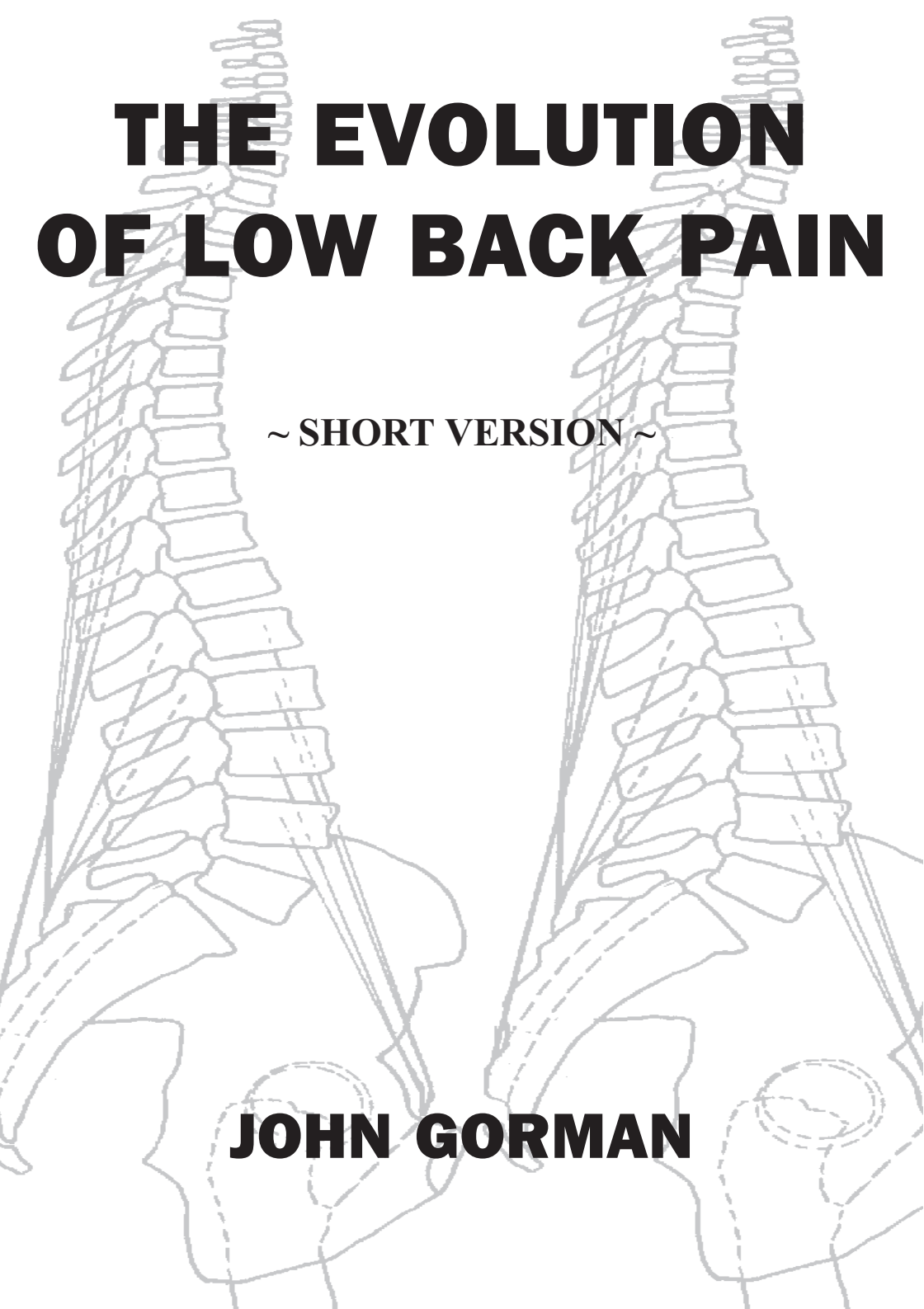
THE EVOLUTION OF LOW BACK PAIN

~ SHORT VERSION ~



JOHN GORMAN

THE EVOLUTION OF LOW BACK PAIN

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Decleration: John Gorman is Director and part owner of the company Pelvic Posture Limited which manufactures chairs designed on the principles in this book. He and the company, claim various patent rights associated with the chairs

LIST OF CHAPTERS

FOREWORD

Low pack pain of structural origin is so common in modern society that current lifestyles are often adduced as the responsible factors, particularly faulty lifting techniques and unsuitably designed chairs on which we spend much of our working and non-working lives.

The present text looks afresh at the problem by applying mechanical principles to spinal structure and function, a study for which John Gorman, as a chartered and graduate engineer is specially qualified. This book is interesting and challenging on that account alone but theory having so often failed when applied in practice, the author has monitored the conclusions by careful observations on back pain sufferers with whom he comes into daily contact as a professional chiropractor.

It may be argued that biological structures such as bones, joints and muscles do not closely obey the laws of mechanical advantage yet in so far as they do, this compliance should be applied for human benefit. Whilst some of the concepts here introduced are original, others are controversial and one or two frankly speculative, all are worthy of critical examination. In his work as a member of the caring professions, John Gorman is aware of the equal aspects of both prevention and relief so he has implemented his beliefs in the design of chairs for work and leisure which have already proved beneficial in practice.

It would be idle to pretend that we have reached finality in the study of an extremely common ailment but this volume is a valuable and thoughtful contribution to the continuing discussion. It merits the attention of all who may be directly or contingently involved in the relief of acute or chronic back pain.

Thomas Lodge. MD.

INTRODUCTION

This book puts forward an hypothesis to explain the low back pain problem in humans.

To support such an hypothesis it is conventional to explain each detailed step and support everything with literature and references. It is also conventional to consider contrary arguments and references and explain why these either do not apply or are incorrect.

The book was originally written in this way but because of the size of the subject it inevitably became excessively long and unreadable. Only very few people would know or use the references and only the expert in each area would be able to follow the detailed argument in his area.

Back pain is a complex subject and desperately needs an overall explanation. It could be said that it suffers from too much detailed literature with no overall conclusion.

I therefore rewrote the whole book so that the overall argument could be read by anyone in a few hours. Many statements are made in a sentence which were previously reached after several pages of argument and reference. I am not therefore proving each point to the reader. Instead I am hoping that the reader will understand the whole argument without demanding proof of each step and ask themselves the question "Does this overall explanation fit the facts that I know about low back pain?:" I think that most readers will be able to answer "yes".

John Gorman
July 1992.

SECTION 1

BASIC MECHANICS OF THE SPINE

Chapter 1.1 The Obstetric Reason for Lordosis

In the evolution of the human spine a major influence has been the need to maintain an adequate birth canal in the pelvis.

This is the reason for the angle and shape of the sacrum in the human pelvis. Fig 1. shows the way in which the sacrum forms an arc of a circle centred on the pubic symphysis. This maximises the anterior-posterior diameters both at the pelvic inlet (x) and at the pelvic outlet (y) and also in between.

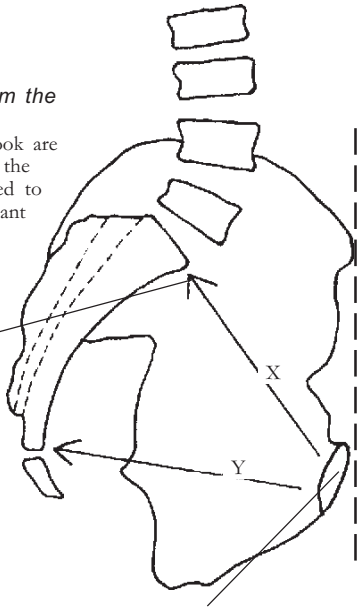


Figure 1. Pelvis from the right (in section)
All drawings in this book are from the right side of the body. Sectioning is used to show the most important points clearly.

Those who are not familiar with medical terminology will find the drawing on page 68 defines most of the relevant points on the spine and pelvis.

With the pelvis in the standing position this line which just touches the anterior superior iliac spine and pubic tubercle will be approximately vertical. In all other drawings in this book the angle through which the pelvis has tilted backwards can be judged by reference to these points.

The effect of this angle and shape of the sacrum is that the base of the spine, the sacral endplate, is not horizontal, as might be expected, but is sloped forwards at a steep angle which averages about 50°. (It also varies greatly between people from as little as 25° to as much as 75°).

In order to compensate for this angle the lowest vertebra in the spine (L5) is wedge shaped by 5° or 10°. This is known to every student of anatomy. However, in the natural or problem free spine, the lowest two discs are also wedge shaped and by a far greater angle (16° to 24° on average see Figure 2.). This point is not usually recognised or shown in drawings of the spine and yet it is critical to the whole understanding of the human low back problem.

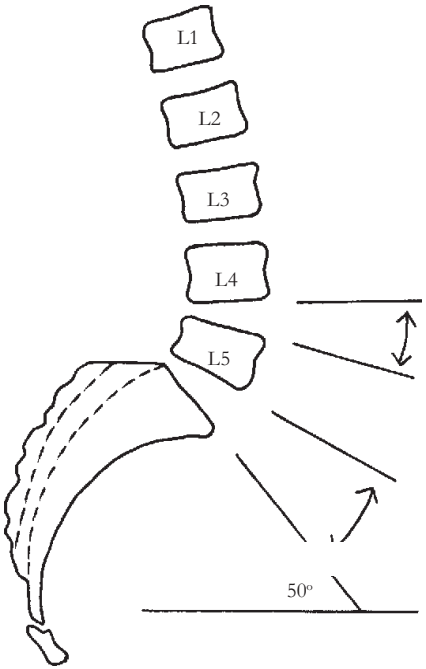


Figure 2. Sacrum and Lumbar Spine from the right (posterior elements of vertebrae omitted for clarity)

The angle of the sacrum and the conse quent wedge shapes produce a hollow curve or lordosis in the lower back. Thus the maintenance of an adequate birth canal defines the angle and shape of the sacrum and is therefore the whole reason for the lordosis in the human lumbar spine.

It is from these lowest two discs, that have this peculiar wedge shape, that 99% of lumbar prolapses (slipped discs) occur. These two joints are the centre of the low back pain problem. If the sacrum didn't have to be angled to accommodate the birth canal, if we had a straight lumbar spine with parallel sided discs then we probably wouldn't have a low back pain (LBP) problem.

However evolution has got over the inherent disadvantages of the sharp lordosis. Among more naturally living peoples the problem hardly exists. One report speaks of "the rarity of the disc syndrome". It is when we live a civilised lifestyle that some aspect of the civilised life style causes problems in this potentially vulnerable part of the spine. The rest of this book is devoted to identifying that aspect of our civilised lifestyle, trying to understand why it causes the LBP problem and how it can be avoided.

Chapter 1.2 The Influence of Civilised Sitting

In trying to indentify the aspect of a civilised lifestyle which causes the problem of low back pain there is strong statistical (epidemiological) evidence that sitting is responsible and particularly when driving motor vehicles.

An analysis of the mechanics of sitting also shows that typical civilised sitting applies a large and continuous flexion to those lowest two joints of the spine where damage is most frequently found. In view of the proportion of time that we spend sitting and the association of sitting with back problems it seems very likely that this is the aspect of a civilised lifestyle that is causing the problem.

It is when we are sitting relatively upright that the mechanical situation is worst. As this is the opposite of what is generally assumed a brief analysis follows:

That sitting bends the back is simple and obvious and so it has long been assumed that sitting in an obviously slumped and rounded manner causes back problems. This is unfortunately an oversimplification and has led us to several generally accepted beliefs which are the exact opposite of the truth.

When we see someone slouching on a settee we see a rounded back. However the rounded shape that we see is the bending of the whole of the middle part of the back, the upper lumbars and the lower thoracics. The bend will be mainly between T6 and L3, eight intervertebral joints. Even if each only flexed by 5° there would be a total flexion of 40° - a very rounded back. We normally say that this is bad but why should it be? None of these joints ever suffers from prolapsed discs. Those joints that do have prolapsed discs - the lowest two L4/5 and L5/S - are not fully flexed or extended by slouching. In fact they are unstressed in the middle of their range of motion and will simply not be affected by sitting in this way. (See Chapter 5.5).

Slouching then is unlikely to be the aspect of civilised sitting that causes the problem but the unnecessary prohibition may not matter. The real problem comes when we try to avoid a rounded back when sitting upright. When we sit upright at a desk and then relax the whole back rounds and the top of the pelvis tips backwards. Again we see the rounded back as the problem and use a backrest

to straighten it. The backrest does straighten the middle part of the back but unless the chair is designed to support the pelvis directly, and most are not at present, the pelvis will simply tilt backwards (Figure 3) just as it would without the backrest. Forcing the spine towards the vertical with a backrest without supporting the pelvis directly will therefore actually increase the flexion in the lowest critical joints of the spine.

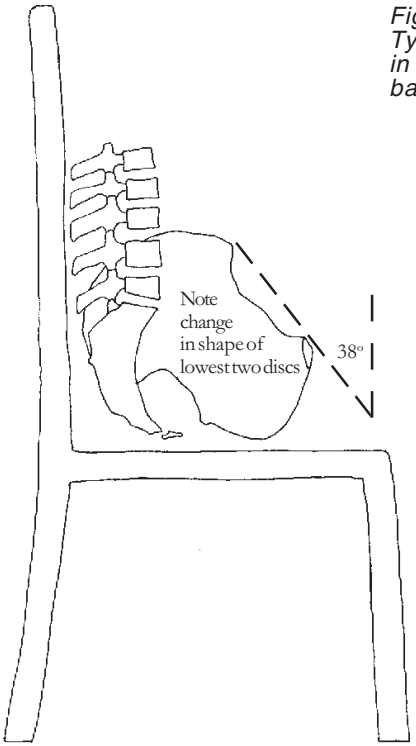


Figure 3.
Typical sitting position in upright chair with backrest.

The "solution" that was developed to solve this problem is lumbar support. The backrest is shaped to provide extra pressure on the lumbar spine to reduce the flexion and maintain the standing spinal shape.

In fact lumbar support has almost the opposite effect to that intended. Increasing the pressure on the lumbar spine can bring the pelvis back to the standing position but only by using the lumbar spine as a lever to control the position of the pelvis. This will apply the maximum bending force to the point where the lever connects to the pelvis. This is the lowest spinal joint (L5/S).

