

## Coronary artery bypass graft

### Introduction

A coronary artery bypass graft (CABG) is a surgical procedure used to treat coronary heart disease.

It diverts blood around narrowed or clogged parts of the major arteries (blood vessels), to improve blood flow and oxygen supply to the heart.

Nearly 80% of those who need to have the operation are men over 60 years old.

### Coronary arteries and coronary heart disease

Like all organs in the body, the heart needs a constant supply of blood. This is supplied by two large blood vessels called the left and right coronary arteries.

Over time, these arteries can become narrowed and hardened by the build-up of fatty deposits called plaques. The narrowing of the arteries is known as atherosclerosis. People with atherosclerosis of the coronary arteries are said to have coronary heart disease.

Risk factors for coronary heart disease include:

older age

smoking

obesity

a high-fat diet

Coronary heart disease can cause angina, which is chest pain that occurs when the supply of oxygen-rich blood to the heart becomes restricted.

While many cases of angina can be treated with medication, severe angina may require a CABG to restore the blood supply to the heart (read more about why coronary artery bypass graft is used).

Another risk associated with coronary heart disease is that one of the plaques in the coronary artery ruptures (splits), creating a blood clot. The blood clot can block the supply of blood to the heart, triggering a heart attack. So, a CABG may also be recommended for people with a high risk of having a heart attack.

## The procedure

CABG involves taking a blood vessel from another part of the body, usually the chest or leg, and attaching it to the coronary artery above and below the narrowed area or blockage. This new blood vessel is known as a graft.

The graft diverts the flow of blood around the part of the coronary artery that is narrowed or blocked. Usually, the surgeon will carry out several grafts to make sure the procedure does not have to be repeated in the future. Read more about how a coronary artery bypass graft is performed.

## Recovery

Recovery after your CABG will take time. Everyone recovers at slightly different speeds. As a rule of thumb, you should be able to sit in a chair after one day, walk after three days and walk upstairs after five or six days.

## Outlook

The outlook for people having a CABG is generally good. Most people will experience a significant improvement in symptoms and their heart attack risk will be lowered. Read more about what you can expect after a CABG.

However, it is important to realise that a CABG is not a cure for coronary heart disease. If you do not make lifestyle changes such as eating a healthy diet and quitting smoking, your grafted arteries will eventually also become hardened

and narrowed. Read more about the lifestyle changes you should make to reduce your risk of further coronary heart disease.

Like all types of surgery, CABG carries a risk of complications, some of which are fatal, such as a stroke or heart attack. The risks of serious complications can vary, depending on factors such as age, whether you have other serious health conditions, such as kidney disease, and the general state of your heart.

On average, less than 2% of people will die in the first 30 days after surgery. Read about the risks of a coronary artery bypass graft.

### When you may need a CABG

A coronary artery bypass graft (CABG) is a procedure that diverts blood around narrowed or clogged parts of the major arteries (blood vessels), to improve blood flow and oxygen supply to the heart.

It may be necessary in the following situations:

There is severe hardening and narrowing of the coronary arteries.

Many coronary blood vessels are blocked.

You are at risk of having a life-threatening heart attack.

Your blood supply needs restoring after a heart attack.

You need emergency treatment for ventricular arrhythmia.

These are discussed in more detail below.

Coronary arteries are severely affected

Your arteries harden and narrow naturally as you get older, but this process can be dangerously accelerated by:

eating a high-fat diet

smoking

high blood pressure (hypertension)

diabetes

When the coronary arteries become so narrow that blood supply to the heart is reduced, it is known as coronary heart disease.

If tests show that many branches of the coronary arteries are blocked, or the levels of hardening and narrowing are severe, then a CABG may be required.

If hardened or narrowed coronary arteries are not treated, you may experience a pain in your chest known as angina. Angina happens because blood flow to your heart is reduced.

