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Effect of Prolonged Sitting on Hamstring Muscle Flexibility and Lumbar Lordosis in Collegiate Student

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ABSTRACT

Background- Prolonged sitting is a part of sedentary lifestyle individuals with prolonged sitting are required to be involved in other physical activity to promote changes in posture. Performing certain movements after prolonged sitting could result in a low back injury. Prolonged sitting leads to tightness of the hamstring muscle it can cause a decrease in range of motion and can lead to different musculoskeletal problems. Prolonged sitting can increase spine height and decrease the lumbar range. After an extended period of sitting full lumbar flexion movement can increase low back pain.
Objective- This study will provide an understanding of hamstring muscle flexibility and changes in lumbar lordosis in collegiate students which sits for prolonged hours.
Method- A sample of 80 collegiate students will be taken from Galgotias University, Greater Noida. The measurement of hamstring muscles is done when the hip is kept at flexion of 90 degrees, the angle of knee flexion is calculated during active knee extension. (As measured with the universal goniometer) and angle of SLR (passive SLR) measured with a goniometer. Lumbar lordosis is measured by flexicurve.
Result- A sample of 80 students was taken with a lifestyle of prolonged sitting more than 6 hours daily. Hamstring muscles tightness which is measured by the angle of SLR and AKE test with a goniometer was found in mainly students with more than 12 hours of sitting and change in curvature of the lumbar spine was observed leading to passive stiffness of lumbar spine and decrease in lumbar lordosis angle which is measured with the help of flexicurve. The known connection of increased intradiscal pressure while sitting which cause a decrease in lordosis.
Conclusion- It has been concluded that an increase in hours of prolonged sitting may cause hamstring tightness. The significant correlation was found between hours of sitting and lumbar lordosis angle. Long sitting hours or prolonged sitting of the collegiate student changes the curvature of the lumbar spine that leads to a decrease in the lumbar lordosis angle.

Keywords- Prolonged sitting, hamstring muscle, lumbar lordosis.

INTRODUCTION

The social, economic, and physical environment changes rapidly with the developing countries mainly technologies for personal use such as communication, entertainment, productive work leading to a decrease in human energy expenditure. Prolonged sitting leads to many health risks. There is larger evidence of the relationship of prolonged sitting time with the pattern of sitting time and cardiometabolic risk. (N. Owen 2012)

Prolonged sitting is a part of sedentary lifestyle individuals with prolonged sitting are required to be involved in other physical activity to promote changes in posture. Performing certain movements after prolonged sitting could result in a low back injury. Individuals mainly are in flexed lumbar posture while

working which results in passive flexion stiffness. Prolonged sitting can increase spine height and decrease the lumbar range. After an extended period of sitting full lumbar flexion movement can increase low back pain. (T.A.C. Beach et al 2004)

Ongoing population-based examinations propose that prolonged sitting period, surveyed by target measures, such as accelerometry, causes harmful effects on cardiometabolic biomarkers, independent of the time invested sedentarily and time spent in moderate to intense physical activity. For instance, the research has indicated that adults with a less number of breaks in sitting time (delayed sitting time), on a normal day, have a more chance of cardiometabolic risk, for example, raised abdomen perimeter and plasma glucose, compared to the individuals who had increasingly visit interferences in their daily prolonged sitting time. (Altenburg TM et al 2013)

In an ongoing test, it was observed that interferences in prolonged sitting in overweight adults decrease the levels of insulin and postprandial glucose compared to an adult with no interference to prolonged sitting. (Altenburg TM et al 2013)

Hamstring muscles have semitendinosus and biceps femoris muscles they start from the ischial tuberosity as a normal ligament. (K. Sato et al 2012)

Flexibility is a part of the fitness required for better musculoskeletal working and increasing physical exercises. Hamstring muscles are the group of muscles in which the problem of flexibility inhibition is faced by both common and sports individuals. Tightness in hamstring not only causes a decrease in movement but also prompts different musculoskeletal issues. The muscle relationships of length-tension act as the shock engrossing capacity of the limb which is influenced by muscle tightness. Diminished flexibility produces an endless loop of decreased range, and prompts different musculoskeletal issues. (Fatima, et al 2017)

