

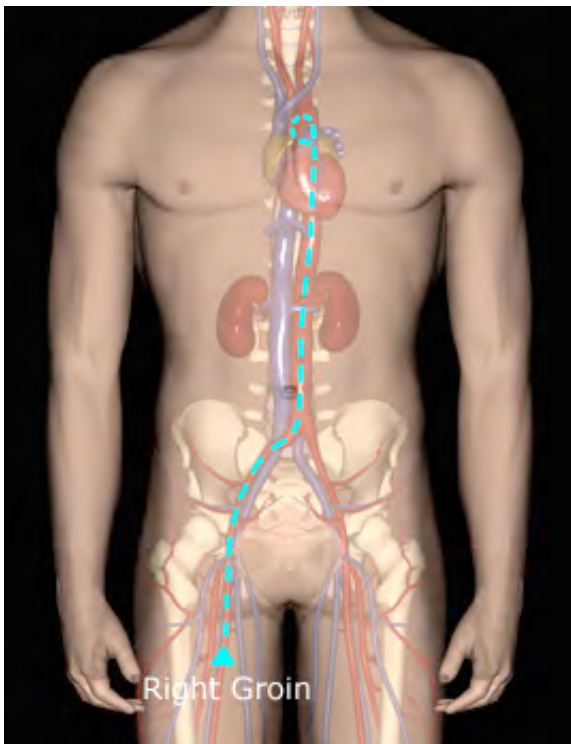
## Cardiac Catheterization

### What is Cardiac Catheterization?

Cardiac Catheterization (Heart Cath) is a specialized study of the heart during which a catheter, or thin hollow flexible tube, is inserted into the artery of the groin or arm. Under x-ray visualization, the tip of the catheter is guided to the heart. Pressures are measured and an x-ray Angiogram (Angio) movie of the heart and blood vessels are obtained while injecting an iodinated colorless "dye" or contrast material through the catheter. Coronary angios are obtained by injecting the contrast material into the opening or mouth of a coronary artery. The iodinated solution blocks the passage of x-rays. X-ray movie pictures taken during the injection of the contrast material allow the coronary arteries to be visualized. In other words, coronary arteries are not visible on x-ray film. However, they can be made temporarily visible by filling the coronary artery with a contrast solution that blocks x-ray.

The coronary arteries are vital because they supply oxygen and nutrients to the heart muscle. Without blood flow, the muscle would sustain permanent damage in the form of a heart attack or myocardial (pronounced my-ow-card-yull) infarction (pronounced in-fark-shun).

Cardiac Catheterization (Cath) is also known as Heart Cath, Angiogram (Angio) (pronounced an-gee-o-gram) or Arteriogram (pronounced ar-tee-rio-gram). The latter two terms describe the use of contrast material to take x-ray pictures of the heart.



If catheters are introduced through the femoral (pronounced fem-rull) or groin artery, the procedure is known as "left heart" catheterization, because the catheter goes from the femoral artery to the aorta, coronary arteries, and the Left Ventricle (LV). This accounts for the majority of procedures. Left heart cath can also be performed by using the artery in the arm.

If a catheter is also placed in the right femoral vein to measure pressures within the right side of the heart, the procedure is called "right heart" catheterization. This is used in patients with congenital heart disease, diseases of the heart valve, or certain conditions involving the pericardium (pronounced perry-card-e-yum), or sac, of the heart. This may also be used in certain diseases of the heart muscle, heart failure, shock, or when measurements of heart output or lung pressures are needed. Right and left heart

catheterization is a combination of both.

There are three major arteries that run on the surface of the LV. This is the most important pumping chamber of the heart and supplies oxygenated blood to the body. The aorta arises from the LV and gives out a series of branches as it makes its way from the heart to the lower portion of the abdomen. The coronary arteries are the very first branches that arise from the aorta. There are two major coronary branches that come off the aorta. The one that arises from the left is known as the Left Main Coronary Artery. This immediately divides into the Left Anterior Descending (LAD) and the Circumflex (Circ).