Figure 4 shows this situation with lumbar support providing direct pressure on the lumbar spine. This will tend to distort the shape from the full line to the dotted line.

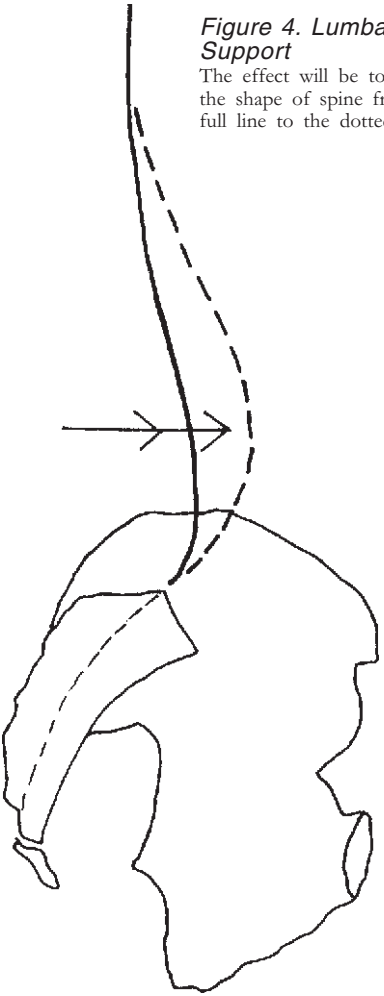


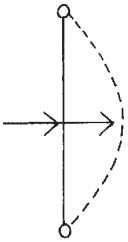
Figure 4. Lumbar Support
The effect will be to distort the shape of spine from the full line to the dotted line.

Although the lordosis has been increased and the pelvis has been held upright it should be obvious that the lowest part of the spine has actually been flexed by the lumbar support. Although there is hyperextension at the point of lumbar support and the total lordotic shape is obviously greater, the dotted spinal shape just above the sacrum is anterior to (in front of) the original (full line) shape. This is flexion of this part of the spine which is the critical lowest one or two joints.

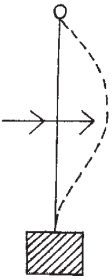
This point is so important that it is worth repeating. Contrary to what is normally thought, the effect of lumbar support and other backrests supp˜rti ˆg the lumbar spine is actually to increase the flexion of the lowest joints of the spine although the upper lumbars are extended. This was shown by an x-ray analysis of the influence of lumbar support on spinal shape and was published in a technical journal.

In many seats and particularly in car seats the actual situation is much worse than this because the pelvis usually tips top backwards despite the lumbar support and most of us don't bother to keep the pelvis upright as we sit intoa chair or car seat. Figure 5 shows a more typical situation with the pelvis tipped back. There is even

The Double Bend

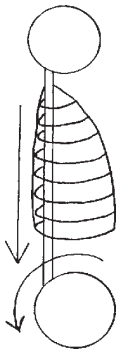


When a force is aplied to a flexible column or rod which is located by a pin at each end the rod will bend in the same direction all along its length. The drawing on the left shows the effect of the force in distorting the rod from the full line to the dotted line.



However if the rod is not connected by a pin at the lower end but is firmly located to a block the situation is different. If the block has other forces on it such that it does not move easily then the flexible rod will bend in one direction as before where the force is applied to it but will bend in the opposite direction near its connection to the block.

This is almost always the effect when a force is applied by a backrest (particularly a lumbar support backrest) to support the spine. The pelvis does not easily roll forwards with the spine. This is because the weight of the head and upper body act down the spine and push the back of the pelvis down.This tends to roll it top backwards.



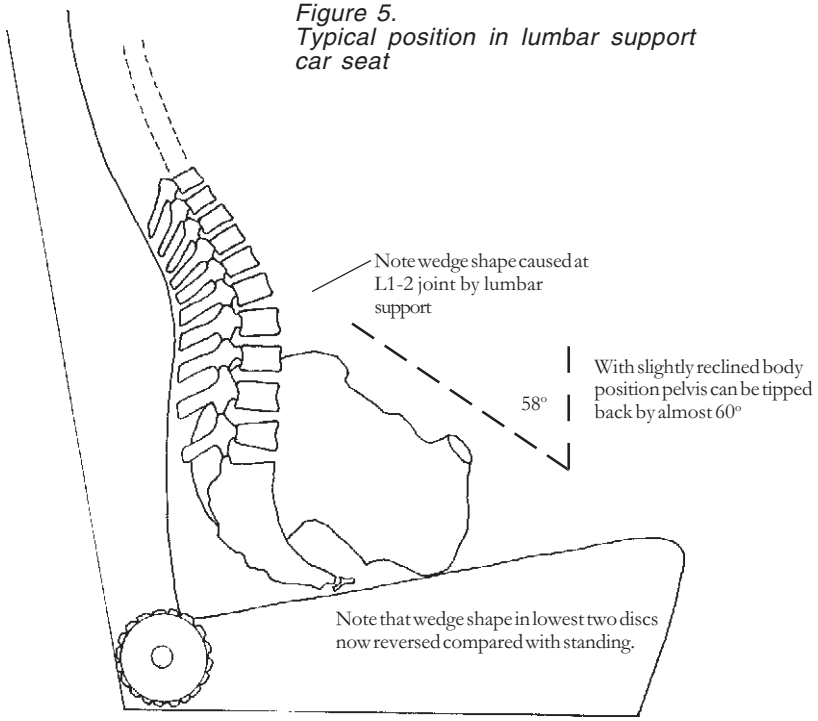
This "double bend" effect tends to be disguised by the hollow shape of the lowest part of the spine but mechanically this is what happens. The lumbar support causes a hollowness where it is applied but causes the opposite force at the lowest part of the spine. The lowest one or two joints are flexed!

This effect of "the double bend" is simply not recognised and leads to much of the confusion that is found in analyses of the mechanics of sitting.

(In most of us who live a civilised lifestyle the spine is distorted in this "double-bend" way. It is permanently flexed near L4 and L5 and hyperextended somewhere between T10 and L4. This is the typical back shape that I have referred to elsewhere as Homo Sedens.)

more flexion in the spine just above the pelvis which will be the critical lowest two joints. (and the lordosis is frequently to be found at the top of the lumbar region instead of being mainly near L4 and L5).

Figure 5.
Typical position in lumbar support car seat



This mechanical analysis suggests that the typical car seat provides the worst conditions for the lowest spinal joints. Car driving always shows up in statistical (epidemiological) surveys as a cause of low back pain. This strongly supports the suggestion that flexion of the lowest spinal joints causes the problem. Only truck drivers, tractor drivers and helicopter pilots have a higher LBP (low back pain) incidence and this correlates with the even worse mechanical situation.

The same mechanical argument applies to sitting at the dining table or to work at a desk with or without a backrest. The weight of the head and arms is further forward to balance and to look down but the tendency of the pelvis to tip backwards is the same and this has the same effect on the lowest spinal joints.

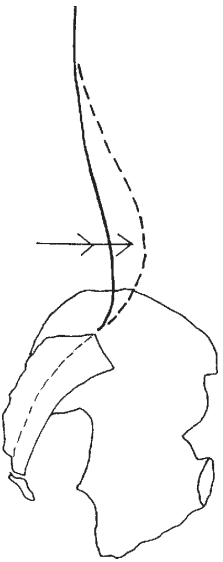
The same logic does not apply to more relaxed sitting or "slouching". In this case the pelvis can tip back until it is balanced on the gluteal muscles but the whole spine and body tips back also. Although there is flexion in the spine this is not concentrated at the lowest joints and there may well be no bending force at the lowest joints.

Thus, contrary to normal assumptions, it is not "slouching" but upright sitting in a car or at a desk or table that applies a continuous flexion or bending force to the lowest joints of the spine. These activities occupy a large proportion of our civilised lifestyle and I am suggesting that this is the aspect of our lifestyle that causes the problem of low back pain.

The obvious solution to this problem is that the pelvis must be supported directly. Several existing seats or accessories can help in this direction. For instance the McKenzie "lumbar roll" is always shown in a position which will support the top of the pelvis. This is mechanically correct. Some car seats do have features which will support the pelvis. Others support only the lumbar spine. It is important to understand that the effects are the opposite of one another. Pure lumbar support will flex the lowest spinal joints while "pelvic support" will limit the flexion. Forms of sitting will be covered in more detail in Section 5. The rest of Section 1 will try to explain why the lowest joints should be particularly susceptible to flexion.

Note:

It is worth observing in Figure 4 all the effects of lumbar support. As we as flexing the lowest part of the spine and causing low back pain, there i typically a hyperextension near the thoraco-lumbar junction (often an are of spinal problems) and an increased thoracic curve or kyphosis, agair a typical source of problems in a civilised lifestyle.



As Figure 4.
but extended upwards to show thoracic spine also

Chapter 1.3 The Chimpanzee Spine

In trying to understand why the continuous forward bending force of upright civilised sitting should cause such a serious problem in the lowest part of the spine, it is necessary to understand the mechanics of the lumbo-sacral area. In trying to understand the mechanics of this area it is necessary to understand the way in which it has evolved and hence the reasons for the details of structure.

We evolved from an ape similar to the chimpanzee or orang-utan and the human line separated from the apes only 5 to 10 million years ago.

The first step was the evolution of a bipedal ape, known as an australopithecene. The earliest fossil of an australopithecene that we have is universally known as Lucy. She is about 4 million years old. Lucy has a body that is almost the same as ours up to the neck. The head however is still that of the chimp. The evolution of intelligence and a large brain came after bipedalism and started about 2 million years ago.

The chimpanzee lumbar spine is more or less straight and one or two of the lowest vertebrae are generally fused into the sacrum. The pelvis is cylindrical giving a straight and large birth canal.

Although quadripedal in ground walking the apes are very upright animals. They sit upright and their normal locomotion in the trees is upright while swinging from their arms. Part of the change to being upright and bipedal had already been made. Much weight is given in this book to arguments which show how the shape of the human pelvis is defined by the need to maintain an adequate birth canal. Many of these arguments come from researches into the evolution of Lucy from a chimp-like ancestor.

Chapter 1.4 The Bipedal Pelvis and Spine

The change from the quadripedal chimpanzee to the upright ape or australopithecene occurred between four and eight million years ago. There were major changes in foot, leg, pelvis and lumbar spine. In simple terms Lucy is a combination of a chimpanzee's head on a human body.

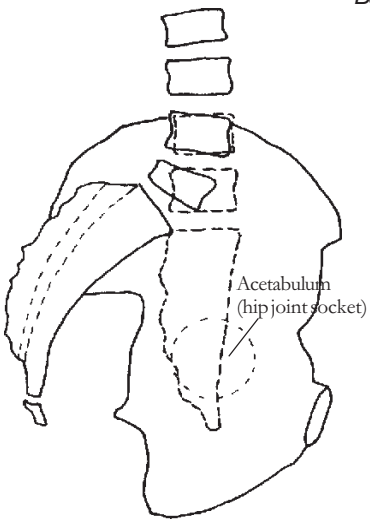


Figure 6.
Pelvis from right

It was necessary to place the lumbar spine above the hip joint in order to stand upright. A straight spine and sacrum (dotted in Figure 6.) would then have left no birth canal in the pelvis so the sacrum had to be curved and angled and this produced the lordosis. (Figure 6.)

The lordotic shape seems likely to be liable to damage from hyperextension but various mechanisms have evolved to protect the spine. The psoas muscle limits the lordosis at the lowest joints by increasing it at upper lumbar levels. The articular joints limit extension at all lumbar joints with the possible exception of L5/S.

Another major influence during our evolution has been the effect that lifting weights has on the spine. This would have been true for Lucy (lifting baby or child) but probably became even more important when intelligence allowed us to hunt, build and carry. When we bend to lift a weight off the ground the force generated in the lower back can be very large indeed.

The strength of the body structure must be analysed like the jib of a crane (Figure 7). The tension component is the muscles and the compression component is the column of vertebral bodies and discs.

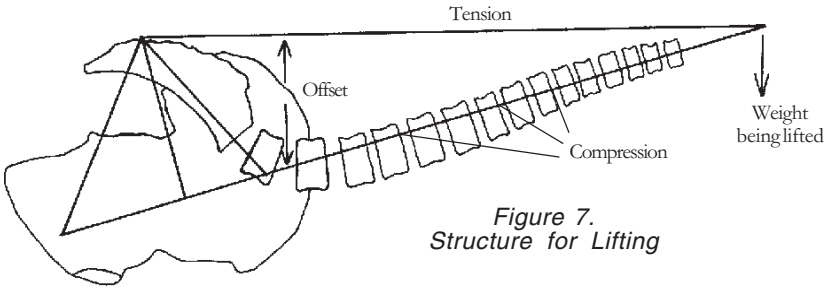


Figure 7.
Structure for Lifting

The most important dimension in defining the strength of the structure is the offset between the lines of these two components at the base of the spine near L5. This "Offset" gives the mechanical advantage which allows the muscles to resist bending forces at the lowest joints.

Figure 7 shows how the lordotic shape of this part of the spine and the prominence of the sacrum allows this offset to be maximised. Although these shapes are really defined by the need to maintain an adequate birth canal, they have been used by evolution to provide the maximum muscular offset for strength in lifting. Most of the most important muscles structurally (those from the thorax) connect to the sacrum via the erector spinae apponeurosis (and to the posterior superior iliac spines).

In achieving strength for lifting, evolution has succeeded. The world record lift is over one third of a tonne!

One detail of the construction is of of particular significance. The most important ligament in limiting the flexion of spinal joints is the supraspinous ligament which is connected to the tips of the spinous processes from the cranium to L4. It does not continue below L4 to the sacrum. (The reason for this is clear from details of the chimpanzee spine and pelvis). This means that the critical lowest two joints L4/5 and L5/S are not protected from hyperflexion by a supraspinous ligament.