### Preventing a life-threatening heart attack

A CABG may also be recommended if you are thought to be at risk of a serious heart attack. You are thought to have such a risk if tests have found there is a particularly high level of narrowing in a section of your coronary artery called the left anterior descending artery (LAD). This is because heart attacks that are triggered by a blood clot blocking the LAD are extremely serious. If they are not treated within five minutes of symptoms starting, they are usually fatal.

### Restoring blood supply after a heart attack

A CABG may also be used to help restore blood supply to your heart after a heart attack.

A coronary angioplasty is usually the preferred surgical option for treating heart attacks, but a CABG may be required if:

The coronary angioplasty fails to restore the blood supply to your heart.

It is not possible to perform angioplasty for technical reasons, for example, because many of the blood vessels are blocked.

### Preparing for going into hospital

Before going into hospital to have a coronary artery bypass graft (CABG), it is a good idea to make some preparations.

You may find the list below useful.

Get informed. Find out as much as you can about what is involved in your operation. Your hospital may provide written information or videos.

Arrange help. Line up a friend or relative to help you at home for a week or two after coming home from hospital.

Sort out transport. Arrange for either a friend, a relative or a taxi to take you to and from the hospital.

Prepare your home. Before you go for your operation, put your TV remote control, radio, telephone, medications, tissues, address book and glass on a table next to where you will spend most of your time when you come out of hospital.

Stock up. Get in a stock of food that is easy to prepare (for example, frozen ready meals, cans, and staples such as rice and pasta) or prepare your own dishes to freeze and reheat during your recovery.

Clean up. Before going into hospital, have a good long bath or shower, cut your nails (don't forget to take off any nail polish) and wash your hair. Put on freshly washed clothes. This helps prevent unwanted bacteria coming into hospital with you and causing complications.

## Before your procedure

Before surgery, you will attend a pre-admission clinic, where you will be seen by a member of the team who will be looking after you in hospital.

At this clinic, you will have a physical examination and be asked for details of your medical history. Any investigations and tests that you need will be arranged. This is a good time to ask questions about the procedure, but feel free to discuss any concerns you might have at any time.

You will be asked:

whether you are taking any tablets or other types of medication; it helps if you bring details with you of anything you are taking (for example, bring the packaging with you)

about previous anaesthetics you have had, and whether you had any problems with these (such as nausea)

whether you are allergic to anything

They will also want to know about your teeth, for example, whether you wear dentures or have caps or a plate.

You will be advised to stop smoking. This is because smoking increases your chances of a serious chest infection and slows down the time your wounds will take to heal. Smoking can also increase your risk of blood clots.

What happens during surgery

Before your coronary artery bypass graft (CABG), your surgeon will discuss every aspect of the procedure with you.

This will give you the opportunity to ask any questions to make sure you understand the procedure fully.

Because the procedure is performed using a general anaesthetic (you are put to sleep), you must not eat or drink for at least six hours before the operation. You may be able to have occasional sips of water until two hours before the operation.

During the operation

CABG surgery usually lasts three-to-six hours. However, it may take longer depending on how many blood vessels are being grafted.

Blood vessels can be taken from:

your leg: this vessel is known as the saphenous vein

inside your chest: this vessel is known as the internal mammary artery

your arm: this vessel is known as the radial artery

The number of vessels needed will depend on how severe your coronary heart disease is and how many of the coronary blood vessels have become narrowed. Most people will need three or four vessels grafted.

One of the graft vessels is usually your internal mammary artery. Surgeons prefer to use this vessel because it does not narrow over time, unlike the blood vessels taken from your leg or arm.

Once all the graft vessels have been taken, your surgeon will make a cut (incision) down the middle of your breastbone (sternum) to access your heart through your ribcage.

During the procedure, your blood will be re-routed to a heart-lung bypass machine. This takes over from your heart and lungs, pumping blood and oxygen through your body.

Your heart will be temporarily stopped using medication while your surgeon attaches the new grafts to divert the blood supply around the blocked artery.

After the grafts have been attached, your heart will be started again using controlled electrical shocks.

Your sternum will then be stitched up using wires and the skin on your chest sewn up using dissolvable stitches.

