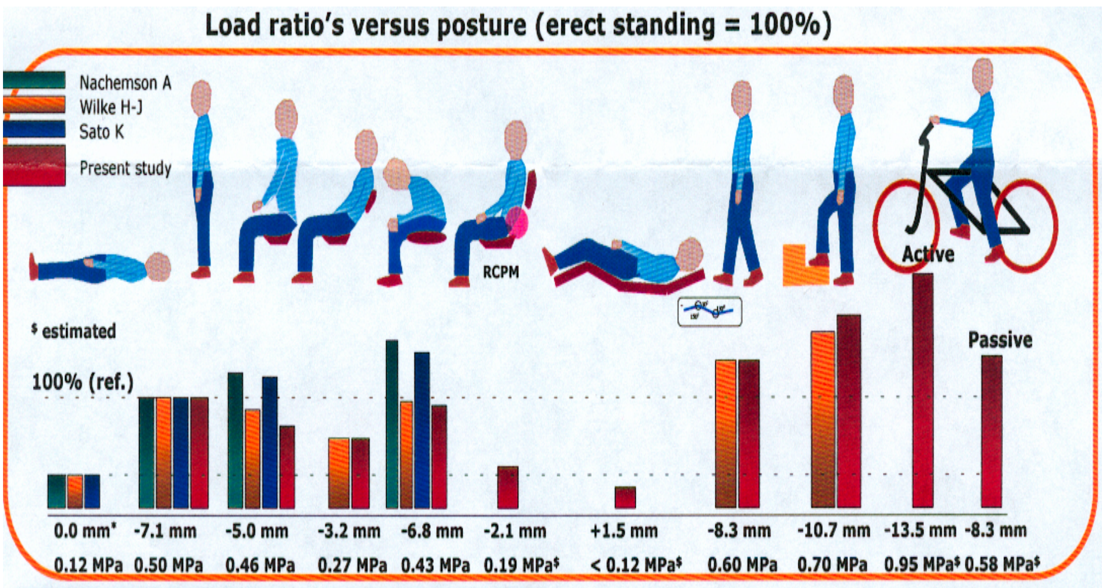
HOMO SEDENS - *The seated man and back complaints*

SEATED WORK – PHYSICAL STRESS – PROBLEM SOLUTIONS

As a physical therapist, I am often confronted with lower back complaints from patients. In 1988 this led to the founding of the Back Training and Advisory Centre, since next to the curative treatment of complaints there is actually no time to provide sufficient information to patients. Gradually I have come to understand that limiting physical stress plays a crucial role in limiting recurrent complaints and working towards a final solution. The sitting posture of a person plays an obvious role here. Technical interest, combined with training and scientific background, has led to product development in which ergonomic principles hold a prominent place. The "why" behind the use of anthropometric data is, in practice, often the most effective.

Homo Sedens by A.C. Mandal was used as the basis of this article.

Epidemiological studies have shown that people who work in a sitting position have a greater chance of suffering back problems. When, for example, the two positions of sitting and standing are compared, we see that when seated the pressure applied to the intervertebral disc is different as when standing (Nachemson, Wilke, Sato) The cause of this lies in the fact that, even when sitting straight up, the lumbar region of the vertebral column clearly loses the protective lumbar curve. The vertebral column in the lumbar region is flattened by at least 30 degrees. The prevention of a flattening of the curve in the lower lumbar region or the maintenance of a lumbar curve is therefore obviously important from the perspective of both prevention and cure In order to understand the problems that arise in the sitting position, it is necessary to study the anatomical changes that take place when a person changes from a standing position to a sitting position. The teaching of anatomy has never focused on more than "normal anatomical posture", which corresponds closely to a soldier's position when at “attention”. The reality is that most people have no interest in maintaining this position for any length of time. In fact, we can no longer regard ourselves as an erect species. It could even be said that Homo Sapiens has become a new species – Homo Sedens. This complete alteration of man's behavioural pattern, from being a hunter, fisherman and cultivator to a sedentary life bent over books, machines, desks and working in front of a computer screens has apparently placed a heavier load on the human back. Few people nowadays reach middle age without having experienced some back discomfort (Keegan).



When we go from the standing to the sitting position, the general view held is that we bend our hip joints 90 degrees. But the movement we make is more complicated than we think. The hips bend only 60 degrees and the vertebral column in the lumbar region is flattened by 30 degrees (Fig 1).