Below L4 the role of the supraspinous ligament is taken over by parts of the lumbo-dorsal fascia. Figure 8 shows the layout from the back. The angled arrangement of the fascia has several implications for these critical lowest twojoints such as the following:

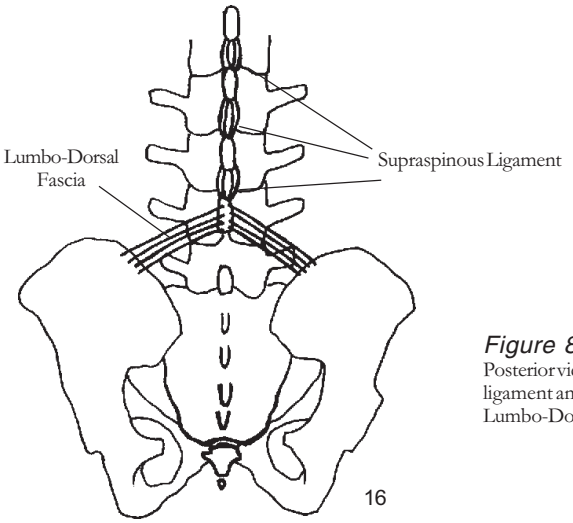


Figure 8. Pelvis
Posterior view to show supraspinous ligament and most relevant part of Lumbo-Dorsal Fascia

1) The limit in flexion is more elastic and may be less effective than for joints protected by a supraspinous ligament.
2) Even in the absence of exercise (for instance when resting an injured joint) the angled fascia cannot tighten enough to reduce the mobility of these joints much. (The angle becomes too far from axial).
3) Conversely a non exercised joint with a supraspinous ligament (eg L3/4) will rapidly lose mobility because the ligament will shorten.
4) (2) and (3) together mean that rest, for instance after a back injury, will tend to transfer mobility to the lowest joints.
5) The same fascia acts as a "supraspinous ligament" for both L4/5 and L5/S. It is perfectly possible for all the permitted mobility to be concentrated into one joint and for the other to have a very low mobility.
6) Because of other details of the lumbo dorsal fascia, it is probable that the function of limiting flexion below L4 can only be fully effective if joints above L4 are also flexed. If, as in civilised sitting, joints above L4 are not flexed the fascia may be less effective in limiting flexion below L4.

These points will be referred to in later chapters.

Chapter 1.5 The Human Pelvis and Head

The body of Lucy of 4 million years ago is very similar to the human body. The head however has changed totally from that of the chimpanzee to ours. There have simultaneously been some minor changes in the pelvis. These are probably associated with the increase in brain size.

We have a brain four times as big as Lucy or the chimpanzee. If childbirth was already difficult for Lucy, as it was, then it must have been a major constraint throughout our subsequent evolution. There are at least four major parts to the solution which has evolved to allow childbirth to occur in humans.

1) The sacrum is angled and curved, as described previously, to maintain the birth canal diameter at pelvic inlet and outlet.

2) The sacro-iliac joints and the pubic symphysis can separate slightly during childbirth in order to increase the diameters of the birth canal.

3) The foetal cranial bones can overlap slightly during childbirth in order to reduce the diameters of the foetal head.

4) The human baby is born very early in comparison with other mammals and primates. Relative to our life span we should have a gestation period of about 18 months not 9. (This is referred to as secondary altriciality).

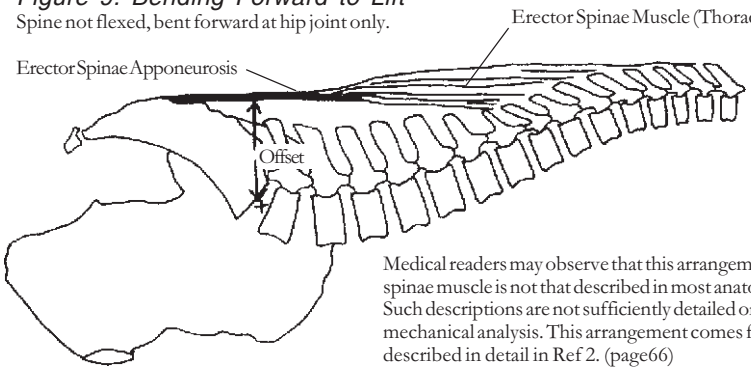
These four evolutionary steps show how important the problem of childbirth must have been throughout our evolution. It must also have defined the shape of the pelvis and other solutions must have evolved to work around this constraint and give satisfactory walking, running, weight lifting and so on.

Chapter 1.6 The Problem

As suggested in Chapter 1.1 there is likely to be a problem associated with extension or hyperextension and this will be examined in Section 3.

However it is suggested here that the central problem of low back pain is associated with flexion or hyperflexion. In Chapter 1.4 it was shown that the

Figure 9. Bending Forward to Lift
Spine not flexed, bent forward at hip joint only.



Medical readers may observe that this arrangement of the erector spinae muscle is not that described in most anatomy text books. Such descriptions are not sufficiently detailed or accurate for this mechanical analysis. This arrangement comes from Ref 5. and is described in detail in Ref 2. (page66)

sacrum was prominent in order to allow an adequate birth canal but that the prominence made the sacrum and the adjacent posterior iliac spines the most advantageous points for attachment of the main back muscles (erector spinae). This is because this attachment (via the erector spinae apponeurosis) gives the maximum offset of muscle line of action from the disc. Figure 9 shows this offset and this gives the maximum strength for lifting.
However, if the same drawing is modified to show a spine that is flexed from the lordotic shape until it is evenly curved then the offset is reduced to less than half at the lowest joints. (Figure 10.)

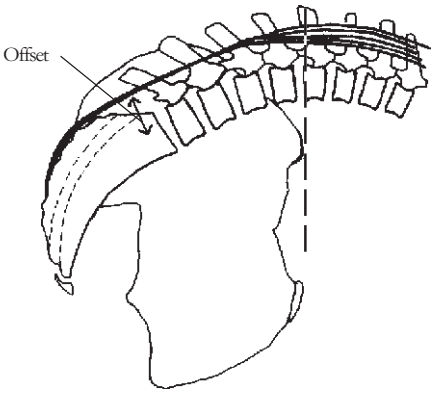


Figure 10.
Spine flexed to bend forwards.
Hip joint not flexed (pelvis as standing)

As the offset is lost the spine cannot resist further flexion of the lowest joints. These can therefore flex further while at the same time the compression is increased because the offset is reduced. These are exactly the conditions that will cause the prolapsed or slipped disc in laboratory tests.

It is suggested that this is the central point of the low back pain problem. The offset is reduced on flexion and can be reduced to a dangerous level which will result in disc prolapse in heavy lifting if the spine can flex too far.
True disc prolapse is however rare. Most cases of severe back pain resulting from lifting have no explanation. There is no tissue damage. I am suggesting that a severe warning pain has evolved to stop actual disc prolapse from occurring. A true disc prolapse is a very serious injury; there would be great evolutionary advantage in a warning pain which prevented such an injury. It is suggested that this warning pain is the central point of low back pain. Many of the odd characteristics that make low back pain so confusing are the result of its being an evolved warning pain not associated with actual tissue damage.

SECTION 2

BACK PAIN

Chapter 2.1 The Warning Pain

The mechanical arguments proposed so far are not speculative. Although not generally accepted, they are well supported by other research and easily checked. The idea of a warning pain is however speculative. Further speculation is then involved in trying to explain the confusing characteristics of the warning pains.

Speculation is not however unscientific and should be evaluated on the basis of how well it explains the facts of back pain.

If the problem of low back pain were easy to explain it would have been solved long ago. It is precisely because something odd has evolved that it is so difficult to understand. The idea of a warning pain does fit the characteristics of low back pain very well. There is also an obvious source for the pain and good evidence that it is the source. This source is the nerves in the posterior annulus of the disc. It may, of course, be proved that this is not the source and that the source lies elsewhere.However in addition to the evidence that this is the source there is a very simple explanation of how it would have evolved. In fact it would be very surprising if such a warning pain hadn't evolved. The sequence is as follows:

If, in heavy lifting, a disc prolapse starts to occur the nucleus will be squeezed out through growing cracks in the posterior annulus and will come into contact with nerves in the posterior annulus before a full prolapse occurs into the spinal canal or intervertebral foramen. This would be an abnormal event for these nerves and would be likely to produce nerve impulses which would be recognised as pain. There would be great evolutionary advantage in a warning pain sufficiently severe to stop further activity and damage and it is likely therefore that any pain would evolve to be severe. This would provide a warning pain as a disc started to prolapse.

However a further evolutionary step is then likely. As the pain evolved to become severe and disabling the nerves would evolve to be very sensitive to the presence of fluid from the nucleus even before significant cracks had developed. These two discs L4/5 and L5/S are normally wedge shaped wide end anteriorly so the nucleus will normally be held anteriorly by the wedging and well away from the warning pain nerves. If however either disc flexes beyond parallel sided the nucleus will be squeezed posteriorly. This may bring the nucleus sufficiently close to the nerves to trigger the warning pain even without there being any significant cracks. The latest research on these nerve endings in the annulus does suggest that they would be sensitive to material from the nucleus in these circumstances. Some diffusion of nuclear fluid through the annulus is likely and this may result in warning pains being triggered simply by a disc flexing beyond parallel sided. (i.e. to a wedge shape wide end posteriorly).

At first sight this may seem to be a false and undesirable warning! If it had been, it would have evolved to be less effective and eventually non-existent. However coincidentally it is when these two joints flex beyond parallel sided that the offset of the line of action of the most important muscles (the erector spinae apponeurosis) is reduced by the flexion to a potentially dangerous level which could allow a prolapse to occur. This is a coincidental effect of the shape of the sacrum, which was really defined by the need to have an adequate birth canal, but it makes the warning pain useful and advantageous in evolutionary terms. It therefore evolved to be severe and very effective as a warning.

This sequence leads to a very important conclusion. This is as follows:

The lowest two discs (L5/S and L4/5) should be wedge shaped (wide end anteriorly in lateral x-ray) when standing and should not flex beyond parallel sided even when fully flexed. A disc that does flex beyond parallel sided will usually cause the low back warning pain.

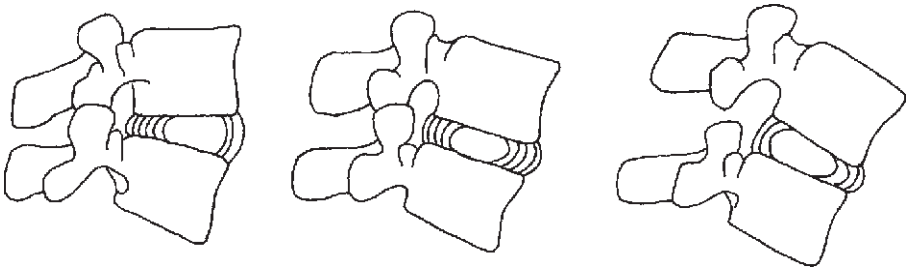
This conclusion is supported by examination of lateral x-rays taken flexed and extended of groups of non-back sufferers.

The nucleus will always tend to be held anteriorly if the disc is wedge shaped and will only move posteriorly if the disc flexes beyond parallel sided. It is therefore easy to suggest ways in which the approach of the nucleus to the nerves in the posterior annulus could trigger the warning pain. This might only occur if there are small cracks in the posterior annulus or might occur by diffusion of nuclear fluid. We now have a very severe warning pain in the lowest two discs which can be triggered not only by actual damage to the disc but also by the shape of the disc with no damage of any kind.

This, I suggest, is the centre of the low back pain problem.

It is also the central point of this book and will be referred to many times in the book. The description "shape warning pain" will be used in each case. The shape referred to is the shape of the disc seen in lateral x-ray. It is normally wedge shaped and should not flex such that the two sides of the wedge become parallel or flex beyond parallel. Although it is the shape of the disc that is being referred to, the sides referred to are not the sides of the disc, they are the two sides of the wedge shape which are the top and bottom surfaces of the disc. The normal wedge shape means that the disc is thicker anteriorly. "Parallel sided" means that it is equally thick anteriorly and posteriorly and "beyond parallel sided" means thicker posteriorly than anteriorly or wedge shaped wide end posteriorly. Figure 11 shows these three shapes of the disc as seen in lateral x-ray: (note that the 20° wedgshape of figure 11(a) is the normal standing shape for L5/S).

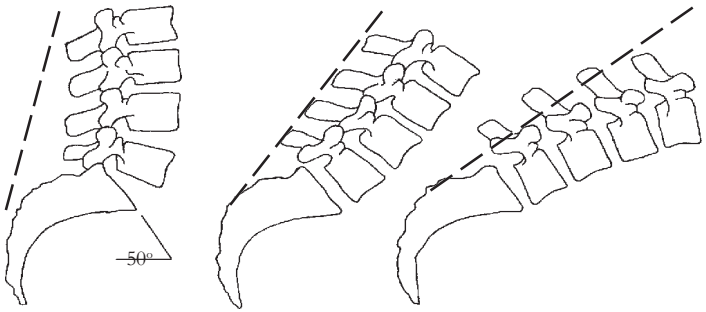
Figure 11 - Shape of L4-5 or L5-S



(a) "Normal Wedge Shape" Standing

(b) "Parallel Sided" Normal Flexion Limit

(c) "Beyond Parallel Sided" Hyperflexion



(a) Standing (b) Normal Full Flexion (c) Hyperflexion

This drawing show the significance for the overall mechanical situation of the "parallel sided" limit to flexion for the lowest two discs. The dotted line shows roughly the line of the erector spinae apponeurosis which is the most important tension component in evaluating the strength of the spine and body in this way.

The line of action clearly has an inadequate offset in the hyperflexed shape and it is roughly when flexion of the lowest two discs passes parallel sided that it becomes inadequate. It is this coincidence that makes a warning pain that starts at roughtly this angle of flexion so advantageous and this is why it evolved to be so effective.

Note: All of these drawings show flat vertebral endplates allowing an easy interpretation of the meaning of "parallel sided". In practice with the effects of degeneration, age and osteoarthritis this will not be so easy and in some cases it will obviously not be possible to keep within the criteria suggested. This is probably why it is increasingly difficult for most of us with the passing of the years to be completely free of low back pain.

Chapter 2.2 The Sublesation

Although the idea of a warning pain explains some aspects of back pain it does not explain the muscular spasms that are so often associated with back pain.