## New surgical techniques

### Off-pump coronary artery bypass surgery (OPCAB)

More surgeons are now performing off-pump coronary artery bypass surgery (OPCAB), which is a variation of the CABG procedure.

A CABG is often described as on-pump surgery as it uses the heart-lung bypass machine to pump blood and oxygen around your body during the procedure, while the heart is temporarily stopped.

During the OPCAB, your heart is still beating while the new blood vessel grafts are attached. According to the National Institute for Health and Clinical Excellence (NICE), this procedure works as well as a coronary artery bypass using a pump. Around 20% of heart bypasses are performed off-pump.

The benefits of an OPCAB are:

It often takes less time to perform than a CABG.

It reduces your chance of bleeding during the surgery.

You are less likely to develop complications after surgery, such as an irregular heart beat or chest infection.

Your stay in hospital is usually shorter.

The main disadvantage is that OPCAB is more technically demanding. The grafted vessels have to be delicately connected to a beating heart. This means that OPCAB may be too difficult to perform if a large number of blood vessels need to be grafted.

For the same reason, if emergency surgery is required, there may not be ready access to a surgeon with the training required to perform an OPCAB.

Read the NICE 2011 guidelines on Off-pump coronary artery bypass grafting.

### Endoscopic saphenous vein harvesting (ESVH)

Endoscopic saphenous vein harvesting (ESVH) is a new method of removing the veins from your legs. Rather than making a large incision in your leg, the surgeon makes a number of small incisions near your knee. This is known as keyhole surgery.

A special device known as an endoscope is then inserted into the incision. An endoscope is a thin, long flexible tube that contains a light source and a video camera, so that images of the inside of your body can be relayed to an external monitor (screen).

The endoscope allows the surgeon to locate your saphenous vein. Surgical instruments can then be passed through the endoscope to remove a section of the vein. Nearby tissue is then sterilised with antibiotic fluid and the incision is healed.

Read the NICE 2010 guidelines on Endoscopic saphenous vein harvest for coronary artery bypass grafting.

## Totally endoscopic robotically assisted CABG

Another new technique in heart surgery is totally endoscopic robotically assisted CABG, which is a minimally invasive ("keyhole") way of performing a heart bypass.

The surgeon will deflate your lungs and make a number of small incisions between your ribs. Robotic arms, controlled by the surgeon, are used to carry out the surgery. An endoscope is attached to the robotic arms so the surgeon can see inside your body and view the results of the surgery on a screen.

With this type of surgery there are lower rates of wound infection, minimal scarring and a faster recovery time.

As this is a very new technique that has only been carried out on a small number of people, it is difficult to assess how effective and safe it is in the short and long term, and how the outcomes compare with other types of surgery.

If you are considering having a totally endoscopic robotically assisted CABG, it is important you understand that there are still uncertainties about how safe the procedure is and how well it works.

## Recovering from heart bypass surgery

### Leaving hospital

#### Top tips

Don't put up with unnecessary discomfort. Take painkillers as advised by the hospital.

Wear loose, comfortable clothing that doesn't press on your wound.

Make sure you follow periods of activity with rest. Be guided by how you feel and take a short rest or nap when you feel like it. Rest for 30 minutes after eating or before exercising.

Avoid lifting, pushing or pulling anything heavier than 4.5kg (10lb) for six weeks after surgery. This includes carrying children, groceries, suitcases, mowing the lawn, vacuuming and moving furniture.

Eat well according to your appetite. Concentrate on a heart-healthy, low-fat diet and make sure you get your five portions of fruit and vegetables a day.

When you're fully recovered, talk to your doctor about taking regular exercise. You may be eligible for an "exercise prescription".

If you haven't already done so, stop smoking.

For the first day or two after your operation, you will be in an intensive treatment unit so the medical staff can check your progress regularly.

You will be given painkillers and you should tell your doctor or nurse if the pain increases or if you lose a lot of blood.

Recovery after your coronary artery bypass graft (CABG) will take time. It's likely you will feel groggy and disoriented after the procedure.

