RESEARCH METHODS

PT 4022

AN INVESTIGATION OF THE MANUFACTURER'S CLAIMS AND THE RECEPTIVITY OF THE NADA-CHAIR®

A PILOT STUDY

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April 1989

ABSTRACT

Man spends increasing amounts of time in a sitting position. Concurrent with this development are increasing reports of low back dysfunction. Numerous researchers have investigated unsupported and supported sitting postures using specially designed chairs. The NADA - (Spanish for nothing) Chair® is a simple sling consisting of two loops of webbing attached to a padded back rest. No literature has been located describing a study of the NADA-Chair®. The purpose of this study was to determine if the NADA-Chair® maintains a convex forward lumbar curve, and to determine people's attitudes toward the test chair.

Fifteen volunteers from the university population (mean age 21.9 years) participated in the study. Lateral photographs were taken of the subjects sitting on a stool with and without the test chair. Body segment angles in these positions were calculated. Data were analyzed with a three factor ANOVA repeated measures test. Significant difference was shown in the lumbar angle between sitting with and without the test chair.

Receptivity of the test chair was evaluated by means of a written questionnaire and relative frequencies were calculated. The test chair was better received in the unsupported sitting positions. Sixty percent of subjects would wear the chair again.

These results lend support to the manufacturer's claim that the test chair maintains a normal lumbar curve.

INTRODUCTION

Advances in modem technologies have dictated that man spend increasing amounts of time in a sitting position, in all areas of production, education, transport, administration, and relaxation. [1] Concurrent with this development are increasing reports of low back injuries, and discomfort. Poor sitting postures are described as those producing or enhancing low back pain.[2-3] Majeske and Buchanan [4] regard relaxed sitting as poor posture. Good sitting posture maintains the spinal curves usually present in the erect standing position. Lumbar support is the main factor in obtaining correct sitting posture. [1] Numerous researchers have investigated unsupported and supported sitting postures using specially designed chairs. [5-7] The Nada-(Spanish for nothing) chair@ (figure 1) is a simple sling consisting of two loops of webbing attached to a padded back rest. The loops slip around the knees to anchor the back rest against the lower back. It was developed as a solution to the back pain designers experienced while sitting for long periods of time in a cross-legged position. No literature has been located describing a study of the NADA-Chair®

The purpose of our study is two-fold : (1) to determine if the NADA-Chair® maintains a convex forward lumbar curve, and (2) to determine people's attitudes toward the NADA-Chair®.

RELATED RESEARCH

Correct sitting posture has been described as that which promotes, or maintains the normal lumbar lordosis. [1-2] Normal lumbar lordosis is that degree of extension established in good standing posture with a balance that does not require considerable muscle work and does not overstretch the muscles and ligaments in the lower back region.[1]

Good sitting posture maintains the spinal curves usually present in the erect standing position. The use of a lumbar support pillow has been found to maintain a lordosis in the lumbar spine.[4] Poor sitting postures however, have been described as those postures that reduce or accentuate the usual curves and place the ligamentous structures under full stretch. [8]

One cause of low pack pain may be prolonged flexion. [9] Wykel[10] suggested that relaxed sitting for any length of time puts the lumbar spine in a fully flexed position.[4] This places increased stress on the lumbar structures. [11-12] Several authors[13-15] recommended the use of specific chair designs to avoid lumbar flexion during prolonged sitting. [4] It has been found that in unsupported sitting, the spine moves into kyphosis which increases the load on the intervertebral disc and increases stress on the posterior structures of the back. [11] An increase in L3 intradiscal pressure, during sitting, may cause high tangential stress on the posterior annular fibrosis. contributing to low back pain and rupture of annular fibres. [16] Gyriax [17] stated that maintenance of the lumbar lordosis when sitting provides the main safeguard against disc protrusion.

Using a lumbar support pillow during sitting is an effective means of avoiding poor posturing of the lumbar spine. [4] Several researcher[5-7] support Majeske and Buchanan's [4] claim that specially designed chairs are required to achieve correct sitting posture.

