An Opinion On

THE THEORY OF ERGONOMIC TASK SEATING VS THE FACTS

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OVERVIEW

Chairs were originally designed to raise those with power above their inferiors. They facilitated an 'authoritative' posture with a straight back, head and neck held in dignified stiffness, knees hips and elbows at a rigid 90 degrees. Chairs were not designed to be sat in all day every day and were not designed for work. Basic chair design hasn't changed since the industrial revolution, when it became commonplace to sit long hours in chairs to work which stress the spine and produce musculo-skeletal pathology.

The human spine has a healthy natural 'S' curve which is automatically and inevitably flattened the minute we sit in a conventional chair (the mechanics of which are discussed). The conventional seated posture, with thighs, knees and elbows at 90° angles, causes the pelvis to rotate backwards, replacing the natural spinal 'S' curve with a kyphotic 'C' curve. This compresses the lumbar vertebrae at the front, putting great pressure on the back of the spinal discs which may in time prolapse. This position is one of great postural stress.

The hips cannot bend past 60°. This takes place in the spine by the pelvis tilting backwards causing the lumbar spine to collapse. Pelvic position, although not externally visually obvious is at the heart of the matter. Measuring pelvic tilt has occupied many researchers (methods are discussed). Pelvic tilt can be understood in non-scientific terms by simply placing the hand on the lumbar spine when standing to feel the natural lumbar curve and then feeling how this flattens out as one sits down in conventional seating, as it provides the last 30° of back flexion to allow you to sit.

Pelvic rotation affects all upper body structures and has often been overlooked by those treating pathologies of the wrist (RSI), neck, shoulders and back. Thus the underlying cause pelvic tilt, remains undiagnosed and untreated.

Attempts to alleviate the problems caused by conventional workplace furniture almost always involve the introduction of corrective add-ons such as backrests with lumbar 'rolls', and cushions designed to correct every human postural aberration. The fundamental design flaw which produces backward pelvic rotation and flattening of the spinal curves is ignored.

The real solution is to totally rethink furniture design, allowing for adjustability of work surfaces and seating, and to design seating which prevents postural deformity.

A more progressive approach has evolved from the observation of neurological patients who, unable to sit upright unaided in a wheelchair or on conventional seating, could readily do so when sitting on horseback. The Bambach is based on this principle. It allows maximum skeletal stability of major postural and functional joints, keeping the pelvis and spine in their neutral positions. This maximises task performance while dramatically reducing stress on the upper body and spine. It also offers significant benefits for a range of people with musculoskeletal and neurological pathologies, improving their posture and their ability to perform tasks. Ergonomic design and case studies of The Bambach are discussed.

Mary Gale

What is 'ergonomics'? Why is it Important for Seating?

The science of 'ergonomics' (the engineering aspects of the worker in the working environment) evolved in wartime, connecting fighting men efficiently to their war machinery, tanks, aeroplanes, rifles, and so forth. In peacetime, it turned to the study of work, industrial equipment and all aspects of human connection to their environment which was becoming increasingly artificial. However, in spite of many advancements in ergonomics, task seating furniture remains trapped in antiquity.

The word ergonomics (Ergos is the Greek word for 'work' nomos is Greek for 'natural law') was coined by Professor Hywell Murrell at a meeting of medical doctors, engineers and sociologists at Queen Anne Mansions, London in 1949. These professionals had been grappling with the question of maximising the efficiency of the fighting man. The failure of the rocket plan 'X2' which was designed to fly higher (into the stratosphere) than was possible up until that time, had highlighted man-machine problems. The hardware worked well, but when it came to piloting the X2 there was room only for a man no taller than 5 feet! War had raised other questions about clothing, equipment, fitting men into tanks and other war machinery, all of which fuelled the development of ergonomics. When the war was over, the committee felt that ergonomics should have peacetime applications and so directed their knowledge to a future in other areas of human activity especially industry.

It is surprising that it took so long for us to engage the need to study how humans interact with their environment. Since the first monkey picked up a stick to knock a banana off a tree, the need for tools has been clear. Humans have taken the talent for making tools with which to modify nature to a point where much of our environment is artificial. Tools and the gradual 'overpowering' of nature have largely excluded the natural world from human experience in the developed countries. Hardly anyone today lights a fire to cook or ignites a lamp with which to see, few sleep on straw or hides, but we do still sit on seats that have not changed much since humans first sat on anything other than the ground.

ERGOS
NOMOS

Why Were Chairs Invented?

As discussed chairs were first used was to raise leaders above the heads of their people or to intimidate the conquered or the peasants. Pharaohs, Czars, and Emperors who sat in these chairs assumed a position of dignified stiffness, their backs in close contact with the backs of the seats. However they were not doing physical work in them, and they did not occupy them day in day out.

The Emperor's throne is the same basic design as the seats which we use today! These seats (and also the stools and benches later used for work) force the human body to conform to a right-angled shape. People occupying seats like these gradually slump to relieve tired muscles. This relieves the pull of the muscles on the pelvis, (which have been attempting to keep the pelvis upright and thus the lumbar spine in lordosis.) With this slump we see the familiar 'C' distortion of the spine. If the person in such a seat leans forward to see or to work with their hands, the spinal position deteriorates even further and intradiscal stress is greatly increased.

Humans have had to adapt their bodies to this sort of chair for work ever since we started sitting down to work. Such furniture became increasingly prevalent as the industrial revolution brought on production lines, and this type of seating is universally used in offices and factories today. We can only hope that a new knowledge will change attitudes, and a demand for body-conscious design, will prompt a radical, beneficial design change to task seating and in fact all seating.

Why Do We Sit Down?

At first, only powerful persons had seats or thrones. The rest sat on the ground, to work, to cook, eat, talk, and rest. The work stool developed along with such activities as the handwriting of manuscripts and later, the development of machinery for such activities as spinning and weaving. Most labour was performed standing up, squatting or sitting on the ground.

The industrial revolution co-opted people from rural areas to work in mass production. Work became more sedentary as machinery became more and more sophisticated. A need developed to sit masses of people on seats for work. Ergonomics did not exist nor was there wisdom to evaluate the effect on a human body sitting to work for long hours.

The traditional seating used for passive, inactive sitting was put to use as work or task seat, and has been causing postural stress for workers ever since. The use of such inappropriate furniture has been largely unchallenged and we are still sitting on it.

So, apart from sitting to impress, why sit down to work or rest? Experts in this field, such as Stephen Pheasant, E. Grandjean, G. Soderberg, Dennis Zacharkow, Robin McKenzie and others, identify the benefits of sitting down to work as :

- **to relieve the joints of the lower limbs of load bearing;**
- **to avoid working in unnatural positions;**
- **to reduce energy consumption making less demands on the respiratory and vascular system;**
- **to provide greater stability for fine work;**

These same researchers agree that there are also disadvantages to sitting, the most serious of these being the poor position of the spine, especially in the lumbar region. They also identify that sitting in a conventional seat compresses the chest and abdomen, which are thereby restricted in their function. While the abdominal muscles are deactivated, the back muscles must work hard to prevent falling forward so that when the back muscles eventually tire and the person 'slumps', the spine is then supported by the ligaments alone.

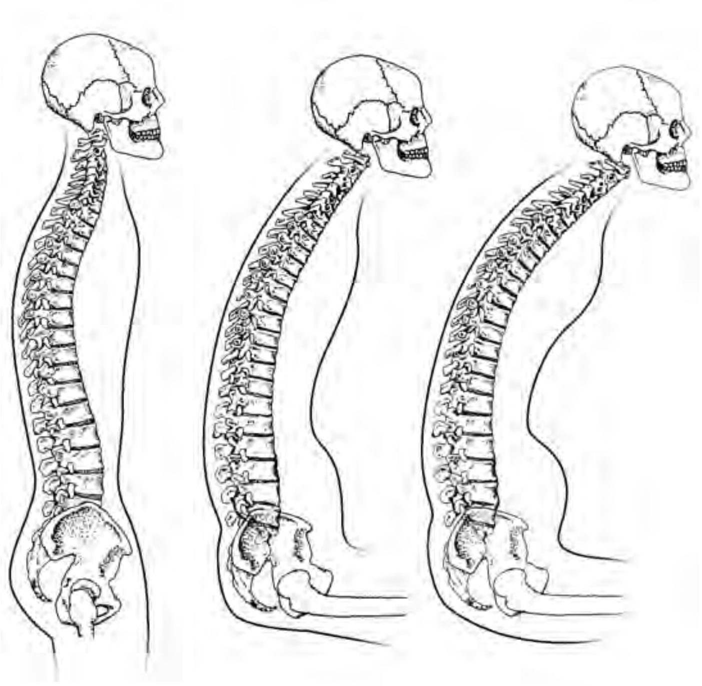
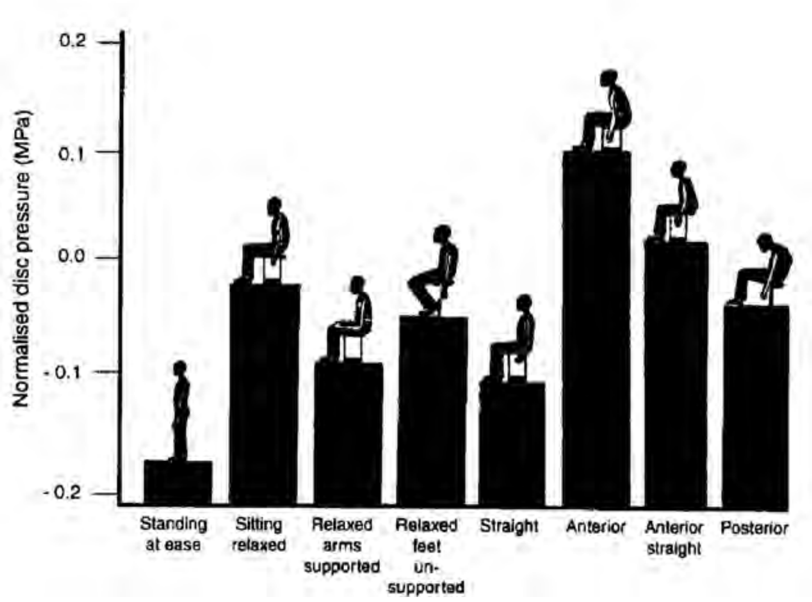


Figure 1. *Above: (A) The natural 'S" shape of the lumbar region of the human spine when standing (B) The spine is distorted into a kyphotic 'C' shape when sitting on a conventional seat. (C) Leaning forward on a conventional seat not only deforms the spine further increasing intradiscal pressure but also produces compression of the thorax and abdomen, which restricts the function of lungs and abdominal organs.*

Ergonomists generally agree that conventional seating, while useful to relieve the fatigue of standing, results in an increase in intradiscal pressure. This is potentially a cause of back pain and trauma due to the displacement of the discs anteriorly This can result in prolapse of the disc, with gradual damage to the nucleus and the possibility of compression of a nerve root. The one most commonly damaged is the sciatic.

This increase in pressure is identified by Keegan, Andersson, Nachemson and others as being the result of the effect of sitting on a conventional seat where the hips flex past 60^{0}. Sitting down with the hip joint at 90^{0} or more causes the pelvis to rotate backwards, flattening the lumbar spine. It is this distortion of the lumbar curve that causes the increase in intradiscal pressure and stress on other major joints. Of course, in the act of sitting to work on conventional seating, we not only put the spine into this negative position but we leave it there for hours, day after day, year in year out.

Figure 2. *Below: Graph shows relative values of intradiscal pressure for various postures. (After Andersson et al)*



Can the Conventional Seat Provide a good position for Work?

As shown when a person sits in conventional seating, the posture becomes "collapsed" even if the person assumes an upright position at first. It deteriorates when in order to perform any task, the person seated in conventional seating leans forward to see their work. While conventional chairs may be adequate for passive sitting (and there is room for argument even about this) they are simply not suitable for seated work as discussed. They result in the pelvis rolling back so that the natural "S" spinal curves are lost and a slumped "C" curve is seen with the neck extended, the head forward with the chin protruding.

Conventional seating cannot support the pelvis in its upright, neutral position so a good position for work is not possible.

LUMBAR RHYTHM, & THE LOSS OF LUMBAR LORDOSIS

The loss of lumbar lordosis is due to the coordinated movement of the lumbar spine and the pelvis, known as lumbar-pelvic rhythm. It is not possible to flex the lumbar spine by itself into a kyphotic curve. There is a little flexion at each lumbar vertebra (R. Cailliet has put it at between 8 and 10 degrees, depending on the condition of the spine). Most of the flexion takes place at the lumbosacral joint. ie the pelvis. So the pelvis must rotate forward to allow for flexion thus flattening the lumbar spine & then rotate back to restore lordosis. This clearly shows us the great importance of understanding the pelvis and its position in the body as well as the mechanisms that affect it.

