Jan Willem Elkhuizen
Menno Iprenburg

Lower Back Pain
Hernia
Acute lumbago

How to get rid of it!

Content

Preface

Bart W. Koes

Backache affects many people. It is estimated that 80 to 90 percent of adults will have backache. Some will experience only one or a few episodes of backache, but in a considerable number pain recurs regularly and sometimes a chronic pain syndrome develops.
Backache sometimes occurs acutely and sometimes gradually, and in some the back pain is accompanied by radiating symptoms in the leg. Fortunately, in many cases the pain decreases within a few weeks and eventually disappears, for some, the symptoms will persist for months or even years.

Despite the fact that back pain occurs so often, in most cases it is not known what exactly causes the pain. In only a very small percentage (around 5 percent) the symptoms can be attributed to an underlying serious illness or condition, such as malignancy, fracture or infection. But in the vast majority of patients the cause is unknown. There are many tissues, muscles, bones and joints in the back, all of which can be responsible for back and leg pain.

The authors of the book in front of you present their insights about the origin and course of backache in a very clear way. An important role is reserved for the intervertebral disc. Step by step, it is explained what the disc is and what happens if a disc herniation occurs. A complex matter is explained in a simple way, using good examples and insightful illustrations. Partly because of this, the book will suit both care providers and patients. Much attention is given to performing daily

activities and also to various exercises and exercise programs that are useful for the patient.

There are not many books in the Dutch language that describe backache and hernia symptoms in such a clear and insightful manner. Jan Willem Elkhuizen and Menno Iprenburg deserve all compliments for this valuable contribution to the literature.

Bart W. Koes
Professor of General Practice, Erasmus Medical Centre, MD, PhD
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Gijs Lemmers
This book offers a clear overview of the problems associated with low back pain, for both (para) medics and lay people. With the help of many drawings, photos and models, scientifically substantiated, it is made clear what exactly happens when someone puts his or her back out. Why does acute lumbago often look so much like it is caused by a disc hernia, but sometimes isn't? The intervertebral disc appears to work differently to what many professionals currently assume.

Johan Cruijff, the Dutch world famous international football player, once said, "You will see it only when you get it." The reader of this book will gradully come to understand why and how symptoms arise and what they can do about them, which is much more often than many think. For many people action may contribute to a reduction in back pain and radiating leg pain (sciatica).

Some new exercises are described. We have had the opportunity to try these within our national spine organization for some time, and yes, they can really contribute to recovery and even work surprisingly quickly.

Not all hernias need surgery, but sometimes this is inevitable. Also in this area the reader gets a nice overview of the available options.

There are many different factors that can contribute to causing and prolonging episodes of back pain. It is important that these are properly mapped by the right professional. And that is no mean feat in today's healthcare.

All in all, this book offers wealth of information, and with this the authors achieve their goal: to bring light to the black box of misunderstood back pain.

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J.N. Alastair Gibson

Lower back pain causes more disability than any other clinical condition and is becoming more common with increasing age. Yet it is often poorly treated and the consequences of ineffective care are dire. Surgeons, physiotherapists, osteopaths and other health workers may direct their practice based on their own excellent expertise but it is clear that each should understand the contribution that others could make if cross-referral took place.

In order to provide a sound rationale for treatment Menno Iprenburg and Jan Willem Elkhuizen have collaborated to clearly describe the pathology underlying acute and chronic low back pain. It is only by first understanding the basic science that practitioners may prescribe optimal therapies. In each circumstance the authors have striven to support their recommendations with sound scientific evidence. Importantly, a section is devoted to exercise management directed at self-care by patients to mitigate their symptoms.

It is a pleasure to welcome this handy book. It will appeal not only to the experienced therapist but to the patient who may have been left with "no hope of cure".

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Erik Traupe

Back pain is a truly widespread disease. In Germany, about every third citizen regularly suffers from back pain. Back pain is the underlying cause of many sick leaves, resulting in around 79 million days of incapacity for work each year. The economic damage is immense.

An entire industry has developed around back pain. Back pain treatment costs between 25 and 35 billion euros a year! In more than 600,000 patients per year, the admission diagnosis for inpatient hospital treatment is "back pain". According to representative statistics, the number of spinal surgeries has increased by around 71 % since 2007...

