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U.O.C. RADIOLOGIA DIAGNOSTICA, INTERVENTISTICA
ed ONCOLOGIA MEDICA INTEGRATA
*Direttore Dott. **Cosmo Damiano Gadaleta***

LINEE GUIDA

adottate dalla

U.O.C. di Radiologia Diagnostica, Interventistica ed Oncologia Medica Integrata

I.R.C.C.S Istituto Tumori Giovanni Paolo II - Bari

PREMESSA

La Radiologia Vascolare ed Interventistica è un'ultra-specialità clinica della Radiologia focalizzata nella diagnosi e nel trattamento mini-invasivo, guidato dall'imaging, di numerose patologie. Abbraccia molteplici procedure diagnostiche e terapeutiche minimamente invasive che interessano patologie vascolari ed extravascolari, benigne e maligne di molti distretti corporei, cerebrale, toracico, addominale fino a quello vascolare periferico.
Spesso (in urgenza, in emergenza o in elezione) le procedure Radiologico-Interventistiche rivestono il ruolo di prima o unica opportunità terapeutica; possono anche costituire semplice palliazione o essere propedeutiche alla chirurgia. Sulla spinta del progresso tecnologico delle apparecchiature radiologiche e della strumentazione specifica, la Radiologia Vascolare ed Interventistica sta vivendo un autentico boom nella espansione del suo campo di interesse.
Il ruolo terapeutico odierno della Radiologia Interventistica è così ampio e così importante sul piano clinico da rendere indispensabile una sua diversa considerazione ed una nuova collocazione nel piano sanitario nazionale.
Il medico Radiologo Interventista interagisce direttamente con i pazienti per quanto riguarda le loro patologie e le opzioni terapeutiche. Per raggiungere questo fine è necessario che il Radiologo Interventista disponga di strutture dove poter eseguire lo screening clinico e dove possa valutare l'appropriatezza all'esecuzione delle procedure interventistiche; disponga di ambienti per la diagnostica per immagini con adeguati requisiti tecnici e strutturali. Il Radiologo Interventista deve possedere requisiti di *clinical competence*, formazione ed accreditamento per l'esecuzione di procedure diagnostiche e terapeutiche. Per ottenere informazioni circa l'outcome clinico del paziente ed essere quindi in grado di valutare l'efficacia della procedura, l'efficienza e l'efficacia della struttura d'appartenenza, il Radiologo Interventista dovrà essere in grado di fornire informazioni cliniche non solo nell'immediatezza della procedura ma anche acquisire notizie a distanza: questo potrà essere attuato sia attraverso controlli clinici diretti sul paziente in via ambulatoriale sia tramite accesso ad informazioni fornite dai medici curanti oppure attingendo dati da archivi informatici costituiti ad hoc. **(Bureau Veritas Certification, Certificazione Standard, Società Italiana di Radiologia Medica Sezione di Radiologia Vascolare ed Interventistica)**

L'Unità Operativa di Radiologia Diagnostica, Interventistica ed Oncologia Medica Integrata dell' I.R.C.C.S Istituto Tumori Giovanni Paolo II Bari si caratterizza per la presenza di medici radiologi interventisti ed oncologi medici che operano in sinergia nella medesima unità operativa, attrezzata con 9 posti letto per la degenza ordinaria e 2 per il day-hospital, al fine di ottimizzare i percorsi diagnostici e terapeutici dei pazienti .

L'Unità Operativa di Radiologia Diagnostica, Interventistica ed Oncologia Medica Integrata dell' I.R.C.C.S Istituto Tumori Giovanni Paolo II Bari nello svolgimento delle proprie attività si ispira ai criteri definiti dal Ministero della Salute nel **Quaderni del Ministero della Salute** n°12 del Novembre-Dicembre 2011, alle **Basi scientifiche e Linee guida definite dall'Istituto Superiore di Sanità** e presenti nel sito internet istituzionale (http://www.iss.it/lgac/docu/cont.php?id=212&lang=1&tipo=%2032) nonché alle **Procedure di Radiologia Interventistica definite a livello Europeo dal CIRSE** (Cardiovascular and Interventional Radiological Society of Europe).

ELENCO PROCEDURE

Ablation

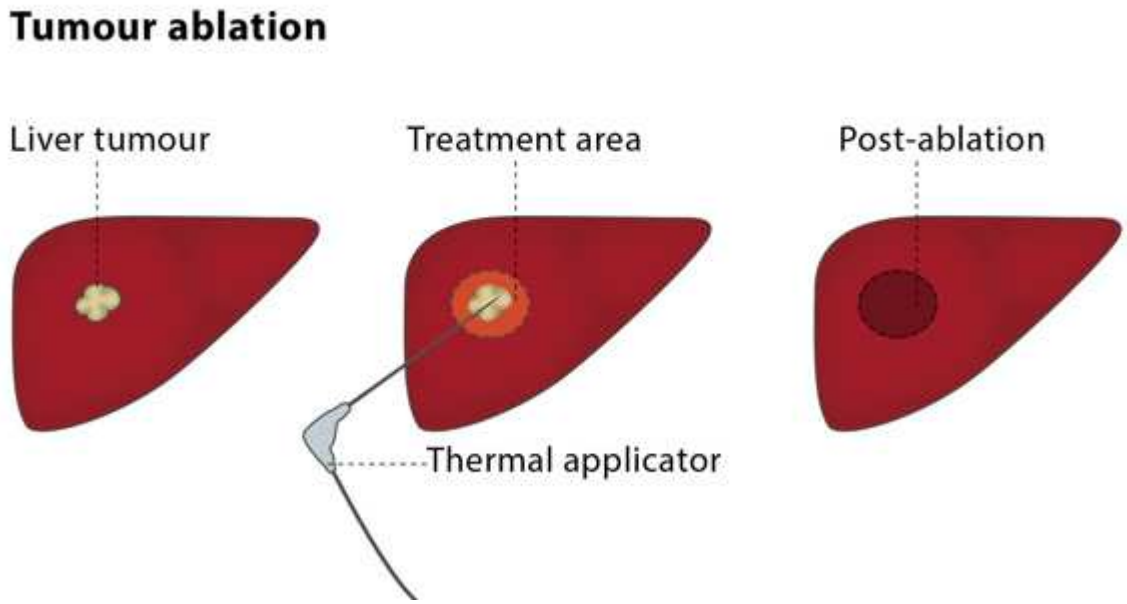
What is percutaneous tumour ablation?

Percutaneous tumour ablation refers to a range of techniques which destroy tumour tissue via needles placed through the skin. Some techniques use chemical agents (such as absolute ethanol), while others use physical agents, which may be thermal (using heat) or non-thermal. Thermal ablation techniques destroy tumours by using different kinds of applicators to freeze the tumour (called cryoablation) or to heat the tumour, such as radiofrequency ablation, laser ablation, microwave ablation and high-intensity focused ultrasound (HIFU).

Non-thermal ablation techniques use other sources of energy to achieve tumour destruction. Coblation uses an electrical plasma field to disintegrate the tissue by rupturing the bonds between the molecules which make up the tumour tissue. Irreversible electroporation uses high voltage electric shocks to pierce the cell membranes and cause cell death.

How does the procedure work?

The procedure will be carried out using image guidance, such as ultrasound, CT or MRI, to control the insertion of the devices and the energy deposition. You will be anaesthetised for the procedure. For most ablation procedures, the interventional radiologist will insert one or more needles or applicators into your tumour to deliver the chemical agent or physical energy.



Why perform it?

The goal of tumour ablation is to destroy the tumour without using surgery. Whether you are suitable for this procedure depends on the size and location of the tumour as well as your clinical situation.

What are the risks?

The insertion of the needle or applicator may cause bleeding or puncture surrounding organs. Another risk is the accidental leakage of the chemical agent or uncontrolled depositing of radiation energy, which may cause serious damage to the surrounding tissues.

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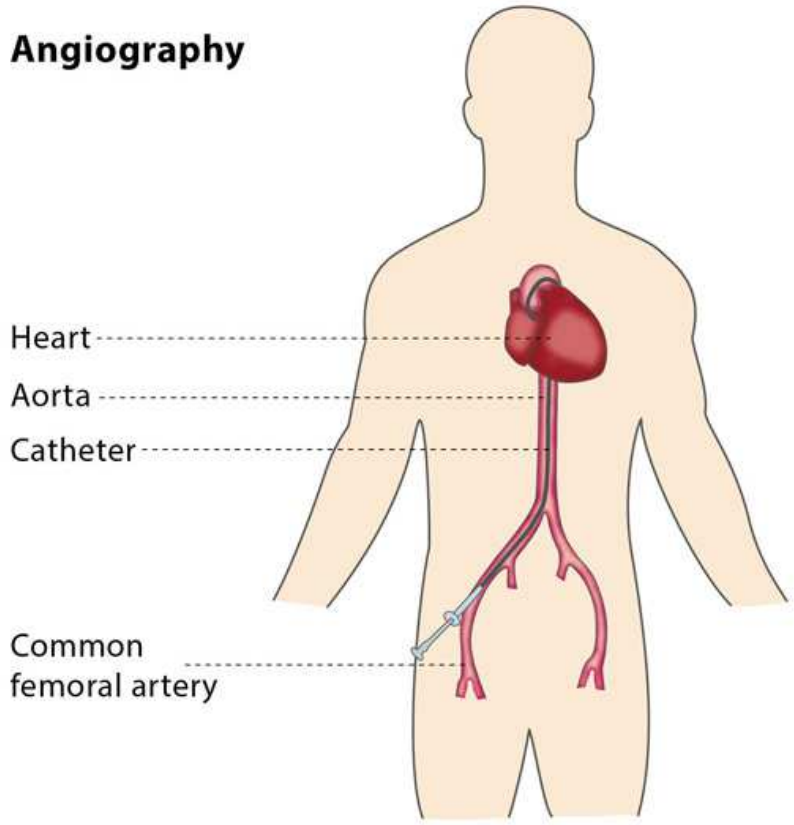
Angiography

What is angiography?

Angiography (also known as arteriography) is a medical imaging technique which is used to visualise the inside of your blood vessels, particularly the arteries.

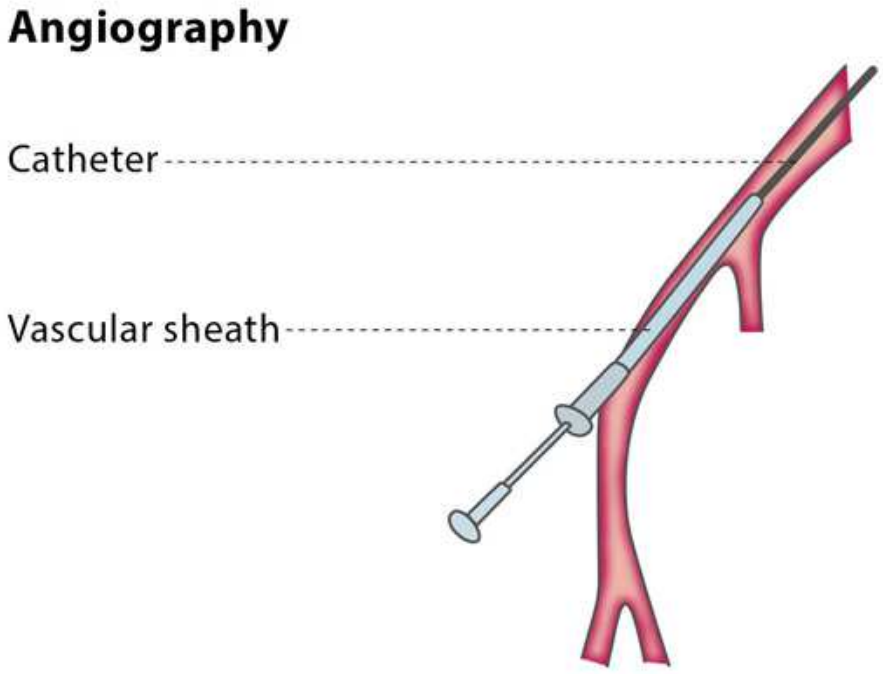
The procedure is carried out by an interventional radiologist, who will inject a radiopaque contrast agent into your blood vessel. This is a substance which will make your blood vessels show up more clearly under imaging. The interventional radiologist will use fluoroscopy for image guidance.

A diagnostic arteriogram is a procedure which involves inserting a needle or catheter into an artery, followed by injection of a contrast agent and then observing the area via imaging.



How does the procedure work?

You will have a local anaesthetic for the procedure. The interventional radiologist will insert a catheter and guidewire into the affected area and will inject the contrast agent so he can visualise the anatomy of your artery and the disease. Occasionally, the interventional radiologist will need to access the artery through your common femoral artery (CFA), which is in your thigh.



Why perform it?

You may be advised to have a diagnostic angiography if your doctor suspects that you have vascular disease, particularly acute pulmonary embolus (a mass which moves around your body and may clog an artery), and other tests have been unclear. A diagnostic angiography can also be used to diagnose and localise a hypervascular tumour (a tumour with a large number of arterial blood vessels).

A further possible reason to have an angiography is as a pre-operative procedure, meaning your doctor would like a more detailed knowledge of your anatomy, as this knowledge is beneficial for procedures such as revascularisation (restoring blood to an area with a restricted blood supply), local tumour resection (surgically removing a tumour) and organ transplantation.

A diagnostic angiography also aids with diagnosis and treatment of post-operative or traumatic complications. It can also be used during procedures such as thrombolysis, angioplasty, stentingand embolisation as it gives the interventional radiologist performing the procedure a clearer view of what they are doing.

What are the risks?

There are a number of possible risks. You may have bruising, a pseudoaneurysm (when a bruise forms outside an artery wall) or a blood clot.

Systemic complications are complications which affect the rest of your organ systems. These occur in less than 5% of cases, and include nausea, vomiting and fainting. In less than 1 in 1000 cases, patients experience a life-threatening reaction to the contrast agent. Mortality associated with the contrast injection occurs in less than 1 in 120,000 cases and this is usually

related to underlying factors, such as severe congestive heart failure, major trauma and general weakness.

Individuals react to the contrast agent in different ways, and it is possible you will experience hives, puffy eyes or wheezing, though these complications occur in fewer than 3% of angiographic procedures. Most reactions are mild, with more than half not needing any therapy at all and less than 1% requiring hospitalisation.

When less strong agents are used, there are fewer reactions. Agents that are more diluted tend to be used in patients with a history of reacting to contrast agents or patients who have more than one other major risk factor.

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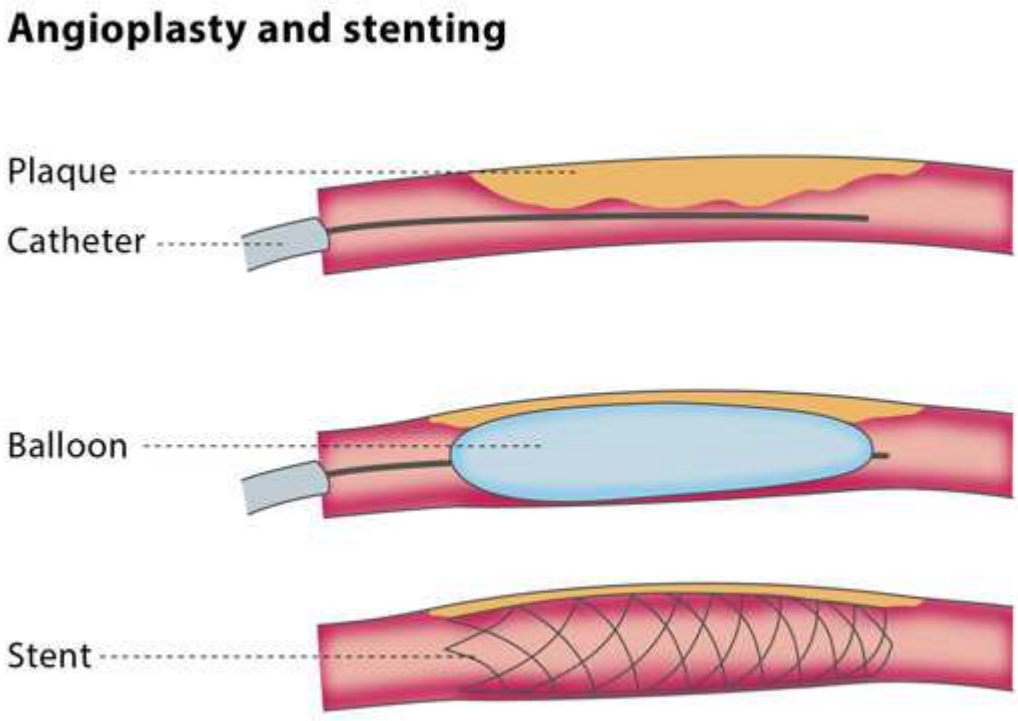
Angioplasty and stenting

What is angioplasty and stenting?

The arteries supplying your head, heart, kidneys and legs may become blocked over time because of smoking, high cholesterol, high blood pressure, diabetes and obesity. These can cause a progressive hardening and occlusion of the vessels (also known as arteriosclerosis). Arteriosclerosis reduces blood flow to your organs as a result of the narrowed or obstructed arteries.

Interventional radiologists are recognised experts in vascular diseases, who can use a technique involving angioplasty and stenting to restore blood flow to the brain, kidneys and legs.

Angioplasty involves the mechanical dilatation of any narrowed or occluded vessel by means of a balloon catheter and a metal stent if necessary. Balloon catheters are tiny empty balloons which are gently inflated to expand the area. A stent is a metal mesh tube that is inserted over a metallic guidewire and positioned at the point of the stenosis or occlusion. Metal stents are permanent implants and act as mechanical scaffolds to support the vessel wall and keep the vessel open.



How does the procedure work?

You will have a local anaesthetic for the procedure. The angioplasty and stenting procedure will last around an hour and tends to be performed as an out-patient procedure, though in some cases patients are admitted to hospital overnight afterwards.

The interventional radiologist will puncture an artery in your thigh with a small needle and will then thread a combination of plastic tubes (called sheaths and catheters) into your arteries. Throughout the procedure, the interventional radiologist will use imaging for guidance. A balloon catheter will be inflated across the narrowed or obstructed part of the vessel; you may experience some discomfort at this point. In some cases, the balloon angioplasty is enough to keep the vessel open, but in other cases the vessel needs more support, so a stent is placed. This means the interventional radiologist will put a stent into the vessel to ensure it stays open.

Your vital signs will be monitored during and after the procedure, and you may be able to eat a light meal later the same day.

Why perform it?

This procedure may be beneficial for you if you suffer from leg pain when walking (intermittent claudication) or if you have a restricted blood supply in your legs (leg ischaemia) as a result of diabetes. The angioplasty and stenting procedure can also be a treatment for peripheral arterial disease and for narrowed or blocked arteries in your kidneys.

Angioplasty and stenting is a way to restore blood flow, relieve pain caused by restricted blood flow, improve kidney function and protect the brain from strokes.

What are the risks?

The success rate of the procedure is usually around 90-95%, though it varies according to the extent and complexity of the blockages in the artery. The majority of patients experience significant clinical improvement, meaning that their pain decreases and any wounds in the area heal better.

In around 10-15% of cases (the rate depends on the location and particular structure of the artery), the affected artery becomes blocked again, known as restenosis. If this happens to you, your symptoms will return and you will need to be treated again.

Minor complications are unusual but include bleeding, bruising and infection. In rare cases, patients have an abdominal haemorrhage, which requires a stay in hospital and patients may need blood transfusions. It is possible that the artery will be damaged by the balloon, causing the vessel to rupture, in which case the interventional radiologist will place a covered stent in the vessel to control any bleeding. The balloon inflation may cause small fragments from the blockage to break off and block other smaller vessels, causing the blood flow to be restricted even more. There is a very low risk of losing a limb or stroke, depending on the location of the artery on which the procedure is carried out.

Although the interventional radiologist will do all they can do minimise the risk of an allergic reaction, there is a risk of a reaction to the dye used in the imaging technique.

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Aspiration

What is aspiration?

Aspiration is the image-guided puncture of a cystic lesion (such as a cyst, an abscess or bruising) or solid lesion (a growth) in order to remove a fluid or tissue sample with a suction needle. The hollow aspiration needles come in different sizes and lengths.

How does the procedure work?

If you are on any medication that prevents blood clotting, you should stop taking it before the procedure, if possible.

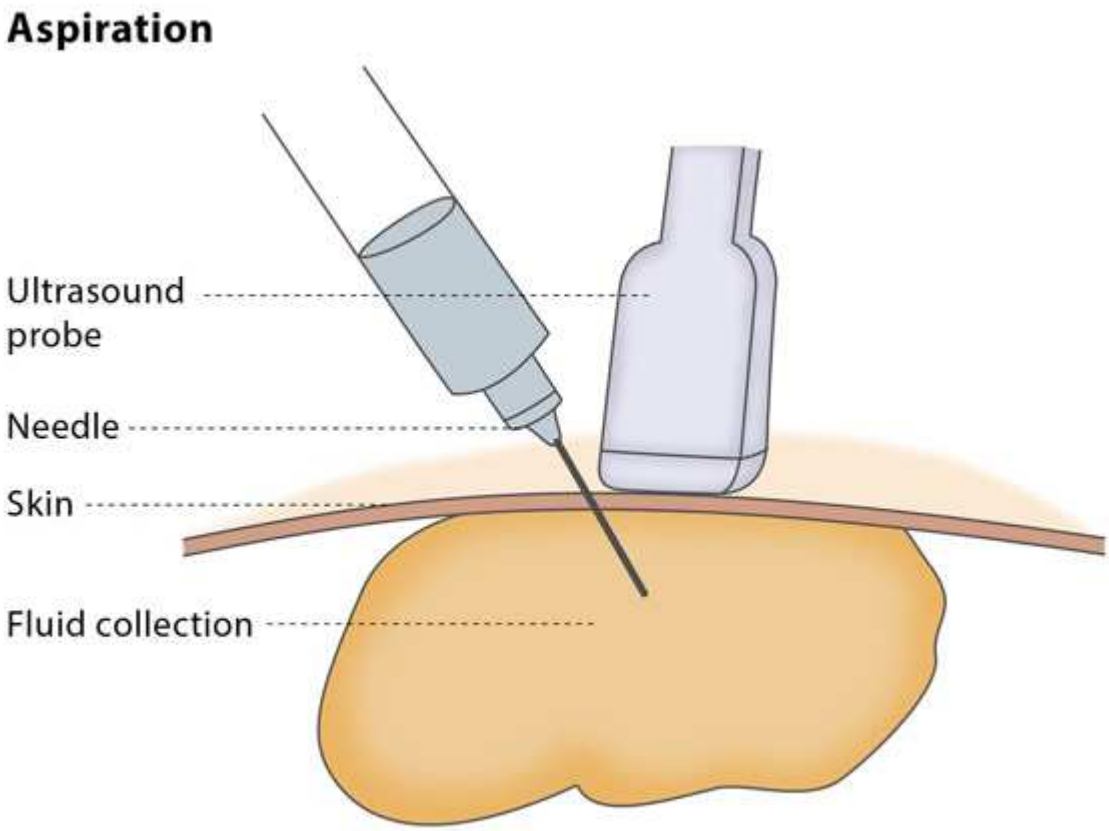
You should not eat anything for at least four hours before the procedure. You may be asked to fast for longer, depending on the puncture and whether the procedure is particularly complicated.

The interventional radiologist may use one of a number of image guidance techniques to plan and monitor the placement of the needle during the aspiration procedure, including ultrasound, CT, MRI and fluoroscopy. You will lie down for the procedure – the exact position you will be asked to lie in depends on the access route that the interventional radiologist will use to safely approach the lesion.

Aspiration is usually performed under local anaesthesia. You may be asked to take antibiotics beforehand to reduce the risk of infection, but this is uncommon.

The procedure will be carried out in a sterile and safe environment. The interventional radiologist will use image guidance to insert a needle until the needle tip is inside the lesion. The interventional radiologist will then insert a syringe to remove the sample or cyst.

Aspiration can be performed as an in-patient or out-patient procedure. The puncture site will be monitored for 2-4 hours to check for bleeding. You may experience some mild discomfort at the puncture site during the first few hours following the procedure.



Why perform it?

You may be recommended to have an aspiration procedure for diagnostic reasons (to provide information on the nature of the lesion) or for therapeutic purposes, such as removal of the fluid collection or cyst. Aspiration is sometimes preferred over drainage of small abscesses (less than 3-4 cm) for which a drainage catheter would be unsuitable.

Aspiration may not be the best option for you if you have a blood clotting disorder or there is no safe access route.

The technical success rate of this procedure is very high, though the clinical success rate can vary depending on the location and nature of the lesion, as well as whether the aspiration procedure is diagnostic or therapeutic.

What are the risks?

Fine needles are used for the procedure, making the complication rate very low. The most common side effects are bruising, infection, and, in the case of lung aspiration procedures, pneumothorax (the collection of air in the space between the chest wall and the lung).

If the aspiration was used to treat an abscess, you may experience procedure-related sepsis (widespread inflammation in the body), but the risk of this is lower than with drainage procedures.

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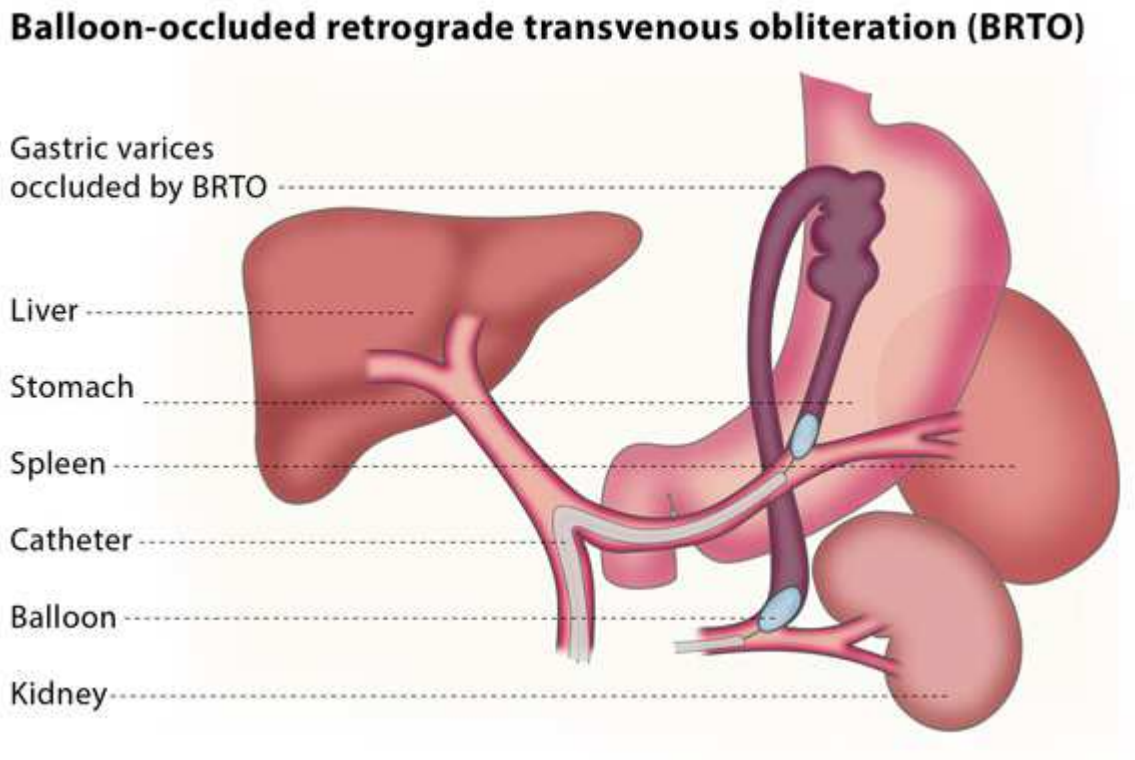
Balloon-occluded retrograde transvenous obliteration (BRTO)

What is BRTO?

Portal hypertension refers to high blood pressure in the liver. One of the major possible complications of portal hypertension is gastric variceal bleeding. Varices are dilated vessels which may rupture, causing variceal bleeding. Gastric variceal bleeding describes the bleeding that occurs when dilated vessels in the stomach rupture, and is associated with high morbidity and mortality rates.

BRTO is a minimally invasive technique that is used to treat gastric variceal bleeding. The procedure involves blocking the dilated vessels, reducing the risk of rupture. It can be used in addition to or as an alternative to TIPS, which is the primary treatment for gastric varices. TIPS aims to relieve the pressure on the dilated vessels by creating new connections between blood vessels in the liver using a shunt.



How does the procedure work?

The interventional radiologist will insert a balloon catheter (a thin, flexible tube with a tiny balloon at one end) through a vein in your thigh or neck and guide the catheter to the liver usingfluoroscopy for guidance. The catheter is then directed to the gastrorenal or gastrocaval shunt and the balloon is expanded to block the shunt.

The interventional radiologist will then perform a venography, which is a type of imaging technique in which X-rays are used to see the vessels clearly. This will allow the interventional radiologist to confirm exactly which vessels need to be treated and if there are any other abnormal or dilated vessels which have not previously been identified. A medication will then be injected into the dilated vessels through the catheter, until they are completely filled. This

medication will remain in the vessel for a short period of time, and will then be removed under fluoroscopy.

Another venography will then be performed, to confirm that the blood flow in the shunt has stopped. Finally, the balloon will be deflated and the interventional radiologist will withdraw the catheter.

Why perform it?

You may be advised to undergo this procedure if you are at risk of or already have gastric variceal bleeding and hepatic encephalopathy as well as a gastrorenal shunt. Hepatic encephalopathy refers to the worsening of brain function that is caused by a damaged liver.

Although TIPS has been considered the standard therapy for gastric varices that have been unresponsive to other treatments, recent reports have stated that BTRO is a less invasive and more effective way to manage varices than shunt surgery or TIPS. TIPS does not always cause the disappearance of gastric varices, while BRTO can in most cases completely destroy these vessels.

