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Effects of Lateral Deviation from Neutral Position on the Perceived Joint Discomfort Rating in Cervical and Lumbar Region in Sitting and Standing Position

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Abstract

Introduction: The human body can adopt various types of postures. Typical examples of deviations from neutral posture around the low back are forward and backward bending, side bending and rotation [1]. Body part discomfort (BPD) scale has become a standard discomfort assessment tool. While performing a task, the worker indicates the body areas in which discomfort is felt as a result of the task, and assigns a severity to the discomfort of each body part [2,19,40,45]. *Aims and Objectives:* The main aim and objective of this study was to observe the effects of deviation from neutral position on the perceived joint discomfort rating in neck and back in sitting and standing position. *Methods:* A total of forty subjects were selected based upon the inclusion and exclusion criteria. The 20 out of the 40 subjects were asked to maintain static joint posture for the neck. The postures included were flexion, extension, right and left side flexion and right and left rotation. The subjects were asked to maintain these posture in the sitting position. The remaining 20 subjects were asked to maintain the same static joint posture in sitting position for the neck but in reverse order. The first 20 subjects were then asked to maintain static joint posture for the low back in sitting position. The postures included were flexion, right and left side flexion and right and left rotation. The remaining 20 subjects were then asked to maintain the same static joint posture for the low back in sitting position but in the reverse order. *Discussion:* These findings suggest as stated earlier that perceived joint discomfort has a direct correlation with the torque produced in the muscle around the joint and higher the torque more will be the discomfort. *H. Monod* reported that exhaustion of a muscle engaged in static activity is mainly due to ischaemia created inside the muscle by the contracting force [35]. *Wilke et al. (1999)* measured spinal disk pressure for various activities and found that there was a lower spinal load in sitting when compared to standing [25,70,72]. In our study flexion of the back produce second highest discomfort rating. This is born out on the basis that trunk flexion increases the load on the spine by increasing the forward bending moment on the spine [30]. *Conclusion:* Based on the finding of this study we can conclude that lateral bending of the cervical appears to cause more discomfort than the flexion, extension and rotation when performed in the standing position as compared to sitting. Similarly, lateral bending of the lumbar spine appears to cause more discomfort than any other static joint posture, when performed in standing position as compared to sitting. *Limitation of the Study:* 1. Small sample size. 2. Perceived joint discomfort scale is a subjective scale and its accuracy depends on the level of understanding of subject. 3. No blinding was done. 4. Lumbar extension in sitting position was not included in the study. 5. Lumbar rotation ROM was not measured.

Keywords: Joint Discomfort Scale; Stop Watch; Perceived Joint Discomfort; Cervical; Lumbar; Static Posture; Sitting; Standing.

Introduction

Daily exposure to static effort over a long period may result in discomfort as well as pain and aches in the muscles, joints, tendons, and other soft tissues. The static loads are associated with a high risk of arthritis of the joints, inflammation of the tendon sheaths and points of attachment of the tendons, symptoms of chronic degeneration of the joints, painful muscle spasms, and intervertebral disc troubles [1].

Body part discomfort (BPD) scale has become a standard discomfort assessment tool. While performing a task, the worker indicates the body areas in which discomfort is felt as a result of the task, and assigns a severity to the discomfort of each body part [2,19,40,45].

Minimization of perceived discomfort by eliminating physical un-natural force can contribute

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to reduction of risk for musculoskeletal disorders. Awakward, extreme and repetitive body postures have also been associated with musculoskeletal disorders in industry [3].

High rate of musculoskeletal disorder particularly in the shoulder and neck among worker having to adopt postures with considerable static load on shoulder and neck muscle [4,41].

Modern technology has led to an increase in the number of seated workplaces in manufacturing and service industries [6].

Physical pain in neck, shoulder and arms were observed by Komoike and Horiguchi in punchers, typists and cashiers [7].

