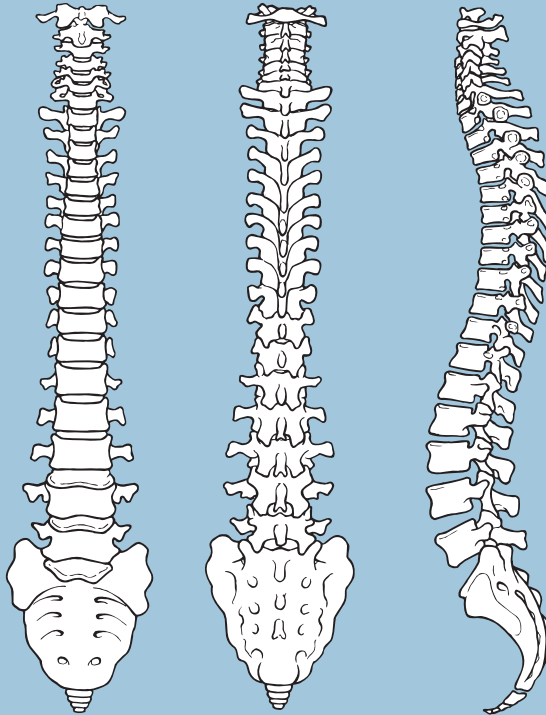




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British Association of Spine Surgeons

Degenerative Scoliosis: Surgical Options



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Surgical techniques included in this booklet

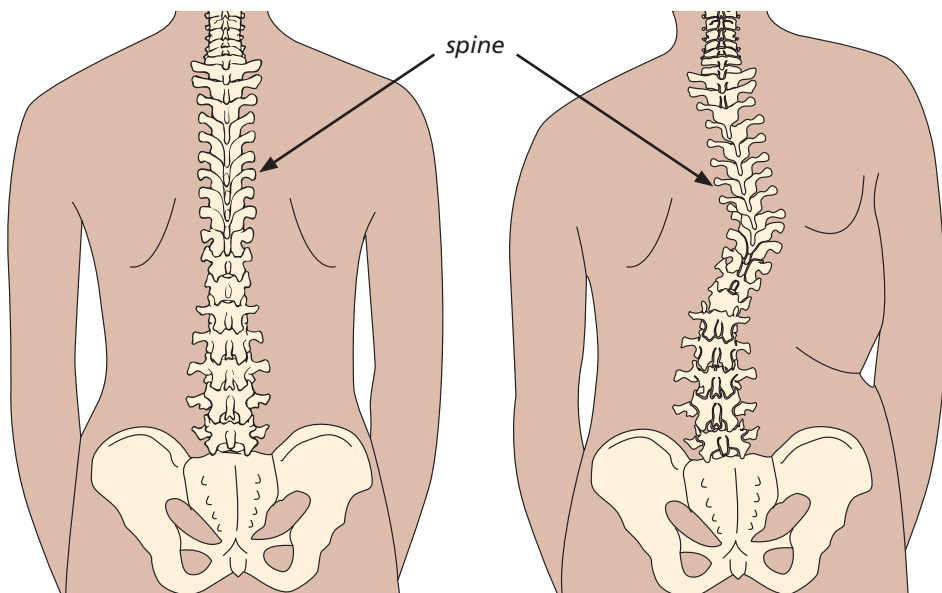
Surgeon to tick which techniques required before giving to patient:

| Technique | Page |
|---|-------------|
| <input type="checkbox"/> Laminectomy and laminotomy | 9 |
| <input type="checkbox"/> Minimally invasive decompression | 11 |
| <input type="checkbox"/> Bone graft | 11 |
| <input type="checkbox"/> Pedicle screw fixation | 11 |
| <input type="checkbox"/> Pelvic screw fixation | 12 |
| <input type="checkbox"/> ALIF | 15 |
| <input type="checkbox"/> TLIF | 16 |
| <input type="checkbox"/> PLIF | 17 |
| <input type="checkbox"/> LLIF / XLIF | 18 |
| <input type="checkbox"/> OLIF | 19 |
| <input type="checkbox"/> Thoracotomy | 19 |

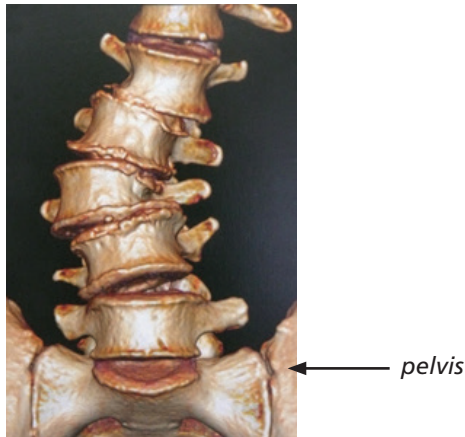
Following your investigations and consultation with your spinal surgeon, you have been diagnosed with degenerative scoliosis, sometimes known as adult onset scoliosis. This is a condition where there is a curvature of the spine from side to side caused by the degeneration (wear and tear) of the intervertebral discs and the facet joints that link at the back of the vertebra (bone of the spine). Everyone experiences natural age-related changes in the joints (osteoarthritis) and discs (degenerative disc disease) as they get older but for some people this process is accelerated and if more pronounced on one side, then the spine is unable to maintain its proper position and degenerative scoliosis can result.

Normal spine

Scoliosis



CT scan showing degenerative scoliosis (front view/close up)

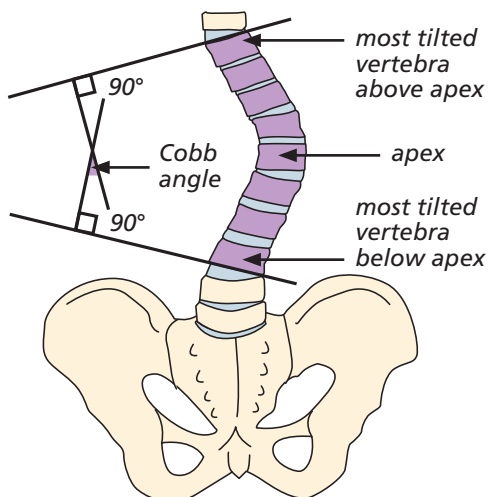


The degree of curvature may vary from mild to severe. Degenerative scoliosis is only diagnosed when there is a sideways spinal curve of at least 10 degrees, called a Cobb angle (see the diagram below to see how this is measured). Special standing and full length spine X-rays are necessary to be able to measure this.

Cobb Method

To measure the degree of scoliosis:

- choose the most tilted vertebra above and below the apex of the curve
- the angle between intersecting lines drawn perpendicular to the top of the top vertebra and the bottom of the bottom vertebra is the 'Cobb angle'.



