



Coronary artery disease

Disease, diagnosis and treatment

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Disorder: coronary atheroma

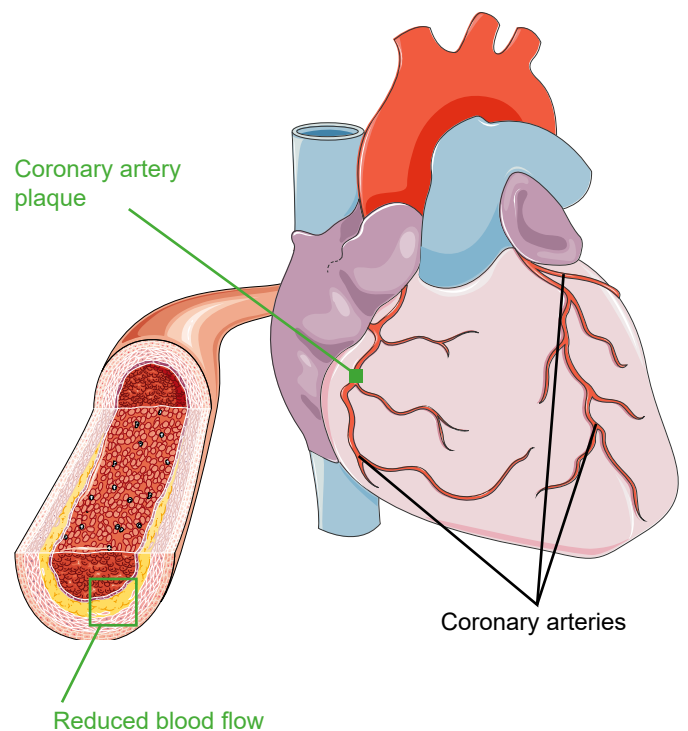
The heart is a muscle which circulates blood around the body. Its function requires energy and oxygen, supplied from the blood and delivered via arteries which are **arranged in a crown-like configuration around it: the coronary arteries**.

What is a coronary atheroma?

It is an accumulation of a substance mostly composed of cholesterol which is deposited inside the coronary arteries and progressively obstructs the passage of blood. Partial obstruction of the coronary arteries is the main cause of angina (chest pain associated with physical exertion).

Complete obstruction of the artery results in myocardial infarction; most often due to a clot. It causes acute and sustained pain (for more than 20 minutes), which occurs whilst resting.

Atheroma is the principal cause of death of men and women living in industrialised countries.



How is coronary atheroma diagnosed?

- **By signs of: thoracic pain during physical exertion**, which radiates to the arm, the left shoulder, jaw, neck, shoulder blades and sometimes to the stomach region.
- **By electrocardiogram analysis (ECG)** carried out whilst resting or during a stress test
Refer to the "Stress test" information sheet for more details
- **By a coronary scan**, which enables us to visualise the coronary arteries under certain conditions. This test is yet to be validated to replace conventional coronary angiography completely. It is predominantly used for the **screening of heart conditions**, rather than as a diagnostic tool in management of the disease. All lesions detected by scan will need to be reconfirmed and validated by conventional coronary angiography. Although not requiring arterial puncture, it does necessitate the injection of contrast medium and X-ray analysis.
Refer to the "Scan" information sheet for more details
- **By cardiac magnetic resonance imaging**
This imaging method has been in operation at the Cardio-Thoracic Centre of Monaco since 2002, and provide an accurate analysis of the cardiac muscle to detect fibrosis or evidence of a previous infarction.
Refer to the "MRI" information sheet for more details.
- **Predominantly by coronary angiography also referred to as coronarography.**



Coronary angiography

This examination is performed under local anaesthetic and requires injection of contrast medium into the coronary arteries by means of a catheter inserted through the radial artery at the wrist or through the femoral artery at the groin crease. The injection is visualised by X-rays and filmed in real time. **During coronary angiography this process allows us to visualise any blood vessel narrowing and/or obstruction** caused by atheromatous plaque deposits **and helps us to determine the most appropriate course of action** to reduce the risk of further complications and improve your quality of life.