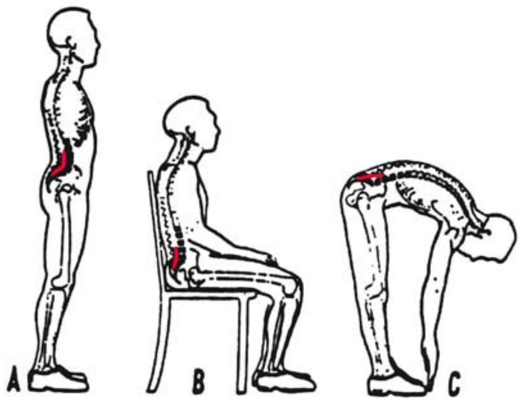
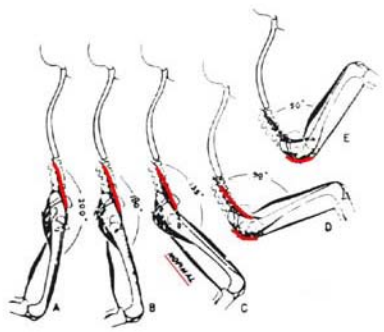


Fig. 1

Rotation of the Pelvis

This rotation of the lumbar region with the associated 30-degree straightening of the curve in the right angle sitting position is extremely important. Keegan shows the rotation in the lumbar region and hip joints in greater detail below (Figure 2).



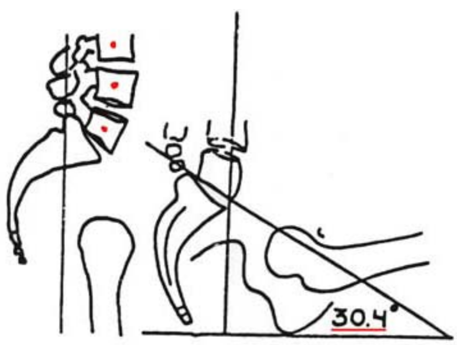


Fig. 2

Fig. 3

C illustrates the relaxed posture we adopt when we are lying on our side. The hip joints are bent 35 degrees (or 135 degrees if the upright position is 180 degrees). In this resting or function position of the hip joints, the muscles at the front and the back of the thighs are in relaxed balance. Here our back has a backward concave curve. When the hip joints are bent upwards, as in D and E, the muscles at the back of the thighs (hamstrings and gluteal muscles) are tightened. These are attached to the back of the hip and seat bones and thereby produce a rotation of the pelvis around a transverse axis. The lumbar curve is therefore altered in D to a slight convex curve, while in E the convexity is more pronounced. The muscles at the front of the thighs are quite relaxed. If the hip joints are straightened or even bent backwards (B), the muscles at the front of the thighs tighten (m. quadriceps and iliacus) bringing about an increase in the concavity of the lumbar curve. Standing straight up therefore increases the lumbar curve due to pelvic rotation. B corresponds to the standing position, and on moving to the right-angled sitting position in D, at first a bend of 60 degrees in the hip joints is produced an then a flatting out of the lumbar curve by about 30 degrees.

The flattening of the Lumbar Curve

The seated working position of 1,035 school children was carefully examined by Schoberth. In a normal, relaxed sitting position he found that not one of them could maintain the lumbar curve. If the children were told to sit up straight – i.e. with conscious muscular tension – he found that only 30.5% of them could maintain a lumbar curve by contracting muscles. Children are particularly well suited to illustrating the problems of the sitting posture since their backs are more flexible than adults' backs. Even by the age of 30/40 the flexibility of the back is reduced considerably and the marked lumbar curvature apparent in children is no longer visible – not even with the help of the farsightedness brought on by middle age.

Loading of the Discs

When stooping, the front edges of the lumbar vertebrae are pressed toward each other with a force of 50-100 kg. and the pressure is shifted backwards with equal force. Ninety-five per cent of chronic back pains are localised in the lower lumbar region and sufferers characteristically find they cannot sit in an upright position for any length of time. Even for a healthy back, 30% seems to be the maximum load the back can take for longer periods (Keegan). In Scandinavia, Akerblom in particular has investigated the problems posed by the sitting position. Figure 3 shows how the pelvis rotates and the lumbar curve changes when moving from a standing to an upright sitting position.

