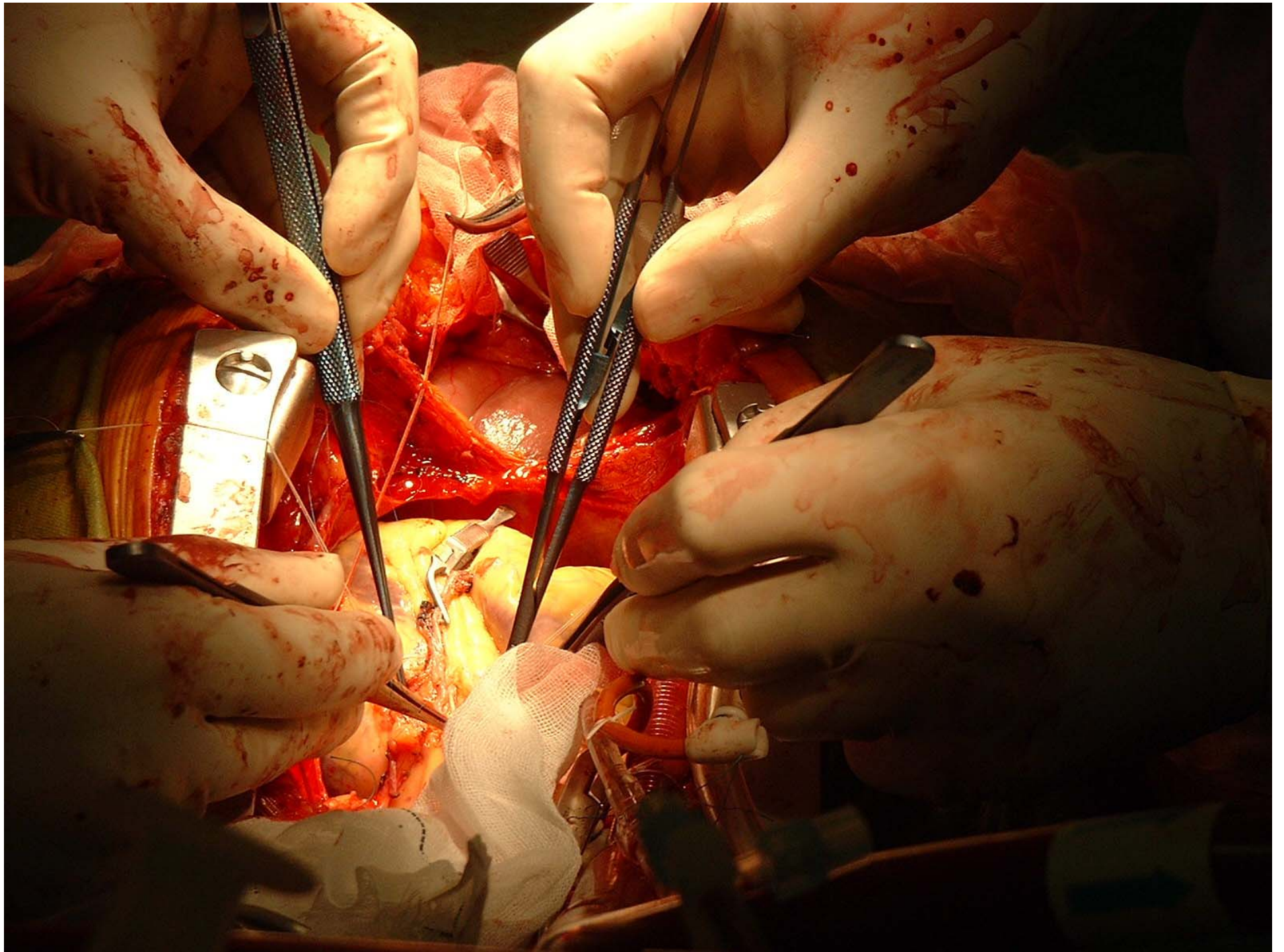


CABG Procedure

- Patient is prepped, general anesthesia
- Chest access is gained, through sternum
- Graft vessel is retrieved
- Expose heart through pericardium
- Divert blood through heart lung machine
- Stop heart
- Insert graft
- Return circulation to heart
- Close incision