Symptoms from degenerative scoliosis usually start gradually and can include back pain, pain in the thighs and buttocks, stiffness, muscle tightness and pain on the side of the inward curve (crushing) or outward curve (stretching) which can come and go. For most patients, this condition can be treated conservatively (manipulation, physiotherapy, medication or injections), combined with some lifestyle changes. If the degenerative scoliosis causes the spinal cord or nerve roots to become involved either by narrowing of the spinal canal (stenosis) or severe stretching of the spine, nerve symptoms can occur.

A nerve is like an electrical wire. It tells your muscles to move and gives your brain information about various sensations such as pain, temperature, light touch, pressure sensation and position of your leg.

The normal spinal column has a central canal (or passage) through which the spinal nerves pass down. At each vertebral level, spinal nerve roots branch out to each side. The solid spinal cord stops at the top of the lumbar spine (lower back) and from this point the nerves to the bottom and legs pass through the lower canal like a horse's tail (cauda equina). The spinal cord, nerve roots and cauda equina are surrounded by cerebrospinal fluid (CSF) and are all contained within a membrane, or covering, called the dura mater, rather like the thin layer that covers a boiled egg.

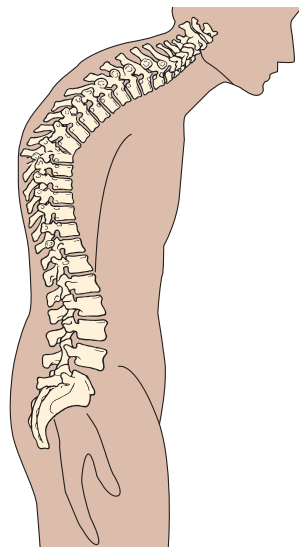
The intervertebral disc is a structure between the vertebrae (bones of the spine), which acts as both a spacer and a shock absorber. Over time as disc degeneration (wear and tear) occurs, the disc will lose water and height which can increase the load on the interlocking connections (facet joints) at the back of the spine. Like any joint in the body, the facet joints can become inflamed due to arthritis and be a source of pain and stiffness, usually in the lower back. When arthritis is severe and affects one side of the spine more than the other, the facet joints can begin to slide, tipping the spine over to one side.

When spine curvature causes the nerves to be compressed or stretched too much, it can produce symptoms of sharp pain, pins and needles, numbness or tingling in the area of the leg that the particular spinal nerve affected supplies. This is commonly referred to as sciatica or sciatic pain. In rare cases, it can produce severe pain and even weakness in the legs, such that the 'legs don't work'. In most cases, the symptoms are produced when standing or walking and are relieved by sitting or bending forward. In rare cases the nerves which control your bladder, bowel and sexual function can be compressed. This is known as cauda equina syndrome (CES) and is often required to have urgent surgical intervention. Fortunately, immediate spinal surgery is only necessary in a few cases.

Excess body weight will increase the load and pressure on the intervertebral discs and may exacerbate any structural problems, causing an increase in symptoms. Losing weight may be beneficial if a patient is obese.

Kyphosis

When there is a severe spinal deformity with a scoliosis curve of 90 degrees or more, there can be a 'hunched' appearance (kyphosis) to the way a person stands. In some cases, this can cause balance problems and could start to push the rib cage against the lungs or other internal organs which could lead to difficulty taking deep breaths or eating.



Major surgery to try and correct the spinal curvature and relieve the symptoms from degenerative scoliosis is only ever considered when all conservative treatments (medication, physiotherapy, manipulation or nerve root injections) are no longer giving any benefit, but a patient's overall health, fitness and risk factors (like heart or lung problems) for such a lengthy operation need to be seriously considered beforehand. This includes risk factors which can negatively affect spinal fusion (see 'factors which may affect spinal fusion' on page 27) and may rule out this type of surgery as an option.

Most people with symptomatic degenerative scoliosis tend to be aged 60 and older, so a person's age is not necessarily the reason not to go ahead with correction surgery. For those, however, who may be frail or have health problems which could increase their risk of potentially life threatening medical complications (like a stroke or heart attack), then a 'smaller', shorter operation to take the pressure off the nerves (decompression) alone, may well be the safest option.

The aim of degenerative scoliosis surgery is to take the pressure off the nerves (decompression) and to stabilise the spine using a series of surgical implants, including rods and screws and bone graft to fuse (join) together the bones of the spine to stop them moving. Often the surgery is performed in two stages, sometimes weeks apart, because of the length of time it can take to carry out and to allow a suitable time for recovery in between each procedure.

Degenerative scoliosis surgery is considered to have the highest potential risks of all spinal operations currently performed and should therefore be considered cautiously. Reported rates in the literature of degenerative scoliosis correction patients having a complication related to their surgery is about 8 out of 10 cases, of which 3 out of 10 cases are considered major complications. 13 out of 100 cases are reported to require further surgery within one year due to complications and 25 out of 100 cases within three years.

The expectation of surgery is not to 'cure' the problem but to try and give a good percentage improvement and relief of some of the symptoms. Good relief from leg symptoms following this type of surgery usually occurs in approximately 7 out of 10 people. This is not necessarily felt immediately but over a period of time (often several months). Sometimes, however, numbness or weakness in the legs can persist (even with a technically successful operation). This can occur when people have more extensive stenosis and nerve damage before they have surgery. The results of the operation are not nearly as reliable for the relief of back pain. Some of the back pain experienced comes from muscular spasms, therefore, surgery cannot eliminate this and should not be regarded as the main aim of the surgery.

Expected outcomes from all the different surgical techniques are very similar and the choice of approach will be decided by your surgeon, who will take into consideration your symptoms (back pain and/or leg pain), previous surgery, your general body shape and fitness. They will also consider the advantages and disadvantages of each approach, including the risks associated with them.