Disc-loading according to Keegan:

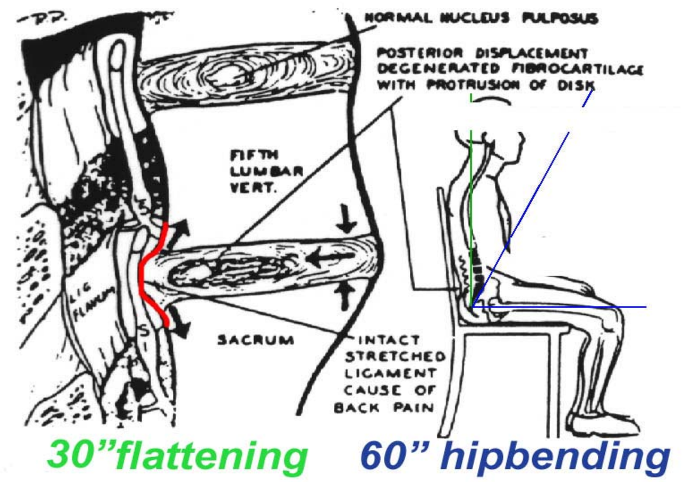


Fig. 4

Working when seated – The Chair.

The chair seat should have a comfortable height above the floor. The seat should be wide and deep enough so that approximately 2/3 of the thigh is supported. The back should be supported in the lumbar region - not high up the back. The height of the chair should be equal to the length of the lower leg minus 3 cm. The hands should be able to slide easily under the thighs. Otherwise the blood circulation will be restricted. The seated position will place the least pressure on the back (discs) when the lower back is supported by a slight convex curve, just as in standing position. For the thoracic region of the spine no support is needed. Only when leaning back 20 degrees does this play a role (Goossens 1994). The shoulders must be supported during desk work so that the muscles around the neck do not pull on the cervical vertebral column and the head too hard. Also, the head must not be tilted too much. Here, too, cervical disc-loading and muscular traction, periosteal irritation on the cervical lumbar bend and linea nuchae (back edge of head) will often cause pain and/or reactionary hypertonia, in turn causing things such as persistent headaches.

The right-angled work position (sitting straight up)

1 The most obvious error of this position is that no healthy child can maintain it for more than a few minutes at a time. Such muscular loading (M. Iliopsoas) and straightening of the trunk (Erector Trunci) is not possible and undesirable to maintain (Staffel). The lumbar curve is the same as in the standing position, while there is an increased curve due to the tightening of the front Rectus Femoris and the Iliacus. In a sitting position, the hip is bent and the lumbar vertebral column can be flattened more easily (Akerblom/Keegan/ Schoberth). In the relaxed position, an approximate 60-degree flexion in the hip and 30-degree flattening in the lumbar curve was observed.

2 This position is not one for working but for backward-inclined rest. It can only be used when listening to lectures, discussions, watching films or driving a car, etc. When we must work, we soon move forward on the seat to reduce the right-angled bend of the hips to one of 60-70° flexion.

3 In the upright sitting position, the eye is 50-60 cm away from the page in a book. Children can see best at a distance of 15-20 cm. That is why children are often observed with their nose practically in a book. For this reason, it is impossible to get children to sit straight when reading and writing. Learning to read and write is, presumably, one of the most difficult tasks man is ever confronted with.

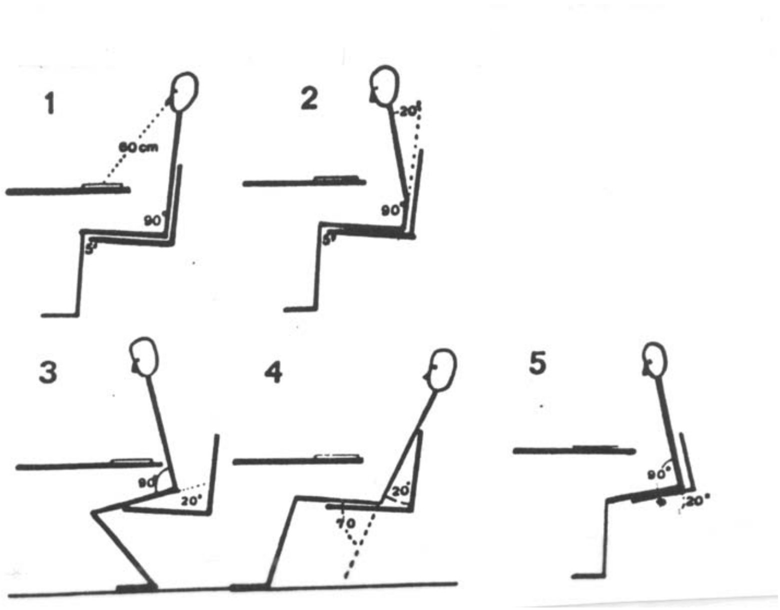


Fig. 5

How to avoid the most uncomfortable sitting positions

1 Actually, the right-angled sitting position is a backward inclined resting position. Because the distance of the eye from a page in a book is around 50-60cm, precision work cannot be carried out. The rightangle position loads both hips and the lumbar vertebral column in extreme positions (remember that the resting position of the hips is with a bend of 45 degrees). Therefore the position feels uncomfortable and, after some time, possibly painful.