METHODOLOGY

Subjects

Fifteen volunteers participated: (three men and twelve women) from the university population, of which fourteen were students. Subjects had a mean age of 21.9, with a standard deviation of 7.6 years (Table 1). Exclusion criteria for the study were pregnancy beyond five months, back pain or problems which required professional attention in the preceding six months, abdominal problems requiring treatment, and any joint pain or stiffness which would prevent sitting for thirty minutes, or assuming a sitting position on the floor. Each subject wore a non-restrictive sleeveless top and loose shorts, and was identified by a number. Informed consent was obtained from each subject prior to their involvement in the study.

Materials

The materials used in the study included: six NADA-Chairs®, one 35mm Pentax K1000 camera, one Vivitar flash, one standard tripod, one spirit level, three rolls of Ektachrome color 100 HC film, six, four-legged, wooden, square seated stools (height 46.5cm). black circles(l9mm) with superimposed white (13mm) self-adhesive circles, five metric rulers in mm, one monitor and VHS videocassette recorder, one VHS videocassette, two sofa chairs, two straight back chairs. a free standing weight in kg and height scale in cm, a Hewlett-Packard 945B computer, a HP9874 A digitizer*, and a single frame slide analysis program was used.

* Hewlett-Packard Company - Desktop Computer Division
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One metric ruler was modified by adding a slider to facilitate the measurement of sitting height.

For testing, the equipment was arranged in the following manner : the five stools were arranged in a V formation on an angle of 60 degrees and at a distance of 65 cm apart, with the two front stools at a distance of 500 cm from the video monitor (figure 2).

Procedure

Each subjects weight and height were measured. Subjects chose their own stools and received an introduction to the study. Verbal instructions and a demonstration regarding donning of the test chair and sitting position were given.

The subjects were seated on wooden stools, with their knees at a 90 degree angle.which was measured using a standard goniometer, their feet flat on the floor, and their hands resting on their thighs. The subjects were instructed not to alter their knee position. Sitting sequence, with and without the test chair, was randomly decided by tag selection. With subjects seated, black circles were placed over the lowest point of the orbit of the eye, lateral border of the acromion process, highest point of the iliac crest, superior border of the greater trochanter, the lateral femoral epicondyle, and the inferior point of the lateral malleolus (figure 3). Where the test chair covered a surface marking, the circle was placed on a point on the test chair corresponding to the surface marking. Sitting height (cm) was defined as the distance between the stool surface and the lateral border of the acromion process.

The subjects sat for two fifteen minute sessions, with or without the test chair, according to tag assignment. During each of the two fifteen minute sitting sessions, two lateral view photographs were taken of each subject using a camera setting of F11 at l/60 seconds, at a standard distance of 275 cm, with a centre of lens-to-floor height of 72 cm. The second fifteen minute sitting session followed a five minute activity break. Subjects then compared sitting with and without the test chair for five minutes in a straight back chair, a sofa chair, cross-legged on the floor, and on the floor with knees up. The subjects used the manufacturer's instructions to apply the test chair. Receptivity of the test chair was then evaluated by means of a written questionnaire completed by all subjects.

DATA ANALYSIS

The body segments which were used to determine body segment angles consisted of the head and neck (S_l),between the lowest point of the orbit(P_1) and the lateral border of the acromion process(P_2); the trunk(S_2), between the highest point of the iliac crest(P_3) and the lateral border of the acromion process: the pelvis(S_3), between the superior border of the greater trochanter(P_4) and the highest point of the iliac crest; the femur(S_4), between the lateral femoral epicondyle(P_5) and superior border of the greater trochanter: and the tibia(S_5), between the inferior point of the lateral malleolus(P_6) and the lateral femoral epicondyle. Body angles were formed at the head and neck(A_l), the trunk(A_2). and femur with respect to the horizontal, intersecting the lateral border of the acromion process, the highest point of the iliac crest, and the lateral femoral epicondyle respectively. Two additional angles, hip angle(A_3) and knee angle(A_5) were formed between the pelvis and the femur, and between the femur and the tibia, respectively (figure 4)

