

Biomedical Engineering for Global Health

Lecture Eighteen

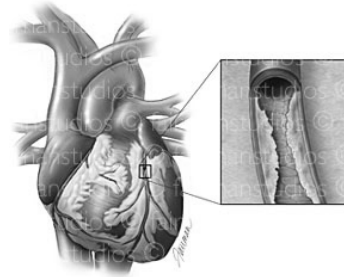


Outline

- 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



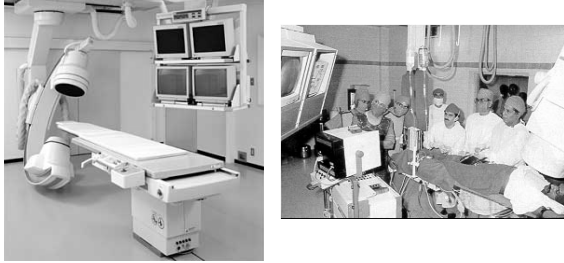
Heart Attack Video

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

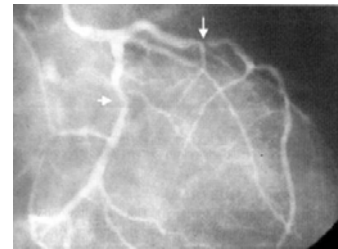
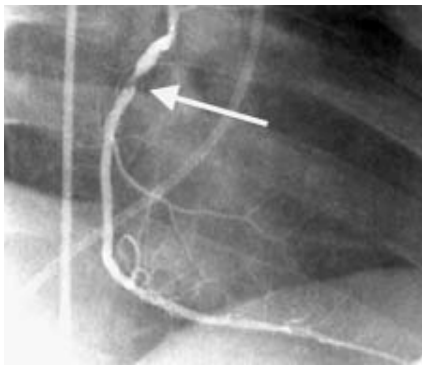
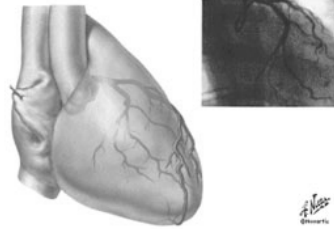
Heart Attacks

Diagnosis of Atherosclerosis

Detection of Atherosclerosis



Left Coronary Artery
Arteriographic View 2

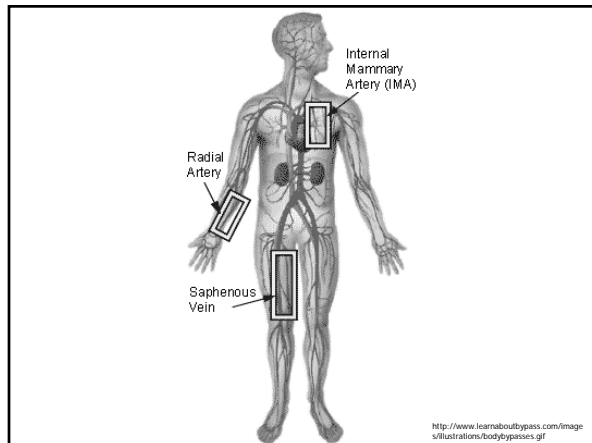
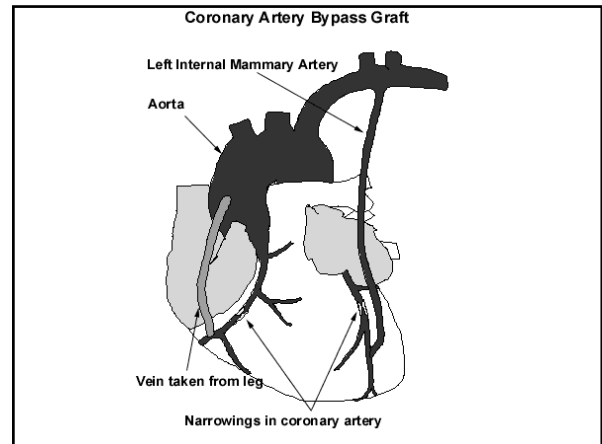
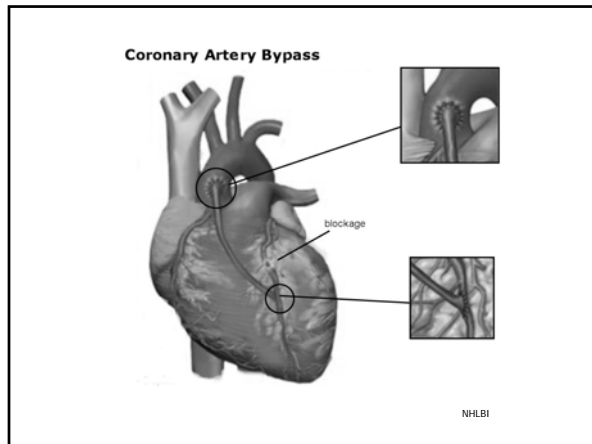


Heart Attacks

Treatment of Atherosclerosis

How Do We Treat Atherosclerosis?