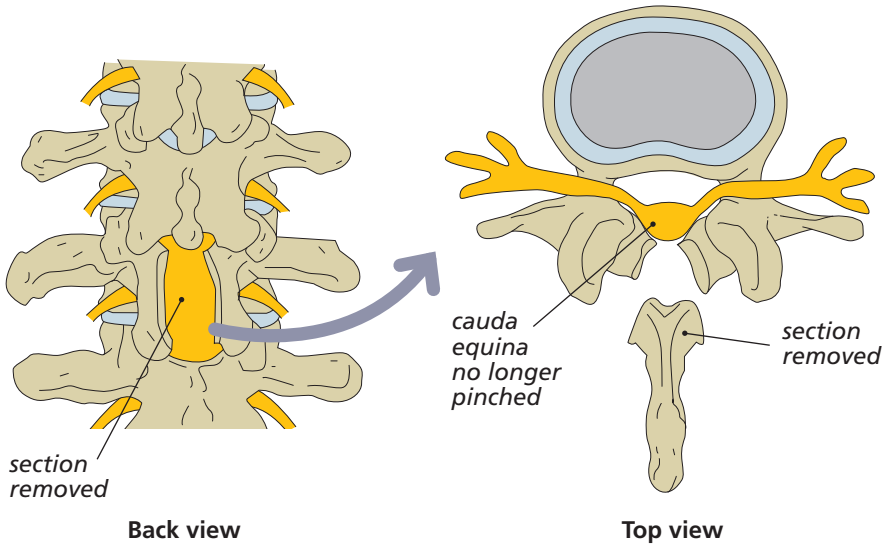
The operation

Decompression

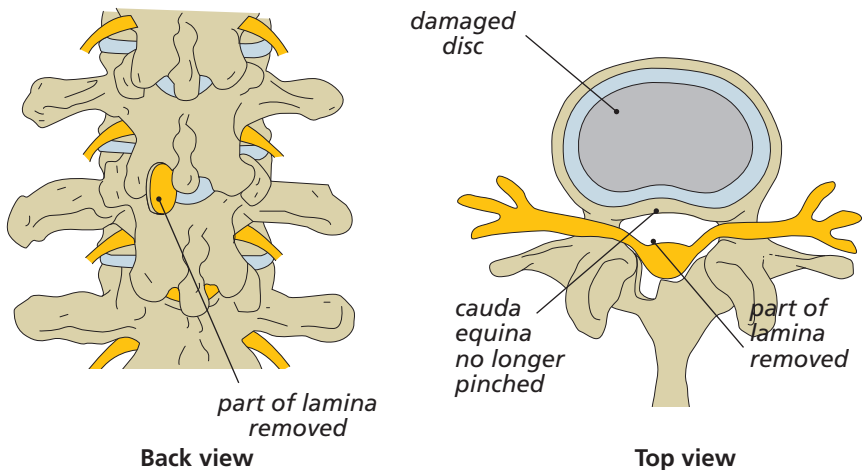
Laminectomy and laminotomy

This is performed through an incision in the lower back. The position and length of incision is determined by which levels of the spine and how many nerves are involved. The muscles are then held apart to gain access to the bony arch and roof of the spine (lamina). Next, the surgeon needs to gain entry into the spinal canal by removing some bone, either by cutting away the whole area of lamina (laminectomy) or making a small window in the lamina (laminotomy) with a high-speed burr (like a dentist's drill). Further bone is then removed and often the facet joints, which are directly over the nerve roots, are undercut (trimmed) to relieve the pressure on the nerves and give them a wider passage as they pass out of the spine.

View of the surgical removal of the lamina (laminectomy) to take the pressure off the nerves



View of the surgical removal of one side of the lamina (unilateral laminotomy) to take the pressure off the nerves



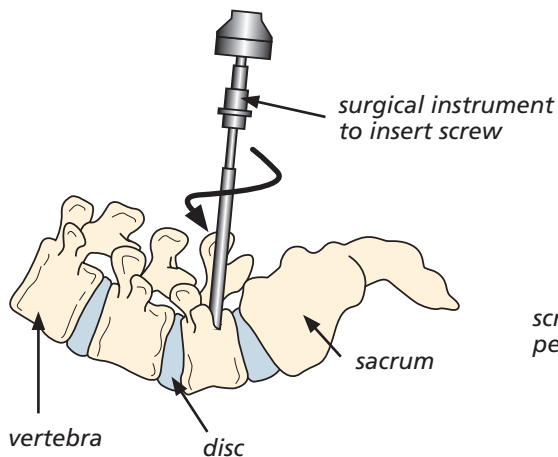
Minimally invasive (tubular) decompression

With this approach, the surgeon attempts to reduce muscle dissection and injury by working through a narrow tube. There may be several small incisions depending on how many nerves are involved.

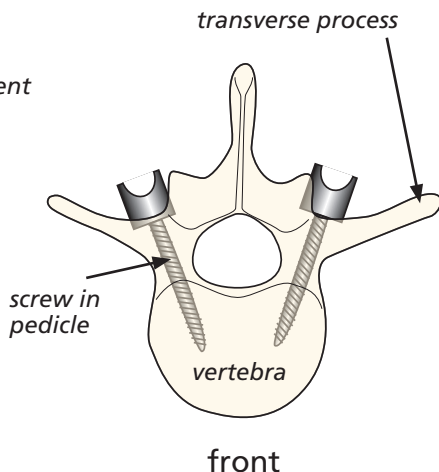
Stabilisation

- 1 Bone graft.** This is used to fuse (join) the spine in conjunction with other techniques which hold the spine stable while new bone is growing. When it is placed in the spine your new bone will, over time, grow into the bone graft. This is a biological process over 6–12 months, known as spinal fusion. There are several techniques to get bone graft needed for spinal fusion:
 - **patient's own bone** (autograft bone). The bone which is removed during surgery can be used as a bone graft. If more is needed, it can be taken from the pelvis (iliac crest) if required
 - **artificial bone** (synthetic bone). These are bony like substances used in addition to patient's own bone
 - **donor bone** (allograft bone). Donor bone graft does not contain living bone cells but acts as calcium scaffolding which your own bone grows into and eventually replaces.
- 2 Pedicle screw fixation.** This is a system of screws and rods which hold the vertebra together and prevents movement at the segment that is being fused, like an internal scaffolding system. Screws are placed into the part of the vertebra called the pedicle, which go directly from the back of the spine to the front, on both sides, above and below the unstable spinal segments. These screws then act as firm anchor points to which rods can be connected. After the bone graft grows and fuses to the spine (after many months), the rods and screws are no longer needed for stability. However, most surgeons do not recommend removing them except in rare cases.

Side view of pedicle screw placement

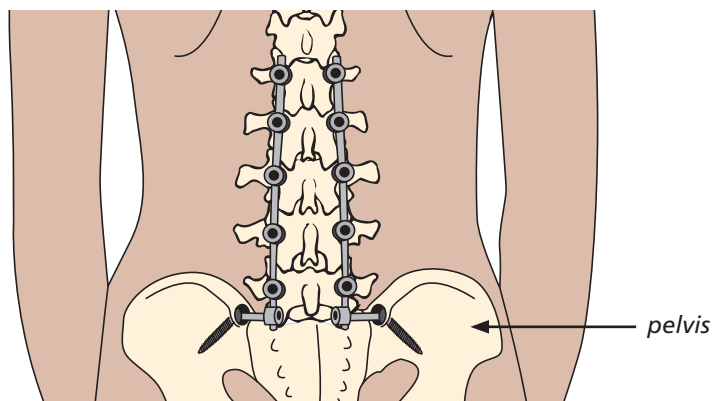


Overhead view of pedicle screw in vertebral body



- 3 **Pelvic screw fixation.** Screws can be placed into the pelvis and joined to the pedicle screw system giving a strong anchor point to the entire system, thus connecting the spine to the pelvis. This provides additional stability to the construct and improves bony fusion.