2 As soon as one begins work, such as reading or writing, the eyes have to be brought to a reasonable distance from the book and this can be done by bending the lower back. In this example a modest bend of about 20 degrees has been assumed. This bending is localised mainly in the 3rd, 4th and 5th lumbar vertebral discs (L3, L4, L5), while the remainder of the back is much less flexible. Most slipped discs are located in this area. Even with this limited bend, the back begins to round, muscles, joints and ligaments become over-stretched, and there is increased backward pressure in the 3rd, 4th and 5th lumbar discs.

3 In order to avoid this rounding of the back, most people move to the front of the seat so that the thighs slope about 20° below the horizontal plane. Thus the worst 20° of rounding is avoided and it is possible to sit in over the table with a somewhat straight back. By bending the neck, the eyes are brought down to a distance of about 20-30 cm from the book. However, the front edge of the seat cuts into the muscles of the thighs and restricts the flow of blood to the legs and possibly pushes on the Iscia nerve. The position provides good mobility and it is principally a balanced position on the front edge of the seat.

4 For resting, lectures, discussions, film viewing and less demanding work, the posterior usually slides forward on the seat. The bend in the hips is thereby reduced from 90 degrees to about 70 degrees and the hip joints are nearer the 45° resting position. The tightening in the back and the backs of the thighs is reduced. But the eyes are 60-70 cm from a book and precision work can therefore not be carried out. However, the smooth seat surface of a school chair makes it difficult to sit in this manner and so the schoolchildren tip the chair on its back legs in order to increase the grip in the backward sloping seat.

5 When we were children, we all learnt the trick of tipping forward on the front legs of a chair. But because of a good upbringing, we have since forgotten the advantages of this position. By tipping the seat forward by 20°, the bending in the back that causes most of the load is avoided - as in 3.

To simulate or achieve this effect, so-called wedge cushions are very useful (Fig.5a). The best angle for this wedge is disputed. It varies between 12° and 30°. Depending on the size of the seat, the slickness of material and alternate support possibilities (such as kneel-chairs), a positive contribution can certainly be made in this respect, particularly when the problem becomes acute. People also train the back muscles while they sit or work. Note: you have to get used to this; gradually add 15 minutes a day. Also consider the possibility of adjusting the desk chair to provide an active incline. Unfortunately, many desk chairs do not have this capacity and the NEN 1812 tells you nothing about this (as yet). When purchasing a desk chair, one should therefore…

take these things into consideration with an eye to the future.

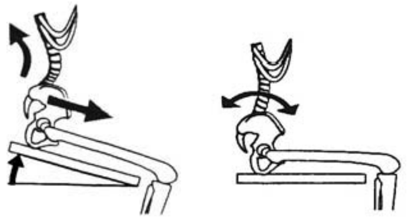


Fig. 5a

Fig. 6

Figure 6 (Keegan) shows the relationship between the movement of the lumbar vertebrae in relation to the sacrum (and therefore also the pelvis 2-3° leeway) (Vleeming/Snijders).

C is the resting position. A and B approach this position, while in D and E there is a much greater load due to a larger curve in relation to C. Sitting straight up (D) - reading/writing position (E). The closer we get to the position in C, the more we protect our back. Studies have shown that the "tilting chair" actually provides greater results with respect to reducing the load on the cervical vertebral column.

The Tilting Chair (chair whose seat inclines forward = positive incline; Fig.7)

Fig. 7

The seat slopes 15° forward in contrast to the normal 5° incline back. Thus 20° of lumbar curve is saved. When you add the slope-to-table, there is a total savings of 30 degrees in the lumbar vertebral column. There is also less pressure on the cervical lumbar bend. At the same time, a more relaxed and balanced posture is obtained, giving greater mobility.