This book aims to help prevent back pain. It is not only intended for those affected by back pain, but also offers some interesting new insight for the interested specialist. The two authors not only explain the pathophysiological causes of this widespread condition but also offer real-life advise on how to avoid back pain or, if affected, how to alleviate back pain through easy-to-follow, effective exercises.

I congratulate my teacher and friend Menno Iprenburg and his co-author Jan Willem Elkhuizen – both experts in their fields – with this book, which not only offers a lot of interesting information, but is also fun to read.

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Introduction

Low back pains are common: about three-quarters of all people have to deal with it in their lives. Much research is being done, but in more than 90 percent of cases the cause of low back pain is unknown.

Acute lumbago sometimes turns out to be a hernia, in which case the diagnosis is clear. But if it is not a hernia, people are in the dark. It is also striking that there are also hernias that do not involve a lumbago attack, and sometimes don't even cause backache. It intrigued us that the cause is so often unknown and that it seems to lack logic. This is not only of professional interest, but also because we have had to deal with recurrent episodes of lumbago and hernia.

We therefore started looking for answers. By combining the insights from our various fields (orthopedics, hernia surgery, physical therapy, manual therapy and biomechanics) and by thinking 'outside the box', possible explanations of the lumbago phenomenon and other misunderstood back pains came into the picture.

To test our assumptions, we produced a 3D printed model of two vertebrae in which an artificial intervertebral disc is mounted in such a way that its function matches that in the human body. This allowed us to demonstrate the characteristics of intervertebral discs that have not been described before. It became clear to us gradually what exactly the cause of acute lumbago is and why hernias often resemble a major lumbago attack and sometimes do not.

Our search has not only led to more insight into causes, but also into prevention and therapy. For example, we have devised some new exercises that may sometimes reduce both acute and chronic back pain surprisingly quickly.

It is our mission with this book to create a clear picture for everyone of what happens when someone experiences backache, what causes it, how to prevent it and what people can do to get rid of it as quickly as possible. The latter applies to patients with both a hernia or chronic non-specific back pain.

Menno Iprenburg
Jan Willem Elkhuizen

Summary

Scientific literature shows that the intervertebral disc is the biggest source of back problems. Due to improper use of the spine, material from within the core of the disc may leak into the surrounding tissue of the disc, known as the annulus (annular ligament).

Surprisingly, this leaking process may initially take place without it being noticed and without damaging the fibers in the annulus. These 'micro-leakages' do however cause extra pressure in the fibers adjacent to the site of leakage. Under normal circumstances the pressure in these fibers is equal, allowing the disc to absorb weight evenly. If however the pressure in some fibers is increased, this section of the ligament is at risk of tearing when the spine is being stressed by weight or movement.

The fibers of the annulus consist of collagen, just like the other ligaments of the body. When it tears, patients will have the same experience as with e.g. a torn ligament of the ankle: instant pain, stiffness, and not being able to use in a normal fashion.
Micro-leakages are not visible on X-ray or MRI (in 2019). Even small tears of the ligament are often invisible. This is the reason why in the vast majority of cases no proper diagnose is made. This does of course not mean that there is no cause.
This book explains the relation between acute lumbago, hernia, sciatica and chronic back pain. In addition it outlines the best strategy for treatment, including possible (endoscopic) surgical interventions.

Special attention is given to prevent recurrences of acute lumbago, which occur in 50% of the cases within the first year. Reversing the micro-leakages by means of specific exercises plays an important role.

A new test, the Ipel Test, is described and explained in Addendum VII. This test can be used to diagnose the presence of micro-leakages. It also provides guidance in how to reverse these leakages and thus reduce, if not eliminate, pain.

1 Hernia

1.1 What is a hernia?

A hernia is a disorder of the intervertebral disc. This ruptures, so that the gel-like contents contained in the core end up outside the disc (see Figure 1).