BRTO has tended to be used to prevent gastric variceal bleeding. It is also an effective therapy for sclerosis (narrowing) of new portosystemic shunts with the additional complication of hepatic encephalopathy. One of the greatest advantages of BRTO is its preservation of liver function. Moreover, the increase of blood flow in BRTO can also improve liver function in cases where the patient has cirrhosis (scarring of the liver).

What are the risks?

Procedure-related complications are minor and include bleeding and infection. In rare cases, the blockage of the blood to the gastric varices can further increase the pressure on the liver, causing damage to the liver.

The most serious complications of the procedure, however, are related to the medication used to block the vessels, which is called ethanolamine oleate. Inflow of a relatively large amount of ethanolamine oleate can lead to serious complications. These complications include pulmonary embolism (blockage in a lung's main artery), fluid in or around the lungs, hypersensitivity, fever, problems with blood flow to the heart and the formation of small blood clots in vessels throughout the body. Ethanolamine oleate also causes haemolysis, which is the rupturing of red blood cells. To prevent this from occurring, only a low dose of the medication is used.

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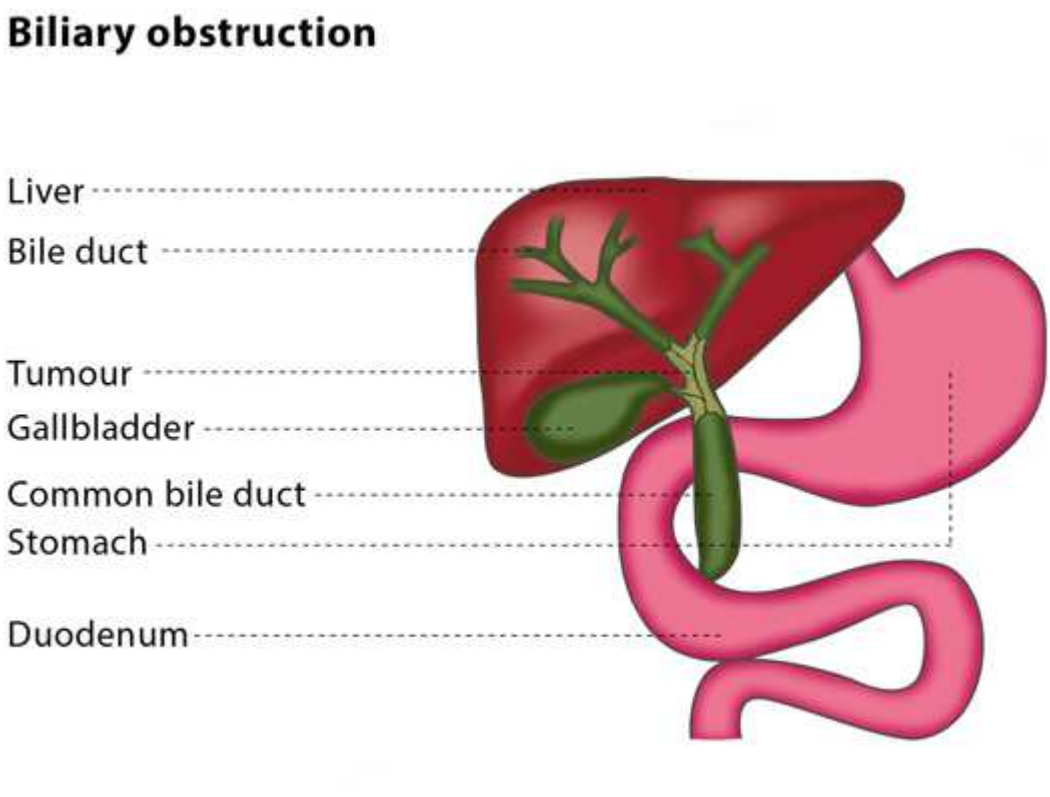
Biliary procedures

What are biliary procedures?

Percutaneous transhepatic biliary drainage (PTCD) is the placement of a drain into bile ducts using needles inserted through the skin. The procedure can be used to treat cholestasis (where the bile cannot flow from the liver to the small intestine), which may be a result of a narrowing or blockage in the bile ducts or of a bile leakage after an operation.

Biliary stenting is performed after biliary drainage if the blockage is malignant (cancerous) to keep the bile duct open and to allow the drain used in PTCD to be removed. This involves putting a stent (a mesh metal tube) into the bile duct, which then functions as a supportive skeleton to prevent the duct from closing.

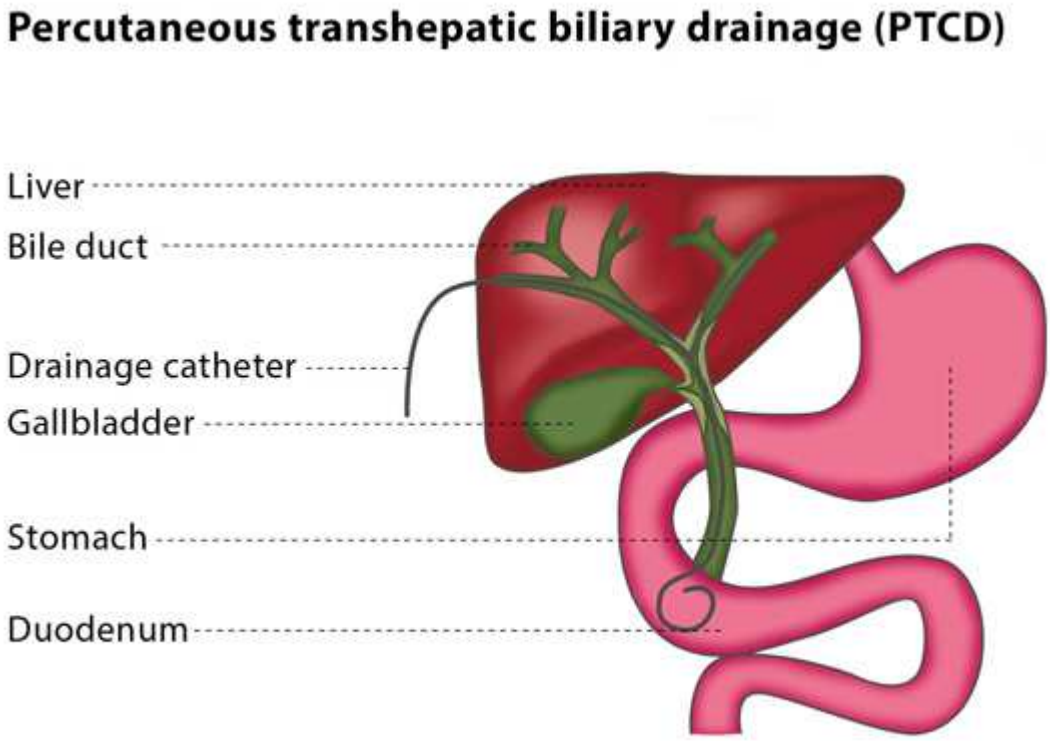
Biliary stone extraction is carried out using percutaneous access to the biliary tree (also known as the biliary tract, this is the path by which bile travels from the liver to the small intestine). Stones can be removed using a tiny basket or with a grasping device. Small and medium-sized stones can be pushed into the first part of the small intestine using a tiny balloon. If the stones are larger than 5 mm, a tiny balloon is used to dilate the entrance to the small intestine.



How does the procedure work?

Puncturing the bile duct is usually performed under sedation and local anaesthesia, though in rare cases and depending on the patient's underlying condition and age, the procedure may be carried out under general anaesthesia.

You will be given antibiotics beforehand to prevent infection. The procedure will be carried out in a sterile room while you lie on your back. The interventional radiologist will perform the procedure under X-ray guidance, though sometimes ultrasound is used in addition to fluoroscopy to confirm the direction for the puncture.



The interventional radiologist will pass a small needle through your skin into either your left or your right liver lobe. If it is the right liver lobe which is punctured, this will be between your ribs and in the middle of your side. If it is your left liver lobe which is punctured, the interventional radiologist will choose an entry site below the tip of your breastbone.

As the needle is withdrawn, the interventional radiologist will gently inject a diluted contrast agent, a substance which makes the area show up better under imaging. This means that, when the needle enters the bile duct, the tubular structure is more clearly visible under imaging. The interventional radiologist will then insert a guidewire into the bile duct, which is followed by a catheter. The guidewire and catheter are used together to move past the blockage and reach the intestine.

Once the interventional radiologist has removed this catheter, they will dilate the blocked liver tract so that the drainage catheter can be placed. A drainage catheter has multiple holes in its side which are used to drain the bile in two directions, outwards into a bag and inwards into the intestine. The bag will be attached to the skin and left in place for a few days until the biliary tract has decompressed. During the period when the bag is attached, the catheter is flushed 2-3 times a day with sodium chloride to keep the side-holes open.

Why perform it?

If you are unsuitable for endoscopic procedures, PTCD is a possible alternative for you. It can be used to decompress the biliary ducts if they are blocked by a mass lesion or a stone, or to bridge a hole if you experience bile leakage.

What are the risks?

One of the most common complications is bleeding into the biliary tract, usually from a vein. This normally does not need treatment as it heals by itself. A less frequent complication is major bleeding requiring a blood infusion or further interventions, such as surgery or embolisation of the vessels.

If you have a biliary infection, the PTCD procedure may cause fever, chills and septicaemia. A further risk is the possibility that the areas around the tract will be punctured during the procedure, such as the gallbladder or bowel.

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Biopsy

What is an image-guided biopsy?

An image-guided biopsy aims to provide diagnostic information by obtaining a sample of tissue from under the skin using imaging to navigate. The interventional radiologist will perform this procedure using special cutting needles which are available in a variety of diameters and lengths. The tissue sampled will usually be examined under a microscope by a pathologist and can also be analysed chemically.

How does the procedure work?

If you are on any medication that prevents blood clotting, you will stop taking it before the procedure, if possible.

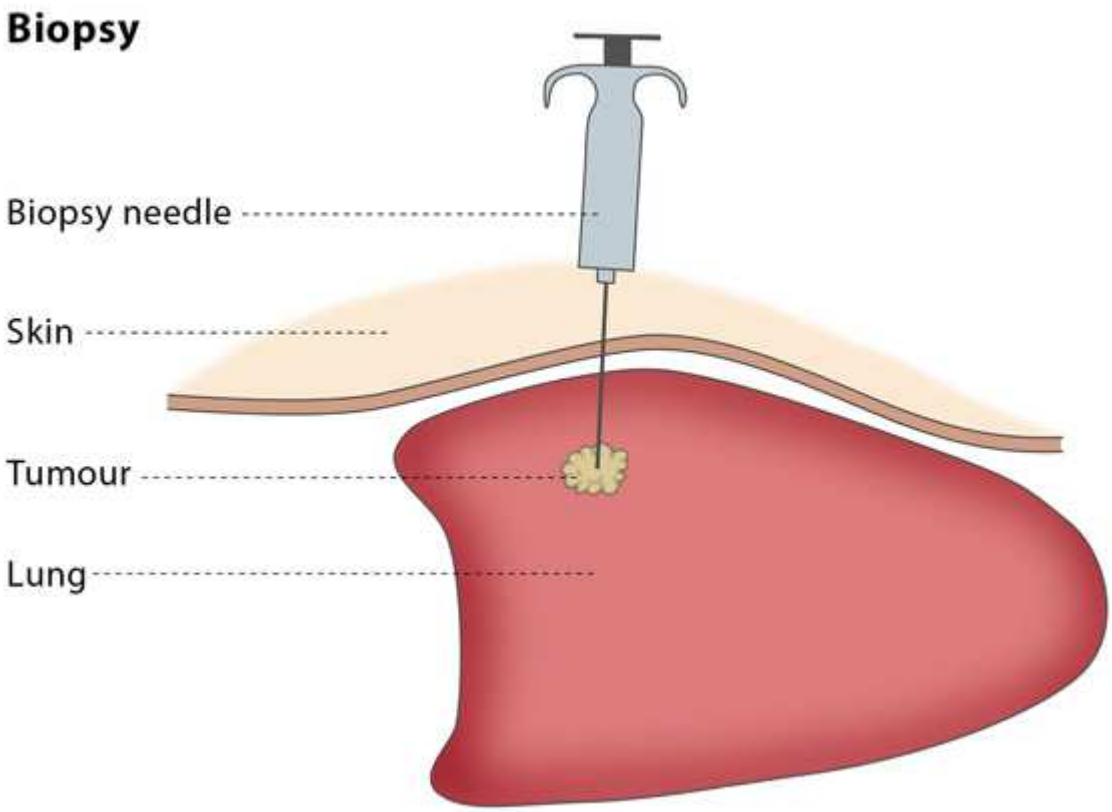
You should not eat anything for at least four hours before the procedure starts. You may be asked to fast for longer, depending on the puncture and the complexity of your particular case. Before the procedure, the interventional radiologist will usually place a needle in your vein to make access easier during the procedure.

The interventional radiologist may use one of a number of image-guidance techniques to plan and monitor the placement of the needle during the aspiration procedure, including ultrasound, CT, MRI and fluoroscopy. This depends on the location and nature of the lesion.

Most biopsy procedures are performed under local anaesthesia or conscious sedation, so you will be awake but feel no pain. You may be asked to take antibiotics beforehand to reduce the risk of infection, but this is uncommon. You will lie down for the procedure – the exact position you will be asked to lie in depends on the access route that the interventional radiologist will use to safely approach the lesion.

The procedure will be carried out in a sterile and safe environment. The interventional radiologist will choose which type of needle to use according to the organ and tissue type which needs to be sampled, such as bone, soft tissue, lung, etc. The interventional radiologist will insert the needle and will guide it using imaging until the needle tip can be seen inside the lesion.

An image-guided biopsy can be performed as an in-patient or out-patient procedure. The site of the puncture and your vital signs will be monitored for 4-6 hours following the procedure. You will experience some mild discomfort around the puncture site during this time. If you undergo a lung biopsy, you will be given a chest X-ray 6-8 hours after the procedure to ensure that no air has been trapped in the cavity between your chest wall and your lungs. In most cases, you will be allowed to drink water a few hours after the biopsy procedure.



Why perform it?

If you have a lesion and your doctor needs further information to make a diagnosis, you may be referred for an image-guided biopsy.

There are a number of factors which may make the procedure unsuitable for you, including if you have a blood clotting disorder, if there is no safe route for the interventional radiologist to access the lesion, or if you have already been diagnosed using other procedures, such as diagnostic imaging.

The success rate of the biopsy procedure can vary depending on the location of the lesion and the type of needle used. Image guidance is used to confirm that the needle is placed correctly inside the lesion and to help avoid complications.

What are the risks?

If the interventional radiologist uses a small bone needle, the complication rate is low. The most common complications are bruising and infection. If you have had a lung biopsy there is a risk of pneumothorax, which means that air fills the gap between the lungs and the chest wall.

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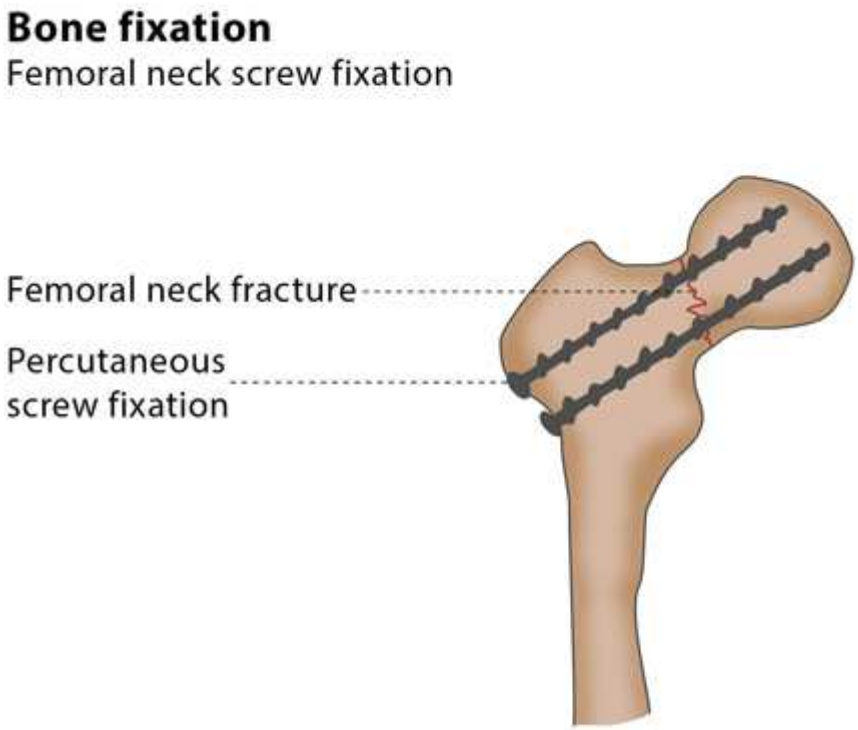
Bone augmentation

What is bone augmentation?

Bone augmentation techniques aim to stabilise a weakened or a fractured bone. These minimally invasive techniques include injection of bone cement designed for this purpose, the insertion of metallic rods or screws, or a combination of both techniques, depending on the location and on the type of fracture.



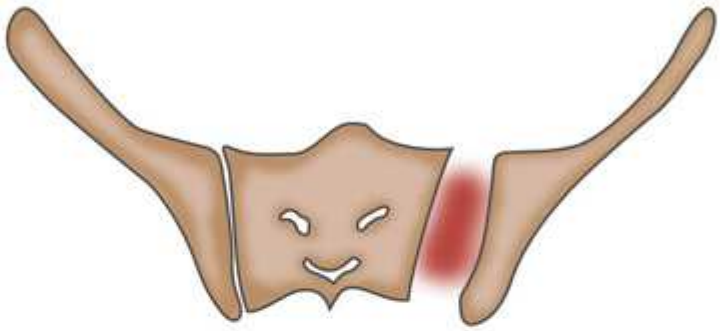
How does the procedure work?

The interventional radiologist will use image guidance to precisely insert the devices used to reinforce a weakened or fractured bone.

Bone fixation

Pelvic bone screw fixation

a) Sacroiliac disruption



b) Sacroiliac closed after screw fixation

Why perform it?

Percutaneous image-guided bone fixation is performed to stabilise a weakened bone. The procedure is a minimally invasive alternative to conventional surgery and it may be recommended to treat a range of conditions, including bone metastases, osteoporotic fractures or fractures caused by trauma.

What are the risks?

Placing needles inside bone carries the risk of bleeding and infection. In rare cases, the surrounding structures such as nerves or vessels are damaged. Occasionally, optimal

stabilisation cannot be achieved, which can cause a delayed fracture to another bone. You are especially at risk for this if you have advanced bone cancer.

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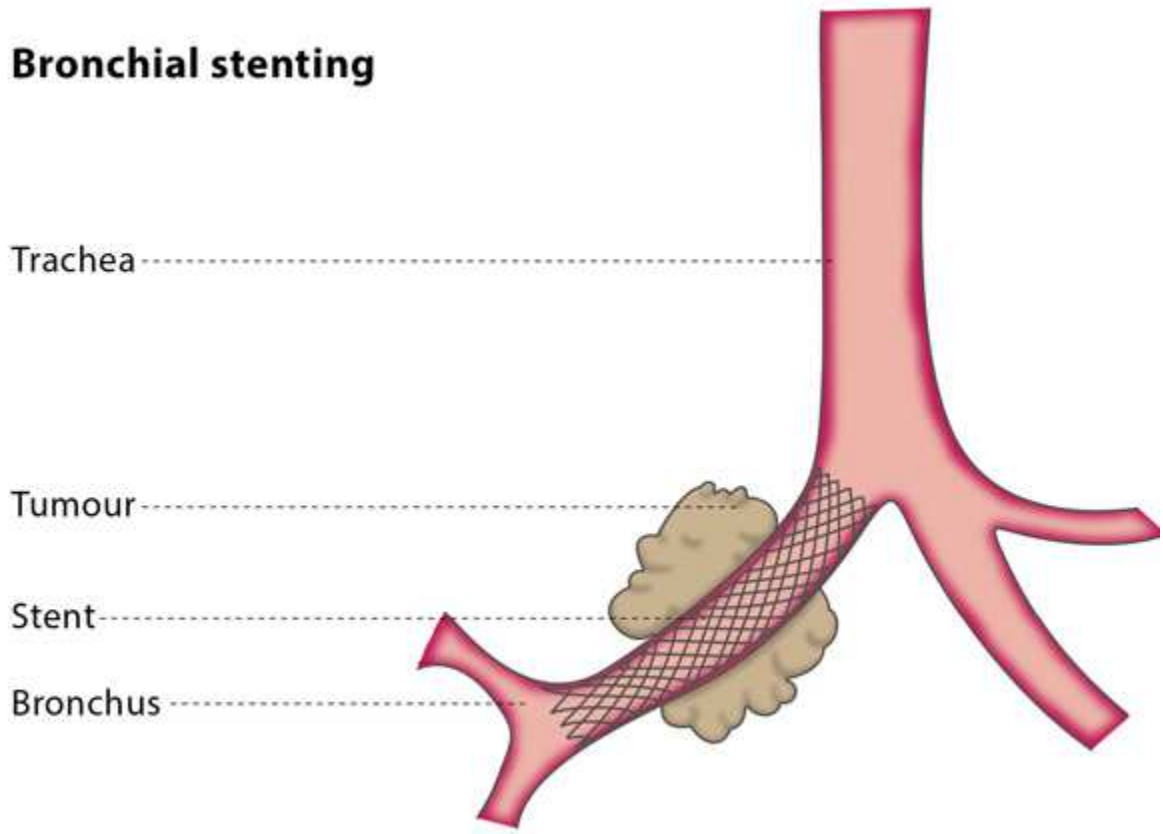
Bronchial stenting

What is tracheobronchial stenting?

Your airway system consists of the trachea, which is then divided into different sections, called the main stem and segmental bronchi, which supply both your lungs. Diseases which block the airways are very dangerous, as they may cause the lungs to collapse and prevent the patient from inhaling enough air, causing death.

A stent is a metal mesh tube that is inserted over a guidewire and placed in a vessel in order to keep it clear. Tracheobronchial stenting refers to the placing of a stent in a patient's airways to treat or prevent restricted airflow. The procedure is minimally invasive and is most often used to relieve symptoms caused by cancerous tumours blocking airways.



Why perform it?

If you have a cancerous growth in your trachea or bronchi which cannot be operated on and is affecting your breathing, having a stent placed may relieve your breathlessness while you undergo chemotherapy and/or radiotherapy.

In some cases, a stent is placed to treat fistulas (holes) that have developed in the airway system or to treat blockages in the airway that are not cancerous. If the

patient is a child, the use of biodegradable stents, which are absorbed over time, is recommended.

How does the procedure work?

You will have a general anaesthetic for the procedure, which will be carried out in an operating theatre by a team of interventional radiologists and surgeons. The doctors will use fluoroscopy and a bronchoscope (a tiny camera inserted into your body on a tube) for guidance.

An interventional radiologist will thread a guidewire into your airway system so that the stent can be guided to the correct location. Once placed in the affected area, the stent will expand, clearing the airway.

An oncologist may take a tissue sample before the stent is placed, if this would be beneficial in planning your optimal treatment.

In most cases, patients stay in hospital overnight, and you will be discharged from hospital once you have had a consultation with the thoracic and oncology teams who will provide your follow-up care.

What are the risks?

The majority of cases (over 95%) are successful, and most patients (70-80%) see significant clinical improvement 24-48 hours after the procedure. In 10-20% of cases, the stent migrates, meaning it moves to another part of the body. If this occurs, the stent will be removed and replaced with a new stent.

Other possible complications include bleeding, chest infection, temporary chest pain and the risk of the airways reacting to the stents, which can cause spasm and breathlessness.

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Closure devices

What are vascular closure devices?

Once a minimally invasive procedure has been performed, the interventional radiologist will remove the devices used during the procedure, such as catheters or sheaths. At this point, patients usually experience some minor bleeding at the access point for the procedure. Physicians tend to stop this bleeding using a technique called manual compression, in which they manually apply pressure to the site for 15-20 minutes. The patient then has to stay immobile for 4-6 hours.

Although this method generally works well, it is time-consuming and often uncomfortable for the patient. Further, this technique is not effective in some patients.

Vascular closure devices provide an alternative to manual compression. First introduced in the early 1990s, they are specially designed to stop bleeding more quickly, which is both more comfortable for patients and allows them to start moving around sooner.

How do closure devices work?

Vascular closure devices are inserted at the end of a procedure. The devices available fall into two categories, passive closure devices and active closure devices. Passive vascular closure devices stop the bleeding with the use of material that leads to the formation of blood clots or by way of mechanical compression. However, these do not stop bleeding particularly rapidly and patients must remain immobile for the same amount of time as with manual compression.

Active vascular closure devices use a variety of methods to directly close the entry site in the artery. For example, such devices include collagen-based and suture-based products or clips. These effectively close the access site, but often require part of the device to remain in the artery, which can cause complications.

Newer devices use materials, such as polyethylene glycol, that dissolve after a short period of time. These are applied to the outside of the artery only and so are considered a more gentle option.

Why use them?

Using vascular closure devices causes less pain and discomfort to patients compared to manual compression. These devices also stop bleeding more quickly, meaning that, following a procedure, patients can move about and leave the hospital sooner than if other techniques had been used.

The devices can be especially beneficial for older and less healthy patients, who may be unable to lie flat on their backs for several hours. They are also a welcome alternative for patients for whom manual compression is generally not effective, such as those who suffer from blood clotting disorders or who are obese. Similarly, they are

useful for patients who undergo procedures that require large arterial access (such as endovascular aortic aneurysm repair). For these patients, manual compression can be difficult and usually does not work well, so vascular closure devices provide a better option.

What are the risks?

Complications can occur, but these are rare. The most common complication is that the device fails (which occurs in less than 6% of cases). When this happens, the physician must immediately resort to manual compression. Sometimes the bleeding occurs after some delay, but this also involves applying simple manual compression to the site. Most of the devices entail a small risk of a blockage in the target artery. The risk of infection is very low (less than 1%).

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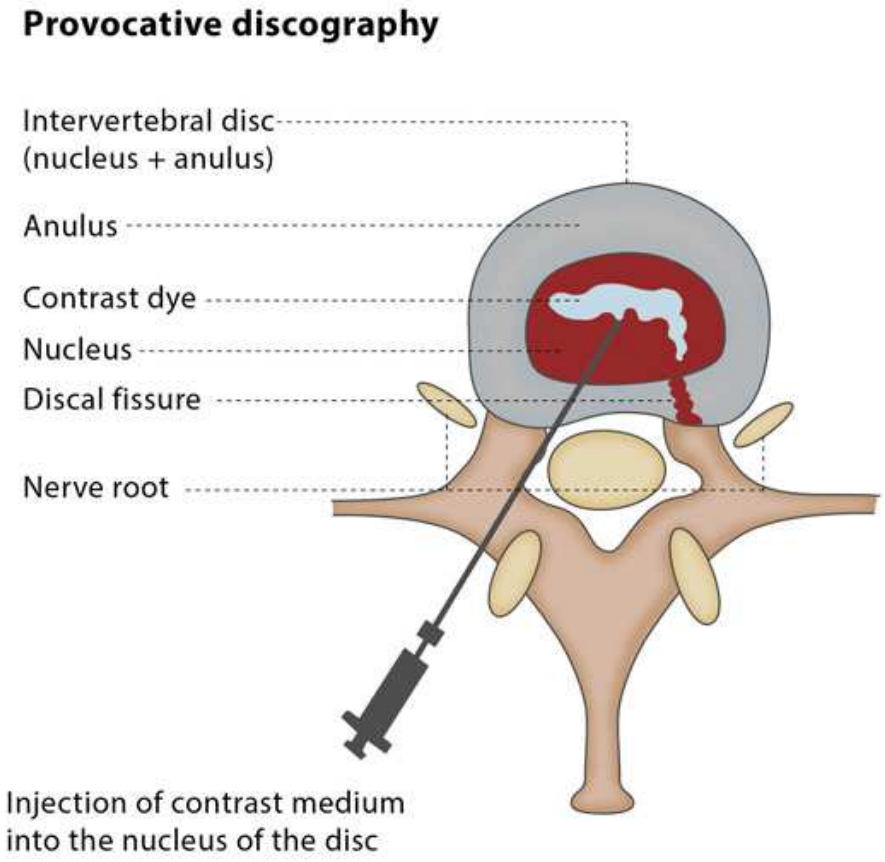
Discography

What is provocative discography?

Provocative discography is an image-guided procedure in which a radiological contrast agent is injected into the intervertebral disc (which is between two vertebrae). The contrast agent makes the area visible under imaging and so provides both anatomical and functional information about the disc.

How does the procedure work?

If the procedure is performed between two vertebrae, the interventional radiologist will insert a thin needle into the intervertebral disc under image guidance. If the procedure is performed on a disc in your neck, the entry point will be at the front or side of your neck, whereas if the disc being treated is lower down, the entry point will be in your back.



Once the interventional radiologist has completed the contrast injection, they will assess the shape of the disc on radiographs or a CT scanner. The contrast injection also increases the pressure between the discs, meaning that the functional evaluation in the discography procedure consists of pain induced by the interventional radiologist and the assessment of your response.

Why perform it?

You may be suitable for a provocative discography if you are suffering from persistent neck or back pain which has not responded to conservative treatment and if non-invasive tests such as MRI have not provided sufficient information about your condition.

You should only undergo a discography if you are being considered for surgery, as the anatomical and functional results of the procedure influence the surgical decision-making process.

What are the risks?

The reported rate of complications following the procedure is less than 1%. The most serious complication is infection. When puncturing an intervertebral disc, needle contact with a nerve may occur but this generally causes only temporary symptoms.