<http://www.ctsnet.org/doc/3311>



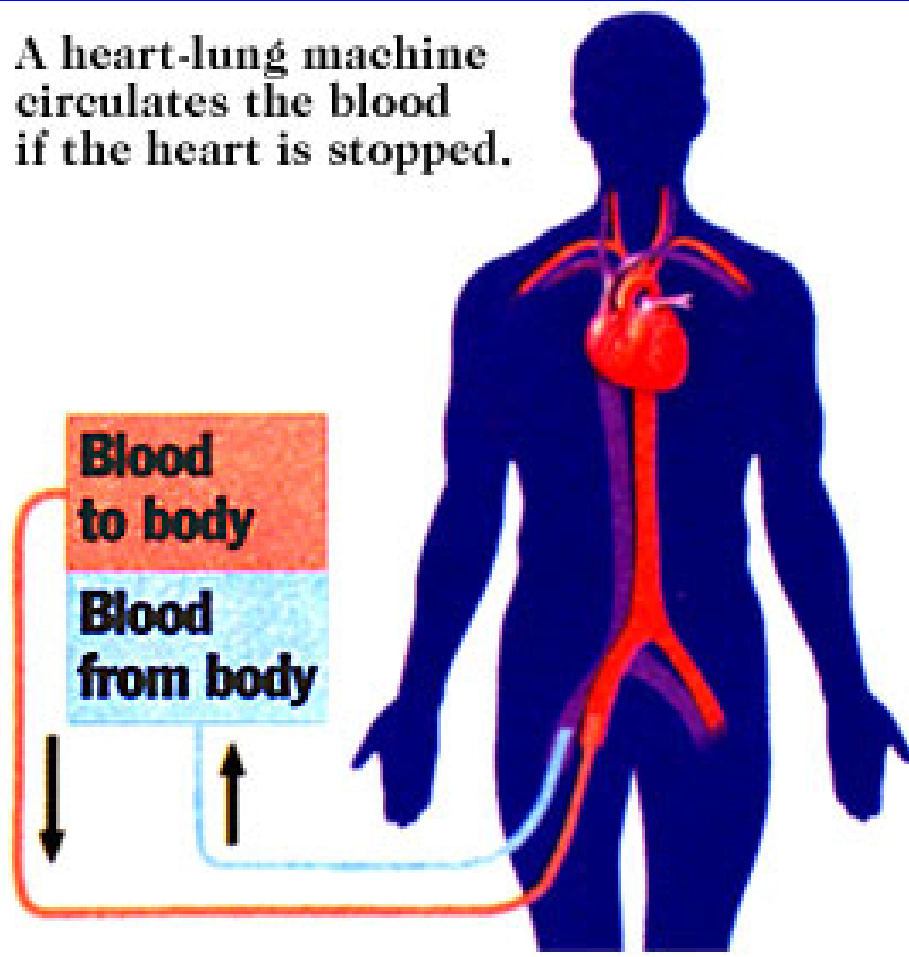
Heart-Lung Machine

■ The heart-lung machine:

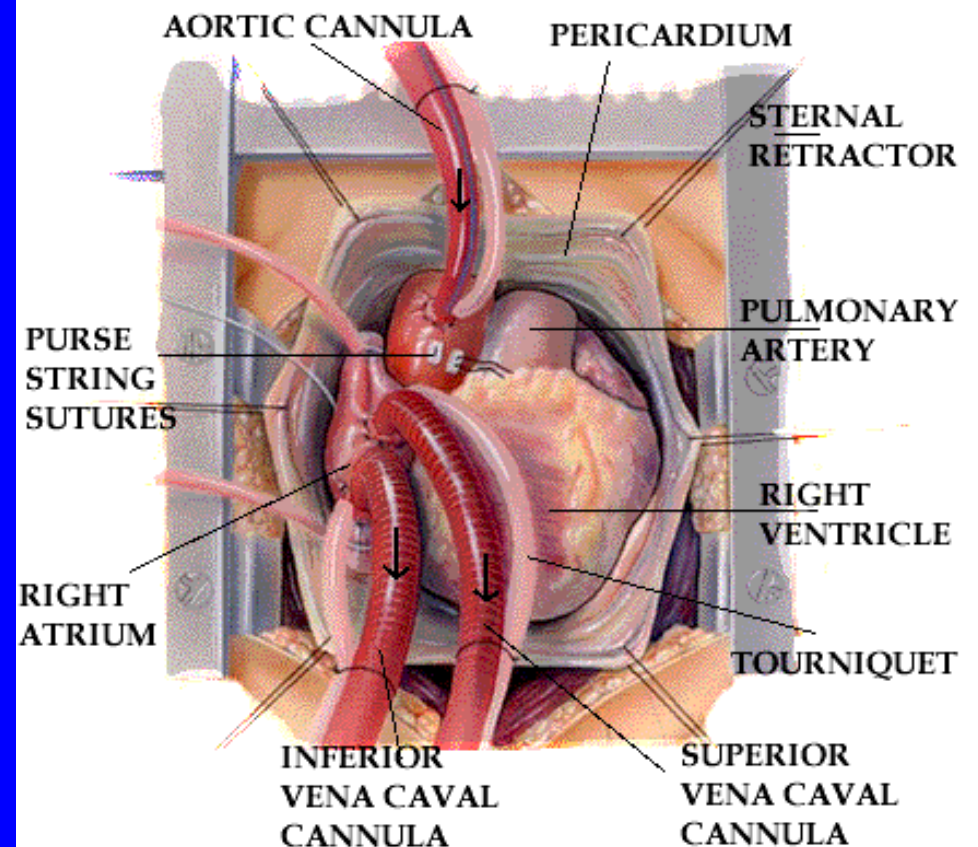
- Consists of a chamber that receives the blood from the body
- Blood is pumped by machine through an oxygenator
- Oxygenator removes CO₂ and adds oxygen
- Pump then pumps this newly oxygenated blood back to the body
- Connected to patient by a series of tubes that the surgical team places

Heart Lung Machine

A heart-lung machine circulates the blood if the heart is stopped.