It seems very likely that these muscular effects are associated with a phenomenon that occurs in the spine of any animal that I shall refer to as a sublesation. The chiropractor refers to this effect as a "chiropractic subluxation" and the osteopath refers to it as an "osteopathic lesion". I shall avoid both words because in medical terms it is neither a subluxation nor a lesion because it is within the normal range of joint mobility and because there is no associated tissue damage. (Osteopaths have recognised this and now call it a somatic dysfunction.) I have also avoided the word "fixation" because this includes cases where the joint is "fixated" by adhesion following trauma. The word sublesation should avoid all these ambiguities because it doesn't exist. It is a combination of the chiropractic term subluxation and the osteopathic term lesion. I hope that sublesation will eventually be accepted by both professions and also by the medical profession so that this important phenomenon can receive the recognision and research effort that it deserves.

In a sublesation local muscles around a joint are permanently energised by nerves that are in some way excited by the clamping effect of the muscles. Thus the effect is self perpetuating. The mobility of the joint is greatly reduced and it is distorted aysmmetrically because the muscle in spasm is only on one side. The osteopath and chiropractor both recognise the characteristics of the sublesation as asymmetry, loss of mobility and local muscle abnormality. The effect can occur in any spinal joint of any animal and has probably evolved in order to allow an injured joint to recover. (This phenomenon is the central point of chiropractic and is also central to osteopathy.)

When the warning pain has been triggered and there is disc damage or potential disc damage, the sublesation is ideally suited to provide muscular immobilisation of the vulnerable part of the spine. It seems likely that the phenomenon of the sublesation has evolved to be a very much more powerful effect in the human lumbo-sacral area. It also seems likely that evolution has used sublesations in the pelvis and sacro-iliac joints to cause muscle contraction in many of the muscles of the lumbar region.

(It is also possible that the warning pain directly energises some muscles. Whichever way large muscles are energised and put into spasm, the balance of most muscles of the pelvic region is bound to be disrupted). Where parts of the erector-spinae and the psoas are involved the lumbar spine can be very effectively "splinted" or immobilised.

Some characteristics of this sublesation should be noted.

1. It is triggered by the warning pain from the disc but may possibly be triggered by other strains as well.

2. It is self perpetuating so it will remain after the triggering pain from the disc has gone away.

3. It probably causes pain because this would be advantageous in inhibiting actions that might injure the weakened disc again.

4. The "loop" that perpetuates the sublesation would normally be released eventually by exercise.

5. Osteopaths and chiropractors have developed methods of releasing the loop by fast manipulation. They use high velocity, low amplitude thrusts to move joints before muscles can react. This releases the clamping effect for long enough to interrupt the stream of nerve impulses from the joint and this "breaks" the nerve loop that is clamping the joint. Physiotherapists use other forms of manipulation. Massage of the muscle can probably have the same effect.

6. The phenomenon of the sublesation is adequately researched inside the osteopathic profession. It is referred to as the osteopathic lesion or somatic dysfunction and is associated with the facilitated segment (Chapter 2.3). Confusion may be created by my invention of the new term sublesation but even more confusion would be created by the use of the above terms without being sure that the meaning was exactly the same.

Some characteristics of the shape warning pain from the disc should also be noted.

1. When the pain is first triggered it is very severe and can last a few months.

2. When it has applied from childhood (i.e. the shape of the lowest discs has been wrong from childhood) it is not severe but is simply a tendency to persistent back ache in bouts which increases with age.

3. When someone has had the first severe attack the intensity reduces and the pain and ache may go completely. Usually a tendency to backache persists.

4. Most of this chapter is written on the assumption that the source of the warning pain is the nerves in the posterior annulus. This seems to fit the facts very well but it may eventually be shown that the source lies elsewhere.

The sublesation is of central importance to the problem of low back pain. An example may help to clarify its role and that of the shape warning pain.

Take a typical bout of LBP which may result from a day's gardening and one slightly painful bend. Initially there may be only a slight pain. The nucleus was already near the warning pain nerves in the posterior annulus due to years of sitting and driving and only needed slight extra flexion to seep or ooze through a fissure to get to the nerves. Even with a very slight seepage to the nerves which does not cause much actual pain the ability to switch on sublesations is activated.

The warning pain first switches on sublesations in the upper lumbar joints. These are the joints that innervate the parts of the erector spinae and psoas that have their insertions on the upper lumbar verterbrae. These muscles therefore go into spasm. Usually it is the erector spinae on one side and the psoas on the other and since both have their origins in the pelvis this constitutes a pair of diagonally placed muscles which can "splint" or immobilise the lumbar spine. This is what is mechanically required to prevent further bending of and possible damage to the lowest joints of the spine. The pair of muscles acting asymmetrically on the pelvis will now twist, tilt and distort the pelvis and sublesations will occur in many joints and muscles of the pelvis probably locking the sacro-iliac joints and perpetuating the misalignments of the pelvis which the chiropractor always finds.

This example may suggest that we know that this is the only sequence of development of an episode of low back pain. It is of course just an example but the erector spinae and psoas muscle spasm is undoubtedly the basic splinting of the spine in a typical episode of LBP and the pelvis is always distorted (and frequently remains so.)

At the most acute phase there will be sublesations and muscles in spasm at several lumbar joints and at various points in the pelvis. Note that the initial warning pain may now have gone away. The initial seepage may have been small but the sublesations are now perpetuating the pain and spasms. In this case the osteopath and chiropractor may be able to release the clamped joints and clear the problem. (Note that the sublesations that are perpetuating the problems will probably not even be close to the L4/5 or L5/S joint where the triggering warning pain occurred. This does tend to disguise the fact that the problems originate at L4/5 or 5/S and give rise to the opinion that upper lumbars are in fact being damaged and must themselves be protected from flexion. In fact they are just in spasm and are not damaged or liable to damage themselves from flexion. In fact they may well be more susceptible to sublesation if their natural mobility is not maintained.)

In other cases the warning pain may persist and continue to turn on sublesations. These will be difficult to free by manipulation. If, because of disc damage or a permanent loss of the wedge shape of the disc the warning pain persists then the problem can last for months. The warning pain does however decrease in intensity with time and will eventually lose its tendency to turn on sublesation. Those sublesations that are there may however persist and be very difficult to free particularly those in the pelvis which may be "clamping" the sacro-iliac joint and producing a twisted pelvis. It may appear as if the whole problem lies in the pelvis. If the shape warning pain has been corrected or just died away with time the problem may be entirely in the pelvis but it is only a persistent series of sublesations which will eventually be released by osteopathy or chiropractic (or exercise or physiotherapy).

In a nutshell the shape warning pain triggers the sublesation and the sublesation cause the large muscle spasms.

Different ways of treating low back pain concentrate on different part of this sequence.

Physiotherapists following McKenzie's ideas concentrate largely on the warning pain, switching it off by correcting the shape. Osteopaths and chiropractors use high velocity low amplitude techniques to "release" sublesations. Physiotherapists use slow forms of manipulation. Massage therapists, kinesiologists, and touch-for-health therapists work directly on the muscles found to be in spasm. Alexander Technique teachers concentrate on body shape which will tend to turn off the warning pain and they also teach the mental control necessary to lower the muscular tone and avoid the tendency to develop muscle spasm. Accupuncturists treat muscles at particular points. All of these techniques are entirely compatible with the ideas proposed in this book and with one another. These therapists should not be competing with one another they should be complementary. What tends to happen is that the successful expert in muscle relaxation techniques or massage, for instance, thinks that the problem starts in the muscles. The osteopath and chiropractor think that the problem starts with the lesion or subluxation (the sublesation). Such disagreements will only be resolved when the importance of the shape warning pain is recognised.

Note: There are many theories about the nature of the sublesation. The interpretation given here comes mainly from Osteopathic research (Korr) and from other papers, researchers and practitioners.

This interpretation seems to be the only one that corresponds to the facts and particularly to the way in which sublesation can be "switched on" by some occurrence at a different point in the spine. This could not occur with a fixation caused by adhesions or tight ligaments. However, if a joint remains immobile for a long time these other restrictions on mobility will obviously develop.

(My conclusion from various sources is that the sublesation is almost certainly a unilateral spasm of the Rotatores muscle in the thoracic area and therefore probably of the laminar fibres of the Multifidus in the lumbar region since they are homologous to the Rotatores.)

This description of the sublesation has of course been written from the point of view of a chiropractor. Those whose particular expertise is in muscles may disagree with certain points.

Every osteopath, chiropractor, Alexander teacher, physiotherapist, kinesiologist etc would agree that there is an almost general problem of tight, short or hypertonic muscles in our sedentary society. Why this occurs and to what extend it is caused by sublesations or other factors is obviously an important area of study but it is not the subject of this book.

Those who see the other factors as more important in causing hypertonic muscles are asked to look upon the shape warning pain as directly causing muscles to go into spasm via connnections in the spinal cord. This is entirely compatible with the main argument of this book.

Chapter 2.3 The Facilitated Segment

The sublesation can occur in other animals such as the horse but has been used by evolution to be a part of a warning pain required only in the human lower lumbar spine. It may have evolved to be more effective to increase the warning.

This may be of major importance because the sublesation has a very important side effect.

Where there is a sublesation in the spine there will also be an effect on other nerves. That area of the spine is referred to by osteopaths as a "facilitated segment". Facilitated means that signals are generated more easily in those nerves which come out of the spinal canal at that joint. This may sound good but it isn't. The nerve signals are in effect amplified in comparison with those at a normal joint. This results in sensory inputs having excessive effect, motor outputs causing excessive muscle tone or spasm and outputs to the sympathetic part of the autonomous nervous system also being amplified. The sympathetic part of the autonomous nervous system is generally the part that provides exciting (rather than inhibitory) nerve inputs to all the organs of the body so excessive excitation can result. This is the main way in which mechanical disorders of the spine can affect the balance and

function of all the organs of the body. There can also be direct nerve root compression causing lack of nerve signal transmission but this is not the case in most instances. The facilitated segment is the normal explanation of the way in which the correct functioning of organs of the body can be affected by spinal problems.

The overall mechanism seems to be as follows: At a sublesation there is a continuous stream of nerve impulses from some part of the mechanical structure of the joint which is distorted. These feed into the spinal cord. A "nerve loop" in the spinal cord feeds the stream of nerve impulses out again to a muscle which 'clamps' the joint limiting its mobility and distorting it which in turn causes the first stream of nerve impulses. This situation is self perpetuating and the stream of nerve impulses is absolutely continuous. Because of this continuous stream of nerve impulses all other nerves which are close to those ones, or possibly have their nerve bodies in the same ganglia or part of the spinal cord are also affected and fire more easily. They are facilitated and signals via these nerves become amplified.

Chapter 2.4 Section Conclusion

Most low back pain is a warning pain which has evolved to stop actual damage occurring such as the prolapsed disc. This warning pain has two parts. The warning pain in the disc has evolved only in the human lumbar spine and is triggered either by the first stages of disc damage or simply by flexion beyond the parallel sided shape without damage. This warning pain is then able to switch on sublesations at many points in the spine and pelvis to produce an even more effective warning pain and one that can be particularly persistent. The sublesation phenomenon can exist in other animals such as the horse but may have evolved to be stronger in the human spine to add to the warning pains.

SECTION 3

DISC DAMAGE AND NARROWING

Chapter 3.1 Section Introduction

This section does not form a part of the continuous argument of this book. The central point of this book is the warning pain that occurs on hyperflexion of L4/5 and 5/S beyond parallel sided, the forms that this warning pain can take and the reason for the hyperflexion, namely civilised sitting. The warning pain normally occurs without any disc damage.

However there are several simple mechanical points that arise from the main argument that may explain how disc narrowing and damage occur. This may or may nor be the main factor behind disc degeneration and narrowing.

The damage that may occur is associated in this case with the extended shape or possibly with hyperextension. However the reason why normal extension may be damaging is that the disc may be thinner or narrower than normal. The reason for the narrowing is the continuous compression force on the disc in civilised sitting.

The conclusion from most of this book is that we should try to maintain the wedge shape of the lowest joints. This section gives one reason why this may not always be possible.

Chapter 3.2 The Hyperextension Problem and Disc Narrowing

When we lie in bed overnight the discs expand and we are marginally taller in the morning. Astronauts in space for a month return up to 5 cms taller. The reason is that the discs become thicker when the pressure on them is reduced. This is because of fluid absorption into the nucleus.

In our civilised sedentary lifestyle we spend a large proportion of our time sitting and these forms of sitting apply a far higher pressure on the discs than standing (or natural sitting - see Chapter 5.2). It is therefore very likely that our discs are somewhat thinner than they naturally should be.

If the disc is more or less parallel sided then this probably doesn't matter. However, if it is significantly wedged as L4/5 and L5/S are then it may well be important. Figure 12 shows how wedging at 17° will mean that only a small reduction in thickness will bring the posterior edges of the vertebral bodies very close. It seems more than likely that this could squeeze the posterior annulus of the disc and damage it.

The angle of the wedging is almost certainly correct and natural for the reasons listed in Section 1 (particularly 1.1 and 1.4) but needed to be checked in a more naturally living population as did the disc thickness.

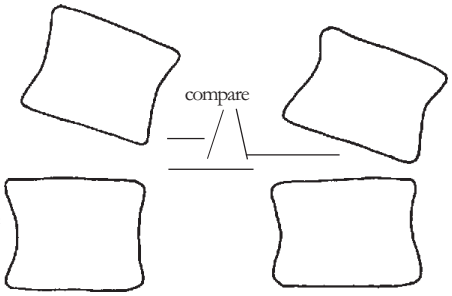


Figure 12

The effect of disc narrowing on a disc with a 17° wedge shape

Comparison between a group of non back sufferers from an English sedentary population and a small sample of tribal living Africans did confirm the wedging angles to be similar. L5/S was actually more wedged among the Africans- (24° average) than among the English (18°). It was difficult to compare disc thickness between x-rays of different magnifications but there was some evidence of a 20% greater thickness among the Africans. Because of the wedging, this 20% measured at the centre resulted in the separation of the two vertebrae at the posterior edge being twice as great among the Africans as among the English. This is a very tentative conclusion but is in line with expectations from the pressure increase during long periods of sitting in cars, offices etc.

