

original Society of Massage and Medical Gymnastics letterheads.¹⁰

I am sure that this is enough for us to appreciate, all that has happened and I hope that the courage, enthusiasm, vigour and ingenuity of our fore-runners will spur us on to an even greater future.

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A Preliminary Study of Chairs with Forward-sloping Seats, and Sitting Postures

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SUMMARY

A radiological study of sitting posture is reported. Lateral views of the spines of subjects were obtained whilst the subjects adopted each of three postures. The postures adopted were: standing erect at a table, sitting on a conventional typist's chair at a table and sitting on a prototype chair at a table. The prototype chair had a forward tilting seat and a stabilising knee platform.

Previous researchers have suggested that more erect sitting postures may be obtained by using chairs designed to permit users to sit with an angle of hip flexion greater than 90°. The study described lends support to this view and the results are discussed with reference to current research on seating.

OPSOMMING

'n Radiologiese studie van die sittende postuur word beskryf. Laterale aansigte van die werwelkolomme van persone is geneem terwyl hulle drie houdings opgeneem het. Die houdings was: regop staan langs 'n tafel, sittend op 'n gewone tikster se stoel en sittend op 'n prototipe stoel langs 'n tafel. Die prototipe stoel het 'n sitplek wat skuins staan en 'n stabiliserende knie platform.

Voorafgaande navorsers het voorgestel dat 'n meer regop sittende posisie kan verkry word met stoele wat die gebruiker toelaat om te sit met heup fleksie van meer as 90°. Hierdie studie ondersteun die mening. Die bevindinge word bespreek met verwysing na huidige navorsing op sitplekke.

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INTRODUCTION

A pelvic tilt chair (Figure 1) consists of a forward sloping seat with an integral knee platform placed below and in front of it. The mass of a sitting person is



Fig. 1. The pelvic tilt chair concept.

distributed between the two surfaces and load is taken by both the ischial tuberosities and the shins.

A forward tilting seat permits anterior tilting of the pelvis which, according to both Mandal¹ and Keegan,² maintains the shape of the lumbar curve when sitting. Conversely, conventional chairs with horizontal seats lead to posterior tilting of the pelvis accompanied by a flattening of the lumbar curve or lumbar kyphosis. Mandal¹ suggests that this is a major cause of poor sitting posture and may be implicated in the incidence of back pain in seated workers.

This paper describes the results of an investigation into the shape of the lumbar curves of subjects sitting in a prototype pelvic tilt chair. The research was carried out as part of a programme aimed at identifying methods for the reduction of low back pain amongst hospital employees.

Although the problem of low back pain is complex, Keegan² describes how flattening of the lumbar curve causes "anterior wedging" of the lower lumbar intervertebral discs resulting in pressure on the posterior spinal ligaments and/or nerve roots and pain. This implies that a chair designed to preserve the shape of the lumbar curve in sitting might have beneficial effects in

reducing low back pain in those patients where flattening of the lumbar curve is a causative factor.

The above considerations led to the design of a prototype pelvic tilt chair based on the concept depicted in Figure 1. A first stage in the evaluation of the prototype chair was to document the shape of the spines of subjects sitting in it. An approach based on the use of X-ray photography was employed and is described below. Details of the construction of the prototype, the design philosophy and questions concerning the acceptability of such chairs as alternatives to conventional work chairs are beyond the scope of this paper.

METHOD

Five healthy subjects, age range 22-30 years were selected, of which 3 were male and 2 were female. Lateral X-rays of the lumbar region were taken such that images of the sacrum, lumbar spine and lower thoracic spine were obtained.

For all subjects, lateral X-ray photographs were taken for each of three postures as follows:

1. Standing erect.
2. Sitting on the pelvic tilt chair.
3. Sitting on a modern typist's chair.

Throughout the procedure for taking the X-ray photographs, subjects were positioned at a table, adjusted to elbow height and given reading material. A reading task was chosen in order that the postures obtained under the above three conditions would have some

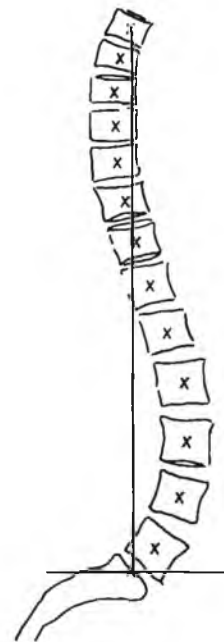


Fig. 2. The method for establishing the coordinates of loci along the axis of a spine. The x axis is taken to be the straight line distance from S1 to T5.

correspondence to the type of postures adopted by workers in their daily activities.

Tracings were then made of the X-ray photographs. These were used as the basis for extracting the data required to characterise the shape of the spines in quantitative terms. Two methods of quantitative analysis were employed:

1. After locating the geometric centres of the image of each vertebra, as illustrated in Figure 2, coordinate systems were constructed about the axes of the spines from S1 to T5. The coordinates of the loci were then established. Thoracic vertebrae above T5 were not adequately defined in the X-ray photographs to warrant inclusion in the analysis.
2. Radii of curvature were calculated at each lumbar vertebra. This is illustrated in Figure 3.

RESULTS

1. The data are presented in summary form. Figure 4 depicts the mean spinal shapes of the 5 subjects as a whole in each of the three postures. The different sizes of the subjects' spines were accounted for by expressing each set of coordinates for a particular subject and position in terms of its percentage of the spinal length for that subject. Spinal length is defined here as the straight line distance from S1 to T5 (Figure 2). These normalised data for each subject were combined for each posture to give the mean curves shown in Figure 4.