Back view of pedicle screws, rods and pelvic screw fixation



Additional stabilisation techniques which may be used in conjunction with these methods of surgery

- 4 **Interbody fusion.** This is a procedure where the surgeon will remove the intervertebral disc, the structure between the bones of the spine (vertebra) and fuse (join) the space together with a cage and bone graft. This can
- 1 increase the height of the disc space, thus opening the space for the nerves
 - 2 improve the alignment of the spine
 - 3 enable the surgeon to achieve an all-round (360°) spinal fusion.

Intervertebral fusion cages

This is like a hollow Lego brick which props up the disc space between the two bones (vertebra). It is a tight fit and gives immediate stability. The cage is available in different width, height and depths to fit your spine exactly. It is made from carbon fibre, PEEK (reinforced plastic) or titanium metal. They can be filled with bone graft or artificial bone if required. Your surgeon may decide the best approach and type of cage suitable to your condition in order to restore alignment and open areas in the disc space which may have collapsed and are causing nerve root symptoms.

Examples of fusion cages

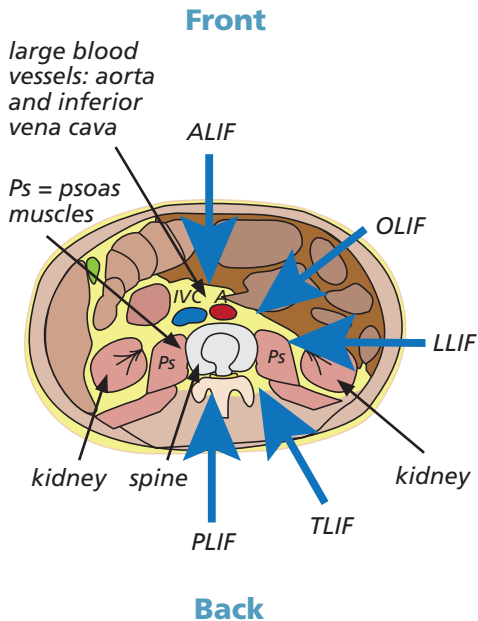


In certain cases, it is necessary to fix the cage with screws into the bone above and below.

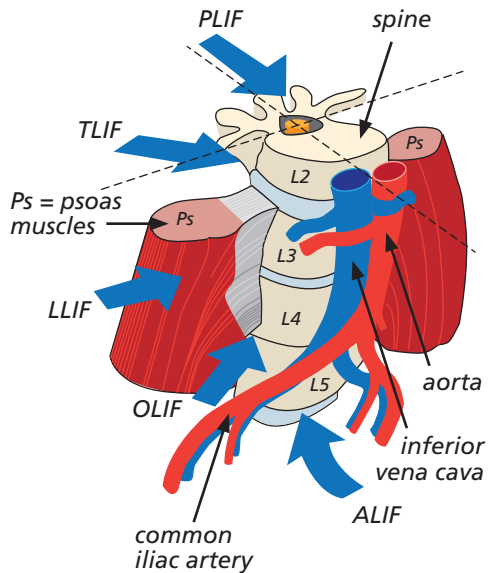


The surgical approach (way in) to interbody fusion varies and can include: **posterior lumbar interbody fusion (PLIF)**, **transforaminal lumbar interbody fusion (TLIF)**, **lateral lumbar interbody fusion (LLIF)** also known as **XLIF**, **oblique lumbar interbody fusion (OLIF)** and **anterior lumbar interbody fusion (ALIF)**, as illustrated below.

Overhead view



Front/Side view



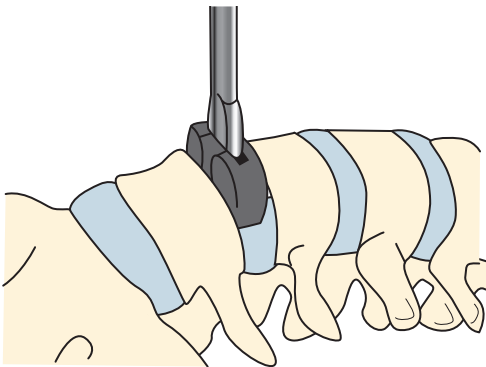
Anterior lumbar interbody fusion (ALIF)

This is performed through an incision in the tummy. The abdominal contents lay inside a large sack (peritoneum) that can be retracted (moved to the side), allowing the surgeon access to the front of the spine without entering the abdomen. The large vessels (aorta, common iliac artery and vena cava) that lie over the front of the spine are carefully moved aside. Sometimes surgery is performed in conjunction with a vascular surgeon, who will mobilise the blood vessels if there are any concerns or difficulty with this.

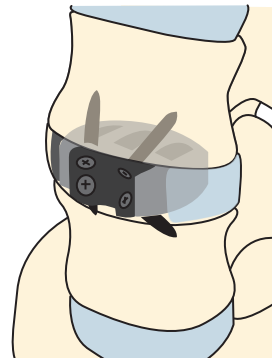
After the blood vessels have been moved aside, a 'window' is cut in the anterior ligament and fibrous wall of the disc (annulus fibrosus). The disc material (nucleus pulposus) is then removed and the cage, containing bone graft, is placed in the space created. Some cages require placement of screws or blades into the vertebral body above and below them. Your own bone will, over time, grow into the bone graft.

This approach to the spine has risks and complications which are specific to it and are listed below the general ones (see 'Risks and complications').

Diagram of cage placement



Cage in situ

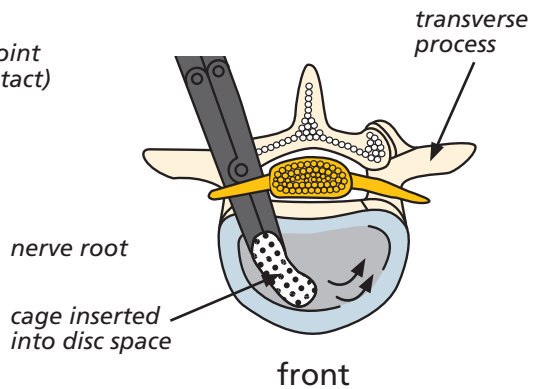
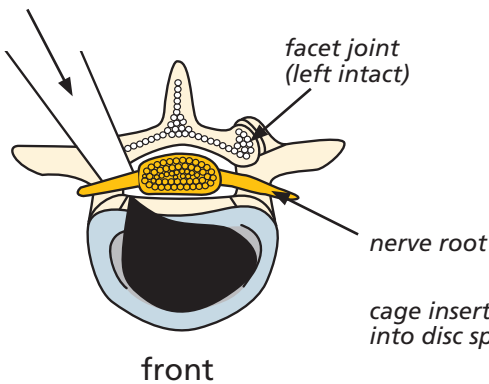


Transforaminal lumbar interbody fusion (TLIF)

This is performed through an incision in your back. The muscles are held apart (retracted) on one side to gain access to the bony arch and roof of the spine (lamina). Next, the facet joint, which is directly over the nerve root, is removed on one side to gain access to the disc. The side approached is usually the same as any leg symptoms which might be experienced, if appropriate, as this will enable the surgeon to explore the nerve root at the same time and ensure that there is no pressure on it (**decompression**). The disc is then removed right back to the bone edge of the vertebral body (end plates). Bone graft is then placed in the space created and/or within the cage and laid between the outer segment of the spine in between the transverse process (inter-transverse region). Your own bone will, over time, grow into the bone graft.