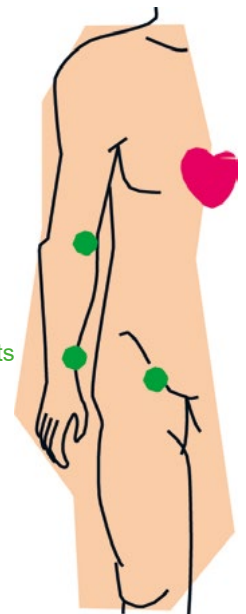
Before a coronary angiography

The examination requires hospitalisation. On admission, we ask you to provide your physicians and nurses with all documentation relating to your condition, such as X-rays, electrocardiogram, results from stress tests, laboratory tests, scintigraphy tests etc.

Please tell us which treatments you are currently taking. Certain medications which you are currently taking and which may affect examination results will be stopped at predetermined intervals before the examination:

- Anticoagulants may be stopped before the examination. If this is necessary, the exact date at which you should stop taking them, will be specified by your treating physician or by the teams scheduled to perform your examination.
- For diabetic patients, Metformin treatment should be discontinued the day before the examination and resumed, subject to renal function monitoring, 48 hours later.
- Fasting before the examination is generally not required, except in some specific cases.

Catheter insertion points



Where is a coronary angiography performed?



The procedure is performed in the catheterisation room, where you will be seated on an examination table. Your electrocardiogram and

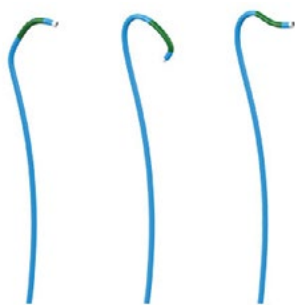
blood pressure will be monitored at all times.

This room also includes X-ray equipment which is used to monitor the insertion, position and progression of the catheter inside the heart cavities.

The region through which the catheter is introduced, is carefully disinfected and isolated with sterile dressings and you must under no circumstances touch this area, as this may inadvertently introduce an infection.

How does the physician introduce the catheters?

First of all, the physician anaesthetises the local area. When the region feels numb, he/she will puncture the artery (or the vein) and insert a small tube (called a sheath) into the blood vessel of the wrist or groin region, through which catheters (or probes) will be threaded.



Catheters are flexible, thin (approximately 2 mm in diameter) plastic tubes which are opaque to X-rays. They are inserted inside blood vessels and their position visualised on a TV screen.

Generally, you will feel no pain during catheter placement, only a normal sensation of warmth due to the contrast medium or injected medications.

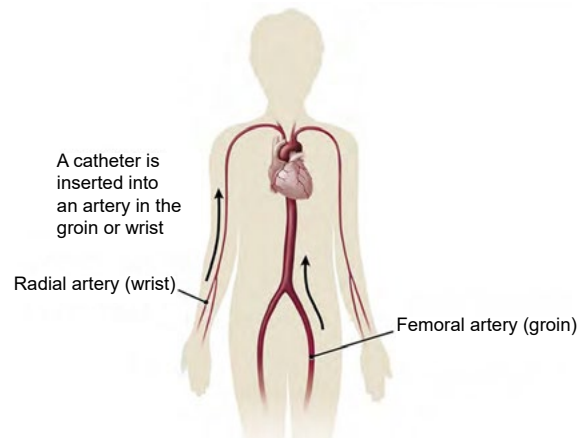
Various stages of the examination

The examination will begin by measuring aortic pressures inside the different cavities (and measuring cardiac output).

An angiography will then be carried out (by injection of a contrast agent inside); this part of the test is designed to identify any abnormalities affecting the valves, to detect possible narrowing and for obstruction caused by atheromatous plaque leading to the thickening of coronary arteries.