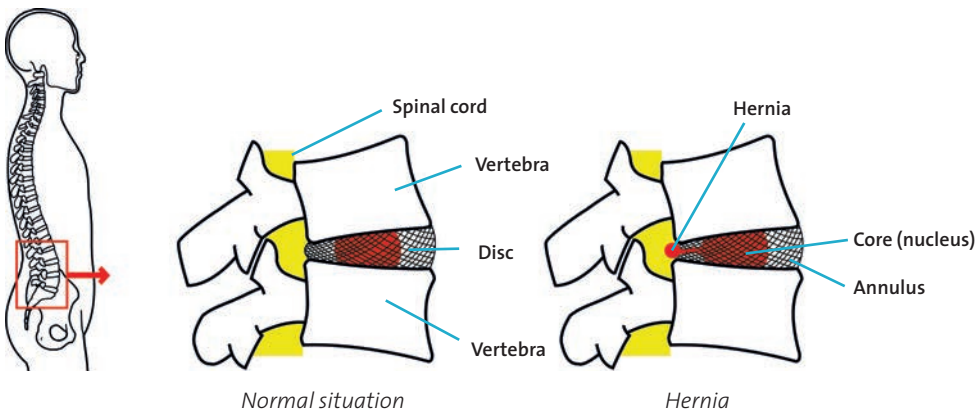


FIGURE 1 *Side view of the spinal column with two vertebrae magnified: without and with a hernia*

Hernias are most common in the lower back, sometimes in the neck and only sporadically in the thoracic spine. It can lead to pressure on nerves (see figure 2). With a back hernia, the pain may radiate to the leg and with a neck hernia, it may radiate to the arm.

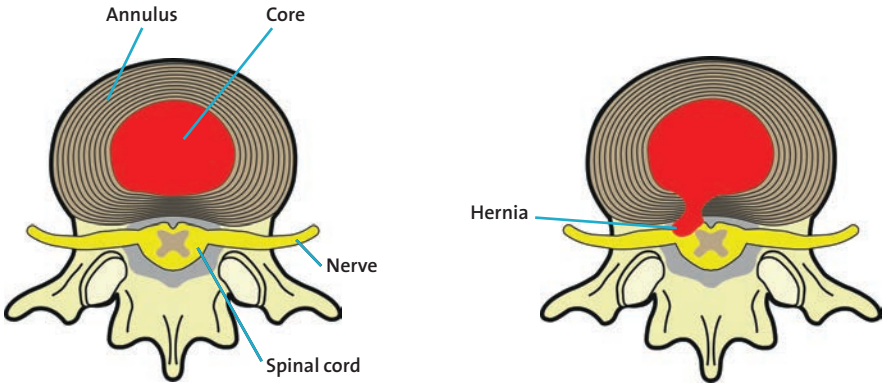


FIGURE 2 *Top view (cross section) of a vertebra and disc. Left without, right with a hernia.*

1.2 What is a disc?

The disc is located between two vertebrae, and is made up of a core (nucleus) and an annulus.

The Core

The core of a disc consists mainly of water and proteins[1,2,3,4]. The proteins make the core content viscous and firm, so that the core content is deformable.

The Annulus

The core is held together and closed off by about twenty thin lamellae that surround it (see Figure 3). There are strong fibres in each lamella, sort of tension-resistant strings. The lamellae together form the annulus: a thick, circular band with thousands of strong fibres embedded[5].

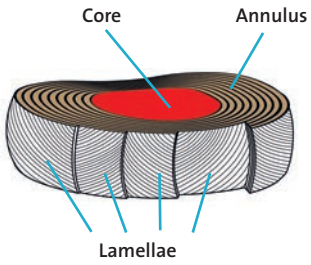


FIGURE 3 *Three-dimensional view of the disc. The annulus consists of approximately twenty lamellae that comprise the core content.*

1.3 What is the function of the disc?

When the back is strained, the core is compressed and therefore protrudes to the side (see Figure 4). The forces are, as it were, "converted" from vertical to horizontal. As a result, the fibres in the annulus can **absorb most forces**, while at the same time **moving** the back is possible. The disc has even more functions, which we will discuss later in the book.