HEART ON CARDIOPULMONARY BYPASS

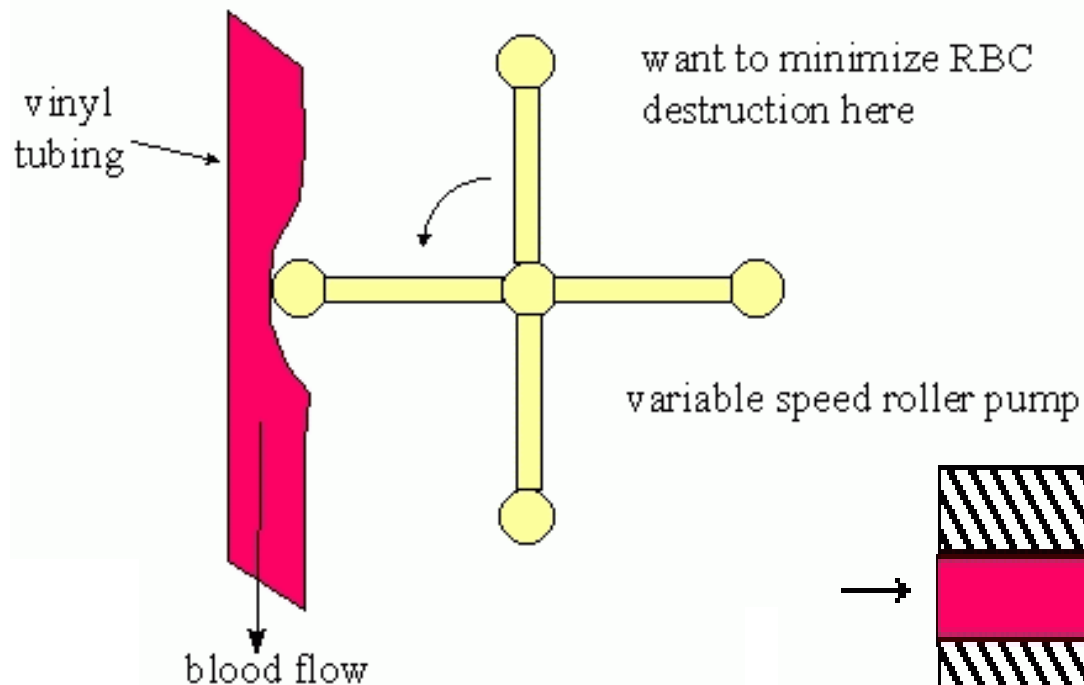


Heart Lung Machine



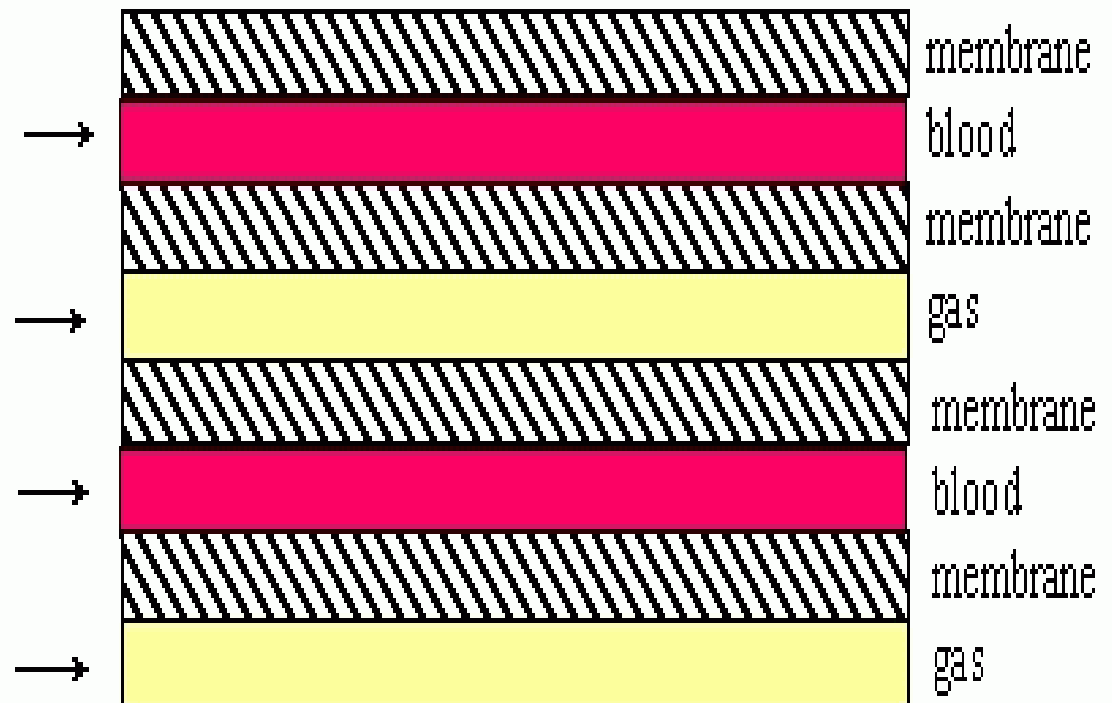
http://www.davidfary.com/hlm_small.jpg

Heart Lung Machine



<http://enr.smu.edu/~cd/EE5340/lect31/sld014.gif>

<http://enr.smu.edu/~cd/EE5340/lect31/sld011.gif>



CABG Effectiveness

- 2001: 516,000 CABG procedures performed
- Procedure takes 4-6 hours, 5-7 day hospital stay
- Grafts remain open & functioning for 10-15 yrs
- Risks:
 - Heart attack (5%)
 - Stroke (5%) (risk greatest in those over 70 years old)
 - Death (1-2%)
 - Sternal wound infection (1-4%)
 - "Post-pericardiotomy syndrome" (30%)
 - Occurs few days to 6 months after surgery
 - Symptoms are fever and chest pain
 - Some people report memory loss and loss of mental clarity or "fuzzy thinking" following CABG

Innovations

■ Off-pump CABG:

- <http://www.surgery.usc.edu/divisions/ct/videos-mpeg-offpumpcoronaryarterybypassgrafting.html>

■ Closed chest CABG:

- <http://www.hsforum.com/stories/st>

The Heart Surgery Forum #2000-0380
4 (1):XXX-XXX, 2001

Online address: www.hsforum.com/vol4/issue1/2000-0380.html

Closed Chest Coronary Artery Bypass on the Beating Heart

(#2000-0380 ... June 8, 2000)

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Dr. Kappert



ABSTRACT

Minimally invasive surgical procedures have become a part of routine cardiac surgery. The surgical techniques have been developed for the treatment of coronary artery disease in order to minimize surgical trauma.