A single frame slide analysis program computed the body segment angles using the digitized x-y coordinates of the body surface markers. A three factor ANOVA ($p<.05$) was applied with repeated measures taken of the third factor. The first factor was sitting order (with and without the test chair). The second factor was the body segment angles and the third factor, termed condition, was the angle measurements sitting with and without the test chair. A Newman-Keuls Post Hoc test was applied to determine which angles were significantly different when comparing sitting with and without the test chair. Relative frequencies of responses were calculated from the questionnaire. For reporting, the five point scale was collapsed to three, combining comfortable, very comfortable and uncomfortable, very uncomfortable.

RESULTS

Postural Alignment

Analysis of the body angle results using a three factor ANOVA test showed no significant difference in order of the sitting sessions (Table 2). When the angles were considered as a primary interaction a significant difference ($p<0.01$) was identified. The condition as a primary interaction showed a statistically significant difference ($p<.001$). The application of the Post Hoc test (Table 3) revealed that there was a significant difference in the angle of the lower back sitting with and without the test chair (Table 4). The result of a secondary interaction between condition and angle did not show a significant difference. Intra-rater reliability was tested. The mean difference in digitizer units (one unit=25μm) was 2.13 with a standard deviation of 3.80 which indicates high accuracy.

Receptivity

Receptivity was investigated through questionnaire responses. A tabulation of questionnaire responses is presented in Appendix A. While sitting on the stool, most subjects (73%) reported being comfortable sitting with the test chair, while 80% reported being uncomfortable sitting without the test chair. Sitting with the test chair cross legged on the floor, 87% reported being comfortable while

47% reported being uncomfortable without the test chair.

While sitting on the sofa and straight back chair, with the test chair, 47% of the subjects reported being uncomfortable. In the same positions, only 7% reported being uncomfortable sitting without the test chair.

The area of the body described as being most comfortable in the test chair was the lower back (93%). Most subjects (86%) found the test chair easy to apply, while 93% found the verbal instructions clear and 64% found the written instructions clear. Sixty percent of subjects reported they would wear the test chair again, while 40% felt they would not.

Three of the four subjects who reported back pain following the study indicated that they would not wear the test chair again, yet reported being comfortable while wearing, the test chair. When wearing a skirt, 75% of the female subjects reported they would not wear the test chair, and 80% of the subjects reported they would not use the chair while wearing heavy clothing.

DISCUSSION

Postural Alignment

Good sitting posture maintains the spinal curves usually present in the erect standing position. [4] Optimal standing posture is achieved when the line of gravity passes through the tragus of the ear. the acromion process and the greater trochanter. forming an angle of 90 degrees with the horizontal at these points. The highest point of the iliac crest in this position is slightly posterior to the gravity line. As the pelvis tilts anteriorly, causing the lumbar spine to move from a position of lesser lordosis toward one of greater lordosis[4] the trunk angle(A_2) more closely approximates 90 degrees. The results of this study showed that the trunk angle moved from an angle of lesser lordosis to more closely approximate 90 degrees, while sitting with the test chair.

Whether subjects sat with or without the test chair first did not alter the body segment angles measured. A significant difference in the primary interaction of angles was expected since the individual body angles of one subject should have different values. The results of the secondary interaction between angles and condition. however, was found not to be significant. This indicates that the angles measured are dependent on each other. As one angle changes, the other body angles are also altered to compensate for the change in body position.

Receptivity

The back pain reported by the subjects following the study does not appear to be related to the wearing of the test chair since these same subjects reported being comfortable while wearing the test chair. The pain they experienced may be attributed to the length of time sitting.

Most of the subjects found the test chair comfortable, with most indicating the low back as the area of greatest comfort. No subjects report other parts of the body being uncomfortable while wearing the test chair, however. approximately one half indicated that they would not wear the test chair again. We speculate that the subjects may be concerned about how others perceive them with regard to their appearance while wearing the test chair.