Transforaminal lumbar interbody fusion (TLIF)

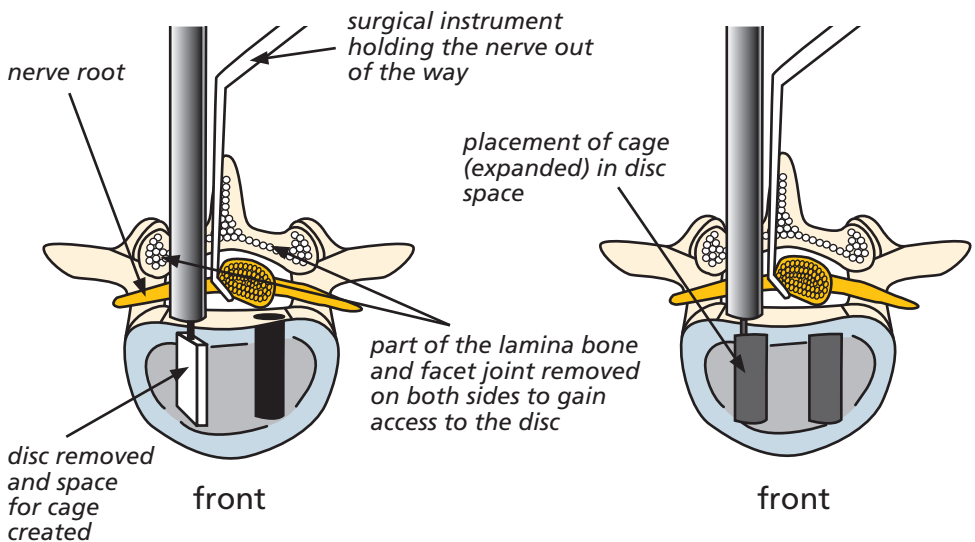
facet joint removed to gain access to the disc for removal



Posterior lumbar interbody fusion (PLIF)

The spine is approached through an incision in the midline of your back and the muscles are lifted off the bony arch (lamina) and held back off the spine. Next, part of the lamina bone and facet joints on both sides, which are directly over the nerve roots, are removed to gain access to the disc. This will also remove any pressure off the nerve roots (**decompression**). The disc is then removed, right back to the bone edge of the vertebral body (end plates). Bone graft is then placed in the spaces created and/or within the cages placed both sides and laid between the outer segments of the spine in between the transverse process (inter-transverse region). Your own bone will, over time, grow into the bone graft.

Posterior lumbar interbody fusion (PLIF)

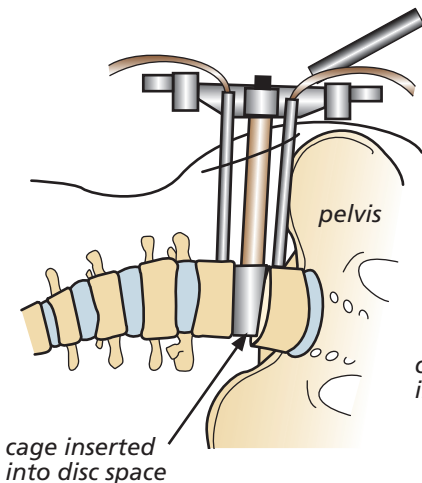


Lateral lumbar interbody fusion (LLIF/XLIF)

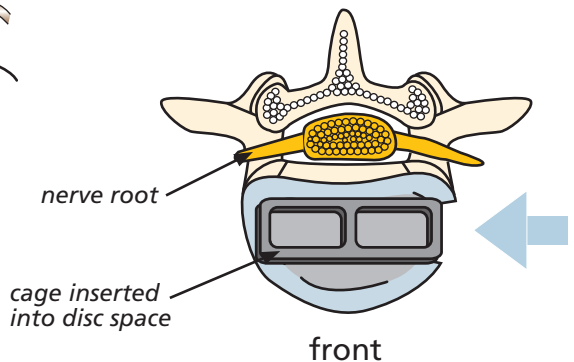
The spine is approached from the side of the body, through an incision just above the pelvis. (This approach is not used to fuse the lowest lumbar disc because the pelvis would be in the way). The abdominal contents which lay inside a large sack (peritoneum) can be retracted (moved to the side), allowing the surgeon access to the side of the spine. A tubular instrument known as dilators is inserted into the incision and allows a blunt probe to push through the psoas muscle (a large muscle that runs from the lower spine, wrapping around the pelvic area and attaching to the hip). Because nerves exiting the spinal canal are close to the psoas muscle, the surgeon will use neuromonitoring, the testing of nerves during surgery to make sure they are not damaged or irritated during the procedure. The disc is then removed, right back to the bone edge of the vertebral body (end plates). Bone graft is then placed within a cage and inserted into the disc space. Your own bone will, over time, grow into the bone graft.

This approach to the spine has risks and complications which are specific to it and are listed below the general ones (see 'Risks and complications').

Lateral interbody fusion (LLIF/XLIF) approach



Lateral interbody fusion (LLIF/XLIF)



Oblique lumbar interbody fusion (OLIF)

The spine is approached through an incision to one side of the tummy. The abdominal contents which lay inside a large sack (peritoneum) can be retracted (moved to the side), allowing the surgeon access to the spine. A tubular instrument known as a dilator is inserted into the incision and allows a blunt probe to push through to the spine. (This approach avoids the psoas muscle and exiting nerves from the spine as in the XLIF procedure and allows access to the lowest lumbar disc because it goes in front of the pelvis). The disc is then removed, right back to the bone edge of the vertebral body (end plates). Bone graft is then placed with a cage and inserted into the disc space. Your own bone will, over time, grow into the bone graft.

This approach to the spine has risks and complications which are specific to it and are listed below the general ones (see 'Risks and complications').

Technical variation for degenerative scoliosis surgery

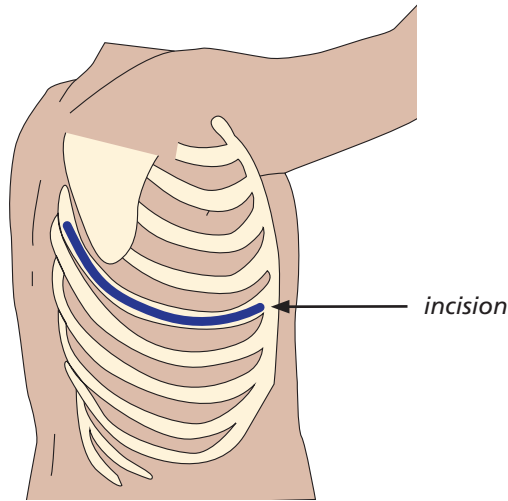
If your surgeon needs to gain access to the front (anterior) of the thoracic spine, then a thoracotomy may be necessary.