With the introduction of a 3-D-based totally endoscopically functioning system into minimally invasive cardiac (MIC) surgery, further reduction of skin incisions became possible and enhanced MIC techniques could be improved. Due to the 6° freedom of motion allowed by wrist-enhanced instruments and a newly developed endoscopic stabilizer, totally endoscopic coronary artery bypass procedures on a beating heart became feasible.

We present here our initial series of totally endoscopic "off-pump" coronary artery bypass grafting in patients suffering from coronary artery single vessel disease. In all patients, the procedure was successfully performed via four 1 cm chest incisions as closed-chest procedures.

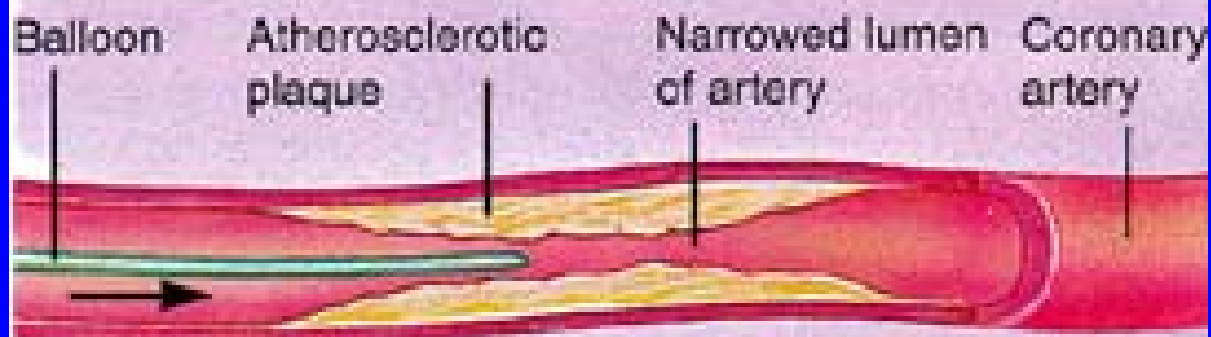
four-point stab incision, thus avoiding sternotomy and minithoracotomy [Falk 1999, Falk 2000]. After performing over 120 minimally invasive surgical procedures since May 1999 (including a series of uni- or bilateral internal mammary artery harvesting and totally endoscopic coronary artery bypass (TECAB) grafting on an arrested heart), we present this report reflecting our observations regarding the feasibility of TECAB grafting on a beating heart. An initial series of closed-chest OPCAB grafting using wrist-enhanced robotic instrumentation in three male patients suffering from single-vessel coronary artery disease (SVCAD) using the left internal mammary artery (LIMA) is presented.