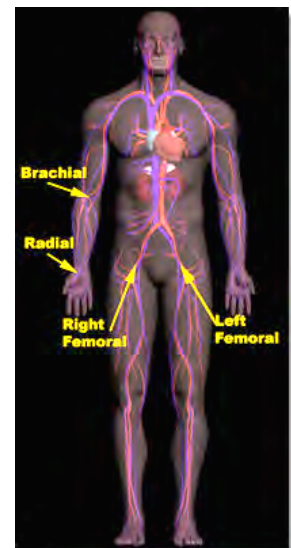
The LAD supplies blood to the front portion (anterior wall) of the LV and the septum (partition wall that separates the LV from the Right Ventricle (RV)).

The Circ wraps around the heart and supplies blood to the back or posterior wall of the LV. The Right Coronary Artery (RCA) arises from the right side of the aorta and supplies blood to the bottom or inferior wall of the LV. It also supplies branches to the RV.

After giving rise to the coronary arteries, the aorta continues down towards the belly and gives off branches that go past the groin and into the legs. The cardiologist can insert a catheter or thin plastic tube into the groin artery (where it comes close to the skin) and "thread it" UP the aorta and to the mouth or openings of the coronary arteries. X-ray is used to guide the passage of the catheter. As noted earlier, an iodinated contrast solution is then injected into the coronary arteries to make it visible on the x-ray. A video image and movie film are simultaneously recorded during injection into the coronary artery.

### **What are the Commonest Access sites**

Cardiac Catheterization (Cath) is most commonly performed by inserting a thin flexible tube into the right femoral artery which is located under the skin, in the right groin. Occasionally the right or left arm (brachial artery) or wrist (radial artery) approach may be employed (as shown below). Step-by-step, we will now walk you through a cardiac cath procedure.



### **What Preparations are Needed?**

Cath may be performed during a hospitalization (inpatient) or as an outpatient procedure, when the patient is admitted and discharged on the same day of the procedure.

### **If an outpatient procedure is planned, the following checklist needs to be followed:**

- Pack a small overnight bag in case you need to spend the night in the hospital. Leave all valuables at home. Pack your contact lenses (with solution) and eye glasses if you wish to view the pictures during the procedure.
- If the procedure is scheduled prior to noon, do not eat or drink after midnight. Medications prescribed by your doctor may be taken with sips of water. If the procedure is scheduled for the afternoon, you may be allowed to have an early liquid breakfast (juice, tea, broth, water, etc.) prior to 7 a.m.

- If your procedure is scheduled in the afternoon, follow the directions of your Cardiologist or the cath lab staff.
- Make certain that you have directions to day surgery and the time that you are to report there. Call your doctor's office or the facility if you have any questions. Also, make sure that you receive instructions about eating, drinking, and the use of prescribed medications.
- Diabetic patients, particularly those on insulin, need clarification about the insulin dose and whether it will be used before or after the procedure.
- Make arrangements to have a family member or friend drive you home. There is a waiting area provided for their use.
- If you are given lab results and Electrocardiogram (EKG) by your doctor, please be sure to give them to the nurse when you arrive. Also, bring all your regular medicines (or at least a list) with you.
- The preparations are similar if you are already hospitalized on the day of the procedure.

### **What Happens After Arrival in the Cath Lab?**

- You will check in at the admission desk
- If you have not had recent blood work or an EKG, they will be obtained by the nurse.
- You will receive instructions about the procedure and what is expected for the day. Your doctor or office staff may already have discussed the procedure, risks and indications with you. You will be asked to sign a consent form. Feel free to ask any questions.
- You will be questioned about your history, medications, and allergies. (If you have an allergy to iodine and shellfish, or have had prior problems during an x-ray procedure or cardiac cath, please be sure to notify the nurse.) You will then change into a hospital gown.
- Make sure that you empty your bladder before being taken to the cath lab.
- The nurse will check your pulse and blood pressure.
- The pulse area on your arm or leg may be marked with a felt-tip pen.
- An Intravenous (IV) will be started in your arm with the use of a small needle or plastic tube. This will allow the administration of fluids and medications.
- You may be given medicines (by mouth or IV) to help you relax.
- When preparations are complete and the cath lab is ready, you will be transferred there.