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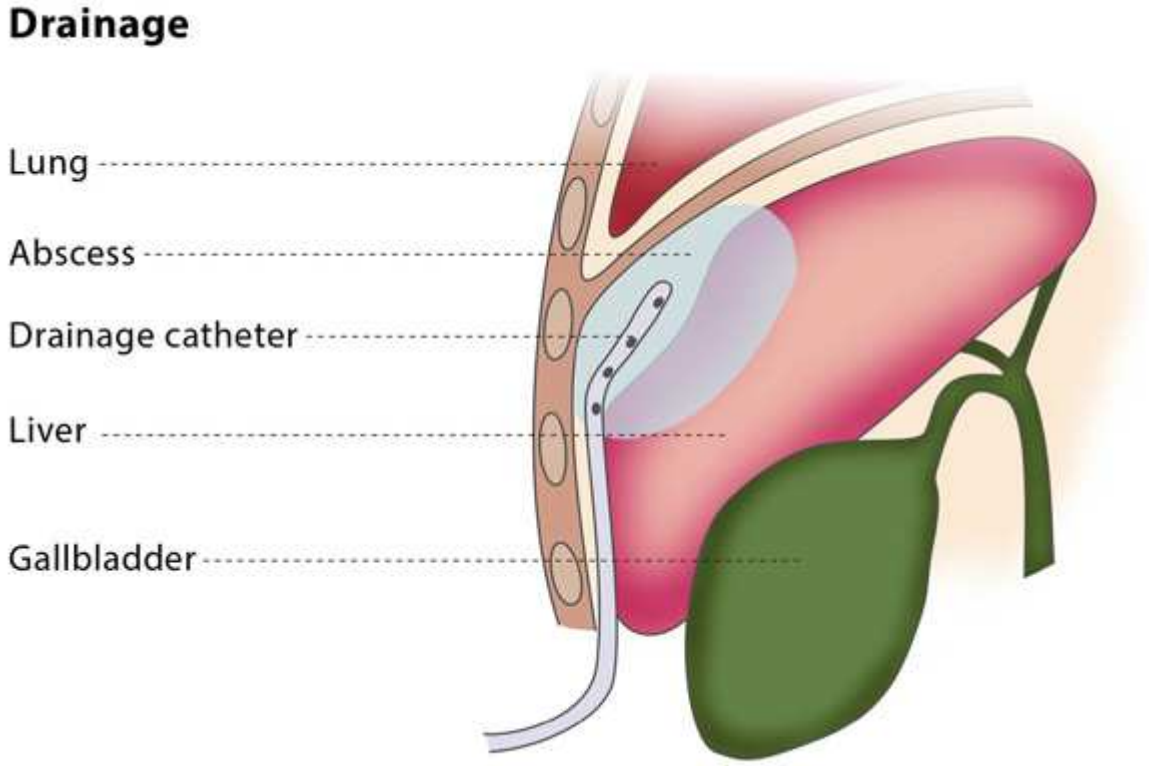
Drainage

What is image-guided percutaneous drainage?

Image-guided percutaneous drainage involves using a catheter (a thin tube) to drain an abscess or a collection of fluid or air under image guidance. The interventional radiologist will insert a flexible catheter through a small cut in your skin and will guide the catheter to the collection of fluid or air. The fluid or air will then be collected in a drainage bag.

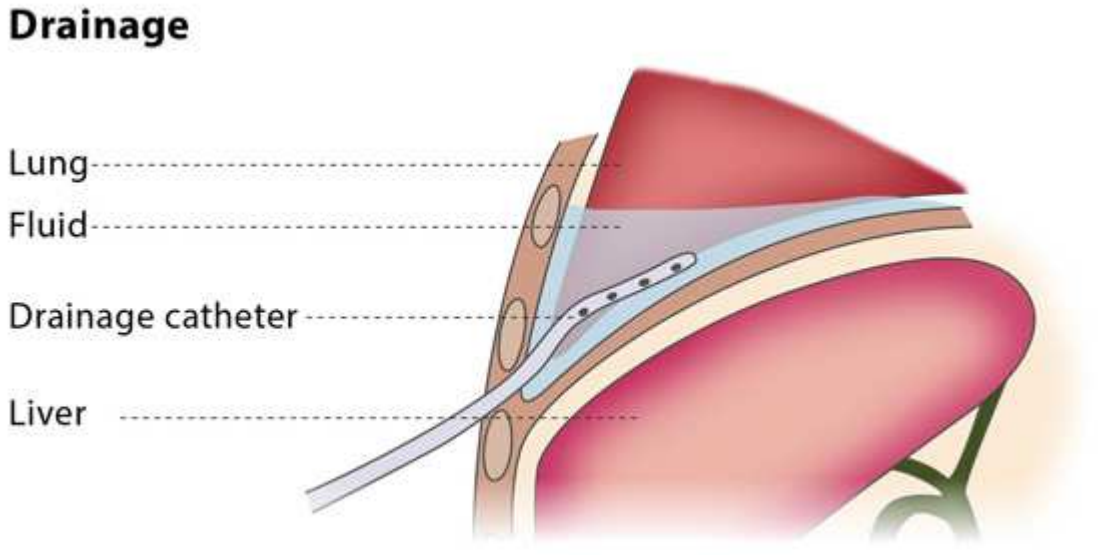
Drainage catheters are available in a variety of sizes, shapes and types. The interventional radiologist will choose the catheter according to the type of fluid, along with other factors.



How does the procedure work?

If you are on any medication that prevents blood clotting, you will stop taking it before the procedure, if possible.

You should not eat anything for at least four hours before the procedure starts. You may be asked to fast for longer, depending on the puncture and difficulty of your particular case. Before the procedure, the interventional radiologist will usually place a needle in your vein to make access easier during the procedure.

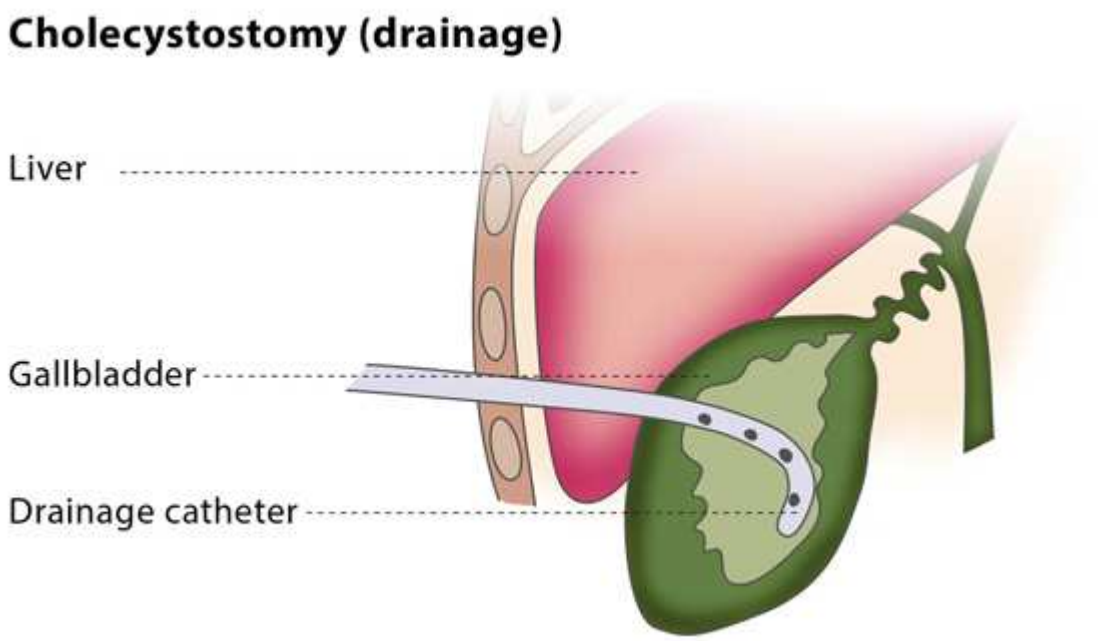


Most drainage procedures are performed under local anaesthesia or conscious sedation, so you will be awake but feel no pain. You may be asked to take antibiotics beforehand to reduce the risk of infection, but this is uncommon. You will lie down for the procedure – the exact position you will be asked to lie in depends on the access route that the interventional radiologist will use to safely approach the lesion.

According to the location of the fluid/air collection or abscess, the interventional radiologist will choose an imaging technique, such as ultrasonography, CT, magnetic resonance or fluoroscopy.

The procedure will be carried out in a sterile and safe environment. The interventional radiologist will use a direct puncture to place a hollow needle called a trocar.

Percutaneous drainage can be performed as an in-patient or out-patient procedure. The puncture site and your vital signs will be monitored for 4-6 hours. You will experience some mild discomfort around the puncture site in the first few hours after the procedure. The interventional radiologist will periodically follow up using imaging to confirm that the abscess or fluid collection has gone.



Why perform it?

Percutaneous drainage is recommended to treat fluid or air collections which produce symptoms (such as pneumothorax, which is the collection of air or gas in the gap between the chest wall and the lungs). It can also treat recurrent fluid collections by using medication and is a minimally invasive method of draining abscesses.

This procedure may not be suitable for you if you suffer from a blood clotting disorder or if the interventional radiologist cannot find a safe access route for the catheter.

The percutaneous drainage procedure cures infected fluid/air collections in over 80% of patients, though failure occurs in 5-10% of patients.

Because of the wide range of types of uninfected collections, the success rate of drainage for uninfected collections is highly variable.

What are the risks?

There are some risks associated with the procedure. Major complications include bacteraemia (the presence of bacteria in the blood, which occurs in 2-5% of cases) and septic shock (caused by severe infection and sepsis, which occurs in 1-2% of cases). Other complications include the risk of haemorrhage and superinfection (infection of a sterile collection of fluid, following a previous infection).

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Embolisation for bleeding

What is the embolisation procedure for bleeding?

Embolisation is a minimally invasive treatment which uses materials to block the affected vessel and so stop bleeding. There are a number of possible causes of bleeding severe enough to require this treatment, including trauma, blood clotting disorders, infections, anatomical defects and tumours.

How does the procedure work?

The procedure aims to stop blood flowing to the source of the bleeding whilst also preserving the blood flow to the surrounding area.

The interventional radiologist will usually insert a 2-3 mm tube into your groin and will guide this to the affected blood vessel. They will then insert small resin particles (microparticles), glue or small metal spirals (coils) into the bleeding vessel or vessels. This causes the vessel or vessels to become blocked and so stops the bleeding.

Why perform it?

The main reason for treating bleeding is that if too much blood is lost, the patient may go into life-threatening shock.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility that microparticles, glue or the coils may move to other areas of the body and block other artery branches.

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Embolisation for haemoptysis

What is haemoptysis embolisation?

Haemoptysis is the medical term for coughing up blood or bloody mucus from your lungs or airway. Massive haemoptysis is defined as 200-600 ml of blood coughed up within a period of 24 hours or less. The causes of haemoptysis include blunt trauma, infections, tumours and defects in your lung.

Haemoptysis embolisation is a minimally invasive procedure which deliberately blocks the bleeding vessel, such as the bronchial arteries or pulmonary veins.

How does the procedure work?

The aim of the procedure is to stop the blood flowing into the veins which are causing the haemoptysis whilst also preserving blood flow to the surrounding area.

The interventional radiologist will insert a 2-3 mm tube into your groin and will guide it under imaging to the affected blood vessel. Small resin particles (microparticles) or small metal spirals (coils) will be inserted into the bleeding vessel or vessels. This causes the vessel or vessels to become blocked and so stops the bleeding.

Why perform it?

There are two main reasons why it is important to treat haemoptysis. If too much blood is lost, the patient may go into shock, which is life-threatening. There is also the risk of the patient inhaling the blood: if the patient breathes in too much blood, they may drown.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility that microparticles or the coils may move to other areas of the body and block other artery branches.

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Embolisation for pelvic congestion syndrome

What is embolisation for pelvic congestion syndrome?

Pelvic congestion syndrome is caused by varicose veins inside the patient's lower abdomen and causes chronic pain, which may become worse when standing. A minimally invasive treatment for pelvic congestion syndrome is embolisation, which reduces blood flow to the enlarged veins by blocking vessels supplying these veins.

How does the procedure work?

The procedure reduces blood flow to the varicose veins, which relieves the symptoms of pelvic congestion syndrome.

The interventional radiologist will insert a 2-3 mm catheter (tube) into a blood vessel in your groin and will guide the catheter to the affected blood vessel using image guidance. The interventional radiologist will usually use glue or coils (small metal spirals) to block the veins supplying the enlarged veins, though sometimes they will use an injection of alcohol (sclerotherapy). This causes blood to be diverted away from the affected veins and so reduces the symptoms of pelvic congestion syndrome.

Why perform it?

It is advised that you undergo treatment for pelvic congestion syndrome if you are experiencing symptoms which cause you discomfort, such as pain in your lower abdomen or a feeling of heaviness in your bladder area.

What are the risks?

Minor risks include bruising in the groin. More significant risks include glue or coils moving to other areas of your body and blocking other vessels.

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Embolisation for uterine fibroids

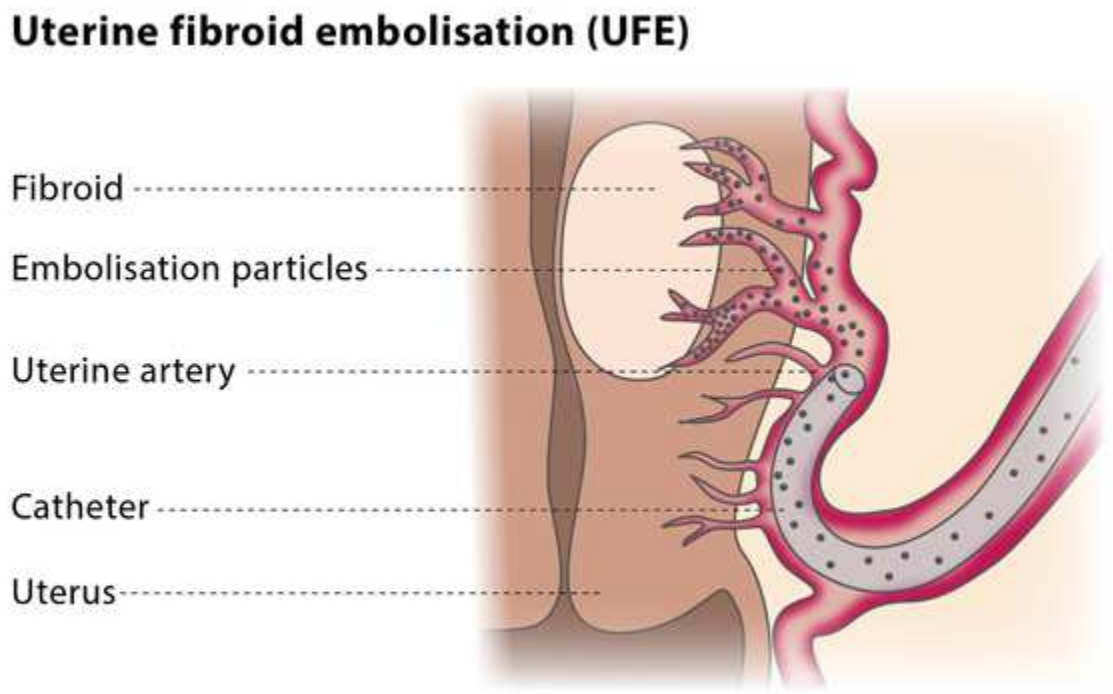
What is uterine fibroid embolisation?

Uterine fibroids cause a number of unpleasant symptoms, including pelvic pain and bleeding. Uterine fibroid embolisation is a minimally invasive procedure which aims to relieve the symptoms by preventing blood flow to the fibroids.

How does the procedure work?

The aim of the procedure is to stop blood flowing into the vessels which supply the fibroids whilst preserving blood flow to the surrounding area.

The interventional radiologist will usually insert a 2-3 mm catheter (tube) into a blood vessel in your groin and will use image guidance to guide the catheter to each uterine artery (right and left). They will then inject microparticles (particles smaller than a grain of sand), into the uterine arteries to stop the blood flowing to the fibroids.



Why perform it?

Uterine fibroid embolisation is performed to reduce the symptoms caused by fibroids whilst avoiding surgical methods.

Patient selection should always be performed by a gynaecologist, so if you are interested in seeing if you would be suitable for this procedure, you are advised to discuss this with your gynaecologist.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility that the glue or coils may move to other areas of the body and block other artery branches.

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Embolisation for varicoceles

What is varicocele embolisation?

Varicocele embolisation is a minimally invasive procedure which is used to treat abnormal enlargement of the veins which drain the testicles, which are known as varicoceles. The procedure works by blocking the blood flow to the enlarged vein, which reduces pressure on the varicoceles.

How does the procedure work?

The interventional radiologist will usually insert a 2-3 mm catheter (tube) into a blood vessel in your groin and will then guide the catheter under image guidance to the affected blood vessel. This will be followed by the interventional radiologist delivering glue or coils (small metal spirals) to the enlarged vessels, although in some cases a direct injection of alcohol can be used, known assclerotherapy. This will relieve your symptoms by blocking the blood vessel and reducing blood flow.

Why perform it?

If you have a varicocele, it is recommended that you seek treatment when you experience clinical symptoms such as pain in your scrotum, a feeling of heaviness in your testicle, you can see or feel the enlarged veins within your scrotum, or you experience infertility as a consequence of the varicocele.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility that the glue or coils may move to other areas of the body and block other artery branches.

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Embolisation for vascular malformations

What is embolisation for vascular malformations?

The embolisation procedure for treating vascular malformations is a minimally invasive method which aims to block blood vessel abnormalities which are causing the patient discomfort. The procedure is performed using specially designed materials, known as embolic agents.

How does the procedure work?

The interventional radiologist will insert a 2-3 mm catheter (tube) into a blood vessel in your groin and will then move the catheter under image guidance to the arteries which lead to the vascular malformation. When the particular vessel which is supplying the blood to the vascular malformation is found, the interventional radiologist will insert a smaller catheter. They will then insert glue or small metal spirals (coils) into this vessel, which causes the vessel or vessels to become blocked.

Why perform it?

There are many reasons why a vascular malformation embolisation may be beneficial for you. If you experience pain, recurrent bleeding or have aesthetic or functional problems as a result of the vascular malformation, it is important that the vascular malformation be treated.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility that the glue or coils may move to other areas of the body and block other artery branches.

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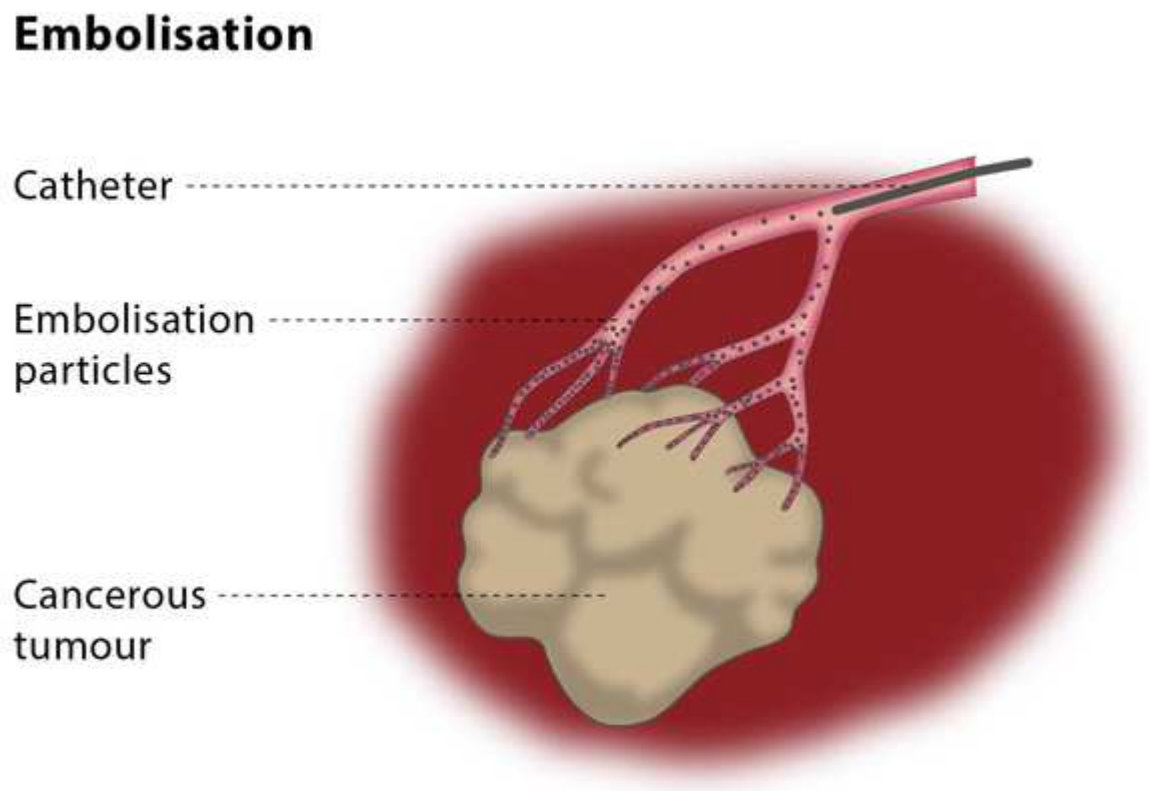
Embolisation in oncology

What is embolisation in oncology?

Tumours need a consistent supply of blood in order to grow. Embolisation is a minimally invasive procedure performed by interventional radiologists, in which the blood supply to masses or vessels which are causing symptoms in a patient is cut off, relieving the symptoms the patient experiences. In oncology, this involves using liquid, particles or microspheres to block blood vessels, redirecting blood flow away from the tumour. This causes the tumour to shrink and die.



Why perform it?

If you have large tumours in your liver, kidneys, lungs or bones, this treatment may be beneficial for you. There are different ways in which embolisation can be used in oncology. It can be used simply to cut off blood supply to the tumour (bland embolisation), or combined with chemotherapy to deliver the drugs directly into the tumour (chemoembolisation), or the particles may contain doses of radiation to selectively kill the tumour cells (radioembolisation).

Embolisation is also suitable for some non-cancerous tumours. Occasionally, embolisation may be used to reduce blood supply before a surgical procedure to increase patient safety.

How does the procedure work?

You should not eat anything before the procedure, and you may be given a sedative to help you relax. It is important that you stay still during the procedure to ensure that the X-ray images taken are accurate. The procedure will last around one hour.

You will be given a local anaesthetic for the procedure. The interventional radiologist will puncture an artery in your thigh with a small needle and will then thread a combination of plastic tubes (called sheaths and catheters) and guidewires into your arteries.

The interventional radiologist will inject a contrast medium (dye) through a catheter so that the area can be seen clearly under imaging. Then, the interventional radiologist will carefully navigate a microcatheter as close as possible to the tumour and will release the embolic particles. The particles are usually microspheres that are less than 0.5 mm in size and these may be combined or loaded with chemotherapy or yttrium radiation.

Most patients experience some pain and nausea after the procedure, so you will be offered strong painkillers and medication to prevent nausea. You may be discharged on the same day, but if you experience severe symptoms after the procedure you may need to stay in hospital overnight.

What are the risks?

The technical success rate, defined as successful delivery of the particles into the tumour, is usually over 95%. Clinical success (defined as a partial or complete death of the tumour and shrinkage of the tumour) and is around 30-50%, though it varies depending on the location, extent and biology of the underlying disease.

You may be offered multiple treatments to optimise the response, and 10-20% of the cases may also require more drastic treatment (surgery or ablation) in the future.

The main risk is non-target embolisation, meaning that the particles are accidentally released to normal vessels, which may destroy healthy tissue or restrict blood supply to an organ. Less severe side effects include bleeding, bruising and infection at the puncture site. In rare cases, the patient experiences abdominal haemorrhage, meaning they must stay in hospital and may need blood transfusions.

It is possible to have an allergic reaction to the contrast medium or for the iodine in the dye to affect the kidney. There is also a risk of post-embolisation syndrome, which causes fever, nausea and pain.

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Embolisation of the bronchial arteries

What is embolisation of the bronchial arteries?

Bronchial artery embolisation is a treatment for haemoptysis, which is the coughing up of blood or bloody mucus from the lungs or airway. Haemoptysis may be caused by blunt trauma, infections, anatomical defects or tumours.

Bronchial artery embolisation is a minimally invasive procedure which reduces blood flow to the affected veins in the respiratory system and so stops the bleeding.

How does the procedure work?

The aim of the procedure is to stop blood flowing to the vessels which are bleeding in the lung whilst preserving blood flow to the surrounding area. The vessels supplying the lungs with blood are called the bronchial arteries.

The interventional radiologist will insert a 2-3 mm catheter (tube) into a blood vessel in your groin and will guide the catheter under image guidance to the affected blood vessel. They will then insert microparticles (resin particles smaller than a grain of sand) or coils (small metal spirals) into the bleeding vessel or vessels. This prevents blood from entering the vessels and so stops the bleeding.

Why perform it?

If the patient loses a lot of blood as a result of haemoptysis, they may go into shock, which is life-threatening. It is also possible for the patient to drown if the blood goes into their airways.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the risk of the microparticles or coils moving to other areas of your body and blocking other artery branches.

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Embolisation of the prostatic arteries

What is prostatic artery embolisation?

Embolisation of the prostatic artery is a minimally invasive method which relieves the symptoms of an enlarged prostate by reducing blood flow to the veins that supply the affected area.

How does the procedure work?

The procedure works by reducing or stopping blood flow to the vessels that supply the central part of the prostatic tissue, thus relieving symptoms.

There are usually one or two vessels on each side (right and left) which supply the blood for the prostate. The interventional radiologist will insert a catheter into a blood vessel in your groin and guide the catheter under imaging to each prostatic artery. They will then inject microparticles (resin particles smaller than a grain of sand) into the prostatic arteries, causing the blood flow to the central tissue of the prostate to decrease or stop.

Why perform it?

Benign prostatic hyperplasia has a number of unpleasant symptoms. Prostatic embolisation can relieve your symptoms without you needing to risk surgery.

What are the risks?

Minor risks include bruising in the groin. More significant risks include the possibility of the microparticles moving to another area of your body and blocking other artery branches.

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Endovascular treatment of arteriovenous malformations

What is the endovascular treatment of arteriovenous malformations?

Arteriovenous malformation (AVM) refers to an abnormal connection between arteries and veins. Different types of AVMs occur in different clinical situations, including infantile haemangioma (a benign tumour made up of blood cells), and connections present at birth which are between vessels larger than capillaries (such as veins or arteries) – these are known as high-flow AVM.

The most common form of AVM is low-flow AVM, in which the abnormal connections are in an area with a low blood flow, meaning the space fills and empties slowly. This may be due to compression or gravity, a condition such as Klippel-Trénaunay syndrome or may be a combination of both these types. Another form of AVM is lymphatic malformations, though these are uncommon and may include cystic lesions (cysts, abscesses or bruising).

Klippel-Trénaunay Syndrome (KTS) is a rare congenital medical condition in which blood vessels and/or lymph vessels fail to form properly. The three main features are a port-wine stain, venous and lymphatic malformations, and soft-tissue enlargement of the affected limb. The condition tends to affect a single limb, usually a leg.

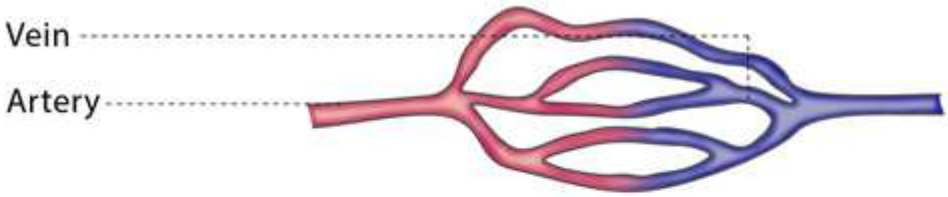
Although AVMs are congenital (present at birth), they are mostly diagnosed in adults under 40, and have a death rate of 10-15%.

In most cases, AVMs have no symptoms and so are discovered by chance, but the symptoms the patient experiences or does not experience depend on the location of the AVM. AVMs sometimes cause intense pain or bleeding and may lead to other serious medical problems. AVMs do not always require treatment.

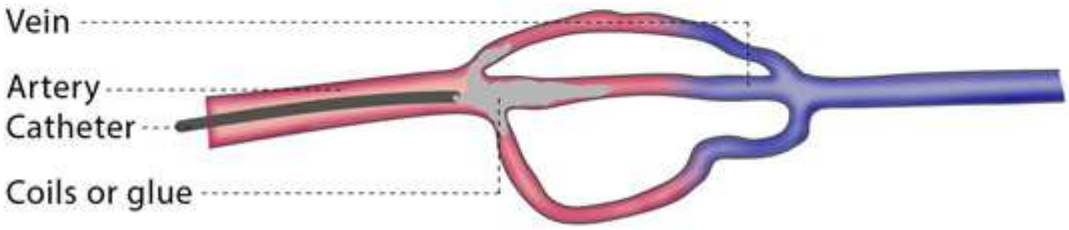
You may be advised to undergo treatment for the AVM if you experience haemorrhaging, pain, ulceration, if your heart is pumping too much blood, if you have a mass which interferes with normal activity or growth, or if you develop disfiguring lesions.

The only indication that the treatment may not be suitable for you is if your anatomical situation would prevent it, meaning that the structure of the affected blood vessels may prevent treatment from being carried out. It is therefore vital that the interventional radiologist carries out imaging before the procedure to evaluate which type of AVM you have and how the feeding vessels are structured.

AV malformation



Normal AV communication via capillaries



AV malformation

How does the procedure work?

The interventional radiologist will choose the type of endovascular procedure which is most suitable for you, depending on the site and type of your AVM. If the treatment is for infantile haemangioma, it may be removed surgically, to prevent psychological trauma, or it may be managed using embolisation.

If you are being treated for high-flow AVM, the therapy will aim to block the connection between the arteries and veins by embolising the tangle of blood vessels (nidus) or the central part of the lesion where the majority of the veins are present. The interventional radiologist will choose the material for the embolisation procedure based on the type of AVM you have and will aim to completely get rid of the nidus whilst also preserving normal blood flow. The materials used for the procedure are usually materials designed especially for the procedure, such as glue or metallic coils. Sometimes the nidus is directly punctured by injecting an embolic agent.

If you are undergoing treatment for low-flow AVM, you will be given an injection of sclerosing agent, a drug which is injected into vessels to make them shrink. In some cases, this will be done under fluoroscopy. There are limited treatment options for congenital venous dysplasia, but sometimes no treatment is needed. In severe cases, the interventional radiologist may use surgical stripping, sclerotherapy or an endovascular ablation technique. If you have symptoms on your skin, such as a port-wine stain, you may be advised to have laser treatment.

