

# PATIENT INFORMATION

## CORONARY ARTERY DISEASE DIAGNOSIS AND TREATMENT

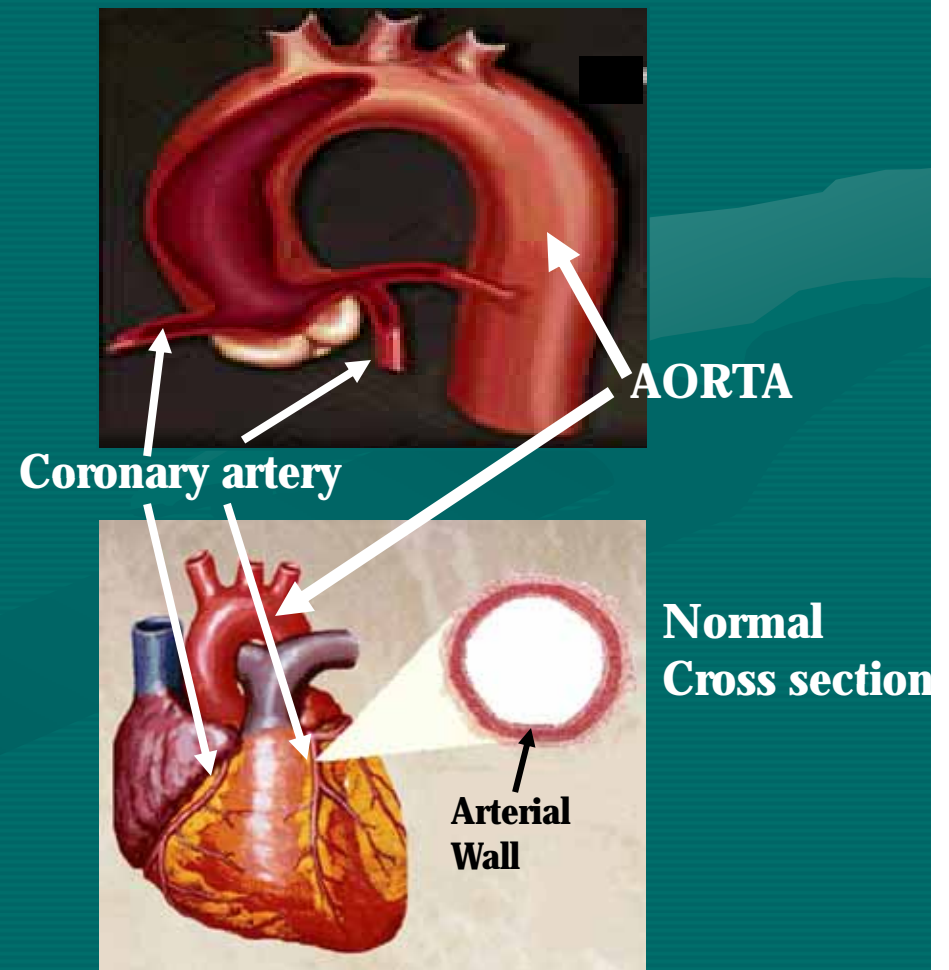
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# WHAT IS CORONARY ARTERY DISEASE?

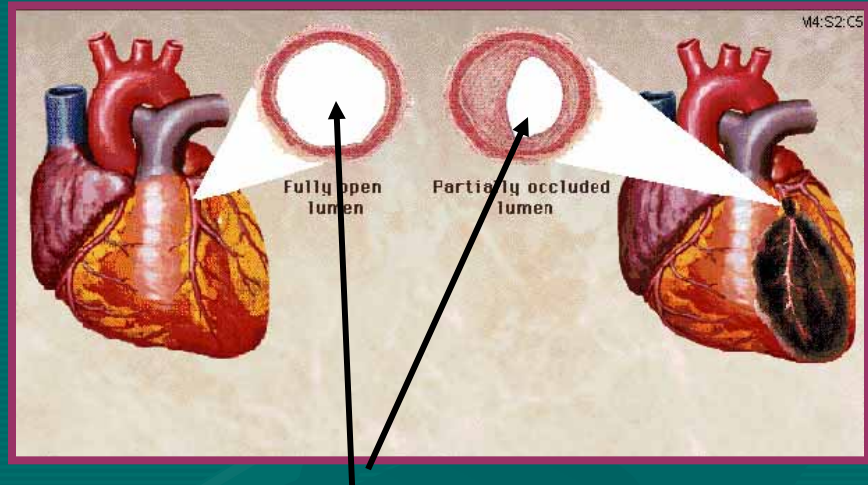
- In the normal heart, arteries arising from the aorta travel over the surface of the muscular pumping chambers. These arteries branch repetitively supplying the heart muscle with oxygen and nutrients.
- Normal arteries have a thin layer of lining cells (the endothelium) and a middle muscular layer which can contract or dilate to change blood flow.



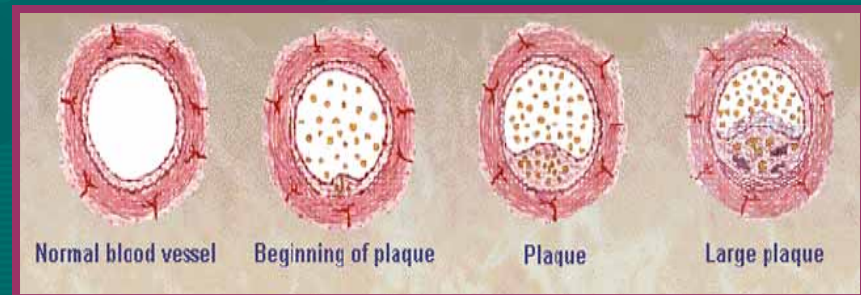
Images courtesy Medtronic

# WHAT IS CORONARY ARTERY DISEASE?

- Repeated injury to the lining cells (endothelium) due to smoking, high cholesterol, diabetes, hypertension, inheritance, or inflammation results in a process called atherosclerosis (hardening of the arteries or coronary artery disease).
- Atherosclerosis is an inflammatory condition of the arteries which results in narrowing of the arteries which can reduce blood supply to the heart muscle.