The need to improve work postures has been documented in a number of studies which have shown a relation between stressful postures at work and functional disturbance or pain in various parts of musculoskeletal system [9].

Musculoskeletal disorders are a major source of morbidity in many industrial populations. Recent survey have focused on the relation between morbidity and posture at work [10,39].

Low back pain trouble is reportedly related to a variety of occupational factors, such as prolonged sitting and standing, lifting, bending and twisting, and heavy manual work [11,39,40,51,52,53,54].

Work-related musculoskeletal disorder have been found to be associated with numerous occupational risk factor including physical work load factor such as force, posture, movement and vibration psychosocial stressors, and individual factors [14,22,49,69].

Numerous reports of postural problem among visual display terminals operators are available problem range from complaints of discomfort, to pain and medical disability. Most frequent sources of complaints are the back, neck and shoulder [18,20,40,34,44,48,55].

But none of the research has studied the discomfort rating of neck and back in different position in sitting and standing position. In our study we have measured discomfort rating related with neck and back in different position in sitting and standing with the use of perceived joint discomfort scale.

Aims and Objectives

The main aim and objective of this study was to observe the effects of deviation from neutral position on the perceived joint discomfort rating in cervical and lumbar in sitting and standing position.

Statement of Question

Which static joint posture of the cervical and lumbar will cause the maximum perceived joint discomfort in sitting and standing position?

Hypothesis

1. Lateral bending of the cervical will cause more perceived joint discomfort than flexion, extension, rotation of cervical in standing and sitting position.
2. Lateral bending of lumbar will cause more perceived joint discomfort than flexion and rotation in standing and sitting positions.

Operational Definition

Perceived joint discomfort: It is defined as discomfort as perceived by the subjects when asked to maintain a static joint posture of either the neck or back in different position. The discomfort is measured using the perceived joint discomfort scale.

Review of Literature

Biomechanics of Cervical Spine

Kinematics

The cervical spine is designed for a relatively large amount of mobility. The motion of flexion and extension, lateral flexion, and rotation are permitted in the cervical region. These motions are accompanied by translation that increase in magnitude from C2 to C7. However, the predominant tradition occurs in the sagittal plane during flexion and extension [25].

The atlanto-occipital joints allow for only nodding movements between the head and the atlas [25,26,27] (Fig. 1).

Approximately 55% to 58% of the total rotation of the cervical region occurs at the atlantoaxial joints [25,26,59] (Fig. 2). The atlas pivots about 45° to either side or a total of about 90°. The alar ligaments limits rotation at the atlantoaxial joints.

The disk at C5/C6 is subject to a greater amount of stress than other disks because C5/C6 has the greatest range of flexion-extension and is the area where the mechanical strain is greatest [25].

Kinetics of the cervical spine

The cervical region is subjected to axial compression, tension bending, torsion, and shear stresses as in the remainder of the spinal column. The cervical region bears less weight and so generally more mobile in comparison to thoracic and lumbar region [25,27,30].

No disks are present at either the atlanto-occipital or atlantoaxial articulation therefore, the weight of the head (compressive load) must be transferred directly through the atlanto-occipital joint to the articular facet of the axis [24,25,27,30].

A. Flexion. B. Extension.

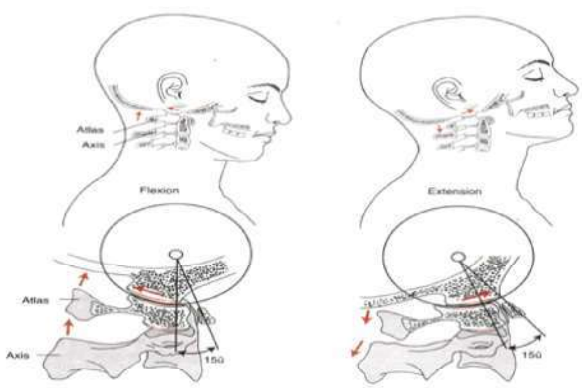

Fig. 1: Nodding motions of the atlanto-occipital joints.

