Effect of Cushion Height on Muscle Activation During Sit to Stand Motion in Healthy Elderly Subjects.

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Abstract: Background: During 2nd phase of sit to stand motion, complex co-contraction pattern of activity at knee joint is in contrast to the flexion only of phase 1 and extension only of phase 3. In this study amplitude of activation of knee joint muscle (vastus medialis and biceps femoris) is assessed. As cushion height is an important factor in sit to stand motion, 30mm cushion, 60mm cushion and 90mm cushion on ideal chair for assessing amplitude of muscle activation during sit to stand have been used. OBJECTIVES: To assess muscle activation while using 30mm, 60 mm and 90 mm thickness cushion during Sit to stand (STS) motion in healthy elderly subjects. To compare between this 3 thickness of cushion. To correlate balance (time up and go score) with amplitude of muscle contraction during STS motion using different heights of cushion. Methods: The study included 75 healthy elderly individuals who were able to do Sit to stand motion (STS) independently. Amplitude of muscle activation of vastus medialis and biceps femoris muscle were assessed using surface Electromyography. Three times subject was told to do sit to stand motion on 30 mm, 60 mm and 90 mm cushion thickness respectively, average value of amplitude of muscle activation on 30mm, 60mm and 90mm cushion thickness was considered. Balance was assessed using Timed up and go scale (TUG). Results: There was no significant difference in the EMG activity of vastus medialis at 30 mm, 60 mm, and 90 mm cushion thickness. (p=0.442), there was significant difference in the EMG activity of biceps femoris at 30 mm, 60 mm, and 90 mm cushion thickness. (p=0.000) Friedman Test was used. There was increased electromyographic activity of biceps femoris muscle on 30 mm cushion thickness followed by 90 mm cushion thickness and less electromyographic activity at 60 mm cushion thickness during sit to stand motion. Multiple Comparisons - Bonferroni Adjusted Wilcoxon signed rank tests was used. Conclusion: This study suggests, the electromyographic activity of biceps femoris muscle during sit to stand motion was more on 30 mm cushion thickness followed by 90 mm cushion thickness and 60 mm cushion thickness. [Salvi S Natl J Integr Res Med, 2019; 10(6):46-49]

Keywords- Electromyography, vastus medialis, biceps femoris, cushion thickness, amplitude of muscle activation, timed up and go scale

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Introduction Sit to Stand is a movement in which the base of support is transferred from the seat to the feet.[1] Among all motor task associated with activities of daily living, sit to stand movement has been identified as the most difficult and mechanically demanding because it requires significant leg muscle strength, a wide range of joint movement, and good balance control. [2] Factors affecting sit to stand motion are external factors like chair height[4], chair inclination [5]chair cushion thickness[3] and internal factors in elderly are muscular weakness-sarcopenia.[6]

Dependency on hand use may be a marker of progressive rise of impairment.[7]So in this study we have restricted hand use by asking the patient to stand by crossing their hands around their chest. Clinicians commonly use questionnaires and tests based on daily life activities to evaluate physical function. However, the outcomes are usually more qualitative than quantitative and subtle differences are not detectable.[8] Hence, we are using EMG to give more quantitative results.

In effect of variation of cushion thickness on Sit to stand motion in elderly, lower limb joint angle changes and joint load was stated with help of video tape, markers, force plate, 3 thickness cushions were used 30 mm, 60 mm, 90 mm respectively.[3] As the amplitude of muscle activation related to the different cushion thickness was not checked, so we have assessed amplitude of muscle activation during STS on different height of cushion thickness.

As the cushion height plays an important role in urbanized life style due to use of various furnished chair cushion and cushion height is important in various institutes like hospital and old age home. Therefore, in this study assessment of knee joint muscle activation (vastus medialis and biceps femoris muscle) using EMG during sit to stand motion on various cushion height in healthy elderly subjects is recorded.

Correlation of balance with amplitude of muscle activation on different cushion thickness is also a part of this study. Time up and go scale is used for assessing balance as it involves sit to stand activity from chair and is one of the reliable outcome measures used to assess balance in elderly.[9]

Material and Methods: After obtaining Institutional Ethical clearance the present study was conducted. The sample size of study was 75 healthy elderly subjects, male and female above 60 years of age were recruited for the study according to the inclusion and exclusion criteria. The nature of the study was explained to the subjects in the language best known to them and signed informed written consent was obtained.
Inclusion and Exclusion criteria-Males and females above 60 years of age and able to perform sit to stand motion independently were included the study. Subjects having musculoskeletal, cardiovascular, neurological disorders, Subjects having skin irritation and visual problems like blurring of vision and diplopia were excluded from the study.