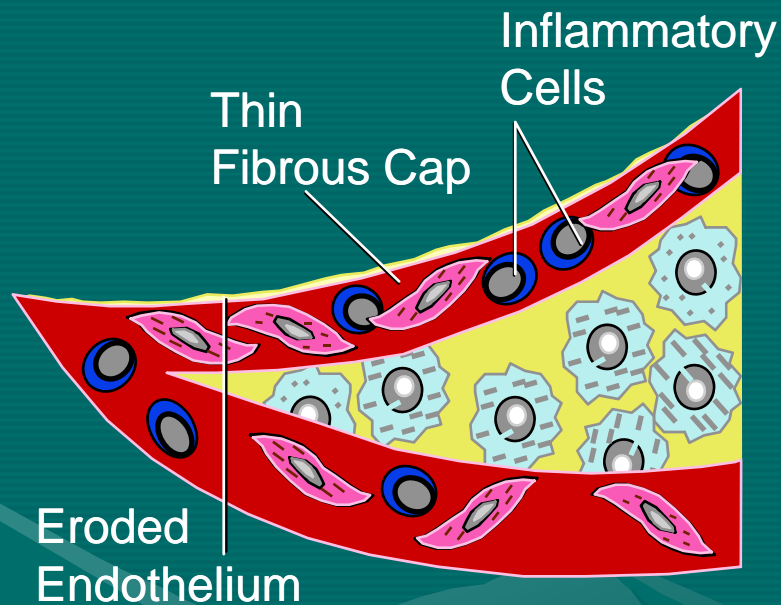


Area of blood flow

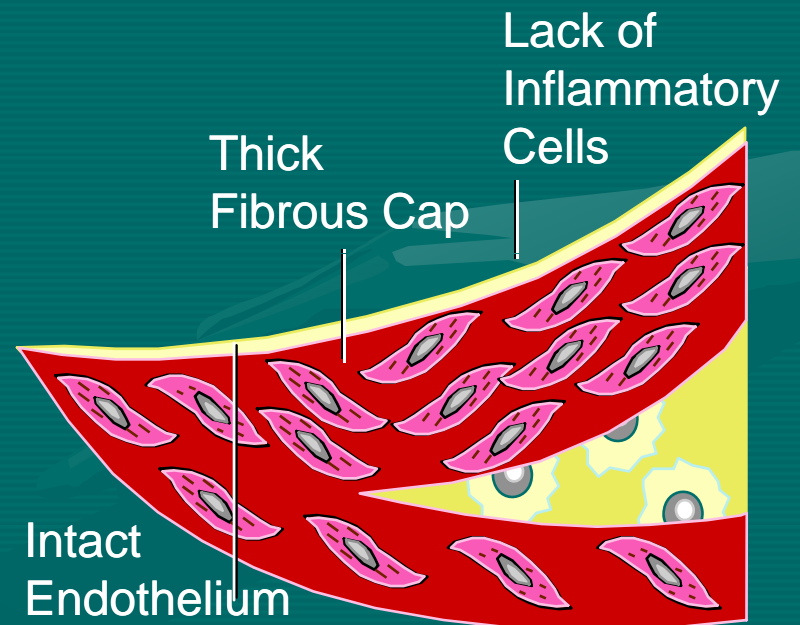


# WHAT IS CORONARY ARTERY DISEASE?

## UNSTABLE PLAQUE



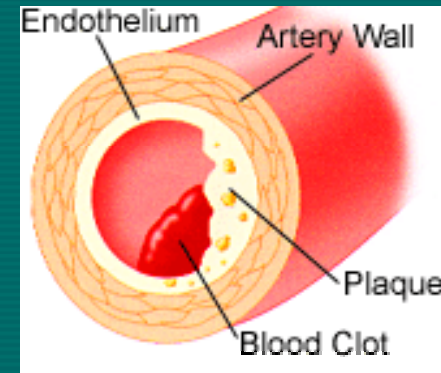
## STABLE PLAQUE



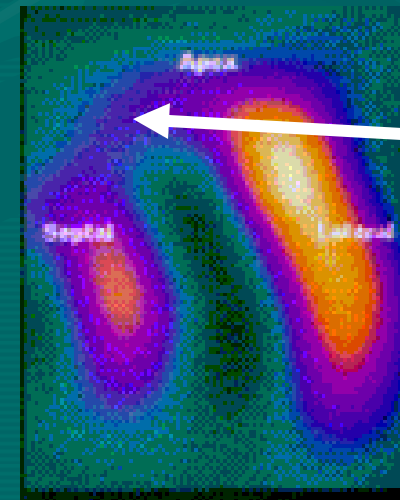
**Narrowed coronary arteries can cause chest pain, shortness of breath, and limitation of exercise capacity. However, some areas of narrowing ( plaque ) are soft and unstable and may crack or split open. These vulnerable or unstable plaques are dangerous and may cause acute clot formation in the artery which may abruptly stop blood flow to the heart muscle causing heart muscle damage (heart attack). Modern medicines help to stabilize these vulnerable plaques thereby reducing heart attack and stroke.**

## HOW IS CORONARY ARTERY DISEASE DIAGNOSED?

- Unfortunately, about 1/2 of patients find out they have coronary disease when they have a heart attack without warning.
- Warning symptoms of chest pain (rest or exercise) shortness of breath, or fatigue may occur.
- Early diagnosis is best using stress and imaging methods when symptoms or risk factors raise concern.



**SUDDEN PLAQUE RUPTURE AND CLOT FORMATION WITHOUT WARNING**



**SEVERELY DECREASED BLOOD FLOW**

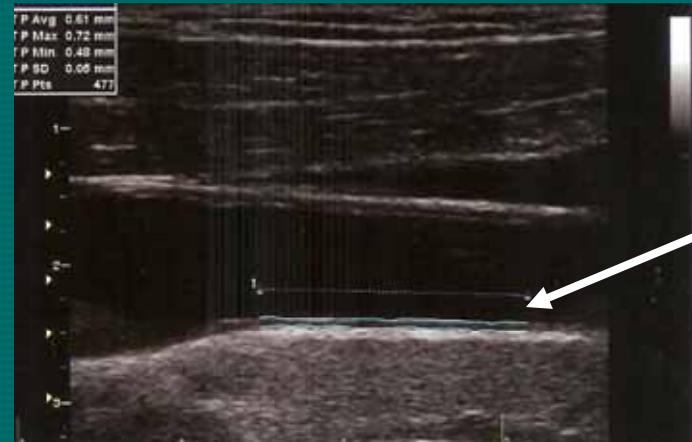
**NUCLEAR STRESS SCAN**

# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? RISK FACTORS, IMT, CALCIUM

SEVERE  
CALCIUM  
(seen in artery)



CT CALCIUM SCAN



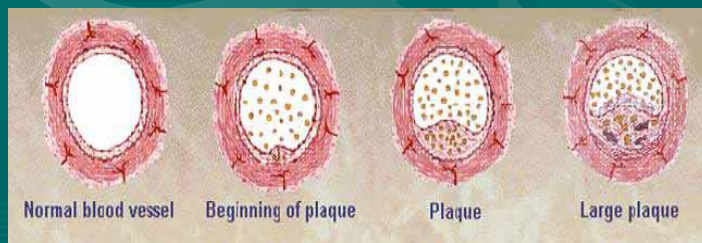
INTIMA

INTIMA-MEDIA THICKENING

- Risk factors mean coronary artery disease is much more likely. Smoking, family history, diabetes, hypertension, high cholesterol, obesity should raise suspicion of disease.
- Calcium scoring using CT scanning is a way of detecting early coronary artery disease. A high calcium score means that the disease is present and that medicines are indicated. Most patients with a high calcium score should have other testing such as stress testing.
- IMT or Intima- Media Thickening is an ultrasound measurement of the thickness of the lining cells (endothelium) of the carotid artery. Thickening indicates early vascular disease and the need for other testing and treatment of risk factors.