Injection of the X-ray contrast agent produces a sensation of diffuse warmth throughout the body which will last between 15 to 20 seconds.

Some patients with allergic symptoms (asthma, hives, eczema), **or patients who have had allergic reactions during previous examinations** (affecting the kidneys, other arteries or veins) **should mention this to their physician prior to the procedure.**



Route of femoral artery catheterisation

This exploratory test requires the patient's input throughout all the stages of the procedure. During the examination, you will be asked at certain times:

- to breathe in deeply,
- to hold your breath for a few seconds to allow cavities and arteries to be filmed.

At other times, the physician will ask you to cough strongly and abruptly.

During coronary angiography, two new techniques will be used to guide and optimise the angioplasty procedure:

- **Fractional Flow Reserve (FFR)** measurement allows us to detect stenoses more accurately which impact heart muscle function;
- **Intracoronary imaging such as optical coherence tomography (OCT) or intravascular ultrasound (IVUS)** may also be performed to complete the anatomical assessment of the coronary arteries.

After the examination

After catheter removal, a compression dressing will be applied to the puncture wound to prevent bleeding from the artery and you will be accompanied back to your room.

It is very important not to move the punctured limb and to follow the recommendations of the physician and nursing staff to assist you in standing up for the first time after the procedure.

Standing up too quickly or making sudden movements may trigger bleeding from the puncture wound and lead to a haematoma.

You will be served a light meal 2 hours after returning to your room, **it is important to drink plenty of fluids (water, broth...) to eliminate the contrast medium.**

Does a coronary angiography entail any risks?

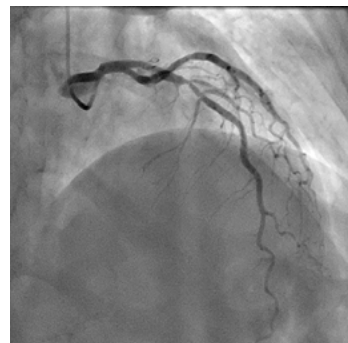
As with any invasive procedure, a coronary angiography does pose some risks, albeit very low, of which patients should nevertheless be aware:

- **allergic complications most often associated with the use of iodinated radiological products or a local anaesthetic;**
- **complications at the artery puncture wound.** The most common complication is the formation of a bruise or haematoma at the punctured site, which may persist for several days but usually resolves without sequelae. Nevertheless, should you observe an increase

in the size of the swelling in the days following the examination please seek medical advice immediately. In very rare cases manipulation of the probes may cause vascular injuries, which may require surgical intervention and/or a blood transfusion, and may also dislodge atheromatous debris giving rise to an arterial embolism (potentially causing ischemia, stroke).

- **heart and vascular complications.** During the examination, discomfort, chest pain, palpitations relating to a rhythm disorder may occur. However, serious complications are very rare. As an indication, a published medical review, based on an extensive patient cohort, calculated a risk of death of 0.2/1000, a risk of neurological disturbances (particularly paralysis) of 0.4/1000 and a risk of myocardial infarction of 0.3/1000. Other, less severe complications have been reported at a frequency of less than 1%.

A recent analysis highlights that the overall mortality rate due to cardiovascular disease has decreased



in the past 20 years, indicating that **modern treatment methods are effective and justify the risks of both the diagnosis and the treatment.**

Coronary angiography

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What are the current treatment options for coronary artery disease?

Therapeutic strategies are based on coronary angiography results. Depending on whether intra-coronary deposits compromise blood flow, treatments include changes in lifestyle to reduce risk factors and medication, but may also require other approaches to improve arterial blood circulation:

- coronary angioplasty and «stent» implants,
- heart bypass surgery.

1 - Coronary angioplasty

What does a coronary angioplasty involve?