Thoracotomy

Thoracotomy surgery is major surgery which involves an incision on the side of the chest wall (rib cage) and the intercostal space (in between the ribs) to enable the ribs to be retracted (held apart) to enter the chest cavity. In spinal surgery, it allows surgeons access to the thoracic spine and therefore, the ability to stabilise it and/or perform an interbody fusion operation. If bone graft is required, part of the rib can also be removed to use as graft.

This approach to the spine has risks and complications which are specific to it and are listed below the general ones (see 'Risks and complications').

Thoracotomy incision



Risks and complications

- **Damage to a nerve root.** This occurs in less than 2 out of 100 cases of primary surgeries but is much more common in revision or re-do surgeries, where injury can occur in up to 10 out of 100 cases. If this happens, you may get weakness in the muscles supplied by that particular nerve root and/or numbness, tingling or hypersensitivity in the area of skin it supplies.
- **Tearing of the outer lining or covering which surrounds the nerve roots (dura).** This is reported in fewer than 10 out of 100 cases. It may occur because of the bone being stuck to the lining and tearing it as the bone is lifted off. Again, it is much more common in re-do surgery. Usually the hole or tear in the dura is repaired with stitches, a patch or a special glue. If the puncture or hole re-opens then you may get CSF (cerebrospinal fluid) leaking from the wound, headaches or, very rarely, meningitis. Although rare, the problems of leakage can persist. This could result in you having to return to theatre to enable the surgeon to revise the repair of the dura but the risk of a second operation being required within a few days or weeks is less than 0.05%.
- **Neuropathic pain (nerve pain)** as a result of damage or scarring around the nerve root. This can occur in 7 out of 100 cases.

- **Problems with positioning during the operation** which might include pressure problems, skin and nerve injuries and eye complications including, very rarely, blindness. Special gel mattresses and operating tables are used to minimise this.
- **Infections.** Superficial wound infections may occur. These are often easily treated with a course of antibiotics. Deep wound infections may occur in 7 out of 100 cases. These can be more difficult to treat with antibiotics alone and sometimes patients require more surgery to clean out the infected tissue. Pneumonia is reported in 8 out of 100 cases and urine infections in around 10 out of 100 cases. These risks may increase for people who have diabetes, impaired immune systems or are taking steroids.
- **Delirium (confused thinking).** Infection, lengthy surgery involving anaesthetics or an imbalance of the body's natural 'salts' can cause a temporary disturbance in mental ability. This usually occurs rapidly, within a few hours and is reported to occur in 13 out of 100 cases.
- **Blood clots (thromboses) in the deep veins of the legs (DVT) or lungs (PE).** These occur when the blood in the large veins of the leg forms blood clots which may cause the leg to swell and become painful and warm to the touch. Although rare, if not treated this could be a fatal condition if the blood clot travels from the leg to the lungs, cutting off the blood supply to a portion of the lung. It is reported as happening in fewer than 1 out of 700 cases. There are many ways to reduce the risk of a blood clot forming. The most effective is to get moving as soon as possible after your operation. Walk regularly as soon as you can, both in hospital and when you return home. Perform the leg exercises as shown to you by the physiotherapist and keep well hydrated by drinking plenty of water. Ladies are also advised to stop taking any medication which contains the hormone oestrogen (like the combined contraceptive or HRT) four weeks before surgery, as taking this during spinal surgery can increase the chances of developing a blood clot.

- **Bleeding.** Surgeons try to minimise bleeding by using devices like diathermy, a technique which passes an electrical current into the wound to cause bleeding vessels to clot. You **must** however, inform your consultant if you are taking tablets used to 'thin the blood', such as warfarin, aspirin, rivaroxaban or clopidogrel. It is likely you will need to stop taking them before your operation as they increase the risk of bleeding. Taking medication like non-steroidal anti-inflammatories (NSAIDs) could also increase your risk of bleeding and your surgeon will advise you if you need to stop taking these in advance of your operation. If your operation is scheduled with only a week's notice, please check with your consultant or nurse what drugs need to be stopped to prevent your surgery being delayed. Blood loss of more than two litres is reported in 2 out of 100 cases. Specialist equipment can be used to 'save' the blood lost during surgery, which can be given back intravenously. A blood transfusion may also be required.
- **Difficulty with screw placement or screw breakage during surgery.** Incorrect positioning of screws can occur in 2 out of 100 cases and could cause injury to the nerves. Breakages of the screw or rods can also happen, occasionally several months after surgery.
- **Bone graft non-union or lack of solid fusion (pseudoarthrosis).** This can occur in up to 5 out of 100 cases. See page 27 for factors which can affect fusion.
- **Cage / Implant movement** can occur in up to 2 out of 100 cases, with 1 out of 100 requiring re-operation. In extremely rare cases, cage movement can cause severe damage and cauda equina syndrome or spinal cord damage (paralysis, bladder or bowel incontinence).
- Although rare, the **surgery may make your symptoms worse than before.**
- **Ongoing pain.** Corrective surgery is a complex procedure and not all patients get pain relief.

There are also very rare but serious complications that in extreme circumstances might include:

- **damage to the spinal cord or cauda equina** resulting in paralysis (the loss of use of the legs, loss of sensation and loss of control of the bladder and bowel). This can occur through bleeding into the spinal canal after surgery (a haematoma). If an event of this nature were to occur, every effort would be made to reverse the situation by returning to theatre to wash out the haematoma. Sometimes, however, paralysis can occur as a result of damage or reduction of the blood supply of the nerves or spinal cord and this is unfortunately not reversible. Neurological worsening of spinal cord function is reported in 3 out of 100 cases
- **a stroke, heart attack or other medical or anaesthetic problems**
- and extremely rarely, **death**, as a result of damage to major blood vessels or vital organs at the front of the spine, which is reported as happening in 2 out of 10,000 cases
- **general anaesthetic fatal complications** which have been reported in 2 out of 250,000 cases.