The conclusion must be that civilised sitting will probably cause discs to be narrower and where these are wedge shaped as at L4/5 and L5/S there is a likelihood that the posterior annulus may be crushed to some extent at the normal extended shape. Any hyperextension at these joints will probably make the situation worse.

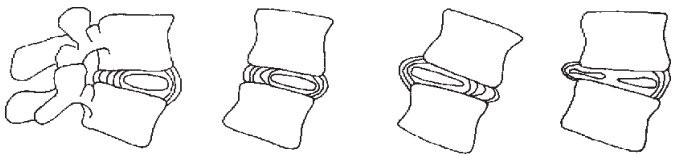
Chapter 3.3 Consequences of Flexion with Disc Narrowing

The previous Chapter 3.2 suggested that it was likely that discs might be thinner due to a civilised sedentary lifestyle.

It was also suggested previously (in Section 1) that the lowest two discs, which are very wedge shaped, should not flex beyond parallel sided. If this condition is complied with it would seem likely that the nucleus would remain anteriorly and would not tend to be squeezed into the posterior annulus where there might be cracks.

However it was also suggested that civilised sitting would be likely to cause these discs to flex beyond parallel sided. If they do flex and extend through the parallel sided shape and are also narrowed then the combination has obvious consequences that may lead to a form of disc prolapse. Figure 13(c) shows how the disc may bulge when sitting or lifting with a flexed back. This would be in a joint that had already flexed beyond parallel sided and where the warning pain had already been activated by the proximity of the nucleus to the posterior annulus but where the pain had died away due to the passage of time. The bulge would not in itself be a problem. Disc bulges are normal. However extension requires that the whole nucleus flows anteriorly and there is an obvious possibility that part of the nucleus will be trapped on extension and form a protrusion that is "pinched off".

Figure 13



(a) Extended or Standing | (b) Normal Full Flexion | (c) Hyperflexion beyond Parallel Sided | (d) Extension Following Hyperflexion

This is the sequence leading to discs prolapse and collapse depicted by Kapandji and by others and seems a likely event. However it should be noted that it is only likely or indeed possible if the disc can flex beyond parallel sided (to allow the nucleus to reach so far posteriorly) and has also become thinner than normal. In a normal thick disc which does not flex beyond parallel sided (Fig 13(b)) this event simply cannot occur.

Chapter 3.4 Section Conclusion

This section has shown how the combination of narrowing and flexion beyond parallel sided might lead to disc damage and collapse as is sometimes found. We don't really need to look any further to explain this damage, (though there may be other causes as well). This problem is associated with the wedge shape of these discs. Inherently the wedge shape is a disadvantage but it evolved a long time ago for the reasons defined in Section 1 and many details have evolved to fit in with the wedge shape including the warning pain. In most cases it is necessary to maintain the wedge shape to avoid low back pain but if the narrowing and hyperextension beyond parallel sided has already produced the situation of Figure 13(c) or (d) then it may be better to accept a parallel sided shape and avoid normal full extension.

One other possible reason for disc narrowing should also be mentioned. Continuous compression probably causes narrowing. This will be caused by civilised sitting, but is also likely to be caused by sublesation due to the compressive forces caused by the muscles or by general muscle tightness. This is probably a very strong argument for trying to release sublesation as quickly as possible and to keep general muscle tone down to a natural level.

This section also leads to another important conclusion. When a disc is generally parallel sided (i.e. equal depth anteriorly and posteriorly) it seems obvious that it should flex and extend on both sides of the parallel sided shape. On the other hand where a disc is sharply wedge shaped, as L4/5 and L5/S normally are, it seems likely that it should remain wedged in the same direction throughout its range of mobility. To flex much beyond parallel sided seems likely to cause the sort of disc damage shown in Fig 13. In other words a disc that is sharply wedged when extended must inherently remain wedged in the same direction when flexed.

In Chapter 2.1 it was suggested that the shape warning pain had evolved to be severe because of the loss of strength of the spine when L4/5 or L5/S flexed beyond approximately parallel sided. If these discs are inherently liable to damage when they flex beyond parallel sided then this is an additional important reason why the shape warning pain would have evolved to be so effective.

SECTION 4

MORE BACK PAIN

Chapter 4.1 Confused?

By now the reader may be confused. Should everyone do extension exercises in order to maintain the wedge shape of the lowest discs at all costs or should everyone flex the lowest discs in order to avoid any possibility of pinching the posterior annulus.

This confusion accurately reflects the same confusion among the experts who treat and write on the subject of low back pain. Some suggest that lordosis should be maintained when active or sitting and others that lordosis should be reduced (flattened) as much as possible when standing or sitting. Each will be right in some individual cases. It isn't very helpful to argue whether one or the other is helpful in more cases. This will still leave a large minority receiving the wrong advice (and treatment). It is important to analyse the individual case which can only be done with a good understanding of the characteristics of the shape warning pain (which is a new suggestion in this book) and of other factors which are already better understood.

Chapter 4.2 Summary of Warning Pains

The pains associated with a low back problem can be very extensive and confusing. Most of these pains are caused by sublesations at various points in the pelvis and lumbar spine. These result in painful muscle spasms. The characteristics of these are well known to the osteopath and chiropractor. When some sublesations have been switched on by the warning pain there is a great tendency for others to be switched on and for the whole of the spine to go into spasm including the neck. If there are sublesations in the neck these can lead to others down in the back and it can appear that the neck problem is causing a low back problem or vice-versa. In view of the way in which each sublesation affects the central nervous system in the spinal cord it should not be surprising that these effects occur. These are well known to osteopaths and chiropractors and will not be covered in more detail here.

The component of back pain that is the whole point of the book is the shape warning pain from the lowest two disc joints. This is new. It has not been proposed previously and it is probably this warning pain that triggers or switches on the sublesations which cause the muscle spasms etc.

It is the combination of this warning pain with the sublesations that it causes that constitutes the typical episode of low back pain. When a long term low back pain sufferer has a continuous ache in the low back from sitting or lying in bed, the pain probably comes from the shape warning pain. Acute phases almost certainly involve sublesations. It is probably worth trying to put together all the characteristics of the shape warning pain. These are:

1) It applies at the lowest joints L4/5 and L5/S only.

2) These joints are normally wedge shaped wide end anteriorly and should not flex beyond parallel sided.

3) The most likely source of the pain is the nerves in the posterior annulus - particularly the postero-lateral corners. These nerves probably detect chemically the proximity of the nucleus. This may however not be the case and it may be shown that the source lies elsewhere. To help explanation, the following characteristics will be explained assuming that this is the source.

4) Even when the pain level is very low, (only a slight "feeling") the warning pain can turn on sublesations.

5) When first triggered the ability to turn on sublesations is particularly strong and these are very difficult to free up.

6) The pain can also be very severe when it first occurs and can take a long time to die away.

7) Eventually in most cases the warning pain and its ability to switch on sublesations both die away to a low level. Usually the tendency to turn on sublesations persists more than the pain but in other cases sublesations and spasms are rare and backache is continuous.

8) In this reduced state the warning pain usually only results in bouts of back ache and the occasional brief episode of spasms and sublesations. In this case, other factors which affect the whole body but have no direct connection with back pain may activate the warning pain as a dull ache. These include influensa, PMT, general tiredness, cold and draughts etc and stress and these may appear to be "causing" low back pain.

9) After their initial "bout" some people suffer an ache in the low back due to sitting/flexing/or lying in bed which can last persistently for a few days at a time.

10) In some cases (possibly in a lot of cases) the shape can have been wrong from childhood. In that case the phase of severe warning pain and sublesations will not have occurred and the person will simply have a 'weak' back with a tendency to bouts of ache due to sitting, bending or lying in bed.

11) Usually this gets worse with age.

12) In any of these cases an actual injury, for instance in flexion when lifting, can tear or crack the posterior disc annulus allowing general access by the nucleus to the warning pain nerves and causing severe pain, many sublesations and general spasms (and maybe a prolapse as well!).

13) After the initial bout of back pain the level of long term warning pain seems to vary considerably. This assumes that any persistent sublesations have been cleared either naturally or by osteopathy or chiropractic. In some people the pain seems to drop to a level at which it is rare and acceptable whereas others seem to spend a lifetime looking for chairs with adequate support to limit the flexion and avoid a bout of backache. Whether this is a difference between people or reflects the angle of flexion I do not know.

14) It seems to be the transition from not flexing beyond parallel sided to flexing beyond parallel sided that causes the most severe pain and sublesations.

15) When it has been activated by this transition, the warning pain does not only apply when flexed beyond parallel sided. It is usually worst on flexion but is felt all the time. It is particularly severe on movement whether flexion or extension. This is entirely compatible with the concept of fluid from the nucleus being squeezed about in the area of the pain causing nerves. It is frequently worst when trying to return to the fully extended shape. This is also compatible with the idea of fluid from the nucleus being in the posterior annulus near to the nerves. However if extension pressure is applied to achieve the correct extended shape repetitively as suggested by McKenzie then the pain can be almost immediately switched off in some cases. This too is compatible with the idea of fluid being squeezed away from the posterior annulus.

16) The warning pain is able to spread to appear as a referred pain in the sacro-iliac area, the buttock, thigh etc as sciatica (note: in most cases the symptoms of sciatica are not caused by direct nerve root compression). This is a normal characteristic of pain that it spreads in area as it become more severe e.g. heart attack producing referred pain in arm etc. It is referred to by McKenzie physiotherapists as "the centralisation/peripheralisation phenomenon". Whether sublesations are responsible for this phenomenon or not I do not know.

These points describe the characteristics of the warning pain and correspond very well to the characteristics that one would expect from pain-causing nerves in the posterior annulus which are sensitive to the presence of fluid from the nucleus. (This does not prove that these nerves are responsible and the warning pain source might of course be elsewhere). These characteristics together with the characteristics of the muscle spasms caused by sublesations do also correspond to the known characteristics of low back pain. I believe that this is strong evidence for this interpretation.

It is probably worth listing the arguments which are contained in Section 1 and which led to the conclusion that there is a shape warning pain.

1) It is necessary. The low back is seriously weakened when the lowest joints are flexed too far. Without a warning pain of this type prolapsed discs and other

serious damage would be common. In fact they are rare. The warning pain works!

2) There is no supraspinous ligament below L4. The function of the supraspinous ligament is taken over by parts of the lumbo-dorsal fascia. True prolapsed discs occur only at these two joints where there is no true supraspinous ligament.

3) It needs to start warning at around about the flexion that corresponds to parallel sided for L4/5 and L5/S.

4) There are suitable nerves in the posterior annulus and these seem to be the source of LBP.

5) No "stretch receptor" as in a muscle, ligament or tendon can explain the continuous nature of backache. The ache often exists without there being any residual clamped joints. The chemical receptor interpretation would explain this.

6) The success of extension exercises, such as the McKenzie exercises in 'switching off' the pain. These exercises will have the effect of squeezing the nucleus anteriorly and can almost instantly switch off the ache and pain in some cases.

7) Examination of lateral x-rays taken flexed and extended of groups of non-back sufferers suggests that these joints should not flex beyond parallel sided.

8) As suggested in Chapter 3.4 the warning pain is also necessary because a disc that has a pronounced wedge shape when extended must also remain wedged shaped even when flexed.

9) My own experience. I know that I can have a warning pain with exactly these characteristics at either L4/5 or L5/S.

Chapter 4.3 Other Factors

This book concentrates on the problems of the lowest two discs L4/5 and L5/S. This is where the LBP problem originates. This does not ignore other problems many of which tie in with the central problem of flexion at L4/5 and 5/S.

Some other problems are listed here to show how they do not contradict any of the ideas proposed and do in many cases fit in very well with these ideas.

Asymmetry — particularly with a sideways bend near the pelvis will add a lateral wedging to any flexion at the lowest discs and squeeze the nucleus into a postero-lateral corner where the nerve endings are concentrated in the annulus.

Twisting — particularly when lifting may increase the size of cracks in the discs increasing the warning pains but may also have the direct effect of switching on sublesations either in the lumbar spine or pelvis when there is already some level of warning pain.

Posture — usually means the shape of the spine seen from the side. This obviously corresponds to these ideas in terms of the lack of lordosis at L4/5 and L5/S but the same forms of sitting with lumbar support which cause this will also cause a lordosis near the thoraco-lumbar junction which should not be there. This can frequently be sharp and is a part of the typical back shape that I refer to as 'Homo-Sedens'. These and other effects of civilised sitting on the upper lumbar and thoracic spine are rarely as serious as LBP but are obviously undesirable.

Stress/Tension — The Low Back shape warning pain has evolved the ability to turn on sublesations. These are associated with a hyper-activity or "facilitation" of the corresponding area of the spinal cord.

Where there is some level of warning pain the likelihood of switching on a sublesation and facilitated segment will probably be much higher if the whole central nervous system is already slightly 'facilitated' by a high level of emotional or physical stress.

Thus we should not be surprised if a bout of LBP is triggered by emotional stress.

The Apophysial or Facet Joints

When any joint of the body such as the knee or ankle is flexed beyond its normal range, pain results. This is a warning pain coming from nerves or ligaments which are slightly stretched or torn.

We should expect a similar form of warning pain to exist in each joint of the lower spine. If so, the most likely source for this "stretch" warning pain would be muscles and ligaments surrounding the facet joints. In addition, because of the susceptibility of the spine to serious injury, we should expect this warning pain also to have evolved to be severe.

There is some evidence that pain from the facet joints is very similar to the shape warning pain. This may explain the belief among some researchers that much back pain originates in the facet joints.

However, we would expect this warning pain to have the characteristics of a normal muscle or joint injury. It would always be caused by significant extra flexion or force. The pain would always be associated with tissue damage or inflammation. It would recover with rest in one or two weeks and would not be persistent. This pain is best prevented by exercise and people who do not suffer from the shape warning pain do find that exercise, stretching etc. are the best ways to avoid this back-ache.

However when they first have a bout of real back pain associated with the shape warning pain they find out that the characteristics are completely different from other joint pains. The problem is nothing like so easy to solve!