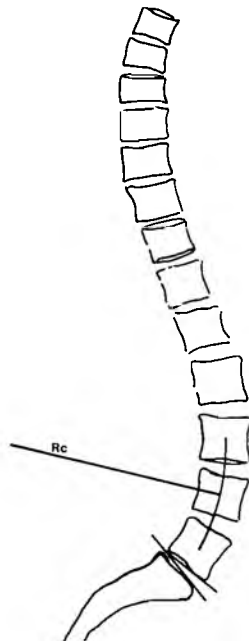


Fig. 3. The radius of curvature (R_c) of the lumbar spine at L4. Values of R_c were calculated for each of the lumbar vertebrae.

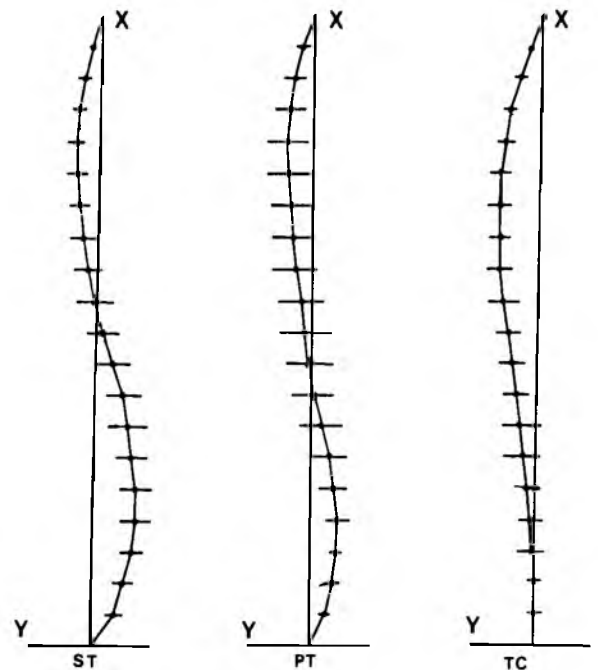


Fig. 4. The shape of the spines from S1 to T5 summarised over 5 subjects for each of three postures. ST = Standing; PT = Sitting on the pelvic tilt chair; TC = Sitting on the typist's chair.

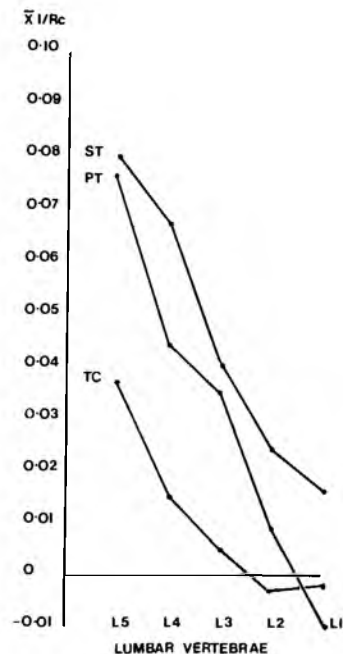


Fig. 5. Mean radii of curvature of the lumbar spine at each of the lumbar vertebra for each of the three postures. ST = Standing; PT = Sitting on the pelvic tilt chair; TC = Sitting on the typist's chair. Positive values of $1/R_c$ correspond to concave, or lordotic curvature and negative values to convex curvature.

2. Figure 5 depicts the mean radii of the curvature for all subjects at each vertebra from L5 to L1 in each of the three postures. The radii of curvature are plotted as reciprocals (i.e. $1/R_c$, where R_c = radius of curvature) to ease visualisation. Larger values of $1/R_c$ indicate greater curvature.

DISCUSSION

The data indicate a trend in the shape of the spines, beginning with a substantial concavity of the lumbosacral curve in the standing posture, to an almost completely flat shape in the traditional sitting posture. The shape of the lumbosacral curve when sitting in the pelvic tilt chair is intermediate, that is, the concave, or lordotic, shape is present although it is flatter than in the standing posture.

Keegan² suggests that the physiologically neutral shape of the lumbosacral curve is obtained when the angle between the thighs and the trunk is 135° . When sitting on a conventional typist's chair, this angle is approximately 90° . The pelvic tilt chair has a forward sloping seat angle of 30° which permits a user to sit with a trunk/thigh angle of 120° (Figure 1). In order to approach Keegan's 'ideal' angle of 135° , a forward slope of 45° would need to be incorporated into the design. This might be impractical for many of the tasks carried out by sedentary workers. However, the results of this investigation are in general agreement with those of Keegan² in terms of the influence of hip flexion on the shape of the lumbosacral curve. If it is accepted that lumbar lordosis is a desirable feature of the sitting posture of sedentary workers, then forward sloping seats clearly have a place in the design of office chairs — particularly where task and work space constraints require that an erect posture is adopted.

The data presented here would lead to the hypothesis that a pelvic tilt chair with a seat angle of 30° would be effective in reducing lower back pain in some instances, depending on the nature and cause of the pain and any underlying pathology.

Limitations of the present study centre around the artificiality of the experimental situation and the requirement that subjects adopt static postures during the X-ray procedure. Some method of sampling posture dynamically under more natural circumstances is required.

Additionally, the present investigations need to be extended to address wider issues concerning the ergonomics of implementing this concept. Important considerations are the characteristics of users, tasks and workspaces, user acceptability, comfort and aesthetics.

CONCLUSIONS

1. These data suggest that one effect of the pelvic tilt chair on posture is that it permits a subject to sit without the flattening of the lumbar curve which tends to occur in conventional office chairs.
2. This may reduce the severity and incidence of low back pain amongst certain sedentary workers

depending on the origins of the pain. Further investigations are required to identify categories of users who may or may not benefit from the use of this type of chair.

3. Implementation of this concept requires further investigations to match chair design to tasks, users and workplaces and to assess user acceptability and comfort.

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Anyone interested in collaborating in further research on back pain related issues, should contact the author.

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