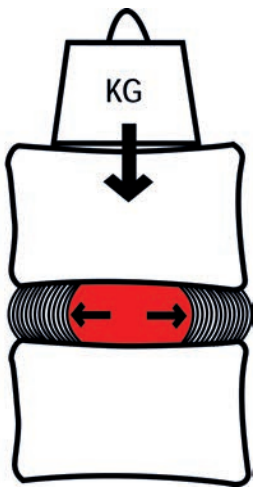


FIGURE 4
Two vertebrae with a disc in between. The fibres in the annulus absorb a large portion of the load.

1.4 How does a hernia occur?

In a healthy situation, the core content cannot penetrate the lamellae of the annulus, but in the event of an overload, or if the disc is weakened, that is sometimes possible.

The core content is then pressed through the annulus **from inside to outside**[6,7]. This process can take place in a short period of time, but it can also take years. A hernia only occurs when **all** the lamellae are leaky and the core contents are pushed out of the disc (see Figure 5a+b).

Starting rupture *Rupture halfway* *Total rupture: Hernia*

FIGURE 5a *Cross sections of three vertebrae with disc. The starting rupture in the annulus (left) extends to a total rupture with a hernia as a result (right).*

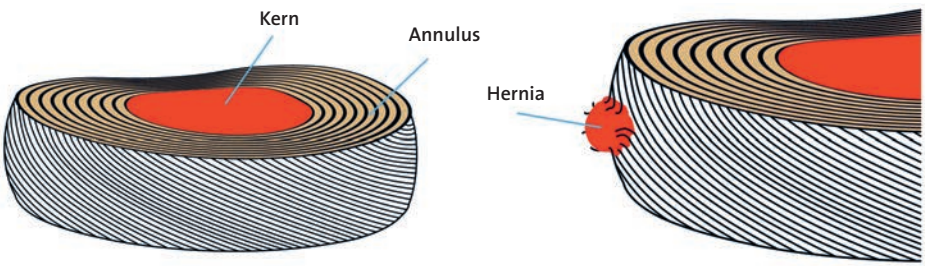


FIGURE 5b *3D view of the disc: to the left without a hernia and to the right with a hernia.*

The height of the rupture in a disc can vary (see Figure 6), but in all cases the core content must go through all the lamellae before a hernia develops[8,9]. Ruptures in the disc and vertebra boundary region (endplate) can be accompanied by damage to the bone of the vertebra itself (Figure 6B).

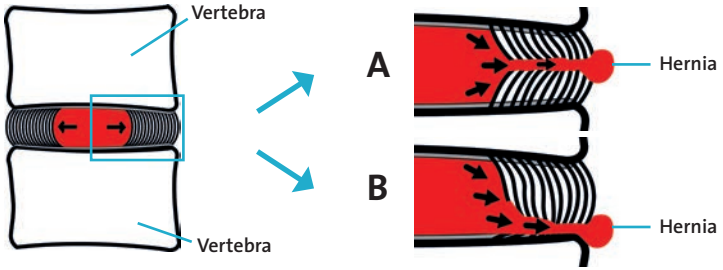


FIGURE 6 *Cross section of the hernia process.*
A) Rupture in the middle: the damage is limited to the annulus.
B) Rupture underneath: damage in the border area between disc and vertebra.

1.5 Preliminary stages of a hernia

A hernia usually does not just happen, as twenty healthy lamellae full of strong fibres would have to break all at once. This is rarely possible, after an accident, but in other cases, there are several prior distinct stages with and without damage to the fibers in the lamellae that must occur first.

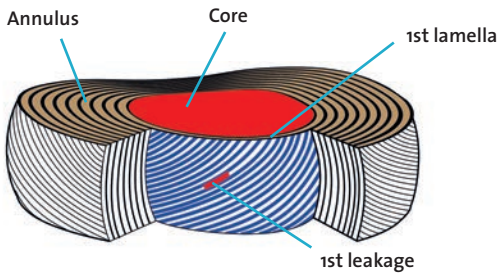


FIGURE 7 *Three-dimensional view of the disc with a view up to the 1st lamella.*
The core content leaks between two fibres.

Leakage of core contents without fibre damage

Experimental research shows that if we bend two vertebrae repeatedly (which corresponds to **repeated bending** by a patient), the core contents can leak to the annulus. This can already be the case with normal load levels[7,10]. The first leakage always occurs in the 1st lamella, calculated from the core (Figure 7).