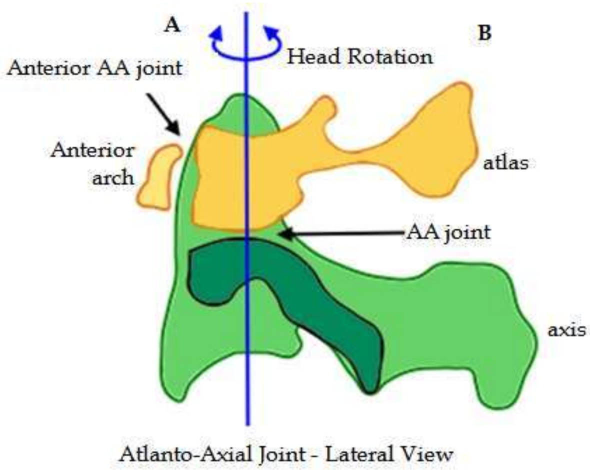

Fig. 2: Rotational movement of cervical spine

Stabilization system of cervical spine

Mechanical stability of the cervical spine is necessary to match the instantaneously varying stability demand due to changes in posture of head and neck, and static and dynamic load. Panjabi MM, introduce an innovative model of the spinal stabilization system which stresses as an appropriate model for understanding the entity of spinal stability and instability.

The model incorporates:

a) Passive subsystem

b) Active subsystem

c) Neural control subsystem

Lumbar kinematics

The vertebra in the lumbar region is capable of movement in flexion, extension, lateral flexion and rotation. The lumbar zygapophyseal facets favour flexion and extension because of the predominant sagittal plane orientation [26]. Flexion of lumbar spine is more limited than extension and normally, it is not possible to flex the lumbar region to form a kyphotic curve. The amount of flexon at each interspace varies, but most of the flexion takes place at the lumbosacral joint. The area of the lumbar spine that supports the most weight is between L4 and L5, and this area also shows the greatest mobility during flexion and extension [25,30].

Rotation in the lumbar region is more limited because of the shape of the zygopophyseal joints [25,27]. The greater the extent of medial orientation of the superior facets, the greater the resistance to axial rotation.

Lumbar-pelvic rhythm

Cailliet described a specific instance of coordinated, simultaneous activity of lumbar flexion and anterior tilting of the pelvis in the sagittal plane during trunk flexion and extension. Cailliet called this combined lumbar and pelvic motion lumbar-pelvic rhythm [25].

Stabilization system of lumbar spine

The stabilizing system of the spine must limit the excursion of spinal motion segments and maintain the proper ratio of neutral to elastic zone motion. Panjabi conceptualized the stabilizing system as consisting of 3 subsystems (Fig. 2.3)-

1. Passive subsystem
2. Active subsystem
3. Neural control system

Posture

Posture is the attitude assumed by the body either with support during muscular inactivity, or by means of co-ordinated action of many muscles working to maintain stability [23,60].

Posture can be either static or dynamic. In static posture the body and its segments are aligned and maintained in certain position by the interaction of group of muscles which work more or less statically to stabilize the joints [25].

The view put forward by Corlett (1983) is that a posture is the position adopted because it is appropriate for the task being performed. He defined some principles for workplace design to provide good and varied work posture, which are listed as follows:

Principles for the arrangement of workplaces to provide good work posture (Corlett, 1983) [17].