A disadvantage of this can be placing too much of a load on the knee joints, which are supported by a knee support. Advocates and opponents of this sitting position often defend their personal views on the subject. Experience shows that almost no one is aware of the fact that some chairs can be adjusted to create this position and so little use is made of it. Also, many chairs simply do not provide the possibility of adjusting to this position and "active sitting" is always more tiring than supported "passive sitting". In acute situations, people typically sit on the front edge of the chair automatically in order to reduce the load on the back!

Additional stimulation of active sitting can be achieved through sacral facilitation via stimulation on the musk. glutei. (back of chair sloping upwards, which should not affect the sitting depth (Snijders).

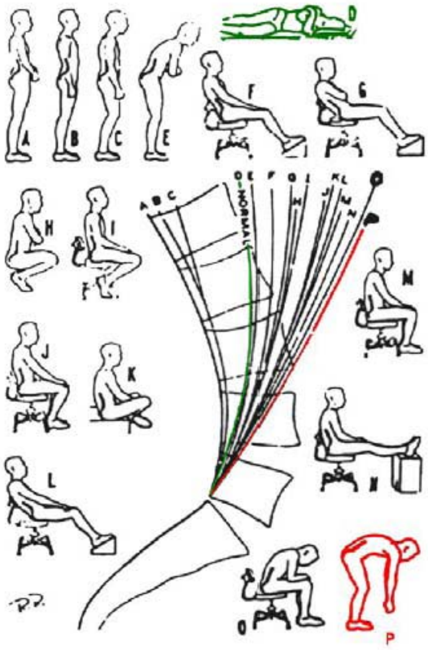


Fig. 8

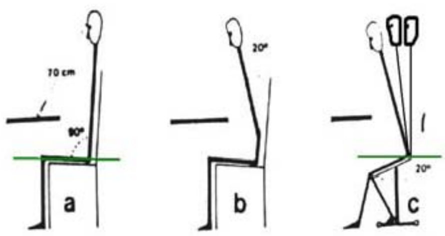
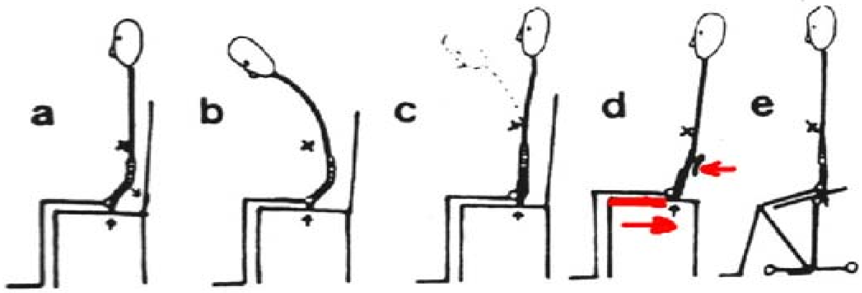


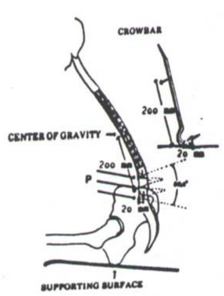
Fig. 9

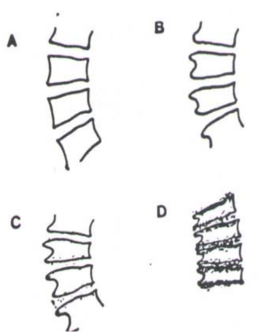
There is general agreement that position P is the most hazardous one for people with a tendency towards developing a slipped disc. This differs only slightly from position 0, which is the one that most children use for many hours a day. D is the relaxed resting position for the disc with a bend of 45° in the hip joints. See figure 5

When sitting in the right-angled, backward-inclined sitting position (a) it is possible to reach across the table in two ways. Either by bending say 20° in the lumbar spine (b) and so rounding the back and loading the discs. Or by stretching about 20° in the knees (c) as with a tilting chair, and so maintaining a straight back in the bent centre of gravity should lie just above the supporting surface. For the upper part of the body, the centre of gravity lies in front of the 9th thoracic vertebra. The supporting surface lies immediately under the seat bone. When sitting on an ordinary chair (a) there is a tendency to rotate the pelvis backward because the centre of gravity lies about 5-10 cm behind the seat bone (Akerblom). If the seat is smooth, there is nothing to prevent the pelvis from rotating backwards. To regain equilibrium, one has to bend forward in the lumbar spine (b) thus moving the centre of gravity 5-10 cm forward to a position just above the seat bone. The back is carried at this point by ligaments and sinews (mainly lig. flava).