If you have a lymphatic malformation which contains fluid, a drainage treatment will be most suitable for you.

Why perform it?

Minimally invasive treatment can be performed for therapeutic reasons (to treat the condition) or for palliative reasons (to relieve the symptoms). The aim of the procedure is to exclude blood flow from the lesion and so reduce the symptoms and risks of AVM, such as bleeding.

The rate of bleeding varies from patient to patient, but if your AVM is associated with an aneurysm then the risk of bleeding is over 50%.

What are the risks?

Endovascular procedures to treat AVM also carry some risks, such as bleeding, bruising or ulcers at the site of the puncture, the embolic agent causing embolisation somewhere other than the target area, restricted blood supply if vessels supplying an area with blood are blocked, and toxicity, either locally or to other organs, caused by the blockage or sclerosing agent.

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Endovascular treatment of peripheral aneurysms

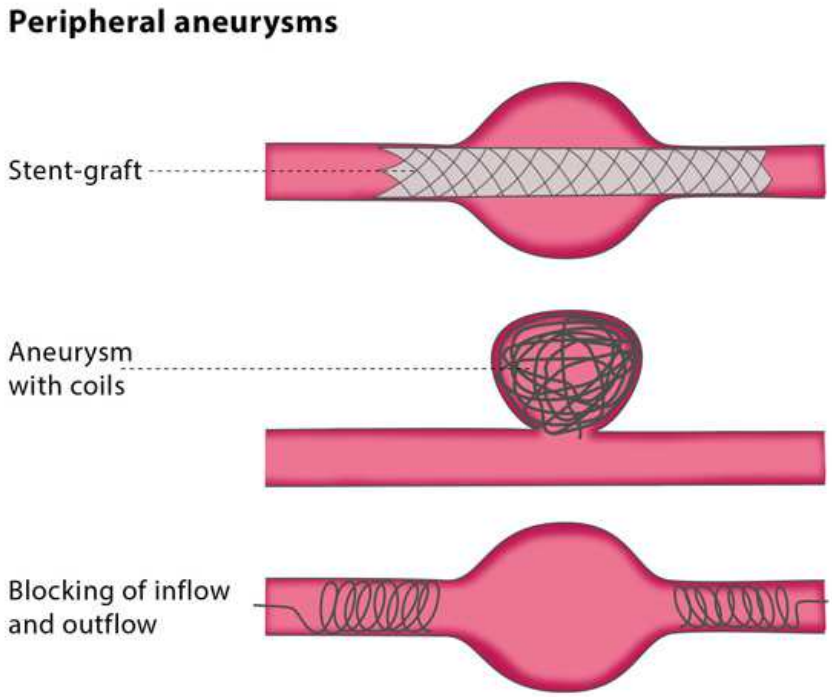
What is an aneurysm?

An aneurysm is a localised bulge in an artery caused by weakening, which may be a result of atherosclerosis or an infection, or injury of the arterial wall. A peripheral aneurysm is an aneurysm which is not located in the aorta. They usually occur in the popliteal artery in your leg, though may also occur in other areas.

How does the procedure work?

The interventional radiologist will access the affected area by inserting the devices for the procedure into an artery in your groin, and will use image guidance to move the devices to the aneurysm. However, you may need surgery to reach the required artery. There are a number of options for treatment – the treatment you will undergo depends on the location and the shape of the aneurysm.

One possible option for endovascular treatment of peripheral aneurysms is to use a stent graft in the artery to cover the area affected by the aneurysm. Alternatively, the inside space of the aneurysm can be filled with embolic material (such as tiny coils or glue) which prevents blood flow to the aneurysm. The other possible option is to block blood flow to the vessel.



Why perform it?

It is important to treat aneurysms, as they may rupture and cause severe bleeding. Clots can form in the inside space of the aneurysm and then move, blocking or restricting blood flow. Aneurysms can also compress nerves and veins, leading to pain, numbness and weakness.

What are the risks?

There is a risk of complications at the entry point for the procedure, including bleeding, another aneurysm and the possibility of injuring a nerve. Materials used in the procedure may dislodge and block other arteries.

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Endovascular treatment of visceral aneurysms

What is the endovascular treatment of visceral aneurysms?

An endovascular treatment is a treatment that is carried out inside the blood vessels, using small plastic tubes that are passed through a 2-3 mm hole in the skin and blood vessel wall.

An aneurysm is an abnormal enlargement of a blood vessel. Blood vessels have a tubular structure and most of these aneurysms are blister-like enlargements. Their walls may weaken and thus have a risk of tearing or bursting.

Visceral is a collective term for an organ in your body, such as the liver or spleen, so a visceral aneurysm is an aneurysm that occurs in an organ.

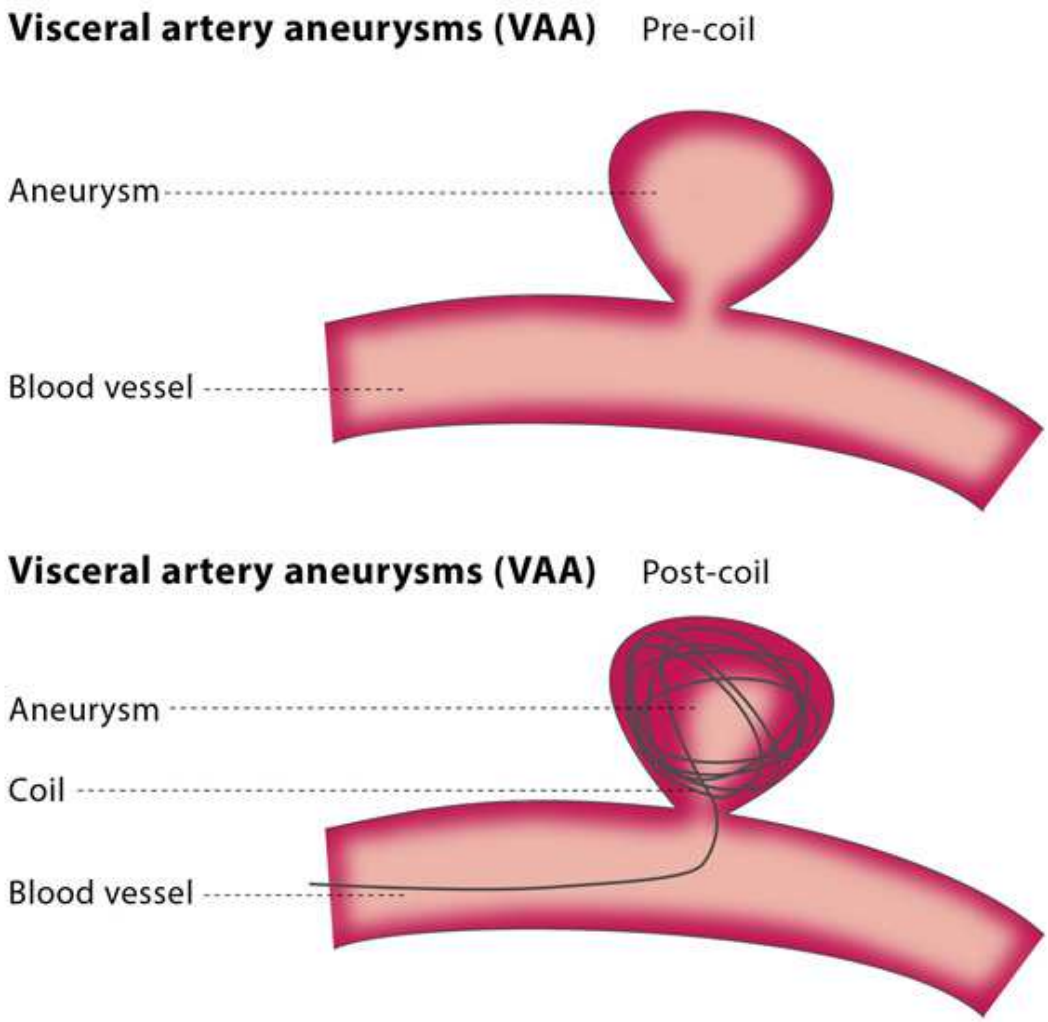
These abnormal enlargements have a risk of bursting and bleeding. The typical size that indicates a need for treatment is 2 cm. Endovascular treatment aims to stop blood flow to the aneurysm while maintaining blood flow to the organ.

How does the procedure work?

If you stop blood flowing, it will clot, just like a cut to the skin. The endovascular approach aims to stop blood flowing into the aneurysm whilst also preserving flow to the organ supplied by the affected blood vessel.

The interventional radiologist will usually enter a blood vessel in your groin and guide a 2-3 mm tube to the affected blood vessel. Typically a small coil (like the spring in a pen) will be pushed into the aneurysm or else into the blood vessel supplying the aneurysm.

Alternatively a small flexible metal tube (called a covered stent) is placed over the hole that feeds the aneurysm. These techniques will cause a clot to form in the aneurysm to stop the risk of rupture.



Why perform it?

A visceral aneurysm should be treated based on the risk of the wall of the aneurysm rupturing or breaking, which can cause serious bleeding. However, not all visceral aneurysms need treatment. The decision as to whether to manage the aneurysm conservatively and observe it or to treat it is also based on patient factors, appearance under imaging (typically ultrasound, CT and MRI) and any recent changes in the aneurysm.

It is generally agreed that larger aneurysms (over 2 cm) should to be considered for treatment.

What are the risks?

There are some minor risks, including the risk of a bruise in the groin. More significant risks include coils moving to another part of the body and blocking other artery branches. When treating an aneurysm, the blood flow in the main artery supplying the organ may decrease, causing an injury to the organ involved.

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Foreign body retrieval

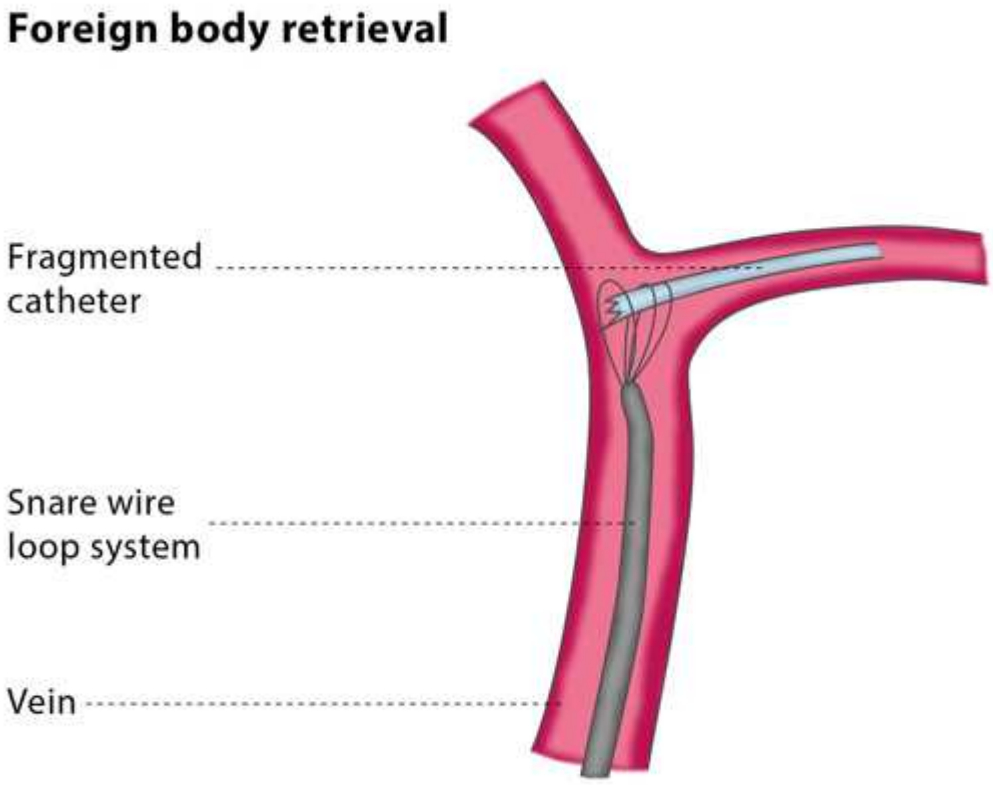
What is image-guided foreign body retrieval?

Foreign body retrieval is the removal, retrieval or manipulation of an item that has been introduced from the outside using image guidance. Foreign bodies are objects that originate outside the body and are usually the result of other medical procedures, such as endovascular (meaning in the arteries or veins) devices which have broken into smaller pieces, have become displaced or were mistakenly placed in the wrong area. Foreign bodies can also occur in extravascular locations, such as the biliary or urinary system and soft tissues.

How does the procedure work?

If you are on any medication that prevents blood clotting, you will stop taking it before the procedure, if possible.

You should not eat anything for at least four hours before the procedure starts. During the procedure, a needle will be placed in one of your veins to make access easier during the procedure, and the medical staff will monitor you throughout the procedure.



The technique used in the procedure depends on whether the procedure aims to remove or reposition the foreign body, as well as on the type and location of the item.

There are a number of systems and grasping devices which may be used for the procedure. The most common tool for endovascular removal is a snare device which consists of a snare wire loop, a snare catheter, a device used to insert a catheter and a device which helps move wires around during difficult procedures. The device is positioned in a blood vessel to capture the foreign body, which is then retrieved inside the introducer and out of the body.

Percutaneous foreign body retrieval is usually performed as an in-patient procedure, so you will stay in hospital overnight. The site of the puncture and your vital signs will be monitored for the first 4-6 hours following the procedure.

Why perform it?

There are a number of reasons why you may be advised to undergo percutaneous foreign body retrieval.

There are a number of risks associated with foreign bodies, including septic complications due to bacteria on the foreign body, as well as the risk of dislocated stents and coils which may cause blood clots and restrict blood flow in the vein. Inferior vena cava filters and fragmented guidewires may pierce the wall of the vein, and cement fragments on soft tissues can be painful.

Possible vascular foreign bodies (in your veins) include a fragmented or badly positioned central venous catheter or an inferior vena cava filter, an arterial catheter or guidewire, or a displaced arterial stent or embolic materials (such as a coil or plug).

Possible non-vascular foreign bodies include displaced ureteral and biliary stents and catheters as well as cement fragments on the soft tissue.

The procedure may not be suitable for you if you have a blood-clotting disorder.

The rate of successful foreign body retrieval is very high – over 90-95% of endovascular retrieval attempts are successful. If the foreign body cannot be retrieved using a minimally invasive technique or your doctor thinks that an endovascular retrieval of the foreign body would be too difficult or too risky, your doctor may suggest the possibility of using the traditional surgical approach.

What are the risks?

The risks associated with the procedure are fairly rare and usually do not require treatment. The most common complications are bruising at the groin, heart arrhythmia and flail tricuspid valve (a valve in the heart which has lost its normal support and flutters in the blood stream).

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Gastrojejunostomy

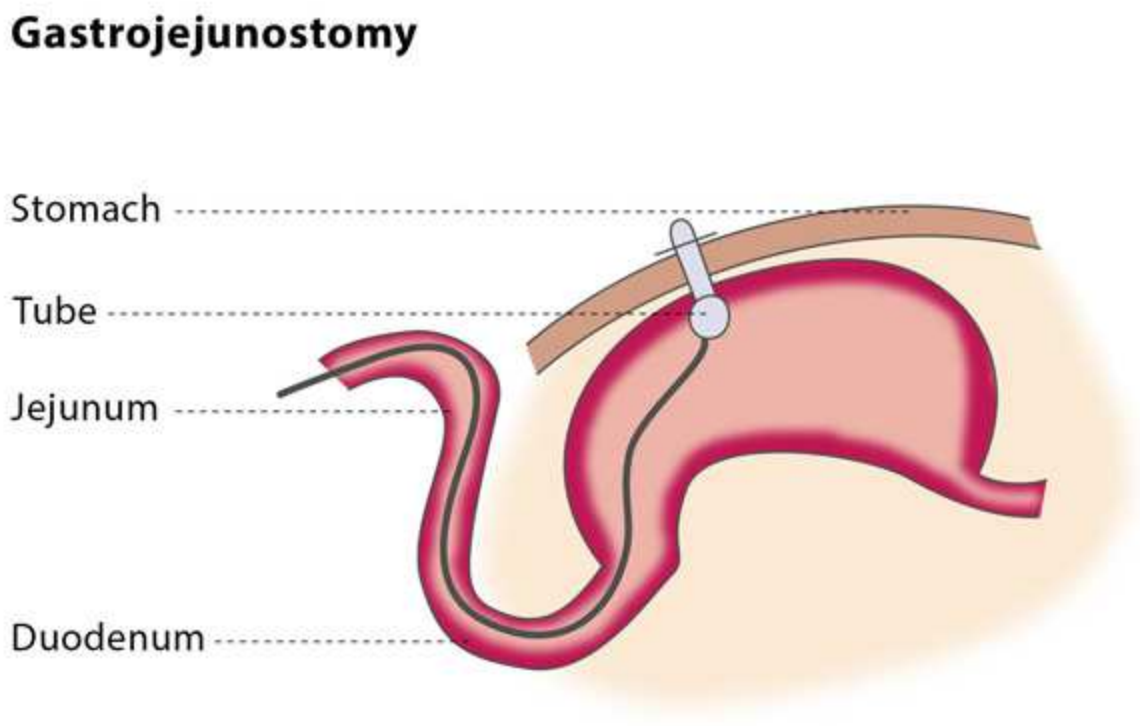
What is a gastrojejunostomy?

A gastrojejunostomy is a minimally invasive procedure in which a long catheter-like tube (called a gastrojejunostomy tube) is inserted through your abdomen and into your small intestine. The tube provides nutritional support to patients who are unable to eat and are unsuitable for a gastrostomy tube due to a blockage preventing food from passing from the stomach into the small intestine, severe paralysis of part of the stomach or a high risk of choking.

How does the procedure work?

If you are on any medication which prevents blood clotting, you will stop taking it before the procedure, if possible.

You should not eat anything before the procedure. The interventional radiologist will insert a tube in your nose which will go into your stomach (called a nasogastric tube) and then will perform an ultrasound of your stomach to check the position of your liver and confirm that the tube is correctly placed.



The procedure is usually performed under local anaesthesia or moderate sedation. You may be given antibiotics to prevent infection, but this is not always necessary. You will lie on your stomach on a C-arm table, a table designed to be used in imaging procedures.

The procedure is similar to that of percutaneous gastrostomy. In most cases, you will be given an injection of glucagon hydrochloride, which temporarily paralyses the muscles in your stomach. The stomach puncture in gastrojejunostomy is aimed at the area where your stomach connects with your small intestine as this is where the tube will go.

The interventional radiologist will then insert a catheter along with a guidewire into the jejunum, which is the middle section of your small intestine. The guidewire will then be exchanged for a stiffer guidewire. The interventional radiologist will insert some dilators which will expand the area, creating enough space for the gastrojejunostomy tube, which is positioned over the stiff guidewire. The interventional radiologist will inject a few millilitres of contrast media through the gastrojejunostomy tube so that the position of the tube can be confirmed using fluoroscopy.

You will probably be required to stay in hospital overnight, although a gastrojejunostomy can also be performed as an out-patient procedure. You may experience slight discomfort at the entry point of the catheter for the first few hours following the procedure. The location of the tube will be checked daily for signs of leakage or infection. You will be allowed to eat between 8-24 hours after the gastrojejunostomy, after you have consumed 50 ml of water per hour for at least four hours without any negative effects. The T-fasteners used in the procedure can be safely removed 10-14 days after the procedure.

Why perform it?

The indications that a gastrojejunostomy may be beneficial for you are similar to those for a gastrostomy – you may be advised to have this procedure if you are unable to eat normally. The most common reasons for this are neurological causes (such as stroke or dementia), anatomical situations (such as during correction procedures of cleft lip and palate anomalies) and if a blockage is preventing food passing from your stomach to your small intestine.

Because gastrojejunostomy is associated with a reduced risk of aspiration pneumonia, your doctor may recommend it instead of a gastrostomy if you suffer from chronic acid reflux. If the interventional radiologist cannot access your stomach for the gastrostomy tube placement or you have previously had a gastrectomy (the surgical removal of all or part of your stomach), they may directly puncture your jejunum (the middle part of your small intestine) instead – this is known as a jejunostomy.

The reasons why this procedure may not be suitable for you are also similar to those for a gastrostomy. You should not undergo the procedure if you have a blood-clotting disorder, if your colon or liver is positioned between your stomach and abdominal wall (as this prevents a safe access route), if you have peritonitis (inflammation of the thin tissue wall which covers most of your abdominal organs as well as the inner

abdominal wall), or if you suffer from untreatable massive ascites (abnormal fluid in your abdomen).

This procedure may not be suitable for you if you have dilated blood vessels in your gullet or stomach, changes in the top layer of the stomach lining, if you have abnormal cell growth in the wall of your stomach, cancer that affects the lining of the abdominal cavity, if you are morbidly obese or if you have had previously had surgery in the area.

The technical success rate ranges from 85-95%.

What are the risks?

The possible complications for a gastrojejunostomy are similar to those for a gastrostomy procedure: peritonitis (inflammation of the thin tissue wall within your abdomen), skin infection around the catheter entry site and bruising. As long as you are suitable for the procedure and the interventional radiologist chooses the technique most suited for you, the risk of complications is low (the rate of procedure-related mortality is 2.4%).

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Gastrostomy

What is a gastrostomy?

Gastrostomy is a procedure in which a gastrostomy tube is placed into your stomach for nutritional support.

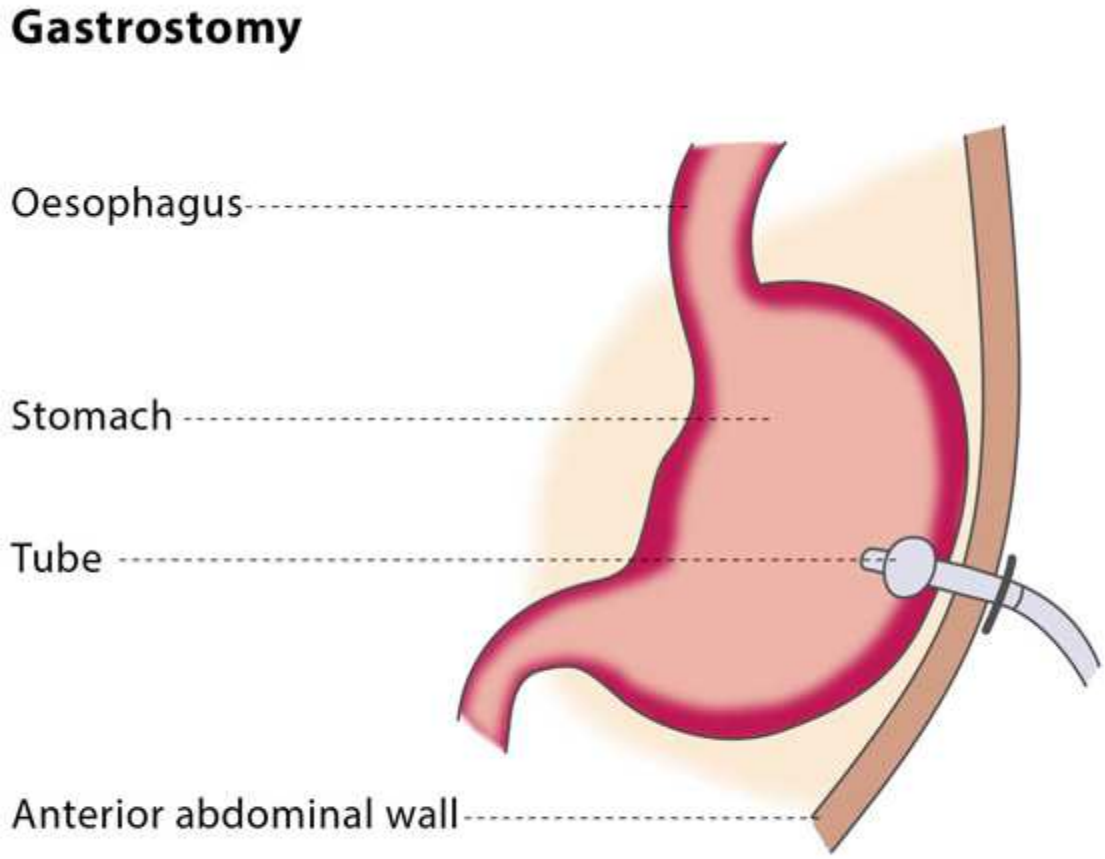
You may be recommended for a gastrostomy if for some reason you are unable to eat enough to sustain you, such as if you are unable to swallow safely.

A gastrostomy tube is a tube which may resemble a catheter or a button (with a detachable extension). Both types of tube have a balloon on the tip which keeps them in the correct area and both are therefore suitable for long-term use.

How does the procedure work?

If you are on any anti-coagulation or anti-platelet medication (medication which prevents blood clotting), you will stop taking it before the procedure, if possible.

You should not eat anything before the procedure. The interventional radiologist will insert a tube in your nose which will go into your stomach (called a nasogastric tube) and then will perform an ultrasound of your stomach to check the position of your liver and confirm that the tube is correctly placed.

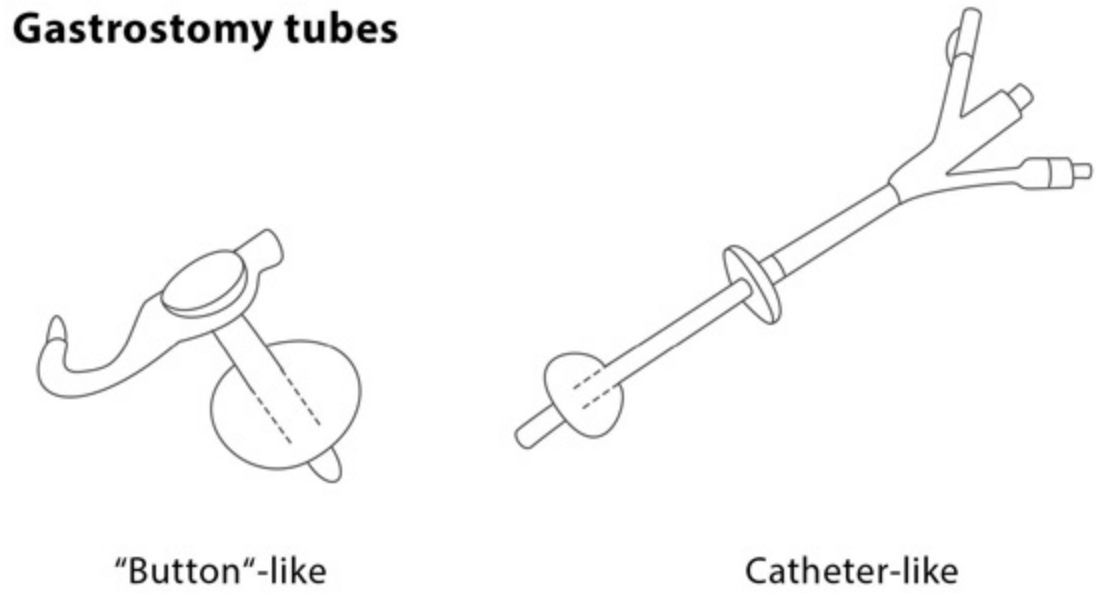


A gastrostomy is usually performed under local anaesthesia or moderate sedation. You may be given antibiotics beforehand to prevent infection, but this is not always necessary. You will lie on your stomach on a C-arm table, a table designed to be used in imaging procedures.

In most cases, you will be given an injection of glucagon hydrochloride, which temporarily paralyses the muscles in your stomach. Then, air will be entered through the nasogastric tube and into your stomach. The interventional radiologist will perform a fluoroscopy of the stomach to determine the exact puncture site, which is usually over the middle part of the stomach. In some cases, such as if part of your colon or liver is in front of your stomach, the gastric procedure may be carried out using CT.

The interventional radiologist will then perform a gastropexy, which is the fixation of the anterior gastric wall to abdominal wall, and here at least three anchors (T-fasteners) will be used to make a triangle on the abdominal wall. The interventional radiologist will use a small needle to puncture your stomach in the centre of the triangle.

The interventional radiologist will confirm the position of the needle tip within your stomach by injecting air or a contrast substance. They will then use the needle to position a guidewire inside your stomach.



The position of the needle tip within the stomach is confirmed using air or contrast media under imaging. The interventional radiologist will then position a guidewire through the needle and into your stomach, followed by a series of dilators which will be inserted over the guidewire to expand the area around it. The gastrostomy tube will then be inserted into your stomach. It has a balloon at the end which will be inflated to keep it in place and the guidewire will be safely removed. The interventional radiologist will inject a few millilitres of contrast media through the gastrostomy tube so that the position of the tube can be checked using fluoroscopy.

You will probably be asked to stay in hospital overnight, though the procedure can in some cases be performed as an out-patient procedure. You may experience some discomfort around the catheter in the first few hours following the procedure.

The entry point for the gastrostomy tube should be checked daily for signs of leakage or infection. You will be able to begin eating again 8-24 hours after the procedure and after you have consumed 50 ml of water per hour for at least four hours without any negative effects. The gastropexy anchors can be safely removed 10-14 days after the procedure.

Why perform it?

You may be advised to have a gastrostomy tube if you are unable to eat normally. The most common reasons for being unable to eat are neurological causes that prevent normal swallowing (such as stroke or dementia), anatomical situations (such as during correction procedures of cleft lip and palate anomalies) and obstruction of

the gullet (such as presence of head and neck tumours, post-radiation conditions). If you have a cancerous tumour in your bowel which causes a blockage, you may be recommended for a gastrostomy tube to decompress the stomach.

As a general rule, enteral feeding (delivering food directly into the stomach) is recommended when the patient is unable to eat for at least 7-14 days. If you have been unable to eat normally for more than 30 days, you may be recommended to have a gastrostomy or a gastrojejunostomy tube placed. If you are unable to eat but are expected to be able to eat normally within 30 days, your doctor will suggest a nasogastric tube (a tube delivering food through your nose to your stomach) or nasoenteric tube (which delivers food through your nose to your small intestine).