Via arterial access (through the femoral or radial artery), the cardiologist introduces a deflated balloon catheter into the artery narrowing and then inflates the balloon to dilate the artery. In most cases, a «stent» (a metal tube designed to open the artery to the required diameter) is implanted.

Angioplasty allows more blood to flow to the heart muscle, thereby improving long-term outcomes and specifically reducing the severity of chest pain.

Prior to the procedure

You must tell us:

- if you are at particular risk of bleeding: a blood disorder, frequent bleeding, blood thinning treatment (anticoagulant or anti-platelet aggregation such as Aspirin®, Asasantin®, Kardegic®, Persantine®, Plavix®, Previscan® Sintrom®, Solupsan®, Ticlid®...);
- if you suffer from an allergy or asthma or have not tolerated a radiological examination well;
- if you have recently had an infection (fever, sore throat) or undergone dental procedures;
- if you have diabetes and take biguanides (Glucinan®, Glucophage®, Stagid®);
- if you suffer from a condition that weakens kidney function;
- if you are pregnant or likely to become pregnant or are breastfeeding;
- Gentlemen, please tell us if you have issues when urinating (benign prostatic hyperplasia).

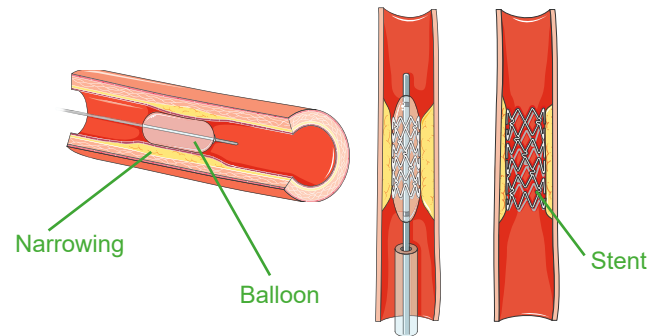
Please do not hesitate, in a more general sense, to provide us with any additional information which you feel is important and to inform us of any other serious illness not listed above.

What will happen during a coronary angioplasty?

The first step is exactly like a coronary angiography; after assessing the condition of the coronary arteries, the physician injects an anticoagulant, Heparin. Once the catheter is placed, the physician, directed by X-ray imaging, slides a very thin guide into the narrow part of the artery. This guide serves as a rail to direct and position a deflated **balloon** at the exact location of the narrowing to be dilated. The physician then inflates the balloon by injecting a substance which is opaque to X-rays.

The inflation time can vary from a few seconds to 45 seconds or 1 minute; **you may feel the same pain you usually feel when exerting**, this is not surprising, because at that particular moment the artery is occluded.

After inflating one or several times and once the blood flow is sufficiently restored, the physician removes the guide and the balloon catheter.



After returning to your room

The health care team will continue to monitor your electrocardiogram, blood pressure, the femoral or radial wound and will inform you when you can start to eat and drink.

As previously mentioned for coronary angiography procedures, in order to reduce the risk of haematoma, in cases of a groin insertion point, **please lie down for several hours after the procedure and do not bend the leg below the puncture wound.**

The day after the angioplasty, you will be allowed to get up and you may even be discharged then or at the latest the following day.

What are the risks of coronary angiography?

- **Allergic complications** are most often related to the local anaesthetic or iodine based contrast agent used. If you have ever had any allergic reactions, you must inform your physician.
- **Complications at the puncture wound** are more common after angioplasty than after coronary angiography because of the anticoagulant treatment. The most common complication is a haematoma resulting in a bluish appearance which may persist for several days but usually has no consequences. In rare cases, an artery may become blocked or injured and require surgical repair and/or a blood transfusion.
- **Heart and vascular complications:** during angioplasty, discomfort, chest pain, or palpitations relating to a rhythm disorder may occur.

- Displacement of a clot, injury to an artery or another complication may lead to:
 - ✓ repeat angioplasty,
 - ✓ heart bypass surgery (0.61%), i.e. emergency cardiac surgery,
 - ✓ myocardial infarction (in 0.05% of cases),
 - ✓ or even death (in 0.08% of cases).