MATERIALS AND METHODS

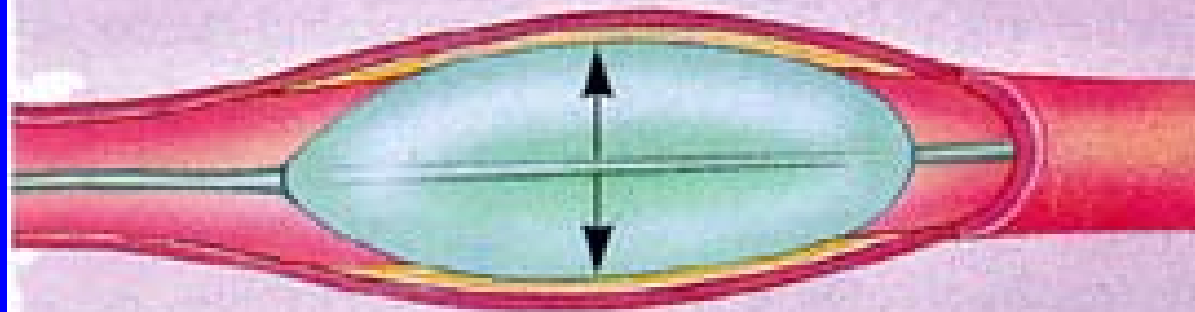
The da Vinci™ 3-D based robotic system (Intuitive Surgical, Mountain View, CA) has been described in detail before [Carpentier 1999, Falk 1999, Loulmet 1999]. Three

How Do We Treat Atherosclerosis?

Angioplasty



Balloon catheter with uninflated balloon approaches obstructed area in artery

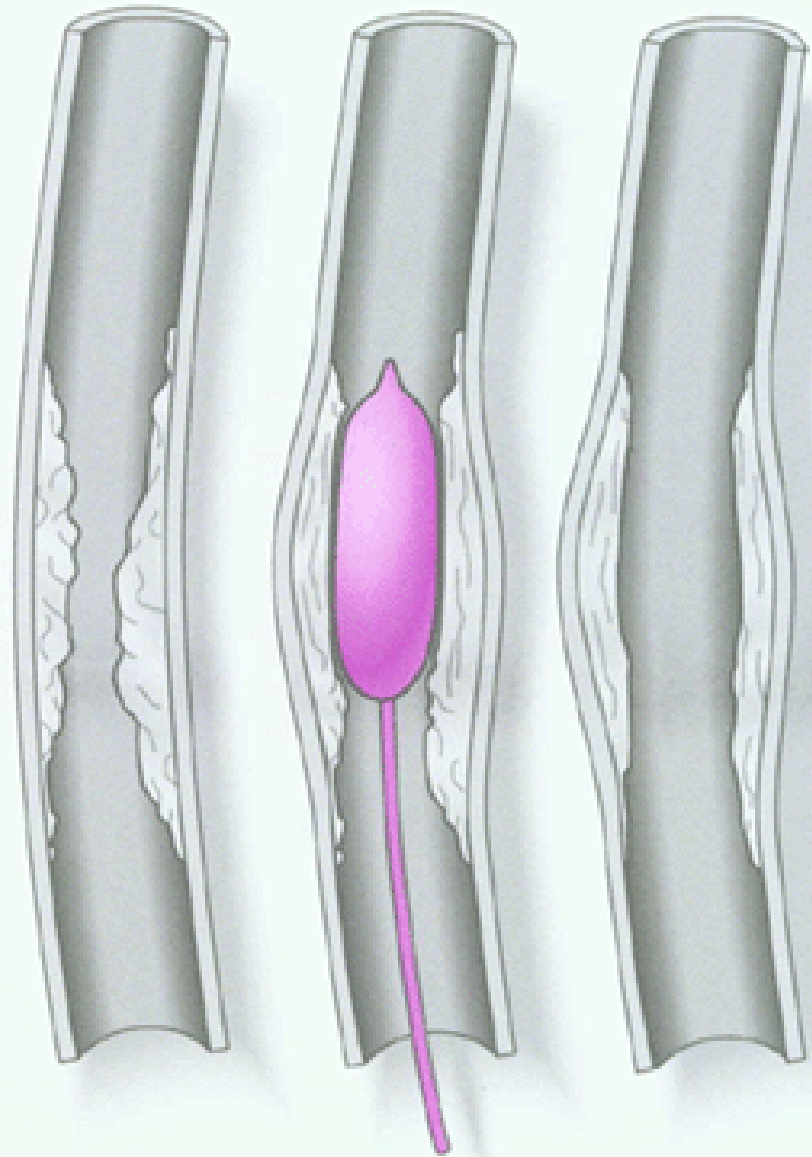
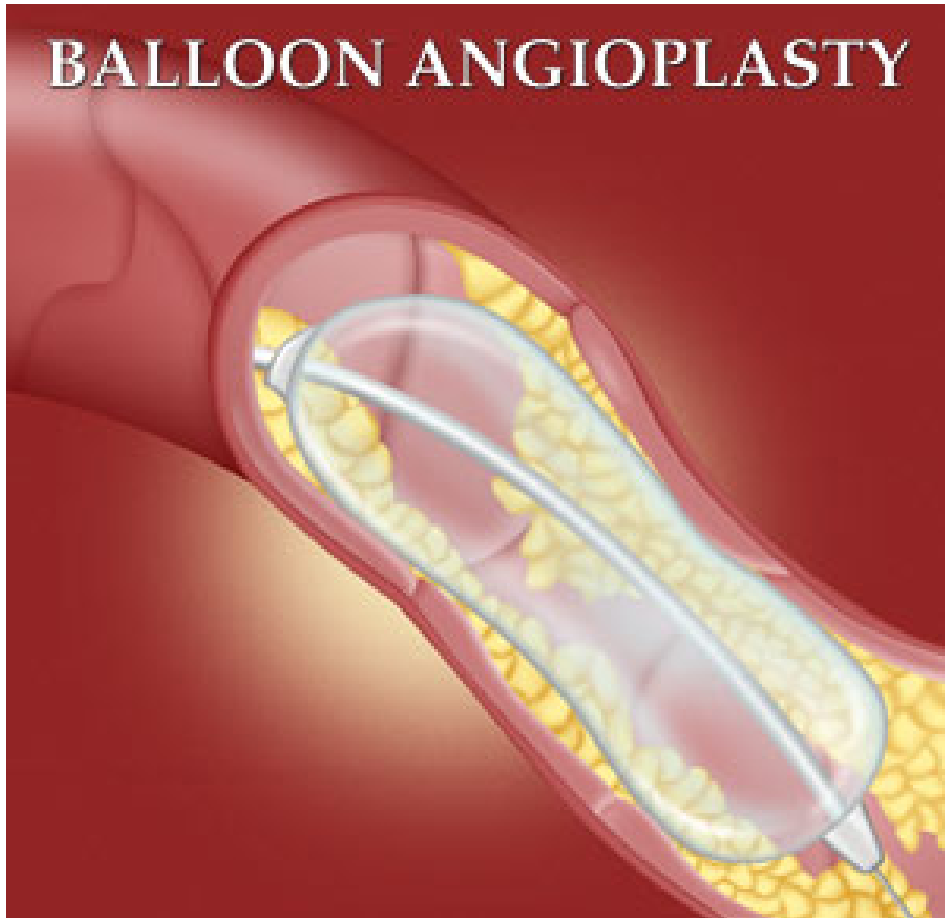