The procedure is not recommended for you if you have a blood-clotting disorder, if your colon or liver is positioned between your stomach and abdominal wall (as this prevents a safe access route), if you have peritonitis (inflammation of the thin tissue wall which covers most of your abdominal organs as well as the inner abdominal wall), if you suffer from untreatable massive ascites (abnormal fluid in your abdomen), or if you have a blockage in your bowel (unless the gastrostomy is recommended to decompress your stomach).

This procedure may not be suitable for you if you have dilated blood vessels in your oesophagus or stomach, changes in the top layer of the stomach lining, abnormal cell growth in the wall of your stomach, cancer that affects the lining of the abdominal cavity, if you are morbidly obese or if you have had previous gastric or upper gastrointestinal surgery.

The technical success rate of the gastrostomy procedure is very high, at around 97%.

What are the risks?

The most common complications include skin infection around the gastrostomy entry point and bruising. It is possible that the colon could be perforated during the placement of the tube, which can lead to severe peritonitis. If the gastrostomy tube is placed through the left hepatic lobe of your liver, you may experience bruising in your liver.

As long as you are suitable for the procedure and the interventional radiologist chooses the technique most suited for you, the risk of complications is low (the rate of major complications is less than 3%).

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High-intensity focused ultrasound (HIFU)

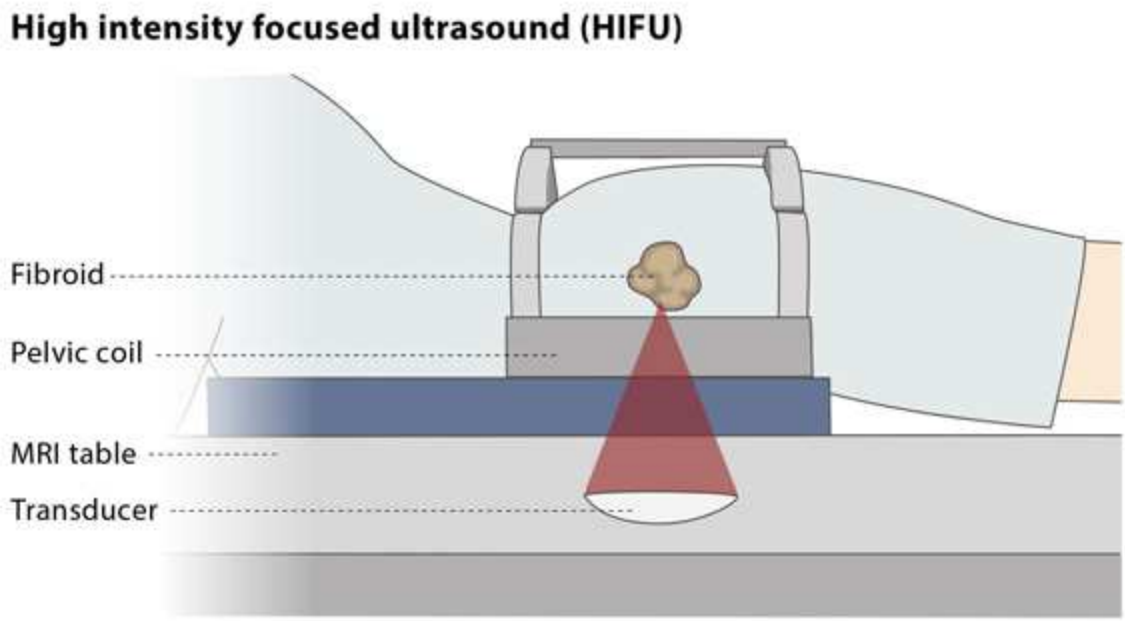
What is HIFU?

High-intensity focused ultrasound (HIFU) is a non-invasive therapy that uses focused ultrasound waves to thermally ablate a portion of tissue, meaning the tissue is destroyed using intense heat. The intense heat causes tissue coagulation necrosis, cavitation and heat shock in the cells, meaning that the portion of tissue which is being ablated is destroyed.

How does the procedure work?

High power ultrasound can be focused on a targeted point to raise the temperature to 70-80°C.

HIFU uses sonication (sound energy) to create this heat. Each sonication heats only a small focal target, so the interventional radiologist will use multiple sonications to ablate the whole affected area. The interventional radiologist may use diagnostic sonography with focused ultrasound (USgFUS or USgHIFU) or magnetic resonance guidance with focused ultrasound (MRgFUS).



Why perform it?

You may be advised to have the procedure to treat uterine fibroids or to alleviate pain from bone cancer. HIFU can also be used to treat prostate cancer, both as a primary treatment and after radiotherapy.

Investigations into using HIFU to treat liver, breast and brain tumours have had promising results.

Positive results with transcranial MR-guided focused ultrasound surgery (tcMRgFUS) as a non-invasive treatment of essential tremors, neuropathic pain and Parkinson's disease have been reported in literature. There have also been some investigations into the use of HIFU for temporarily opening the blood-brain barrier, allowing absorption of drugs into the brain.

A minimally invasive catheter-based system designed to ablate heart tissue responsible for atrial fibrillation has been approved for use in Europe and is undergoing an FDA approved trial in the United States.

What are the risks?

The risks of this procedure are related to non-target specific sonification (when tissue surrounding the area being treated is affected by the ultrasound waves). A further possible risk is the incomplete destruction of the lesion due to inadequate heating.

HIFU is not suitable for use in some areas of the body as ultrasound waves have a negative effect on some materials, though your interventional radiologist can avoid these effects by doing the procedure under magnetic resonance imaging.

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Inferior vena cava (IVC) filters placement and retrieval

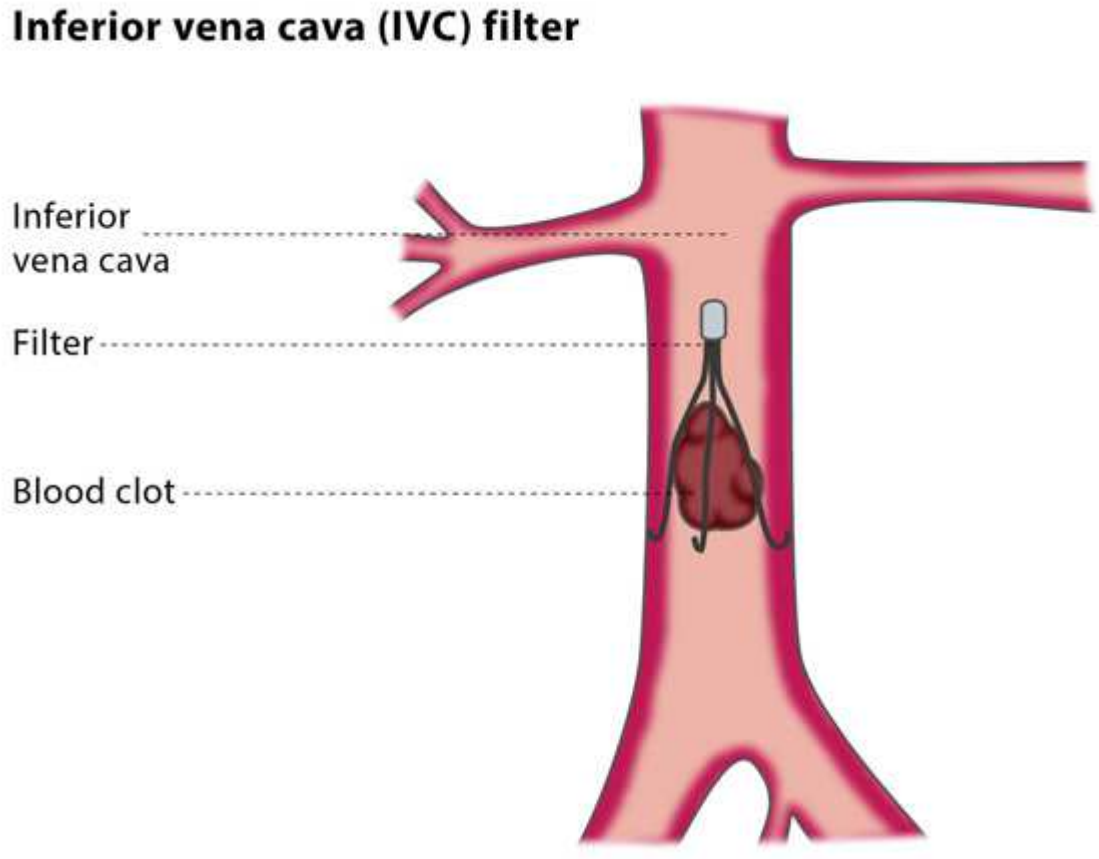
What are the endovascular placement and retrieval of an IVC filter?

IVC filters are metal devices which are designed to be used in the inferior vena cava (IVC), the large vein that carries deoxygenated blood from the lower half of the body back to the heart.

A pulmonary embolus is a blockage in the main artery of a lung. IVC filters can be used to prevent or manage pulmonary emboli and deep vein thrombosis (DVT), and can be temporary or permanent. The shape of an IVC filter resembles that of an umbrella, and it functions in a similar way.

How does the procedure work?

The interventional radiologist will insert a 3 mm plastic tube (called a sheath) into the base of your skull or your groin. They will guide the sheath to the blood clot in the inferior cava vein, which is where the IVC filter will be placed.



If you receive a temporary IVC filter, the interventional radiologist will remove the filter after the necessary period of time has passed. To remove the IVC filter, the interventional

radiologist will insert a long plastic tube and a goose-neck system (like a miniature lasso) as before and use this to remove the IVC filter.

Why perform it?

There are a number of treatments available to manage or prevent pulmonary emboli and DVT, including conservative (medical) therapy, IVC filters, intravenous systemic thrombolysis, catheter thrombolysis and a surgical operation.

Your suitability for this treatment depends on a number of factors, including how stable your blood pressure is and how well your heart is working. Other factors which will be taken into consideration are the type of IVC filter and your clinical situation, as permanent placement means you will need to take medication to prevent blood clotting for the rest of your life.

What are the risks?

There are some minor risks, including infection and bruising at the puncture site in your neck or groin. Major risks include the filter moving to another part of your body, the development of another thrombus, or a leg of the IVC filter breaking through the wall of the vein, which can be painful.

If you have a permanent IVC filter, the medication preventing blood clots that you will need to take carries further risks.

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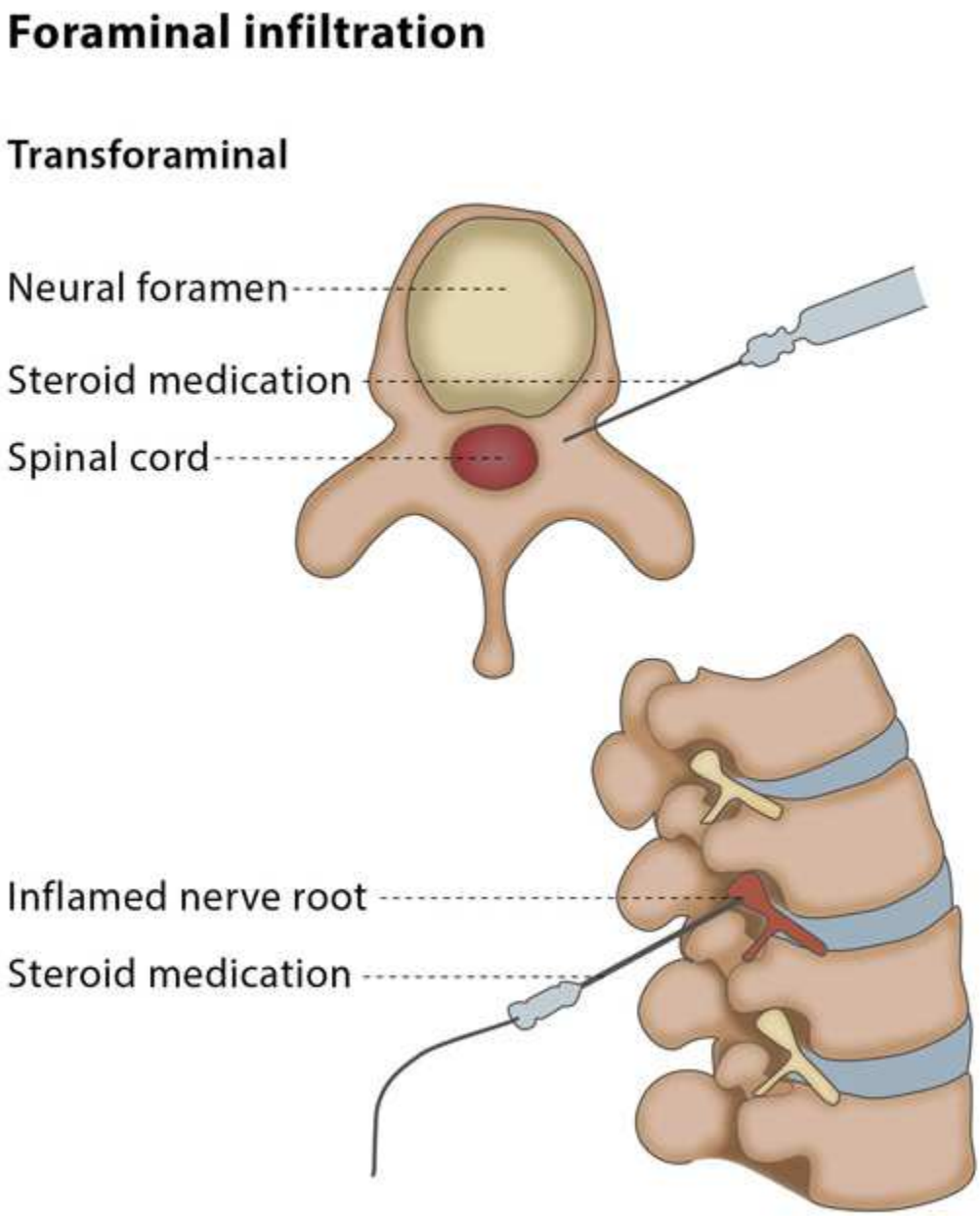
Infiltrations and guided injections

What is an infiltration and guided injection?

In between the vertebrae in your spine there are spinal discs (also known as intervertebral discs), and in the middle of each spinal disc is a jelly-like substance which is called the nucleus pulposus. Occasionally, the nucleus pulposus bulges through the outer ring which normally keeps it in place. This is known as herniation of the intervertebral disc or a 'slipped disc' and is a major cause of lower back pain, affecting mobility, physical function and quality of life.

Facet joint syndrome is another form of chronic lower back pain. It is characterised by stiffness and pain that increases when twisting and bending backwards. It is frequently caused by osteoarthritis, a type of arthritis that causes joint cartilage to deteriorate. This can also be caused by the joints bearing an unusual amount of weight as well as by repetitive stress injury. Facet joint syndrome is not easy to diagnose because it may be unclear where the source of the pain is located, making it easy for symptoms to be confused with the many other causes of back pain.

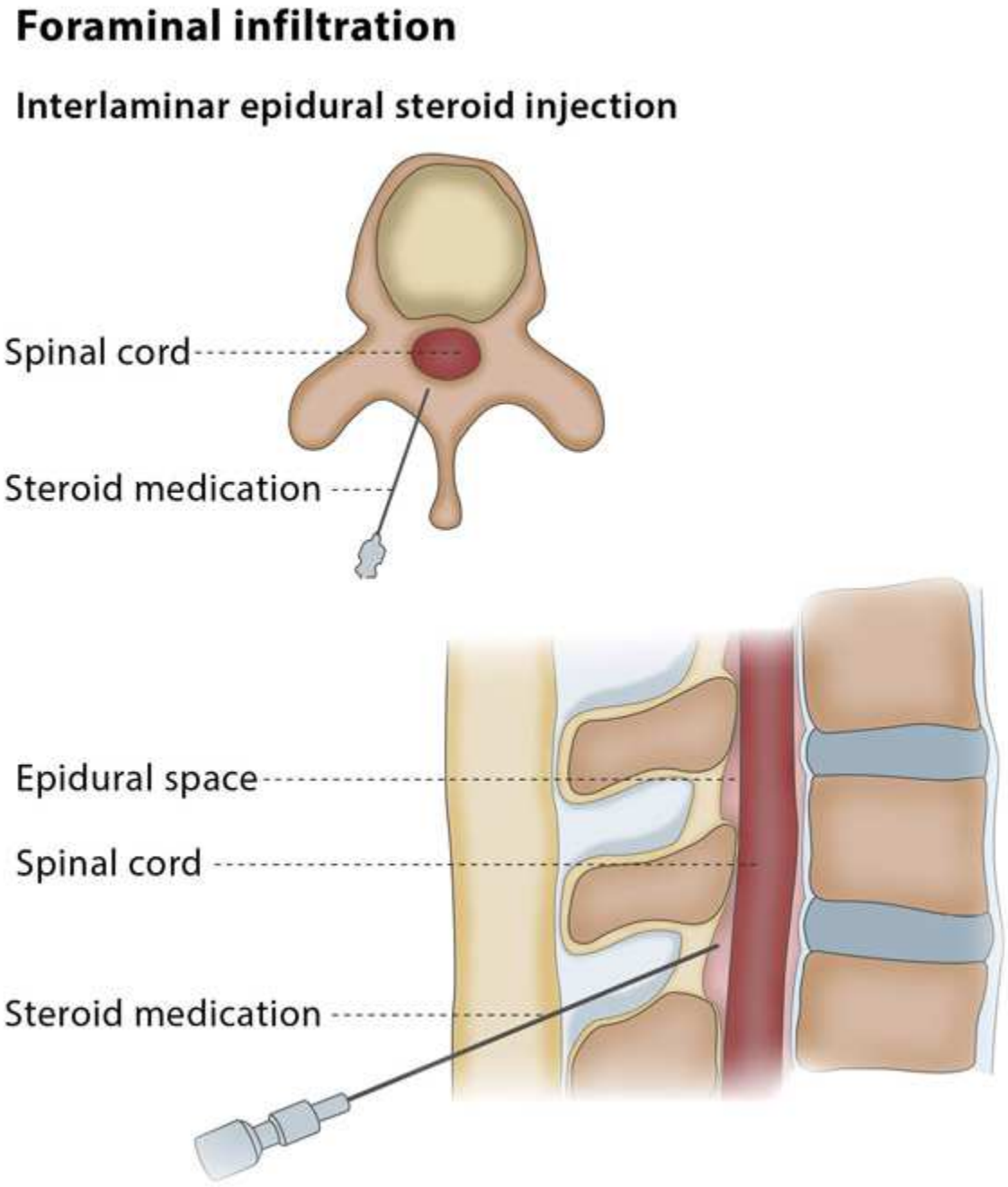
An infiltration and guided injection is the injection of local anaesthetics, steroids or ozone into your lower back for the treatment of sciatic pain due to disc herniation or facet joint syndrome. The procedure can be done under fluoroscopy or CT guidance.



How does the procedure work?

Under CT or fluoroscopy guidance, a mixture of local anaesthetics and corticosteroids is injected into the lumbar region (lower back).

The procedure is similar when performed in the neck region, though it is more difficult and there are more risks associated with this procedure. Before the injection of local anaesthetics and steroid medication can be carried out, a contrast agent (X-ray dye) must be injected.



Why perform it?

Radiculopathy means that one or more nerves do not work properly due to being inflamed or affected by disease. This may be caused by a deterioration of the spinal discs or a narrowing of the spinal canal. Both of these diseases require steroid injections in your lower back.

The injections can also be used to treat back pain caused by degenerative osteoarthritis of the joints between the centre of the spinal vertebrae or the gaps

between the vertebrae, regardless of whether you also have a condition affecting your nerves.

You may be recommended for a radicular block, which prevents particular nerves from transmitting pain signals, if you suffer from chronic nerve pain in your legs, post-surgical pain, pain caused by a tumour or pain caused by blisters. A surgical test can show if you may benefit from a radicular block.

What are the risks?

Headaches when standing upright occur relatively frequently as a result of the procedure, but due to the small size of the needles these are usually only temporary or can easily be treated.

Injections in the lower back can cause severe complications, though this is rare. If the needle is positioned incorrectly, the medication may affect your senses or movement.

Injection into an artery can cause spinal-cord ischaemia (restricted blood supply). Complications can be more severe when the injection is applied at the cervical or upper-thoracic levels, as the uncontrolled injection of anaesthetic can cause a complete spinal block, meaning sensation in the spine is lost.

Other severe complications are very rare but include infection in the lower back area, meningitis, inflammation the membranes which protect the spine, and the risk of an injury to the brain.

Intervertebral disc decompression

What is intervertebral disc decompression?

In between the vertebrae in your spine there are spinal discs (also known as intervertebral discs), and in the middle of each spinal disc is a jelly-like substance which is called the nucleus pulposus. Occasionally, the nucleus pulposus bulges through the outer ring which normally keeps it in place. This is known as herniation of the intervertebral disc or a 'slipped disc' and is a major cause of lower back pain which affects mobility, physical function and quality of life in addition to the financial cost.

Intervertebral disc decompression treatments are used to treat small- to medium-sized hernias of intervertebral discs by reducing the volume of the nucleus pulposus. This reduces the pressure between the discs and creates space for the herniated fragment to implode inwards, reducing pain and improving mobility and quality of life.

This involves the percutaneous removal of the nucleus pulposus by a variety of chemical, thermal and mechanical techniques.

How does the procedure work?

All the procedures are performed as an out-patient procedure under fluoroscopic or CT guidance. The percutaneous approach to the intervertebral disc is the same for all techniques. You will lie on your stomach and a needle will be inserted, followed by the device used for the procedure. The interventional radiologist uses a gel that shows up under X-ray to ensure that they have the correct angle to reach the middle of the nucleus pulposus, whilst avoiding injuring the nerve root.

There are a number of procedures available to reduce the amount of nucleus pulposus and so relieve the pressure. Cryoablation reduces the volume by forming ionic plasma, while percutaneous laser disc decompression reduces the volume by vaporising the middle part of the nucleus pulposus. For chemodiscolysis, a small quantity of ethanol gel or ozone is introduced into the nucleus pulposus, or alternatively, medical devices can be used to remove a small part of the nucleus pulposus.

Why perform it?

It is used to treat small- to medium-sized contained intervertebral disc herniation which has caused back pain, sciatica or leg pain that has limited the patient's activity for at least six weeks. The diagnosis will be confirmed using MRI before you can be considered for the procedure.

The procedure may also be recommended to treat pain caused by nerves which has shown no significant improvement after conservative therapy. This has been shown to have high success rates.

What are the risks?

The complications which you may experience during intervertebral disc decompression can result from the technique or the devices used in the procedure, such as if the catheter breaks or there is an injury to the nerve root. Post-operative complications include bleeding, infection and other general complications.

The most common complication of percutaneous disc decompression techniques is infection, which occurs in up to 0.24% of patients, and may develop into an abscess if left untreated.

There are a number of other, less common, complications of this technique. You may experience complex regional pain syndrome, in which the patient suffers from severe pain, swelling and changes in the skin. The area at the bottom of your spinal cord filled with fluid may be punctured, which can cause a headache, haemorrhage and injury to a nerve. You may have an allergic reaction to one of the agents used in the procedure. After an intervertebral disc decompression in the middle of your spine, you may develop pneumothorax, which is the abnormal collection of gas or air in the space between the lung and chest wall. Another possible complication is fainting, which can occur after an intervertebral disc decompression in your neck.

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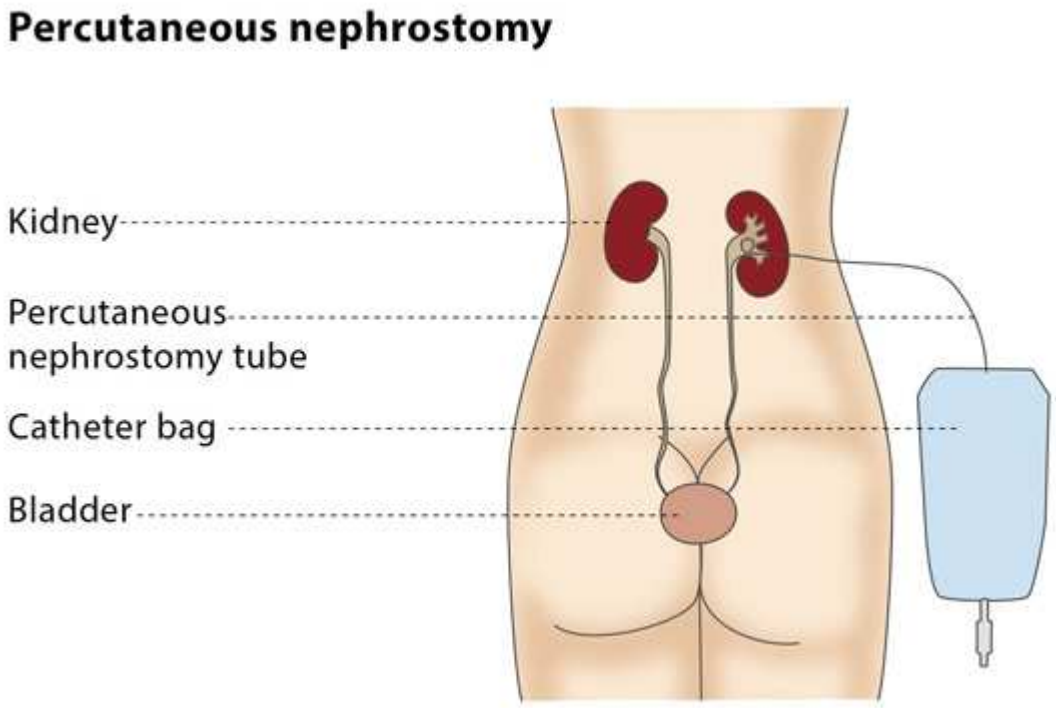
Nephrostomy

What is percutaneous nephrostomy?

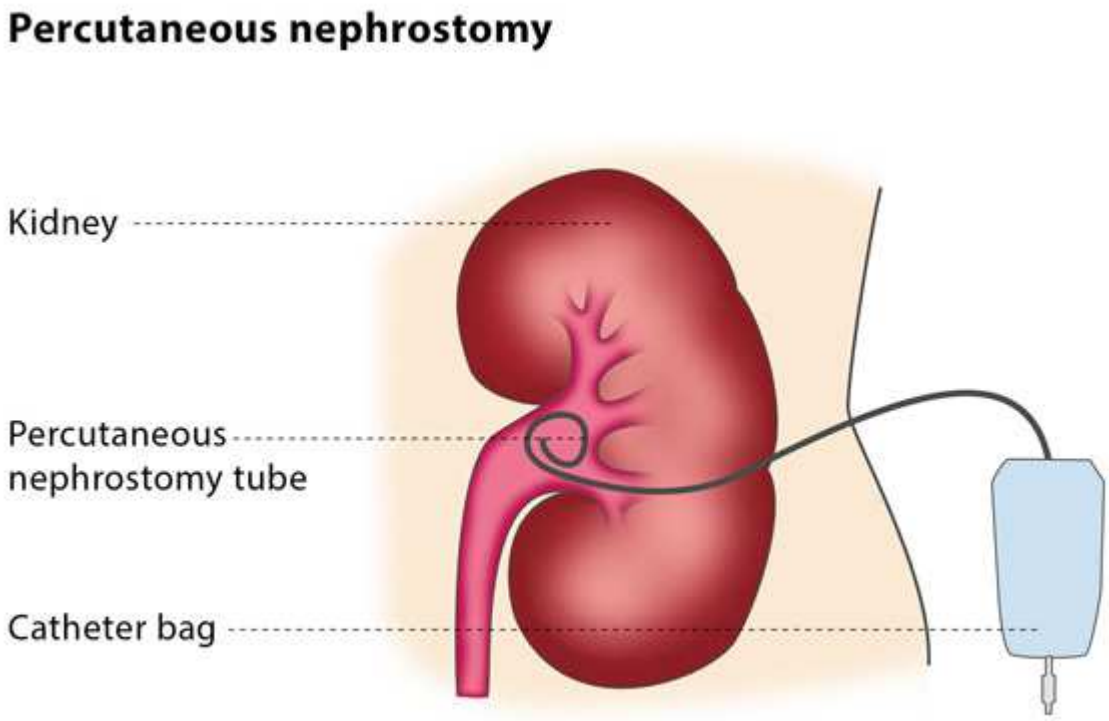
A nephrostomy tube is a thin, flexible, plastic tube that is used to drain urine from the kidney. Urine leaving the kidney is collected in a plastic bag attached to the tube outside your body. The bag can be strapped to your waist or leg so you can move freely.

Percutaneous nephrostomy describes the procedure in which the nephrostomy tube is inserted through the skin and into the kidney.



How does the procedure work?

You will lie on your stomach, usually with one side slightly raised on a pillow. You will be given an injection of a painkiller and a sedative to reduce any discomfort. The area of skin around the entry site will be anaesthetised before the procedure.



Under the guidance of ultrasound, X-ray or CT, the interventional radiologist will insert a needle through the skin and into the kidney and will then put a wire through the needle and insert the nephrostomy tube into the kidney over the wire.

Why perform it?

You may be advised to have this procedure if the passage of urine to your bladder is blocked, most commonly because of a stone, infection, injury to the ureter or cancer. It can also be the first step of a procedure known as percutaneous/ante grade ureteric stenting.

What are the risks?

Some patients report minor bleeding from the kidney after a nephrostomy. Severe bleeding that requires treatment occurs in less than 5% of patients. In less than 1/500 patients an adjacent organ is injured during the nephrostomy. Although temporary low-grade fever is common after the procedure, a high fever occurs in around 1-3% of patients, which is usually the result of an unresponsive infection.

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Obstruction relief

What is obstruction relief?

Occasionally, tumours grow so large that they obstruct the normal flow route in areas of the body that should remain open, such as the biliary tree, the digestive tract, the airway or the urinary tract. This blockage causes fluids that would normally pass through the area to build up in the body. If left untreated, the blockage and resulting build-up may cause pain, infection and organ failure.