1. The worker should be able to maintain an upright and forward facing posture during work.
2. Where vision is a requirement of the task, the necessary work points must be adequately visible with the head and trunk upright or with just head inclined slightly forward.
3. All work activities should permit the workers to adopt several different, but equally healthy and safe, postures without reducing capabilities to do the work.
4. Work should be arranged so that it may be done, at the worker's choice, in either a seated or standing position.
5. The weight of the body, when standing, should be carried equally on both feet.
6. Work activities should be performed with the joints at about the mid-point of their range of movement. This applies particularly to the head, trunk and upper limbs.
7. Where muscular force has to be exerted it should be by the largest appropriate muscle groups available.
8. Work should not be performed consistently at or above the level of the heart; even the occasional performance where force is exerted above heart level should be avoided.
9. Where a force has to be exerted repeatedly, it should be possible to exert it with either of the arms, or wither of the legs, without adjustment to the equipment.
10. Rest pauses should allow for all loads experienced at work including environmental and informational loads, and the length of the work period between successive rest periods.

Such guidelines can help the ergonomists to access the work place designs to some extent. Therefore, the effects of posture are not simply due to the orientation of the body in space, but are equally the result of the forces imposed on the muscles in maintaining position and balance, and also of the time for which these are held [17].

Methodology

Sample

A total of forty healthy male subjects were recruited from William Carey University Meghalaya Physiotherapy OPD. All the subjects participated in the study after signing the informed consent with mean age 23.82±2.69 years, mean height 167.92±5.75 cms, mean weight 61.62±10.47 kgs. sample of 40 subjects each in 2 groups were selected according to inclusion and exclusion criteria. Inclusion criteria includes-Healthy male subjects, Age group - 20-30 yrs, Weight - 50-75 kgs and Height - 160-180 cms. Exclusion criteria include - Any history of trauma to cervical and lumbar region, Any history of neurological disorder in cervical and lumbar, Cervical spondylosis, Deformity of spine e.g. scoliosis, kyphosis and lordosis, Lumbar spondylolysis and Spondylolisthesis, Any history of joint hypermobility/hypomobility and Malignancy, tumors or recent surgeries of spine. Instrumentation-Stop watch was used to record holding time, chair with back rest and Perceived Joint Discomfort Scale.

Procedure

The 20 out of the 40 subjects were asked to maintain static joint posture for the cervical. The postures included were flexion, extension, right and left side flexion and right and left rotation. The subjects were asked to maintain these posture in the sitting position. (Fig. 3, 4, 5 & 6).

The remaining 20 subjects were asked to maintain the same static joint posture in sitting position for the cervical but in reverse order. The first 20 subjects were then asked to maintain static joint posture for the lumbar in sitting position. The postures included were flexion, right and left side flexion and right and left rotation. (Fig. 14 to 16).

The remaining 20 subjects were then asked to maintain the same static joint posture for the lumbar in sitting position but in the reverse order.

After a gap of 24 hours the first 20 subjects were asked to maintain static joint posture for the cervical in standing position. The postures included were the same as performed on the first day. (Fig. 7, 8, 9 & 10).

The 20 remaining subjects were asked to maintain static joint posture for the neck in standing position but in reverse order of sequence as performed by the first 20 subjects. The first 20 subjects were asked to maintain static joint posture for the lumbar. The postures included were the same as on the first day but in the standing position. (Fig. 11 to 12).

Lastly, remaining 20 subjects were asked to maintain the same static joint posture for the lumbar as performed by the first 20 subjects in standing position but in reverse order of sequence.

Each static joint posture was held for 60 seconds at the end range followed by a rest period of 60 seconds. Discomfort rating was calculated immediately after a static joint posture was completed during the 60 seconds rest period.

Fig. 3: Subject maintaining cervical flexion at the end range of motion in sitting position

Fig. 4: Subject maintaining cervical extension at the end range of motion in sitting position

Fig. 5: Subject maintaining right lateral flexion of the cervical at the end range of motion in sitting position

Fig. 6: Subject maintaining right rotation of the cervical at the end range of motion in sitting position

Fig. 7: Subject maintaining cervical flexion at the end range of motion in standing position

Fig. 8: Subject maintaining cervical extension at the end range of motion in standing position

Fig. 9: Subject maintaining right rotation of the cervical at the end range of motion in standing position

Fig. 10: Subject maintaining right lateral flexion of the cervical at the end range of motion in standing position

Fig. 11: Subject maintaining lumbar flexion at the end range of motion in standing position

Fig. 12: Subject maintaining right lateral flexion of the lumbar at the end range of motion in standing position

Fig. 13: Subject maintaining right rotation of the lumbar at the end range of motion in standing position

Fig. 14: Subject maintaining lumbar flexion at the end range of motion in sitting position.