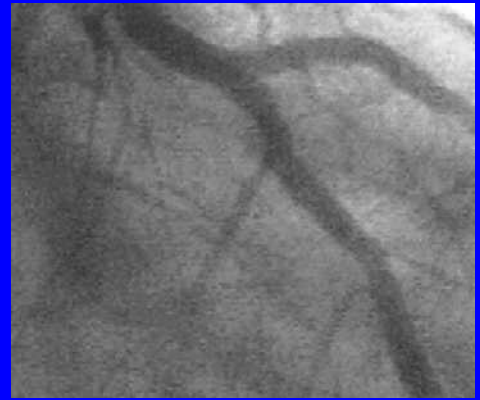
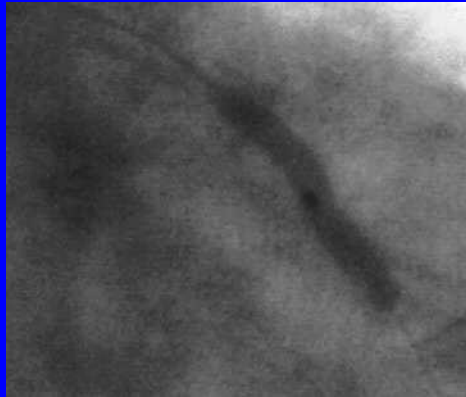
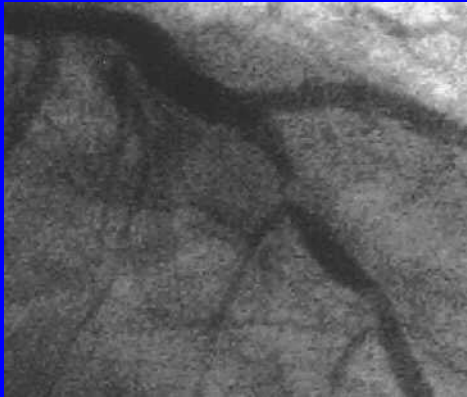
When balloon is inflated, it breaks up atherosclerotic plaque