The combination of these two pains can make an episode of back pain even more difficult to understand. If a back sufferer tries to avoid flexing the low back to avoid the shape warning pain at one joint then other joints will "tighten up" like any unused knee or ankle. Soon the sufferer may be getting the shape warning pain from one joint because it is being flexed too much and the stretch warning pains from the adjacent joints because they are not being flexed enough! To complicate things further the pains may feel similar. As described in Chapter 1.4, the arrangement of the supra-spinous ligament will tend to cause this situation.

It is also possible that there are warning pains in the facet joints associated with hyperextension when the superior facet is pushed inferiorly beyond the articular surface of the inferior facet causing damage to the joint capsule or other tissue. Once again such tissue damage might cause severe pain but it would have the normal characteristics of tissue damage pain (ie caused by overload, quick recovery etc.) and not those of low back pain.

This is not meant to be a comprehensive list of spinal problems. It is simply meant to show that there is no contradiction between most of the ideas that have developed from experience and the new factor introduced by this book, namely the shape warning pain from the lowest two discs. However it is strongly suggested that the shape warning pain is the real centre of the low back pain problem. Many other pieces of the "jig-saw puzzle" will fall into place when this central point is fully understood.

SECTION 5

SITTING

Chapter 5.1 The Cause : Civilised Sitting

This section looks at various forms of sitting, at the way in which these cause problems and at the way in which these problems can be avoided by changing the ways in which we sit.

It must be emphasised again that the problem is almost the opposite of what is normally assumed.

1) Contrary to general belief it is not slouching on a settee or easy chair that is the problem. This is not harmful because the whole body is tilted back and any flexion between thorax and pelvis is spread evenly along the spine. There is no tendency to concentrate the flexion into the lowest joints and flexing the mid back is not harmful.

2) The worst situation occurs when we try to sit with the upper body upright as at a desk or when driving a car. In this case the pelvis tends to roll top backwards flexing the spine. In order to "sit upright", we resist flexion near the lumbar-thoracic junction either muscularly or with a backrest and this concentrates this flexion into the lowest lumbar joints.

3) Lumbar support makes this situation even worse. It generally hyperextends the part of the spine above the lumbar support while increasing the flexion of the lowest part of the spine.

These forms of sitting, in a car seat or at a desk, will therefore tend to cause a continuous flexion force on the lowest spinal joints, typically L4/5 and L5/S. This will have two effects. The ligaments at these joints will tend to stretch increasing the flexion mobility and possibly allowing the joints to flex beyond

parallel sided. In addition the continuous flexion force of sitting will increase the pressure on the discs which will tend to cause the discs to become narrower.

It was not possible in Section 3 to come to a firm conclusion as to whether disc narrowing did occur generally. However if it does occur the the most likely cause is the extra compression force on the disc caused by the same flexion forces from sitting which tend to result in hyperflexion. It doesn't therefore matter whether disc narrowing is caused by civilised sitting. If it is, then it too will be avoided by modifying our forms of sitting to avoid hyperflexion of the L4/5 and L5/S joints.

The rest of this section will therefore concentrate on different types of sitting, whether they will tend to cause excessive flexion of the lowest joints and if so how to correct the situation.

One of the first questions must be "why don't more naturally living peoples have the same problems?"

Chapter 5.2 Slumped Sitting

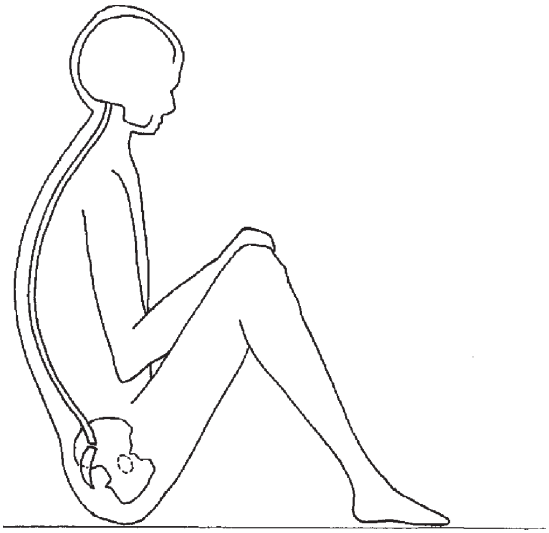


Figure 14
Slumped Sitting

By slumped sitting I mean the form of sitting on the ground practised by more naturally living peoples. (Figure 14)

When sitting in this way the whole of the spine is flexed except the neck. This in itself is an important difference from most civilised forms of sitting but there is a critical difference. The thorax folds down onto the abdomen with flexion of the whole spine until the weight of the thorax and upper body is taken largely by the abdomen acting as a pressure vessel and not by the spine as in all other forms of sitting. The compressive force on the spine is then greatly reduced and so is the downward force on the back of the pelvis. This is the force which in civilised sitting tends to tip the pelvis backwards so this tendency is also reduced as is the resulting flexion of the lowest joints.

Slumped sitting is a form of sitting that we are normally told is bad but it is in fact the most natural form of sitting. It will not have the disadvantages of upright civilised sitting in which flexion is concentrated into the lowest lumbar joints.

As well as being harmless, slumped sitting is almost certainly beneficial. We have evolved over a very long period to sit in this way and if we do not habitually sit in this way some of the time it is likely that some disadvantage will result.

When we do sit slumped all the joints of the spine will be flexed and all muscles and ligaments will tend to be stretched to a natural length.

Any new definition of ways to sit should probably include periods of slumped sitting each day in order to maintain a natural spine. For most people slumped sitting will actually have to be learned. We are so used to trying to "sit up straight" that most people cannot easily sit slumped.

Note that slumped sitting does not have to be done on the ground: the body can of course adopt a slumped sitting posture on a chair or stool.

Chapter 5.3 The Working Posture When Sitting

This is the upright posture when working at a desk, sitting at the dining table or just sitting upright.

The problem here is that the pelvis tends to roll backwards. We can all check this easily. Just sit up very straight and push the top of the pelvis forwards. Now relax;

the pelvis rolls top backwards. We then maintain an upright posture by hollowing the back near the lumbar thoracic junction without keeping the pelvis upright also. This we achieve either by muscular effort or by the use of a backrest. On average the pelvis is tipped back by more than 30° (anticlockwise seen from right).

The Solution - Alexander Sitting

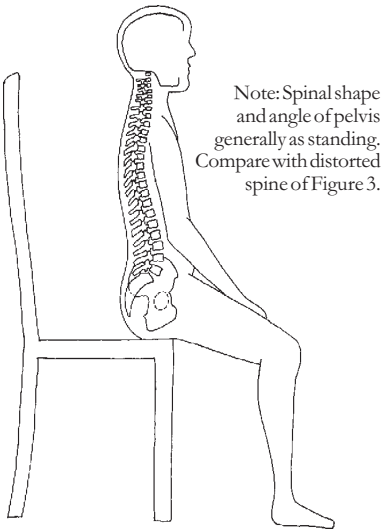


Figure 15

Alexander Sitting

The solution to this is to sit in such a manner that the pelvis does not tip back. This means maintaining the spine in approximately the standing shape when sitting to work. The hip joint is flexed but the pelvis is not tipped back in the normal way.This is the form of sitting which is normally taught as a part of the Alexander Technique and I have therefore referred to it as Alexander sitting. (Figure 15) The body is active and alert and is generally in the same posture as in standing. This may sound tiring but is a balanced posture and is usually found to be easily maintained by those who have learned it. (It is referred to by McKenzie as "10% less than the extreme good position".)

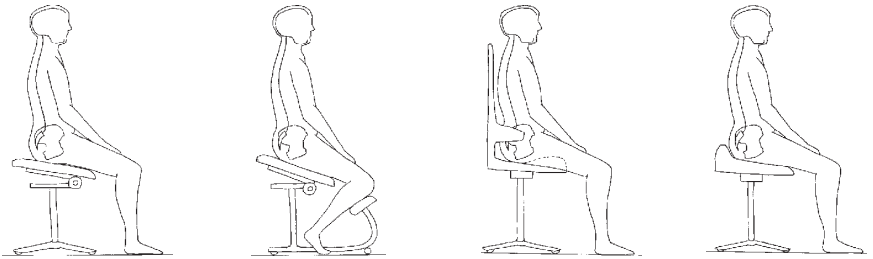
Good Alexander sitting is made much easier by having the thighs angled downwards. This reduces the tendency for the thigh muscles to roll the pelvis backwards. Various forms of chair which help good Alexander sitting are shown. (Figure16)

If a forward tilted seat is used in the working posture to angle the thighs downward then it is difficult to use a backrest at the same time. The force from the backrest would simply make the thighs slide down the seat. A backrest is usually therefore only of use when the body can lean back slightly as in resting or reading. A backrest should either be designed for use in a completely slouched

resting position or if it is to be used in an approximately upright position it must incorporate some forms of pelvic support similar to that described in the next chapter. The seat angle must also be adjustable to limit the tendency to slip forwards.

Figure 16

Chairs which help good Alexander Sitting



(a) Adjustable forward tilted seat

(b) Kneeling-sitting

(c) Pelvic Support backrest with slight forward tilt or saddle shaped seat

(d) Wedge up at back of seat to help prevent the pelvis from rolling back

Chapter 5.4 The Car Seat - Pelvic Support Sitting

Absolutely central to the whole problem of low back pain is the car seat. Car driving always shows up as a cause of back pain in any epidemiological survey. This book has emphasised that the mechanical situation in a car seat almost always tends to flex the lowest joints and to concentrate the flexion into these joints.

Lumbar support does not improve the situation. It actually makes it worse in that the spine is forced towards the vertical while the pelvis tips top backwards. The result is maximum flexion in the lowest and most vulnerable lumbar joints.

Most of us do not bother to try to keep the pelvis upright when we sit into a car. We simply allow the pelvis to roll back until it is restrained by the spine resting against the seat back. Even if we do sit into the car with the pelvis upright it quickly slips down at the back under the influence of the downward weight of the head, arms and upper body down the spine. In addition the seating position in a car means that the knee is above the hip so the strong thigh and leg muscles will tend to tip the pelvis further back. The pelvis tips top backward but the spine

is restrained by the backrest and so the lowest joints of the spine are flexed. If there is a prominent lumbar support shape then the spine can be bent backwards over it which may initially limit the flexion at the lowest joints but as the spine becomes hyperextended at the point of lumbar support the pelvis will again be able to tip top backwards.

All of this is shown in an investigation of the "influence of lumbar support" using x-rays to evaluate the effect of variable lumbar support. There will always be a hyperextension force in the spine at the level of the lumbar support. The spine will initially resist this hyperextension and the forward force on the spine at that point will be transferred to the pelvis to stop it tipping back. Because of this, lumbar support will appear to work and will appear to be comfortable initially. In the course of a car journey the spine will hyperextend at the point of support and the pelvis will be able to tip backwards. As the journey progresses more lumbar support will be required to achieve the same results. This is a sequence familiar to many back sufferers.

The only logical mechanical solution is that the pelvis must be supported directly. This support must limit its tendency to roll or tip top backwards without using the lumbar spine as a lever to achieve this.

This is the principle of the Pelvic Support chair. The pelvis can be supported at various points but the most effective support is achieved by placing the support as high as possible. The pelvis is much higher at the sides than centrally at the back so the most effective form of pelvic support must come round the sides of the body covering the area about 10 cms high up to the top of the iliac crest.

Figure 17

Pelvic support car seat. Adjustable version in which pelvic support cushions can be hinged back to give normal seat.

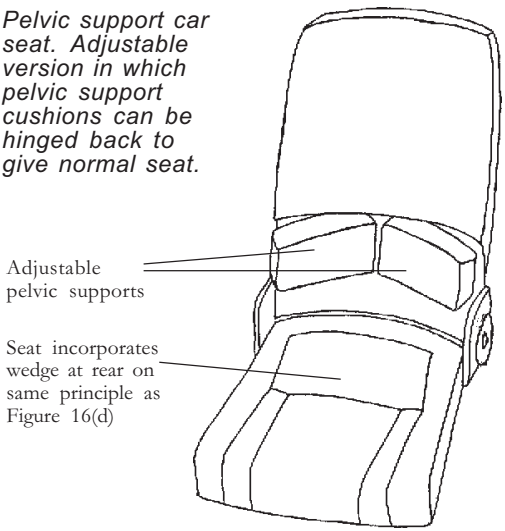


Figure 17 shows a pelvic support seat designed to provide support in this way. The pelvic supports are a pair of cushions which protrude on either side of the top of the pelvis. The angle between the two cushions is about 90°. They can be shaped to provide support to the posterior iliac spines as well as the iliac crest.

The pelvis can also be usefully supported by a wedge shape underneath the back of the pelvis to provide an upward force which will also resist the tendency of the pelvis to roll backwards.

Car seats in current use vary greatly. Most lumbar support is very high up and many adjustable lumbar supports are near the lumbar thoracic junction. Others show some signs of aiming to support the pelvis either with a wedge shape to the seat or a firm surface to the seat back behind the pelvis and a softer lumbar area. Most provide lumbar support which is too high up.

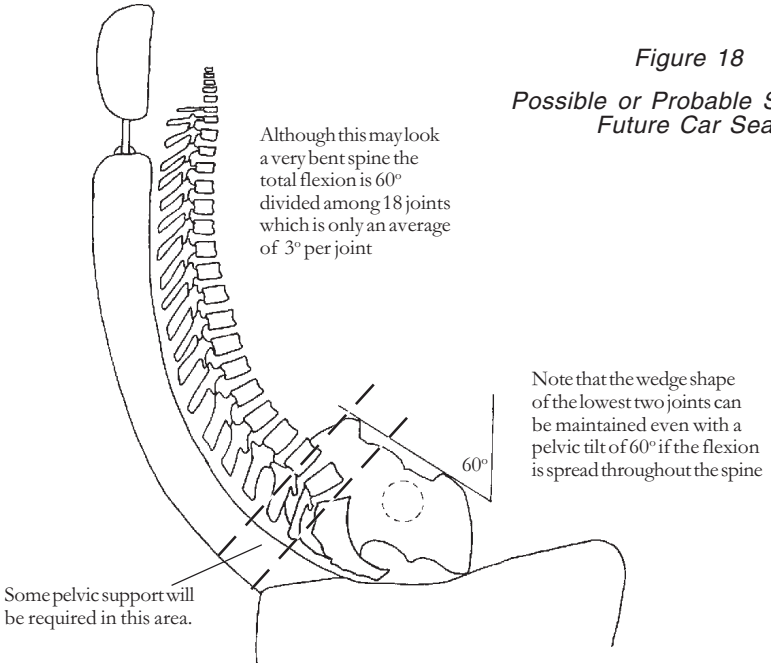
It is important to realise that Pelvic support and Lumbar support are the opposite of one another in their effect on the critical L4/5 and L5/S joints. Pelvic support limits the flexion. Lumbar support increases it.