In the majority of cases, catheters are introduced through a tiny needle hole in the right groin. In such cases both groins are shaved in preparation for the procedure, on the outside chance that the other groin may have to be used.

The patient is then transferred from the stretcher to the Cath table. The Cath Lab technologists (Techs) and nurses help reassure the patient and explain the various things that the patient will experience.

The groin areas are scrubbed with an antiseptic solution and the patient is covered with sterile drapes from the neck down . This is just another step in ensuring that the cath procedure remains sterile.

Intravenous medications are used to relax the patient. The patient is able to ask questions and follow the requests of the cardiologists, nurses and Techs. This can include having to take a deep breath or let the cath team know if there is any discomfort being induced by the procedure. The goal is to keep the patient extremely comfortable and relaxed without being put to sleep. This process is known as "conscious sedation".

The groin area is then "numbed" with the use of local anesthesia. This is induced by injecting lidocaine into the skin and adjoining area. The process is similar to a dentist numbing the gums prior to a dental procedure. The patient may feel a little stinging sensation at this time.

The artery is felt by the fingertips, and a needle is directed towards the arterial pulsation. When blood escapes out of the needle, the cardiologist knows that entrance to the artery has been gained. Since the area was previously "numbed" with local anesthesia, there is usually very little discomfort associated with this.

A thin flexible wire is then introduced into the needle. This is known as a guide-wire because it helps guide catheters, just like a rail guides the path of a train. The purple plastic "tip deflector" helps straighten the curved and floppy tip of the guide wire. The needle and the tip deflector are then removed.

A tubular and flexible plastic sheath that is usually about 2 1/2 or three millimeters in diameter (thickness) is advanced over the guide-wire and placed in the artery. This serves as a passage-way or introducer for the insertion of catheters. The sheath has a white plastic "hub" that sits outside the skin. The hub contains a one-way valve that allows catheters to be introduced through the sheath but prevents blood from escaping.

Through the sheath, and over a guide-wire, a long soft plastic tube or catheter is inserted and guided towards the heart. An x-ray monitor is used to observe the path of the catheter. Different catheter shapes are used during the procedure.

Working from the groin, the cardiologist rotates and gently manipulates the catheter to guide its tip into the opening of the coronary artery. X-ray movies are then taken during the injection of contrast material. Contrast material or "dye" is injected through the catheter and x-ray pictures are recorded on a movie film. The cardiologists steps on floor pedals to view x-ray images (fluoroscopy) or to film (cine angiograms) portions of the study.

A rotating handle sits on the side of the table. By rotating the handle, like that of a motorcycle, and by pressing on levers the cardiologist can rotate the x-ray camera around the patient's chest. The camera can be moved from left to right, towards and away from the patient's head, and up

and down over the chest. This allows different view or rotations of the coronary arteries to be viewed and filmed.

### **What do I need to know about the equipment?**

The x-ray camera hovers on top of the patient's chest, while the x-ray beam is delivered from underneath the table. A movie camera is attached to the tube to record images on a 35mm film. Images are also noted "live" on the monitor and are also recorded on a computer disk drive and / or a video tape. The x-ray tube is rotated around the patient (side-to-side, and also towards and away from the head), as shown to the right. By taking pictures from different angles, the cardiologist can inspect blockages from several



points of view. This increases the accuracy of assessing the clinical importance and severity of a blockage. It also helps determine the patient's candidacy for angioplasty, stenting, surgery, medical treatment, etc.

The patient lies on a table with an attached handle. This handle allows the cardiologist to move the table and also to rotate the x-ray tube. A plastic covered shield is present between the cardiologist and the patient to cut down on radiation. The top portion of the shield is transparent so that the cardiologist can see the patient through it. The cath lab is kept cool. Otherwise, heat would damage the sensitive electronic and x-ray equipment.