Everyone recovers at slightly different speeds. As a rule of thumb, you should be able to sit in a chair after one day, walk after three days and walk upstairs after five or six days.

Your stay in hospital will usually be around seven days. It may be longer if the doctors wish to monitor your condition more closely.

Normally, you'd expect to make a full recovery within 12 weeks. However, if you experience complications during or after the surgery, your recovery time is likely to be longer.

Someone from the cardiac rehabilitation team or physiotherapy department will discuss your rehabilitation with you before you go home. They will be able to advise you on the best ways to get back to full health.

## At home

To ease any soreness where the cut was made, you may need to continue taking painkillers at home.

For the first three-to-six weeks, you will probably feel tired. By six weeks, you should be able to do most of the things you want to. By three months, you are likely to have regained full health.

### Caring for your wound

The stitches (sutures) holding your sternum together are permanent. However, the stitches closing your skin will gradually dissolve as the skin heals (within six weeks).

Care for your chest wound by keeping it clean and free from infection. Make sure you protect it from the sun.

You will have a scar where the surgeon cut down your breastbone. This is red at first, but will gradually fade over time.

See your DOCTOR if you experience any of the following symptoms:

severe pain in or around the wound

increased tenderness around the wound

swelling around the wound

any pus coming from the wound

a high temperature

### Side effects

After you have been discharged from hospital, you may experience some side effects as a result of the CABG. These can include:

a loss of appetite

constipation

swelling where the blood vessel graft was removed

feeling tired and having difficulty sleeping

feeling depressed and having mood swings

having muscle pain or back pain

It is natural to feel a bit low after your bypass surgery. You will experience good and bad days, but it is important to remember your recovery will develop in weeks rather than days.

Side effects tend to disappear within four-to-six weeks after your CABG. A full recovery may take a few months or longer, depending on your overall health before the procedure.

Speak with your DOCTOR or contact the British Heart Foundation, who can provide you with details of local support groups.

## Recommendations

A CABG is not a cure for coronary heart disease, so if you don't address the underlying factors that caused your heart disease, your symptoms may return and you may need to have more surgery.

There are five ways you can help reduce your risk of further coronary heart disease:

Quit smoking (if you smoke).

Eat a healthy diet.

Try to lose weight (if you are overweight or obese).

Drink less alcohol.

Take regular exercise.

These lifestyle changes are discussed in more detail below.

### Smoking

If you smoke, it is strongly recommended that you quit as soon as possible. The NHS Smokefree website can provide you with support and advice. Your DOCTOR will also be able to recommend and prescribe medication that can help you give up. Find out more about treatment for quitting smoking.

## Diet

It is recommended that you eat two-to-four portions of oily fish a week. Oily fish contains a type of fatty acid known as omega-3. Omega-3 can help to lower your cholesterol levels.

Good sources of omega-3 include:

herring

sardines

mackerel

salmon

trout

tuna

If you are unable or unwilling to eat oily fish, your DOCTOR may recommend that you take an omega-3 food supplement.

Never take a food supplement without first consulting your DOCTOR. Some supplements, such as beta-carotene, could be harmful.

It is also recommended that you eat a Mediterranean-style diet. This means you should eat plenty of fruit, vegetables and fish, and less meat. Replace butter and cheese with vegetable and plant oils, such as olive oil.

## Weight management

If you are overweight or obese, it is recommended that you lose weight and then maintain a healthy weight using a combination of exercise and a calorie-controlled diet. See Treating obesity for more information.

## Alcohol

If you drink alcohol, do not exceed the recommended daily limits (no more than three-to-four units a day for men and two-to-three units a day for women). A unit of alcohol is roughly half a pint of normal-strength lager, a small glass of wine or a single measure (25ml) of spirits. Regularly exceeding the recommended alcohol limits will raise your blood pressure and cholesterol level, increasing your risk of coronary heart disease.

## Regular physical activity

Once you have fully recovered from the effects of surgery, it is recommended that you do regular physical activity.