Other rare and less serious complications have been observed.

The success of the procedure depends largely on your prior health status (stable or unstable angina, recent myocardial infarction, diabetes...) and the aspect of the narrowing (short or long, presence of tortuosity, calcification, junction, suitability for stenting...). The complication/failure rate in routine cases is of the order of 5%.

- **Restenosis:** regions that have previously been dilated will scar. A gradual re-narrowing of blood vessels (restenosis) may occur (at a rate of 1 in 4 to 1 in 5 procedures) and usually occurs within the first 6 months of the procedure; it can be treated by dilating the vessel again. The risk of restenosis is reduced (to < 10%) with the use of new-generation stents coated with a compound which inhibits this process. They have been available since October 2003 but are not extensively used.

Post discharge

If there are no problems with the wound, the physician will not delay your resumption of normal daily activities and work. **Regular check-ups, the frequency of which are determined by your cardiologist, are nevertheless essential.**

Recurrence of symptoms should always prompt you to consult your cardiologist.

Risk factors will need to be reduced: smoking, hypertension, high cholesterol, obesity, diabetes and physical inactivity.

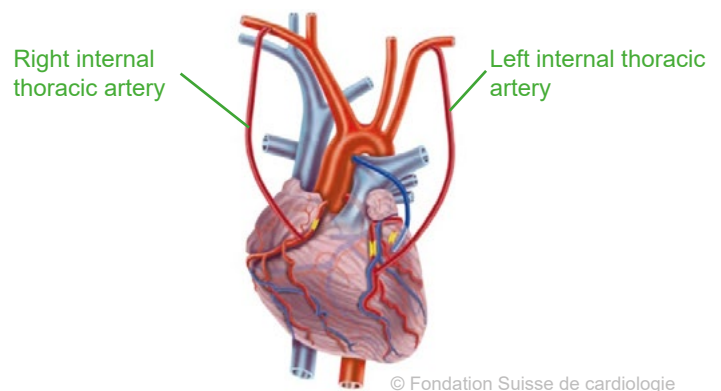
2 - Heart bypass surgery

Some coronary lesions will require heart bypass surgery. For example, narrowing of arteries affecting the left trunk and/or several major arteries usually necessitate surgical intervention, particularly in diabetic patients.

What does heart bypass surgery involve?

Heart bypass surgery is a procedure which improves myocardial perfusion by creating new arterial grafts (alternative routes). **Implanted downstream of the narrowing, these grafts divert blood flow around the obstacle present in the coronary artery.**

Depending on the number of coronary arteries affected, 1 to 5 bypasses are possible.



Where is the graft taken from?

Usually, the bypass graft used can be:

- the internal thoracic artery: two exist, the left and the right internal thoracic arteries; grafts are taken from the anterior thoracic wall;
- the saphenous vein, which is taken from the leg;
- the radial artery, which is taken from the forearm;
- the gastroepiploic artery, taken from the stomach region.

What does the surgery involve?

It is performed under general anaesthesia and requires an incision in the middle of the sternum (sternotomy). Depending on the graft, other incisions may be necessary.

In the majority of cases, the heart is stopped so that intricate suturing (anastomosis) can be performed; during this procedure an extracorporeal circulatory support unit is installed to carry out the work normally performed by the heart and lungs.

In some specific cases, the procedure can also be carried out without extracorporeal circulation, this is known as "beating heart" surgery.

This intervention, however requires a sternotomy.

The surgery takes between 3 to 6 hours depending on the complexity of the individual case.

Your stay in the intensive care unit



Post-surgery, **patients recover in the intensive care unit and remain under observation for approximately 48 hours.**

Assisted breathing by way of a ventilator is maintained for the first few hours and then gradually removed by withdrawing the tube from the mouth.