The lumbar-pelvic rhythm is the key to spinal position, and the spine is the key to movement for all the upper body structures. So, for all of us who deal with functional health as well as efficiency in humans, it is important to know how to teach people to understand the position the pelvis and how it affects our comfort, efficiency and health.

The reason that we need to understand the mechanics of this lumbar-pelvic rhythm is so that we can design to prevent the loss of natural lumbar lordosis rather than inventing more and more ingenious ways and appliances to fix it. The belief that the corrective devices are necessary because spinal deformity is the inevitable result of sitting down must be challenged. In fact the very fact they need to exist admits the design of conventional seating is fundamentally flawed.

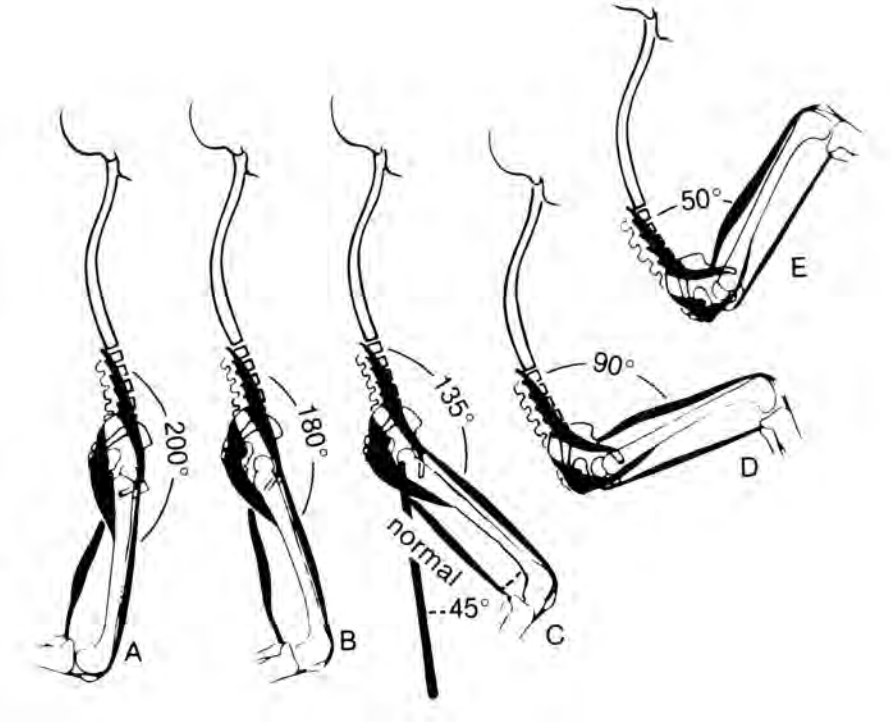


Figure 3. *This illustration is based on a series of X-rays of the lumbosacral spine, pelvis and spine of a person lying on their side with only the angle between the trunk and the thighs being varied. The anterior and posterior thigh muscles show how the limited length of these muscles causes the pelvis to rotate thus changing the lumbar curve. In the 'normal' position of relaxation, the leg-trunk angle is 135°. As the thighs are brought forward (and the leg-trunk angle decreased), the lumbar curve decreases (J.J. Keegan, Alterations of the Lumbar Curve Related to Posture and Seating July 1953)*

LUMBAR RHYTHM, & THE LOSS OF LUMBAR LORDOSIS

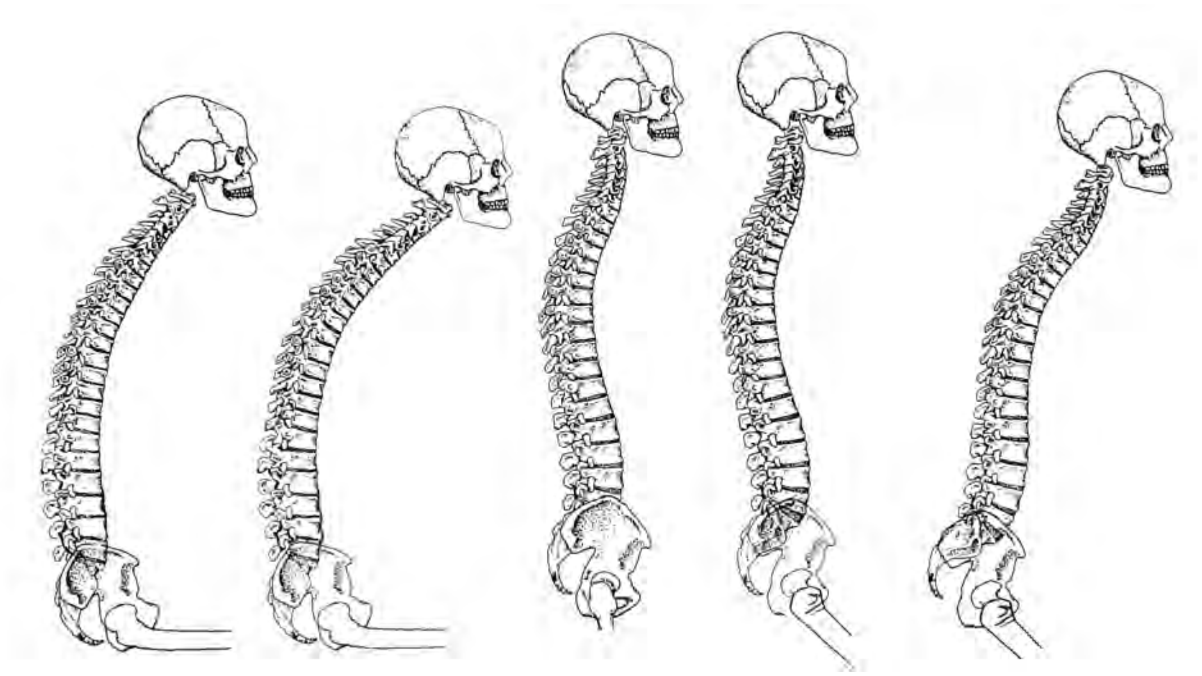


Figure 4

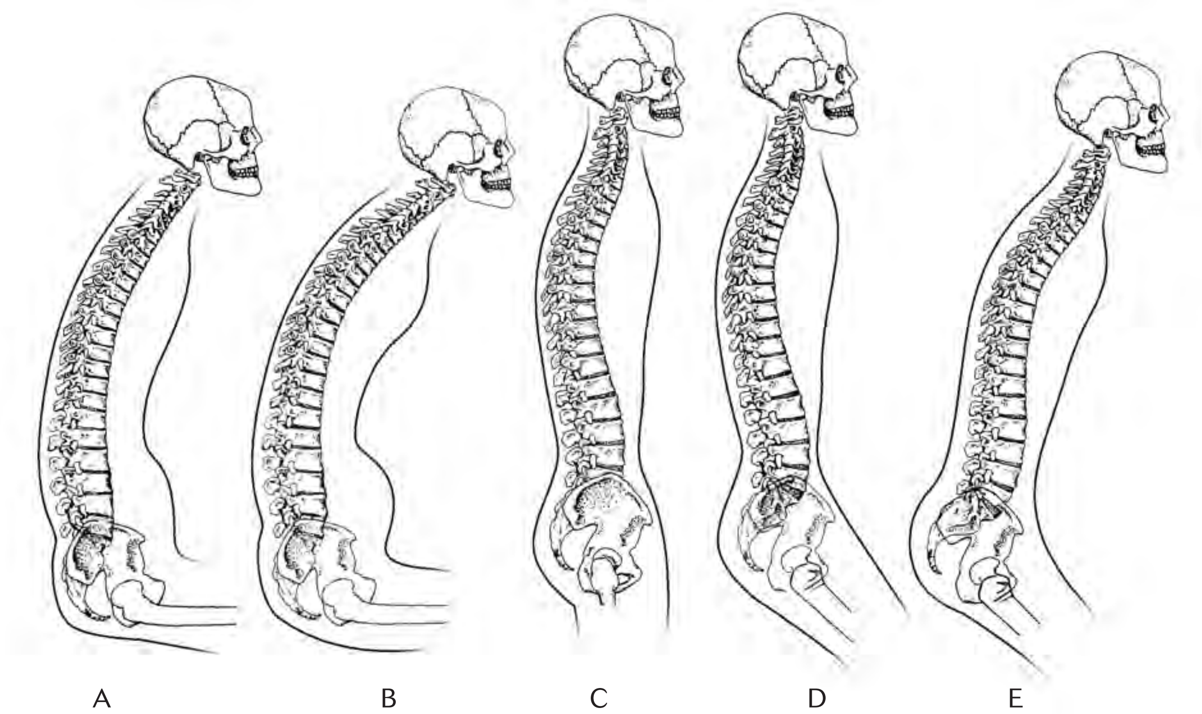


Figure 5

A *Chest and abdomen compressed from seated posture on conventional seat*

B *Chest & abdomen even more compressed from seated posture on conventional seat when leaning forward to work*

C *Normal chest & abdominal space restored from seated posture on The Bambach*

D *Normal chest & abdominal space retained from seated posture on The Bambach*

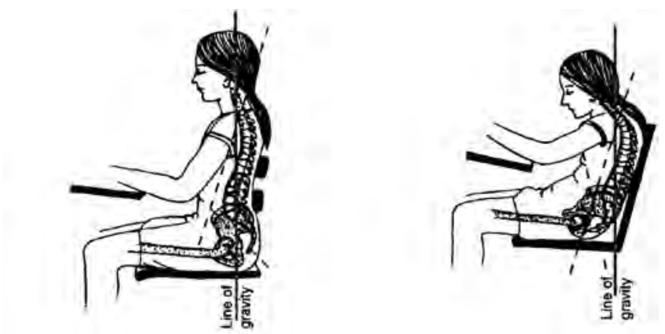
E *Normal chest & abdominal space retained even when leaning forward to work from seated posture on The Bambach*

Measuring the 'Pivotal' Pelvis

There are various ways of measuring the pelvic angle, but it has not been a simple thing to standardise. We need to know how to use the available research to tell us what the pelvic position is. This will be linked to the understanding of the lumbar-pelvic rhythm.

Of all the ways of measuring the pelvis directly and externally, there is not one that allows for this measurement to be made while a person is sitting on a seat with a backrest. The difficulty of measuring the pelvis is that it is not attached to the surface of the body as are other bony structures, nor has it a visible, separate identity such as the elbow, hip, knee, shoulder, or hand, or leg. The pelvis does not move obviously but slides about under the skin complexly, subtly, powerfully and almost secretly, except for its effect on the upper body. Most people do not ascribe movement to the pelvis but to the structures that it influences.

The reference points for measuring lumbosacral angle and pelvic tilt (in order to determine pelvic position) vary from researcher to researcher.



Pelvis upright *Pelvis rolled back*

Figure 6. *Left: Lordotic sitting posture. The solid grey line indicates the line of gravity; the broken line indicates the centerlines of the trunk and pelvic cavities. Right: Kyphotic sitting posture (After Bennett, 1928)*

Researchers name this the 'lumbosacral angle' and say that the size of this angle varies with the position of the pelvis and it affects the lumbar curvature. They say that an increase in this angle results in lumbar kyphosis and an increase in the shear stress at the lumbosacral joint.

Cailliet uses a line taken across the flat inclination of the surface of the first sacral segment to intersect with another straight line drawn horizontally.

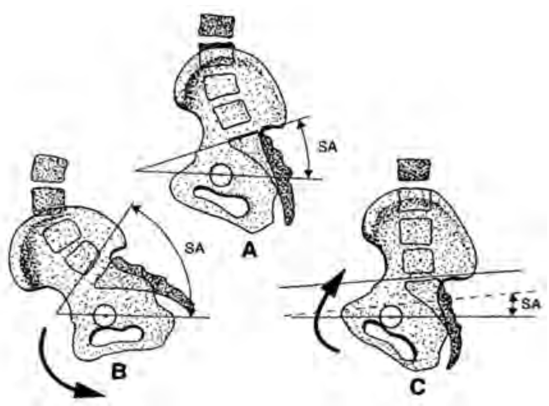


Figure 7. *'Pelvic tilt' is commonly used to describe the lumbosacral angle and pelvic rotation. (A) shows the pelvis, with its firmly attached sacrum, in its neutral position. The sacral angle (SA) is the angle between the horizontal and the top of the sacrum. As the pelvis is rotated forward (anteriorly) (B), the sacral angle changes (increases) When rotated posteriorly (C), the sacral angle decreases as the sacrum comes into more vertical alignment. (Cailliet,R. Low Back Pain Syndrome 1995)*

Measuring the 'Pivotal' Pelvis

Stephen Pheasant draws a line along the inclination of the first sacral segment to intersect with a line drawn across the inclination of the superior surface of the first lumbar vertebra and with a horizontal line drawn below the first sacral segment.