CABG



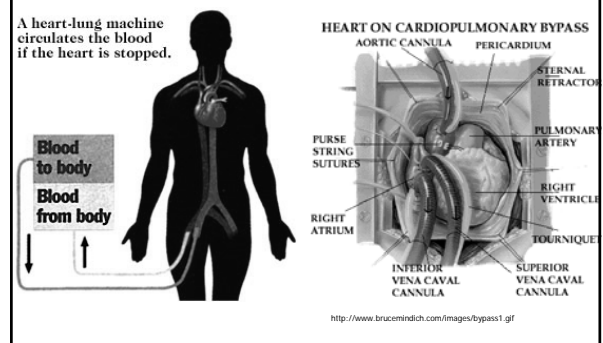
- CABG Procedure**
- Patient is prepped, general anesthesia
 - Chest access is gained, through sternum
 - Graft vessel is retrieved
 - Expose heart through pericardium
 - Divert blood through heart lung machine
 - Stop heart
 - Insert graft
 - Return circulation to heart
 - Close incision



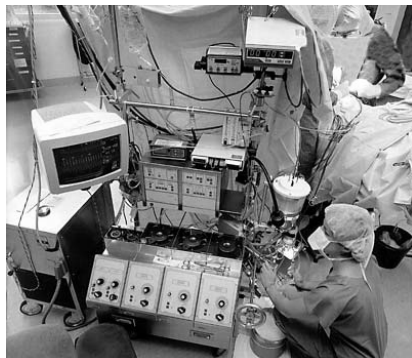
Heart-Lung Machine

- 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

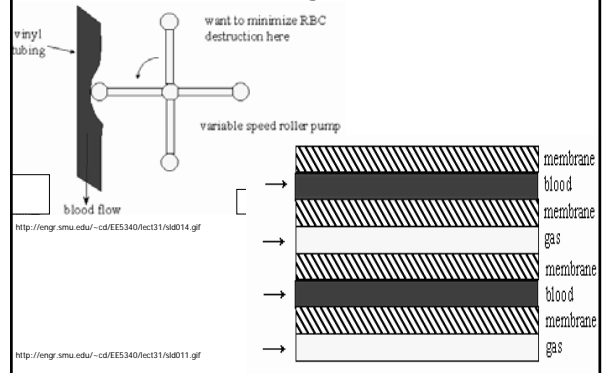
Heart Lung Machine



Heart Lung Machine



Heart Lung Machine



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

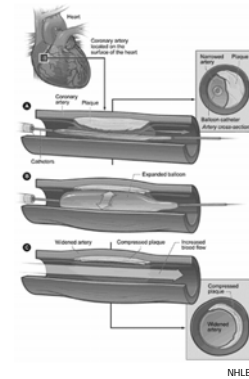
- **Off-pump CABG:**
 - <http://www.surgery.usc.edu/divisions/cv/videos-mpeg-offpumpcoronaryarterybyypassgrafting.html>
- **Closed chest CABG:**
 - <http://www.hsforum.com/stories/st>



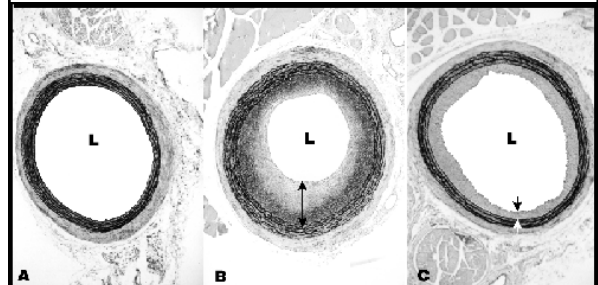
How Do We Treat Atherosclerosis?

Angioplasty

Balloon Angioplasty



Scott et al. 2007 Abstracts: Subintimal Angioplasty for the Treatment of Occlusion and Critical Limb Ischemia: 5-Year Results. Southern Association of Vascular Surgery.

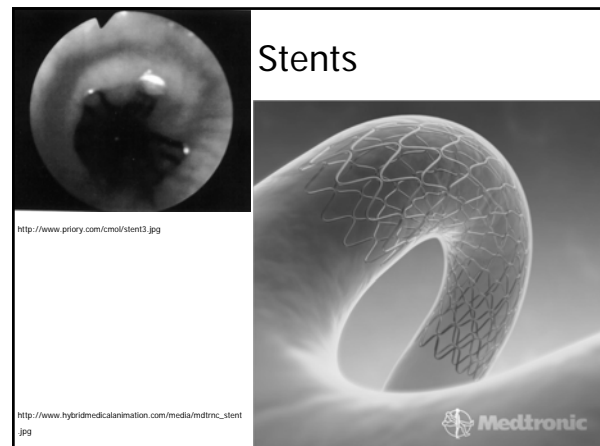
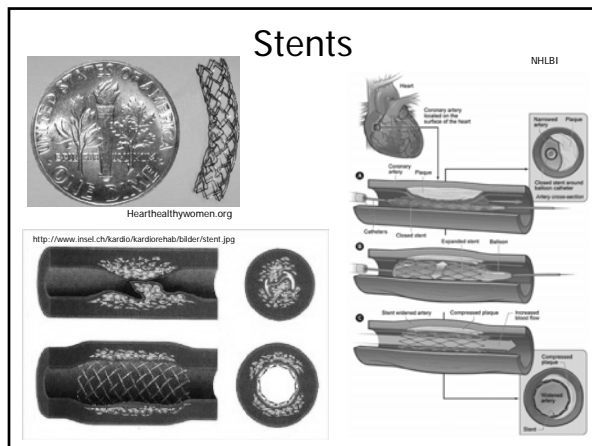


PTCA: Effectiveness

- 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



Drug Eluting Stents

- <http://www.npr.org/features/feature.php?wId=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&_asset=B-WA-A-A-A-MsSAZYA-UJA
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 8&_version=1&_urlVersion=0&_userid=108429&md5=5f493caa565762c23cd90eaa88292d

Prevention or Treatment?

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

Progression of Heart Disease