In the right-angled sitting position (c) the entire spinal column is straightened up by considerable use of muscle power, thus bringing the centre of gravity forward over the seat bone. A permanent contraction of the muscles is, however, neither possible nor desirable because the muscles would be ruined within days. The curve obtained by this method is not an actual lumbar curve as most of the bend takes place in the lower part of the thoracic vertebrae (Schoberth and Akerblom). In the right-angled sitting position a retraction is often seen corresponding to the lower part of the shoulder blades. The position is almost identical with a soldier's position at attention and is similarly unsuited for anything other than display. To maintain the posture requires such large muscle force that it is not possible to do anything else. Within a few minutes it has to be abandoned because of muscle stretch. The tendency of the pelvis to rotate backwards can be counteracted by a low lumbar support (d), provided the friction of the seat is increased as well. But for the lumbar support to give a forward pressure there must be a corresponding backward force, which can only be obtained by tilting the seat back. But for each degree the seat is tilted backward, the back must bend an extra degree to get within a reasonable working distance. A more severe loading of the hip joints occurs, including increased pressure in the discs. With the tilting chair (e) the bending of the hips is kept down to about 60-70° and the turning movement in the pelvis remains at a minimum as the centre of gravity is just above the seat bone.





When bending forward in the sitting position, most of the movement comes from the region of the 3rd, 4th and 5th lumbar discs. In 25 people moving from an upright to a relaxed sitting position, Schoberth measured an average bending of 30°. Movement in the whole chest region of the spine is minimal due to the stability given by the ribs. This stiff portion of the spine functions as a lever. The centre of gravity corresponds to the 9th thoracic vertebra (T 9) and the distance from here to the lumbar vertebrae is, for example, 200 mm. The movement takes place around the disc - marked here by a black dot - and the distance from the centre of the disc to the anterior edge of the lumbar vertebrae is about 20 mm. The force on the anterior edge is thus increased ten-fold, and the pressure here can be several hundred kilos. In children the pressure is assumed to be no greater than 50-100 kg when in the normal sitting position. But since this pressure is maintained on the soft bones of the child for many hours of the day, it is not surprising that the first signs of disc degeneration appear here as bone projections. Further compression of the edges often causes calcareous deposits to occur in the disc as shown previously. For comparison purposes a crowbar is illustrated (see figure 8) showing how the same leverage is used when pulling out a nail. The power is hereby increased tenfold. We also know the pressure relationships between the different loads, cf. Nachemson.

Active/Passive Sitting

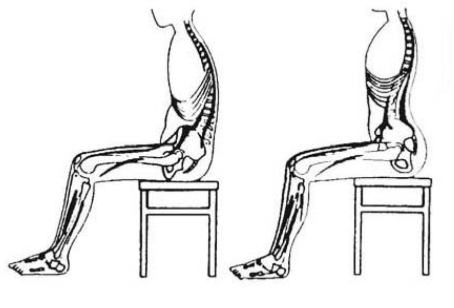
In summary, there are two ways to sit in a chair: *Active sitting and passive sitting.*

Active sitting provides a protective lumbar curve in the lower back, expends considerable energy and can therefore not be maintained for long, unless one is trained to do so. Active sitting will, in principle, cause virtually no disc loading, so there is no danger of incurring pain when sitting for long periods. But there will eventually be a feeling of tiredness due to the exhaustion of energy sources for the mm. Erector Trunci in particular. But, again, an advantage of this position is that the back muscles are trained while working. But, as mentioned earlier in this article, this must be built up in phases. Active sitting can therefore not be kept up for a long time; after a while, we automatically revert to passive sitting (Fig. 14).

Passive sitting is much less tiring because it expends little energy. The big danger, though, is that it quickly puts a load on the discs, which practically happens in every situation due to the lack of real lumbar support or the non-use of such a support when it is there (slumping/sliding bottom forward). Probably in 90% of car seats there is little or no "real support". When sitting on a desk chair when working at the computer, it is of course essential that a person actually *uses* the lumbar support provided, otherwise you could just as well sit on a kitchen chair. Usually, people

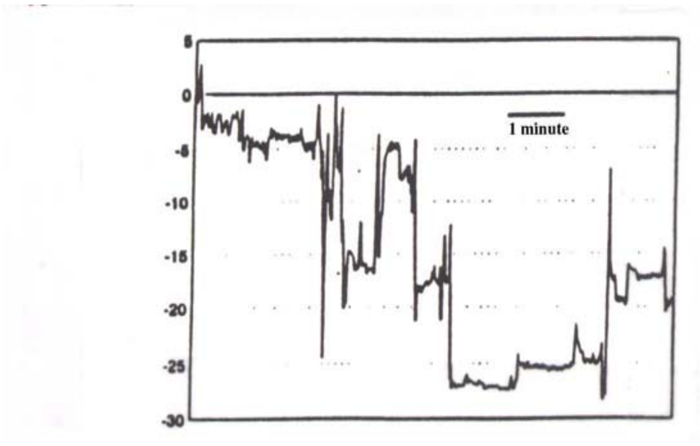
sit a little forward, causing the lumbar vertebral column to bend forward and thus resulting in pain.