Another line is drawn above the inclination of L1 and this line intersects to form a second angle. He concludes that when the pelvis is upright the resulting two angles provide an angle for the lumbar spine of 60º and a lumbosacral angle of 30º. These angles are true when the anterior superior iliac spine and the pubic symphysis are level on a vertical line and the pelvis is orientated over the ischial tuberosities. All of these are based on the idea of using an X-ray image. This is not practical in everyday life.

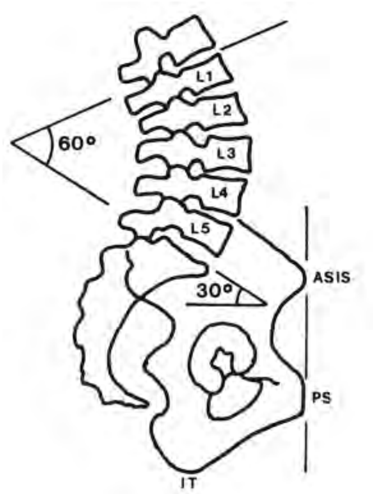


Figure 8. *Position of the lumbar spine and pelvis (standing). ASIS = anterior superior iliac spine; PS = pubic symphysis; IT = ischial tuberosity. (Pheasant,S, Ergonomics, Work and Health 1991) (The lumbar sacryl angle is where the 30º line is)*

Other researchers set about ways of obtaining reliable measurements with instruments that could measure the pelvic angle using external reference points and thus recording the change in pelvic angle, ideally, during continuous movement. Some of these are discussed below.

Lueder and Noro describe the method used by Ackerblom et al. The posterior superior iliac spine (PSIS) and the anterior superior iliac spine (ASIS) were marked, and the distance to the floor from each was measured. The distance between the PSIS and the ASIS was measured with bowleg calipers, and pelvic tilt was measured by a trigonometric calculation. The reliability of this was called into question, as there is a need to locate each PSIS and ASIS position after every movement. *(Lueder and Noro, Hard Facts about Soft Machines 1994)*

Thurston (1985) used three TV cameras to monitor the angular displacement of the pelvis using a computer-generated motion analysis system. The method also had the problem of skin movement over the bony reference points, making the measurements unreliable. *(Lueder and Noro, Hard Facts about Soft Machines 1994)*

Day et al. (1984) used a computerised system to obtain co-ordinates of external body surface landmarks from which pelvic tilt was measured. Continuous readings were not possible because of the complexity of the process (Lueder and Noro, Hard Facts about Soft Machines 1994).

Other tests by Loebl (1967) used inclinometers but, again were not useful for measuring a person using a backrest. There was also a problem of the reference points needing to be checked frequently, as the motion of the bone under the skin made readings unreliable. *(Lueder and Noro, Hard Facts about Soft Machines 1994)*

A photographic technique devised by Gill et al. (1988) measures co-ordinates between the lateral epicondyle of the knee, the greater trochanter, anterior superior iliac spine and the 10th rib. Photographs were used to define the angle of the lumbar spine. *(Lueder and Noro, Hard Facts about Soft Machines 1994)*

Another method was developed by the Vermont Rehabilitation Engineering Centre. Here a device was constructed which could be clamped on to posterior superior iliac spine and ASIS, which meant that continuous palpation was not needed to locate these two bony landmarks. This is excellent for measurements for upright, mobile tasks, especially manual handling, but not for seating with a backrest. *(Lueder and Noro, Hard Facts about Soft Machines 1994)*

Gale, Feather, Jensen and Gale (1990) used a method devised by Dr. A.C. Mandal to measure the lumbar curve. The first line was drawn from the highest point of the ASIS to the acromium process. A second line was then drawn from the greater trochanter to the ASIS and projected. This angle showed the position for the pelvis and lumbar spine. The smaller angle, the more anterior rotation of the pelvis, therefore the more lumbar lordosis.

So it seems that, in order to have a simple, practical way of assessing the pelvic position, and therefore the position of the lumbar spine, it may best use the evidence of radiographic studies, e.g. Keegan's.

Keegan's radiographic studies (See fig 3-D) show that sitting with the hips flexed to 90^{o} or more rotates the pelvis posteriorly and thereby flattens, or kyphoses, the lumbar spine greatly increasing intradiscal pressure. (Nachemson, fig 26, p21)

There is a very simple way to evaluate the position of the lumbar spine for ourselves. Standing upright normally, put the flat of your hand vertically on your lumbar spine. Now, sit down on any conventional seat or office chair. You will feel the change from curved (or lordosis) to flatness (or kyphosis) in your lumbar spine. When you stand up again your spine will be restored to lordosis.

From this we can conclude that the work of Keegan, in showing the pelvis rotating posteriorly and the lumbar spine flattening when a person assumes the sitting position, is correct, and that it was a conventional seat necessitating the 90-90-90 degrees at hips, knees and elbows that was used to test this. It seems reasonable also to conclude that, when one is standing, the pelvis will be at or close to, its ideal position, upright and neutral, or in mid position between posterior and anterior rotation.

Why Spend So Much Time on Measuring Pelvic Angle?

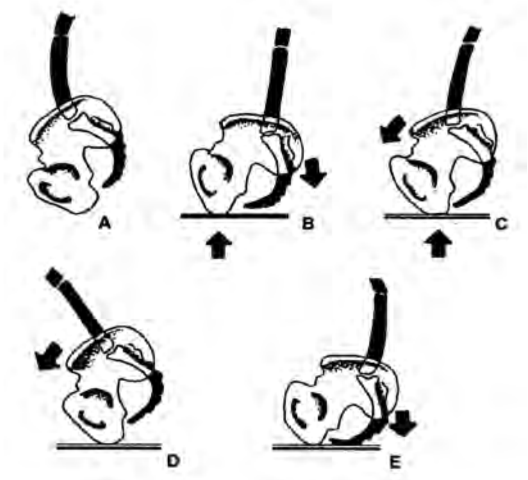


Figure 9 *Relative positions of the pelvis and lumbar spine when: (**A**) standing; (**B**) sitting relaxed, unsupported in the middle position; (**C**) sitting erect, unsupported in the middle position; (**D**) sitting (anterior posture); (**E**) sitting (posterior posture). (Chaffin & Anderson,Guidelines for Seated Work 1980)*

This review of some of the methods developed to measure the pelvic angle, and the difficulties arising in doing so, is to illustrate that, in spite of all of the sophistication in so many fields of medical science, there is no really easy way to measure this structure. The pelvis is the most important influencer of spinal posture for good function of the upper body. A knowledge of pelvic spinal position is one way to know how we can avoid damage to the spine, especially the lumbar spine.

What we do know is that pelvic rotation affects all the upper body structures every time one changes position. Why has this subject been so consistently overlooked compared to the amount of study devoted to other areas?

It seems that the effort to treat pain symptoms and pathologies in such areas as wrist (repetitive strain injury RSI), neck shoulders and most especially, back pain, remedial therapies and corrective action are effective but are focused on pathology at the obvious site rather than on the primary cause.

Figure 10

Figure 11

Figure 12

Figure 10: *Showing school girl sitting on a conventional seat with resulting collapsed spine 'C' posture.*

Figure 11: *Showing school girl standing to illustrate normal spinal 'S' curves restored. These curves remain the same when seated on The Bambach but collapse when on conventional seating.*

Figure 12: *Showing school girl sitting on The Bambach with natural spinal 'S' curves restored dramatically.*

What Else Goes Along With pelvic Rotation?

The pelvic position affects the lumbar spine and exerts a primary control over its shape. (Some trunk flexion is initiated in the lumbar spine before the pelvis moves to accommodate the flexion caused by pelvic rotation) so all structures attached to the spine are affected by pelvic movement. So it is important to consider how and what happens to the spine and attached structures as a result of this pelvic rotation.

The shoulder girdle, head and neck are important functional parts of the trunk, they make it possible for us to work with our hands by stabilising the proximal joint

The arm is designed for easy, powerful mobility, so rather than having a deep bony socket (like the hip joint) the head of the humerus rests in the shallow dish of the glenoid process of the scapula or shoulder blade. The scapula is attached to the first rib at the sternum by way of the clavicle or collar bone. The scapulae slide freely and efficiently across the back of the rib cage and to be most efficient need to slide close to the ribs. The distal part of the clavicle, (the acromial process) forms part of the shoulder joint which is held strongly yet flexibly in place by ligaments as well as muscles and their tendons. This structure (the shoulder girdle) is in this way attached to the spine, which is in turn positioned by the pelvis. Therefore, if the pelvic spinal relationship is not balanced and stable, the arms will be in a position of poor balance to start with, and there will be inefficiency and strain in every movement the arms make. Pelvic position is crucial to efficient, comfortable positioning of the arms and efficient functional performance.

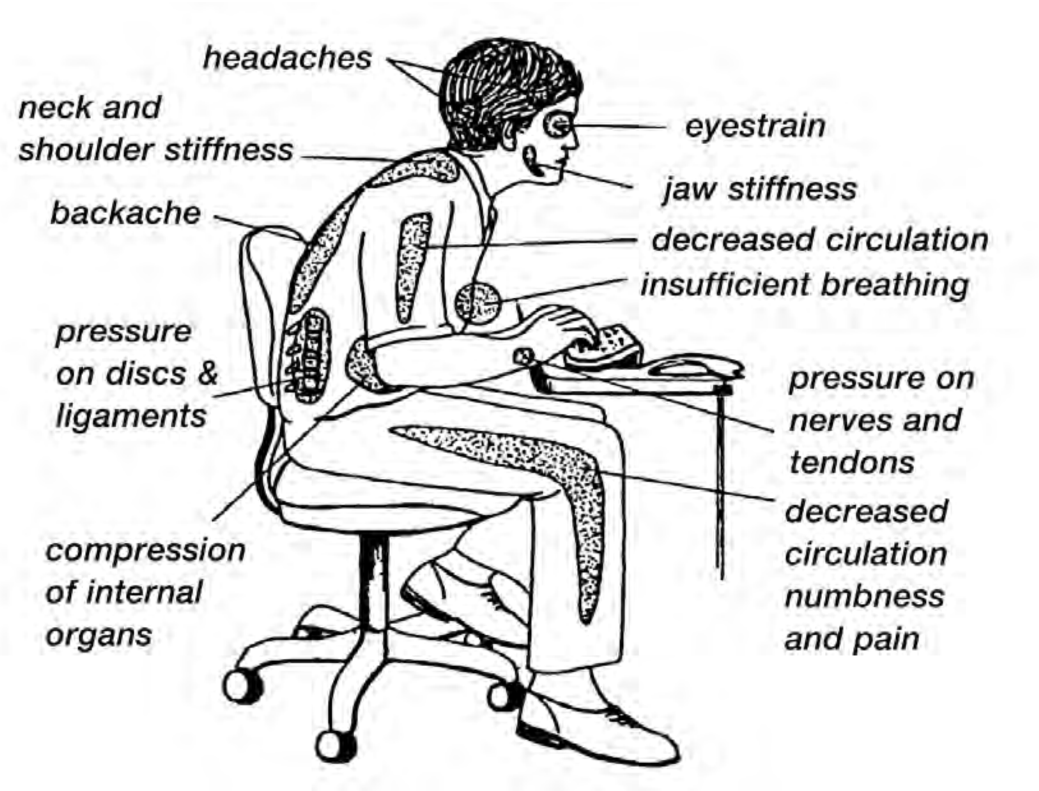
There is a simple test to demonstrate the effect of the pelvis on the arms. Sitting on a conventional seat allows your pelvis to rotate back even though it is possible to hold the pelvis up for a short period of time on this seat. Notice how your collar bone, shoulders and shoulder blades roll forward. With your hands facing down, and your arms straight out in front raise your arms to shoulder level. You will notice some restriction and discomfort. Now stand up and perform the same action. It becomes much easier to raise the arms, and the tension in the upper back and neck is relieved. (This observation is very important in understanding the strains that typists and those engaged in fine work experience).

We can also demonstrate this to ourselves by standing with the arms hanging relaxed by the sides, let the pelvis roll backwards. The hands will then naturally tend to follow the arms as they rotate internally, as do the collar bones. The shoulder girdle sags, and the hands face not against the thighs, as is their natural position, but backwards. This shows that, functionally, this is not a good position for the arms and hands as they must work 'against' a postural disadvantage. This position is a direct result of pelvic backward rotation which happens in conventional seating.

WHAT ELSE GOES ALONG WITH PELVIC ROTATION?

The head and neck are also affected by pelvic position. Figure 13 shows how the head is positioned when sitting on a conventional seat at a desk of standard height. The head is shown in an all too familiar position for many who sit at desks neck extended so that when the person looks at the screen or other work, the head rolls back and the chin protrudes as the spine collapses.