### **What is Experienced in the Cath Lab**

The patient may have a feeling similar to a bee sting when the groin is "numbed" with local anesthesia. A sticking sensation is also felt when the needle is inserted. This is very tolerable. The cardiologist should be notified if there is a lot of discomfort or pain. Additional local anesthesia or more sedatives will usually alleviate the discomfort.

The patient will be lying on a relatively firm table and the room will be cool. During the procedure, the patient may be asked to hold his / her breath or cough. This improves the quality of the x-ray movies when the diaphragm (muscle partition between the chest and abdomen) partially obscures a certain portion of the coronary artery. A deep breath improves the picture.

The contrast material may occasionally cause the heart to slow down. Coughing helps clear the contrast from the coronary artery. Coughing may also help correct certain types of abnormal heart rhythm.



The patient should be able to watch most of the study on the TV monitor. The cardiologist may explain the findings as the procedure is carried out.

It is important to remember that the blue or green sheets covering the patient are sterile. Hands should be kept by the side and not placed on top of the sheet. The patient should not reach for the groin because it will contaminate the catheter. If a pillow needs to be rearranged or a cheek scratched, the staff will be happy to help.

Fleeting chest discomfort may also be felt during some coronary artery injections. A transient "hot flash" is usually felt when pictures of the Left Ventricle (LV) are taken, as shown below. This sensation generally clears up in less than 30 seconds.

### **Angiogram of the Left Ventricle**

The coronary arteries are relatively small and can be easily filled by injecting around 5 to 8 cc or ml of contrast or "dye", with the help of a hand-held syringe. X-ray movies are usually taken when the arteries are filled with contrast. The left ventricle (LV or the major pumping chamber of the heart), on the other hand, is larger and requires more contrast to fill it. To allow proper visualization of the LV, nearly 30 or more cc of contrast is injected over 2 to 3 seconds with the use of a power injector.



The cardiac cath Tech helps load the power injector with contrast material or "dye". When instructed to do so by the cardiologist, button is pushed and the contrast is injected into the left ventricle through the catheter (which has its tip positioned in that chamber of the heart).

The x-ray pictures are taken by a movie camera. It will sound like a hum, motor or loud sewing machine when pictures are being recorded.

After completion of the procedure (which usually takes 30 to 90 minutes), the sheath may be removed from the groin in the cath lab or the patient may be taken to their room, where the sheath is removed. Firm pressure is applied for approximately 20-30 minutes (the time may vary) to stop/prevent bleeding from the small needle hole. In many cases, hand pressure may be substituted with, or followed by, the use of a compression device.

A dressing is then placed on the groin and a sand bag may be used on top of the dressing. The patient will have to lie flat for three to six hours. It is important to not sit-up, bend the leg or strain during the time of bed rest. However, the head of the bed may be raised slightly and the feet can be moved to a small degree. Removal of the sheath is delayed if heparin or other "blood thinners" are used during the procedure. The sheath is pulled when a blood test indicates that it is safe to do so.

If there is a warm or wet sensation around the catheter insertion site or if there is blood on the dressing, pressure needs to be applied at the site and the nurse called immediately. If there is

bleeding, there is no need for panic. Additional pressure will almost always take care of the problem.

If there is a need to sneeze or cough, light finger pressure must be applied right above the catheter insertion point. A nurse will provide instructions. This will reduce the risk of bleeding.

If the arm is used during the procedure, pressure will be applied over the insertion point.

At Marshall, a closure device may be used in the cath lab. In such cases, the hole is sealed when the patient leaves the lab and application of pressure is not usually needed or the duration and amount pressure is decreased. This increases the cost of the procedure and carries a very small and acceptable complication rate.

When the anesthesia wears off, the patient may experience soreness. The nurse can provide pain medication to take care of this problem. The blood pressure and pulse rate are monitored during the recovery phase.

The nurse needs to be notified if there are any problems with dizziness, lightheadedness or chest discomfort. Nausea may occasionally occur and is usually resolved with medications. The contrast material acts as a diuretic or "water pill." Also, a lot of intravenous fluids are used. This combination will cause the patient to produce large amounts of urine. Some patients may not be able to void in the flat or supine position. If the bladder gets distended and causes discomfort, a catheter may be temporarily placed in the bladder.

