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Ergo-Human Optimum Sitting Position With Enhance the Biomechanics to Maintain the Natural Curvature of Spine Posture in Prominent Support and High Comfort of Backrest In Automobile Seating

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ABSTRACT

Nowadays, customer's expectations for comfort in automobile seating rise continuously. The ultimate aim is to minimizes fatigue and reduce the pressure, to provide an ergonomic feature in an optimum sitting posture ,so that even longer journey do not lead to physical discomfort. Design objectives such as comfort, safety and health need to be satisfied simultaneously. Prolonged period of driving results in manifestation of physical problems such as Low Back Pain (LBP), and other Musculoskeletal Disorders (MSDs). Lumbar support is to prevent the muscular fatigue while vehicle occupant is sitter. Design the seating system is made to be ergonomic, user-friendly, comfortable and safe. Good sitting posture and relaxed position of driving is mainly focused on concentration and responsibilities. It's also benefit to assess the ease Ingress/egress.

Keywords: Body posture, Biomechanics, Spine alignment, Neutral sitting posture, Ergonomics

I. INTRODUCTION

Normally, the human spine is a self- supporting system of skeleton cartilage, ligaments and muscles. Overall shape of spine is naturally "S" shaped curve when viewed from lateral (side).The main function of the spinal column is to supporting the majority of body weight, shock absorption, protection of spinal cord and providing a stable structure to maintain an upright posture (1 & 5)

The human spine is one of the most important parts in human body. With the strong and flexible structure, it provides support to entire human body and enables the body movement. Back complaint is mainly caused by poor sitting posture (2).

The relative pressure changes in lumbar vertebrae disc on performing the various task and its position such as standing, sitting and lifting the weight. Postural changes have varying effects on lumbar disc pressure at various positions (3). It indicates that the highest pressure is placed on the disc of the Lumbar spine occurs in the seated position and leaning forward, while bearing weight (Figure 1)

A. Human Spine

The spine is a crucial and complex structure in the human body. It offers main upright support for human body and protection to the spinal cord and nerve roots. Meanwhile, it allows the body to perform different motions, such as bending, twisting and rotating.

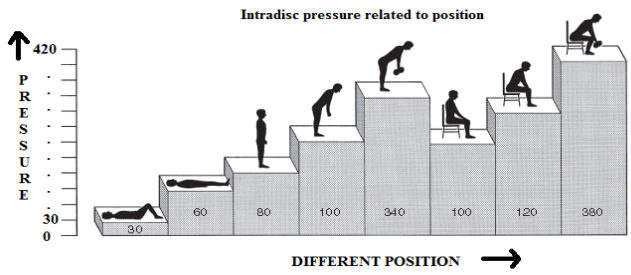


Figure 1. Relative increases and decreases in Intra-disc pressure in relation to different body positions

B. Functions of disc

The primary function of the disc is to join the vertebrae and allow movement between them. The other functions are typical of the erect spine; a shock absorber and a load distributor. Supports each vertebral disc in the lumbar region, providing relief for the spinal column and relaxation of back muscles (7)