Figure 13 *The many repercussions of sitting to work on a computer from a conventional seat*



Stigliani J., Computer Users Survival Guide 1995

How The Pelvis is Moved

The muscles which affect the pelvis and lumbar spine are, broadly, the abdominals and the paraspinals.

The abdominals support the spine from the front and when contracted pull the pubic bone up flattening the lower back, when relaxed pelvis will drop the pubic bone down to allow more lumbar lordosis. The quadriceps are part of the hip flexors and act on the pelvis by pulling it down at the front. The hamstrings, part of the hip extensors, limit anterior forward pelvic rotation in sitting.

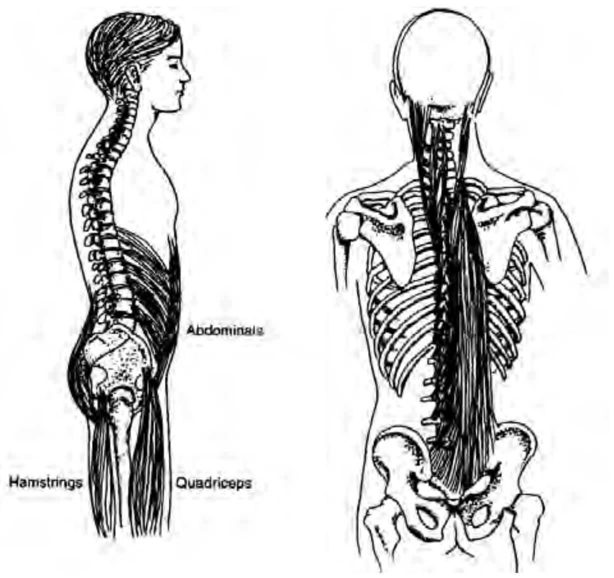


Figure 14 *The abdominals, hamstrings and quadriceps are the chief muscles affecting the curvature of the lower back by the tilt of the pelvis. The abdominals support the spine from the front and are capable of pulling the pubic bone up so as to flatten the lower back, or to let the pelvis drop down, creating swayback. The quadriceps, which are part of the hip flexor group, can contribute to swayback by pulling the front sides of the pelvis down. The hamstrings contribute to flattening the lumbar curve if they are short and tight (M. Schatz, Back Care Basics 1992)*

Other muscles that can affect pelvic orientation are the hip flexors, most notably the iliopsoas. The paraspinals support the spine from behind. They terminate in an extremely strong web of fascia, at the base of the spine, which attaches the muscles to the spine and pelvis. The flexor muscles are not active during normal standing but are essential to counter the pull of the back extensors balancing the pelvis in a neutral upright position keeping the whole body upright and symmetrical.

All posterior trunk muscles can produce spinal extension, increasing lumbar curves. Flexors likewise produce flexion which decreases the lumbar curves. As gravity inclines us to forward flexion, the back muscles must act intermittently or continuously to correct the body back to upright. This control of flexion is the result of longissimus thoracis and iliocostalis positioning the thorax on the lumbar spine. Multifidus, longissimus lumborum and iliocostalis affect flexion of the lumbar spine, as part of a group of extensors. Continuous correction by extensors as in sitting in conventional seating results in these muscles tiring and 'letting go' which results in the 'collapsed' position we are so familiar with.

How The Pelvis is Moved

The muscles of the pelvis are complex and can interact in a great variety of ways to enable the human body to stand up, to move, to run, to dance, to perform extreme sports, to lift, to sit and to lie down. A great amount of effort is needed to counteract the action of gravity, even more to perform tasks, even passive ones, like standing and sitting. These muscles need to be flexible, strong and supple, and yet they are very likely to be limited in range and strength, as we do not seem to recognize the need to keep these groups fit and fully useful.

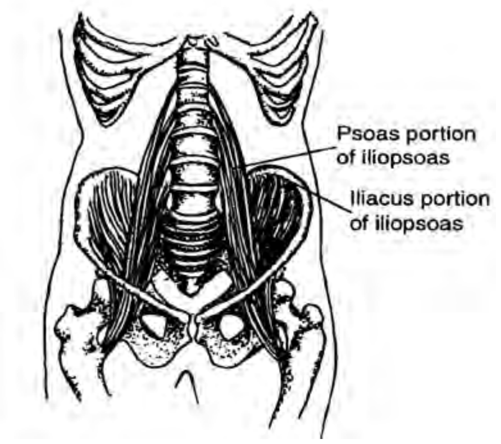


Figure 15 *The iliopsoas, part of the hip flexor group, can contribute to swayback by pulling the lumbar vertebrae and the rear of the pelvis down and forward (M. Schatz, Back Care Basics 1992) The iliopsoas can also inhibit hip extension and therefore lumbar lordosis.*

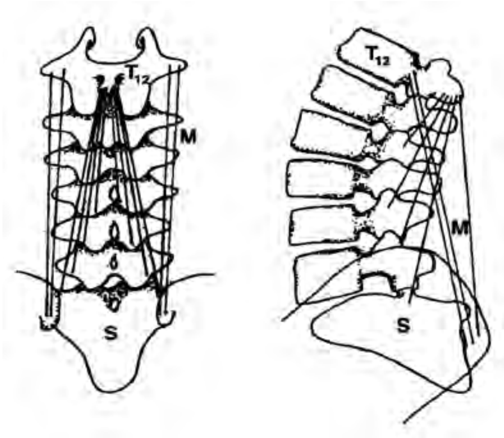


Figure 16 *Attachments of erector and multifidus muscles, posteroanterior (left) and lateral (right) views. (Cailliet and Bogduk et al. Low Back Pain Syndrome 1995)*

A full understanding of the ways these muscles work, how they work in harmony with each other, requires a profound understanding of anatomy, physiology, and kinesiology and requires the attention of a specialist to fully understand and explain it. We can only expect to know part of the story and, hopefully, learn enough to help us to appreciate the effect of pelvic position on the posture of the human body, the need to know how to position it and keep it strong.

A conventional seat requires a great amount of effort to counteract the action of gravity...

Closing The Barn Door After The Horse Has Bolted

Much clever effort is devoted to corrective devices and to ways of keeping the muscles and joints from sustaining trauma from continuous work in poor posture. However, if the poor posture was permanently corrected by good seat design and the worker made conscious of how to maintain good posture by positioning and supporting the pelvis, the results would be much more successful. Prevention should be incorporated into seat design.

It is therefore surprising to find so comparatively little study of the pelvis as "the prime mover" with all its significant effects. Why has it been so neglected, so overlooked as a subject of study as the most important factor in posture?

Following are illustrations of some of the consequences of sitting on conventional furniture past and present. In all cases the pelvis rolls back with bad consequences for the spine and functional posture. Of special interest is the work of Eliza Mosher who, among others in the 19th and 20th centuries, identified (and made efforts to correct) the detrimental effects of the seating on which we are still sitting today! Contemporary moulded plastic, stackable school seats are, if possible, even worse than the school furniture of the 1800's.

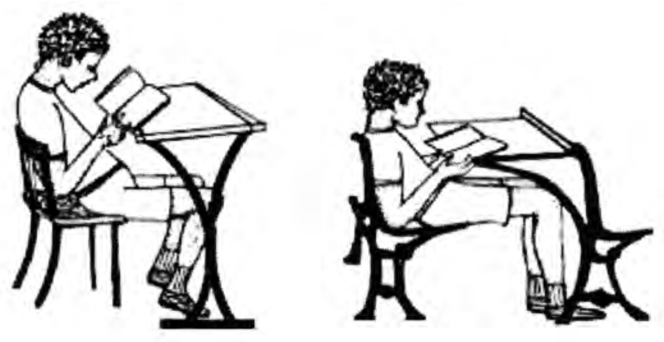


Figure 17 *School seating from the last century, illustrating what happens with pupils sitting on their school furniture (After Bobrick, Hygienic Requirements of School Furniture 1892)*

It does seem amazing that, with all of the study of poor posture over such a long period, we are still talking about backrests with lumbar rolls for 'correction', 'pause' exercises, and a plethora of cushions and supports designed to correct every human postural aberration. We are no further advanced in a matter that would seem so fundamentally obvious. A seat design which is actually designed to allow the human body to remain upright while sitting to work.

Closing The Barn Door After The Horse Has Bolted


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Figure 18 *Collapsed Kyphotic reading posture (as shown in a 19th century text) with the weight of the upper body partially taken on the elbows. The hands supporting the head - a familiar sight in schoolrooms then and now (Afer Roth, 1899)*

Figure 19 *19th century student is forced to use the desk for support (After Bradford & Stone 1899)* **Figure 20** *Early 20th century school furniture in a Boston school encourages this stressful posture (After Cotton 1904)*

Over the past fifty years international standards of furniture design have seen a reduction in recommended heights of tables and chairs (Mandal 1982). At the same time people in developed countries (where more time is spent sitting at work) have been getting taller. Taller figures sitting at lower desks is a recipe for back trouble caused by the unnatural bending of the spine. As was true in the last century, today's schoolchildren still subconsciously improve their skeletal position and achieve some comfort by tilting their desks and/or their chairs. School children spend many hours a day for many years of their lives hunched over a desk, and necessity has been the mother of invention.

School Children's' tricks for relieving postural stress

Figure 21 *By inclining the desk towards the body this contemporary student has reduced the amount of forward bending required to bring his work into a comfortable position. (M.Gale, The Seated Spine 1997)* **Figure 22** *By tilting the chair forward this student has placed her legs at a more open hip angle restoring the natural curvature of the spine. (M.Gale, The Seated Spine 1997)* **Figure 23** *Another 'trick' for reducing pressure on the lumbar spine is demonstrated by this student who, by sitting forward on a tilted chair, reduces the amount of forward bending necessary to see the work and places the spine in a more natural position. (M.Gale, The Seated Spine 1997)*

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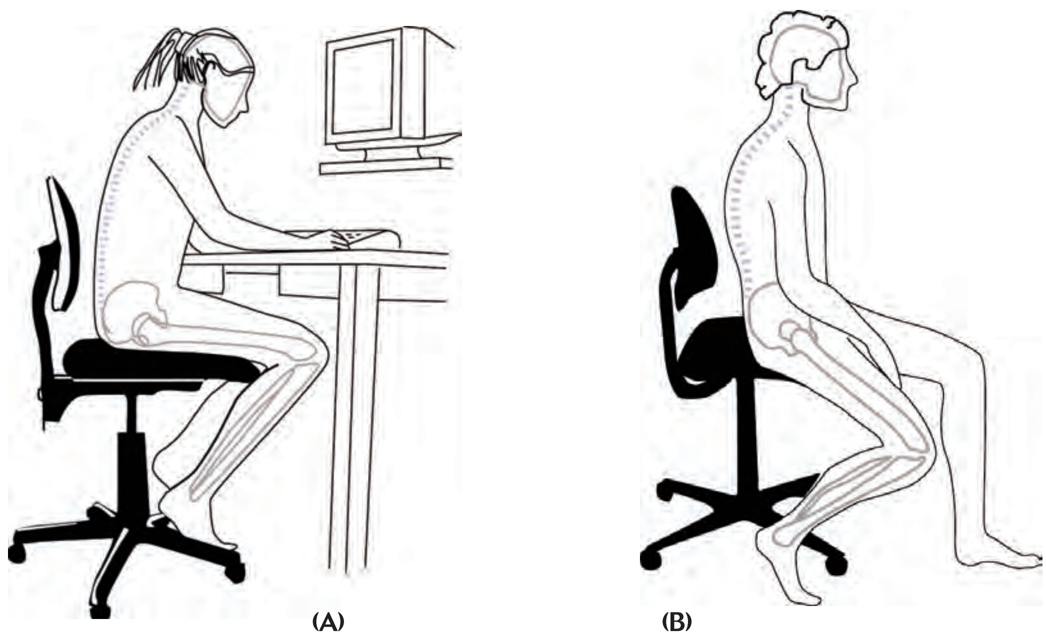
Figure 24 *Reading desk designed by Mosher, MD in 1899. It has a slightly sloped writing table with adjustable reading stand that can be rotated into position by the student. This desk produces a more desirable reading posture than many modern school desks. (After Mosher, 1899)*



(A) **(B)**

Figure 25 (A) *Back rests and lumbar supports on chairs have no effect when the back is not in contact with them.* **(B)** *One way adults try to relieve sciatic pain which can become worse or noticeable when in conventional seating is to drop the leg over the side of a chair or bench, reintroducing the natural lordotic curve to the lumbar region by allowing he pelvis to be in its neutral, upright position.*

Can the Sitting Position Prolapse Lumbar Discs?

Experts agree that the backward rotation of the pelvis, which occurs when sitting on conventional seats is compensated for by flexion of the lumbar spine and that this position is close to, or at the limit of, the range of movement of the lumbar spine. Moreover that this position is held statically for long periods of time when sitting. This is achieved at the expense of a considerable degree of deformation of the intervertebral discs. *(Stephen Pheasant, Bodyspace, Anthropology, Ergonomics and the Design of Work 2nd Ed p.70 1986)*. This opinion is commonly held and is one found consistently throughout the literature.