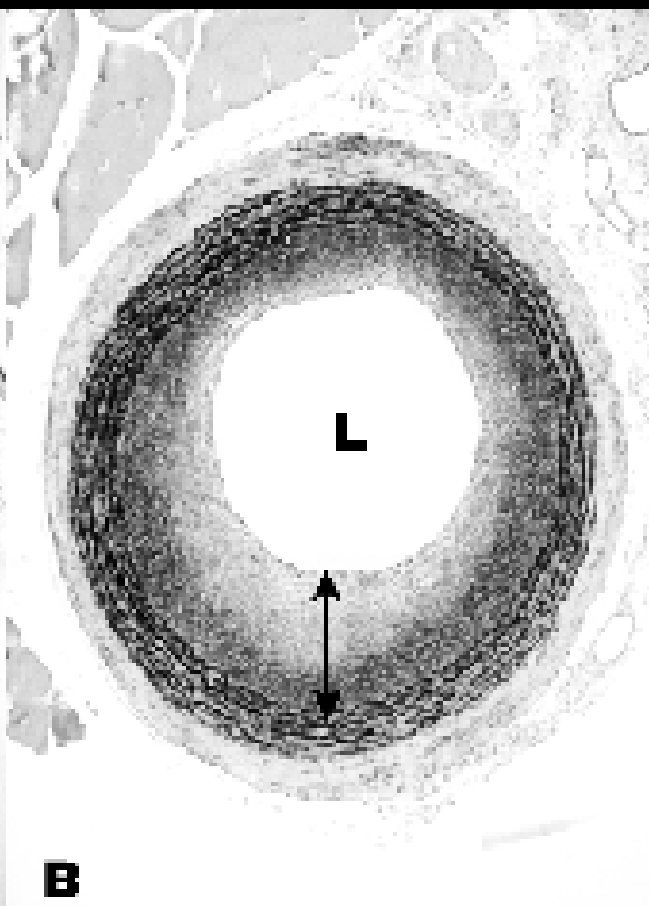
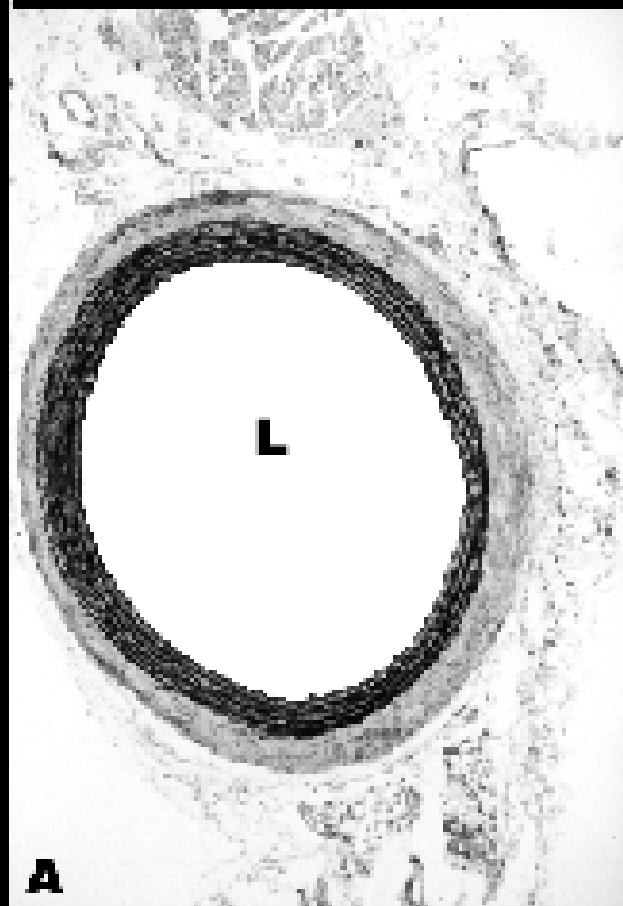


After lumen widened, balloon catheter with deflated balloon is withdrawn

BALLOON ANGIOPLASTY







PTCA: Effectiveness

- Cannot always successfully perform procedure
 - Diffuse disease
 - Total occlusion
 - Calcified disease
- Restenosis
 - Occurs in 25-54% of patients
 - Usually occurs within 6 months

How Do We Treat Atherosclerosis?

Stent

Stents

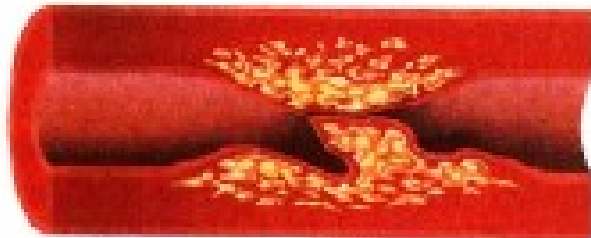
<http://www2.cajun.net/~wpharo/stent.jpg>



<http://www.wbamc.amedd.army.mil/images/newsphotos/stent%20implantation.jpg>

How is a Coronary Stent Implanted?

<http://www.insel.ch/kardio/kardiorehab/bilder/stent.jpg>



A stent is mounted on a balloon catheter.



The balloon is inflated and the stent is expanded.



The balloon is removed and the stent is implanted in the vessel.