The primary explanation of tightness in the muscle is the capacity of muscle to distort, prompting a decreased range at the joint. Tightness in hamstrings is related to a defective pattern of motor control, prompting a submaximal terminating of postural muscle pattern, bringing about the capacity of the hamstrings as stabilizers as opposed to their fundamental capacity of prime movers. This adjustment is an essential capacity that prompts the introduction of hamstring tightness. Numerous reasons can prompt the advancement of hamstring tightness, for example, hereditary inclination, muscle injury, and shortening of muscles due to any chronic condition. (Fatima, et al 2017)

In the literature, the straight leg raise (SLR) test is used to determine the length of the hamstring muscle and as a diagnostic aid for sciatica and nerve root pain. The SLR test is identified as a passive test conducted when the neck is in a neutral position and also the hip of the opposite limb is extended.

Another method is also used for calculating the hamstring muscle length. In the AKE test, the measurement of hamstring muscles is done when the hip is kept at flexion of 90 degrees, the angle of knee flexion is calculated during active knee extension.

The AKE test subjects were in a supine position in such a way that the thigh comes in contact with the wooden frame on the crossbar, and the thigh is placed with the trunk at a point of 90 degrees (as estimated with the general goniometer). The subject is advised to extend their knee while keeping in touch with the crossbar. (Denise M. Cameron, et al 2019)

Lumbar lordosis defined as a lumbar spine's ventral curvature surrounded by the wedging of the bodies of the lumbar vertebra and the intervertebral plate. Dorsal wedging of the vertebra and plates determines the angle of lordosis while gradually ventral wedging of these structures reduces the angle of lordosis. Lumbar lordosis determines the state of the bodies of the vertebra and the state of the intervertebral plates because of each record

for about half of the inconstancy seen in the adult's lordotic angle. All the five vertebrae of the lumbar region form lordosis. The L5 lumbar section gives practically 40% in general lordosis and the L1 segment contributes just 5%. (E. Been and L. Kalichman, 2013)

The Flexi curve can represent the curvature of the spine in a continuous manner. The Flexi curve is an instrument that has a plastic coating over a metal ruler which is flexible that can be twisted in such a way that the shape of the spine can be replicated. The Flexi curve involves measuring the abnormalities. The Flexi curve is seen as a true method used for the lumbar area. (Tatiana Scheeren de Oliveira et al 2012)

MATERIALS & METHODS

A sample of 80 collegiate students having prolonged sitting ≥6hrs recruited from Galgotias University, Greater Noida. College student within the age group of 18-28 years with prolonged sitting (more than 6h) (Fatima et al., 2017) were included in the study. Students with history of recent trauma, previous surgery, and any spasm in the hamstring muscles, limb length discrepancy or any spinal deformity and any neuromuscular disorders of the lower limbs were excluded from the study.

Procedure

Collegiate students were recruited from Galgotias University and informed about the study. All the possible risks and methodology of the study were explained to the subjects. They were given a consent form that explains the research subject's rights. Selection was take place on the bases of inclusion and exclusion criteria. All the personal information and demographic data of the subjects were kept confidential. The subject's height was measured by a stadiometer and weight was measured by the weighing machine. The study was carried out in the Physiotherapy department, Galgotias University.

Protocol

Prolonged sitting

The subjects having prolonged sitting were included in the study. The selected students were those having age groups between 16 to 30 years and sits for longer than 6 hours. (Fatima et al., 2017)

Criterion measures

Hamstring muscle flexibility

Hamstring muscle flexibility was measured using the angle of SLR & Active knee extension tests.