It is agreed we need to have seating that is designed for the human form rather than designed according to how seats should have looked for centuries. The design would then be based on an understanding of the pelvic-lumbar position. The ability to adjust the height of seats and work surfaces is of such obvious importance that it defies understanding that this is not the subject of an occupational health and safety standard. If there were one, we would have fully adjustable task seats for use at a height-adjustable work surface, purpose-designed to allow the human body to hold correct posture for work performed at the correct height for the individual. Such a seat would be costly at first but what is the cost to industry and the health system of the damage done to children at a time they are growing and forming lifetime habits? This lack of attention to early trauma caused by postural stress is often paid for later as a work injury. Early trauma from repetitive postural stress can result in chronic invalidism through back pain and other conditions.

For example, R.A. McKenzie, a prominent New Zealand back and neck pain clinician and researcher, says in his book – The Lumbar Spine :

"A poor sitting posture may produce back pain in itself without any additional other strains of living"

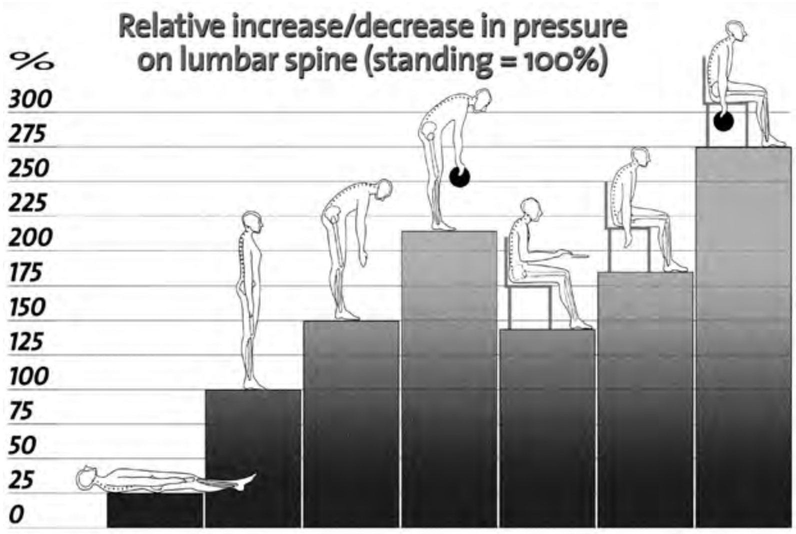


Figure 26 *Adapted from "Towards a better understanding of low-back pain" a review of the mechanics of the lumbar disc, by Alf Nachemson. Published in Rheumatology & Rehabilitation (1975)*

McKenzie shows the changes in pressure that take place within the discs as the spine moves from neutral to flexion. He notes that the nuclei moves backwards compressed by the discs, that this compression is greater at the front of the vertebral bodies and that the most consistently applied force is due to the effect of our continually flexed lifestyle, forcing the disc back against the nerve. In the sitting position, we put the compression there and leave it there.

Can the Sitting Position Prolapse Lumbar Discs?

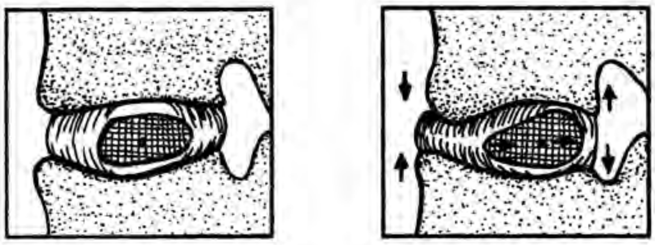


Figure 27 Left: *The nucleus pulposus with the spine in neutral position.* **Right:** *The nucleus pulposus with the spine in flexion (After McKenzie, The Lumbar Spine 1981)*

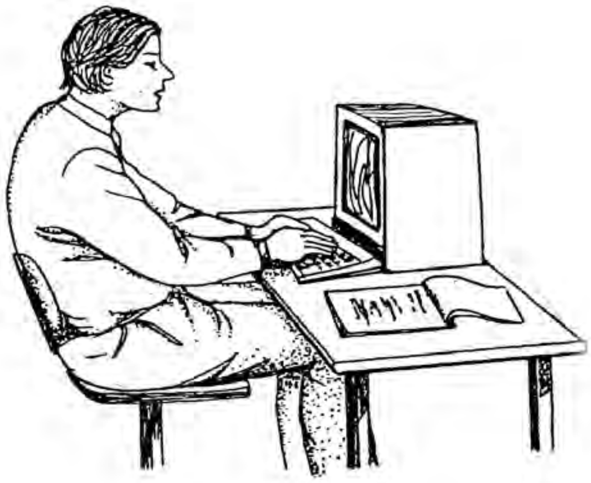


Figure 28 *Computer operator with commonly used furniture exhibiting what Stephen Pheasant described as the 'yuppie hump' brought about by furniture heights and seating completely inappropriate to the purpose. (From Stephen Pheasant, Ergonomics, Work and Health 1991)*

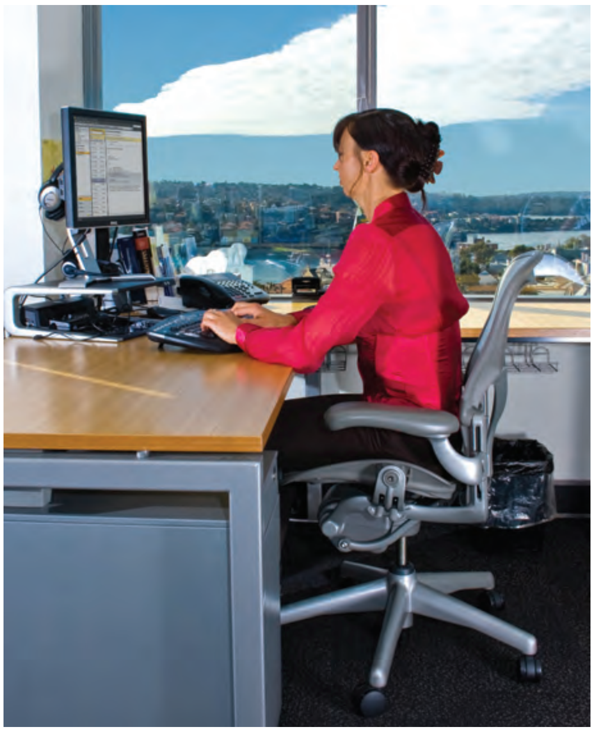
McKenzie also gives the example, familiar to most, of the person boarding an aircraft, fit and free in movement, who then arrives at the destination stiff, in severe pain and in need of treatment. He says we do to our lumbar spine what we would not do to no other joint. We do not for example, hold our wrist, ankle or leg in one position and leave it there all day.

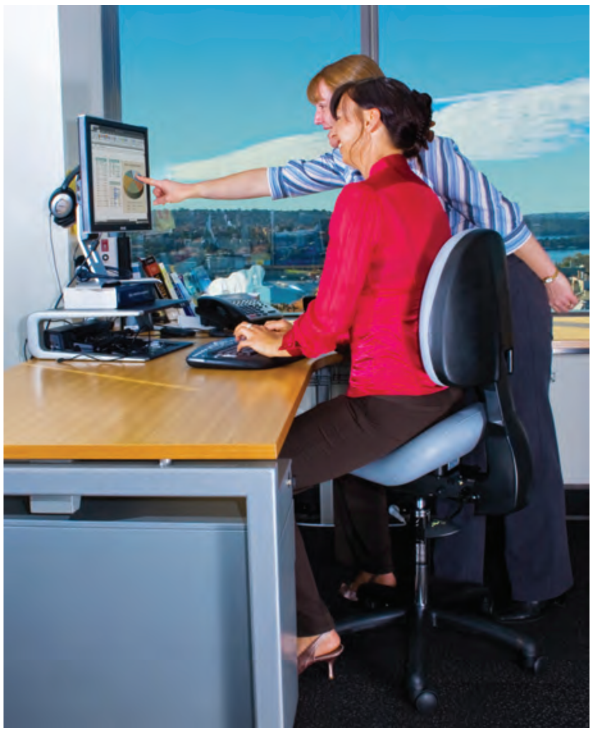
I can fully attest to all of this. Every year I travel to promote The Bambach Saddle Seat all over the world on long hauls. If I am not able to lie down, as in First Class seating, I am better off sitting upright in Economy. First Class seats are the only ones that fully recline; a half-reclined position leaves the back with the stress fully in the lumbar spine. After a trip from London to Sydney in this half recline business class position, I was undergoing surgery 2 weeks later for my second laminectomy for discal prolapse. To sit upright is safer but to sit upright for long hours in economy is not easy. Wedging the pelvis higher than the knees, and supporting the pelvis in anterior tilt as well as using a cushion to support the lumbar curve, also helps. However, as McKenzie says, all of the expensive redesign based on ergonomic and anthropometric studies and undertaken by expert ergonomists has clearly failed to prevent primary postural stress. I can give personal testimony to the fact that it can cause discal prolapse. The annular ligaments just cannot take that kind of static load continuously without the risk of damage.

The seating and furniture that most of us use encourages poor posture by its very design, and although an awareness of and achievement of good posture is briefly possible on such seating, it requires over use of muscle groups to achieve and maintain. In a short time these muscles tire. In a work situation, when extra demands are made of the hands (and consequently the entire shoulder girdle), and it is necessary to position the head to see work, it becomes impossible to avoid placing serious stress on the spine and lumbar discs.

What is The Most Important Thing To Change

It seems obvious from this discussion that the most important thing to change in current furniture design is the position of the pelvis. Yet more attention is given to correcting lumbar curve, and poor posture of shoulders, head, neck, arms and hands, **AFTER** they have been forced out of correct alignment by conventional furniture, than to designing furniture that doesn't create the problem in the first place.





SEAT COMPARISON

Conventional Seat

The Bambach Saddle Seat

What About Alternative Designs for task Seating?

There are quite a few alternative designs for task seating, but none challenge the standard. The Bambach is an exception, and this seat is discussed in some detail later.

The seat designs and products of Herman Miller are excellent, and they are the result of serious ergonomic research. They exhibit creative sourcing and use of materials as well as a fine appreciation of aesthetics. These seats are certainly an example of good industrial design. However, I do not believe they do much to correct, or avoid, postural deformity.

There has been a general recognition that keeping the pelvis upright is important and that a way of doing this is to tilt the seat pan forward to allow the knees to drop below the hips. This allows the pelvis to rotate forward or in fact to its upright neutral position. Some have this function. Others also employ lumbar “support” and other features that may or may not help. The tilt helps to restore lumbar lordosis because the pelvis rotates forward. However, in order to prevent oneself from sliding forwards and off these seats one has to prop back with the legs, this results in hydrostatic pressure and fatigue. To do this is a much more difficult postural task than it would be to simply ‘get it right’ in the first place.

Another way of achieving an upright pelvis is afforded by the ‘kneeling’ seat. This seat provides the sitter with a way of achieving the advantages of tilt, but the person must now kneel on a bar, or knee pad, to prevent sliding off. This works very well for pelvic and spinal posture, but it is quite an awkward seat to get into and out of, as the legs must be tucked back under the body, and on getting up, they must be extricated from the kneeling pad. A further disadvantage of the kneeling seat is that the feet lose plantar contact with the floor. This means that weight is taken through the knees which are not designed for weight bearing. Using the feet flat on the floor enables the sitter to take weight through the feet and offers a broad base of support and easy mobility around the workplace.

The “Kneeling” Chair

What About Alternative Designs for task Seating?

The idea of the kneeling seat is that with balanced posture there is no need for a backrest. However, if one sits all day from time to time one needs to rest the abdominals. And when one is performing tasks that require a more upright position, such as typing, phoning, listening and talking it is an advantage to have the backrest to use as a rest point.

'Sitting balls' are often recommended. These balls are equipment that are used for exercise and therapy, with great success. The reason I would not recommend them for task seating is that they are not height adjustable, most importantly they are not shaped to support the pelvis in its upright position and require great muscular effort to achieve this. Further, the legs are in front of the body, and because of the bulge of the ball it is not easy to get close to the task. Finally, as can be imagined these seats are very cumbersome to move from one workplace to another especially where arms and backrests have been fitted.