Predictably, the test chair was better received in sitting positions where back support was not available. When back support was available, the subjects may have attempted to use that support. However, the test chair would have prevented this, thus creating discomfort in these sitting positions.

Receptivity of the test chair appears dependent upon clothing worn. The position of the straps on the knees, which braces the test chair against the lower back, prevents the individual from keeping his knees close together or assuming a cross-legged position. The position the knees are forced to assume, while wearing the test chair, i.e. knees apart, is a socially unacceptable position while wearing a skirt. Most of the female subjects indicated that they would not wear the test chair while wearing a skirt.

In order to assess receptivity, several variables such as the subject freedom of movement, tension on the test chair knee straps, and the test chair position of the lower back, could not be controlled. Further research could concentrate on controlling the uncontrolled variables in this study, so that the differences between sitting with and without the test chair could be attributed solely to the test chair.

An ideal method of measuring lumbar spine curvature in sitting would be with sitting radiographs. Use of this method was precluded by cost and radiation risk factors.

CONCLUSION

Significance ($P<0.05$) was found at the trunk angle. This suggests an anterior rotation of the pelvis, while wearing the test chair, moving the spine toward a greater lordosis. This supports the manufacturer's claim that the test chair assists in the maintenance of a normal lumbar curve.

The procedure used in this experiment did not provide a direct measure of the lumbar curvature. The sample was not selected randomly: the subjects were all from the university population. Therefore these results cannot be regarded as representative of the general population. The small sample size also limits generalization of the findings in this study to the general population.

This pilot study provides a basis for further research into the effects of the NADA-Chair® on sitting posture.

ACKNOWLEDGEMENT

We thank James Crouse, M.Sc. for writing the data analysis program.