Fig. 15: Subject maintaining right lateral flexion of the lumbar at the end range of motion in sitting position

Fig. 16: Subject maintaining right rotation of the lumbar at the end range of motion in sitting position.

Data Analysis

The data was analyzed using SPSS 12.0 version. Mean and standard deviation for age, height and weight was calculated.

Paired T-test was used to analyze perceived joint discomfort in different positions (at end range of anatomical movement) of cervical and lumbar between sitting and standing position. The level of significance was set at $p<0.05$.

Results

The mean and standard deviation of age, height and weight was calculated for all the subjects (Table 1).

Comparison of perceived joint discomfort in different position (at the end range of anatomical movement) of cervical between sitting and standing position was calculated using paired t-test (Table 2).

The results showed that lateral flexion of the cervical was the position in which maximum perceived joint discomfort was recorded both for sitting and standing position, but was statistically, significant only for right lateral flexion (0.040). The results showed that all are significant except lateral flexion of the cervical is insignificant ($p>0.05$).

Comparison of perceived joint discomfort in different position (at the end range of anatomical movement) of lumbar between sitting and standing was calculated using paired t-test (Table 3).

The results showed that lateral flexion of the lumbar was the position in which maximum perceived joint discomfort was recorded both for sitting and standing position and was statistically significant for right and left lateral flexion. All the other positions also showed statistically significant difference between sitting and standing except for forward flexion. The results showed that all are significant except forward flexion of the lumbar is insignificant ($p>0.05$).

Table 1: The mean and standard deviation of age, height and weight.

Variable	Mean ± SD
Age (yr)	23.82±2.69
Height (cm)	167.32±5.75
Weight (kg)	61.62±10.47

SD = Standard Deviation

Table 2: Comparison of perceived joint discomfort in different position of cervical between sitting and standing position.

Variable	Sitting	Standing	t-value	p-value
C Flex	2.87±0.72	3.65±0.62	7.02	0.000
C Ext	4.05±6.71	4.82±0.78	7.91	0.000
CLFR	4.92±0.91	5.37±1.07	3.05	0.040
CLFL	5.10±0.87	5.80±1.09	4.46	0.075
CRR	3.65±0.89	4.45±0.90	6.15	0.000
CRL	3.97±0.89	4.80±0.72	5.60	0.000

C Flex = Neck Flexion

C Ext = Neck Extension

CLFR = Neck Lateral Flexion Right

CLFL= Neck Lateral Flexion Left

CCRR = Neck Rotation Right

CRL = Neck Rotation Left

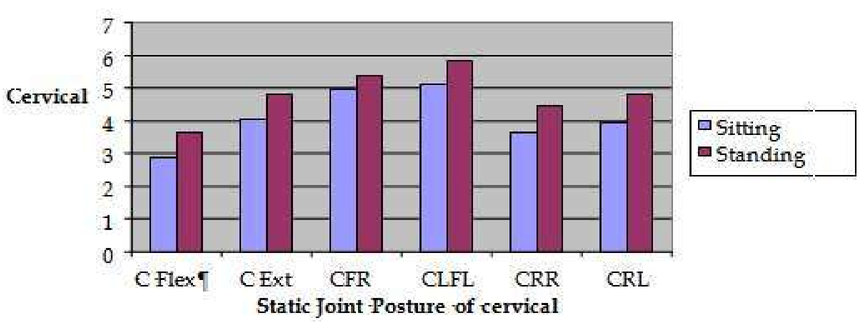

Fig. 17: Graphical representation of perceived joint discomfort cervical in sitting and standing position.

