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To Find Out the Effect of Varying the Back Rest Angles on Drivers Posture While in a Static Condition

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Abstract:
A total of 32 male subjects, with a mean age of 26, were recruited for the study on the basis of inclusion and exclusion criteria .Before included in the study , the consent form were taken from all the subjects. They were recruited from different hospitals of Dehradun. 32 male subjects were taken for photographs with car seats adjusted at three different angles. Subjects were asked to assume their comfortable sitting posture, while resting their backs on the car seat, holding the steering wheel and looking directly though the wind shield. Photographs were taken of each subject at three different backrest angles; 110°, 120°, and 130°. Each photo was analyzed using corel-draw software, to calculate the craniovertebral angle, craniohorizontal angle, and sagittal shoulder posture.
The result, CHA vs CVA (p=0.001), CVA vs SSP (p=0.045) and SSP vs CHA (p= 0.001) was found to be significant. Similarly, post hoc analysis for multiple comparisons test was applied for 130°. The result, CHA vs CVA (p=0.001), CVA vs SSP (p=0.042) and SSP vs CHA (p=0.001)) was found to be significant.

Keywords: Craniovertebral Angle, Craniohorizontal Angle, Agittal Shoulder Posture.

Introduction

Posture is a term that indicates the relative position of the body segments during rest or activity[31,32]. Posture can be good or healthy posture and a bad or awkward posture. The posture committee of the American academy of orthopaedic surgery defined healthy posture as “skeletal alignment refined as a relative arrangement of the parts of the body in a state of balance that protects the supporting structures of the body against injury or progressive deformity”[1,32]. On the other hand, awkward postures are postures that when used repetitively or for prolonged periods result in increased risk of fatigue, pain or injury[31]. These postures are sustained either actively by muscle contractions or passively by compressive or tensile loads on bones, muscles, tendons, ligaments, etc. This leads to fatigue and pain in the muscles[33]. Passive loading stress the tissue and may result in strain. This tissue strain may lead immediately to feeling of pain and numbness or may accumulate over time and result in tissue damage or pain [33]. Kendall states that “postural faults that persist can give rise to discomfort, pain and disability. The range of effect from discomfort to incapacitating disability is related to the severity and persistence of the faults” [20]. There is no single posture that can be comfortably maintained for long periods of time. Any prolonged posture will lead to static loading of the muscles and joint tissues and consequently can cause discomfort [25,26]. McKenzie and May wrote,“ Postural syndrome is a painful disorder caused by prolonged static loading of normal soft tissues continued until the point when mechanical stress triggers discomfort”[33]. Postural syndrome differs markedly from the other mechanical syndromes, in that the symptoms are transient and there is n persisting impairment or disability. It is claimed that many experience postural pain specially during prolonged sitting, but because the symptoms are transient and quickly abolished once the upright posture is resumed individuals rarely seek treatment. The clinical presentation is usually a young person who spends a lot of time in sitting position, and leads a generally sedentary lifestyle; they have a poor posture and if sustained sitting is performed symptoms will be provoked [33.] Sitting is an extensively studied posture. Although, the ergonomics of sitting in a factory or office has been studied extensively the biomechanics of automobile drivers and passengers have received less attention [16,17]. Because the design of a driver’s seat directly affects the driver’s spinal biomechanics and extremity ergonomics, the posture of driver is also of interest. “The driving posture is a restricted seated working posture in which the driver must interact with and operate vehicle components”(adopted from a report submitted to the University of Michigan Transport Research Institute).Drivers are in a high risk group for spinal disorders, including back pain, neck pain, sciatica, spondyloarthrosis degeneration and herniated discs [36,,56,33]. Drivers have a little room to change posture because of being confined to a small space by the constraints of control positions, pedals and vision requirements. Professional driving frequently involves known risk factors such as prolonged sitting, ergonomic factors, whole body vibrations, twisting and bending and heavy lifting[.32,26] Amongst the driving population, complaints concerning the musculoskeletal system are most frequently reported from the neck, shoulders and lower back [7,8,26.] Neck and shoulder pain was found in conjunction with LBP in a study of bus and lorry drivers by Magnusson et al[52.] However, musculoskeletal disorders in the neck and the shoulder regions have not been studied as extensively as the lower back. It has been observed that, while sitting in a driver’s posture the arms are elevated, with extreme wrist postures and pronated forearms[26.] These all contribute to the change in the normal seated posture. This seated posture assumed by a driver is an awkward posture, and prolonged maintenance of such posture would lead to development of musculoskeletal disorders, in the neck and upper extremities. The seated posture is determined by both the design of the seat and the task to be performed. The parameters which are considered the most while designing a seat are, the seat back inclinations, seat bottom inclinations, and the lumbar support[16,17.] Among these parameters, the lumbar support and seat bottom inclinations are kept fixed by the car companies, but the seat back inclinations could be varied by the individuals as per his comfort. It is found through studies that, the seat back inclinations varying from 110° to 130° are usually preferred by the seated drivers[12.]