Fig. 13



passive seat active seat

A study of the effects of a lumbar (roll) support was published in one of the leading trade journals for orthopaedics: SPINE / volume 16 / no. 10 / 1991. In the study, significant differences were named, with the exception of two orthopaedic ailments. In his doctoral dissertation, Goossens (1994) indicates that during a sitting test lasting 55 minutes the lumbar curve can clearly not be maintained. Also, each sitting position, regardless of what chair was used, clearly produced more flattening of the lumbar curve than the standing position.



lumbar curve

less lumbar curve

Problem Solutions

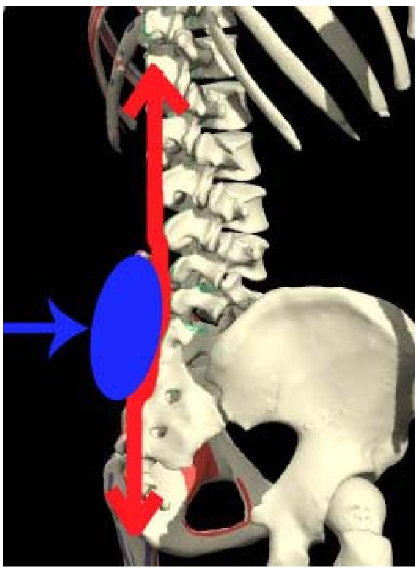
Because of regular confrontation with his problem in real situations and the "tinkering instinct", in addition to the scientific side, gradual innovation and product development has occurred. As long as four years ago, the LordoSit and ActiveSit (correction cushions for an active and passive seat) were developed. They can often improve large problems with minimum financial investment necessary.

With this experience, the **Dynamic** was developed.

The Dynamic ®.

The Dynamic is a stool that has most of the characteristics named in this article. The hypothesis of the curative effect of the Dynamic is also written in the sponsored attachment of Back Quality Ergonomics: see www.worldcongresslbp.com that takes place in November 2007 in Barcelona (Spain).

The Dynamic work stool is specially designed to give maximum stabilization to the LBP part of the spine and SI joints. Due to the "patented scissor-mechanism" the backrest of the Dynamic **goes** automatically **into** the lower back and stabilizes the lordosis of the LBP. Due to the fact that the lumbar support (not too big) exact fits the lordosis, it provides the support of the spine at the level of L4L5 and SI joints. On the other hand the stool facilitates the active position with a positive angle of 3 degrees in order to give a better balanced position for the upright sitting person.



Hypothesis: curative and preventive effects

1 The stabilization is reached through the pressure on the ligamentum thoraco-lumbalis, where the underlying muscles are the thickest. The backrest provides the necessary pressure on that part.

2 The other hypothesis is that due the fact that the backrest comes into the back, and not vice versa as by all other stools, the sitter knows that he has to keep his back slightly hollow, otherwise the backrest does not fit. The sitter contracts his lower back muscle group as a reflex without knowing it.

All this stabilizes the spine in the passive seating position. Also, we believe that by changing the active and the passive positions the user decreases the creep in the discus inter-vertebralis.

Characteristics of the DYNAMIC®:

The Dynamic gives the user a protective lumbar curve in both the active and passive sitting positions. As a result, in *both* of these sitting positions the load placed on the spinal column is kept to a minimum.
The primary position of the seat is at a positive angle of + 3° (positive incline) and for the passive seat it changes to a negative incline of -6° (negative incline).

The Dynamic can be adjusted to a person's weight so that a switch from the active to the passive position can be made, fully automatically, simply by shifting the weight, without having to pull on any levers. Alternating the sitting position like this is known as dynamic sitting.