The fibres, coloured blue in the drawing, can remain intact: the core content is, as it were, pressed between two fibres. If repeated bending is continued, the subsequent lamellae start to leak one by one, also without damaging the fibres[7].

If several lamellae leak, a kind of "pathway" is created in the annulus. The direction of the leakage follows the direction of the fibres and jump through the lamellae[7]. This is described as a "criss-cross" pattern (see Figure 8).

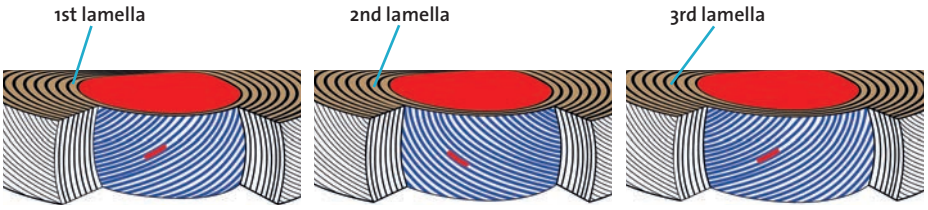


FIGURE 8 *Cut-out of the disc with a view of the 1st, 2nd and 3rd lamella in succession. The leakage changes direction per lamella (red stripes between the blue fibres).*

Leakage of core contents with fibre damage

The "pathway" described above is a **weak spot** that is vulnerable to overload.

In heavy lifting or other forms of overload, the fibres adjacent to the pathway are under extra stress, and they can fail first (see Figure 9).

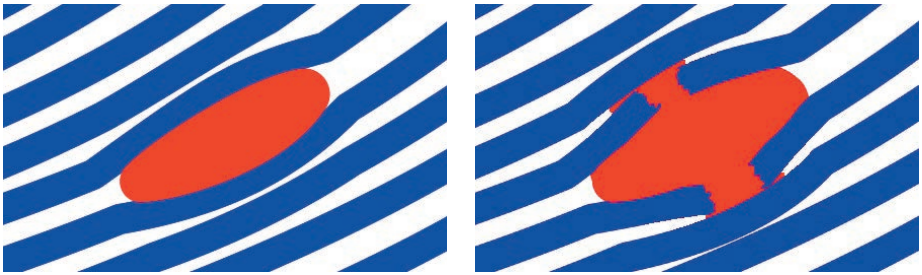


FIGURE 9 *Detailed drawing of the leak in a lamella.*
Left: fibres still intact, but leaked core content provides extra tension in the adjacent fibres.
Right: fibres torn, the leakage gets bigger.

As long as the rupture does not run through the entire annulus, it is not a hernia, but we are dealing with an early stage thereof.

Four degrees are distinguished on the so-called Dallas scale[11,12]:
1st degree: rupture in the inner 1/3 portion
2nd degree: rupture halfway
3rd degree: rupture to the outer 1/3 portion
4th degree: rupture to the outer 1/3 portion + ruptures to the side (in between lamellae)

Fibre damage without leakage of core content
The place where the rupture starts may vary (see Figure 10). In many cases, the fibre damage starts on the inside of the annulus (counted from the core in the first lamellae). In the event of an accident or a forced turning movement, however, the initial injury can occur **inside** the annulus, while the first lamellae are still intact (see Figure 10B). If these also fail later, the end result can be equal to a rupture created from the centre[8].

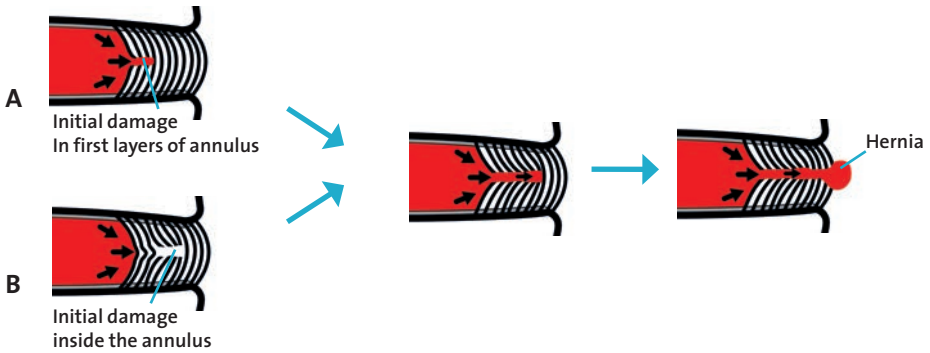


FIGURE 10 *Detailed drawings of the annulus.*
A. The damage to the fibres on the inside of the annulus.
B. The damage to the fibres begins in the centre of the annulus.