METHODOLOGY:

A total of 32 male subjects, with a mean age of 26, were recruited for the study. They were recruited from Different hospitals of Dehradun.

Inclusion Criteria

- Healthy male subjects
- Age: 20 – 35 years
- Pain free cervical range of motion.

Exclusion Criteria

- H/O low back pain

- H/O neck pain
- H/O shoulder pain
- H/O any spinal injuries

Instrumentation

Goniometer : A 360° goniometer was used to measure the backrest angles of the car seats.

Digital Video Camera : A digital Nikon (Cool pix L10) camera, with 5 megapixel, mounted on a tripod was used to take the still photographs of the subjects.

Adhesive Markers : The circular reflective balls of about half inch were placed on the anatomical points of the subjects to capture the postural information on body segments.

Standard car seat : The Maruti Alto car was taken in the study to provide the standard car seat required for the study.

Motion analysis software : This corel draw software was employed to calculate the angles from each anatomical landmarks from photographs.

Protocol:

32 male subjects were taken for photographs with car seats adjusted at three different angles. Subjects were asked to assume their comfortable sitting posture, while resting their backs on the car seat, holding the steering wheel and looking directly though the wind shield. Photographs were taken of each subject at three different backrest angles; 110°, 120°, and 130°. Each photo was analyzed using corel-draw software, to calculate the craniovertebral angle, craniohorizontal angle, and sagittal shoulder posture.

Study Design: Observational study design.

Procedure:

Assesment of the subjects were done and assessment forms were filled in. all the subjects were given the explanation of the procedure of the study and all their questions were satisfactorily answered. An informed consent was signed by each subject. The subject was asked to sit in the car, resting his thorax on the car seat. The whole cervical spine of the subject was exposed. The adhesive markers were put on the subject, the location of which were: :

- External canthus of the left eye
- Left tragus
- A mid point between the greater tuberosity of humerus and posterior aspect of acromion process of left shoulder
- Spinous process of C7

Subjects were asked to sit comfortably with arms holding the steering, and was asked to look directly ahead through the windshield. A digital camera was placed outside the car to photograph the sagittal posture. The camera was made to focus on the left side of the subject’s cervical spine and shoulder. The camera was placed perpendicular to the ground resting on a tripod stand. In order to evaluate the posture of the cervical spine and shoulder region, three angles of measurement were used. The angles of measurements used were:

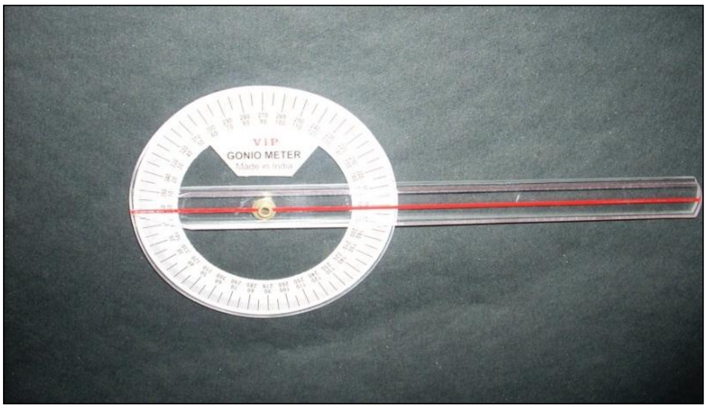
1. **Craniohorizontal angle:** The angle formed at the intersection of a horizontal line through the tragus of the ear and a line joining the tragus of the ear and the external canthus of the eye. It is believed to provide an estimation of the head on neck angle or position of the upper cervical spine.[31]
2. **Craniovertebral angle:** This angle was defined by Wickens and Kiputh (1937). It is the angle formed at the intersection of a horizontal line through the spinous process of C_7 and a line to the tragus of the ear. This is believed to provide an estimation of the neck on the upper trunk positioning. A small angle indicates more forward head posture.[31]
3. **Sagittal shoulder posture:** The angle formed between the line joining the mid point of the lateral side of the humerus (determined when the anterior and the posterior aspects of the humeral head were palpated) and C_7, and the horizontal will be measured in degrees. This angle provides a measurement of the forward shoulder position. A smaller angle indicates that the shoulder is further forward in relation to C_7, in other words a more rounded shoulder.[31]

Sagittal view of the subject showing CHA, CVA, SSP at 110°

Sagittal view of subject showing CHA, CVA, SSP at 120°

Sagittal view of subject showing CHA, CVA, SSP at 130°

Goniometer



Nikon Camera

Reflective balls

RESULTS:

One way ANOVA was done for different degree of angles (110°, 120°, 130°) to determine the difference between different postural variables, (CHA, CVA, SSP). The result, CHA (p=0.514), CVA(p= 0.245), SSP(0.914), showed no significant difference. (Table 5.1) . Post hoc analysis of multiple comparisons test was applied for different postural variables. The result, in CHA of angles between 110° vs 120° (p=0.588), 120° vs 130° (p=0.541), 130° vs 110° (p=0.250), showed no significant difference. (Table 5.2) . Similarly, post hoc analysis for multiple comparisons test applied in CVA of angles between 110° vs 120° (p=0.095) , 120° vs 130° (p=0.370) , 130° vs 110° (p=0.434), showed no significant difference. (Table 5.2) . Similarly, post hoc analysis for multiple comparisons test applied in SSP of angles between 110° vs 120°(p=0.930), 120° vs 130° (p=0.930), 130° vs 110° (p=0.688) showed no significant difference.(Table 5.2) . One way ANOVA was done for different postural variables (CHA, CVA and SSP) to determine the difference between different degree of angles (110°, 120°, 130°). The result of 110° (p=0.001), 120° (p=0.001), 130° (p=0.001) was significant.(Table 5.3) . Post hoc analysis for multiple comparisons test was applied for different degree of angles (110°, 120°, and 130°). The result in 110° for postural variables CHA vs CVA (p=0.001), CVA vs SSP (p=0.240), SSP vs CHA (p=0.001) was found to be significant. (Table 5.4) . Similarly, post hoc analysis for multiple comparisons test was applied for 120°. The result, CHA vs CVA (p=0.001), CVA vs SSP (p=0.045) and SSP vs CHA (p= 0.001) was found to be significant. (Table 5.4) . Similarly, post hoc analysis for multiple comparisons test was applied for 130°. The result, CHA vs CVA (p=0.001), CVA vs SSP (p=0.042) and SSP vs CHA (p=0.001)) was found to be significant. (Table 5.4)

Anova between different backrest angles for CHA, CVA, SSP

Angles	F value	p value
CHA	0.670	0.514
CVA	1.426	0.245
SSP	0.90	0.914

Multiple comparisons of different degree of backrest angles.