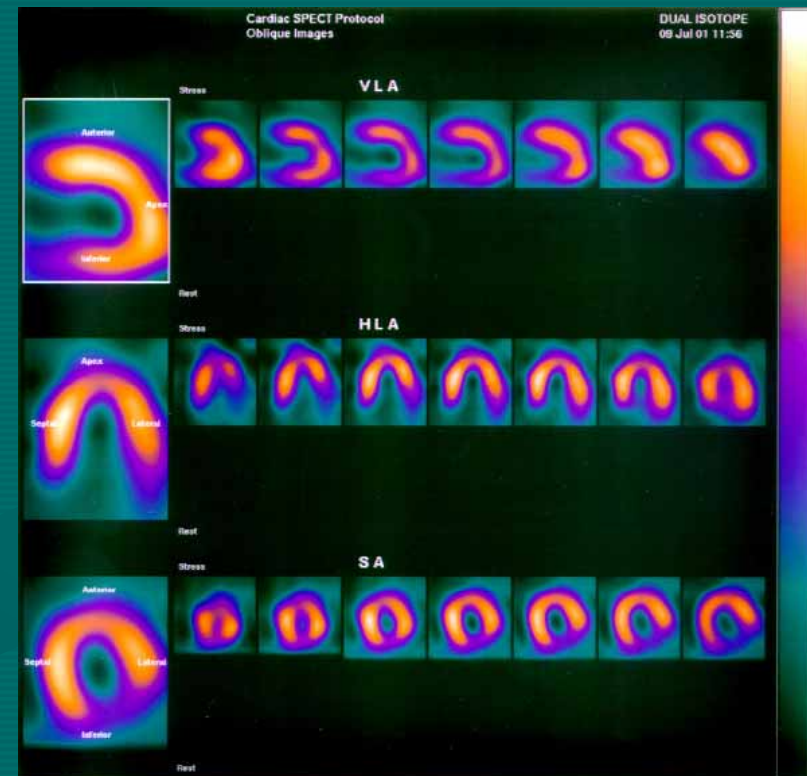
# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? STRESS TESTING

- **Blockage of a coronary artery may reduce blood flow to the heart. However, only very severe artery obstruction results in reduced blood flow at rest (>85% narrowing).**
- **Stress testing with physical exertion (or medications) is used to demonstrate reduced blood flow due to plaques which block flow.**
- **Stress testing cannot demonstrate plaques in the artery which are present but do not reduce blood flow.**
- **Originally, stress testing relied completely upon simple measurements of heart rate, blood pressure, and the electrocardiogram. Today, these indirect measures of heart function are an important part of each examination.**
- **However, the diagnostic accuracy of just using these simple, indirect functions is inadequate for such a serious disease. The diagnostic accuracy of stress testing using EKG only is about 50%.**
- **Newer imaging techniques have been developed to improve the reliability of diagnosing coronary artery disease.**



# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? NUCLEAR STRESS TESTING

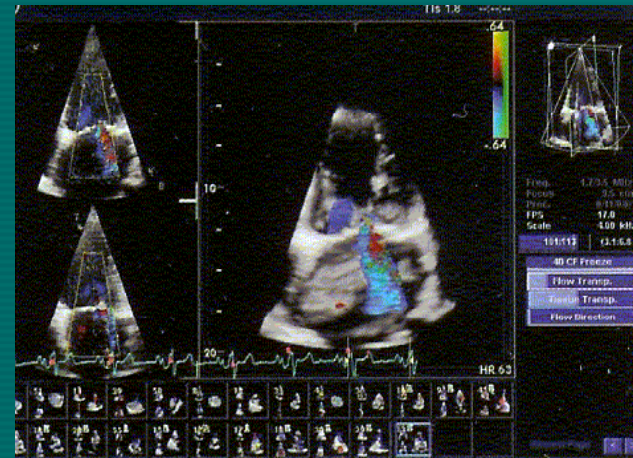
- Nuclear stress testing uses radioactive isotopes which are injected into a vein at rest and during exercise. The radioactive material is distributed in the heart in proportion to blood flow and can identify areas of heart muscle which are scar (heart attack damaged) or areas of muscle with inadequate blood supply. Stress is performed using a treadmill or with medications which stimulate blood flow.
- This technique is very reliable (95%) but does not provide information about valves or other heart structures.



NUCLEAR STRESS IMAGES  
(show the effect of artery narrowing)

# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? STRESS ECHOCARDIOGRAPHY

- Stress echocardiography uses ultrasound to show heart chambers, valves, and contraction of the heart. These functions can be measured at rest and at maximum exercise.
- When severe blockages are present, the reduced blood supply causes the heart muscle to stop contracting. These changes can be compared with the resting images.
- This test does not require the injection into the body of any radioactive substance.