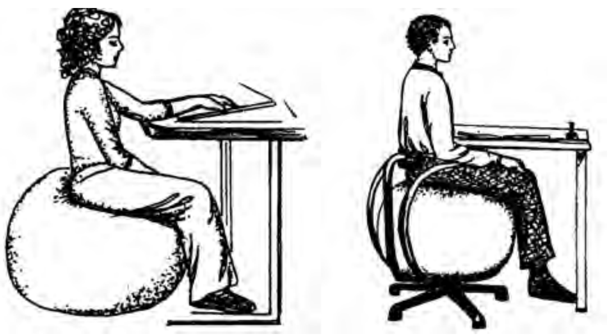


Figure 29 Left: *A therapy ball being used as a seat.* **Right :** *Therapy ball adapted to become a seat. Both have a number of disadvantages as task seating*

Some 'saddle' type seats have been produced most notably the Hag 'Capisco'. Again, manufacturers such as Hag and Stokke produce designs of innovation superb construction and elegant use of materials they are 'high craft'. However, again, I believe they cannot provide the core design essential an upright, stable pelvis because they have failed to understand that to achieve this something has to be built into the basic design.

Figure 30 *The Capisco 'saddle' chair by Peter Opsvic offers support from the front, back or side, but does not provide the basic essential: secure upright and stable pelvis.*

What About Alternative Designs for task Seating?

A group of surgeons led by Congleton researched and designed a 'saddle' type seat especially for surgery, where the surgeon not only needs great stability but must assume a static posture. The Congleton team produced a saddle only in so far as it had a 'pommel' that was intended to stop the sitter from sliding off the tilted seat. In fact, this seat more closely approximates a supported standing position rather than a sitting position The surgeon in the illustration has lost plantar contact, and the leg appears less than relaxed. The spine appears to be in a better position than a conventional stool although the whole posture seems somewhat tense.

Figure 31 *The Congleton surgeon's 'saddle' is tilted and has a pommel to prevent the sitter from sliding off.*

There are many other seats that have 'ergonomic' as a claim, and some seem to be carefully designed and have some really good features. Yet none of them has really changed the basic concept of seating nor moved conceptually very far away from the Pharaohs.

In his book, "Compute in Comfort", Paul Linden says after describing a range of options to cope with conventional seating that if all else fails :

"There is one last sitting option which may seem odd but which I use a lot and find quite comfortable. This sitting posture allows your legs and pelvis to find a natural, relaxed stability, which enables them to support your torso in a comfortable manner. It also encourages a very comfortable opening and relaxation of your breathing"

As will be seen later in this book, what Linden has done to make 'natural' good posture achievable (i.e. roll up a blanket and place it on the seat so that a natural lumbosacral angle is adopted while sitting) is admitting that the design of The Bambach is ideal.

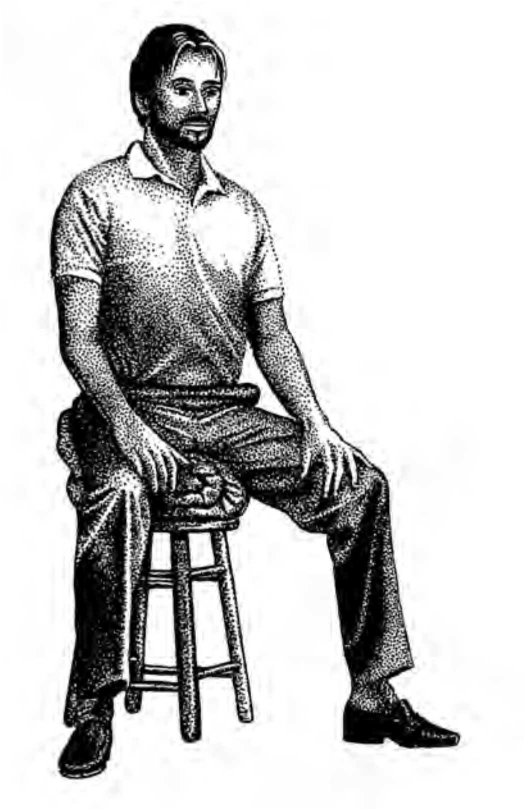


Figure 32 *A blanket rolled up and placed on the stool, as suggested by Linden (1995), enables the legs and pelvis to find a natural relaxed, stability so that the torso is supported comfortably. This posture has good implications for the lumbar spine and also results in less compression of the thorax (and less restriction of internal organs.) (From Compute in Comfort by Paul Linden 1995)*

The Bambach – A New Approach

What is the ideal seat? In theory, a sitting position where the angle at the hip joints is about 45º is ideal, since in this position the pelvis is upright, the muscles at the front and the back of the body are in balance and the body's centre of gravity is over its supporting base rather than behind it. The ideal seat, therefore, is one that preserves the natural spinal 'S' curves while allowing free balance and easy use of the arms, trunk and head as well as facilitating easy mobility around the work station. Hip abduction and external rotation are also essential for a pelvis which can remain upright and stable in the sitting position.

There is an obvious similarity between the ideal sitting position and the way a rider sits on a horse. In the horse-riding position, the spine is upright, with the hips flexed at 45º, and the body is in perfect balance, capable of adjusting as required to the movements of the horse.

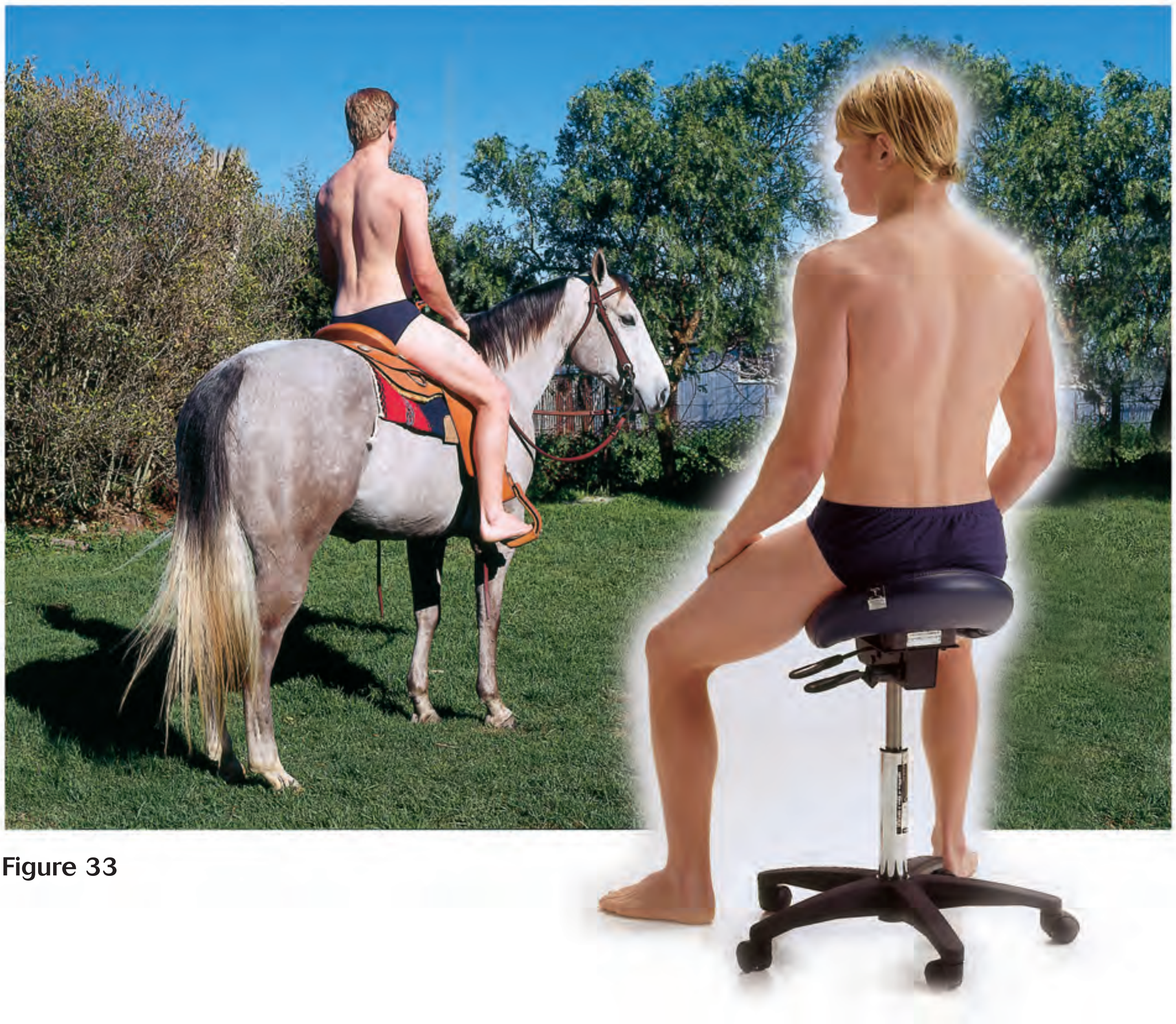


Figure 33

The Bambach is shaped like a saddle to enable the body to maintain ideal posture when sitting. It is purpose-designed to position the pelvis in its upright, neutral position and keep it there. In this position the person now bends forward from the hip joints rather than the "waist" (or spine).

In the Bambach position, the hips are abducted in external rotation and at between 45° and 60° of flexion. This is the position in which the head of the femur is in its ideal close-packed contact with the acetabulum which means the joint is stable and at ease in the "rest" position. This also means that the thoracic and cervical spinal curves are in natural, neutral alignment. This being the case, the shoulders, neck and head are positioned for maximum ease, accuracy and powerful function because they also are in their neutral positions The legs are able to move freely, the feet are in full plantar contact with the floor, able to take more or less weight as required. The person can move the seat freely around the workplace or the room with ease and safety. The arms, hand, head and neck are positioned for least stress, resulting in a natural increase in range and strength of reach and ease of functional activity.

WHAT HAPPENS TO MY LOWER BODY IN SADDLE SITTING?

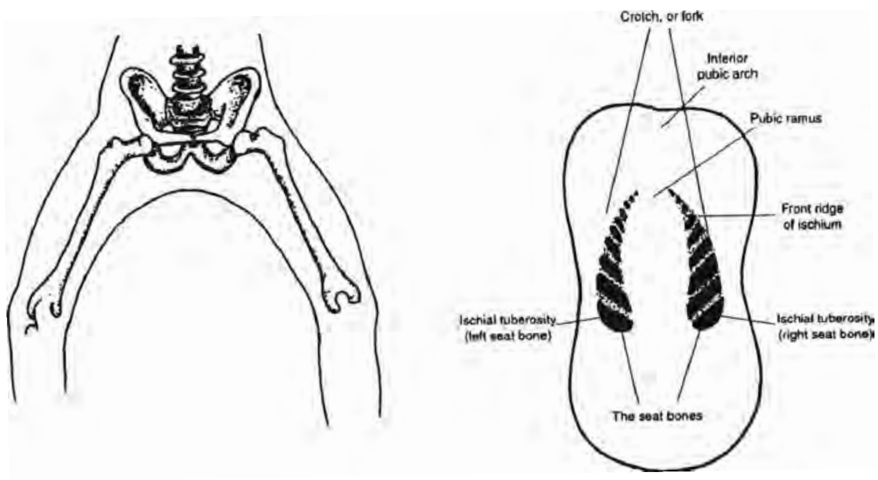


Figure 34 Left: *There is a horizontal section at the top of the femur, or thigh bone, which permits a person to settle into The Bambach .* **Right***: An aerial sketch showing the three-point seat contact in a saddle (shaded area illustrates variations of contact). The three contact areas that link together as the broad base of support are the two seat bones (ischial tuberosities) and the crotch (the latter contact area may be either the inferior pubic arch, the pubic ramus, or the frontal ridge of the ischium). The upper body rests symmetrically above this base. The mobility of the hip joint means the direction of the weight may be eased and diversified. The pelvis is joined to the spine in such a way that the seat bones are lower than the crotch. This is a naturally balanced position.*

Do We Need A Body-Conscious Design?

Humans should not hold unnatural positions for long periods. But in order for anyone to comprehend whether a position is unnatural and potentially harmful, they need some knowledge of how their body works and what is the ideal position for a given activity.

We should know which positions restrict movement, those which do not enable or assist the limbs to move freely, positions that place the head, neck and back in a position which results in stress, positions that restrict the rib cage and abdomen, that confine, control and force conformity to a poor seated position or that put image before ergonomics. Such positions ultimately disable, deform and disempower people.

It does seem obvious from the previous discussion that there is a great need to challenge existing standards of design in task seating and to repeatedly ask the question "Does this seat ensure good, stress-free, upright posture?"

It also seems obvious that we should look to all the ways people, and especially children, sit in school, at study, and at all the situations in which they are asked to sit for long periods (for example car and other travel).

We can develop a wisdom that says it is of great importance for everybody to look carefully at the way their body works at leisure as well as at work and have the confidence to change what needs to be changed. The price of the effects of postural stress is often paid for by not being able to perform activities that we want to do outside of work. It might be as simple as just not being able to pick up a grandchild, to garden, travel, play golf or enjoy sitting to watch TV. Most of all, I believe we must be aware of the fact that most seats seem to want to offer the same 'comfort' as a bed does.