Dependent variables	Different degree of backrest angles	Mean difference	Standard error of mean	p value
CHA	110° Vs 120°	1.2106	2.2280	0.588
	120° Vs 130°	1.3665	2.2280	0.541
	130° Vs 110°	2.577	2.2280	0.250
CVA	110° Vs 120°	2.1915	1.2985	0.095
	120° Vs 130°	1.1709	1.2985	0.370
	130° Vs 110°	1.0206	1.2985	0.434
SSP	110° Vs 120°	0.4503	5.1167	0.930
	120° Vs 130°	1.6131	5.1167	0.753
	130° Vs 110°	2.0634	5.1167	0.688

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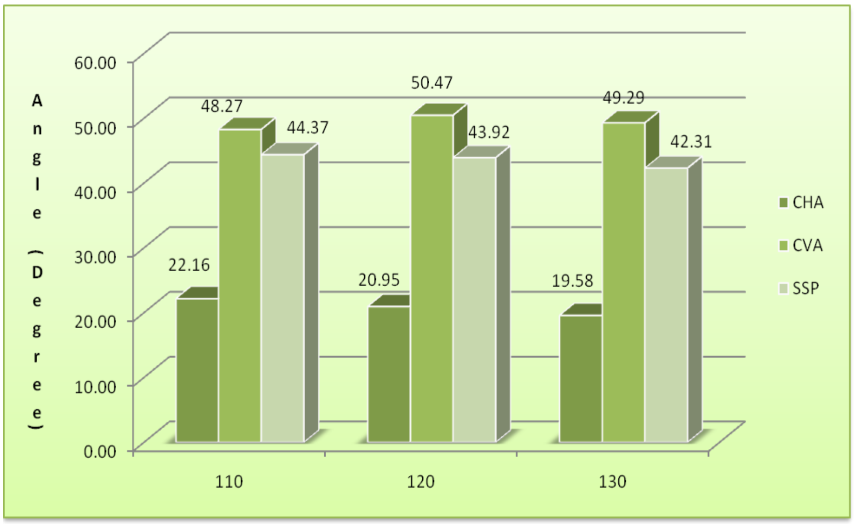
ANOVA between CVA, CHA, SSP

Degrees	F value	p value
110	36.354	0.001
120	46.228	0.001
130	41.888	0.001

Multiple comparisons of the CHA, CVA, SSP

Dependent variables	Postural variables	Mean difference	Standard error of mean	p value
110°	CHA Vs CVA	26.1128	3.3037	0.001
	CVA Vs SSP	3.9031	3.3037	0.240
	SSP Vs CHA	22.2096	3.3037	0.001
120°	CHA Vs CVA	29.5150	3.2241	0.001
	CVA Vs SSP	6.5450	3.2241	0.045
	SSP Vs CHA	22.9700	3.2241	0.001
130°	CHA Vs CVA	29.7106	3.3944	0.001
	CVA Vs SSP	6.9871	3.3944	0.042
	SSP Vs CHA	22.7234	3.3944	0.001

Mean value of CHA, CVA, SSP at 110°, 120°, 130°



DISCUSSION:

Among drivers, complaints concerning the musculoskeletal system are most frequently reported from the neck, shoulders and lower back [8,9,13,18]. An awkward and static posture, which is maintained by the driving population, is recognized as a risk factor for the development of musculoskeletal problems [2,,19,25]. Awkward and jerky movements are acutely more dangerous to the spinal tissues than prolonged use. If the body is kept in a single seated position, a specific set of postural muscles will need to work continually to maintain that posture[31,64]. These muscles eventually tire because they have no opportunity to relax. The posture attained while driving is considered to be an awkward posture and subsequently