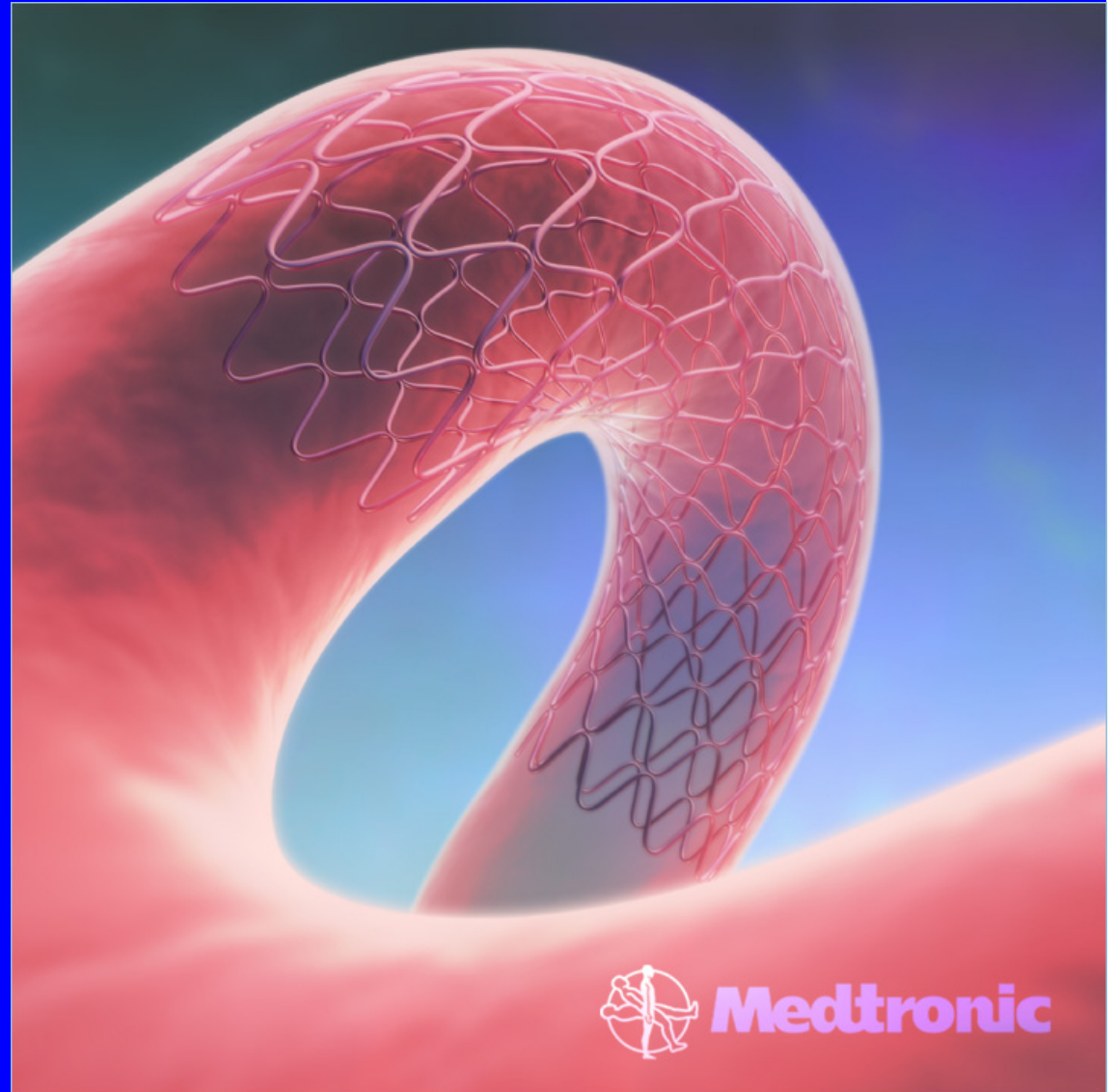


Image provided courtesy of Cordis Corporation.

Stents



<http://www.priory.com/cmof/stent3.jpg>



http://www.hybridmedicalanimation.com/media/mdtrnc_stent.jpg



Drug Eluting Stents

- <http://www.npr.org/features/feature.php?wfid=1452217>

Comparison of RX Methods

■ Hospital Stay:

- CABG – 4-7 days
- Angioplasty – 1-2 days
- Stent – 1-2 days

■ Restenosis:

- CABG – 5-6%, usually after 5 years
- Angioplasty – 25-45%, usually within 6 months
- Stent – 15-20%, usually within 6 months

Comparison of RX Methods

■ Cost

- CABG \$35,000
- Angioplasty \$17,000
- Stent \$19,000

■ Cost-effectiveness

- Additive procedures:
 - Within 5 years, 20-40% of patients have second PTCA, 25% have CABG
- Additive costs:
 - 0 years: per patient costs of PTCA 30-50% those of CABG
 - 1 year: 50-60%
 - 3 years: 60-80%
 - >3 years: >80%
- Moving Target Problem

What Would You Do?

- Angioplasty
- Stent
- CABG

Cost-Effectiveness

Therapy	Patient Group	\$ per yr life saved
tPA	Post MI high risk	\$3,600
tPA	Acute MI, large infarct, treatment started >2 hours post	\$24,200
Counseling	Smoking cessation	\$1300-\$3900
CABG	Two vessel disease, severe angina	\$9,200-\$42,500

http://www.sciencedirect.com/science?_ob=ArticleURL&_aset=B-WA-A-A-A-MsSAYZA-UUA-AUYWDCBYZYAUUYUBBVZZYBWAUBWEUBAU&_rdoc=1&_fmt=full&_udi=B6T1048NJXK25&_coverDate=5%2F22%2F2003&_cdi=4876&_orig=search&_st=13&_sort=d&view=c&_acct=C000004378&_version=1&_urlVersion=0&_userid=108429&md5=5f493caa5f65762c23c0d90eaea8b92d

Prevention or Treatment?

- <http://www.nytimes.com/2004/03/21/health/21HEAR.html>

Progression of Heart Disease

High Blood Pressure
High Cholesterol Levels

Atherosclerosis

Ischemia

Heart Failure

Heart Attack