Angle of SLR (passive SLR)

In the literature, the straight leg raise (SLR) test is used to determine the length of the hamstring muscle and as a diagnostic aid for sciatica and nerve root pain. (Denise M. Cameron et al 2019). The passive straight leg raise angle should be greater than or equal to 80 degrees to be described as normal hamstring flexibility (Esther Liyanage et al 2020)

Methodological considerations

The SLR test is identified as a passive test conducted when the neck is in a neutral position and also the hip of the opposite limb is extended. A normal examination couch was used for the SLR test. Participants lie supine and were advised to relax during the entire study. The therapist flexed the tested limb, with the knee completely extended and the foot in a relaxed position. The contralateral limb was secured by the other examiner. When the participant feels a strong resistance the movement is stopped. The goniometer was placed over the greater trochanter, with one arm parallel to the table and other arm aligned with the lateral femoral condyle. (Neto et al 2015).

Active knee extension test

In the AKE test, the measurement of hamstring muscles is done when the hip is kept at flexion of 90 degrees, the angle of knee flexion is calculated during active knee extension. (Denise M. Cameron et al 2019) Hamstring tightness is often measured by the AKE test as a part of the orthopedic physical assessment, with normal values of knee motion to within 20 degrees of full extension (Magee 2002).

Methodological considerations

The AKE test, subjects were in a supine position with the thigh in contact with the crossbar, and the thigh is placed with the trunk at a point of 90 degrees (as estimated with the general goniometer). The subject is advised to extend their knee while keeping in touch with the crossbar. The second examiner stabilizes the contralateral limb and the limb is fully extended. The foot should be kept in neutral position and the knee is flexed at 90°, a universal goniometer was kept over the lateral femoral condyle, with one arm placed along the thigh and the other arm was kept over the leg in the direction of the lateral malleolus. From this position, subjects were instructed to extend the knee without any earlier warm-up until they felt a strong resistance, keeping this final position for 2 to 3 seconds to allow goniometric reading. (Neto et al 2015)

Lumbar lordosis

To assess lumbar lordosis flexicurve was used. An ideal parameter for evaluating lumbar lordosis is the Lumbar Lordotic Angle. The normal LLA value is 20-45 degrees. (Lin RM et al 1992)

Flexicurve

The Flexi curve can represent the curvature of the spine in a continuous manner. The Flexi curve is an instrument that has a plastic coating over a metal ruler which is flexible that can be twisted in such a way that the shape of the spine can be replicated. The Flexi curve involves measuring the abnormalities. The Flexi curve is seen as a true method used for the lumbar area.

Methodological considerations

A flexible Flexicurve ruler was used to measure the curve of lumbar lordosis. The base of the sacrum and spinous process of L1 was located by palpation and marked with removable stickers for this purpose, the individual was in relaxed standing. A flexible ruler was placed on a subject's lumbar curve, it is kept over the spinous processes of lumbar L1 – S1. The flexible ruler curve, replicating the size of the individual lumbar curvature, was drawn on a paper, noting where the two L1 and S1 reference points were present. The explained method was used to calculate the degree of lumbar lordosis (Θ). A line (L) connected the two points on the curve, referring to L1 and S1. A perpendicular line (H), which represents the lumbar curve's height, bisected line L. The length of each line was calculated, and the values were utilized within the following formula to calculate the angle of lumbar lordosis. (A.M. Arab and M.R. Nourbakhsh)

$\theta = 4 \times [\arctan (2H/L)]$

Where θ *=lumbar lordosis in degrees,* L = length of the curve and H = height of the curve.

DATA ANALYSIS & RESULTS

SPSS version 19 was used for data analysis. A p value of < 0.05 was considered as significant. Mean and standard deviation was used for presenting data. Correlation analysis of Pearson's was used to understand the correlation between hours of sitting and the tightness in hamstring muscle and hours of sitting and lumbar lordosis angle.

The present study was conducted to test the effect of prolonged sitting on hamstring muscle length and lumbar lordosis in collegiate students. In this study, we took a sample of 80 healthy collegiate students satisfying the inclusion criteria and measures for the tightness hamstring muscle (Straight Leg Raises Test and Knee extension test) and lumbar lordosis (flexicurve). The results are described and represented under tables and graphs. The basic demographic data of participants are shown in Table 1.