CHAMBERS, VALVES

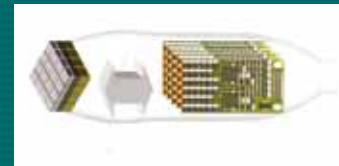


9 SLICE "LOAF OF BREAD" VIEW

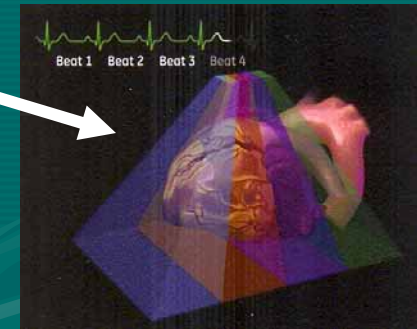
Images: GE VIVID 7

# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? STRESS ECHOCARDIOGRAPHY

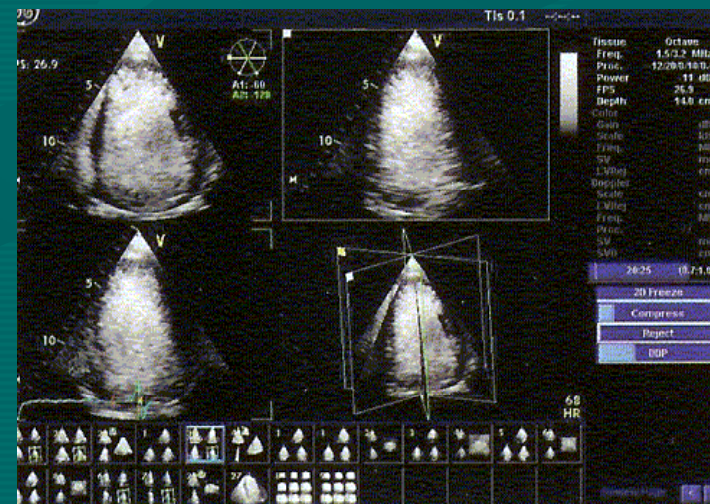
- Stress echocardiography had limitations in some patients because the walls could not always be seen. Nuclear stress testing was therefore thought to be better.
- However, new multi-plane (3D) transducers and Definity® contrast injection (no radiation; no drug effect) result in more reliable information and diagnostic reliability.
- Stress echocardiography can be done with a treadmill or with medications with more comfort and less testing time.



3D Transducer



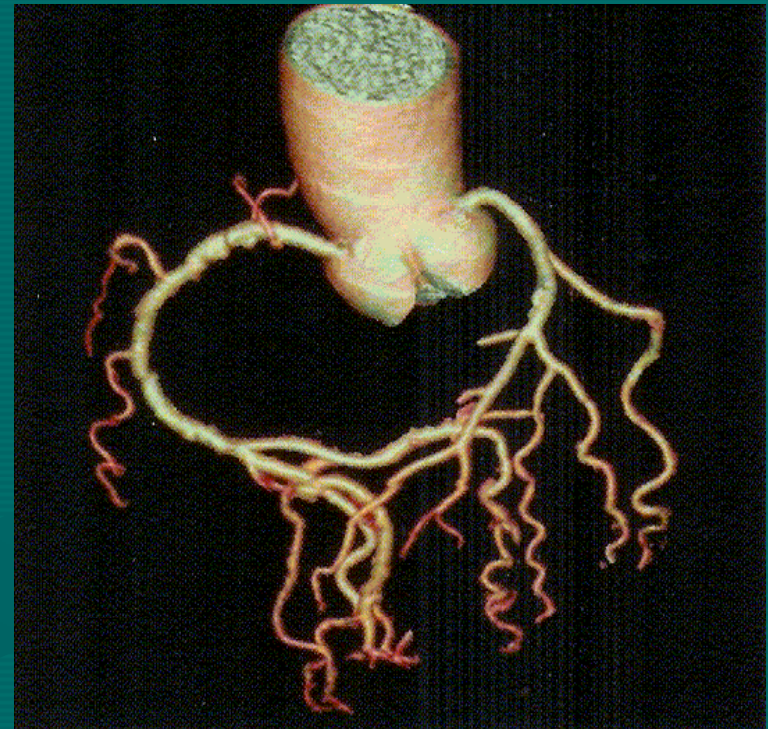
3D Volume Imaging



Definity® shows best definition of function

# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? 64 SLICE CT SCANNING

- Advances in computer technology have resulted in new CT scanners which can provide amazing pictures of the coronary arteries. When arteries are normal, the test approaches 100% reliability.
- Unfortunately, the diagnostic reliability if the test is reduced when calcium or metal (from stents or surgery) are present. Twice as much radiation and twice as much contrast (dye) is required compared to coronary arteriography. Newer advances may solve these problems in the future.



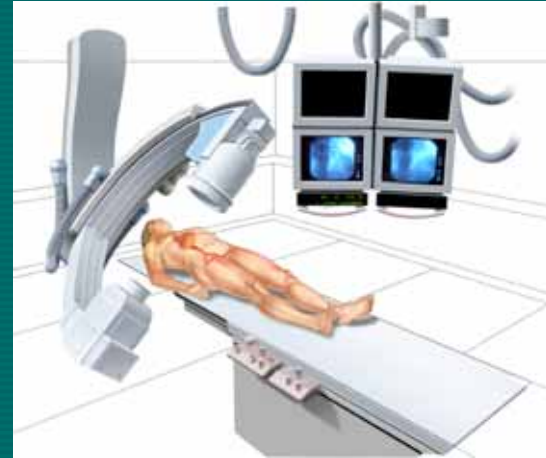
RECONSTRUCTED CT IMAGES  
OF THE CORONARY ARTERIES

# WHICH STRESS TEST IS BEST?

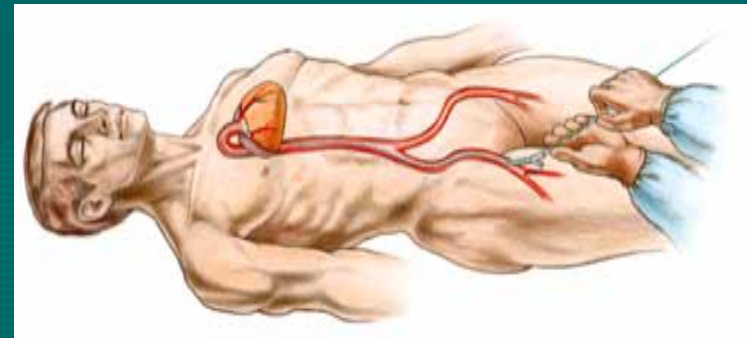
- **Fortunately, we have many excellent techniques for the early diagnosis of coronary artery disease. These tests are also helpful in patients with known coronary artery disease to evaluate the results of therapy and predict risk of future problems.**
- **Testing can be individualized to meet the needs of each patient and circumstance.**
- **For routine out-patient evaluation, we favor stress echocardiography if performed with modern equipment and Definity® contrast. Comparative studies of echo and nuclear stress testing have shown equal diagnostic accuracy, but stress echo is more specific (fewer unnecessary angiograms). Both are equal in predicting future events. Stress echocardiography also has the advantages of avoiding any radiation exposure and providing information about wall thickening, valves, heart chamber sizes, and the presence of congenital heart conditions**

# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? CORONARY ARTERIOGRAPHY OR ANGIOGRAPHY

- When severe coronary blockage is suspected due to a heart event or testing, coronary arteriography (or angiography) is often recommended.
- This minimally invasive test is performed in the hospital in a catheterization laboratory. After the patient is covered and the groin area skin prepared, a small tube or catheter is inserted through a small nick in the skin at the groin.