One of the greatest disadvantages of lumbar support is the fact that it can only limit the flexion of the lowest joints at all by applying a hyperextension force higher up the lumbar spine. The joints from T10 to L2 are frequently extended or hyperextended. With the body leaning back slightly this then requires more flexion in the thoracic area or neck to allow the head to face forwards. (see note on page 13)

When the pelvis is properly supported in a pelvic support seat then all of the joints in the lumbar and lower thoracic spine can be allowed to flex slightly. If all joints up to T10 are flexed by say 3° by shaping the main part of the backrest in the opposite way to lumbar support then there will be a general rounded shape to the body. This we would normally see as bad but because the pelvis is supported there will be no concentration of flexion into the lowest joints so it will be a good position. It will also be easier and more comfortable to support the pelvis in this tipped back position as it requires less force. For this reason it is likely that pelvic support car seats in the future will have a generally more reclined and flexed shape but will have adequate pelvic support to ensure that there is no concentration of flexion into the lowest joints. A possible shape is shown in Figure 18.

Figure 18

Possible or Probable Shape of Future Car Seat



As emphasised earlier people vary greatly in their spinal shapes and in their use of muscular effort when sitting. Some current seat designs may be satisfactory for some people. However the statistics suggest that most designs are not satisfactory for most people.

The development of new forms of car seat which incorporate the principles of pelvic support is critical to any long term improvement in the low back pain problem. When good solutions have been developed the same principles of design can be applied to many other applications.

Chapter 5.5 Relaxed Sitting

It is normally assumed that slouching is bad for the spine and that we should "sit up straight" against the back of the chair.

Once again the opposite is in fact the case. Slouching on a settee or easy chair is not harmful. Figure 19 shows a body slouched on a settee. The pelvis has rolled backwards with the whole body and is now balanced on the gluteal muscles (and maybe partially on the back of the sacrum).

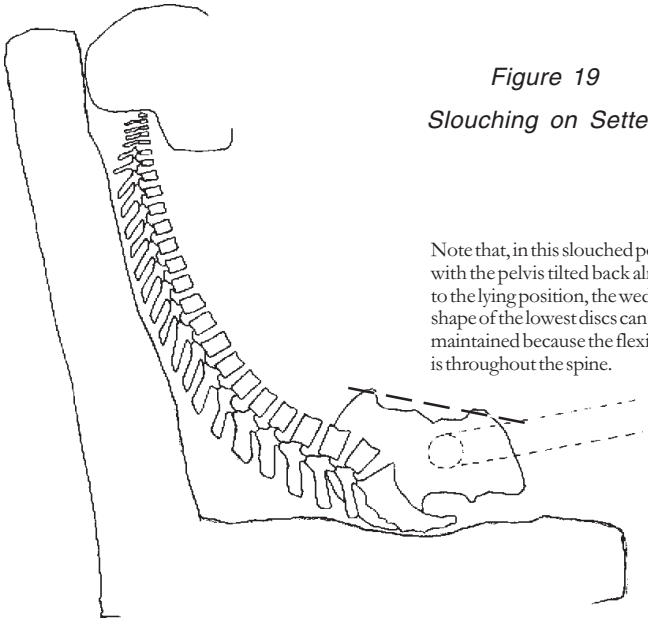


Figure 19

Slouching on Settee

Note that, in this slouched postion with the pelvis tilted back almost to the lying position, the wedge shape of the lowest discs can be maintained because the flexion is throughout the spine.

There is no tendency for the pelvis to tip back any further and therefore there is no flexion force in the lowest spinal joints and no harm in sitting in this way. The whole of the lumbar and lower thoracic spine will be flexed. Any flexion will be divided between these 12 or 14 joints. In the diagram the pelvis is tipped back by about 80° and the thorax by about 25 - 30° so the spinal flexion required will be 50 - 55° over the 12 or 14 joints or 4 - 5° per joint. This is acceptable. There is no tendency to concentrate flexion into the lowest joints and these will not be fully flexed. Anyone can check this conclusion by slouching with the pelvis near the edge of a settee. Now use the muscles to move the pelvis. It will be found that the pelvis can easily be flexed on the spine showing that the lower spinal joints are not fully flexed so there can be no continuous flexion force on them.

The same applies when sitting on a conference room chair or large dining chair. If the pelvis is placed sufficiently far forwards to produce a complete slouch it is a satisfactory sitting position and much better than sitting up against the backrest of such a chair as we are normally told to do.

The real problem with these chairs only arises when we try to sit up. Then the pelvis still has the tendency to remain tipped back and we push the spine upright concentrating the flexion into fewer and fewer low spinal joints the more upright we are. Eventually we straighten all joints except the lowest two but still have the pelvis tipped back by 40° and hence 20° of flexion in each of the lowest joints. This is four times as much as when the whole spine was flexed when slouching! This is the critical difference.

This argument should have established that slouching is not a basic cause of low back pain but there are other problems that should probably not be ignored.

Obviously if someone always sits in a slouched and slumped manner and avoids exercise there may be a tendency for the spine to "set" in this shape. This however is because the spine is never used in the extended shape not because it is bent too far when sitting. If the person has a good standing posture and exercises adequately no problem will result. If they sit at a desk in an Alexander sitting posture this alone will ensure good posture.

There may also in slouching be some discomfort if the back rest is too hard or too vertical. A soft cushioned settee back seems to be satisfactory. With some conference chairs slouching can mean resting on the top edge of the backrest. When chairs are designed with slouched sitting in mind these detailed problems should be resolved easily.

It may also be suggested that the neck will need to be flexed too much. In fact it will be flexed far less than when someone bends the neck right down to look at what they are writing or drawing on a desk as so many of us tend to do!

In conclusion it does not seem that any change is necessary in our normal lazy slouching ways of sitting. This is fortunate as most recommendations for good posture insist that slouching must be avoided and most recommendations for good posture are ignored as soon as the pain has gone!

Many people however do not want to sit in a complete slouch. They like to sit more upright. In this case exactly the same argument applies as for a car seat. A chair must be used in which the pelvis is supported directly. This will also be useful to the person who already has a back problem and obviously cannot sit in a slouched manner.

Figure 20 shows an example of such a chair. The backrest incorporates the pelvic support in the form of two angled cushions which support the back and sides of the pelvis in the area which includes the posterior iliac spines and the outside of the ilium up to the iliac crest. The upper part of the back rest can be soft to give general support to the whole of the upper back.

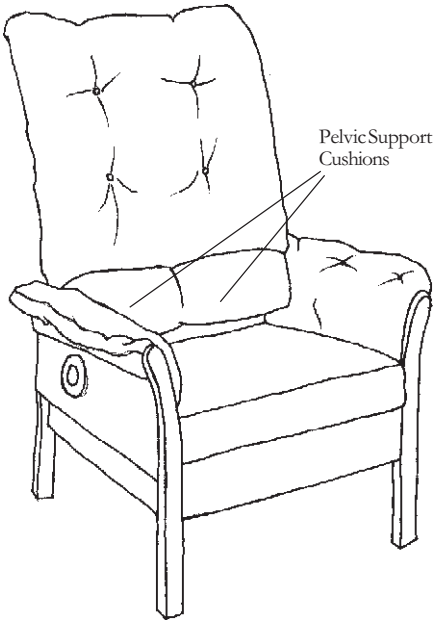


Figure 20
Pelvic Support Relaxing Chair

The backrest angle must be adjustable to allow the person to sit upright for reading or knitting and to recline more for telewatching or resting.

The seat needs to be reasonably firm to ensure good alignment with the pelvic supports and must be tilted back. This is because the pelvic supports need to apply a force forwards on the pelvis to stop it tipping over backwards. This force needs to be opposed by the seat being tipped back. On a horizontal seat the pelvic supports will just push the body forwards and the chair will not be effective.

This form of Pelvic Support Relaxing Chair has been available for several years and has been used by back-sufferers and others to provide comfortable relaxed sitting which is not harmful.

Chapter 5.6 Hyperextension

This chapter is about the possibility of hyperextension at the L4/5 and L5/S joints. It is not about the hyperextension above L4 particularly near T12/L1 which is an inevitable consequence of the use of Lumbar Support and existing ways of civilised sitting.

The subject of this book is the problem of flexion of the lowest two joints. However there is great variation in the shape of the lumbo-sacral area and some people are probably liable to hyperextension problems. This chapter looks at the mechanical activities that may cause this. These are:

1) Lack of Slumped Sitting/Weak Abdominal muscles.
Contrary to what is normally assumed, slumped sitting will probably have the effect of improving the tone and tightening the abdominal muscles. This is because slumped sitting brings the front of the thorax nearer to the pelvis and so allows the abdominal muscles to shorten. In the standing shape the muscles will be tightened.
Avoiding slumped or slouched sitting will probably result in slack abdominal muscles which will not be able to adequately protect the spine from hyperextension as they should.

2) Sitting
Generally the effect of sitting is always to flex the lowest joints. However if one is slouching with the pelvis near the edge of a seat it is possible to use the legs to hyperextend the pelvis on the spine. This is easily avoided by being conscious of the situation and raising the knees slightly.

3) Lying on front or back in bed with legs straight.
All naturally living peoples sleep on their sides with hips and knees bent. Lying with legs straight may tend to keep the psoas muscle stretched which may allow it to elongate unnaturally and this may reduce its effectiveness in protecting the lowest lumbar joints from hyperextension which is one of its main functions (see Chapter 1.4). Lying in bed simply does'nt concentrate flexion into any one area of the spine in the way that civilised sitting does. This is why I do not regard it as a basic cause of low back problems.

Note 1: Back sufferers and those who suffer from occasional backache often wake up with back pain. For this reason it is often assumed that beds and sleeping are a cause of back pain. This is not the case. The sitting and sleeping requirements of back sufferers are completely different from those without any problem.

For the non-sufferer it doesn't matter how far each joint is flexed or extended in its range so long as the activity does not force any joint beyond its range. A car seat tends to force the flexion of the lowest joints and is therefore bad for everyone. Slouching, slumping and sleeping in soft beds flex the spine but there is no tendency to concentrate the flexion in the lowest joints so these activities are all right for the non-back sufferer.

The back sufferer on the other hand frequently finds that pain increases with flexion of the lowest joints and the time spent with them flexed. This would be explained by the nucleus seeping closer to the warning pain nerves. Because of the time spent in bed many back-sufferers find it desirable to keep the lowest joints as close to extended as possible. Hard beds and boards are worth it to reduce the probability of a day's back ache!

Note 2: This is probably the point to mention spondylolysis (the separation of the inferior articular process and spinous process of L5). Mechanically this would seem likely to be a result of the pronounced extended shape around L5 and not of flexion. It is usually asymptomatic and even where problems do occur (spondylolisthesis) they are not typical LBP. One authority remarks that these sufferers are largely free of the disc syndrome.The obvious explanation is that a high sacral angle protects against typical disc based LBP by maintaining the wedge shape but predisposes towards spondylolysis because of the pronounced or excessive wedge shape of L5/S.

Chapter 5.7 Conclusions From Section 5

The conclusions must be that the problem of low back pain is caused by the flexion of the lowest two spinal joints caused by civilised sitting.

The mechanical effects of different types of sitting are the opposite of what is normally assumed. Upright sitting and lumbar support flex the lowest joints and are harmful. Reclined slouching does not concentrate the flexion into these joints and is not harmful. Slumped sitting is probably beneficial and desirable. In a nutshell it could be said that anything that bends the whole spine is all right but that sitting that bends only the lowest joints is bad.

For upright unsupported sitting, Alexander sitting must be learned. For car driving and similar activities the pelvis must be supported directly in a pelvic support seat or chair.

SECTION 6

THE FUTURE

Chapter 6.1 Section Introduction

Prevention and cure must be the twin aims in the future. Prevention will require a significant change in sitting habits. Cure will require treatments that analyse the individual situation with adequate recognition of the role of the shape warning pain.

Critical to both will be a good understanding of the characteristics of the shape warning pain. Since this warning pain is a new suggestion in this book its characteristics cannot be fully defined. Some characteristics were listed in Chapter 2.7 with a more comprehensive list in Chapter 4.2 (Summary of Warning Pains). This will be added to by experience once the existence of the warning pain is generally recognised. A brief list of the essential characteristics is repeated here with some additional comments.

1) When both L4/5 and L5/S are within the shape criterion (ie cannot flex beyond parallel sided) there is no warning pain.

2) When either of these joints is hyperflexed beyond parallel sided the pain is initially severe and the ability to turn on sublesation is a maximum.

3) At this stage it can be difficult to release the sublesation by chiropractic methods. (This may explain why in a recent survey, chiropractic was not more successful than hospital treatment in the early stages of LBP for people suffering their first attack of LBP)

4) The severity of the initial pain usually reduces in the course of a month or two to an occasional ache.

5) This ache frequently results from long periods of sitting or lying in bed but does not generally trigger sublesations so severe bouts of LBP are rarer.

6) If sublesations have persisted since the acute phase they can generally be released by osteopathy or chiropractic (This may explain why chiropractic was particularly successful in the recent survey for patients who had suffered LBP for a year or more).

7) If either L4/5 or L5/S has been the wrong shape since childhood then the ache will probably develop with age but will not usually cause sublesations or acute attacks.

8) Further flexion either suddenly or slowly can trigger sublesations and acute LBP.

9) A disc which has flexed too far and is producing the warning pain corresponds very closely to the "derangement" as recognised by physiotherapists following the ideas of Robin McKenzie.

10) The long term ache varies greatly from an occasional ache on waking up to a permanent and nagging pain.