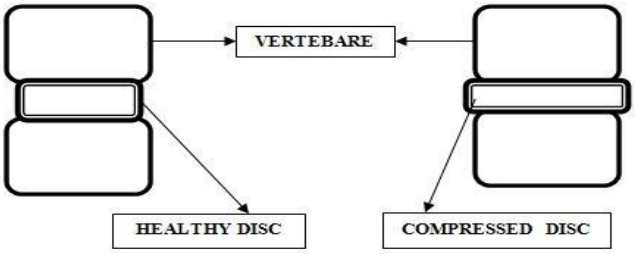


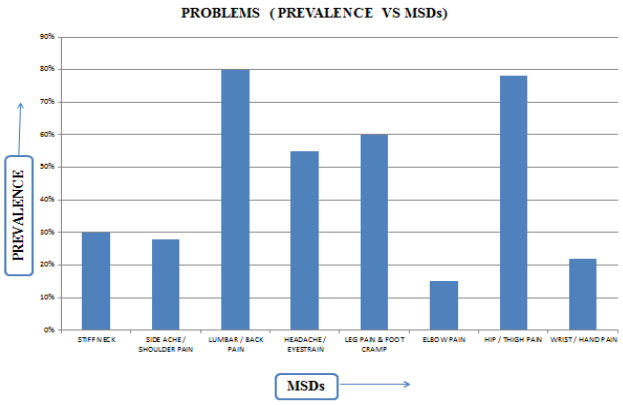
Figure 2. Vertebrae disc in normal and compress position

II. IDENTIFICATION OF PROBLEM

Improper sitting in the prolonged period of time is not good for the human body. Long-time driving is mainly results in Work –Related Musculoskeletal Disorders are mainly caused by poor posture, stress tension, position for extended period. Discomfort and Low Back Pain are frequent complaints from driver (4).

CTD- Cumulative Trauma Disorder is a collective term for syndromes characterized by discomfort, disability or persistent pain in joints, tendons, discs muscles, ligaments and other soft tissues, with or without physical manifestations.

The correct sitting position is an important step towards a healthier back and correcting bad sitting habits. Unnatural curvature of the spine that often leads to lower back pain (6)



The figure 3 shows that the majority of the prevalence percentage occurs in lumbar and back region of the occupant. According to Survey, National Institute of Health Low Back Pain affects about eight out of ten.

III. METHODOLOGY

First of all, clearly list out what are major problems they are facing in prolonged period of driving. Then identify the root cause for serve problem. Collect the parameters relevant to the discomfort. To conduct experiment, an ergonomically comparison test sitting in various position for significant amount of time. Each of them sat for an hour in three sitting postures (i.e., upright, slumped, and forward leaning sitting postures).

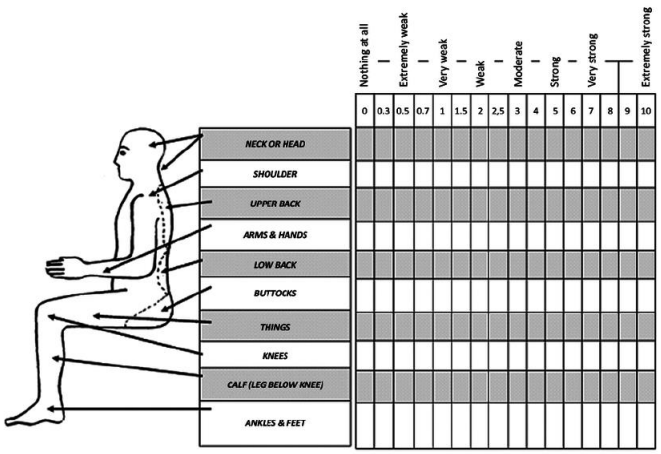


Figure 4. Borg's CR-10 Scale rating

Subjects rated perceived body part discomfort using Borg's CR-10 to indicate pain location in three sitting posture. An adapted Borg CR-10 scale was used to access the subjective discomfort on each body parts. A rating was given for each of 10 regions of the body parts including neck, shoulder, upper back, arm and hands, low back, buttocks, thighs, knees, calf and feet.

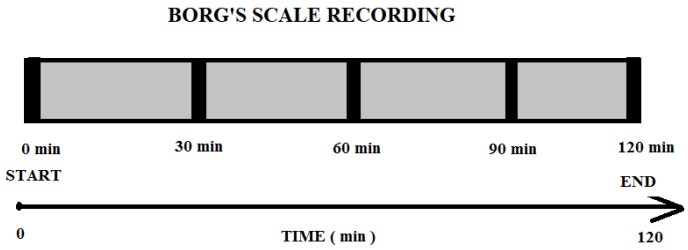


Figure 5. Borg's Scale reading with time

Ergonomic intervention has to play an important role to provide sitting comfort due to increased exposures to seated postures. Borg's scale recording with respect to certain time period and collect the feedback from each subjects discomfort rating in body parts.