CATHETERIZATION LABORATORY  
DEMONSTRATION IMAGE  
PATIENTS ALWAYS FULLY COVERED

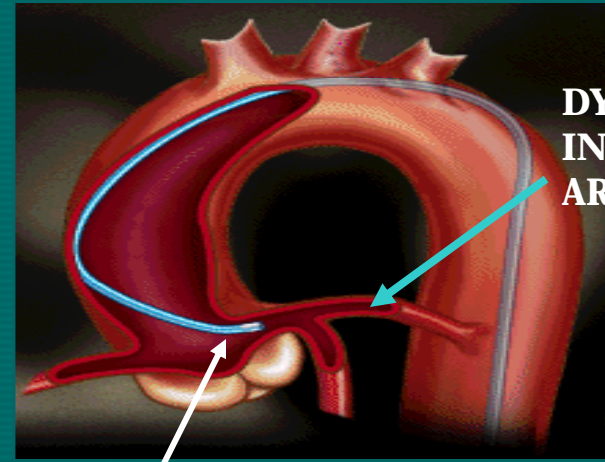


DEMONSTRATION IMAGE  
PATIENTS ARE ALWAYS FULLY COVERED

Courtesy Medtronic

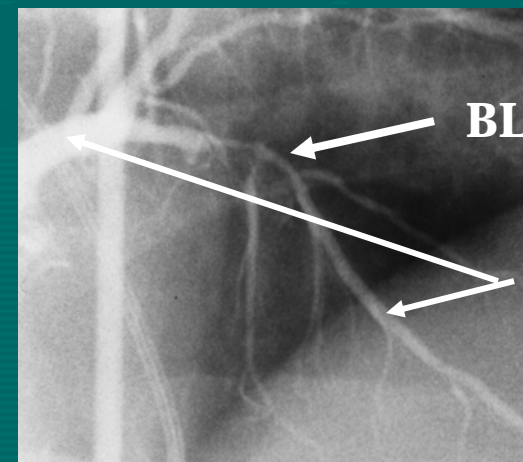
# HOW IS CORONARY ARTERY DISEASE DIAGNOSED? CORONARY ARTERIOGRAPHY OR ANGIOGRAPHY

- The treatment of coronary blockages depends on the number, severity, location, and vulnerability of plaques.
- Coronary arteriography is a low risk procedure which clearly answers these questions about the disease which non-invasive testing cannot. Physical or mechanical treatments of plaques by open heart surgery or stenting require coronary angiography to define the plaque location, severity, and stability features.



DYE FLOWS  
INTO  
ARTERIES

CATHETER TIP IN CORONARY ARTERY



BLOCKAGE

DYE IN  
ARTERY

ANGIOGRAM PICTURE

# WHAT ARE MY TREATMENT OPTIONS?

A healthy lifestyle is essential to reducing the risks of coronary artery disease:

- healthy eating
- regular aerobic exercise
- no smoking
- treatment of hypertension, blood pressure, cholesterol, and diabetes
- weight control



# WHAT ARE MY TREATMENT OPTIONS?

## MEDICAL THERAPY

- Although medicines like nitroglycerine for relief of chest pain are well known, modern medical therapy is given to reduce the adverse outcomes of heart attack, stroke, heart failure, and arrhythmia. 3 groups of medicines are recommended to all patients with arterial disease.
- ANTI-PLATELET DRUGS (aspirin, clopidigrel)
- ACE INHIBITORS / ARB
- STATIN CHOLESTEROL MEDICATIONS  
(Beta-blockers are also indicated after heart attack, for reduced blood supply, and heart failure)

# WHAT ARE MY TREATMENT OPTIONS?

## MEDICAL THERAPY



### ANTI-PLATELET DRUGS:

Aspirin and clopidogrel reduce clot formation on plaques or stents.

### ACE INHIBITORS / ARBs:

These blood pressure medicines also reduce stroke, heart attack, heart failure, and kidney failure.

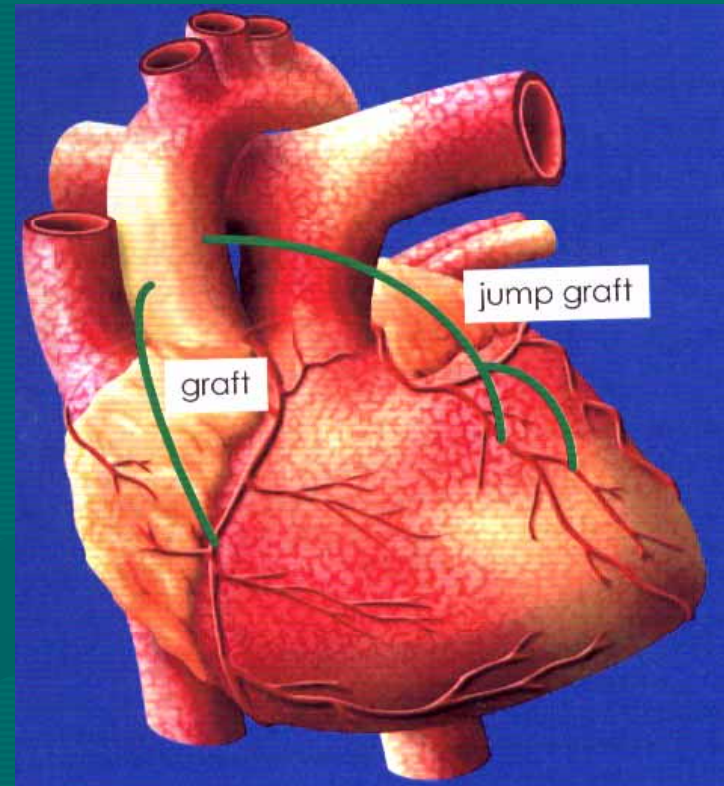
### STATIN CHOLESTEROL DRUGS:

In addition to lowering blood levels of cholesterol, these drugs reduce inflammation in arterial walls and stabilize vulnerable plaques.