In view of the differences there will certainly be cases where we can bring the joints within the shape criterion by treatment and keep them there by a change in sitting habits. The effort will be justified by the level of the problem.

In other cases it may not be worth the effort and the joints will be allowed to have a flexed shape which is beyond parallel sided. The extended shape will still be less than parallel sided but less wedged than previously. Osteopathy and chiropractic can be used to avoid persistent sublesations and the occasional ache will just be accepted.

Only a very good understanding of the shape warning pain and the other factors which are already better understood will allow a good decision to be made by each individual.

Chapter 6.2 A Change in Sitting Habits

This chapter was almost entitled "a change in lifestyle". Although significant effort must be made it is not really that extreme. It does not require strict sitting up straight all the time! For theatres, cinemas, sports events, conferences, lectures etc the position will probably be more relaxed and reclined than now and more comfortable.

Most forms of lazy relaxed sitting can probably remain unchanged. This will probably make the ideas more acceptable.

Car seats and desk working positions will have to be modified. Since most people find those activities tiring, stressful and uncomfortable changes should also be welcome and again make the changes more acceptable.

Central to the whole solution to LBP is the development of a form of car seat which is both effective and comfortable. This will certainly require many adjustments to allow for the variation between people. It may be a very upright form of pelvic support seat or it may be more reclined with more flexion in the mid back than we accept now. Probably it will be adjustable between these shapes but always with adequate pelvic support. When the critical difference between lumbar support and pelvic support is understood, the car manufacturers will very quickly develop new and effective seats. As long as the idea persists that lumbar support protects the lowest joints from flexion there will be no progress.

When the car seat problem has been solved the same principles can be applied to all forms of transport and to many other uses such as theatres and fairly upright chairs for the home.

Sitting at the dining table is really the same problem as the desk working position. The obvious solution is simply to learn to sit in the Alexander sitting way without allowing the pelvis to roll over backwards. Forward tilted dining chairs would help as would knee rest versions.

There is an alternative for the dining table. We could lower both the table and the seat and adopt a slumped sitting posture to eat. This is after all the way in which more naturally living peoples eat. (Though it is not necessary to actually sit and eat off the ground). This may sound like a dramatic change in habits and would only be adopted very slowly. However we must be open minded to such ideas if we are to make a major change in the incidence of low back pain.

The working position will continue to receive much attention from chair manufacturers. A forward tilt will help as will the system with knee rests. These both encourage good upright sitting to work at the desk but, with the ever more electronic office, we should consider a more reclined working position (as in a car seat) with the VDU screens, keyboards etc placed accordingly.

In this chapter it is not necessary to go into great detail. There are many people working on the design of seating for each of these areas. If those forms of sitting and seating which cause problems are correctly indentified the expert in each area will quickly be able to produce solutions which incorporate the correct forms of support.

Chapter 6.3 Treatment

As in the previous chapter, so also in this chapter it is not the intention to go into great detail. There are many thousands of people treating back pain worldwide. Doctors, orthopaedic specialists, neurologists, physiotherapists, osteopaths, chiropractors and many others all have great knowledge and experience. Despite this the problem is not well understood and the results are not good in most cases.

Some of these groups are already applying ideas which are close to the principles of this book. For instance physiotherapists following the ideas of Robin McKenzie use exercises to achieve a more extended shape in the lower lumbar spine and sitting habits to maintain the shape.

However the lack of basic understanding leads to great confusion between groups and even animosity. I hope that the ideas and basic understanding in this book will be useful to all groups and help to develop forms or combinations of treatment which will really cure back pain and help prevent its occurrence.

In some cases it will not be necessary to try to keep within the shape criterion suggested. The warning pain will die away to a low level in time and there will only be a slight occasional ache. Acute attacks will be rare and controllable by chiropractic or osteopathy. This person will take no particular trouble over sitting habits and after a period of months with several acute attacks will be relatively free of further problems.

This probably applies to many people and this is probably the way these people wish to treat their back problems. They ignore them most of the time and get some professional help when necessary. Will these people benefit from pelvic support in car seats for instance? Many do suffer from back-ache after driving so they may well benefit. However they may not like to flex the mid back as suggested for the pelvic support car seat in Chapter 5.4. In addition, because they flex beyond parallel sided they may be in danger in extension of "pinching off" the nucleus as described in Chapter 3.3. There might therefore be some benefit from the hyperextension in the mid back that would be caused by lumbar support. This would reduce the extension required in the lowest joints in standing up. All in all it seems that car seats must have sufficient adjustments to provide lumbar support or pelvic support. After all those who don't have a problem won't want to change their habits at all.

For others, bending or sitting causes persistent bouts of back ache. For those people it is worth making the effort to keep within the shape criterion. McKenzie exercises will correct the shape and a change of sitting habits will maintain the situation. In the course of time, ligaments and muscles in the low back will tighten enough to maintain the shape of the lowest joints without any great effort being required if care is taken with upright forms of sitting. Some form of pelvic support will have to be used when driving and a good posture will have to be maintained when working at a desk.

For a proportion of people however, sitting will be a constant and long term problem. Aches will always result from periods of sitting and from other bending activities. Benefit will come from McKenzie type extension exercises and from chairs providing strong pelvic support but it will not be possible to maintain the situation however careful the person is. For these people it may be effective to limit the mobility of the lowest two joints (L4/5 and L5/S) with a carbon fibre

or nylon supraspinous ligament - inserted surgically. Due to the angle of the part of the lumbo-dorsal fascia which provides the function of a supraspinous ligament for these joints it may in some cases not be possible for the ligament to limit the flexion of these joints at the parallel sided shape. Although there is reluctance to consider surgery except where there is serious and direct nerve root impingement this surgery would be very superficial and might "switch off" the warning pain permanently. This would only be restricting the joint or two joints to their natural level of mobility and any loss of mobility would easily be replaced by an increase of hip and upper lumbar mobility (both of which will almost certainly be less than the natural level anyway!)

All of the above scenarios refer to cases where there is no actual tissue damage. This covers the vast majority of instances of low back pain. There are however some cases of serious disc protrusion where lamiectomies, fusions or recently introduced techniques such as percutaneous discectomies may be the only answer. Almost invariably a true disc prolapse is preceded by several incidents of severe LBP. These are warning pain incidents and in view of the ideal warning pains that evolution has given us we should be able to heed the warnings, analyse what is happening and ensure that the situation never progresses to a disc prolapse.

At the moment these different treatments will be applied by different practitioners, usually with different understandings of what the real cause of the problem is. For the best treatment in each case, it is essential that there is a common understanding of the cause of the problem and what can be achieved by all the available treatments so that the right combination of treatments is used.

SECTION 7

CONCLUSION

There are two points in this book which are essentially new. The first is the shape warning pain in the lowest two lumbar joints. This is the reason why it matters when we flex the spine too far. The second is the critical difference between lumbar support and pelvic support. We know for epidemiological and other experimental reasons that sitting causes back problems. We can see that sitting in certain ways obviously bends the back. Because we have not correctly analysed the mechanics of sitting we have tended to condemn those forms of sitting which most obviously bend the back. The bend in the back is most obvious in the mid back and so we say that slumping and slouching are bad. In fact the mid back does not have a specific flexion limit. The shape warning only exists at the lowest two joints and these are flexed least by slouching. These joints (L4/5 and L5/S) are flexed most when we sit fairly upright in a car or at a desk but fail to keep the pelvis upright.

These are the forms of sitting which will tend to cause low back pain. This too has been recognised epidemiologically but the solution applied, lumbar support, limits the flexion only in the upper lumbar area and actually increases it in the lowest one or two joints. There is again insufficient recognition that it is only the lowest two joints that must be protected and inadequate analysis of the mechanical effect of lumbar support which only gives this protection at the expense of hyperextending joints higher up. The only solution is to apply support directly to the pelvis to limit the flexion at the lowest two joints. Sitting in its many forms has been covered in some detail with proposed solutions.

The shape warning pain is central to the human low back pain problem. The reasons why it is there have been explained as have the coincidences that have led to its coming into effect whenever either of the lowest two joints (L4/5 and L5/S) can flex beyond parallel sided; coincidences that stem from a shape of pelvis, sacrum and spine that is really defined by the need to provide an adequate

birth canal. The most likely source of the pain is nerves in the posterior annulus which are sensitive to the proximity of material from the nucleus. This would be a very ideal and simple form of warning pain but future work may prove that this is not the actual source and that the shape warning pain originates elsewhere.

Great variation exists between people in the shape of the spine and pelvis and particularly in the sacral angle. It is therefore certain that there are a number of different combinations of angle and shape even among those who do not have back problems and among more naturally living peoples.

It will not therefore be possible to define one shape and mobility of lower back which is right with all others being wrong. However, this must not stop us understanding the basic rules and applying them to each case. We must not be confused by the number of variations into thinking there are no criteria.

For instance it will probably be suggested that the lowest discs should really be approximately parallel sided with the pelvis 'tilted' accordingly. If we kept them flexed from childhood, the warning pain might never develop beyond an ache. The reply to this is that they aren't parallel sided even among more naturally living peoples and to make them parallel sided would lose much of our lifting strength and athletic ability. We simply weren't designed that way.

Another suggestion could be that the mobility should be high enough for the flexed shape to be well beyond parallel sided from childhood. There would then be no transition to flexing beyond parallel sided. The transition is the normal start of severe back pain. With a wedging of 24° at L5/S when standing for naturally living peoples this would require an impossibly high joint mobility but it might conceivably be the case at L4/5 in some people. If so do they suffer from persistent ache from this joint or not?

It could also be suggested that we must change to parallel sided discs at some stage of life. This would mean that everyone would have to make the transition at some age with a period of bad back problems. This is approximately what happens but it is really not necessary. More naturally living peoples are relatively free of the problem and back problems vary with lifestyle and activities; a clear

indication that LBP is a disease of civilisation which we should be able to control and avoid.

The answers to these and many more questions can only come when the existence of the warning pain is recognised by all of those treating or researching back pain. Until then we shall continue to be confused by the multitude of pains and muscle spasms which stem from the sublesations that nature has recruited into the evolution of a very effective and very disabling warning pain.

APPENDICES

The following is a very brief description of the Appendices which will be included in a future version of this book.

1. A study of the way in which the apophyseal joints provide a limit in extension for the lumbar spine. (As appendix 2 in "The Cause of Lumbar Back Pain") Ref 3

2. An analysis of the shape of the lower lumbar spine and pelvis of a small group of tribal living Africans from lateral x-rays.
   Results: 1) Sacral angle averages about 50° as with other studies in western countries.
   2) Variation in sacral angle is large as I have also found among an English group (e.g. 25° - 70°)
   3) Wedging of L5/S and L4/5 was similar to the English groups with L5/S at 24° being slightly greater.

   Conclusion: The shape of the lower spine is generally the same in tribal living Africans as in Western peoples (e.g. English) who are not back sufferers but the variation is very large in both cases.

3. Intra-Abdominal Pressure
   There has been no mention in this book of the role of intra-abdominal pressure. This is because it is not necessary to the argument of the book. In any analysis of lifting or spinal strength, however, it is essential. This appendix will show how it is a necessary part of the body structure in stressful activities and can provide a major contribution to body strength. (This subject is covered briefly in Ref 2.)

4. Evolution. The Last 100 Million Years
   A brief history of our evolution from the first primates. Generally as in Chapter 1 of Update 87 (Ref 4).

PUBLICATIONS USED FOR REFERENCE

1 The Obstetric Pelvis of A. L. 288-1 (Lucy). J. Human Evolution 15: 237-255, 1986 Tage R. G. & Lovejoy C. O.. (This covers the evolution of Lucy's and the human pelvis from the ape (chimp))

2 The Obstetric Reason for Lordosis and the Implications for Lifting and Low Back Pain. J. D. Gorman A4 spiral bound 46 pages. £25.00 inc post in U.K.* (This covers the mechanical arguments of Section 1 in detail as a paper submitted to technical journals)

3 The Cause of Lumbar Back Pain. J.D. Gorman A5 book written in 1983 covers the mechanical problem of sitting and why it is likely to be the cause of the LBP syndrome. This was prior to the understanding either of the warning pain or of chiropractic and sublesations etc. The mechanical analysis of sitting is however more detailed than in this book.£12.00 inc post in U.K.*

4 Update 87. J.D. Gorman. A5 book. An update to the above book written in 1987. Consists of 12 separate essays including the first on the "shape warning pain" but it is still prior to any understanding either of the evolutionary importance of the obstetr ic argument or of sublesations and chiropractic. £12.00 inc post in U.K.

5 Clinical Anatomy of the Lumbar Spine. Bogduk & Twomey. Published by Churchill Livingstone. This is the definitive book containing all the correct muscle and ligament connections in the lumbar spine. Anatomy textbooks have insufficient detail and are frequently inaccurate.

6 The Seated Man. A.C. Mandal - Pub Dafnia Publications - Copenhagen 1985. This is the classic book which puts forward the argument in favour of forward tilted seats for the working posture. A5 95 pages. £12.00 inc post in U.K.*

7 Osteopathy by Leon Chaitow - pub Thorsons. A clear explanation of osteopathy including the osteopathic lesion, somatic dysfunction and facilitated segment.

8 Chiropractic - A Patients Guide by Dr Michael Howitt-Wilson

9 Lucy - The Beginings of Humankind by Donald Johanson and Maitland Edey (Granada)

10 The Making of Mankind by Richard Leakey (Michael Jospeph).

11 Ever Since Darwin by Stephen Jay Gould (Burnett Books) (covers secondary altriciality among other subjects.)

12 Treat Your Own Back by Robin McKenzie pub: Spinal Publications Ltd

This book "The Evolution of Low Back Pain" costs £10.50 inc post in UK* (Quantities of 10 or more can be ordered at 30% discount.)

** These publications are available from John Gorman at Oaklands, New Mill Lane, Eversley, Hants RG27 ORA at the stated price for postage in the U.K. They can be posted to other countries at the following additional prices. Europe - £2.00 extra, USA £3.00 extra, elsewhere £4.00 extra. Foreign currency cheques accepted but please add £2 for cheque clearing charges and then convert at current exchange rate. Prices valid till August 97 unless change becomes essential for any reason.*

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