Variables for hamstring tightness and lumbar lordosis were analyzed for all the participants:

Measure of hamstring length

Straight leg raise test (SLR): Data analysis shows that the mean value for all the participants was 52.39±7.1. Although there is no significant correlation found between hours of sitting and straight leg raise test, but on comparison between chair

sitting hours it is found that there is a decrease in the straight leg raise angle as chair sitting hour increases.

Active knee extension test (AKE): The mean value for all the participant of active knee extension was observed as 33.41±5.73. There is no significant correlation found between the hours of sitting and active knee extension test on co-relational analysis. The mean value of active knee extension was observed as 26.00±3.52 for the participants who had longer than 12 hours of sitting per day.

Measure of Lumbar lordosis

Lumbar lordosis angle (LLA): On analysing the data it was found that the mean value of lumbar lordosis angle for all the students was 17.05±5.99. There is a significant correlation was found between hours of sitting and lumbar lordosis angle. An inverse correlation was found between lumbar lordosis angle and sitting hours (r = −0.746, P = 0.000)

Table 5.1. Shows demographic data

Demographic data

Variables	Age (years)	Ht. (cm)	Wt. (kg)	BMI (kg/cm^2)
Mean±SD	20.95±1.97	167.46±8.52	59.39±7.04	21.24±2.72
Minimum	18	148	45	16.78
Maximum	25	182	75	30.13
Abbreviations- BMI: Body Mass Index; Ht: Height; Wt: Weight				

Table 5.2. Data are represented as mean± (SD) for the dependent variables

	SLR	AKE	LLA
Mean±SD	52.39±7.1	33.41±5.73	17.05±5.99
Minimum	40	22	5
Maximum	65	50	30
Abbreviations-SLR: Straight Leg Raise; AKE: Active Knee Extension; LLA: Lumbar Lordosis Angle			

Table 5.3. Data are represented as mean±(SD) for the variables in which there was a significant difference in accordance with hours of sitting.

HOS	SLR	AKE	LLA	p-value
6-8	54.70±6.72	34.03±3.90	21.42±3.92	0.000
8-10	51.96±7.23	35.96±6.58	17.39±3.79	
10-12	50.22±7.48	31.50±5.59	11.22±4.19	
>12	47.83±2.92	26.00±3.52	9.17±4.70	
Abbreviations- HOS: Hours of Sitting; SLR: Straight Leg Raise; AKE: Active Knee Extension; LLA: Lumbar Lordosis Angle				

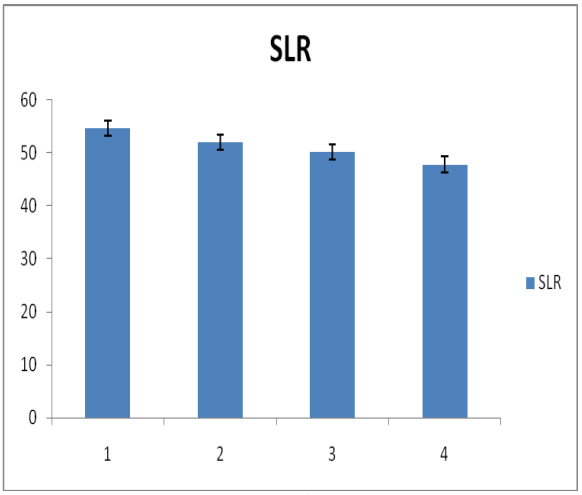

Figure 5.1: Mean±SD comparison for angle of straight leg raise (SLR) between sitting groups

