

An introduction to

Limb length discrepancy

This booklet provides general information on limb length discrepancy (LLD). It is not meant to replace any personal conversations that you might wish to have with your physician or other member of your healthcare team. Not all the information here will apply to your individual treatment or its outcome.



About unequal limbs

A person may limp when lower limbs are not the same length. When the difference between limbs is bigger, the limp is worse, which can cause back pain and a significant curve of the spine.

If the difference between limb lengths is small, a person can hide his/her limp by tilting the pelvis, which can cause a slight curve of the spine. If the difference is more than 0.75 inch, it is difficult to tilt the pelvis enough to hide the limp. In such cases, a shoe lift can level out the pelvis and get rid of the limp.

Limping causes abnormal pressure on the joints and can lead to painful arthritis of the spine, hip, knee and/or ankle, if left uncorrected.

Unequal limb lengths, whether of the upper or lower limbs, may cause social problems, especially with children.

One or both bones in the lower limbs can be different lengths from those of the opposite limb. Both the upper and lower bones of the leg shown here are different.



What is LLD?

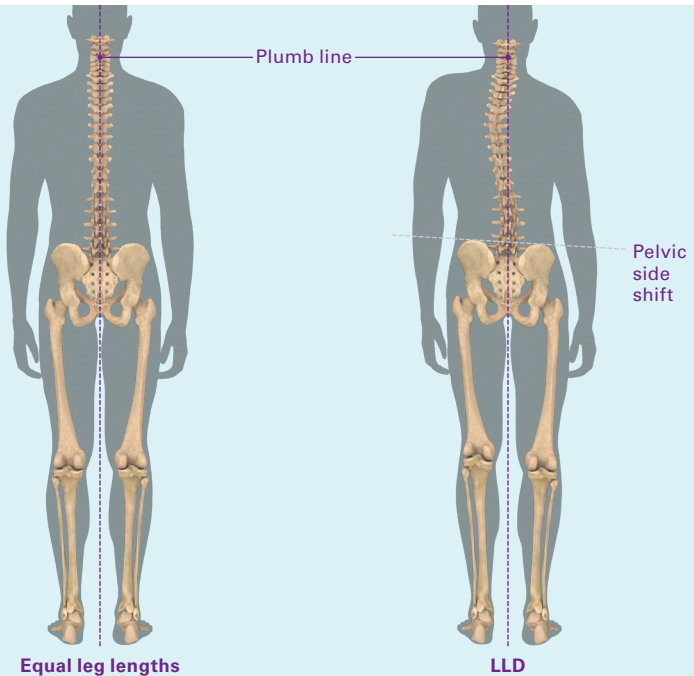
LLD is a difference between the lengths of the upper and/or lower limbs.

If the lower legs are equal in length, but one thigh bone is shorter than the other:

- both knees will still be at the same height,
- the pelvis will be tilted, and
- the spine will be curved.

If one lower leg is shorter than the other:

- the knees will not be at the same height,
- the pelvis will be tilted, and
- the spine will be curved.



How common is LLD?

LLD does not cause a problem for everyone who has it, though it is more common than one might think.

- One study found that up to 90 percent of people had lower limb length differences of about 0.25 inch.¹
- A study of military recruits saw lower limb length differences of 0.2 to 0.6 inch.²
- A survey of long-distance runners showed that almost 40 percent have a small amount of lower LLD.³

What are the symptoms?

There are some common and not-so-common signs of having a LLD. As noted from the studies mentioned earlier, it is possible that you are not aware of a slight difference in your limb lengths, but a big LLD may cause any of the following:

- pain caused by curvature of the spine,
- toe-walking on the short side and limping, and
- pain in the spine, hip, knee and/or ankle.



What can cause LLD?

At birth

Some babies are born with a LLD. The difference can be small at first, but can increase significantly over time. In some cases, the limb length difference remains the same during growth (static LLD); but in most cases, the difference worsens as the child grows (dynamic LLD). In extreme cases, some babies can be born with part of their lower limb missing.

During growth

Many babies are born with equal limb lengths; however, this can change due to injury or illness, which can cause a major LLD. Causes of such injuries or illnesses include:

- **growth plate injury:** Bone gets longer through a special cartilage zone called a growth plate. Each end of a bone has a growth plate. If a growth plate is injured, a bone may stop growing at that end. This type of injury may not be noticed at first, but will show over the years as the limbs grow at different rates;
- **infections and diseases:** Bone and joint infections can permanently damage growth plates. If the growth-stopping infection occurs on one side during infancy, a limb might end up significantly shorter than the normal side; and
- **joint inflammation (juvenile arthritis):** This affects 70,000–100,000 (active and inactive) children under age 16.⁴

After injury

A broken or fractured leg bone may heal and result in shorter-than-normal or longer-than-normal length.

