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Influence of the pelvis position and ischial support in the seated position on the column curvatures

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Abstract

Background: An adequate seated position may relieve and prevent many of cervical or lumbar pains. The long lasting seated positions are likely to result in non-physiological ranges of motion, which can be considered a risk factor for lumbar and cervical pain. The aim of the study was to quantify and compare different body angles modified by placing a five-centimetre diameter support to restrain pelvic retroversion in young adults.

Methods: A cross-sectional study was designed and 94 patients were recruited (26 male and 68 female). The assessment of posture was made by photogrammetry in sagittal plane in the sitting and corrected sitting positions. The neck slope (NS), upper cervical (UC), lower cervical (LC), thoracic spine (TS), lumbar spine (LS) and pelvic plane (PP) angles were analysed computationally with 2D software. Statistical analysis of the data was performed using SPSS 20.0 software for Windows.

Results: The mean age of participants was 26.6 (±13.24) years. There were significant differences in the medial angles of the cervical, dorsal and lumbar spine in the normal position, as compared to the corrected position ($p<0.01$). Moreover, there was a significant inverse weak correlation between NS and LS angles versus sitting hours ($p<0.05$).

Conclusion: The use of a five-centimetre support under the ischial tuberosities restrains pelvic retroversion by modifying all spine angles, improving the position with less lumbar flexion and decreasing the forward-head posture when compared with sitting without the support.

Keywords: Human engineering, sedentary lifestyle, neck pain, low back pain, posture.

Introduction

The pelvis is the base of the spine. When it is in anteversion or retroversion positions, various spinal curves in the lumbar, thoracic and cervical regions are affected. The neutral pelvic position when standing has been described as the position in which the anterior and posterior iliac spines are nearly horizontal [1].

In a sitting posture the pelvis is tilted backwards, which decreases lumbar lordosis, increases thoracic kyphosis and pushes the head forwards so as to maintain the stability of the centre of gravity [2,3].

The sitting postures exert excessive pressure on the musculoskeletal system. As a result, a forward-head posture [4,5] or a lumbar flexion position [6] might be associated with spinal pain.

Our posture correction capacity has been proved to decrease with age [7]. Therefore, the adoption of preventive measures among young individuals is essential to reduce the prevalence of posture-induced cervical and lumbar pain. Several studies were devoted to the modification of cervical angles in older adults by means of an ischial support [8] yet there are no reports regarding these changes in young adults.

Although radiographic survey is considered the “gold standard” for posture measurements in the sagittal plane, the risk of radiation exposure limits

its use. For this reason, 2D and 3D motion analysis systems have been proposed and used to measure posture in different planes, both in dynamic and static positions [7–11].

The study findings have demonstrated a relationship between lumbar pain and sedentary lifestyle [12]. Moreover, a certain relationship, although potentially modifiable, has been found between cervical pain and postures at work [13] even among young individuals [14 15]. Increased attention has recently been paid to these ergonomic risks among population groups [16]; however, there are no studies assessing the capacity to improve sedestation with ergonomic correction [17]. Different types of chairs have been proposed for more correct sitting positions in which the natural spinal curvatures are maintained without excessive muscular activity. Since choosing the best chair or seat is not always possible, ischial supports should be applied to keep the spine in a relaxed upright position without excessive muscular activity, which seems to be an effective method to prevent prolonged sedestation from being a risk factor for lumbar or cervical pain.

In order to determine the effectiveness of such device in improving spinal curvatures, a cross-sectional study involving young adults was suggested comparing the normal sitting position and the sitting position corrected with an ischial support.

The study aimed at quantifying and comparing the modifications of different body angles after placing a five-centimetre diameter support to restrain pelvic retroversion in young adults using a 2D photogrammetic analysis.

Materials and methods

An analytical comparative cross-sectional study was designed.

The dependent variables were spine angles measured with 2D software, a method which had already been used in previous studies to measure sitting postures [7,10]. The independent variable was the type of sedestation, with or without an ischial support. All participants gave their written informed consent for participation in the study in accordance with the Declaration of Helsinki.

The participants were young college volunteers. The inclusion criteria for participation were age ≥18 years, capacity to maintain, the sitting position unaided, being asymptomatic at the time of measurements. The exclusion criteria were history of cervical, thoracic or lumbar spine surgery or treatment which could affect the posture in the last 6 months and any symptoms present at the time of measurements.

Independent variable

The independent variable for this study was seated position without support or with a five-centimetre support under the ischial tuberosity.

The procedure used was as follows:

1. For regular sitting posture, the position was standardised by asking each of the subjects to keep sitting naturally on a stool, facing forward, with hands relaxed on the thighs with the fingertips touching the knees [7]. The backless, armless stool was adjusted at the height of the knee joint [8]. When participants could not reach the floor with their feet, a support was placed beneath to keep them stable.
2. For corrected sitting posture, the same instructions were used. However, an approximately five-centimetre-diameter ischial support was placed immediately posterior to the ischial tuberosities in order to restrain pelvic retroversion.