As long as the inner lamellae have not yet been "broken through" (Figure 10B), there is still no leakage of core contents in the annulus. However, any weakening can be viewed as a kind of hernia precursor.

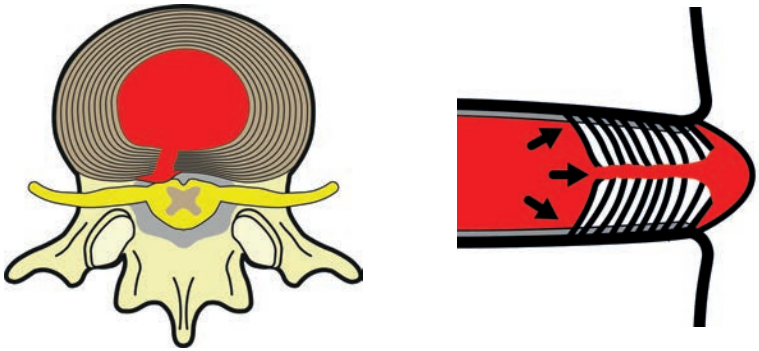


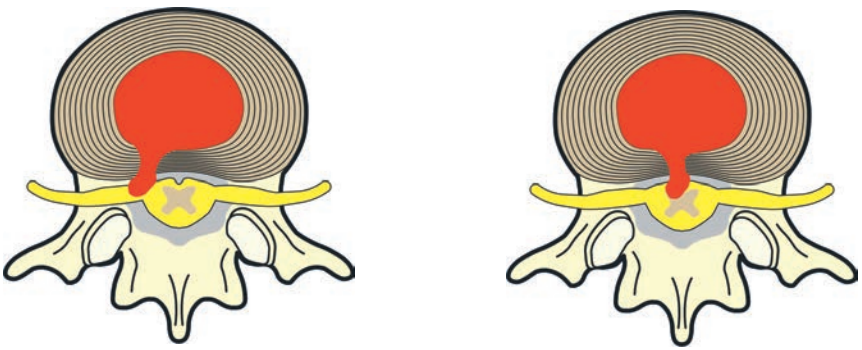
FIGURE 11 *A contained hernia: the last lamella has not yet ruptured, but does cause a bulge.*
Left: cross section, top view.
Right: cross section, side view.

Contained hernia
There is another stage between the aforementioned precursors and a real hernia: a "**contained hernia**" (Figure 11). Here the last lamellae (or single lamella) protrudes extensively, without it rupturing. The core content therefore does not end up outside the disc, which is why this is in fact also a preliminary stage (although it might already cause pain in some cases).

1.6 Types of hernias

Hernias are distinguished by their location.

Central hernia
Nine out of ten hernias are located in the central part of the spine. This is called a **central hernia**. When such a hernia bulges in the middle of the vertebral canal, it is called a **medial hernia**. However, a central hernia may also be located more to the side at the edge of the vertebral canal. In that case it is referred to as **lateral hernia**. In Figure 12a both a lateral and medial hernia are shown.



Left: lateral hernia *Right: medial hernia*

FIGURE 12A *Two examples of a central hernia located in the vertebral canal (gray area).*