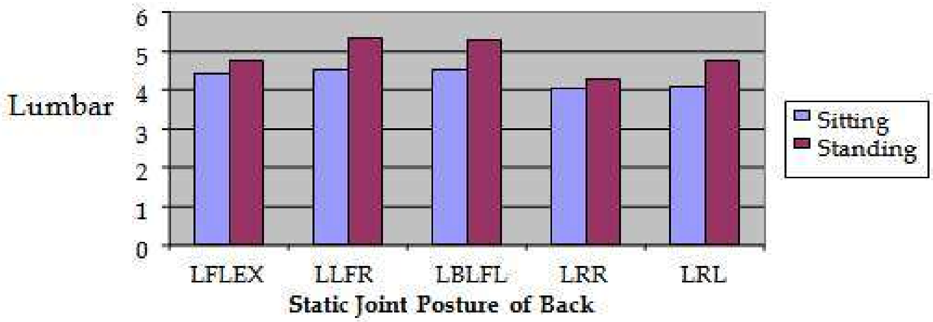

Fig. 18: Graphical representation of perceived joint discomfort of lumbar in sitting and standing position.

Table 3: Comparison of perceived joint discomfort in different position of lumbar between sitting and standing position.

Variable	Sitting	Standing	t – value	p-value
LFLEX	4.40±1.17	4.77±0.86	1.86	0.070
LFR	4.50±0.90	5.30±0.93	5.09	0.0001
LLFL	4.52±0.87	5.27±0.84	5.11	0.0001
LRR	4.02±0.89	4.30±0.91	2.05	0.047
LRL	4.07±0.72	4.72±4.64	5.87	0.0001

LFLEX= Lumbar Flexion

LLFR = Lumbar Lateral Flexion Right

LLFL = Lumbar Flexion Left

LRR = Lumbar Rotation Right

LRL = Lumbar Rotation Left.

Discussion

Several studies have been performed to find out the cause of fatigue of a muscle engaged in static activity. Arnold et al. (1980) recorded increased joint pressure when animal peripheral joints were moved toward motion limits and suggested that this might possibly cause pain [8].

Trousier and Brodin (1979) reported that patients habitually keeping spinal motion segments or joint in extreme position complain of pain from the strained structures [8].

S.P. Moroney et al. examined lumbar torques produce during different anatomical postures, it was found that lateral bending produced the maximum torque in lumbar vertebrae when compared with flexion and extension [56].

Wilke et al. (1999) measured spinal disk pressure for various activities and found that there was a lower spinal load in sitting when compared to standing [25,70,72].

These findings suggest as stated earlier that perceived joint discomfort has a direct correlation with the torque produced in the muscle around the joint and higher the torque more will be the discomfort.

Thus according to the findings of this study lateral bending produced the maximum discomfort for both cervical and lumbar static joint postures. The discomfort was more in standing as compared to sitting joint postures.

Future Research

Future research could be carried out along following lines.

1. The experiment was conducted in the laboratory rather than in the industrial setting.
2. Only static postures held for 60 seconds were investigated, and no other factors, such as the external load (force), repetitiveness (frequency) or longer exposure time should be considered.
3. Joint postures and motions were expressed using a single degree of freedom. But in real life situation a posture is actually a multiple combination of joint postures and this should be considered in future research.

Limitation of the Study

I. No blinding was done.

II. Perceived joint discomfort scale is a subjective scale and its accuracy depends on the level of understanding of subject.

III. Lumbar extension in sitting position was not included in the study.

IV. Lumbar rotation ROM was not measured.

V. Sample size should be small.

Conclusion

This study we can conclude that lateral bending of the cervical appears to cause more discomfort than the flexion, extension and rotation when performed in the standing position as compared to sitting. Similarly, lateral bending of the lumbar spine appears to cause more discomfort than any other static joint posture, when performed in standing position as compared to sitting.

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