ALIF specific risks and complications

- **Damage to the large blood vessels** which may result in excessive blood loss. This is reported as happening in up to 15 out of 100 cases, although it is less common in the hands of an experienced spinal or vascular surgeon. Usually small tears in the vessels can be controlled reasonably simply, though there remains the very small risk of catastrophic bleeding that could, in extremely rare circumstances, lead to death.
- **Sympathetic nerve damage.** There are small nerves directly over the disc space which can be damaged during surgery. These nerves are responsible for many involuntary organ functions, including the heart rate, peristalsis (gut movement), kidney function and, in men, the ability to ejaculate. If these nerves are damaged it can cause problems including:

- **retrograde ejaculation (men only).** This is a condition where the valve that causes the ejaculate to be expelled outward during intercourse does not work and the ejaculate takes the path of least resistance, which is up into the bladder. The sensation remains largely the same and this condition does not cause impotence (the ability to have an erection) but it can unfortunately make conception very difficult. This is reported in fewer than 1 in 100 cases and can resolve over time (a few months to a year)
- **warm leg.** This sensation is felt in just one leg, the same side as the surgery has been performed. This can resolve over time but may be a permanent sensation.
- **paralytic ileus.** This is a condition where there is an interruption of the normal bowel contraction and the bowel temporarily 'goes to sleep'. It can be a common side effect of abdominal surgery or nerve damage in this type of surgery. Symptoms include constipation and bloating and occasionally vomiting. Diagnosis can be confirmed by a doctor listening to the abdomen with a stethoscope and hearing no bowel sounds. Food should be avoided until sounds are heard and flatus (gas) passed again. This condition can occur in 11 out of 100 cases.

LLIF/XLIF specific risks and complications

- **Damage to nerves** which could result in thigh pain and/or numbness and weakness of the muscles involved with hip flexion, which may be temporary or permanent.

OLIF specific risks and complications

- **Damage to the large blood vessels** which may result in excessive blood loss. This is reported as happening in up to 15 out of 100 cases, although it is less common in the hands of an experienced spinal or vascular surgeon. Usually small tears in the vessels can be controlled reasonably simply, though there remains the very small risk of catastrophic bleeding that could, in extremely rare circumstances, lead to death.

- **Sympathetic nerve damage.** There are small nerves directly over the disc space which can be damaged during surgery. These nerves are responsible for many involuntary organ functions, including the heart rate, peristalsis (gut movement), kidney function and, in men, the ability to ejaculate. If these nerves are damaged it can cause problems including:
 - **retrograde ejaculation (men only).** This is a condition where the valve that causes the ejaculate to be expelled outward during intercourse does not work and the ejaculate takes the path of least resistance, which is up into the bladder. The sensation remains largely the same and this condition does not cause impotence (the ability to have an erection) but it can unfortunately make conception very difficult. This is reported in fewer than 1 in 100 cases and can resolve over time (a few months to a year)
 - **warm leg.** This sensation is felt in just one leg, the same side as the surgery has been performed. This can resolve over time but may be a permanent sensation.
 - **paralytic ileus.** This is a condition where there is an interruption of the normal bowel contraction and the bowel temporarily 'goes to sleep'. It can be a common side effect of abdominal surgery or nerve damage in this type of surgery. Symptoms include constipation and bloating and occasionally vomiting. Diagnosis can be confirmed by a doctor listening to the abdomen with a stethoscope and hearing no bowel sounds. Food should be avoided until sounds are heard and flatus (gas) passed again. This condition can occur in 11 out of 100 cases.

Thoracotomy specific risks and complications

- **Pleural effusion or haemothorax** is a build-up of fluid or blood which accumulates between the outside of your lung and the inside of your chest wall (ribcage) called the pleural space. This can interfere with normal breathing by limiting the expansion of the lung fully (pneumothorax) (see overleaf).

- **Pneumothorax or ‘collapsed lung’** is when air, fluid or blood builds up in the pleural space which stops the lungs from expanding fully. In most surgical thoracotomy cases, a chest tube (drain) is placed within the pleural space to drain into a water-filled bottle. The drain is removed a day or so after surgery once the air bubbles and/or drainage has stopped, indicating that the lung has re-expanded within the pleural space.
- **Bronchopleural fistula.** This is an abnormal passageway (fistula) that develops between the large airways in the lungs (bronchi) and the pleural space, which can occur following a large pneumothorax. When a passageway like this develops, air that is breathed into the lungs can travel through the fistula and enter the pleural space, also known as bronchopleural air leak. Symptoms may include a persistent cough or shortness of breath. Treatment usually involves maintaining the use of the chest drain or, rarely, surgery may be necessary to close the fistula.
- **Chylothorax.** This is a type of pleural effusion which can occur following damage to the thoracic duct, an important part of the lymphatic immune system and leakage of lymph fluid (chyle) into the pleural space.
- **Chronic post-operative pain at the thoracotomy site.** This is reported in 1 out of 10 cases. The pain that occurs following a thoracotomy procedure is quite commonly very severe. Chronic post-operative pain is usually defined as pain occurring within the area of the thoracotomy incision that persists for at least two months or more following surgery. Patients suffering from severe pain after surgery often have difficulty taking a deep breath into the lungs. This may also lead to problems with the diaphragm muscle which has an important function in breathing in and out.
- **Pulmonary oedema.** This is an excess collection of watery fluid in the air sacs of the lungs, making it difficult to breathe. It has been reported as happening when the lung is re-expanded

following thoracotomy surgery. Treatment can include diuretics (water pills), that encourages diuresis, the increased production of urine. This will increase the excretion of water from the body.

- **Acute respiratory failure.** This can occur if fluid builds up in the air sacs of your lungs and your lungs cannot release oxygen into your blood. In turn, your organs cannot get enough oxygen – rich blood they need to function. This failure may lead to death if not treated immediately.
- **Damage to the spinal cord** resulting in paralysis (the loss of use of the legs, loss of sensation and loss of control of the bladder and bowel). This is reported in 10 out of 100 cases where the thoracic disc is removed from the front of the spine.

Factors which may affect spinal fusion and your recovery

There are several factors that can negatively impact on a solid fusion following surgery, including:

- smoking
- diabetes or chronic illness
- obesity
- malnutrition
- osteoporosis
- post-surgery activities (see note on recreational activities)
- long-term (chronic) steroid use.

Of all these factors, the one that can compromise fusion rate the most is smoking. Nicotine has been shown to be a bone toxin and inhibit the ability of the bone-growing cells in the body (osteoblasts) to grow bone. Patients should make a concerted effort to allow their body the best chance for their bone to heal by not smoking, ideally 2–3 months before the operation. Your surgery may be delayed if you have not stopped smoking (or taking nicotine in another form) beforehand.

What to expect after surgery and going home

Immediately after the operation you will be taken on your bed to the recovery ward where nurses will regularly monitor your blood pressure and pulse. It is likely, because of the length of time that this type of surgery takes, that you will be transferred to ITU (intensive therapy unit) or HDU (high dependency unit) from recovery for the first night or two, where your condition can be closely monitored. Oxygen will be given to you through a facemask for a short period to help you recover from the anaesthetic. You will have an intravenous drip until you can drink adequately.

A drain (tube) may be placed near the surgical incision if there has been significant bleeding during the operation. This removes any excess blood or fluid collecting under the wound. The drain will be removed when the drainage has stopped, usually the next day after surgery.