Based on the results, the sitting posture with the highest low back discomfort after prolonged sitting was the forward leaning posture. Sitting in an upright posture is recommended because it increases muscle activation. Upright (good) posture is to prevent back slouch and strengthens the back muscles. Slouched (bad) posture, spine in a 'crab' position with strain on back muscles

Figure 6. Different Siting position (Upright, Lean forward and Slouched sitting posture)

IV. COMFORT DRIVING POSITION

A.Driving and effects

A vehicle is in motion; the body is subject to different forces such as to accelerations and decelerations, to lateral swaying from side to side and to whole body up and down vibration. On driving, the feet are actively being used right front on the gas (acceleration) pedal, left on the brake and also used on the clutch to shift the gear. When the feet are active they can't be used to support and stabilize the lower body as normally sitting position in chair. This is major evidence factor that leads to increase the back problems

Figure 7. Correct & Bad driving posture

Lumbar region

In vertebral column, lumbar region is the largest portion in the spine anatomy. It supplies a number of important functions for the human body. This region

include functions such as structural support, movement and protection of certain body tissues. Proper lumbar support with optimum sitting posture is to ensure the spine alignment and relax the back muscles for hours of pain – free. Ensure the lumbar support and correct sitting posture together will give good ergonomic comfort Lumbar support is to aids the spine into anatomically correct position and provides added support for the lower back to ensure good sitting posture. Evenly distributing body weight and minimizing the pressure point under thighs to promote proper blood circulation. The prominently use of lumbar support has to reduce the intra-disc loads on the spine and retrieve the lordosis curve in spine.

B. Sitting bones

Most of the people do not sit properly on their sitting bones; instead they sit on their tailbones. It mainly leads to problems such as low back-pain, additional forces on the spinal discs, ligaments and muscles. Ischial tuberosities (Sitting bones) is to rest automatically correct itself. Proper sitting posture is ideal pelvic tilt position with better comfort and keep the spine in a Neutral position – maintaining the natural curvature of spine.

Sitting is a body position in which weight of the body is transferred to a supporting area mainly by the Ischial tuberosities of the pelvis and lumbar surface. Pelvis is the foundation for sitting and strongly influences postural alignment of the entire skeleton. A neutral pelvic position is optimal for sitting .Both the Ischial Tuberosities should be equally utilize for weight bearing. Sitting is routinely performed in order to transfer the weight of the body to the supporting seat.

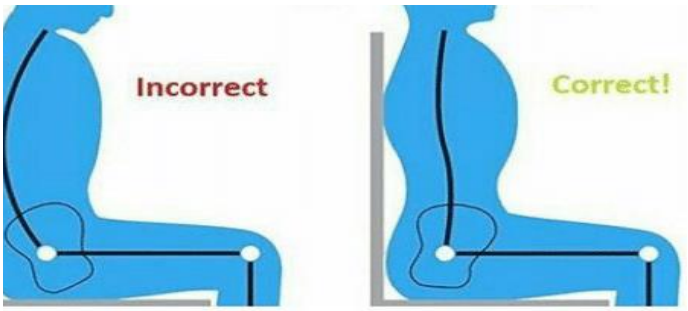
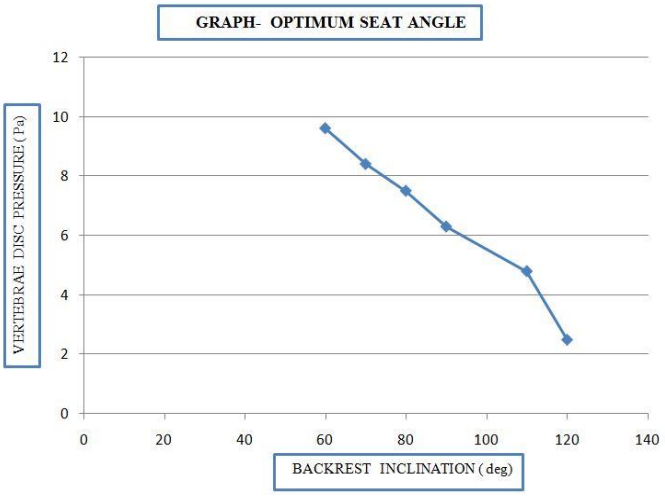