After bed rest is completed, the patient is allowed to sit up and then stand with assistance. After further observation, if there are no problems or bleeding, the patient is discharged.

### **How Long Does It Take?**

The actual left heart cath procedure usually takes approximately 10 to 15 minutes. However, it may take longer if the patient has unusual anatomy of the arteries and there are technical difficulties. Additional time will be needed if the patient has had prior bypass surgery since additional pictures of the bypass vessels are needed. This can add another 10 to 15 minutes to the procedure time. An additional 10 to 15 minutes are needed if the patient requires right heart catheterization.

Approximately three to four hours after the procedure, the patient gets out of bed. The patient is usually discharged within six hours of the procedure unless additional treatment or procedures are required. A little soreness and a Band-Aid are usually the only traces of the procedure. Some patients may display a bruise at the site.

Following discharge, the mild soreness and slight bruising should resolve. However, some patients may experience tenderness and mild pain that can last a few days. If there was bruising at the time of discharge, the area of discoloration may increase in size. This does not necessarily indicate additional bleeding and may be due to the spread of blood pigments under the skin. However, you must notify your cardiologist if you note an increased swelling, particularly if it pulsates. Persistent fever is rare and also requires that the patient contact the cardiologist's office.

You may be instructed to drink plenty of fluids on the night of the procedure to compensate for the urinary fluid loss induced by the contrast material.

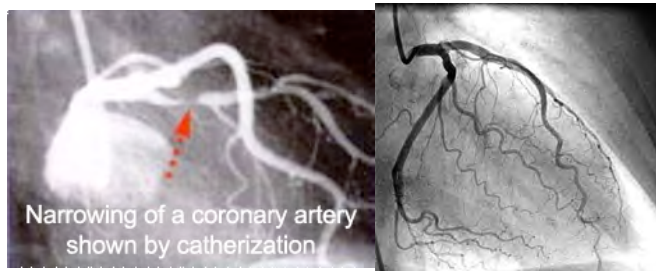
### **How Safe is the Procedure?**

Cath is a relatively safe procedure and is carried out all over the world on an outpatient basis. However, it must be recognized that the procedure is frequently carried out in patients with heart disease and that catheters have to be inserted into blood vessels. Despite this, the risk of a serious complication is estimated to be less than 4 and probably around 1 to 2 per thousand. Rare serious complications can include death, a heart attack, stroke and need for emergency surgery. Occasionally, patients may exhibit a rash as an allergic reaction to the contrast material. Serious allergic reactions are rare and can usually be controlled. Rarely, the contrast material may affect kidney function. This problem is more likely to occur if the patient has underlying kidney disease, and is more likely among diabetics than among non-diabetics. Other infrequent complications can include bleeding that requires blood transfusion or surgical repair, blood clots, and a sustained abnormal cardiac rhythm.

### **What is the Reliability of the Test?**

Cardiac Cath is the "gold standard" against which all other coronary diagnostic tests are measured. However, it should be remembered that it can only pick up "fixed" Coronary Artery Disease (CAD) and may miss coronary spasm where the blockage may come and go. In these cases, medications may be used to provoke and confirm, or exclude, the presence of spasm.

### **How Quickly Will I Get the Results?**



The cardiologist will give the patient and family a preliminary report immediately after the procedure. However, a final report will not be available until the patient is ready to go home. Some cardiologists will meet with the family prior to discharge, while others will set up a subsequent

appointment to go into the details of the procedure and how it will change treatment. If there are serious blockages, and if indicated by the patient's clinical picture, hospitalization for medical treatment may be scheduled. Others may be set up for a balloon angioplasty or stent procedure, or even bypass surgery. In some cases, the angioplasty and stent procedure may be required and carried out immediately following cardiac cath. This will be discussed with the patient and family before it is performed. However, the far majority of patients go home on the same day of the procedure.