Medications are prescribed to relieve pain and intravenous fluids are administered to maintain hydration.

Temporary drainage tubes (chest drains) are left in place for a few days, to divert serous fluids and blood from the wound. A small percentage of patients may require a blood transfusion.

Eating can generally be resumed the day after the operation.

Return to the room

Most patients will obtain consent from the medical staff to get up and walk around 48 hours post surgery.

Regular physiotherapy sessions will help you regain autonomy and recover respiratory functions. Patients do however still have reduced mobility due to the presence of ECG electrodes for continuous monitoring (biotelemetry) and venous infusions as required. Pain and insomnia will also ease over time.

What are the risks of heart bypass surgery?

Surgically restoring normal blood flow to the heart by grafting thoracic arteries or by venous bypass, is a procedure, which like all other surgical procedures, is associated with an inherent risk of morbidity/mor-

tality which is taken into account by the medical team (the surgeon, anaesthesiologist and cardiologist) and very much depends on the patient's heart condition and general health status.

Such complications may be of an intra- or peri-operative nature.

Some complications, such as heart rhythm disorders (arrhythmia, bradycardia) may require the fitting of a pace-maker; other, less frequent complications include post-operative infections (less than 2% in the Cardio-Thoracic Centre of Monaco's experience) or neurological (less than 1.5%) and exceptional complications.

These risks, about which the patient and their family are advised, are significantly lower than the risks involved in letting the disease run its natural course, resulting in surgery being proposed.

What happens once you have been discharged?

Upon discharge you will either return home or be admitted to a specialised rehabilitation centre, depending on your condition and/or your personal preference.

Generally speaking, physical recovery is fast. Driving and sexual activity may be resumed within 4 weeks. The main limiting factor to resuming normal activities is the healing of the sternum. Like any bone fracture, this can take between 6 to 8 weeks to consolidate. **Any activity likely to put pressure on the chest during this period of time is categorically ruled out.**

Return to work

This depends on the speed of your recovery and the physical and stressful nature of your profession. A desk-bound activity can potentially be resumed after 4 weeks. An occupation with extensive physical activity will require a rest period of approximately 12 weeks.

Your treating cardiologist will help you determine when you will be fit enough to return to work.

Do you need to follow a rehabilitation programme?

A cardiac rehabilitation programme can help monitor progress and expedite the resumption of a normal active life. General guidance and recommendations will also be given regarding beneficial lifestyle changes: diet, weight loss and thresholds of physical exercise or sports activities to attain.

Depending on the condition of your heart and your overall health, the cardiologist and surgeon will help you to implement this rehabilitation programme.

Does heart bypass surgery cure coronary artery disease?

No. Heart bypass surgery improves blood flow to the heart, relieves symptoms and in some cases increases life expectancy. Almost all patients will need to take aspirin (80 to 100 mg) daily for the rest of their lives. Other medications may be prescribed (to reduce cholesterol levels as well as beta-blockers, angiotensin-converting enzyme (ACE) inhibitors, anti-arrhythmic agents) if necessary.

Long-term follow-up

Patients will need to be monitored at regular intervals by their treating physician to check for risk factors and once a year by their cardiologist for coronary assessment.

Heart bypass surgery allows most patients to lead normal, very healthy, symptom-free lives and to return to a full working life.



Over time, atheromatous disease can continue to progress and affect the coronary arteries and grafts. For this reason, **it is essential, to reduce risk factors which favour atherosclerosis, after coronary angioplasty or heart bypass surgery.**

These measures include:

- losing weight (if overweight),
- quitting smoking,
- reducing cholesterol levels,
- maintaining normal blood pressure,
- where necessary regulating diabetes,
- regular, gentle physical exercise.

References: Fédération Française de Cardiologie (French Federation of Cardiology), Fédération Française de Radiologie (French Federation of Radiology), Fondation Suisse de cardiologie (Swiss Heart Foundation).

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