Fig. 15

Seat A: activates the lumbar curve
The Dynamic: facilitate position + 3°

Seat B: prevents flattening of the lumbar curve
The Dynamic: correct position - 6°

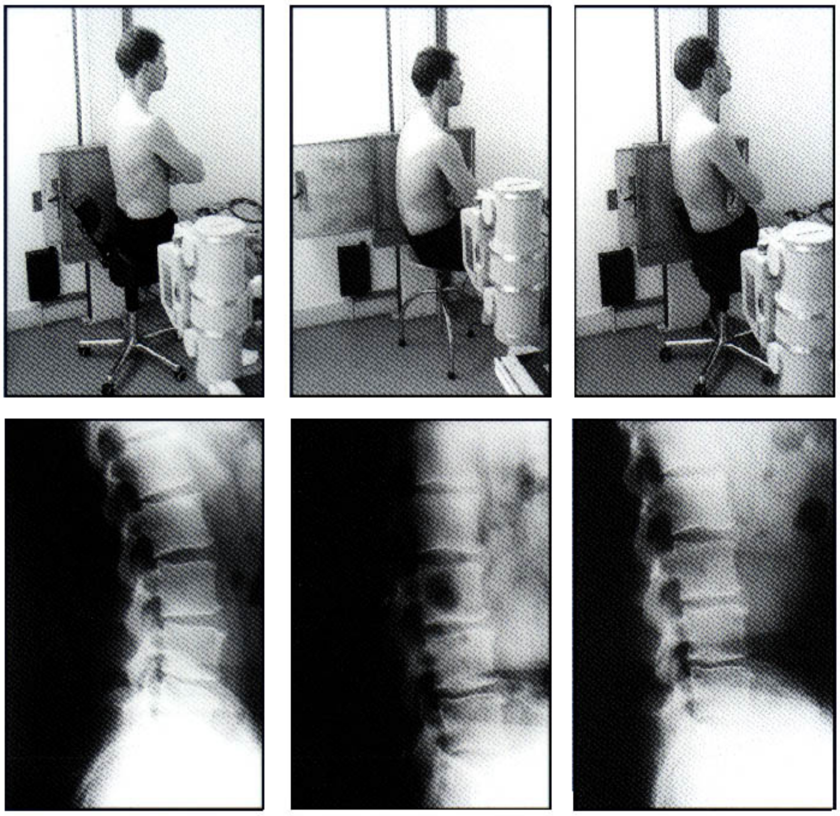
The stool has a saddle-shaped seat, which facilitates opening the hip angle and, as a result, makes it easier to maintain the lumbar curve. The saddle is produced in two different sizes providing either more or less leg contact with the seat surface. The back of the seat raises a little, again facilitating the formation of the lumbar curve via the sacrum. The front of the saddle is somewhat rougher to provide grip and counter sliding off and also rises slightly. The thickness of the material and the resistance to depression or hardness (s.g.) has been selected so that in the passive position the circulation of blood in the thighs is not cut off and there is no irritation to the thighs.

The lumbar support is kept especially small. Soft parts to not need to be supported; the focus is on keeping the pressure in the disc low. Due to the mere 14 cm of lumbar support, the level of the segment to be supported, usually L4-L5 / L5-S1, can be better specified. Higher support is only effective after 110°. Because of the smaller lumbar support, the person has greater mobility and therefore will be less likely to slump in the seat. The thickness and hardness of the seat have been chosen to provide "real support".

The height of the Dynamic can be adjusted through a gas spring. On the front there is a knob/slide adjustment with which the tilt mechanism of the system can be adjusted to a person's weight. The lumbar support can be adjusted in both the horizontal and vertical plane.

By taking X-ray photos, a clear difference was made visible between active sitting (A) and the passive sitting on a conventional stool (B). The corrected passive seat with the lumbar support (C) results in less flattening of the lumbar curve. Photos B and C look very similar, as described in the literature (Frey / Tecklin) partly due to inhalation at the moment the photo was taken. Lowering the disc pressure, muscular relaxation and less traction force on the ligaments (particularly lig. long. post.) also result in less irritation in these (pain) structures

Fig. 16 X-ray photo taken during seating



A. Active B. Passive C. Corrected Passive

The Dynamic was designed for people that perform a range of duties in their work but who also have to remain mobile. Specifically: the medical professions such as dentists, dental technicians, surgeons, pharmacists, veterinarians, physiotherapists, anesthesiologists, general practitioners, lab technicians, as well as reception staff, sorters, horticulturalists and many other professions in which work is performed both standing and sitting.

Fig. 17 Dynamic in the practical situation

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***Design Criteria for Furniture*:**

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***X-ray photos*:**

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