What are the treatment options?

If a LLD is established, your doctor may recommend one or more of the following treatments based on your individual condition.

Nonsurgical treatment

Shoe lift

If your leg difference is uncomfortable or causes pain, the most common nonsurgical treatment is a shoe lift, which equalizes limb lengths. Every pair of shoes worn must have the lift, and sometimes custom-made shoes are required.

What are the potential risks of a shoe lift?

- High heel shoes cause predictable gait changes that increase the risk of traumatic falls and inversion ankle sprains.⁵
- Heel lifts and higher heel shoes cause a neuromuscular response, which increases contractile activity of the calf musculature.⁶⁻⁸
- A simple heel lift without extended contour under the midfoot may be detrimental to the treatment of plantar fasciopathy by increasing pressure under the calcaneus and reducing support of the shoe or insole under the arch of the foot.^{9,10}

Requirement

- Purchase of inserts or custom-made lifts for every pair of shoes

Proper lifts cover the entire sole of the shoe, not just the heel.



Surgical treatments

Growth arrest

In children whose bones are still growing, lower limbs can be made equal in length with surgery that slows down or stops the growth of the longer and good limb.

Growth arrest will not instantly fix the LLD. Instead, the LLD will slowly even out as the short limb catches up, which may affect the patient's full potential adult height.

What are the potential risks of growth arrest?

Sometimes the longer and good limb will be slowed down too much. If this happens, the shorter limb will end up being longer.

- Restriction of bone growth may result in less-than-full potential adult height
- Possible over-arrest of shortened leg may result if patient does not follow up to "turn off" the arrest
- Surgeon may need to adjust the length of longer and good limb if legs do not end up being even

Requirements

- Regular follow-up visits to the surgeon's office
- Hardware removal

Blocking screws are placed into the bone at the top and bottom of the growth plate, which prevent the bone from growing. Surgeons can also remove the remaining cartilage to permanently stop growth.



Bone shortening

In some cases, the longer limb can be shortened. The longer bone is cut and a section is removed. Then, the ends of the cut bone are joined together. During healing, fixation is necessary in order to hold the bone in place. Either a metal rod is inserted down the center of the bone or a metal plate with screws is placed on the bone.

If too much length is removed from a bone, muscle strength can decrease permanently. This procedure will make a person's full potential adult height shorter than if the other leg were lengthened to equalize the two limbs.

What are the potential risks of bone shortening?

- Muscle weakness
- Patient's adult height could be shorter than his/her full potential height
- A non-union, when a bone fails to heal

Requirements

- Regular follow-up visits to the surgeon's office
- Extensive physical therapy, as prescribed by the surgeon

Growing new bone

The body is able to regrow or repair bone through a natural process called osteogenesis. This can be done through a lengthening procedure with either **an external fixator or an internal device**. By gradually moving two segments of a bone apart, the body will fill in the missing space with new bone. After new bone forms in the distraction zone, it will enter the consolidation phase. Once the bone has fully consolidated and achieved stability, the new bone will be as strong as the original bone.¹¹⁻¹²

External fixation

Using the pulling-apart method, bone can be lengthened by anchoring a cage-like device to the leg. The external fixator is connected through the skin to the bone with wires, pins or both. The bone is surgically separated and the frame extends when the device's struts are lengthened which is done several times each day. The lengthening process begins about five to seven days after surgery. The fixator remains on the limb throughout the entire process, which can take up to a year or more.

What are the potential risks of external fixation?

- Pin-tract infections and possible pin breakages¹³⁻¹⁶
- Nerve or vascular damage following insertion of wires/pins¹³⁻¹⁶
- Soft tissue tethering around wires or pins¹³⁻¹⁶
- Bone weakening while in fixator¹³⁻¹⁶
- Permanent loss of range of motion in the nearby joints¹³⁻¹⁶

Requirements

- Regular follow-up visits to the surgeon's office
- Frequent cleaning of the area around the wires and pins
- Adjustment of the frame several times a day
- Extensive physical therapy, as prescribed by the surgeon
- Hardware removal

Once the bone has reached the desired length, the external fixator must stay in place until the new bone becomes stronger.