It is very normal to experience some level of discomfort or back and leg pain after the surgery. The nursing and medical staff will help you to control this with appropriate medication. The symptoms in your legs may fluctuate due to increased swelling around the nerves. As the nerves become less irritated and swollen, your leg pain should settle. This can take eight weeks, or longer. Normal feeling and strength in your legs is likely to take a lot longer and is likely to improve slowly over the next year or so. It is important not to suddenly stop taking certain pain relief medication such as morphine, or neuropathic medication (gabapentin, pregablin or amitriptyline). It will be necessary to gradually 'wean' yourself off these medications – your GP can advise you if necessary.

The ward physiotherapist will visit you after the operation to teach you exercises and help you out of bed. They will show you the correct way to move safely. Once you are confident and independently mobile, you will be encouraged to practise climbing stairs with the physiotherapist. Once stable you will be allowed home, usually a week or more after surgery depending on your procedure and recovery.

Please arrange for a friend or relative to collect you, as driving yourself or taking public transport is not advised in the initial stages of recovery. If you qualify for patient transport and are likely to require this service, please let one of the nurses know as soon as you can as this may need to be pre-arranged. Your discharge home could be delayed if not.

Wound care

Skin wound closure depends on your surgeon's preference and includes absorbable sutures (stitches), removable sutures or clips (surgical staples).

If you have removable sutures or clips, you will be advised by the ward nurse to arrange an appointment with your GP's practice nurse after the operation, for them to be removed.

If you have absorbable sutures, you will be advised by the ward nurse whether you need to make an appointment with your GP's practice nurse to have a wound check or when you can take off the dressing yourself.

You may shower 48 hours after surgery if you are careful but you must avoid the dressing getting too wet. Most dressings used are 'splash proof' but if water gets underneath, then it will need to be changed. A simple dry dressing from the chemist is sufficient to use. Bathing should be avoided for two weeks.

Please contact your hospital or your GP if you think your wound might be infected. Symptoms could include:

- redness around the wound
- wound leakage
- you have a high temperature.

Once the wound has been checked and if the scar is sensitive to touch, you can start to massage around the scar using a non-perfumed cream or oil to encourage normal sensation and healing.

Driving

Normally you will be advised to avoid driving for at least four weeks depending on your recovery. If you have no altered sensation or weakness in your legs at that point, then you may resume driving if you feel safe to do so but you must be confident to be able to do an emergency stop. It is advisable not to travel for long distances initially (no longer than 20 minutes), without taking a break to 'stretch your legs'. Gradually increase your sitting tolerance over 4–8 weeks.

Recreational activities

It is important to keep mobile after surgery. You will find you get stiff if sitting for longer than about 20 minutes, so get up and walk about regularly. Walking outside is fine but again, increase your walking distances gradually. Walking will promote healthy circulation and aids the healing process but you should avoid activities which involve repetitive bending or twisting in the first few weeks. You will also be advised to avoid lifting anything heavy, certainly for the first few weeks but maybe as long as three months after your operation.

Please check with your consultant and physiotherapist when you can resume specific activities, like swimming or golf, as the advice could range from between six weeks to three months. A graduated return to sport is then advisable. Your surgeon may advise you to avoid flying for six weeks (and long-haul flights for up to three months), because of the increased risk of deep vein thrombosis after surgery.

Work

Returning to work is dependent on both your recovery and your job. Most people are off work for an initial 6 weeks but if you are in a strenuous job you may need up to 8 weeks or more. Please check with your consultant for specific advice. It is always sensible to discuss with your work if you can return on 'light duties' and reduced hours at first. There will be nothing to stop you doing computer/office work at an earlier date provided you can keep moving about. The hospital will issue you with a fitness to work (off work) certificate or you may ask your GP.

Follow-up

Your surgeon will advise you when you should attend clinic after your operation. If you have any queries before this appointment please contact the nurse specialist or other member of your consultant's team.



What is the British Spine Registry (BSR)?

The British Spine Registry aims to collect information about spinal surgery across the UK. This will help us to find out which spinal operations are the most effective and in which patients they work best. This should improve patient care in the future.

The Registry will enable patient outcomes to be assessed using questionnaires. These will allow surgeons to see how much improvement there has been from treatment.

This has worked for hip and knee joint replacements through the National Joint Registry. We need your help to improve spinal surgery in the UK.

What data is collected?

Your personal details allow the BSR to link you to the surgery you have had. They also allow us to link together all the questionnaires you complete. If you need any further spinal surgery in the future, details of previous operations will be available to your surgeon.

Personal details needed by the BSR are your name, gender, date of birth, address, email address and NHS number.

Your personal details are treated as confidential at all times and will be kept secure. This data is controlled by the British Association of Spine Surgeons (BASS) and held outside the NHS. Personal details will be removed before any data analysis is performed, retaining only age and gender. Your personal data and email address will not be available to anyone outside BASS and its secure IT provider. Anonymised data may be released to approved

organisations for approved purposes, but a signed agreement will restrict what they can do with the data so patient confidentiality is protected.

Your personal data is very important, as this will allow us to link details of your diagnosis and surgery with any problems or complications after surgery. You may also be asked to complete questionnaires before and after surgery to work out how successful the surgery has been. This will only be possible if we can connect you to the questionnaires through your personal details.

Do I have to give consent?

No, your participation in the BSR is voluntary and whether you consent or not, your medical care will be the same. Your personal details cannot be kept without your consent. This will be obtained either by asking you to physically sign a consent form or electronically sign one through an email link to a questionnaire or at a questionnaire kiosk in the outpatient clinic.

You can withdraw your consent at any time or request access to your data by:

- going to the patient section of the BSR website at www.britishspineregistry.com; or
- writing to us at the BSR centre (see address on next page). Please state if you are happy for us to keep existing data but do not want to be contacted, or whether you want your data to be anonymised (so it cannot be identified).

Research

Your consent will allow the BSR to examine details of your diagnosis, surgical procedure, any complications, your outcome after surgery and your questionnaires. These are known as 'service evaluations' or 'audits'.

Operation and patient information, including questionnaires in the BSR, may be used for medical research. The purpose of this research

is to improve our understanding and treatment of spinal problems. The majority of our research uses only anonymised information which means it is impossible to identify individuals. From time to time, researchers may wish to gather additional information. In these cases we would seek your approval before disclosing your contact details. You do not have to take part in any research study you are invited to take part in and saying no does not affect the care you receive.

All studies using data from the Registry will be recorded on the BSR website at www.britishspineregistry.com

Children

Parents are asked to consent for data to be collected from their child. Looking at the outcome of spinal surgical procedures is just as vital in children as it is in adults.

Further information

The BSR website at www.britishspineregistry.com contains more information, including details of any studies and any information obtained through the Registry data.

To contact the BSR, write to:

The British Spine Registry
Amplitude Clinical Services
2nd Floor
Orchard House
Victoria Square
Droitwich
Worcestershire
WR9 8QT

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