There are a number of minimally invasive techniques available to relieve the obstruction, including therapeutic treatments (which treat the blockage) and palliative treatments (which reduce discomfort caused by the blockage). These techniques aim to drain the fluid collections or bypass the obstruction, allowing the fluid to drain normally.

How does the procedure work?

There are two types of minimally invasive techniques available: the collection of fluid may be drained or the blockage may be bypassed, so fluid can pass through the vessel.

Percutaneous drainage is a minimally invasive method which involves using a catheter (a thin, flexible tube) to drain a fluid collection or abscess. The procedure is carried out under image guidance; the type of imaging used depends on the blockage and the build-up of fluid. You will receive local anaesthetic or be sedated for the procedure.

Alternatively, the vessel with the blockage can be opened using minimally invasive devices. These include guidewires, tiny balloons (which when inflated expand the area), and stents (metal mesh tubes which are inserted to support the vessel's walls and keep the vessel open). Once the blockage is relieved, the collected fluid can drain normally.

Why perform it?

If left untreated, such obstructions and the resulting collections of fluids or other substances can cause pain, infection and organ failure.

What are the risks?

There are some possible complications, but these are rare. In 2-5% of cases, bacteria enter the bloodstream. Septic shock, in which organs fail as a result of infection or bacteria in the blood, occurs in 1-2% of cases. Other complications include haemorrhage and infection in a fluid collection. Some patients experience stent migration, in which the stent travels to another area of the body, or re-obstruction, meaning the vessel once again becomes blocked. If you have a re-obstruction, you may need to undergo further treatment.

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Neurolysis and plexus infiltrations

What are neurolysis, nerve block and plexus block?

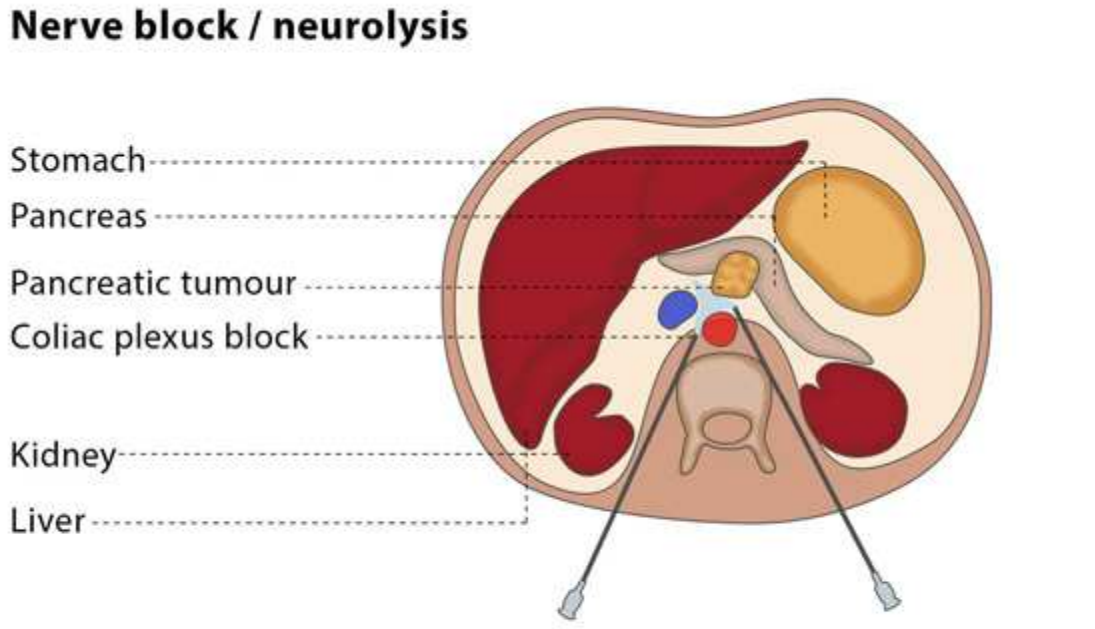
Neurolysis is the deliberate destruction of a nerve or a network of interlacing nerves (plexus) with the aim of providing permanent relief from pain by interrupting the transmission of pain signals in the nerves.

Nerve block refers to temporarily blocking the function of a nerve by injecting painkillers into the area around the affected nerve, thus blocking the transmission of pain signals. This temporarily disables the nerve without causing permanent damage.

How does the procedure work?

If you are undergoing neurolysis, there are a number of techniques which the interventional radiologist may use. The most common method of causing permanent nerve destruction is the injection of a chemical such as alcohol. Alternately, the interventional radiologist may choose to use ablation techniques to destroy the nerves. In these cases, the interventional radiologist will insert a needle or a thermal probe into the area so it is in contact with the nerve or the plexus.

If you are having a nerve block, the interventional radiologist will use a single thin needle to inject anaesthetics (sometimes mixed with anti-inflammatory drugs) into the area around the nerves responsible for pain.



Injection of analgesics for coeliac block of neurolytic agents for neurolysis

Because these procedures are carried out under image guidance, the interventional radiologist can target the precise area, which reduces the risk of complications when targeting deeply situated nerves.

Why perform it?

Neurolysis can be used to treat severe diseases including chronic pain. It is most often used as a pain control technique for cancer patients but can also be used to treat other conditions causing chronic pain which appear to have no cure or no clear cause.

What are the risks?

There are some minor side effects associated with the procedure, depending on the nerve targeted. For example, neurolysis in the abdominal splanchnic nerves often causes orthostatic hypotension, also known as 'head rush', when a person's blood pressure falls when standing or stretching. Severe complications for nerve block or neurolysis are rare. However, as is the case with all procedures near the spine, there is an exceptional risk of paralysis of the area supplied by the nerve or elsewhere.

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Why perform it?

If left untreated, such obstructions and the resulting collections of fluids or other substances can cause pain, infection and organ failure.

What are the risks?

There are some possible complications, but these are rare. In 2-5% of cases, bacteria enter the bloodstream. Septic shock, in which organs fail as a result of infection or bacteria in the blood, occurs in 1-2% of cases. Other complications include haemorrhage and infection in a fluid collection. Some patients experience stent migration, in which the stent travels to another area of the body, or re-obstruction, meaning the vessel once again becomes blocked. If you have a re-obstruction, you may need to undergo further treatment.

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Precision pulmonary trans-arterial chemoembolization (PPTACE)

Researchers in experimental studies have investigated the possibility of overcoming the limitation of single treatment whit RF and improving the effectiveness of lung RF ablation, particularly the use of combined techniques in which the activity of lung RF ablation is potentiated by simultaneous bronchial balloon occlusion (15,16), intraparenchymal injection of saline solution (17,18), or arterial pulmonary embolization (19,20). In addition, researchers in several studies (21–27) have investigated the pharmacodynamics of several antineoplastic agents, administered as regional therapy by using unilateral isolated lung perfusion, which have demonstrated the high level of regional cytostatic activity without notable systemic toxicity.

While chemoembolization of the liver has become routine in clinical practice, pulmonary chemoembolization, because of its perceived complex and risky nature, has received only limited attention (28,29). However, exploiting the effects of arterial chemoembolization to increase the ablative margin around lung nodules and hence optimizing the effectiveness of lung RF ablation remains a powerful rationale for combined therapy that aims to improve local disease control.

Selective chemoembolization through the bronchial artery allows vascular bed embolization of bronchogenic tumors (and, rarely, some metastases such as renal carcinoma and sarcoma) without leading to infarction of peritumoral lung tissue (30,31). Thus, it can induce ischemia within the tumor, while leaving the healthy perinodular parenchyma aerated. On the other hand, chemoembolization of the tumor-bearing segment through the pulmonary artery, with consequential white infarction, replaces the air in the perinodular tissue (ie, the most common site of local tumor progression) with edema and protein. By changing the tissue composition from highly resistive air to fluid, this could enable RF waves to then progress more easily around the tumor, thus creating a greater ablative margin.

Percutaneous Ultrasound-guided ethanol injection (PEI)

PEI for liver cancer

Percuataneous ethanol injection (PEI) is used as an alternative to liver resection when an individual has a single localized mass or several small tumors. Pure alcohol (i.e., ethanol) is injected into the tumor bed to block blood flow to the cancer.

How is percutaneous alcohol injection done and how does it work?

In this technique, pure alcohol is injected into liver cancers to kill the cancer cells. The alcohol is injected through the skin (percutaneously) into the tumor using a very thin needle with the help of ultrasound or CT visual guidance. Alcohol induces tumor destruction by drawing water out of tumor cells (dehydrating them) and thereby altering (denaturing) the structure of cellular proteins

PEI for benign thyroid nodules

Ultrasound-guided percutaneous ethanol injection (PEI) was first proposed by Livraghi in 1990 as a possible therapy for autonomously functioning thyroid nodules (AFTN). The procedure is performed on out-patients; is rapid; there is no need of anesthesia, nor of bed rest or patient observation after treatment. Under direct sonographic control a limited amount of 95% sterile ethanol (1-5 ml) is slowly injected into the nodule. In predominantly cystic nodules complete fluid removal is preliminarily performed, and thereafter ethanol is injected on the basis of the aspirated fluid volume without removing the needle.

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T Livraghi, , A Giorgio, , G Marin, , A Salmi, , I de Sio, , L Bolondi, , M Pompili, , F Brunello, , S Lazzaroni, and G Torzilli DOI: http://dx.doi.org/10.1148/radiology.197.1.7568806

Thyroid. 1995 Apr;5(2):147-50.
Percutaneous ethanol injection (PEI): what is its role in the treatment of benign thyroid nodules?
Papini E[1], Pacella CM, Verde G.

Pleurodesis

What is pleurodesis?

Normally, the lung is covered in a thin film of tissue, as is the inner lining of the rib cage and chest wall, and these two films are stuck together. However, sometimes air, fluid or both gets between these layers, separating them and limiting the ability of the lung to expand during breathing. When excess fluid develops between these layers, this is called pleural effusion. Pleurodesis is a technique to make these two layers stick together.

How does the procedure work?

The interventional radiologist, using image guidance, will typically place a small tube in the space between the layers. The fluid or air is nearly completely drained. Then a substance will be placed between the layers to cause an inflammation on their surfaces. The newly inflamed surfaces then stick together. This keeps the lung expanded and stuck up against the inner chest wall and helps prevent re-accumulation of fluid or air.

Why perform it?

This procedure aids breathing by helping the lungs maintain their maximum volume. It can be used for cancerous and non-cancerous causes of air and fluid accumulation, such as cancerous fluid, infected fluid and punctured lung. In most cases, simple drainage will be sufficient treatment, but if they recur frequently or rapidly pleurodesis may be recommended.

What are the risks?

The initial placement of the tube through the chest wall can cause bleeding or injury to the lung or surrounding organs. You may experience an infection of the skin or the fluid.

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Radioembolisation

What is Y-90 radioembolisation?

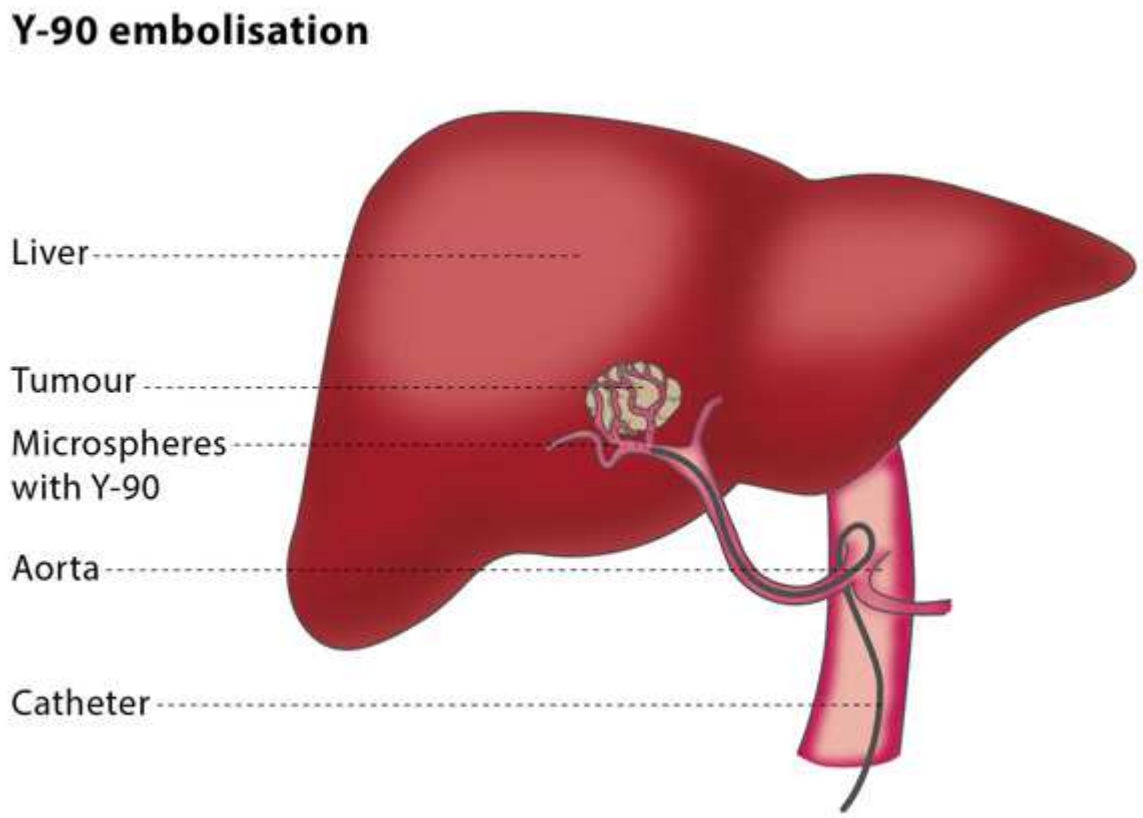
Y-90 radioembolisation is a palliative treatment for primary liver lesions and liver metastatic disease which uses ionising radiation to shrink tumours. It is generally used to relieve the symptoms of liver tumours rather than to cure the underlying condition.

The liver has two sources of blood supply: the hepatic artery and the portal vein. Liver tumours tend to rely on the hepatic artery for their blood supply.

During a radioembolisation procedure, an interventional radiologist injects microspheres filled with the radioactive isotope yttrium (known as Y-90) into the vessels feeding the tumour. Because the radiation is focused only on the tumour, higher and more effective radiation doses can be used compared to other treatments.

How does the procedure work?

Depending on your individual situation, you may be given the procedure as an out-patient or you may require hospital admission following the treatment. The interventional radiologist will carry out the procedure using fluoroscopic guidance.



You will be given a local anaesthetic. After this, the interventional radiologist will insert a catheter (a thin tube) and a guidewire into an artery. You will then have some images taken of your upper abdominal arteries to show the exact location of the vessels feeding the tumour. The interventional radiologist will then insert microspheres filled with Y-90 into these vessels to deliver a high dose of radiation to the cancer cells. This radiation dose will decrease over the following two weeks.

Your vital functions will be monitored during the procedure. You may be given antibiotics to prevent infection, and, if necessary, IV analgesics or medication to prevent nausea.

Why perform it?

If you have an inoperable liver tumour or if you are not fit for surgery, you may benefit from Y-90 radioembolisation. Y-90 is beneficial for hepatocellular carcinoma (the most common type of cancer) affecting the portal vein of the liver, or if you have not responded to chemoembolisation.

Because the radiation dose is delivered directly to the tumour, the dose is higher than in standard radiation therapy and there are fewer possible complications. Radioembolisation can extend the patient's life expectancy from months to years, as well as improving quality of life. In some patients, this procedure enables them to undergo surgery or liver transplantation.

What are the risks?

Y-90 radioembolisation is a relatively safe procedure. The most common complication is post-radioembolisation syndrome, which occurs in around 50% of patients. Symptoms include fatigue, low-grade fever, nausea, vomiting and abdominal discomfort.

Less common complications include a build-up of fluid, high levels of alkaline phosphatase and infection. You may also experience stomach ulcers, inflammation of the pancreas, raised blood pressure, gallbladder inflammation or pneumonia. As with all percutaneous procedures, there is a risk of bleeding or damage to a blood vessel.

In some cases, patients react to the iodinated contrast materials used in the procedure, experiencing allergic reactions and harmful effects on the kidneys.

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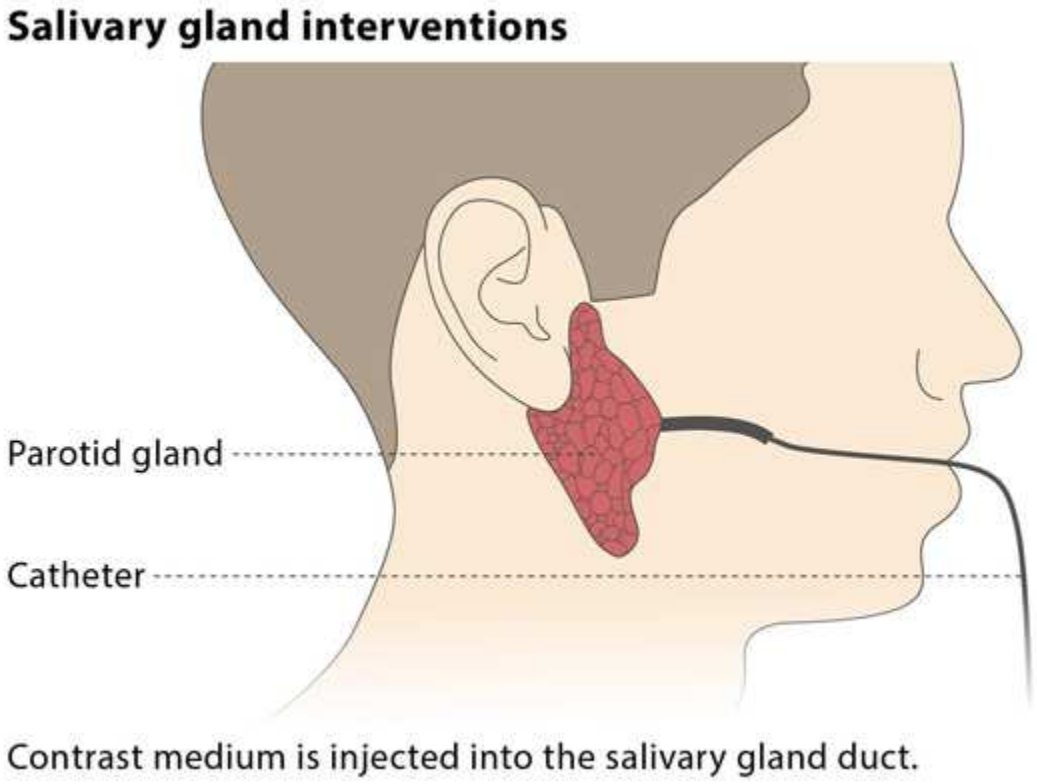
Salivary gland interventions

What is a salivary gland intervention?

The salivary glands produce saliva, which drains into the mouth via ducts and helps break down food. There are three major pairs of such glands – the submandibular glands (under the jawbone), the parotid glands (between the ear and the jaw) and the sublingual glands (beneath the tongue). Sometimes the glands are obstructed because stones have formed or the ducts are restricted for other reasons. These conditions affect about 1% of the adult population.

Surgical procedures for opening restrictions of the salivary ducts or to extract stones can be complicated, and carry risks of facial nerve injury and paralysis. Interventional radiology offers minimally invasive procedures, such as sialoplasty, which uses dilators, baskets or balloons to restore proper function in the submandibular and parotid glands.



How does the procedure work?

The sialoplasty procedure is carried out using fluoroscopy for guidance. An interventional radiologist will insert a catheter (a thin flexible tube) and a tube into the affected area. Before the sialoplasty procedure can be carried out, a diagnostic

sialography will be performed to assess the location and extent of the condition requiring the procedure. Diagnostic sialography is an imaging technique, in which the interventional radiologist injects contrast medium into the affected salivary gland and then performs an X-ray.

During the sialoplasty, a flexible guidewire will be passed into the salivary duct and directed to the narrowed or blocked area. Using a dilator, wire retrievable basket or balloons, the interventional radiologist will then expand the narrowing of the salivary duct or extracts the stones (or both), thus relieving the cause of the condition.

Why perform it?

Interventional techniques can be used to remove stones or other causes of obstruction in the salivary glands, relieving the symptoms caused by the blockage. When stones form in the glands, patients may experience a range of symptoms including pain, swelling and infection.

It has been suggested that interventional techniques may not be a suitable treatment if the stone causing the blockage is too large. However, the number of reported cases of this is small, making it impossible to give firm recommendations for these techniques. On the whole, interventional procedures are considered safe and successful.

What are the risks?

Patients usually experience swelling following the procedure, but this does not last longer than 24-48 hours. Some patients experience a tingling sensation in the tongue, but this resolves itself with time.

The procedure carries risks of bleeding in the mouth (though this is self-limiting so does not need treatment), pain during the procedure and infection. Contrast dye may leak into the tissue around the vein in which the needle was placed, or the doctor may accidentally create a false passage (an unnatural passage leading off from a natural canal). However, these usually do not cause lasting effects. More serious complications include ductal tears or duct detachment, which may subsequently require removal of the gland.

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Sclerotherapy

What is sclerotherapy?

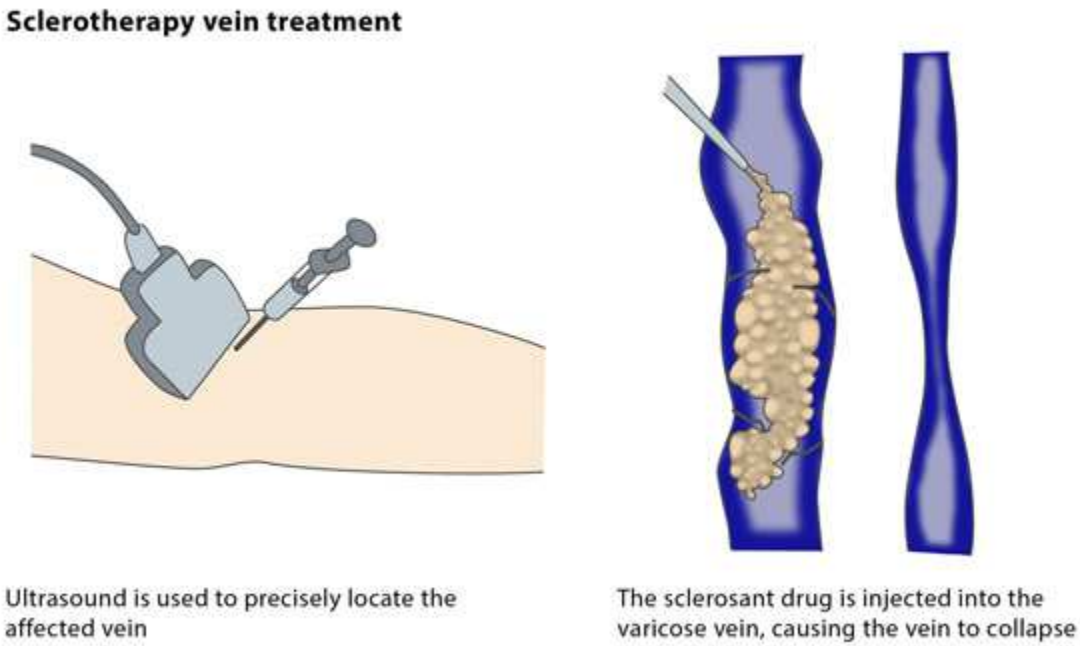
Sclerotherapy is a minimally invasive procedure which is used to treat abnormal or enlarged blood vessels, usually varicose veins. During the procedure, a solution (a special type of alcohol or foam) will be injected directly into the vessel, causing the vessel to collapse, re-routing the blood into healthier veins. The collapsed vein can eventually be reabsorbed into the body.

How does the procedure work?

You will be anaesthetised for the procedure. The interventional radiologist may take one of two approaches to performing the sclerotherapy. The first possible way to carry out the procedure is by inserting catheters into a blood vessel and then injecting a solution of 90% alcohol into the affected vein, causing the vein to become blocked. This is known as an endovascular approach.

The other way in which the interventional radiologist may perform the procedure is a percutaneous approach. For this approach, the interventional radiologist directly injects the solution into the selected vessel or vessels, usually guided by sonography.

Recently, other minimally invasive alternatives have been used as alternatives for patients undergoing sclerotherapy, such as laser or cryoablation.



Why perform it?

Sclerotherapy is recommended as a treatment as it has a higher rate of success than other methods.

What are the risks?

There are a number of severe risks associated with this procedure. The substance used in the procedure may extend into other veins, or the patient may experience pain if the level of anaesthesia is insufficient. If the interventional radiologist uses a percutaneous approach, damage to the skin is possible.

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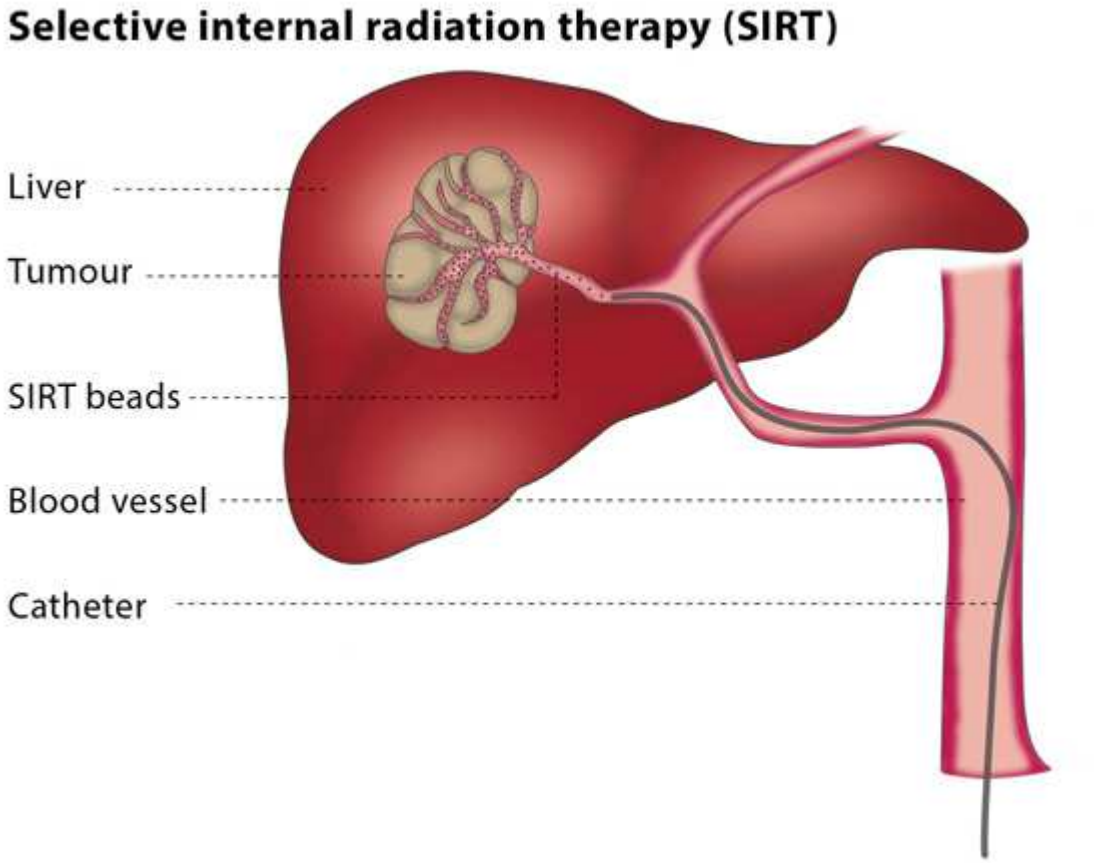
Selective internal radiation therapy (SIRT)

What is SIRT?

SIRT is a radiation treatment for cancer. In this procedure, a radiation source called yttrium-90 is administered in small beads delivered through the blood stream into the organ affected by cancer.

How does the procedure work?

First the interventional radiologist will map out the blood vessels of the organ, and may block some of them to ensure the spheres only go to the tumour. Once this is done, a catheter (small tube) is placed inside a blood vessel that goes directly to the organ affected by cancer. The interventional radiologist will guide the catheter close to the tumour and then will administer the specially prepared beads that contain the radiation. When the beads land in the tumour, they emit a form of radiation energy that kills the cancer cells over a short distance around the bead.



Why perform it?

The aim of the procedure is to cure or slow the growth of cancer. It may be performed alone or in combination with conventional therapies. It is typically used to treat cancers located in an organ, most commonly the liver. It is a local therapy, meaning it only treats cancer cells near where it is administered. Usually it is used for tumours in solid organs that cannot be treated by other means alone, though it may be used together with conventional surgery and chemotherapy.

What are the risks?

There is a risk that the blood vessel will be injured or bruised while the tube is being placed. If the beads travel to normal tissues, these tissues will be killed. When the tumour is killed, you may experience pain, fever and nausea. In unusual cases, the treated area can become infected which may require medication or another intervention.

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Thrombectomy

What is an endovascular thrombectomy?