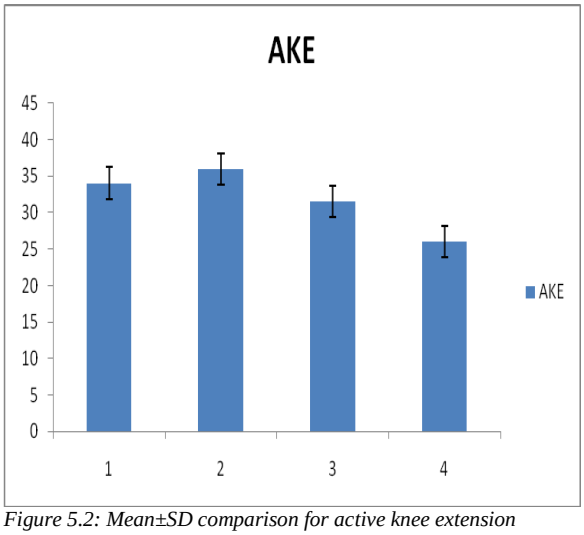

Figure 5.2: Mean±SD comparison for active knee extension (AKE) between sitting groups

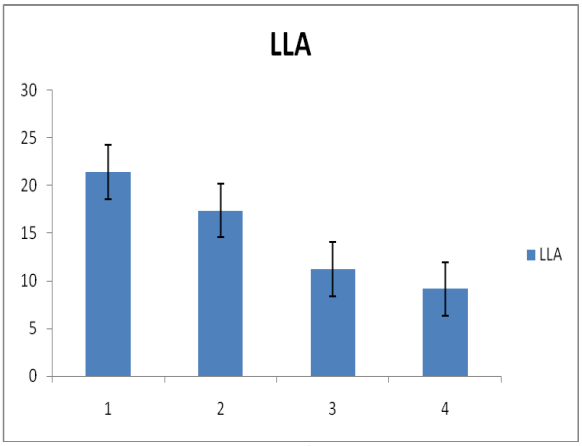

Figure 5.3: Mean±SD comparison for lumbar lordosis angle (LLA) between sitting groups

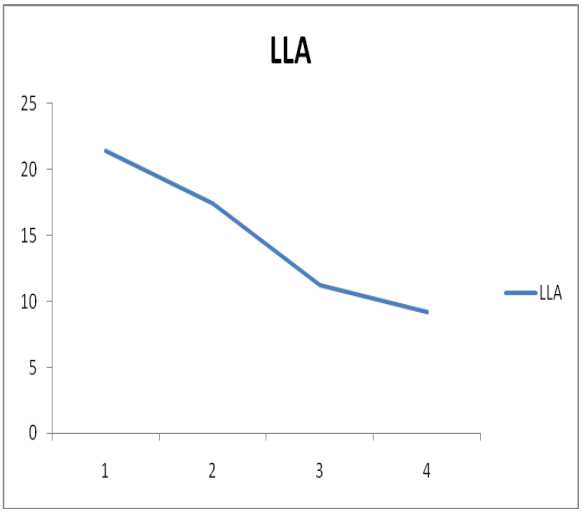

Figure 5.4: shows negative correlation between lumbar lordosis Angle (LLA) & hours of sitting

DISCUSSION

The current examination was attempted to discover the impact of delayed sitting on hamstring muscle adaptability and lumbar lordosis in university students. It has been accounted that prolonged sitting fundamentally modifies hamstring muscle flexibility and lumbar lordotic curve.

This investigation is one of its sorts, giving essential data for the effect of prolonged sitting on the hamstring muscle flexibility and lumbar lordosis. As far as anyone is concerned, no examination has been done where we can watch the effect of prolonged sitting on the hamstring flexibility in instructional arrangements, particularly in healthy and symptomless college youth. Fatima, et al (2017) gave a perspective on a significant finding of hamstring tightness among a large portion of students, and a positive connection was found among prolonged sitting hours and hamstring tightness and lumbar lordosis. Felipe Jose Jandre Reis et al in his study clarified tightness of muscle may cause disturbances in posture. Both can add to various musculoskeletal conditions diminished extensibility because of increase stiffness in hamstring may be a potential contributing element to injuries to the low back. There is the biggest proof of the relationship of prolonged sitting time with cardiometabolic hazards.