# WHAT ARE MY TREATMENT OPTIONS?

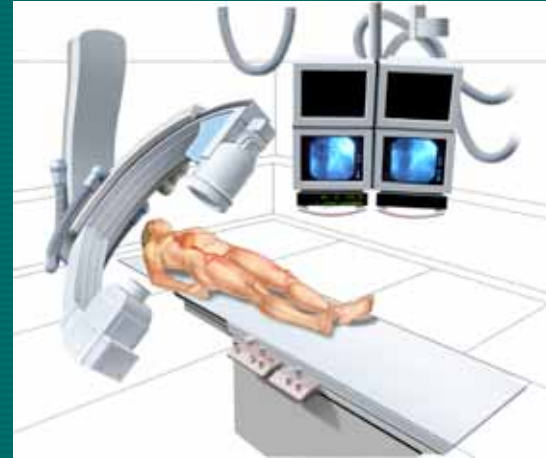
## BYPASS SURGERY

- Bypass surgery uses veins from the leg or an artery in the chest to restore blood flow by going around blockages.
- Bypass surgery has been proven to be more effective than medicines alone in certain types of severe coronary blockages. For example: blockages of all three main arteries, blockage of the left main artery, blockage of specific large arteries, in diabetics with blockage of the artery to the front of the heart. This type of surgery is external to the plaques and is therefore not limited by the internal features of the artery.

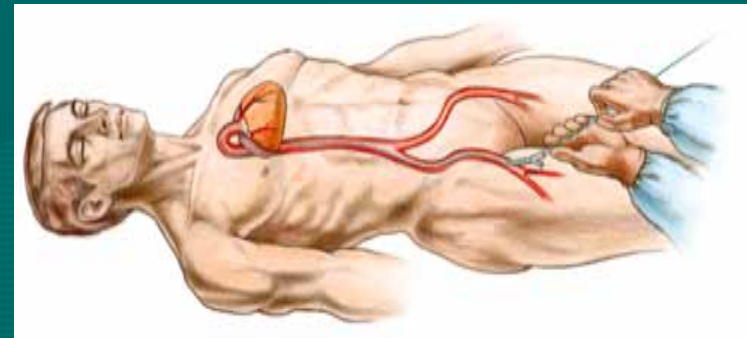


## WHAT ARE MY TREATMENT OPTIONS? CORONARY ARTERY STENTING

- When severe coronary blockage is demonstrated during a *diagnostic* coronary angiogram, the procedure can be continued as a catheter *treatment* procedure for opening the blocked artery.
- Angioplasty (PTCA) or stenting are routinely performed using similar catheter techniques as are used for the coronary angiogram.



CATHETERIZATION LABORATORY  
DEMONSTRATION IMAGE  
PATIENTS ALWAYS FULLY COVERED

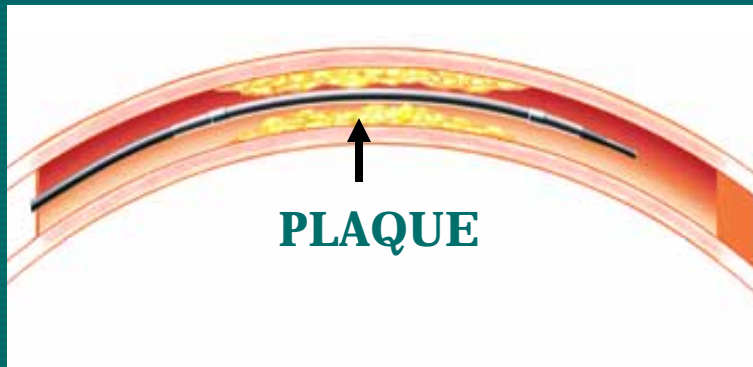


DEMONSTRATION IMAGE  
PATIENTS ARE ALWAYS FULLY COVERED

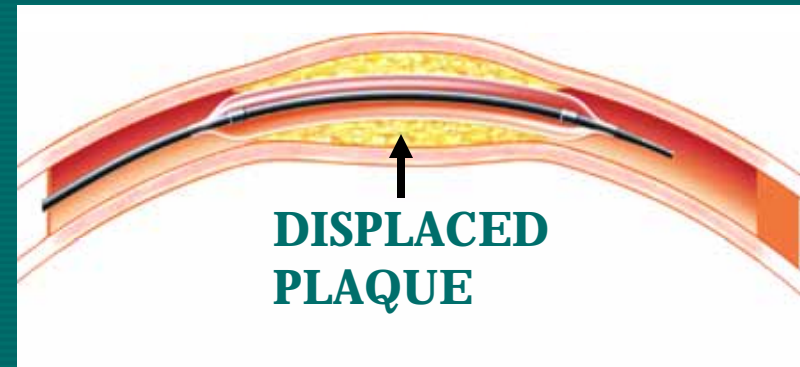
Courtesy Medtronic

# WHAT ARE MY TREATMENT OPTIONS?

## CORONARY ARTERY STENTING



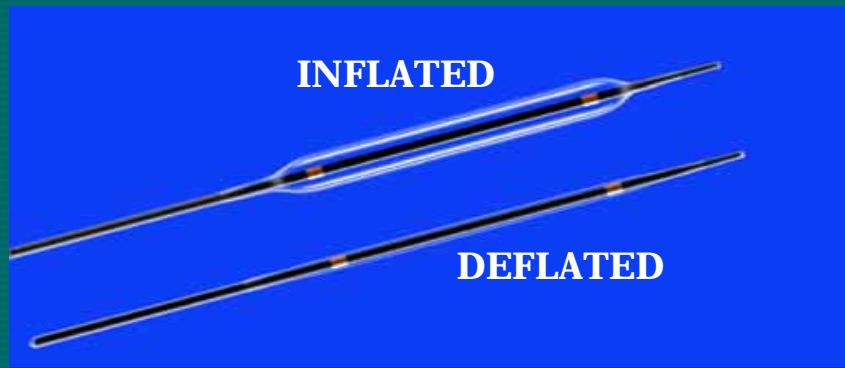
DEFLATED BALLOON CATHETER



INFLATED BALLOON CATHETER  
( THEN DEFLATED AND REMOVED)

- **Balloon angioplasty (PTCA) is a method of opening narrowed coronary arteries using catheters in the catheterization laboratory. Balloon angioplasty has been shown to be equally as effective as bypass surgery in some situations. Plaque is part of the artery and does not break away; it is pushed out or displaced.**
- **However, problems with acute blockage and re-narrowing after angioplasty have resulted in this procedure being replaced in most situations by coronary artery stenting, a safer more effective treatment.**

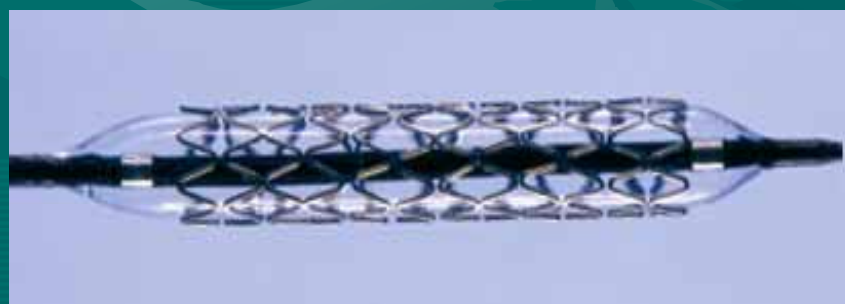
# WHAT ARE CORONARY ARTERY STENTS?