lead to discomfort and pain [22,23]. The backrest angle maintained while driving as considered to play a very important role in keeping the stress to the spinal structure to minimum [17,31.].
According to a study done by D. Ravnik et al, 60% of those who felt discomfort in the neck , had the position of the backrest angles between 110° and 120°[12]. Although the backrest inclination of 110°bto 130° is found to cause the lowest disc pressures and lowest EMG activity from the spinal muscles, this position can provoke a forward head position, which can be a reason for the discomfort appearing in the neck region [12,16,17]. Thus the present study proposed to study the relationship between different backrest angles and there effect on the Craniohorizontal angle(CHA), Craniovertebral angle(CVA) and the Sagittal shoulder posture(SSP). In the present study, it has been hypothesized that, as we increase the backrest inclination from 110° to 130°, then the Craniohorizontal angle, Craniovertebral angle, and the Sagittal shoulder posture would decrease, in order to provoke a forward head positon. The result of the present study showed that CHA, CVA and SSP are insignificantly affected by the change in backrest angles from 110° to 130°. Forward head posture, that is commonly adopted by sedentary workers involve a combination of lower cervical flexion, upper cervical extension (head tilt), as well as rounded shoulders [23.] Sustained forward flexion of the cervical spine and prolonged static work, results in increased compressive loading in the cervical spine and a creep response in the tissues [3,10,11,14,27]. These phenomena may occur concurrently with increased electromyographic activity in cervical musculature [19]. The increased loading in the joints and muscles of the cervical spine as a result of the forward head position may be a major contributing factor for pain and discomfort around the neck [23].
Upper cervical extensor muscles are short and it has been proposed that even a small increase in extension can place these muscles in an inefficient range of their length-tension relationship. This may leave these muscles more vulnerable to fatigue [23,54]. The amount of cervical flexion and head tilt is also closely related to the angle of upper thoracic spine. It has been proposed that when the thoracic spine is leant backwards by 10°-15°, the cervical spine is still in flexion, but the muscles load in the neck is lowered [23]. This occurs because flexion results in more activity of the trapezius muscles and less in sternocleidomastoids. The sternocleidomastoids flex the neck whereas the trapezius maintain the flexion. The trapezius are larger and stronger than the sternocleidomastoids,so flexion would seem to pose less risk of fatigue[15]. Moreover, an a study by R. A. Bonney and E.N. Corlett done on head posture and loading of cervical spine, concludes that, the forward head posture is assumed by an individual due to the shrinkage of the cervical spine. The shrinkage, loads the cervical musculature and the cervical discs [61]. In the present study, subjects were mostly sitting with their backs resting against the back of the car seat. The exact thoracic angle was not measured, but most subjects were in reasonably upright position. Moreover, the time factor was not considered and the subjects were not allowed to change posture once seated. The photographs were captured as soon as the subjects seated themselves. This explains the insignificant decrease at 110°, 120° and 130°. In the present study, it was also found, that the CHA, CVA, and SSP are correlated significantly with each other. Findings of Kendall and Mc. Creary 1983, supports this [20]. In their study, they found that, the forward head position was related to the forward shoulder position. Study by Joao Paulo Caneiro et al shows that there is a clear link between thoraco-lumbar posture in sitting and head/neck posture and the motor activity [31]. Any curvature change in the thoracic spine will be compensated by the cervical spine, due to the kinematic linkage[63]. Hence the postural angles, CHA, CVA and SSP, which are dependent on the position of the head resting on the thoracic spine, will also be affected equally.

FUTURE RESEARCH

Future study can be done by measuring the amount of head flexion, at different backrest angles.

Study can be done to find out the effect of driving on the cervical spine. Electromyographic activity of the cervical spine muscles should be examined while driving to provide a complete picture about the biomechanical loadings of the spine while driving.

RELEVANCE TO CLINICAL PRACTICE

Increasing the backrest angles decreases the Craniohorizontal angle, Craniovertebral angle, and the Sagittal shoulder posture, but the decrease is insignificant. In our study, we made the subjects rest their backs on the car seats, and hence supporting the thoracic spine, which inturn is taking the load off the cervical spine. Physiotherapists role in in treating patients with the Musculoskeletal disorders resulting from driving is to offer suggestions to the patients to maintain a back supported sitting while driving.

LIMITATIONS OF THE STUDY

In our study, the subjects were aware of the fact that, there photographs are to be taken, so they were consciously aware of their posture. Therefore a realistic environment was not created.

Sample size taken was small

Short observation period make the results less meaningful than they could have been in a more elaborate study.

Conflict of Interest: No conflict of interest

Ethical Clearance; The complete work is done by me .

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