T.A.C. Beach et al said delayed sitting is a piece of an inactive way of life, people with delayed sitting are required to be engaged in other physical activity to advance changes in posture. Playing out specific developments after delayed sitting may prompt low back injury. Individuals mainly are in flexed lumbar posture while working which brings about passive flexion stiffness. Drawn out prolonged sitting can build the height of the spine and decrease the lumbar movement. Sitting can prompt inactive stiffness of the lumbar spine. After a prolonged time of sitting full lumbar flexion development can expand low back pain.

Fatima, et al (2017) also discussed tightness in hamstring is likewise connected with the expansion of plantar fasciitis similar to patellofemoral pain syndrome and tendinopathy. A relationship of tightness in the hamstring and low back pain is additionally seen in the researches indicating a positive connection among tightness in the hamstring and low back pain. The muscle relationships of length-tension act as the shock engrossing capacity of the limb which is influenced by muscle tightness. Diminished flexibility produces an endless loop of decreased range, and prompts different musculoskeletal issues. Tight muscles likewise pack the veins and lead to decreased ideal performance.

Shah Vidhi et al said hamstring muscle act as a hip extensor muscle and knee flexor muscle. Hamstring muscles are the most common muscles to undergo

tightness. Hamstring tightness can lead to back rotation of the pelvis, decreasing the curvature of lumbar and causing back pain. Tight hamstrings leads to postural changes and various back problems such as SI joint pain which will result in pelvic displacement from its original place. Blood vessels compression is caused by tight muscles which cause the blood to move out of them which results in inefficiency of the muscles, changing their function.

Gurpreet Kaur and M Kashif Reza gave a view that limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries and also significantly affect a person's functional level.

Pratik A Gohil in his study explained Soft tissue injuries, menisci injuries, knee pain Chondromalacia patella, and bad posture is a result from tight hamstrings and also change in flexibility of the hamstring muscle may produce significant postural changes and affect the functions of the hip joint and lumbar spine. During high speed or high-intensity exercises, hamstring muscle injuries can be seen and have a high rate of recurrence. Lack of flexibility in the hamstring was the most important feature of hamstring injuries in athletes.

The primary explanation of tightness in the muscle is the capacity of muscle to distort, prompting a decreased range at the joint. Tightness in hamstrings is related to a defective pattern of motor control, prompting a submaximal terminating of postural muscle pattern, bringing about the capacity of the hamstrings as stabilizers as opposed to their fundamental capacity of prime movers. This adjustment is an essential capacity that prompts the introduction of hamstring tightness. (Fatima, et al 2017)

In the literature, the straight leg raise (SLR) test is used to determine the length of the hamstring muscle and as a diagnostic aid for sciatica and nerve root pain. (Denise M. Cameron, et al 2019) Data analysis shows that the mean value for all the participants was 52.39±7.1. Although there is no significant correlation found between hours of sitting and straight leg raise test, on a comparison between chair sitting hours it is found that there is a decrease in the straight leg raise angle as chair sitting hour increases.

Another method is also used for calculating the hamstring muscle length. In the AKE test, the measurement of hamstring muscles is done when the hip is kept at flexion of 90 degrees, the angle of knee flexion is calculated during active knee extension. (Denise M. Cameron, et al 2019) The mean value for all the participants of the active knee extension was observed as 33.41±5.73. There is no significant correlation found between the hours of sitting and active knee extension test on co-relational analysis. The mean value of active knee extension was analyzed as 26.00±3.52 for the participants who had longer than 12 hours of sitting per day.

Felipe Jose Jandre Reis et al portrayed the development of limitations or postural asymmetry is accepted to prompt movement pattern of the lumbar spine, and in this manner to increase stress on soft tissues of spine and an increased danger of injury. The LBP patients demonstrated limitations in the movement of pelvic. It has been hypothesized that, when the two body segment moves, the section with more mobility will move first. This is determined as relative flexibility.

On analyzing the data it was found that the mean value of the lumbar lordosis angle for all the students was 17.05±5.99. There is a significant correlation was found between hours of sitting and lumbar lordosis angle.