Figure 8. Proper Pelvic tilt position

V. OPTIMUM SITTING ANGLE

Normally, sitting position leads to 40-60% more stress/strain on the back (disc pressure) than standing posture .Instead of most people sitting in awkward posture. Moreover, it further increases the back pain. Positive seat angle helps to maintain good contact with backrest.



The graph shows that vertebrae disc pressure should minimum in the backrest inclination optimum angle should be seems in the range of 90 -120 deg. Maintaining a good posture is an easy way to reduce the Lower Back-pain (LBP) .It indicates that take away the painful spine by keeping the natural curves in their normal position

A. Proper posture

To sustain good posture (i.e.) neutral posture is the muscle of body must be imbalance to support an aligned spine .In a neutral spine there is optimum between the musculature right-to-left and front-to-back. When neutral posture, the body is in its

strongest and most balanced allowing for optimal efficiency and minimal stress on the joints. Best posture – imposes the least amount of stress and strain. Postural comfort is defined as the absence of an idea in sitting posture.

The secret of sitting correctly is to encourage the spine to its neutral 'balanced' position. The pelvis crest should tilt forwards allowing the spine to hold its natural 'S' shape. This means weight is evenly distributed across the inter-vertebral discs and there is a better balance in the supporting musculature.

B. Alignment of spine

Maintaining the proper alignment can alleviate a significant amount of posture discomfort. Seat profile shape is already designed to ensure the perfect alignment to achieve the natural curves of the spine. Neutral posture is essential for optimal wellbeing and functioning of the body such as holding the weight of body, good breathing, musculoskeletal balance, proper functioning of internal parts, concentration, memory and cognitive ability and flow of energy throughout the body. Bad pain causes bad posture; it indicates that more correlation exists between posture and pain

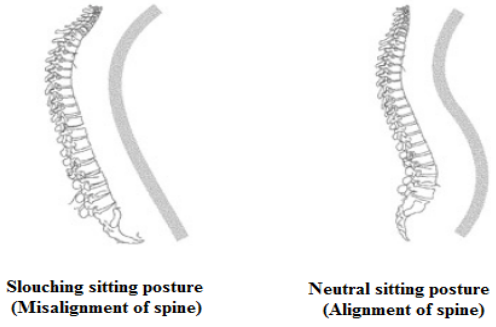
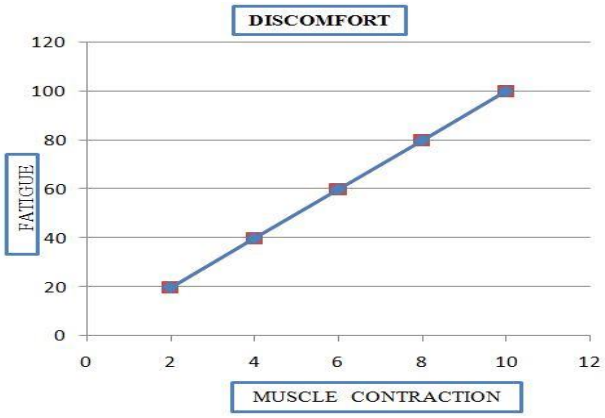


Figure 9. Alignment &Misalignment of spine

C. Awkward Sitting Position

Improper posture is manifests that add more stress to the spine and tighten muscles in the shoulders and chest area. Flattens of the lumbar region leads to a problem that is prone to shoulders pain, neck stiffness and back muscle tension. Poor posture and position can potentially cause/lead to musculoskeletal issues.