The posture was a dependent variable assessed by measuring the different spine angles. Measurements were made by using photogrammetry in the sagittal plane with a digital camera (Sony Handycam model HDR-CX130E) placed on an adjustable tripod. The lens was always placed right-sided at the shoulder height..

Prior to taking photographs, a tester (always the same person) placed some adhesive markers on the following anatomical landmarks, serving as a reference for further angular measurements: ear tragus, nasal flaps, sternal manubrium, chin, spinous processes of T1, T3, T11, L1, S2, and ASIS.

The placement of skin markers on these anatomical landmarks were previously described and resulted in good intra-rater reliability in standing positions (ICC=0.83-0.92) [9,11].

Finally, each of the postures was analysed computationally with 2D software. The following angles considered as dependant variables were measured (Fig. 1):

1. Neck slope angle (NS): the angle formed by the horizontal line that crosses the T1 spinous process and the line which joins the T1 spinous process and the ear tragus. This measurement proved to be highly reliable (ICC=0.88) [10]. The forward position results in NS angle reduction.
2. Upper cervical angle (UC): the angle formed by the line which joins the nasal flap with the ear tragus and the line which joins the ear tragus and the T1 spinous process. The forward head posture increases the UP angle increase.
3. Lower Cervical angle (LC): angle formed by the line which joins the ear tragus and the T1 spinous process and the line that joins T1 spinous process and suprasternal notch. Forward head posture causes a reduction of the LC angle.
4. Thoracic spine angle (TS): angle formed by the intersection between the straight line that joins T11 and L1 and the line that joins T1 and T3.
5. Lumbar spine angle (LS): angle formed by the horizontal line that joins the T11 and L1 spinous process and the perpendicular line which intersects the horizontal line that joins S2 and ASIS.
6. Pelvic plane angle (PP): angle formed by the horizontal line which runs the S2 spinous process and the line which joins S2 spinous process and the anterior superior iliac spine (ASIS). If the ASIS lies below the S2 spinous process it is considered a negative angle.

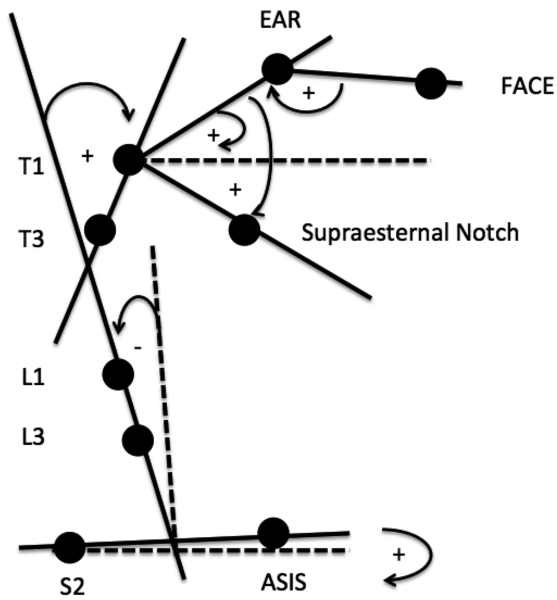

Fig 1. Angle definition. Increasing head tilt and neck slope angles indicate that the face is tilted upward and the neck is inclined less forward. Increasing upper and lower cervical spine angles indicate extension. A positive thoracic angle indicates flexion, and a negative lumbar angle indicated extension. A negative pelvic plane angle (S2-ASIS) indicated that the anterior superior iliac spine (ASIS) moved below the horizontal plane.

Procedure

One of the measurers registered the anamnesis and the main socio-demographic data of the patients included in the study, once they had signed the informed consent. Afterwards, another measurer placed the skin markers to analyse subsequently the angles in the skin references marked formerly.

Then a third measurer asked them to sit comfortably on a flat stool, looking forward and keeping the posture, and a fourth measurer took a photograph. Later, the third measurer asked them to sit again but with a five-centimetre ischial support and keep the posture and the fourth measurer took a photograph.

Data analysis

Statistical analysis of the data was performed using SPSS 20.0 software for Windows.

A descriptive analysis of the entire sample was performed. A comparative analysis of the angles measured both in regular sitting posture and corrected sitting posture was also performed using parametric tests if the variables were distributed in a normal way or non-parametric test if they were not. A comparative study between the different angles in subjects who have suffered from cervical pain and those who have never suffered from cervical pain was performed.

A correlative analysis among the different variables and the number of hours the subjects were sitting daily was performed using parametric or non-parametric tests, depending on the distribution of the variables.

Results

A sample of 94 subjects -71.3% (67) women and 27.7 % (26) men- was included.