It would be more beneficial to evaluate any seat for the positions that it can realistically offer your body, and ask yourself "Will these result in my sitting in a position of minimal postural stress?" *(After Mandal – The Seated Man 1985)*

Perhaps Dr. Mandal said it all :

Without doubt the best sitting posture is obtained on horseback. The hip joints are in the resting position with a bend of 45º. The hip joints and lumbar spine are not loaded in an extreme position. The lumbar curve is maintained and a perfect balanced position is obtained in which the body adjusts its centre of gravity.

VARIOUS POSITIONS OF LUMBAR CURVE

STANDING

SITTING ON A CONVENTIONAL SEAT

SITTING ON THE BAMBACH

SITTING LEANING FORWARD ON THE BAMBACH

SITTING LEANING FORWARD ON A CONVENTIONAL SEAT

YOU CAN DEMONSTRATE THE POSITION OF YOUR LUMBAR CURVE YOURSELF

Standing, place your hand on your lower back (or lumbar spine). Feel your spine's natural curves

Leave your hand in place

Sitting on a conventional seat and feel how your natural lumbar spinal curve is lost as your pelvis rolls back

Leave your hand in place

Stand and feel how your natural lumbar curve is restored

Leave your hand in place

Sit on The Bambach and feel how your natural lumbar curve is retained the same as in standing

YOU CAN TEST THE ABDOMINAL SPACE FOR YOURSELF

Standing, place your hands on each side of your abdomen, spread your fingers out. See and feel how much space you have for your abdominal organs

Leave your hand in place

Sit on a conventional seat. See how your fingers close up as your abdomen is compressed, also compressing the abdominal organs

Leave your hand in place

Stand up feel how your abdominal space is restored relieving abdominal organs of compression

Leave your hand in place

Sit on The Bambach, see how your abdominal space is the same as when standing

YOU CAN TEST YOUR CHEST SPACE FOR YOURSELF

Standing, place both of your hands on each side of your chest. Spread your fingers out over your ribs. Feel the way your ribs have opened up.

Leave your hand in place

Sit on a conventional seat and feel how your ribs close up leaving less lung space for breathing.

Leave your hand in place

Stand, feel how your ribs open up again. Lung space is restored.

Leave your hand in place

Sit on The Bambach, see how your fingers remain the same as when standing showing that your ribs and chest are still open.

The Postural Benefits of Horse Riding

When we look at the bio-mechanics of task seating, it seems to lead to the inescapable conclusion that the application of ergonomics to seating used in rehabilitation is much neglected. The effort always seems to be directed towards how to 'fix' pathology created by sitting incorrectly rather than preventing it. This fact becomes sharper when considering the person with a physical disability. Disabled persons can suffer further impairment of function due to the poor seating that we universally accept.

As a therapist I was frustrated in my attempts to treat neurological patients from wheelchairs. Often it was not practical to transfer them to other (usually equally unsuitable) seating. The alternative seats were only marginally better for posture than the wheelchairs. From this widely accepted conventional seating, the performance of functional tasks was most difficult due to their 'collapsed' posture.

It was when I saw these same people on horseback (a routine part of treatment at the hospital where I was employed) that I realized that they were actually capable of sitting independently and unsupported when on a horse. They showed improved functional abilities simply as a result of being put up on a horse in a saddle. Some of these people could not even sit unless supported (or strapped) in their armchair or wheelchair.

What looked like a miracle was simply the result of giving to these patients the opportunity to sit in postural correctness. The centre of gravity was in correct alignment over the base of the pelvis. They were liberated in a way that nothing we did in therapy could even approximate. On horseback they had good independent balance and symmetry, improved trunk, head, arm and hand control. Those with abnormal tone were able to work with less spasm, with fewer abnormal involuntary reflex reactions, with improved righting reactions and good midline recognition.

What was really happening? I still don't believe that we really know the whole story. To have an expert fully explore the theories of say, the Bobaths and Jean Ayres, and to apply knowledge of contemporary developments in neuromuscular science and the study of posture and its effect on human function, would be most interesting.

Having seen positive results for very disabled when put on horses over a period of years, the inescapable conclusion I drew was that a 'saddle seat' had to be investigated. It seemed an obvious practical way to replicate the effect of being on horseback without the obvious problems of having a horse attached to the seat.

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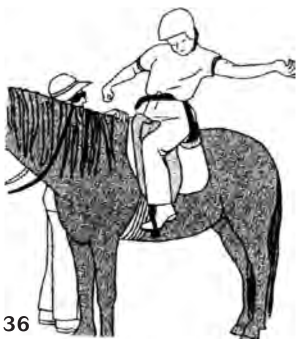

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Figure 35 *Young woman with Athetoid Cerebral Palsy has poor balance in her wheelchair making it necessary for her to hook her arms under the arm rests to maintain an upright posture, as well as a waist belt to prevent her extensor thrust ejecting her from her chair.*
Figure 36 *On horseback the same person is able to sit upright unassisted. The posture induced by the saddle, with hips abducted slightly and hips at a 45° angle, produces proper alignment of pelvic-spinal elements.*

Figure 37

A counter to unilateral neglect.

Sitting on The Bambach, it is impossible to overlook both sides of the body as well there is a clearly defined midline. The proprioceptive and sensory message resulting from this position encourages awareness of the whole body. Full plantar contact makes partial weight bearing possible. The position of the legs, with the weight already over the body's centre of gravity, makes coming to a standing position easier. Weight bearing in both legs and feet is encouraged.

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Figure 38 *Showing a woman with right hemiplegia (one side partially paralysed) sitting on a conventional seat showing how she sits to the left of the seat with an asymmetric posture and loss of midline symmetry.*

Figure 39 *Showing the same woman on The Bambach sitting with more symmetry, closer to her correct midline position.*

Some Special Benefits of the Bambach Position

Midline recognition and righting reactions

It is easy for a person to see their midline as well as feel it on The Bambach. Righting reactions can assist with symmetrical upright balance easily as they do not have to bring their body up to the alignment of the centre of gravity as you do in a conventional seat, it is already there.

Improved lung and abdominal space.

The posture in The Bambach allows better function of the organs contained in the lung and abdominal spaces. The diaphragm is no longer pushed up into the chest. The Bambach position is more comfortable for breathing and function of abdominal organs.

Improved hand control

As a result of good posture, the shoulder girdle is stable in its ideal neutral position allowing good arm and hand function as well as the head and neck being in the ideal position for functional performance.

Back pain management

The Bambach allows a posture of least intradiscal stress; the pelvis is upright and secure so that the spine has its natural curves just as when standing. As this is the position of least intradiscal stress people sitting on The Bambach report relief from back pain. In the case of workers, this can improve the chances of their not having to take time off work. For those who must have time off to recuperate, The Bambach can allow them to return to work earlier.

Postural stability

Because The Bambach holds the pelvis in a very stable position, the proximal joints can also be stabilised more effectively for movement of the distal joints. This is often an issue in cases of hemiplegia and cerebral palsy. The shoulder girdle is in the position of maximum stability and function when the pelvis and spine are in their natural alignment, and this assists with arm and hand control.

In exercises for the feet and legs, The Bambach allows the feet to bear some weight so it is possible to push down on the legs and feet to extend to half-standing without leaving the safety of the seat. This movement becomes very close to normal, where the proximal joint moves across and over the distal joint rather than the other way around, such as occurs when this exercise takes place on a bed or plinth.

Figure 40 *Showing a woman after a stroke on a conventional seat showing the tendency to collapse and lose functional posture*

Figure 41 *Showing the same woman now sitting upright in a more functional position.*

Psychological results

In restoring a person's ability to function as closely as possible to normal, self-esteem is restored, and it is possible to resume one's place in the family or community earlier.

EXAMPLES OF THE BAMBACH'S BENEFITS

Figure 42 *A young woman was badly injured in a work incident where she ruptured three discs in her lumbar spine. After many surgical interventions, she had less pain but had impaired the use of her legs. She found a wheelchair bulky and restrictive. Her kitchen and house would have required extensive modifications to be suitable for a home-maker in a wheelchair.*

Using The Bambach gave her ready access to all her kitchen, stove and benchtops. She then had sufficient mobility and the 'reach' required to gain access to her cupboards without the need to change anything. This person even painted her house whilst on The Bambach.

Figure 43 *A second example is an amputee who found that she could not easily do her housekeeping, particularly duties in her kitchen, while on a wheelchair or using crutches. With The Bambach she found cooking and household duties not a problem.*

Both these people said that the most important thing for them was the relief from frustration and the humiliation of their dependency. Their morale, and consequently the mood of their families, dramatically improved. This was of critical importance for their relationship with their spouses and their children.

For Children With Physical Impairment

All children, as they grow and develop, be they normal or with a disability, have physical and psychological needs which if not met can make life difficult and perhaps sometimes, even seem not worthwhile. In satisfying the physical needs of children with disabilities, we often, coincidentally, satisfy their psychological needs.

In our attempts to provide safe, functional seating that facilitates their care, it often seems that we have immobilised them in clever cocoons. Many specially made seats are often bulky; cumbersome to move, and distort natural spinal alignment with the result that function is actually impaired further disabling and even disempowering them.

Most disabled children wish to be as much like other children as possible. They want to participate, not just in school activities, school excursions and family outings, but in all the other activities just as their peers do.

As if growing up isn't difficult enough, so much to understand, so many people to please! There are conflicting goals and expectations they must reconcile and for some children there is the added and undeserved barrier of physical impairment.

That we should add to the difficulties would seem unconscionable, but I am suggesting that indeed we often do just that and we do it with what is called 'conventional' & "disabled" seating.

In many cases, wheelchairs or 'custom' seats, no matter how special and how many modifications they have, are little more than mobile beds, or a kind of cupboard in which to store disabled children.

Disabled children get the most physical freedom when they are taken out of their wheelchairs for physiotherapy, swimming, horse riding (if that is available) or other physical activities.

As we have seen conventional school seating causes considerable strain on children's spines, if they can they unconsciously try to adapt their posture to relieve the strain (as already shown in the illustrations of 19th and 20th century schoolchildren on pages 18 and 19). Children do not have the necessary wisdom or experience to inform them of the needs of their own bodies, as they grow and change or what options are available. Adults have all the power, and they do not know either.

Usually disabled children cannot tip their seats up to get comfortable, nor can they pull the desk up onto their lap to straighten their spines, nor slide to the edge of the seat and prop with their legs to allow the pelvis to rotate upwards to relieve the postural stress in their spines. Far more insidious is the fact that, even though they may not always feel the strain, it is still there. These consumers of health care cannot know that there is a better deal for them, and even if they did, they have no power to demand it.

Children's (particularly teenagers) bones, muscles and tendons often grow at unpredictably differing rates. For a child using conventional seating or in the case of children with physical impairment often strapped into wheelchairs and other seating, I see no evidence of changes to the design of seating that allows for healthy growth.

The same has to be said for children in strollers and various other baby equipment. Back pain has been linked to the requirement for young children to sit for long periods. From grade two children must sit still, and while this controls them, it is the start of their slouching, shifting weight in order to re-align their spines, leading to back pain.

Damning appraisals have been made of the wheelchair position. To such opinions can be added the appalling posture that the average stroller offers a child, as does most other children's furniture. The spines of babies do not have the curves which they acquire later, but we do not appear to acknowledge that there will be a change and we never provide for the postural support that the spinal development a growing child requires.

Normal children can and do wriggle free of most of their seated confinement. They have ingenious ways of relieving their postural stresses. (See figs. 17 to 23) However, disabled children cannot free themselves from such confinement and must stay put day after day, for weeks, months and then years. It does seem that nothing much changes with their seating as they grow other than that it gets bigger.

When it comes to football, netball etc, anyone sustaining a sporting injury will have the most sophisticated resources available, and an application of professional energy which is not applied to seating.

Typical strollers and a standard wheelchair.

Figure 45 *Standard wheelchair*

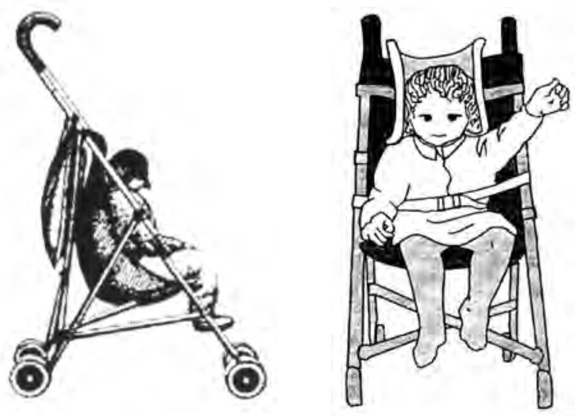


Figure 44 *Typical Strollers*

Children and Children With Physical Impairment

Prolonged poor positioning of the spine results in spinal damage and deformities. Poor posture greatly inhibits the performance of tasks such as writing, drawing and use of educational equipment, which in turn results in deficiencies in learning. Poor health and poor respiratory function may be brought about by restriction of the thorax and abdomen – the postures they assume in conventional seating.