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APPENDIX A

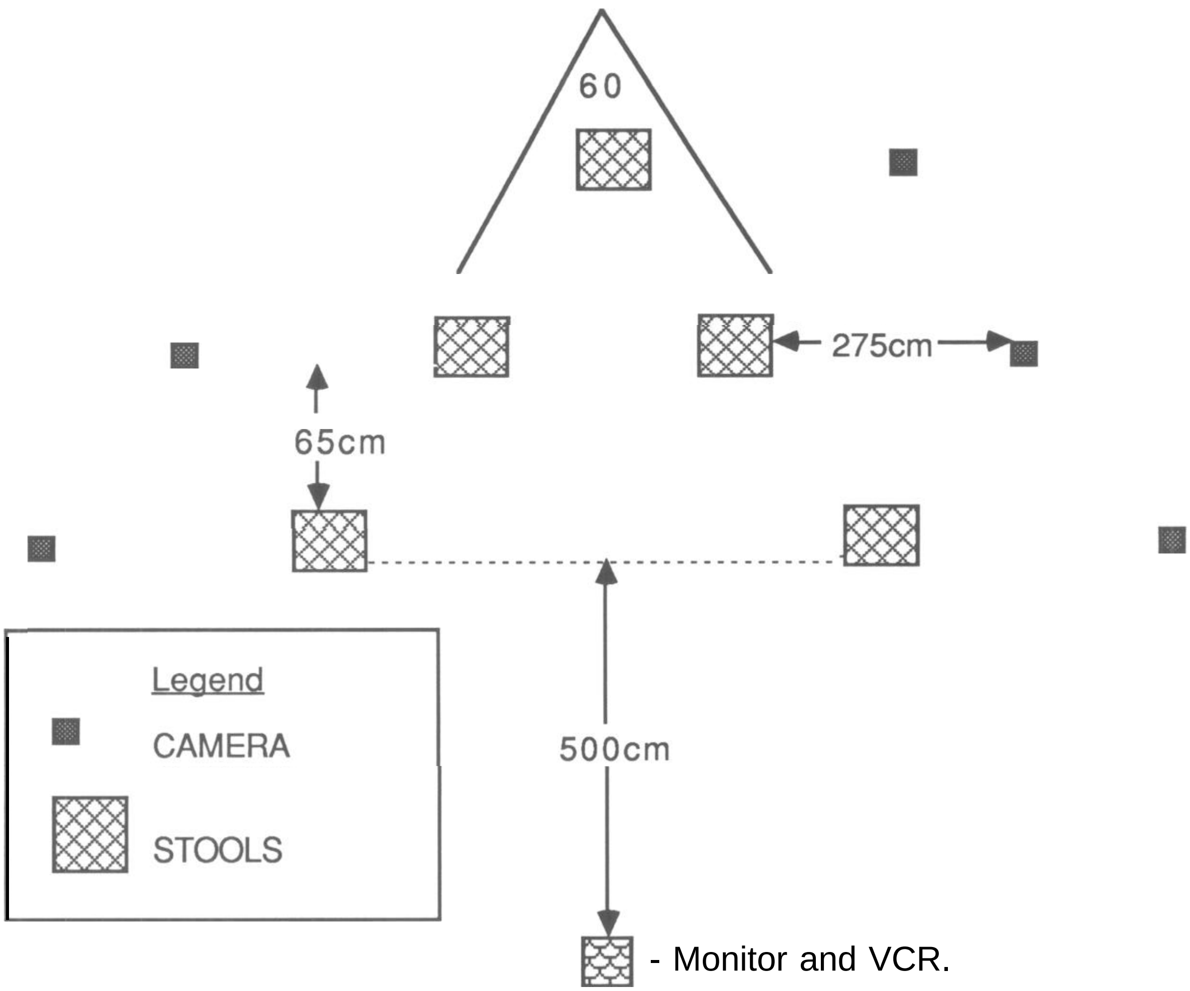

FIGURE 2: Floor layout during sitting sessions.