Bending this naturally elongated, "**S**" out of shape for long periods of time can often leads to muscle fatigue and back-pain. Poor sitting posture causes the unnecessary problems. Sitting flattens lumbar curve is to the change biomechanics of curve, increased the force on disc and also increases the muscle strain

The graph clearly indicates that increase the muscle contraction is drastically rises the fatigue of driver. Increased load on spinal vertebral column and it creates further discomfort.

VI. COMFORTABLE SITTING POSTURE

Recommendations

1) Ensure the seat back support to reclined position within the range of 90-120 degrees
2) Hold the steering wheel with both hands at the 9' clock and 3' clock positions
3) Back-rest should support the entire back from hips to shoulder
4) Natural "S" shape seat design is appropriately maintain the spine alignment and also proper back support is evenly distributing the weight
5) Knees should be slightly lower than hip position.

Eliminate pressure on the spine

Neutral posture is to reduce the force of gravity acting on the spine and vertebral column .It also helping to reduce the pressure, back- pain and swelling and greatly improve the breathing, muscle relaxation, tension relief and relieve pain. Support the upper body, easing neck tension and offering relief for the vertebral disc. Eliminate pressure points on legs and disc is to improves the blood circulation, thus preventing from numbness, leg pain and fatigue

Neutral Spine

Natural curvature of human spine is also known as "Neutral spine". In the neutral posture, body muscles to be in strongest and more stable and hence it be injury – resistant position. Posture is important because it support a vast range of daily function, in addition to supporting internal processes such as breathing, vision, digestion, circulation and temperature regulation

To keep correct alignment of spine in order to prevent injury and strain. Correct sitting position is the sitting upright with back straight and shoulders to be in the back. Body weight should be evenly distributed on both hip and gluteus should be touching the back of seat

Not aware of best sittings positions and sit in the wrong way, thereby abusing backs, necks and arms

1) Proper sitting position is the right angle or erect position
2) Sitting upright with aid of hips, knees and ankles all at right angles
3) 90 – Degree bending of the hip joint while preserving lordosis (concavity) of the back and that this equated to the best posture while sitting
4) Proper sitting posture is a more suitable position and allows the spine to carry the body weight in a more comfortable way
5) "Balanced seating" and "Best sitting position" is to ward off back-pain and stiffness

Neutral posture promote comfort

Generally, the spine is in its most natural position with minimal bending or twisting. It limits stress on the parts of the spine and ensures neck & back muscles aren't being contracted / stretched. Neutral sitting posture is to superiorly equalize body pressure distribution and promote the correct lumbar posture, mitigating pressure points and significantly improving long trip comfort

Benefit for proper balance posture

When the body is positioned correctly there is minimal strain on the muscles, ligaments, bones and joints, internal organs are not compressed, blood vessels are not pressed, nerves are not irritated. It's maintaining the skeletal alignment and to promoting the comfort and relaxation. Preventing the development of sores and decreasing the fatigue. Proper aligning and maintaining a natural S–curve is important for overall health and comfort.

VII. CONCLUSION

Optimum sitting angles is to allow the better blood flow, which in turn increases oxygen and therefore a more sustainable position for natural and comfortable position. Increased blood flow enhances the brain function as results in greater alertness. A well-relaxed posture of driving stimulates more concentration.

90-90-90 posture (90 degrees at the hips, knees and ankles) is the ideal sitting posture. The backrest must provide good support for the entire lumbar region. It provides a foundation that minimizes fatigue and reduces the pressure points. A backrest that is able to maintain the spine's natural S-shape and distributes the pressure over the largest possible area, a reclined sitting position, about 90°-120° is the position that gives the best relief from stress

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