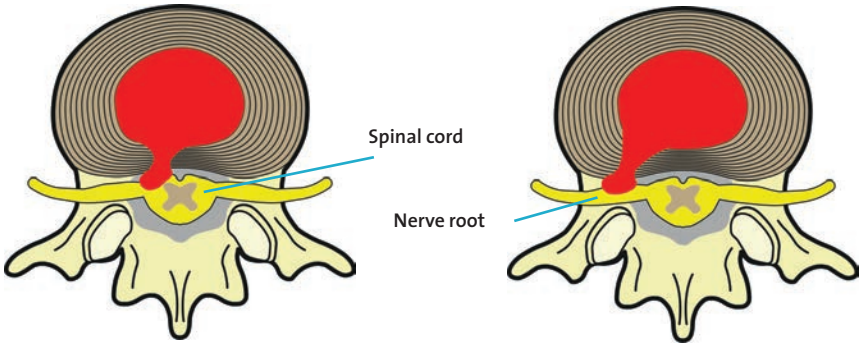


FIGURE 12B

Left: a central hernia borders the vertebral canal and spinal cord
Right: a foraminal hernia is more sideways and borders a nerve rood

Foraminal hernia

In about 10 percent of the cases, the hernia is more to the side, a so-called 'foraminal hernia'. In this case the hernia is not located in the vertebral canal but in the opening (foramen) between two vertebrae, see Figure 12b. A foraminal hernia gets its name from the opening (foramen) between two vertebrae in which it is located (Figure 13).

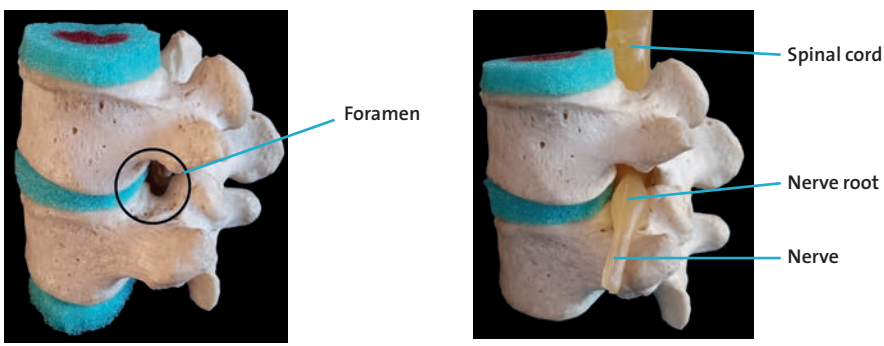


FIGURE 13 *Side view of two human vertebrae. The foramen is the opening between two vertebrae (left) through which the nerve root emerges and leaves the spine (right).*

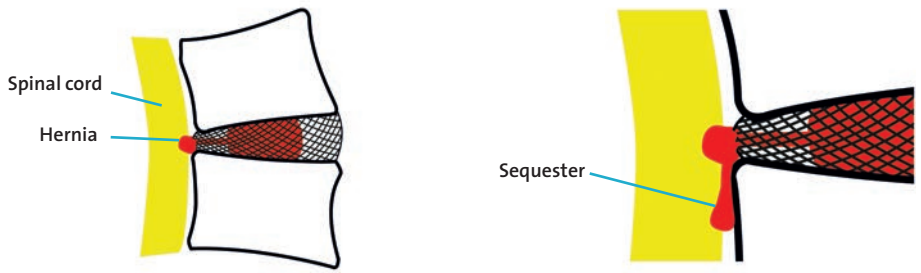


FIGURE 14

Left: a 'normal' hernia.

Right: a piece of hernia tissue has largely split off (sequestrated) and ended up between the spinal cord and a vertebra.

Sequester

Sometimes a piece of hernia splits off and forms a **sequester.** Such a sequester may end up in the spinal cord, between the spinal cord and a vertebra. A sequester may still be connected to the hernia with a thin piece (Figure 13), but it may also be detached completely.

Important

- Leakage of core contents to the annulus can be accompanied with or without rupturing of the fibres in the annulus
- Four stages of rupturing are distinguished on the Dallas scale.
- A hernia occurs if core content has ended up outside of the annulus.
- A contained hernia is actually not a true hernia but an intermediate form: the last lamella is still intact, but bulges extensively.
- Damage can also occur in the transition area between disc and vertebra.
- A central hernia is located in the centre of the spine.
- A foraminal hernia is more to the side and borders on a nerve root.
- A sequester is a split piece of herniated tissue.

2 Acute lumbago

2.1 What is acute lumbago?

Acute lumbago is characterized by a sudden onset and sharp pain in the back. The muscles become hard and the back cannot move properly. The pain can be extremely intense in the beginning, but it drops to a tolerable level in a few days or in weeks.