In disabled children, poor posture and bulky cumbersome wheelchairs inhibit socialisation. Wheelchairs can form a barrier for the disabled child between them and their social group. They cannot see and communicate with others easily because of the bulk of their seat. Spontaneously relating to peers is difficult, e.g. turning around in class to talk to someone behind them is impossible.

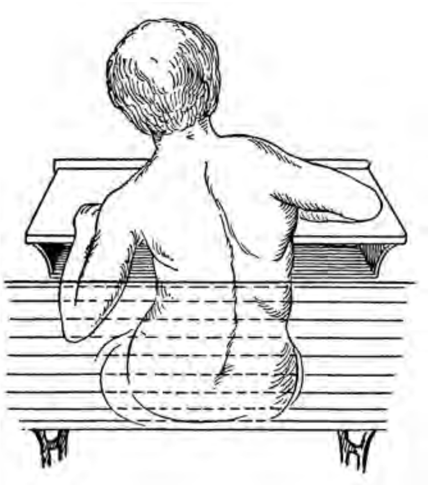


Figure 46

D.Zacharkow, Posture, Sitting Standing 1988

We knew last century what this seating does to children

Figure 47

Conventional Seat

Figure 48

The Bambach

Little has changed here

A new approach
A great improvement

Figure 49

Conventional Seat

Figure 50

The Bambach

Special Considerations for the Child With Cerebral Palsy

Pamela Stewart and Gordon McQuilton, in their article 'Straddle Seating for the Cerebral Palsied Child' (Physiotherapy UK, 1987) say the following about the use of conventional seating for children with cerebral palsy:

"When the cerebral palsied child carries out activities seated in this conventional position, there is a tendency for the sitting posture to deteriorate. We have noted that the extension of the hips, retraction of the shoulders, and flexion of the upper limbs are common, and usually result in associated lateral instability and loss of mid-line symmetry. External supports can control unstable posture, but will often have little effect on the intrinsic postural imbalance resulting from the child's condition."

Very often, having stabilised the sitting posture by various means, the result is often a position from which it is difficult for the child to work.

Stewart and McQuilton are supported by so many researchers and therapists, it is disappointing that so little real innovation has come forward in the way of seating to change the situation! An Occupational Therapist from Cairns, Australia – was determined to find a way of positioning children correctly. She believed that the progress of these children would be impaired unless they found a way to improve their posture and in so doing give them improved function. She relentlessly sought a seat that gave their patients the desired posture a seat that yielded a position which 'anchored' the pelvis in its upright position. Her constant enquires to colleagues resulted in their being told about The Bambach. The outcomes are documented in the paper by Debbie Michael and Barbara Houston "Evaluating the Use of The Bambach to enhance functional outcomes in a disabled client group" presented at the 37th Annual Conference of the Ergonomic Society of Australia Inc. 2001 and published in the proceedings of the conference.

She relentlessly sought a seat that gave her clients the desired posture, a seat that yielded a position which 'anchored' the pelvis in its upright position.

Daniel, a Cerebral Palsy sufferer, is receiving refreshment. Note that when on The Bambach his pelvis is supported in its upright position. His hips are in abduction and external rotation so that he can now achieve tasks with good posture and easy normal movement. Compare this to the difficulty he experiences performing the same task when seated on a conventional seat.

Comparing The Bambach with Conventional Seating


CONVENTIONAL SEAT


THE BAMBACH

Danielle – Cerebral Palsy

FAR LEFT: Danielle using a conventional classroom chair, showing how she has to move to the edge of her seat and lean over to perform her work. This position is one of postural stress, with her spine in a collapsed "C".

LEFT: Danielle's posture corrected, pelvis upright and neck in normal position, she has improved functional ability, less postural fatigue.


CONVENTIONAL SEAT


THE BAMBACH

Patrick – Spondyloepiphyseal Dysplasia Congenita

FAR LEFT: Patrick in his wheelchair, showing thoracic kyphosis, bilateral shoulder protraction and elevation causing shoulder fatigue, head protraction, loss of spinal curves. The sheer bulk of the wheelchair in the classroom causes difficulty with mobility and access to resources.

LEFT: Patrick in The Bambach with an upright stable pelvis and improved posture giving his head and shoulder position full plantar contact. The seat optimises his comfort in correct posture and avoids the risk of further deformity. The Bambach maximises his activity rather than inhibiting it.


CONVENTIONAL SEAT


THE BAMBACH

Luke – Cerebral Palsy

FAR LEFT: Luke, in his wheelchair, having obvious difficulty in operating his computer. The visibility of, and his access to, the equipment are very poor, as is his position, which is typically the inactivating position forced by wheelchairs.

LEFT: Luke using The Bambach at his computer. He is now in an active position with good posture, good functional ability to reach and manipulate the equipment. His chest is open for improved lung function, and he has easy mobility using his feet on the floor.


CONVENTIONAL SEAT


THE BAMBACH

Ruby- Muscular Atrophy

FAR LEFT: Ruby on her conventional classroom seat. Her lumbar curve is flattened, her head, neck and shoulders statically held out of natural alignment in order to work. The thoracic spine is in contact with the seat back. This is poor posture, resulting in difficulty performing fine motor tasks. Poor posture puts Ruby at risk of kyphotic spinal deformity and fatigue.

LEFT: Ruby on The Bambach, with pelvis secure in its natural position, which enables her spine to assume and maintain its natural curves. Her centre of gravity is now over her ischial tuberosities, her shoulders are relaxed in natural alignment. She now suffers less fatigue, has better function of lungs and abdomen. Her posture facilitates fine motor skill function.

Comparing The Bambach with Conventional Seating

CONVENTIONAL SEAT

THE BAMBACH

Nathan- Spina Bifida

FAR LEFT: Nathan using typical school seating, with poor results for his posture. His spine and abdomen are collapsed, with his head protruding to enable him to see work. His shoulders are elevated statically, his functional ability poor.

LEFT: Nathan on The Bambach, his postural deformities corrected, his head and neck in natural alignment. He has greatly improved function as well as morale. He can pivot in all directions, eliminating trunk rotation.

CONVENTIONAL SEAT

THE BAMBACH

Travis – Down's Syndrome

FAR LEFT: In his classroom chair, Travis's spine is collapsed as his pelvis tilts back. The back of his head and neck are in a poor position as he tries to perform his work. In this forward-leaning position, Travis tires and slumps.

LEFT: On The Bambach, Travis's spinal curves are corrected, reducing spinal stress. The position of his head and neck are restored to natural position, which allows his shoulders to relax, the shoulder blades resting on the rib cage. This gives Travis a better opportunity to perform writing, reading and other tasks important to his schooling and development.

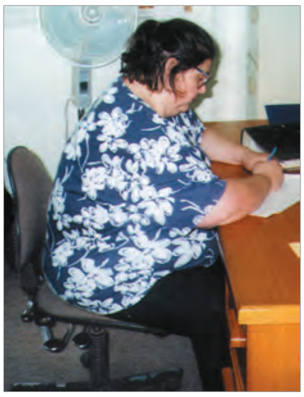
CONVENTIONAL SEAT

THE BAMBACH

Kerryn – Mild Cerebral Palsy - Scoliosis

FAR LEFT: Kerryn in classroom chair sits with rounded upper and lower spinal curves, her head protruding, shoulders slumped. There is risk of worsening her scoliosis. Poor postural stability and postural stress causes Kerryn to slump, making it difficult to concentrate on her work and to perform fine motor skills. She tires easily.

LEFT: Kerryn on The Bambach, her spinal curves have maintained position. She now does not 'slump' over her work due to fatigue, and with improved head and shoulder position her handwriting has improved as has her concentration and her level of fatigue is lower. Kerryn is able to achieve and maintain symmetry, so the risk of worsening her scoliosis is diminished.



CONVENTIONAL SEAT

THE BAMBACH

Rhonda – Office Worker

FAR LEFT: Rhonda at clerical work using a conventional, flat office seat. Her pelvis is tilted back and her spinal curves lost; her head and neck are distorted from the neutral position. This is a position of postural stress resulting in neck and shoulder pain.

LEFT: Rhonda on The Bambach, her spinal curves restored to their neutral position, her head, neck, shoulders and back in a position of least spinal stress. Her functional position is much improved.

COMPARING THE BAMBACH WITH CONVENTIONAL SEATING

CONVENTIONAL SEAT

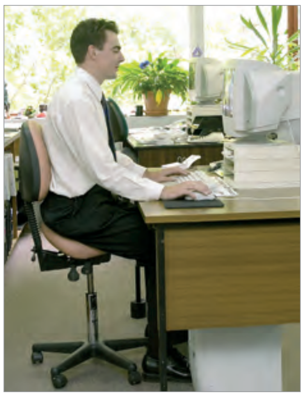
THE BAMBACH

Robert – Musician

FAR LEFT: Robert in his conventional, musician's seat. His pelvis is rotating backwards, flattening his lumbar curve; his abdominals are inactive, and he has poor head, neck and shoulder posture.

LEFT: Robert on The Bambach, his lumbar lordosis restored. His head and neck are now in good alignment, his shoulders relaxed, his arms and hands in optimal functional position.

CONVENTIONAL SEAT



THE BAMBACH

Anthony – Computer Operator

FAR LEFT: Anthony sitting on a conventional seat which results in a slumped posture with a collapsed spine, head poked forward and restricted arm movement.

LEFT: Anthony sitting on The Bambach showing improved, upright posture, head in, neutral position, improved function for arms and hands.

CONVENTIONAL SEAT

THE BAMBACH

Dr Distolesi – Dentist

FAR LEFT: Showing dentist seated on a conventional seat and demonstrating the curvature of spine that a flat chair causes.

LEFT: Showing the dentist and his assistant seated on The Bambach and demonstrating the benefits that an upright posture brings to health professionals.

CONVENTIONAL SEAT

THE BAMBACH

Dr Thyne – Dentist

FAR LEFT: Dr Thyne on conventional dentist's stool. Note hunched position of shoulders and the outline of his back in a 'C' shape.

LEFT: On The Bambach Dr Thyne's shoulders are now relaxed, his lumbar curve restored, his head position improved with greater access to his client's head from above. His assistant is still in a "C" position on her conventional stool.

Comparing The Bambach with Conventional Seating


CONVENTIONAL SEAT


THE BAMBACH

Sam – Kindergarten Child

FAR LEFT: Showing how a child using conventional seating designed for small children adopts a very poor position for functional work with a collapsed spine.

LEFT: showing how the same child when seated on The Bambach adopts an upright posture with spinal curves restored and functional position much improved.


CONVENTIONAL SEAT


THE BAMBACH

Laura – Schoolchild

FAR LEFT: Laura sitting on a conventional seat which results in a slumped posture with a collapsed spine, head poked forward and restricted arm movement.

LEFT: Laura sitting on The Bambach showing improved, upright posture, head in, neutral position, improved function for arms and hands.


CONVENTIONAL SEAT


THE BAMBACH

Carolyn – Secretarial

FAR LEFT: Computer user on conventional seat showing how the spine collapses in this position resulting in poor posture position for the head (protruded forward) neck (collapsed) and awkward position for work.

LEFT: Computer user on The Bambach with good posture and in a good functional position with shoulders, arms, hands, head and neck, all in mid range.


CONVENTIONAL SEAT


THE BAMBACH

David – Cerebral Palsy

FAR LEFT: Showing collapsed spinal curves.

LEFT: Corrected spinal curves to the natural curves showing improved posture.

THE FUTURE FOR SEATED SPINE

BY MARY GALE

My hope is that we will become aware of how their own bodies work, and how to be as strong and healthy as possible. This can give the ability to avoid furniture which creates postural stress and deformity, and to choose seating which can give us the best ergonomic posture.

Most people now understand our power to choose the good nutrition and exercise which can give us healthy bodies so we get the best out of their work time, leisure and home life.

So I am hoping that people will choose to understand how their bodies work and that the healthy choice for sitting will expose the fact that the conventional seating on offer for offices, travel, lounge chairs and in fact most seating is actually harmful.

People will then recognise that seating must offer a real opportunity to sit upright with a natural "S" shape spine and upright pelvis and that this not only relieves and prevents postural stress and spinal deformity, but also lessens intradiscal pressure. It also must give symmetry and balance for active body function. Most importantly they will realise that this posture is governed by the position of the pelvis.

All of us, especially those of us with physical impairments, need to sit in the best posture possible to avoid deformities developing or deteriorating. The key to good posture, and the difference between a healthy "S" spine and a deformed "C" spine is the pelvis being secure in its upright, neutral position while sitting. They will then have the wisdom to choose seating for a healthy functional spine. The Bambach Saddle Seat offers these benefits.

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