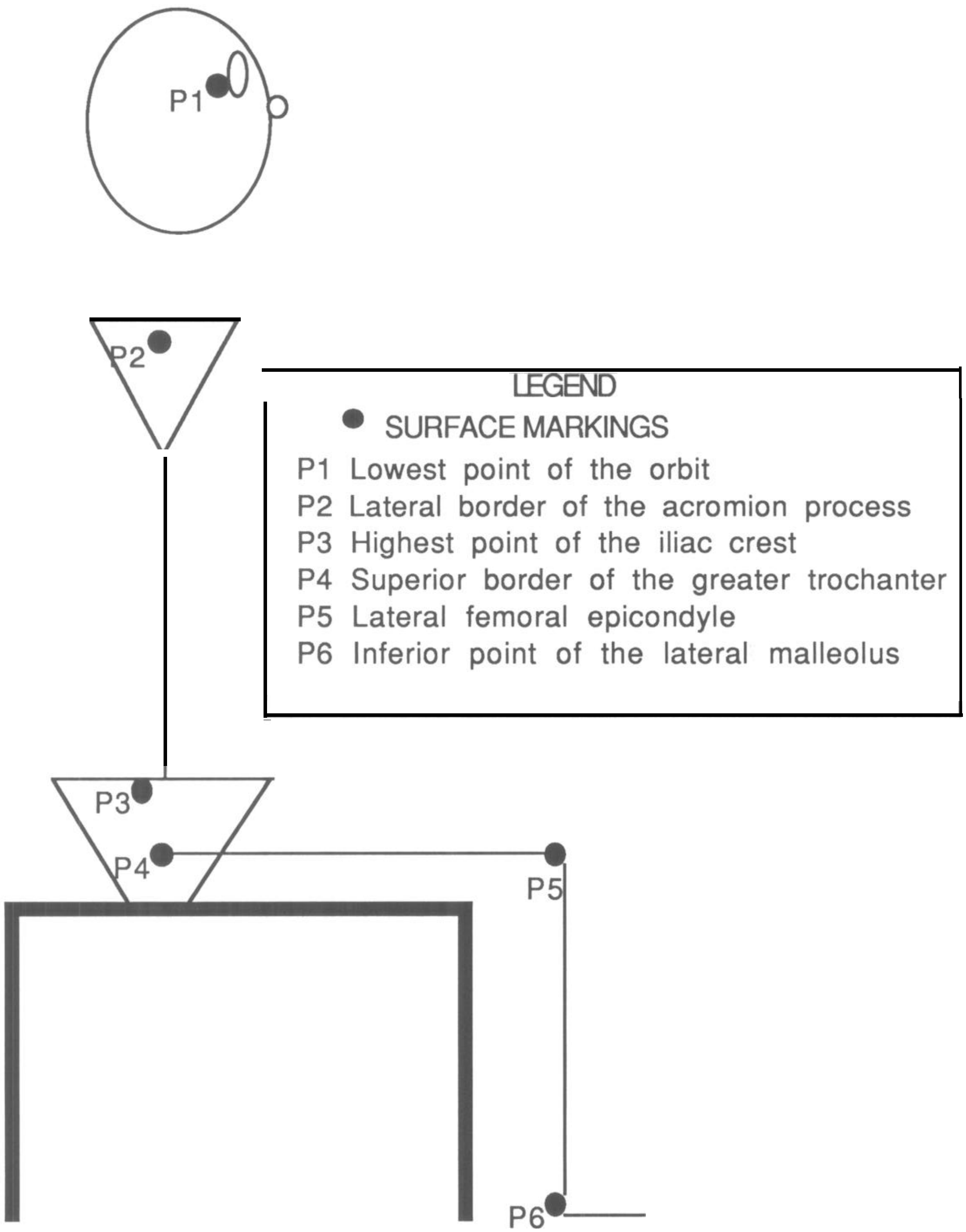

FIGURE 3: Body surface markings.