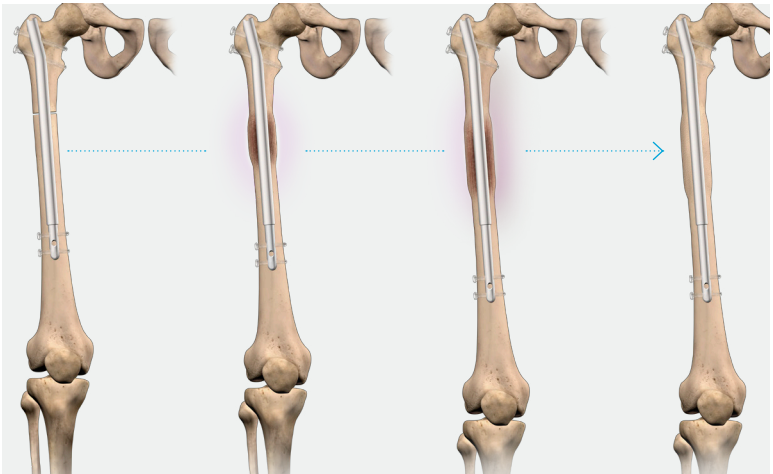
Internal fixation

An individual's surgical procedure and recovery may deviate from what is described herein. This information is not intended to supersede or supplant the information provided by your surgeon.

The Precice® system, makes it possible to lengthen bones with a telescopic device inside the bone's marrow cavity. In many cases, the internal device interacts with an external remote controller (ERC) to lengthen the limb about 1 millimeter per day, approximately 1 inch per month. The device is usually removed after 12 to 18 months.



The customizable programming of the ERC allows for lengthening sessions to be performed at the patient's home. This allows for a precision-controlled process with the ability to customize treatment in a non-invasive manner.



The internal rod is implanted into the middle of the bone. It is then lengthened outside the body through a magnetic interaction with the external ERC.

What are the potential risks of internal fixation?

- Infection^{11,17,18}
- Nerve or vascular damage following insertion of screws¹⁸⁻²¹
- Device may break, bend, loosen, lose length or fail to lengthen^{17-20, 22}
- Injury to the growth plate in skeletally immature patients^{23, 24}
- Injury to the blood supply of bone²⁵
- Loss of range of motion in the nearby joints^{14,17-19, 22, 26}

Requirements

- Regular follow-up visits to the surgeon's office
- Three to four sessions (about seven minutes each) to reach a maximum of 1 millimeter per day, using the ERC, following surgeon's prescription
- Extensive physical therapy, as prescribed by the surgeon
- Hardware removal



Patient using the ERC to perform a lengthening session of the tibia.

A surgeon experienced in limb lengthening techniques can explain the treatment options, risks and benefits in more detail. Only you and your surgeon can decide what treatment, if any, is best for you.

Frequently asked questions

What are long-term concerns for LLD?

When lower limbs are not the same length, it creates a limp. To hide or lessen the appearance of a limp, one may tilt their pelvis, causing a slight curve of the spine. The greater the difference in limb length, the worse the limp can be. This can cause a significant curve of the spine often resulting in back pain. Additionally, limping causes abnormal pressure on the joints and can lead to arthritis.

Will I have a scar from limb lengthening procedures?

Your physician can discuss the incisions that will be made during the procedure.

How much discrepancy can limb lengthening procedures correct?

The limitations of leg lengthening surgery mostly depends on the underlying reason for why the bone is to be lengthened in the first place. In general, the longer the lengthening, the more risks are involved, so it's important to consult with your surgeon to determine how much lengthening is realistic for your specific circumstances.

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Notes

Resources

For more information about LLD, please visit:

[nuvasive.com/nso](https://www.nuvasive.com/nso)

If you would like to learn more about patient support and education for LLD sufferers and their loved ones, please visit:

[reachyourheight.com](https://www.reachyourheight.com)

If you have any questions about LLD or spine surgery, please call or visit your physician, who is the only one qualified to diagnose and treat your spinal condition. This patient information brochure is not a replacement for professional medical advice.



Reach Your Height is a program created by NuVasive Specialized Orthopedics, an innovator of orthopedic solutions and the Precice internal fixation system, to provide an all-encompassing resource for patients who have been diagnosed with a LLD and their families. Information includes causes of LLD, whether the patient is born with a congenital disease that leads to a LLD as they grow, or the patient acquires a LLD through a traumatic accident or disease that shortens a limb or limbs. Reach Your Height provides the latest on treatment options, patient success stories, frequently asked questions, clinical evidence, a podcast series and a surgeon locator to assist patients in finding a limb reconstruction specialist.

Learn more at reachyourheight.com

Renee Voss was diagnosed with a LLD in 2012. Precice successfully lengthened her limb by 6.5 cm.



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