A.M. Arab and M.R. Nourbakhsh discussed that sitting position includes lumbar flexion. Sitting posture increases the pressure on posterior components of spine. Muscle movement and back strain levels have been demonstrated to be different during various positions of sitting (drooped sitting, upstanding sitting, and upright sitting with the forward tendency of the chest area). There was a hypothesis

regarding the impact of lifestyle and work setting on lumbar lordosis size. A few specialists have recommended that prolonged sitting and the constant flexed posture of lumbar leads to LBP and changes in lumbar lordosis.

E. Been and L. Kalichman (2013) said lumbar lordosis defined as a lumbar spine's ventral curvature surrounded by the wedging of the bodies of the lumbar vertebra and the intervertebral plate. Dorsal wedging of the vertebra and plates determines the angle of lordosis while gradually ventral wedging of these structures reduces the angle of lordosis. Lumbar lordosis determines the state of the bodies of the vertebra and the state of the intervertebral plates because of each record for about half of the inconstancy seen in the adult's lordotic angle. All the five vertebrae of the lumbar region form lordosis. The L5 lumbar section gives practically 40% in general lordosis and L1 segment contributes just 5%.

E. Been and L. Kalichman (2013) explained that lumbar lordosis is framed by the combination of vertebrae and endplate angles. The lordotic angle may change at the point where the intervertebral disc is displaced or when the bodies of the vertebra are compressed. A decrease in lordosis can likewise happen and can result in flat back syndrome.

J. Drzał-Grabiec et al. (2016) in his study demonstrated body posture is a particular and one of a kind (for every person) shape and course of action of the different components of the body compared with each other in the vertical position. At the point when the right position is achieved, the load is distributed equally to every intervertebral disc. A load of each part of the body is transmitted uniformly on the sacrum through the physiological curve of the spine. The spine satisfies its capacity appropriately when the body weight and the force of gravity are moving along its axis. The primary weight is borne through the spine lumbar vertebrae, and its volume relies upon the supine position. Intervertebral discs are liable for the balance of pressure because of their high durability and flexibility.

During day to day exercises, intervertebral discs change their height by around 10–20%, and their appropriate capacity depends upon satisfactory nutrition by dissemination through the endplates, which might be upset by a long, static, and non-physiological sitting position. This affects the musculoskeletal system.

J. Drzał-Grabiec et al additionally clarified the reasons for changes in the length and depth parameters of lumbar lordosis and the tendency of the thoracolumbar and upper thoracic spine and the situation of the shoulder bones. In the casual sitting position, a decrease was noted in the depth of the physiological shapes of the spine and a decrease of their tendencies, which is for the most part because of the bending in the knee and hip joints that happens in this position. As the principle purposes behind the increase in pressure, while sitting in a flexed position, the author showed changes in the center point of gravity of the body, the load distribution inside the intervertebral plate, and paraspinal ligament stretch to breaking point.

Sitting caused a decrease in the Lumbar Lordosis. Sitting essentially reduces lumbar lordosis and segmental angle when contrasted with standing. The lower lumbar segmental points (L4–5 and L5–S1) fundamentally decrease in every single sitting position, however, the reduction was moderately less on the seat with lumbar support and in the 90°-calculated seat. The sacral slope reduces and the pelvic tilt increases with decreasing lumbar lordosis in the sitting position. Practically speaking, it is smarter to choose a sitting position that outcomes cause minimal change to Lumbar lordosis. (IL Youp Cho et al. 2015)

Michael J Lord et al said the known connection of increased intradiscal pressure while sitting which causes a decrease in lordosis.

CONCLUSION

It has been concluded that an increase in hours of prolonged sitting may cause hamstring tightness. It is concluded that the tightness of the hamstring muscle is only observed in students having more than 12 hours of sitting. Long duration sitting is a contributory factor for hamstring tightness. The significant correlation was found between hours of sitting and lumbar lordosis angle. We observed in our study that long sitting hours or prolonged sitting of the collegiate student changes the curvature of the lumbar spine that leads to a decrease in the lumbar lordosis angle.

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