Adults should do at least 150 minutes (2 hours and 30 minutes) of moderate-intensity aerobic activity (i.e. cycling or fast walking) every week.

The level of activity should be strenuous enough to leave you slightly breathless.

If you find it difficult to achieve 150 minutes of activity a week, start at a level that you feel comfortable with (for example, around 10 minutes of light exercise a day) and gradually increase the duration and intensity of your activity as your fitness begins to improve.

Read more about fitness and exercise to get advice about the right levels of exercise for your circumstances.

## Medications

It is likely you will be prescribed medications to help reduce your risk of developing coronary heart disease.

Most people are given two types of medications:

anticoagulants, which are used to prevent blood clots

statins, which are used to lower cholesterol levels

### Anticoagulants

Anticoagulants lower the risk of blood clots forming. They reduce the ability of platelets (small cells in the blood) to stick together.

It is usually recommended that you take low-dose aspirin, which is an anticoagulant as well as being a painkiller.

If you are allergic to aspirin, you can be given an alternative anticoagulant medication called clopidogrel. Side effects of clopidogrel include:

diarrhoea

abdominal pain

indigestion

heartburn

You usually need to take clopidogrel for four weeks to twelve months. If you are on aspirin, you may need to take this for the rest of your life.

If you are unable to take either aspirin or clopidogrel, you may be prescribed a different anticoagulant called warfarin. Warfarin is usually prescribed for a maximum of four years.

Excessive bleeding is the most serious side effect of warfarin. Seek immediate medical attention if you experience any of the following side effects:

passing blood in your urine or faeces (stools)

passing black faeces

severe bruising

nosebleeds that last for longer than 10 minutes

blood in your vomit

coughing up blood

unusual headaches

in women, heavy or increased bleeding during your period or any other bleeding from the vagina

Also seek immediate medical attention if you:

are involved in major trauma (an accident)

experience a significant blow to the head

are unable to stop any bleeding

Statins

Statins are a type of medication used to lower your blood cholesterol level. This will help prevent further damage to your coronary arteries and should reduce your risk of having another heart attack.

Statins sometimes have mild side effects, including:

constipation

diarrhoea

headaches

abdominal pain

Occasionally, statins can cause muscle pain, weakness and tenderness. Contact your DOCTOR if you experience these symptoms, as your dosage may need to be adjusted.

## Additional medication

If your CABG was carried out to treat a heart attack, you will be given an additional medication called a beta-blocker. If high blood pressure (hypertension) was thought to be an underlying factor for your coronary heart disease, you may be given a medication called an ACE inhibitor (read more about treating high blood pressure).

## Results of surgery

After your coronary artery bypass graft (CABG), you should feel relief from most of your symptoms, such as chest pain.

Research has shown that 83% of people are free of heart-related symptoms for five years, and 63% for 10 years after the procedure.

However, over time, other arteries or even the grafted arteries may become clogged. This means you will need another CABG or an angioplasty (where the blood vessels are inflated). Four in every 100 people need another bypass operation or a coronary angioplasty within a year.

CABG is not a cure for coronary artery disease. To get the most out of the procedure, try to live a healthy lifestyle and make sure you take any prescribed medication as directed by your DOCTOR.

## Long-term results

As CABGs were not routinely performed until the 1980s, it has been difficult to assess how successful they are in the long term.

This is now beginning to change as information is becoming available on people who had surgery 30 years ago.

One study carried out in Holland found that the average life expectancy after surgery was just under 18 years.

This figure is probably an underestimate of the current average life expectancy due to advances in surgery and the introduction of new medications such as statins.

## Risks of surgery

As with all surgery, especially major surgery, a coronary artery bypass graft (CABG) carries risks of complications.

There are several factors that increase your risk of complications, which are described below.

Your age. People aged 70 and above are at a higher risk of complications.

Having another serious long-term health condition. Having a condition such as diabetes, chronic obstructive pulmonary disease or kidney failure for which dialysis is required (dialysis is when a machine is used to replicate the functions of the kidney) increases your risk.