PTCA ANGIOPLASTY BALLOON CATHETER



STENT MOUNTED ON PTCA BALLOON

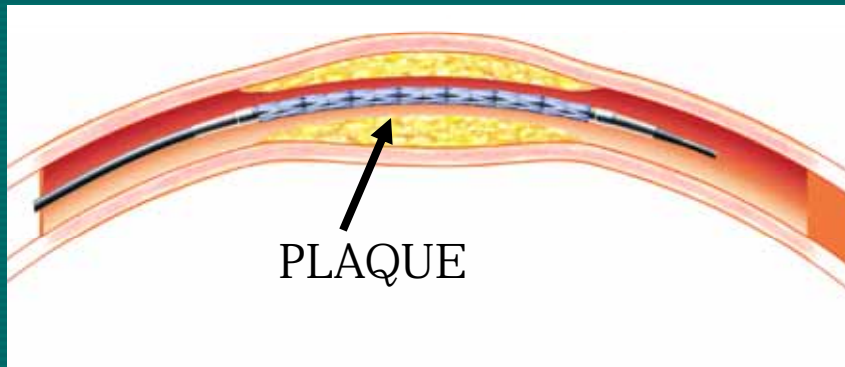


MEDTRONIC STENT EXPANDED BY BALLOON

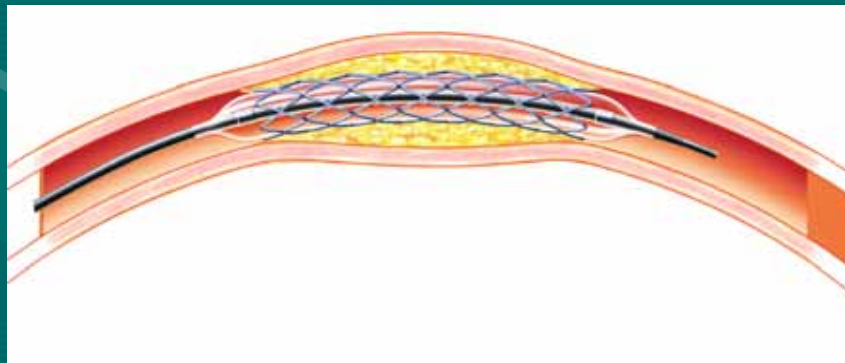
**Angioplasty** ( PTCA) balloons are mounted on the ends of tiny catheters which are advanced from the inside of larger catheters into the coronary arteries. After inflation and deflation of the balloon, the catheter is removed. Today the PTCA or balloon procedure is often done first to open the artery enough to permit passage of the stent catheter.

The **stent** is a cylinder made of stainless steel which looks like a rolled piece of chain-link fence. The stent expands to hold the artery open and remains imbedded in the arterial wall. The balloon is then removed. The procedure is safer than PTCA (balloon angioplasty) because the plaque is held back and stabilized. Stents reduce the chance of re-narrowing (re-stenosis) compared to PTCA.

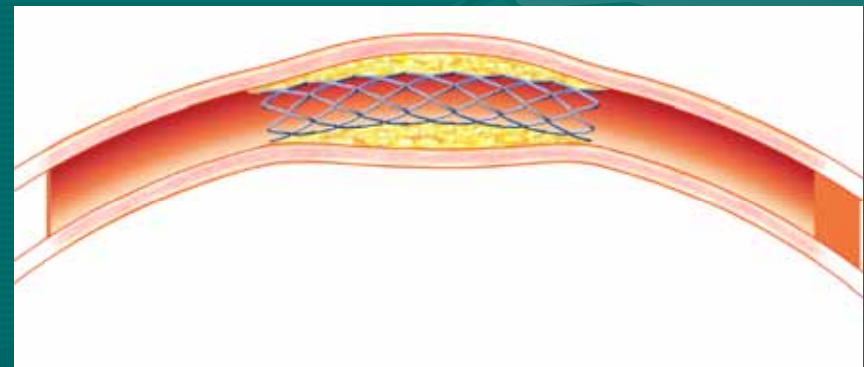
# HOW DO STENTS WORK?



**STENT CRIMPED ON DEFLATED BALLOON**



**STENT EXPANDED BY BALLOON INFLATION**

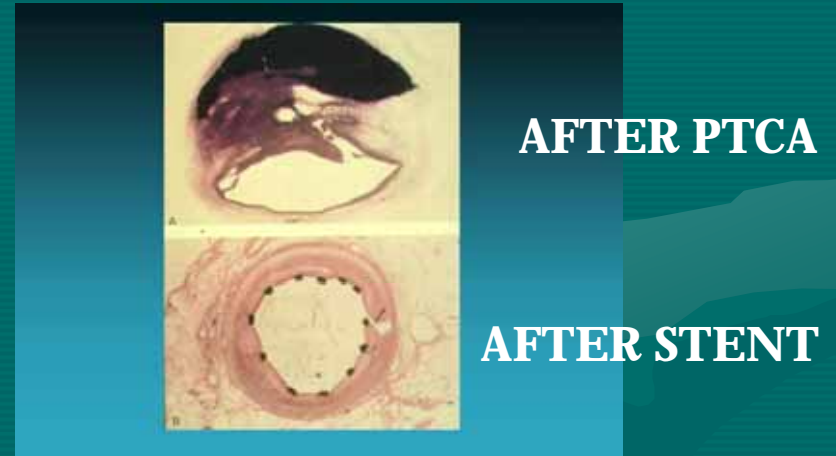


**BALLOON REMOVED LEAVING STENT  
ARTERY WIDELY OPEN  
PLAQUE PUSHED AWAY**

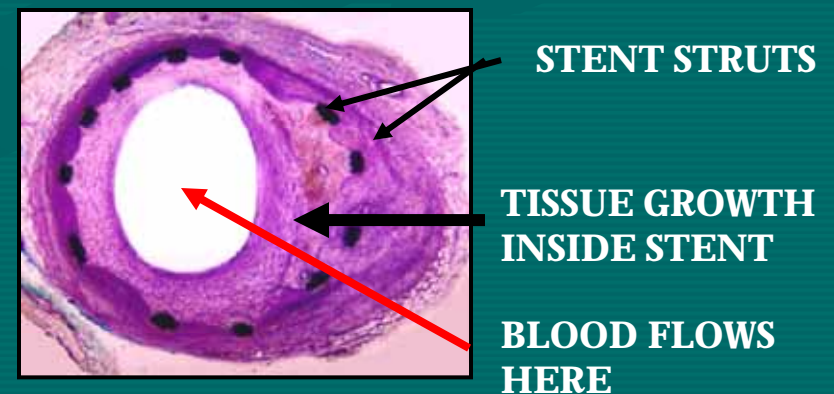
Images courtesy Medtronic

# WHAT ARE DES? (DRUG ELUTING STENTS)

- Stents are a better treatment than balloons alone (PTCA) due to lower procedure risk, less artery splitting, acute blockage, or urgent surgery. Stents give a better opening and less chance of re-narrowing over time.
- However, stents heal by the growth of lining cells over the metal. In 10-20% of patients, this normal tissue growth is excessive and may cause narrowing inside the stent.