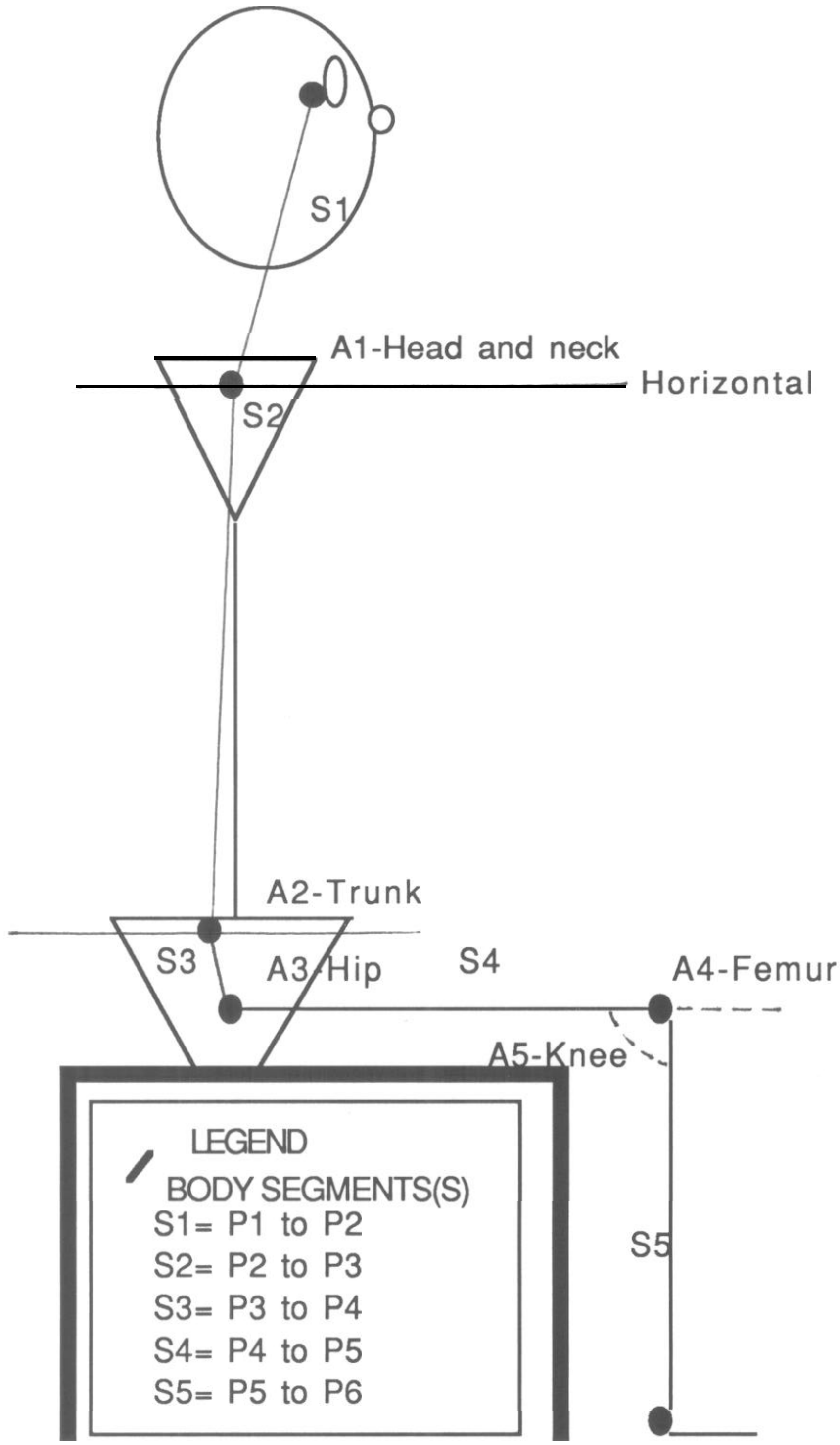

FIGURE 4: Body segments(S) and angles(A).

Table 1 Demographic Data

Characteristics	Mean	S.D.
Age (yr)	21.9	7.6
Height (cm)	156.4	40.0
Weight (kg)	64.7	7.4
Sitting Height (cm)	54.3	3.5

Table 2 Three factor repeated measures analysis of variance

source of variation	df	sum of squares	mean square	f	p
Order(O)	1	166.52	166.52	4.01	0.07
error	13	539.98	41.54		
Angle [A)	4	213208.59	53302.15	1076.42	0.00
OA	4	201.30	50.32	1.02	0.41
error	52	2574.94	49.52		
Condition(C)	1	139.30	139.30	28.22	0.001
OC	1	1.91	1.91	0.39	0.55
error	13	64.17	4.94		
AC	4	167.49	41.87	1.74	0.16
OAC	4	129.97	32.49	1.35	0.26
error	52	1252.71	24.09		

Table 3 Newman-Keuls Post Hoc Test ($p<0.05$)

	Angle*	Trial**	A	B	C	D	E	F	G	H	I	J
A	1	1	x	-	s	s	s	s	s	s	s	s
B	1	2	-	x	s	s	s	s	s	s	s	s
C	2	1	s	s	x	s	s	s	s	s	s	s
D	2	2	s	s	-	x	s	s	s	s	s	s
E	5	2	s	s	s	s	x	-	s	s	s	s
F	5	1	s	s	s	s	-	x	s	s	s	s
G	3	1	s	s	s	s	s	s	x	-	s	s
H	3	2	s	s	s	s	s	s	-	x	s	s
I	4	1	s	s	s	s	s	s	s	s	x	-
J	4	2	s	s	s	s	s	s	s	s	-	x

*Angle: See page 6 and figure 4.

**Trial (l-with test chair, 2-without)

Table 4

Means(X) and standard deviations(s) for body segment angles(degrees) and sitting height(cm)

Segment	Sitting without(1)		Sitting with(2)		d*	
Angle	X	s	X	s	X	s
A l	60.7	6.2	64.0	5.3	3.5	1.9
A2	78.2	4.5	82.9	5.6	4.7	2.0
A3	107.9	9.8	109.2	9.1	1.2	2.5
A4	171.1	3.1	173.1	3.4	1.9	5.0
A5	90.9	2.9	89.4	5.1	-1.5	1.3
Sitting Height	54.3	3.5	54.0	3.5		

$*d=\sum(2-1)/n$