The previous chapter explained how a hernia develops and how fibres in the annulus are damaged. These consist of collagen connective tissue, just like the fibres that are located in the ligaments of the knee and ankle[13]. If such fibres are damaged (stretched and ruptured), swelling and pain will occur. This can be "damned painful" in the back, just like a sprained ankle.

The swelling in the annulus is 'in the way': the disc can no longer deform freely. This limits the movement of the back and makes it impossible to stand upright How this works exactly is described in chapter 2.3.

All symptoms that occur with lumbago (acute pain, tense muscles, stiffness, inable to stand up) can be explained by the acute damage of fibres in the annulus. Massive muscle tightening blocks movement and prevents further damage and pain. This reaction also occurs in joints and is known as "bracing"[14].

The intensity and duration of the pain varies quite strongly[15] and depends, among other factors, on:

- The number of damaged fibres (size of the rupture)
- The location: the outer lamellae are much better equipped with nerves[11].

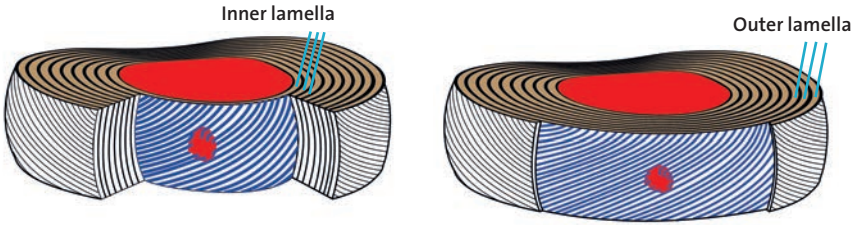


FIGURE 15 *Three-dimensional image of the disc with a view of the inner lamellae (left) and outer lamellae (right). The degree of pain depends on the location of the lamella in which the damage is located.*

The next stage of acute lumbago is usually more painful than the previous one. Every time fibres rupture, this leads to an acute phase. The farther the rupture extends from the inside to the outside, the more painful it becomes[16,17,18].

Only an **acute phase** is called "acute lumbago". If months later residual pain still exists, it is called chronic back pain or lumbago. Conversely, with chronic low back pain, a damaged disc is thought to be the most common cause[19,20,21,22,23].

Relapses are common. In the year after recovery from a lumbago attack, a recurrence occurs in a majority of cases[16,24,25].

The clinical complaints of patients with acute lumbago and ruptured ligaments are very similar. Those similarities are no coincidence, because the anatomical basis is the same in all three cases: sudden damage to collagen fibres[13].

Often hernia patients have had acute lumbago years before their hernia. This is usually not recognized as a step towards a hernia. It then seems as if the hernia has "just happened".

Sometimes, a person gets a hernia without having had lumbago before, for example with trauma. This can also happen if the "mini-leakage" has already reached an end in the annulus, without any overloading. The fibres are then still intact (see Figures 7 and 8). If in such situation the back is strained, the first rupture can immediately reach the last lamella and lead to a hernia.

This "extra strain" does not always have to be something extraordinary, e.g. the strongest man of The Netherlands put his back out when sitting on the couch and simply reaching over for something on a table. That may seem strange, but it can be explained by mini-leaks. The pressure of the leaked core content on the adjacent fibres provides extra tension in the fibres, such as in a string that is moved sideways (see Figure 9, left image). This makes them more vulnerable.
When reaching out with one hand, rotation of the back takes place and fibres are stretched. This can be "the straw that breaks the camel's back" and ruptures the already tighter fibres.

2.2 3D-model

To gain more insight into the functioning of the disc, we have produced a 3D printed model based on scans of two human lumbar vertebrae (the 4th and 5th, see Figure 16). A flexible core has been constructed based on a number of important anatomical assumptions:

1. The annulus consists of fibres that are all well anchored in both the underlying and the upper vertebra[5,13,26].
2. The direction of the fibres changes per lamella[5,13].
3. The fibres in the outer half of the annulus mainly consist of type 1 collagen[13,26]. This type also occurs in ligaments and is comparable with strong, tensile strings.