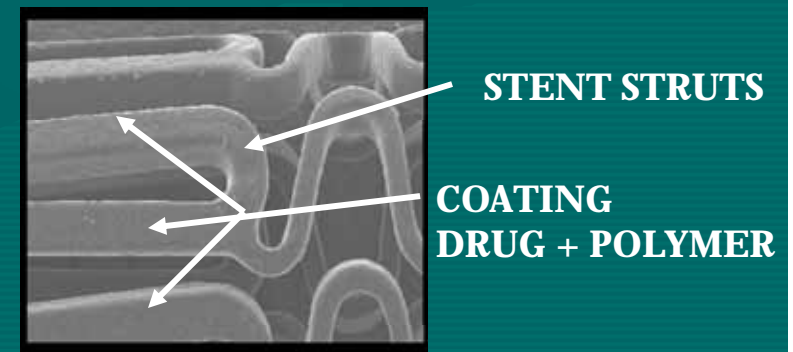
ARTERY CROSS-SECTION



ARTERY CROSS-SECTION

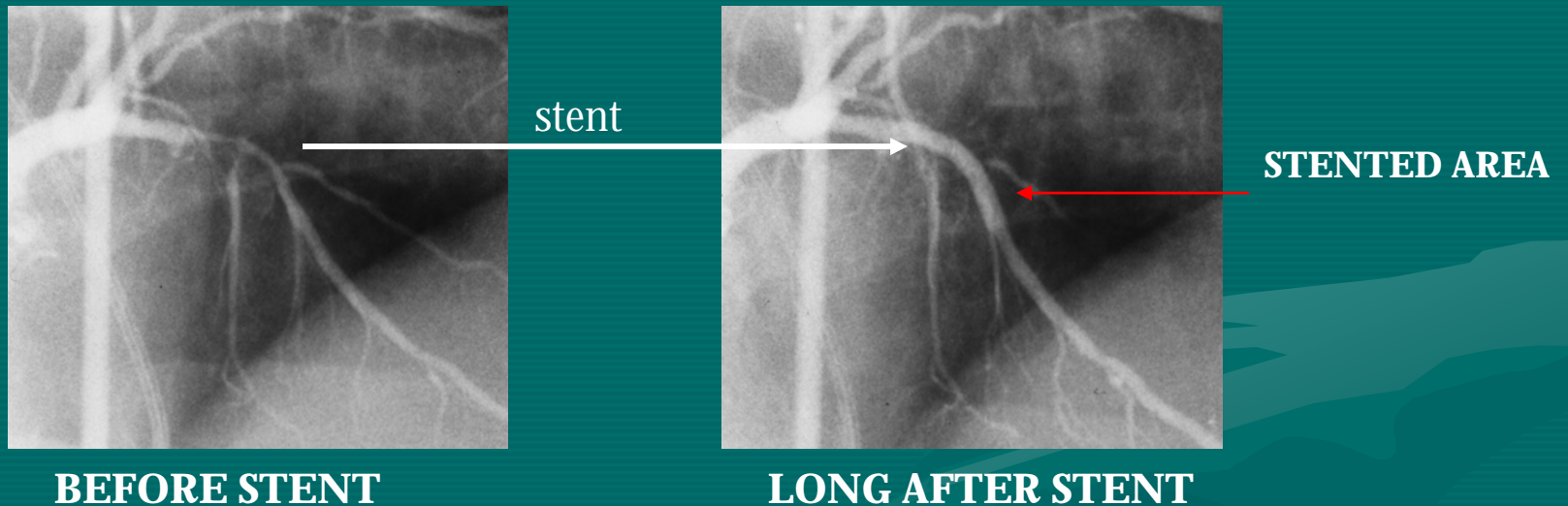
# WHAT ARE DRUG ELUTING STENTS?

- Drug coated (drug eluting, or medicated) stents have been developed to reduce lining cell growth inside the stent which may reduce blood supply.
- Stents are lightly coated with a polymer which is impregnated with a drug which inhibits cell growth (paclitaxel or sirolimus). Like a Tic-Tac, the drug is slowly released thereby reducing re-narrowing.



CLOSE-UP OF DRUG COATED  
CYPHER STENT

# WHAT ARE DRUG ELUTING STENTS?



**A very large number of scientific studies have shown that drug eluting stents greatly reduce the chance of re-narrowing and the need for repeat treatments to restore blood supply.**

**This benefit occurs for all categories of narrowed coronary arteries: large and small, single or multiple, long or short, and in all types of patients including diabetic patients.**

**However, the delayed healing may result in uncovered stent metal in the artery resulting in dangerous clot formation (about 1/2 %). Although this risk can be reduced by long term aspirin and clopidogrel ( 1 year) treatment and care in selecting this treatment, a small risk still exists.**

# WHICH TREATMENT IS BEST FOR ME?

- **All of us should live a healthy lifestyle**
- **Every patient with coronary artery disease should be treated with aspirin, a statin cholesterol medicine, and an ACE or ARB unless side effects limit use (as can occur for any medication). Medicines are needed with all other treatments**
- **There is no cure for coronary artery disease and heart attack and its complications can occur with surgery, with medicines or with stenting. Combining information from your clinical history, previous treatments, risk factors, and stress testing makes it possible to arrive at the right decision for you**

# WHICH TREATMENT IS BEST FOR ME?

- Coronary artery bypass surgery and coronary artery stenting are physical or mechanical treatments for a mechanical problem = narrowing of the artery. The best treatment therefore depends on the type of narrowing. In some situations, bypass surgery is best and stenting ill advised----and vice versa. For many patients, these treatments are not needed.
- In our program, 20 years of experience spanning the improvement of bypass surgery, the development of PTCA and stenting, and extensive experience with new stress imaging helps us to provide an integrated and safe approach to your testing and treatment.