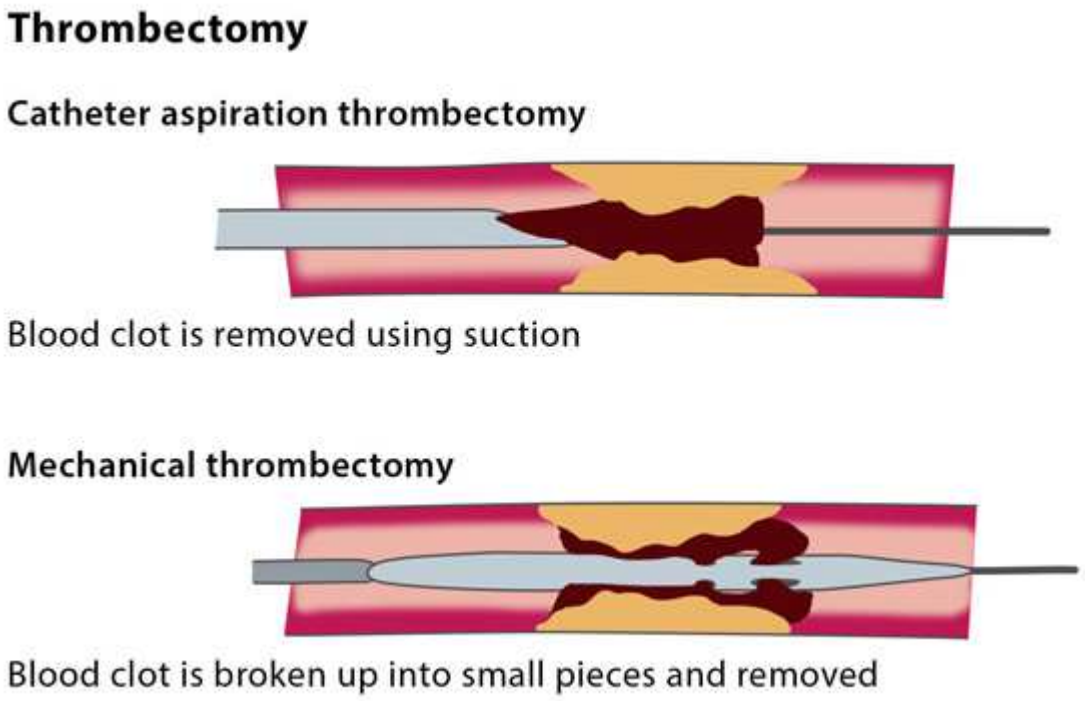
An endovascular thrombectomy is the removal of a thrombus (blood clot) under image guidance. A thrombectomy is most commonly performed for an arterial embolism, which is an arterial blockage often caused by atrial fibrillation, a heart rhythm disorder. An arterial embolism causes acute limb ischaemia (restricted blood supply) which leads to pain in the affected area. A thrombectomy can also be used to treat conditions in your organs, such as in your liver or kidney.

Your doctor may recommend that you have a thrombectomy as a treatment for stroke or for mesenteric ischaemia, where the blood flow in your small intestine is restricted due to inflammation or injury.

How does the procedure work?

The interventional radiologist will insert a 3 mm plastic tube (called a sheath) into the base of your skull or your groin. They will guide the sheath to the blood clot.

There are a number of different techniques for this procedure. The blood clot can be removed using a vacuum to suck the thrombus out, or mechanical equipment to break up the clot, or with clot using saline jets or ultrasound waves.



The devices for these techniques are inserted over the sheath into the affected artery. You may also need additional catheter thrombolysis, a procedure in which clot-dissolving medication is delivered to the clot under X-ray imaging.

A combined treatment using both thrombectomy and thrombolysis can continue over 24-48 hours with several follow-ups using angiography at regular intervals.

Why perform it?

An interventional thrombectomy is used to remove the blood clot and to avoid a permanent blockage in the vein or artery which would prevent blood flow to a limb or an organ, causing acute symptoms of pain, lack of a pulse, paleness, paraesthesia (when a limb 'falls asleep') and paralysis, as well as the possibility of permanent complications such as the death of tissue cells in your body.

A thrombectomy is often combined with other treatments, such as treatment to stop blood clots forming or thrombolysis, which involves using medication to break the blood clot down and is followed by strict observation for 24-48 hours.

You will also be treated for the underlying condition which caused the arterial thrombus, such as a heart rhythm disorder or a small blood clot caused by deep venous thrombosis.

What are the risks?

Minor risks include the risk of bruising at the puncture site in the neck or groin or in the affected limb. Major risks include the risk of the blood clot travelling deeper into the artery or vein or an injury to the affected area during the treatment.

In rare cases, patients experience bleeding in the skull as a result of the combined thrombectomy and thrombolysis – if this occurs, the treatment must be stopped immediately.

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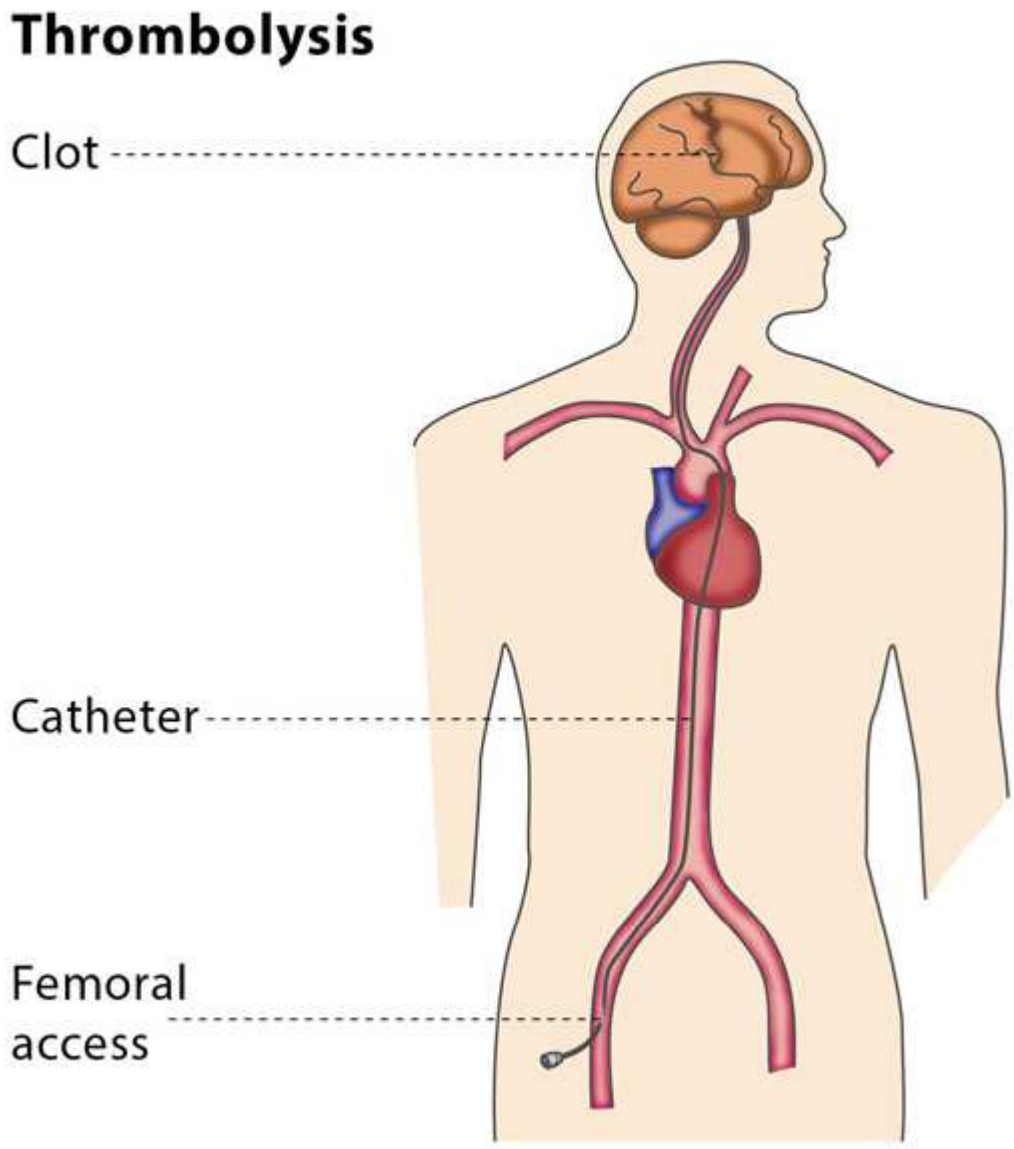
Thrombolysis

What is thrombolysis?

Thrombolysis is a procedure which uses medication to dissolve a blood clot. The medications used in thrombolysis are called thrombolytic agents.

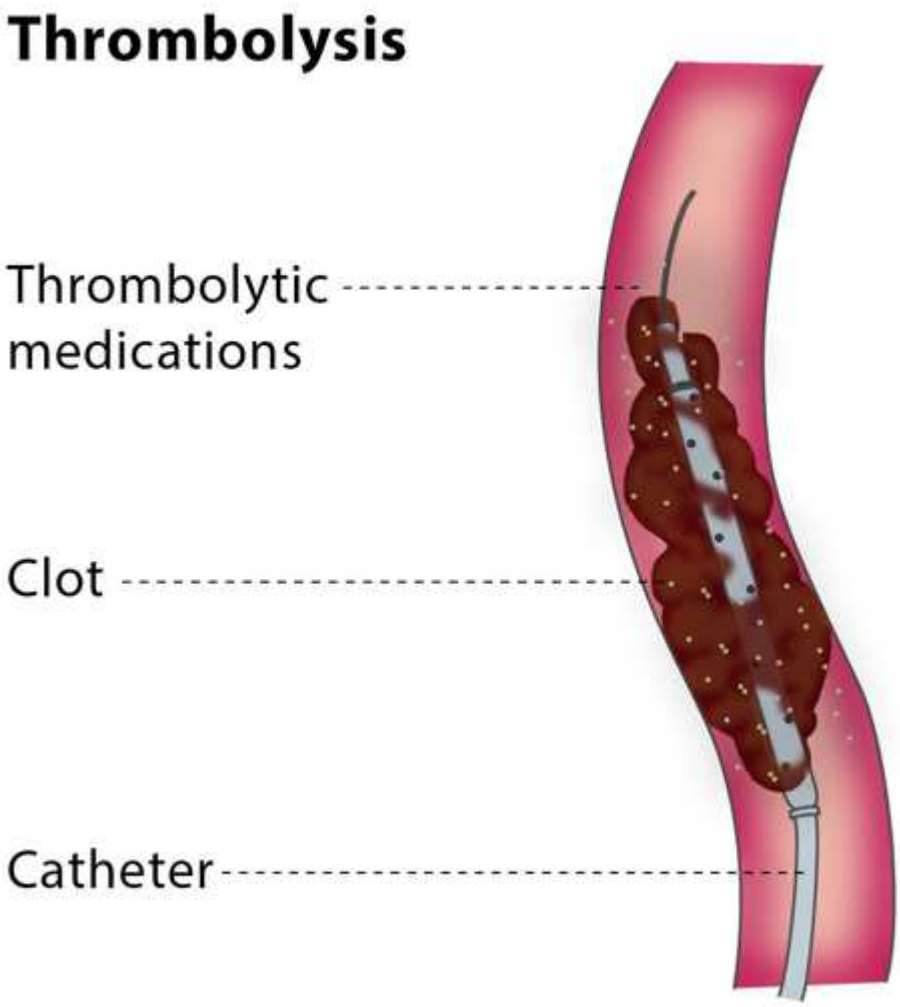
Thrombolysis is most commonly performed to treat a blood clot in the lower limbs, which causes acute limb ischaemia (restricted blood flow in the affected limb), leading to pain in affected area. It can also be used to treat blood clots in organs such as the liver or kidney, as well as treating restricted blood flow in the small intestine due to inflammation or an injury, massive pulmonary embolism (a blood clot in main artery of a lung) or stroke.



How does the procedure work?

The interventional radiologist will insert a 3 mm plastic tube (called a sheath) into the base of your skull or your groin and will guide the sheath to the blood clot.

Thrombolysis is performed using medications which prevent blood clots from growing (known as lytic substances), which are administered via a catheter into the thrombus. Catheters designed to be used in this treatment have lots of tiny holes. This means that the distribution of lytic substances can be spread out across the catheter and have maximum effect.



Why perform it?

Thrombolysis is performed to remove the blood clot and to prevent the vein or artery from becoming permanently blocked and restricting blood flow to a limb or organ. Restricted blood flow leads to acute symptoms of pain, a lack of pulse, paleness, paraesthesia (when a limb 'falls asleep') and paralysis, as well as the possibility of permanent complications such as tissue necrosis (the death of tissue cells in your body).

You will probably also need medication to prevent blood clots forming as well as a thrombectomy, for which you will be under strict observation for a 24-48 hours with several angiographic follow ups.

You will also be treated for the underlying condition which caused the thrombus, which may be a heart rhythm disorder or a small blood clot caused by deep venous thrombosis.

What are the risks?

Minor risks include the risk of bruising at the puncture site in your neck or groin, or in the affected limb.

The major risks tend to be due to the devices used in the procedure, such as the risk of the blood clot travelling deeper into the artery or vein or an injury to the affected area during the treatment.

In rare cases, the patient experiences bleeding in the skull due to the thrombolysis – if this occurs, the treatment will be stopped immediately.

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Transjugular intrahepatic portosystemic shunt (TIPS)

What is TIPS?

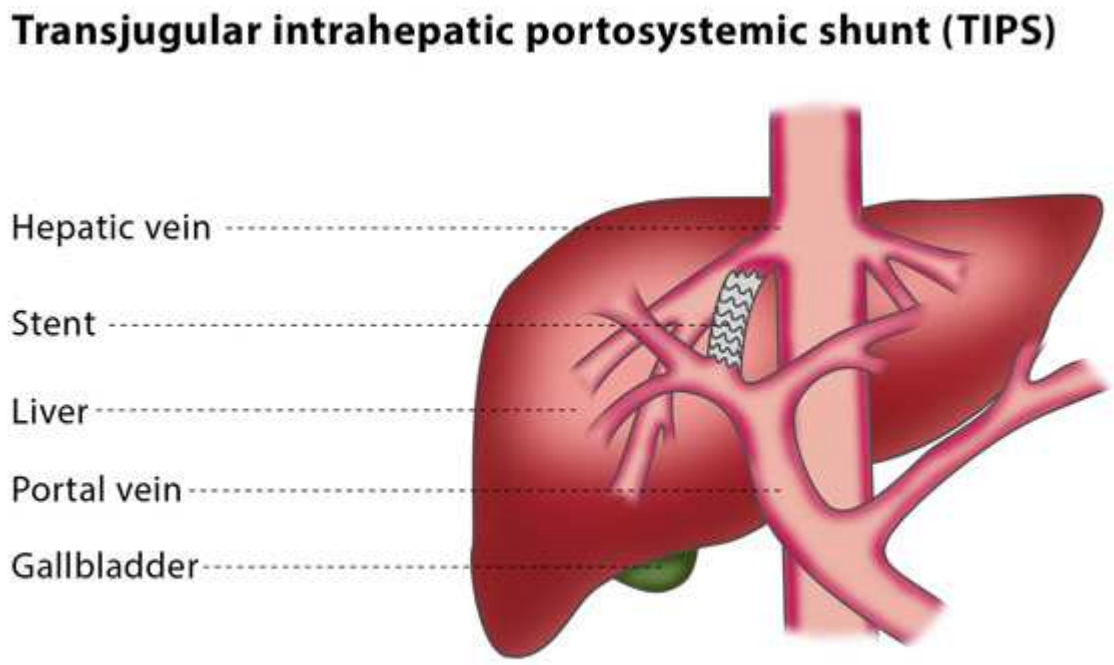
A shunt is an artificial passage which allows fluid to move from one part of your body to another. A transjugular intrahepatic portosystemic shunt (TIPS) connects the vein which brings blood from your gastrointestinal tract and intra-abdominal organs to your liver, and the vein from your liver to the right part of your heart.

How does the procedure work?

You will be conscious but sedated for the procedure, which the interventional radiologist will carry out using fluoroscopy and ultrasound for guidance.

The interventional radiologist will puncture your jugular vein on the right side of your neck with a needle and will then insert a vascular sheath over a wire into the inferior vena cava. They will explore the hepatic vein with a catheter designed for this purpose.

The interventional radiologist will puncture the portal vein through the liver with a special needle and position a wire between the two veins. After the area has been dilated, a stent or stent graft will be placed between the portal and hepatic vein to create a lasting connection.



Why perform it?

The TIPS procedure is usually performed in patients with liver cirrhosis. If you have this condition, your normal blood flow through the liver is blocked by scar tissue within the liver, which increases the pressure in your portal vein.

The increased pressure in your portal vein makes thin veins in your gullet or stomach become abnormally enlarged and so at risk of bleeding. Another symptom of liver cirrhosis is an abnormal collection of fluid (ascites) in the abdominal cavity.

You may be advised to undergo TIPS if you have varices which bleed acutely or recurrently and have not responded to other treatments.

Once the interventional radiologist has placed the shunt, the pressure in the portal vein decreases, protecting the area from bleeding and reducing the ascites.

What are the risks?

Because a liver suffering from cirrhosis is shrunken and the liver tissue can be very hard, it is possible to puncture the outside of the liver. This can cause bleeding which requires further treatment.

Another risk is that after the TIPS procedure ammonia from the intestine might bypass the liver and be delivered to the brain, which may result in a condition called hepatic encephalopathy, the symptoms of which range from mild (alterations in thinking) to severe (confusion and coma).

Due to the shunt, there is an increased amount of blood flowing directly to the heart, which can cause heart failure. If you experience this, your doctor will decrease or disrupt the blood flow through the TIPS.

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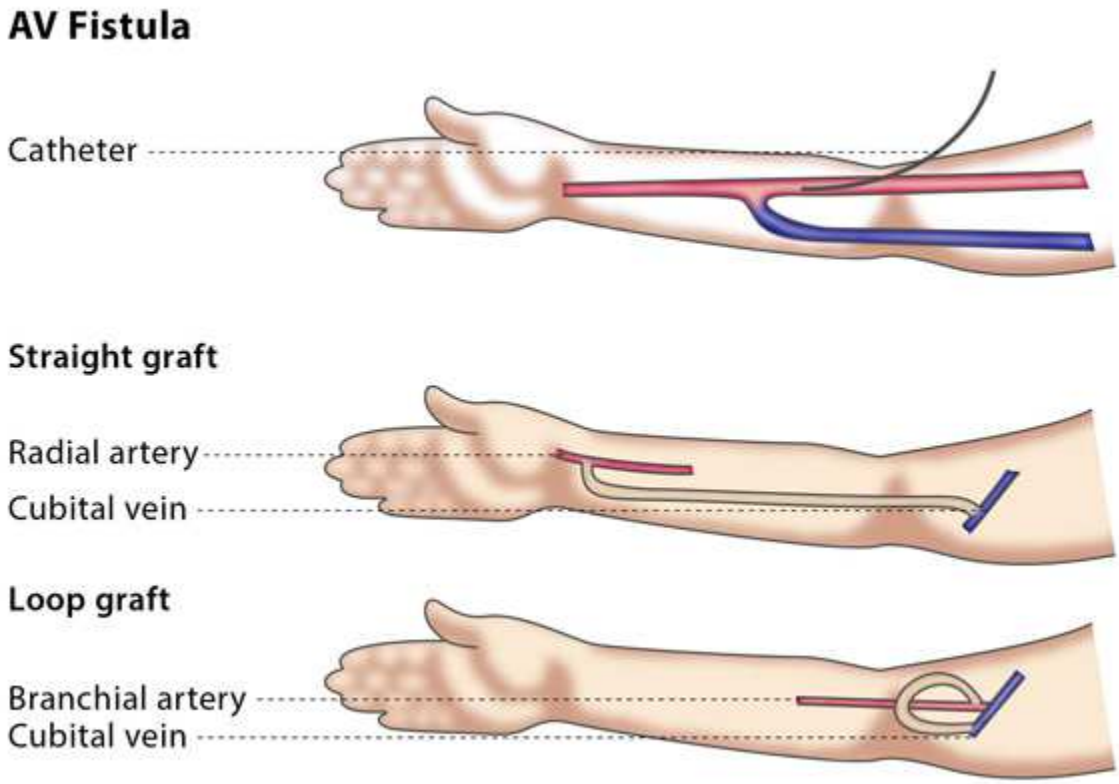
Treatment of AV fistula and graft malfunction

What is the endovascular treatment of AV fistula graft malfunction?

An AV fistula is an abnormal connection between an artery and a vein, and is sometimes surgically created to help with haemodialysis treatment. In these cases, a shunt graft is inserted to aid the treatment.

Unfortunately, sometimes the shunt will fail, known as graft malfunction. If you experience this, your doctor may recommend that you have endovascular treatment. The aim of this minimally invasive procedure is to stop narrowing of the fistula and remove any blockages from the shunt, such as blood clots.

The techniques used in the procedure depend on the type of lesion as well as its location.



How does the procedure work?

The interventional radiologist will usually enter the AV fistula through a direct puncture into the shunt, though they may instead choose to enter through a puncture in your elbow flexure or in your groin. The interventional radiologist will choose the entry point and technique depending on the condition which needs to be treated (such as narrowing of the fistula or a blood clot in the shunt) and its location.

If you have a narrowing of the AV fistula, the interventional radiologist may perform a technique called percutaneous transluminal angioplasty (PTA), which involves inserting and expanding a balloon to widen the vessel.

In rare cases, such as if the AV fistula starts to narrow again (restenosis) or if the area has been injured during the procedure, the interventional radiologist may insert a metal mesh tube (a stent) into the fistula. This acts like a skeleton and keeps the vessel open by supporting the walls of the vein. You may also need to take medication to prevent blood clots forming, but this depends on the PTA, the stent and your clinical situation.

If you have a blood clot, it can be sucked out by a vacuum, or mechanical devices can be used to break it up. These devices are applied over the sheath into the thrombus.

These techniques may need to be followed by catheter thrombolysis, in which medication is inserted through a catheter to break up the thrombus. If you undergo combined therapy with athrombectomy or thrombolysis, you will be kept under observation for 24-48 hours with repeated follow-ups using angiography.

Why perform it?

The endovascular treatment of AV fistula graft malfunction is recommended to prevent or reverse blockages and so restore the function of the AV fistula and shunt.

There are a number of techniques and tools which your interventional radiologist may use, depending on the problem. If you have a stenosis (narrowing), the best treatment option is a balloon which can be inserted and gently inflated, while if you have a blood clot, a combination of thrombectomy, thrombolysis and medication to prevent blood clotting may be recommended.

What are the risks?

Minor risks include bruising at the puncture site in your neck or groin or in the affected limb. Major risks include injury to the wall of the blood vessel, which can happen if the devices are used incorrectly. You may experience bleeding if you undergo thrombolysis.

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Tumour marking (pre-operative)

What is pre-operative tumour marking?

Pre-operative tumour marking is the placement of special markers like hook wires and coils inside the tumour under image guidance. Tumour marking may also include a colouring agent to aid in visualising the lesion.

Pre-operative tumour marking may be used to assist surgeons in the removal of tumour tissue by clearly defining the margins of the tumour. This will help a surgeon during the removal procedure by allowing them to both see and feel the edges of the tumour. This means the surgeon can remove as much of the tissue surrounding the tumour as possible, greatly reducing the need for further surgical procedures to remove further tissue. An imaging technique, such as mammography, CT or magnetic resonance may be employed to visualise the tumour.

How does the procedure work?

Pre-operative tumour marking is mainly used for tumours in the breast and lung. There are different types of tumour marking materials. The main purpose of these materials is to make the target lesion easy to find.

The IR will introduce the materials into the lesion of interest with the use of a puncture needle that is placed through the skin under image guidance. The most frequently used method of marking changes in the breast that cannot be seen or felt is the use of special hook wires that are "anchored" in the selected breast area.

To confirm that the tumour can be completely removed, the IR will perform a preparation X-ray, which also allows them to evaluate the marked edges of the tumour. It is possible to use pre-operative coil-marking of tumours in muscles and bones with the use of MR guidance.

Why perform it?

Pre-operative tumour marking is widely used in cases of breast lesions where it would otherwise be difficult to be sure of the exact margins of the tumour. About half of breast cancers in surgical practice are non-palpable in examination.

These patients are candidates for breast conserving therapy (BCT). It is crucial to remove the tumour with a proper margin of healthy tissues which minimises the need for further surgery.

Localisation markers can be applied to virtually all parts of the body. They offer perfect guidance for the surgeon, and surgical results can improve significantly with a reduced operation time.

What are the risks?

Intra-operative complications are related to the technique itself and include bleeding, bruising, infection and, if the patient has pulmonary lesions, pneumothorax (the abnormal collection of gas or air in the space between the lung and the chest wall). Dislocation of the marker can also occur between the time of pre-operative marking and surgery. All of these complications are extremely rare.

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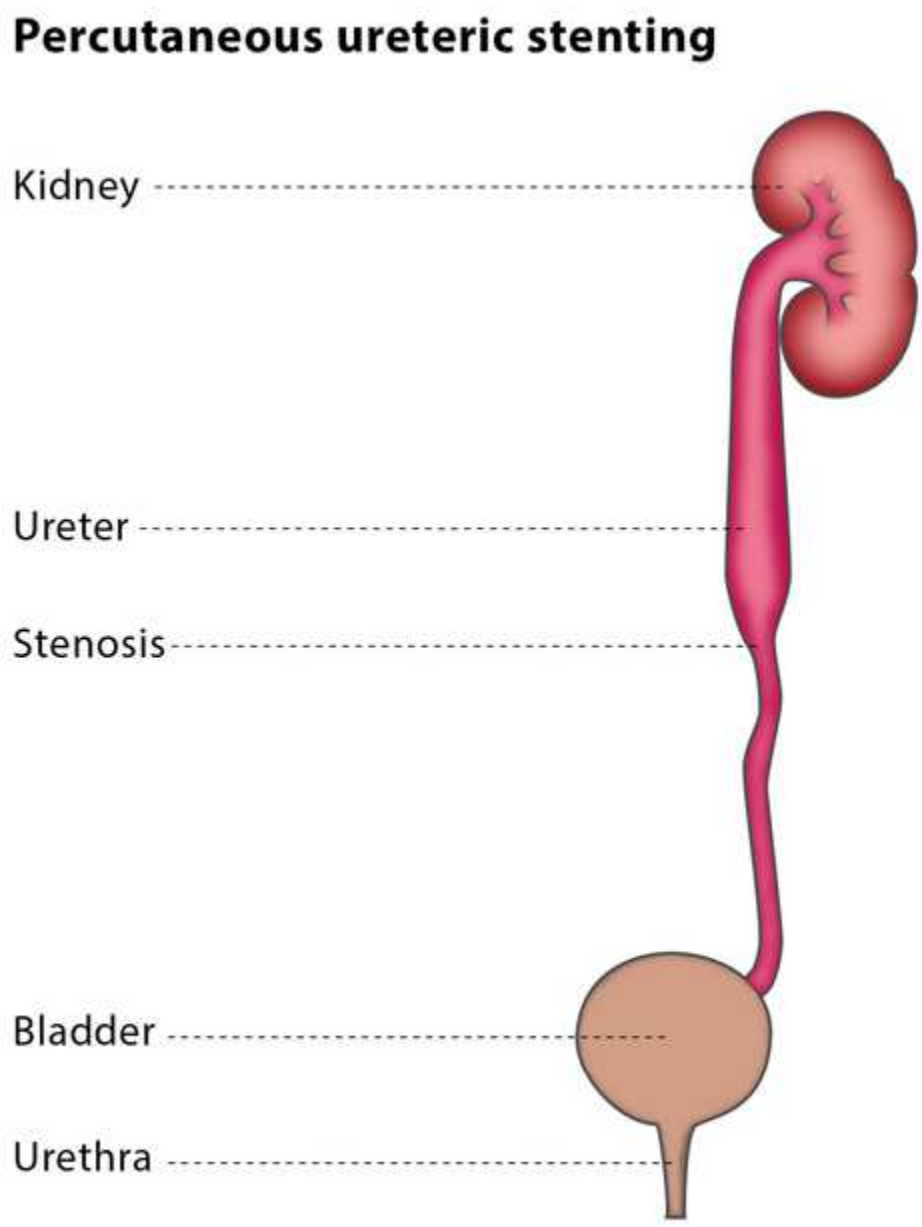
Ureteric stenting

What is ureteric stenting?

A ureteric stent (also called a J-J stent or double-J stent) is a thin, flexible plastic tube which is curled at both ends to avoid damaging the kidney and urinary bladder and to prevent it from dislocating. The stent is placed so that its upper end is in the kidney and its lower end is in the urinary bladder.

Ureteric stenting is the procedure in which stents are inserted into the ureter through the skin and via the kidney, to allow urine to pass from the kidney to the bladder.

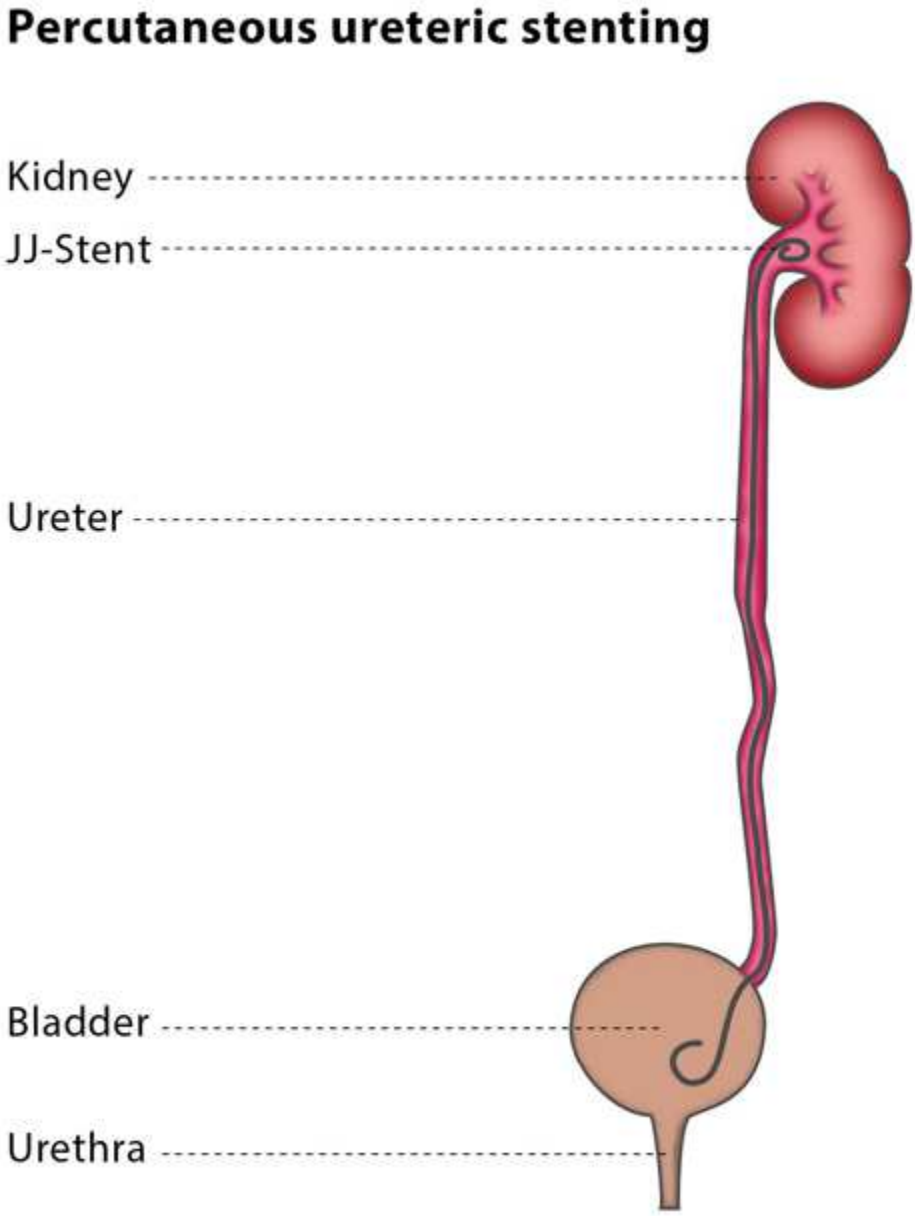


How does the procedure work?