Demographic data at the beginning of the study are shown in table 1.

Table 1. Characteristics of the sample participants. Demographics and self-reported occupational sedentary baseline.

	Average (SD)
Age	26.6 (±13.24)
Height	1.68 (±0.10)
Weight	64.41 (±11.53)
BMI	22.94 (±3.06)
Sitting hours	8.16 (±2.33)
Physical activity	4.31 (±3.82)

Regarding previous cervical pain, 21.3% of the sample had a previous history of cervical pain or experienced recurrent episodes of cervical pain, whereas 23.4% had a previous history of lumbar pain or experienced recurrent episodes of lumbar pain.

Statistically significant differences were demonstrated in the medial angles in the cervical, dorsal and lumbar spine in normal positions, as compared to corrected positions ($p<0.01$) (Table 2).

Furthermore, an inverse weak correlation was found in the ability of cervical corrections of angles C1 and C2 ($p<0.05$) (Table 3).

Table 3. A significant correlation between sitting hours versus NS angle and LC angle. Pearson correlation coefficient < 0.005.

	NS angle	LC angle
Sitting hours	-0.255	-0.218
p-value	p = 0.14	p = 0.37

Table 2. Comparison of the effects of sitting with and without support. (NS angle = Neck slope // UP angle = Upper cervical // LC angle = Lower cervical // TS angle = Thoracic spine // LS angle = lumbar spine // PP angle = Pelvic plane angle) t-Student analyses.

Angles	Without correction (SD)	Corrected (SD)	Average change	p-value
NS	40.78 (±7.18)	45.98 (±5.5)	5.2 (±5.24)	p<0.01
UP	121.67 (±9.37)	116.71 (±13.76)	4.95 (±11.5)	p<0.01
LC	73.55 (±7.71)	77.80 (±7.19)	4.24 (±3.19)	p<0.01
TS	36.99 (±8.54)	32.40 (±7.6)	4.58 (±4.5)	p<0.01
LS	11.17 (±8.92)	3.10 (±7.79)	8.01 (±6.75)	p<0.01
PP	10.67 (±6.1)	4.56 (±5.63)	6.1 (±5)	p<0.01

Discussion

The aim of this study was to assess the effects regarding the position of the different spinal angles adopted during sedestation by using a five-centimetre support under the ischial tuberosities.

The results of the study showed that the control of the position of the pelvis by means of the five-centimetre support under the ischial tuberosities results in a decrease in lumbar and thoracic flexion and a significant decrease in forward head posture. These findings concur with those in other study in which a larger-diameter ischial support was used [8], but a smaller range shift was achieved, most likely because the study was performed in over 65-year-old people, who have lesser posture correction capacity [7].

Our results are complemented by those published by O'Sullivan in 2012 [18], which proved that a more ergonomic chair with a more elevated back was able to restrain the flexion position in the lumbar spine, typical of the normal sitting position where the pelvis is automatically retroverted. Therefore, with the support proposed in our study the same objective can be achieved regarding the lumbar spine without the ergonomic chair. Besides, the support not only restrains lumbar spine flexion but it also influences the dorsal and cervical curvature, decreasing forward head posture.

Moreover, it should be considered that muscular activation in this position has been proved [18] to be lesser than in regular sitting positions, in which more muscular control is needed. For this reason, the excessive contraction of musculature could imply muscular and joint pain in these areas, both lumbopelvic and cervical ones.

Therefore, the results of this study are relevant, since with the ischial support, angular changes of the lumbar thoracic and cervical spine are moved to the positions of lesser stress and with slighter muscular activation.

The ability to modify these angles is of a clinical relevance both for lumbar and cervical problems, since the position of the pelvis can change not only the lumbar angle but also the cervical spine position. This underlines the importance of treating the pelvis and working on its position This underlies the importance of working on the pelvis position in patients with cervical problems. The ischial support proposed could be relevant for patients with pain because it improves sedestation passively; from the active point of view, the back straightening muscles are not acting correctly [19].

This study has relevant clinical implications both for prevention and treatment of postural pathologies, given that the lumbar, thoracic and cervical positions can be modified to the position of lesser stress and slighter muscular activation with the ischial support. An interesting further research project would be to test the long and mid-term effects of this kind of support applied to symptomatic and asymptomatic subjects on cervical and lumbar regions.

It would be interesting to assess the use of a support for various sitting postures (not only on chairs) adopted by people in their daily life.. To achieve as correct and effective outcomes as possible, participants should attend some informational seminars, since, as shown by other studies, self-administered interventions tend to be ineffective without suitable instructions and information [20].

Conclusion

The use of a five-centimetre support under the ischial tuberosities restrains pelvic retroversion by modifying all spine angles, improving the position with lesser lumbar flexion and decreased forward head posture when compared with young subjects sitting without the support.

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