Being a woman. Women tend to develop coronary artery disease around 10 years later than men. It is thought that this may lead to a higher risk of experiencing complications due to the increased age at the time of surgery.

Having emergency surgery to treat a heart attack. Emergency surgery is always riskier as there is less time to plan the surgery, and the heart can be seriously damaged from the heart attack.

Having three or more vessels grafted. The more complex the operation, the greater the chance that complications will occur.

Being obese. If you are obese the surgeon will have to make a deeper incision to gain access to your heart, and deeper incisions carry a higher risk of becoming infected.

Your surgical team will be able to provide you with more detailed information about your specific risk before surgery takes place.

The most common types of complications that can occur after a CABG are explained below.

### Infection

An infection can occur in the incisions made in the sternum (breastbone). This type of infection can develop deep inside the chest and is known as mediastinitis. Mediastinitis requires treatment with injections of antibiotics.

One study in 2011 looked at the results of 500 CABGs carried out between 2007 and 2010. The study found that mediastinitis occurred in 28 people. Nine people died after developing the condition.

An estimated 14% of people will also develop an infection in their arm or leg, where the blood vessels were removed. These infections are usually a lot less serious and can be treated with antibiotic tablets.

### Loss of kidney function

An estimated 4% of people will experience loss of normal kidney function after a CABG. In most cases, this is only temporary and the kidneys begin working normally after a few days or weeks.

In around one in five cases, the loss of function is permanent and dialysis is required.

### Brain complications

The most common brain complications after a CABG include:

loss of memory

some loss of intellectual function, such as the ability to plan effectively

However, these complications are usually temporary and should improve over time.

The other half involve serious complications, such as:

stroke

coma

serious brain damage

Around 1-2% of people will experience a stroke due to CABG.

### Heart attacks

Both the heart and the coronary arteries that supply the heart with blood are in a vulnerable state after surgery, especially in the first 30 days after a CABG.

Around 5-10% of people will have a heart attack during surgery, or shortly afterwards. Heart attacks are the leading cause of death after a CABG.

### Alternatives to heart bypass

The most common surgical alternative to a coronary artery bypass graft (CABG) is a coronary angioplasty.

#### Coronary angioplasty

During a coronary angioplasty, a long, flexible hollow plastic tube called a catheter (about the width of the lead in a pencil) is inserted into a blood vessel, either in your groin or your arm.

The tip of the catheter is guided under X-ray to the arteries that supply your heart, to the point where the narrowing of the artery has occurred.

A balloon attached to the catheter is then inflated to widen the artery and a small metal tube called a stent is often used to help keep the artery open.

Complications of a coronary angioplasty are uncommon, but can be serious and include:

heart attack, which is estimated to occur in 1 in 100 cases

stroke, which is estimated to occur in 1 in 200 cases

excessive bleeding after the operation, which is estimated to occur in 1 in 200 cases and requires a blood transfusion

death, which is estimated to occur in 1 in 500 cases

A coronary angioplasty may not be recommended if multiple coronary arteries have become blocked and narrowed. It may also not be technically possible if the anatomy of the blood vessels near your heart is abnormal.

CABG or coronary angioplasty?

If you are able to choose between having a coronary angioplasty or a CABG, be aware of the advantages and disadvantages of each technique.

As a coronary angioplasty is non-invasive, you will recover from the operation quicker than you would from a CABG. Angioplasty also has a lower complication rate.

Research has shown that one person in four who has a coronary angioplasty requires further surgery because the widened artery narrows again. However, the number of people who need further surgery will probably fall sharply in the future due to the use of new stents that slowly release a medication that helps prevent the artery from narrowing again.

CABG has a longer recovery time than coronary angioplasty and a higher complication rate. However, only one person in 10 who has a CABG requires further surgery.

Also, research published in 2009 found that CABG is usually a more effective treatment option for people who are over 65 years old and for those with diabetes.

Discuss the benefits and risks of both types of surgery with your surgical team.