You will lie on your stomach, usually with one side slightly raised on a pillow, and will receive an injection of a painkiller and a sedative. The interventional radiologist will insert a needle through your skin and into your kidney under the guidance of ultrasound, X-ray or CT. If you already have a nephrostomy catheter in place, the interventional radiologist will use this as the entry point for the needle into the skin.

The interventional radiologist will use the needle to insert a wire, which is then used to guide a nephrostomy tube into your kidney, and a catheter, which is led through the ureter and into your bladder. At this stage, you may experience discomfort in your bladder. The interventional radiologist then places the J-J stent over the wire. You may also have a nephrostomy catheter placed in your kidney to drain urine externally.

A ureteric stent must be changed every three to six months. This is usually performed as an out-patient procedure.



Why perform it?

Ureteric stenting is performed when long-term urinary drainage is needed. The procedure is often more favourable than nephrostomy, which can have a larger effect on the patient's quality of life.

What are the risks?

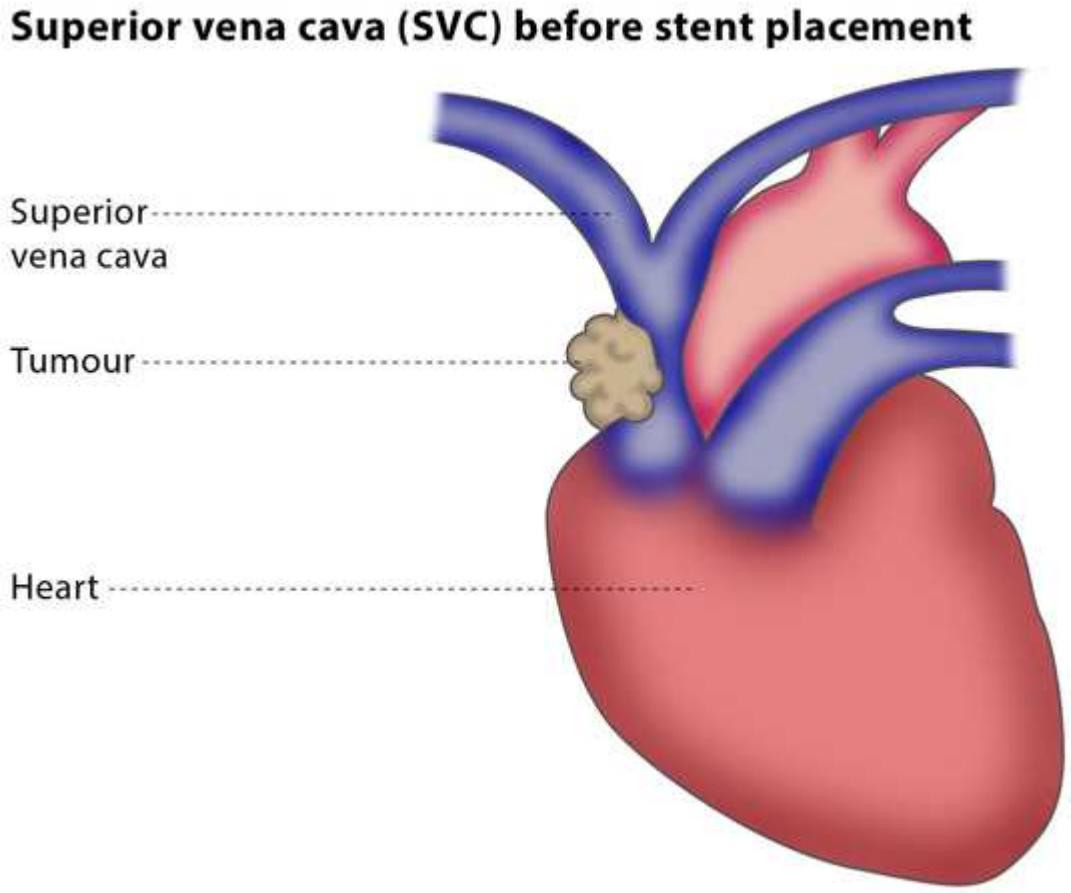
It is possible that you will experience minor bleeding from your kidney after the nephrostomy, though severe bleeding that requires treatment occurs in less than 5% of patients. In less than 1/500 patients an organ near the kidney is injured during the nephrostomy. Although temporary low-grade fever is common after the procedure, a high fever occurs in around 1-3% of patients, which is usually the result of an unresponsive infection.

Vena cava stenting

What is vena cava stenting?

A stent is a metal mesh tube. Vena cava stents are designed for use in the superior vena cava (SVC), which transports deoxygenated blood from the upper part of the body back to the heart. In rarer cases they are used in the inferior vena cava (IVC), which carries the deoxygenated blood from the lower part of the body back to the heart.

Vena cava stenting is used to manage a stenosis (narrowing) or blockage in the vein, which is most commonly caused by a malignant (cancerous) tumour. The procedure may be recommended if you are in an emergency situation, but this depends on your clinical symptoms.

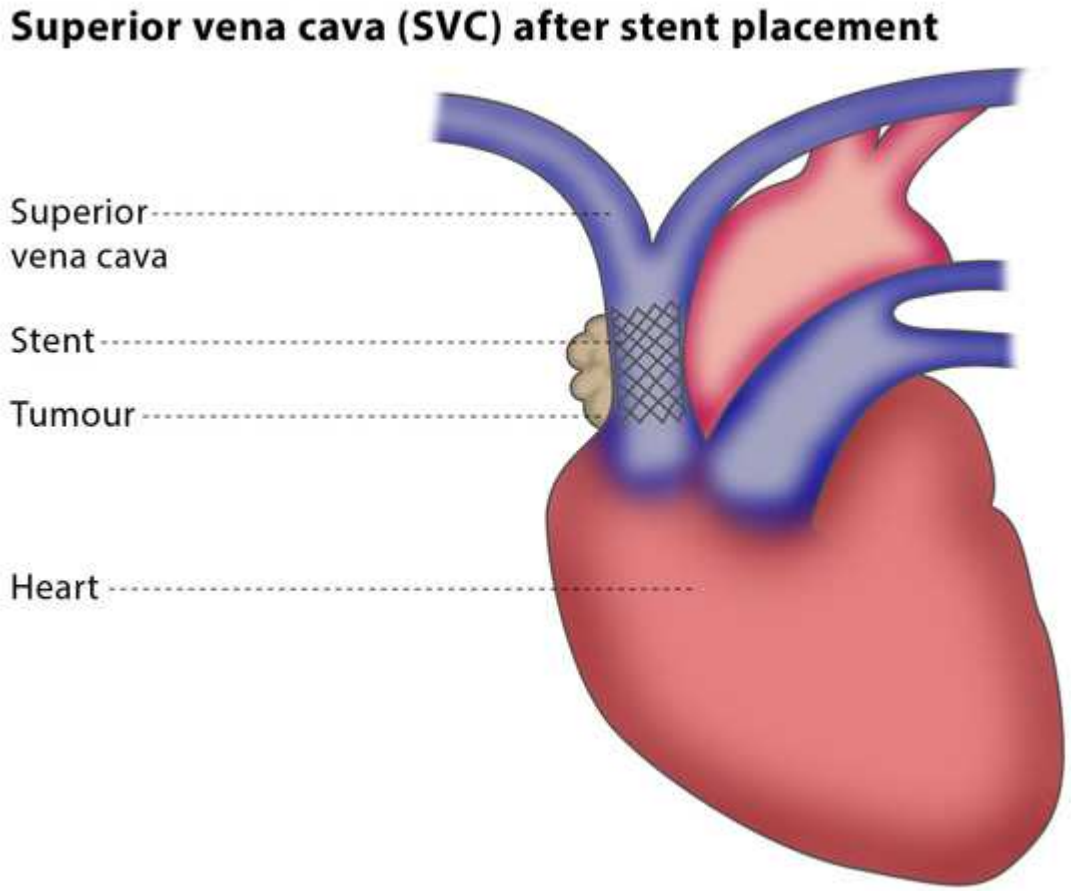


How does the procedure work?

The interventional radiologist will insert a 3 mm plastic tube (called a sheath) into the base of your skull or your groin. They will then guide the sheath near to the stenosis or blockage in the affected vein. The vein will be reopened using a metallic wire and a selective catheter using a technique called recanalisation, after which the vena cava stent is placed.

The stent is self-expanding and acts like a skeleton to keep the vena cava open. If your vena cava is completely blocked due to a tumour, your interventional radiologist may also insert a

tiny balloon which inflates once it is in the vein before and after inserting the stent. You will need to take medication that prevents blood clotting for 1-2 weeks following the procedure; the exact time period depends on the type of stent used and your clinical situation.



Why perform it?

The aim of vena cava stenting is to manage symptoms caused by an obstruction of the blood flow in the vein, which is much more common in the SVC than in the IVC.

The main symptom of an obstructed blood flow in the vena cava is shortness of breath, followed by swelling of the face, neck or arms, a headache, a cough and enlargement of the veins in the neck, chest and arms. You may experience other symptoms but they are rare.

Your symptoms should stop within 48 hours of the stent placement.

What are the risks?

There are some minor risks, including the risk of infection and bruising at the puncture site in your neck or groin. Major risks include the risk of the stent accidentally going into the heart during placement, the development of a blood clot, or the stent later becoming blocked due to a tumour, though in this case the vessel can be reopened in a second intervention.

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Venous access ports

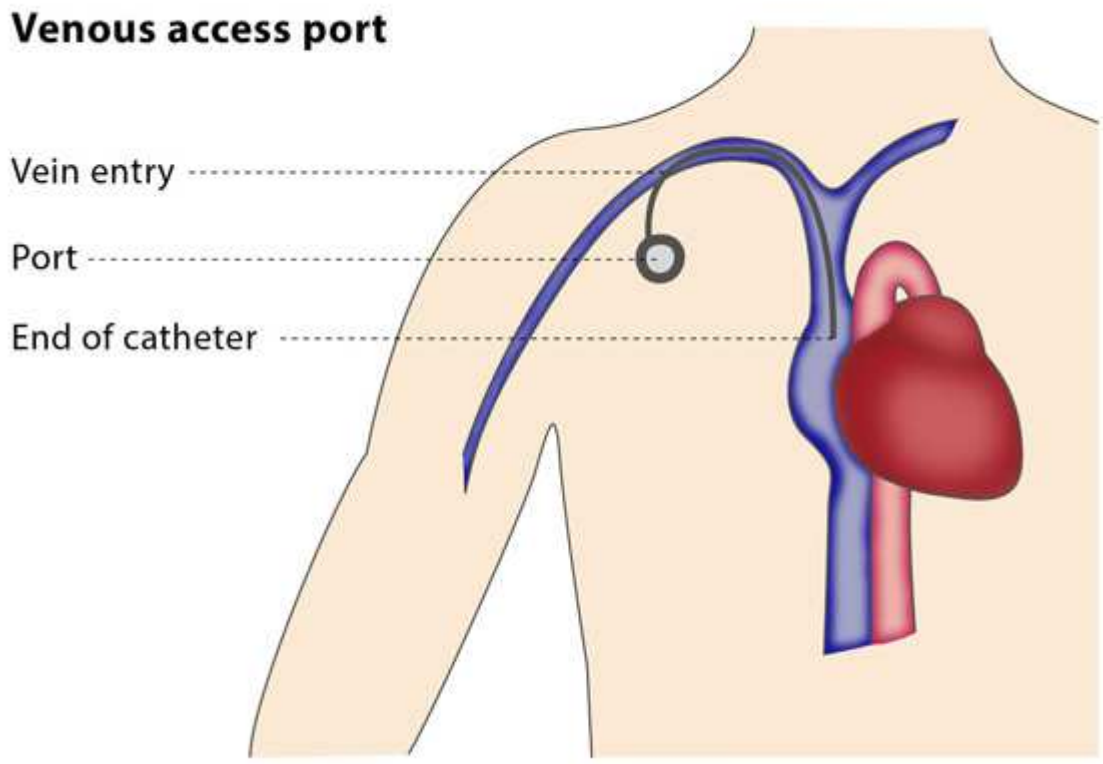
What is a venous access port?

A venous access port is a central venous access device that allows doctors to easily access your veins to give treatments and to take blood. It is made of a non-irritant material and is designed to be inserted under your skin and remain in place for weeks or months. It is also known as a subcutaneous infusion port, and includes a catheter (a thin hollow tube), which is inserted through the skin and is then connected to a port in a pocket under the skin.

Venous access ports are commonly used in the care of patients with chronic liver disease, particularly cancer patients, and are considered an integral part of cancer therapy. The port provides reliable access for taking blood, blood transfusions and administering nutrition, fluids and medication with minimal disruption to the patient's lifestyle. The venous access ports used today are light and can be used during imaging procedures.

How does the procedure work?

The procedure for implanting a venous access catheter is performed on an out-patient basis, underfluoroscopic guidance. In most cases, the port is inserted into the patient's upper chest or arm. The interventional radiologist will access the vein under ultrasound guidance using a thin needle. The right internal jugular vein, which collects blood from your brain, face and neck, is the preferred vein for this as the risk of blood clots and pneumothorax (collection of air or gas in the space between the lung and the chest wall) is lower.



Once the interventional radiologist has accessed the vein, they will use a guidewire to introduce a sheath and create a small pocket under the skin in the chest area. The catheter is then tunnelled to the vein and the port is connected to the catheter and placed in the pocket. Most physicians prefer to wait a week before starting to use the port. The wall of the port can be used for approximately 2000 punctures.

Why perform it?

The procedure is ideal for patients in need of long-term yet intermittent intravenous access. These patients typically receive chemotherapy or transfusions on a weekly or monthly basis and are unable to use a catheter inserted into a vein in the arm or hand.

Although the placement procedure is more complex and invasive than the more common technique of inserting a catheter into a vein in the hand or arm, central venous access ports reduce the restrictions on patient's daily activities, such as bathing, swimming and other forms of exercise. A venous access port has a lower risk of being dislodged than a catheter in the arm or hand. The port also requires fewer injections of heparin and fewer dressing changes. Because it is beneath the skin, it has an aesthetic advantage as well as a decreased risk of infection. Although venous access ports are expensive, the maintenance costs and risk of infection are low.

What are the risks?

Early complications are related to the technique itself, such as bruising, pneumothorax, nerve injury and an abnormal connection developing between an artery and a vein (called an arteriovenous fistula). Complications that may occur after the procedure include infection, a blockage or fracture in the catheter, blood clots and blockages in the vein. Some of these complications can have serious consequences and may even lead to death.

If the catheter breaks or fractures, any medication in the catheter may leak under the skin, causing soft tissue death or wounds that do not heal. Complications are usually associated with the route of implantation, a lack of experience in the physician implanting the port, and if appropriate care is not taken with the catheters while they are in use.

If the venous access port is implanted under image guidance, the risk of procedure-related complications associated with surgical implantation is virtually eliminated.

Venous recanalisation

What is venous recanalisation?

Blood clots that form inside veins can damage venous valves and cause chronic obstruction. This can lead to chronic high blood pressure inside the vein, resulting in swelling, inadequately oxygenated tissue and skin ulcerations. Returning the blood flow to an obstructed venous segment is referred to as recanalisation.

How does the procedure work?

Venous recanalisation involves delivering drugs to the area to break up the blood clots, preserving the vein valve function.

The interventional radiologist will insert a sheath (a long plastic tube 2-3 mm in diameter) into a vessel in your neck or groin, and will then guide the sheath under imaging to the obstructed vein. The interventional radiologist will deliver specific drugs used to dissolve clots (called fibrinolytic substances) into the clot via a catheter (a thin tube).

You may also need to undergo anti-coagulation therapy and a procedure called a thrombectomy in order for the treatment to be successful. This may include receiving regular imaging tests over the following 24-48 hours.

Why perform it?

The permanent obstruction of the vessel into an extremity or into an organ leads to various acute symptoms. These include pain, a weak or non-existent pulse, paleness, paraesthesia ('pins and needles') and paralysis. In the long term, it can cause permanent complications such as tissue necrosis (the premature death of cells).

You will also need to receive treatment for the underlying condition that caused the clot.

What are the risks?

Minor risks include bruising at the puncture site or in the affected area. Major risks triggered by the mechanical manipulation of the obstructed vessel include a deeper blockage of the clot or injury to the vessel wall. In rare cases, the procedure may cause bleeding within the skull, in which case the treatment must be stopped immediately.

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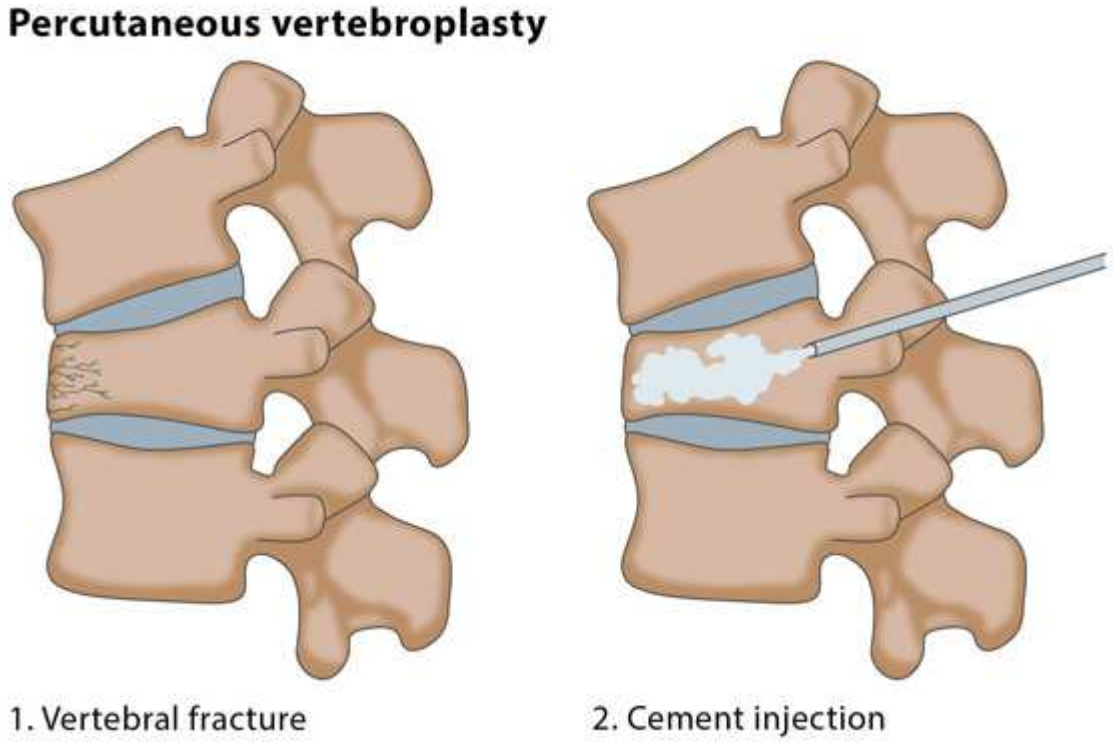
Vertebral augmentation

What is a vertebral augmentation?

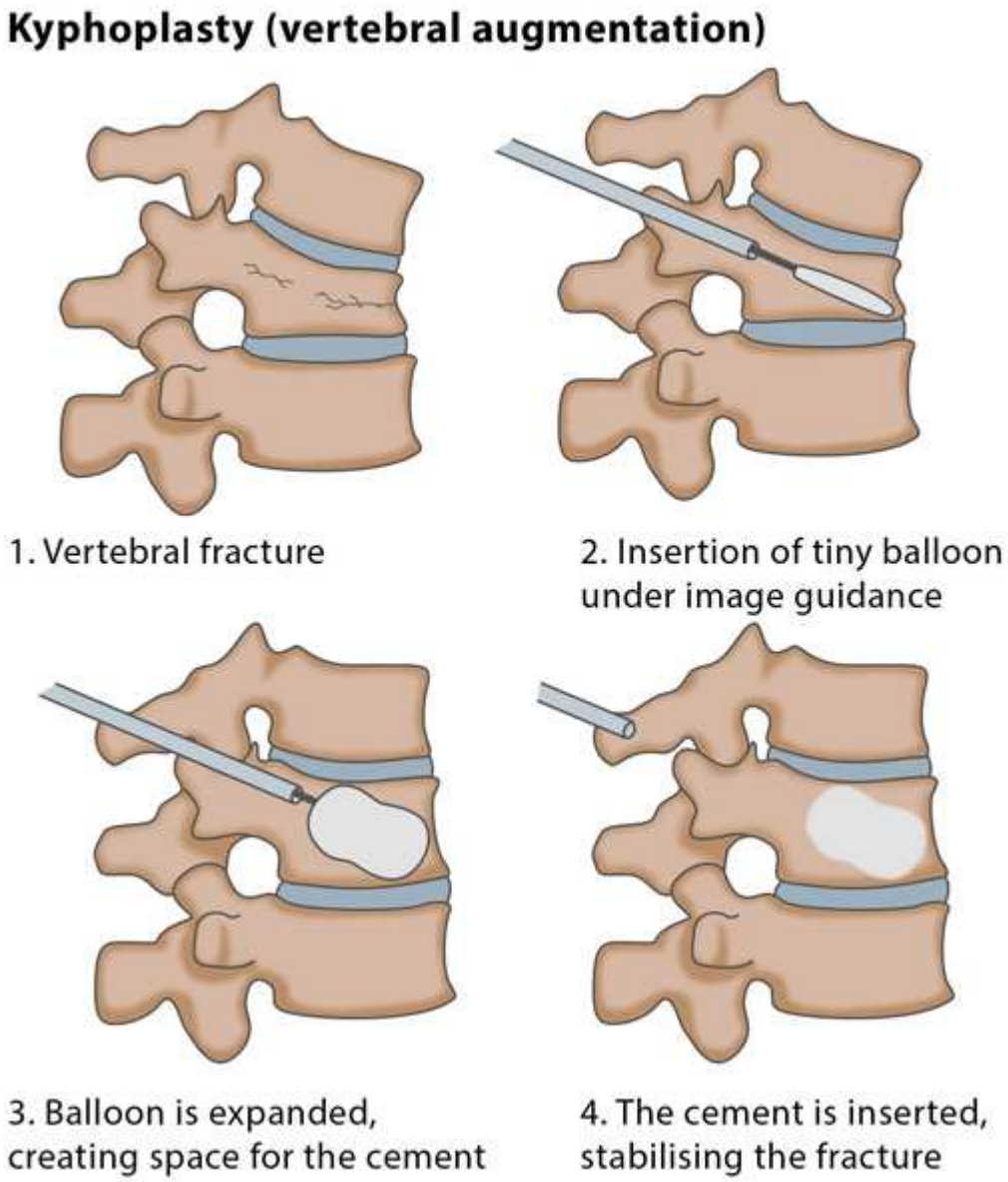
Percutaneous vertebroplasty is a minimally invasive procedure in which cement designed for use in bones is injected into the vertebral column (spine).

You may be recommended for this procedure if you are suffering from pain caused by a vertebral compression fracture. This means that a vertebra (part of your spine) has collapsed, possibly due to a fall or the weakening of the vertebra. The cement functions as a sort of internal cast, providing pain relief and stabilising the affected area of the spine.



Kyphoplasty is when balloons are inserted into the compressed vertebra under CT or fluoroscopicguidance. If you have suffered a fracture due to trauma or have significant height loss caused by a fracture, your doctor may recommend that you undergo kyphoplasty.

Vertebral augmentation is used to restore height by introducing an artificial vertebra. This may be followed with the injection of bone cement for the treatment of painful vertebral fractures, especially ones caused by trauma or entailing a significant loss of height.



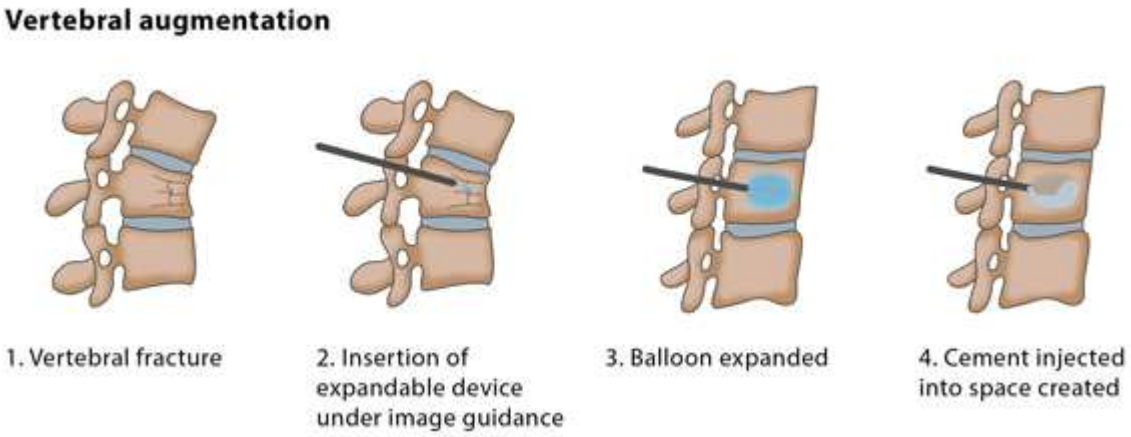
How does the procedure work?

Vertebroplasty and kyphoplasty are usually out-patient procedures. However, they are occasionally performed under general anaesthetic, and in these cases patients are kept in hospital overnight.

You will lie on your stomach and will be given a local anaesthetic. The interventional radiologist will insert a needle into the spine using X-rays (sometimes combined with CT) to guide the needle, and will inject bone cement to the targeted area to make sure the bone does not collapse again.

During the kyphoplasty procedure, two balloons are inserted and inflated before the injection of the bone cement, while, in the other vertebral augmentation procedures mentioned above, an implant is expanded before being inserted into the vertebral area.

If you are given a local anaesthetic, you will be kept in hospital for two hours after surgery to be monitored before being discharged.



Why perform it?

Vertebral augmentation can be performed to ease back pain which is caused by vertebral compressive fractures. Vertebral fractures are a common cause of pain and disability and are associated with increased mortality.

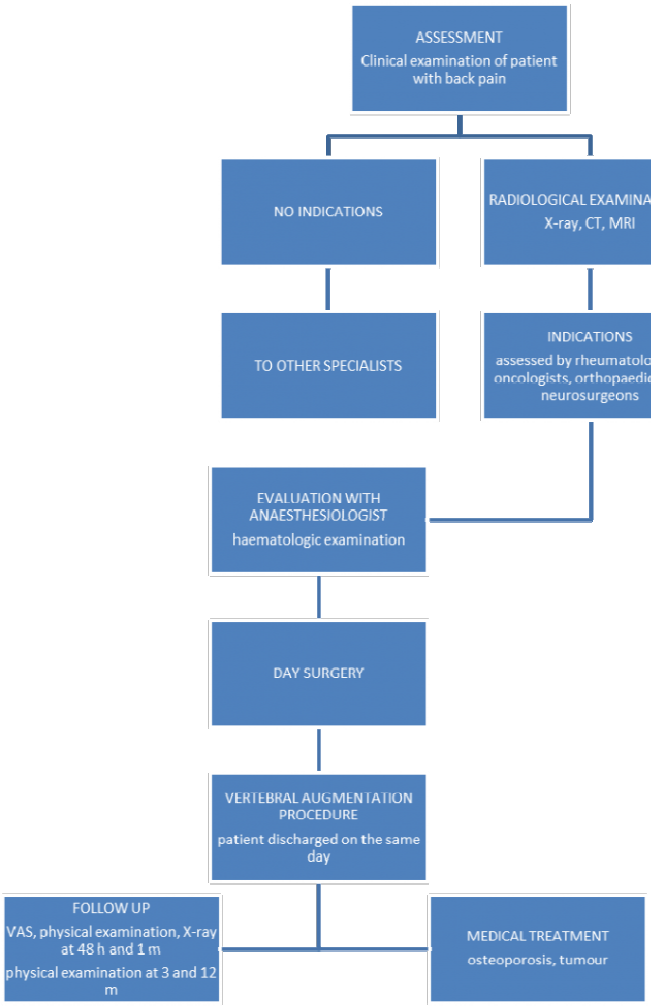
What are the risks?

A large number of studies have found vertebral augmentation to be an effective and safe way to treat vertebral fractures, especially when high-quality image guidance is used.

You may experience minor complications such as an infection, an allergic reaction or bleeding from the puncture site. You may also experience the accidental blockage of a vein in your lower back, small cement leaks in the soft tissue around the vertebrae, inflammation of part of the spinal nerve, or a small blockage in your lung.

Unfortunately, there are a number of possible severe side effects, though these are rare. Severe side effects include cement leaks into the surrounding area (a condition which requires immediate surgery), spinal cord direct lesion, which can lead to disability, and a large blockage in the lung, which can cause acute respiratory failure and death.

Flow chart for patients



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Finito di redarre il 11.09.2014