Surfaceelectromyography (SEMG): SEMG is commonly used to quantify the magnitude and timing of muscle activation during various physical tasks. EMG reliability for both vastus medialis and biceps femoris muscles for both isometric and ballistic activity wasgood.[9,10] Surface electromyography is a non-invasive, easy-to-use method, being quite useful for continuous monitoring. a) PowerLab Data Acquisition Unit ML70 POWERLAB ML408 Dual Bio Amp/Stimulator (ADInstrument). PowerLab is a data acquisition developed by ADInstrument compromising hardware and software designed for use in life and science research. Electrically isolated and high performance differential biological amplifiers optimized for the measurement of a variety of biological signals such as EMG, EEG, and ECG.[11,12]b) LabChart software It provides a range of powerful features that transcend the limitations of pen-and ink recorders and do it yourself data acquisition systems. It transforms your computer into a digital chart recorder with analysis features such as data extractions, arithmetic calculations, statistical analyses, data display and graphing options.
c) Disposable ECG electrodes
d) Wooden chair without arm rest: 45 cm.[13] 3 cushions of thickness: 30mm, 60mm, 90mm, cushion made of coiler and non- slippery cover. 30 mm Wooden platform below 60 mm cushion height, 60 mm wooden platform below 90 mm cushion height, Stop watch.

Balance was assessed using timed up and go scale in subjects participating in the study. After that 1 minute rest was given and Surface electromyography of vastus medialis and biceps femoris muscles was assessed during sit to stand motion on 30 mm,60 mm and 90 mm cushion heights, 3 readings were taken by asking the subject to do three times STS motion on 30 mm cushion height for 3 times after that 1 min rest was given and same was done with 60 mm cushion height and again after 1min rest was given and same was done with 90 mm cushion height. Average reading of integral values of muscle activation during STS on 30mm, 60mm and 90 mm cushion was taken. To find the effect of cushion chair height was kept constant by using 30 mm platform under 60 mm cushion height chair and 60 mm platform under 90 mm cushion height chair.

Results : Values of activation of Vastus medialis on 30mm, 60 mm, 90 mm cushion thickness. Friedman Test was used. Chi-square= 1.634 with 2 degrees of freedom; P = 0.442 According to table 1 there was no significant difference in the EMG activity of vastus medialis at 30 mm, 60 mm, and 90 mm cushion thickness. (p=0.442)

Table 1: EMG activity of vastus medialis

	No. of subjects	Standard Mean	Standard deviation	Median
30mm cushion	75	0.5	0.28	0.43
60mm cushion	75	0.48	0.30	0.42
90mm cushion	75	0.52	0.46	0.43

values of activation of biceps femoris during STS on 30 mm, 60 mm,90 mm cushion thickness Friedman Test was used. Chi-square= 15.362 with 2 degrees of freedom; P = 0.000. According to table 2 there was significant difference in the EMG activity of biceps femoris at 30 mm, 60 mm, and 90 mm cushion thickness (p=0.000). There was increased EMG activity of biceps femoris muscle on 30 mm cushion thickness followed by 90 mm cushion thickness and less EMG activity at

60 mm cushion thickness during sit to stand motion

Table-2: EMG activity of biceps femoris muscle

	No. of subjects	Standard mean	Standard deviation	Median
30 mm cushion	75	0.5283	0.2936	0.47
60 mm cushion	75	0.4139	0.2288	0.36
90 mm cushion	75	0.4687	0.3979	0.36

values of comparison of difference of means of EMG activity of biceps femoris muscle while STS motion on 30 mm, 60 mm and 90 mm thickness cushion. Multiple Comparisons - Bonferroni Adjusted Wilcoxon signed rank tests was used. According to the table 3 there was significant difference between comparison of 30 mm and 60 mm cushion thickness ;30 mm and 90 mm cushion thickness and there was no significant difference between 60 mm and 90 mm cushion thickness in activation of muscles during sit to stand movement.

Table-3 : comparison of EMG activity of biceps femoris muscle

Comparison	Difference of means	P<.05
30mm vs 60mm	2.367-1.787=0.58	Yes
30mm vs 90mm	2.367-1.827=0.52	Yes
60mm vs 90mm	1.787-1.847=-0.06	No

Discussion: Muscle mass decreases beginning at around age 50 years, and by age 80 years 40% of muscle mass has been lost. Muscle force production likewise decreases at a rate of about 30% between 60 and 90 years of age. Decrease muscle mass in a person older than 60 years of age can lead to decreased size, fewer type II muscle fibres, and increase in fat infiltration into the muscle tissue.[14] Clinically these factors can cause reduced muscle force production during high velocity movements.

Sriann M Palmieri-Smith conducted a study on Association of the Quadriceps and Hamstring Co-contraction patterns with Knee Joint loading, in this study surface EMG data from medial and lateral hamstrings and quadriceps was recorded during 100-cm forward hop, overall co-contraction was lower in women than in men whereas activation was lower in the medial than in lateral musculature in both genders. So as there is no significant activation in medial musculature, vastus medialis muscle will also not show significant difference in activation while sit to stand on 3 different cushions.[15]This is in accordance with the no significant change in mean of amplitude of vastus medialis activation on 3 different cushion thickness.

Pamela J. Millington et al conducted a study on Biomechanical analysis of sit to stand motions in Elderly persons, in this study it was stated that the transition phase, phase 2, seems to be particularly important because several key events take place. During this phase, the center of gravity must be controlled closely while the transition from forward motion to upward motion is made. This seems to be accomplished by concentric activity of the quadriceps muscle at the knee and eccentric activity of biceps femoris at the knee and gluteus maximus at the hip. There is eccentric activity of biceps femoris at the knee during 2nd phase of sit to stand motion we have assessed biceps femoris activation during sit to stand motion on 30 mm, 60 mm and 90 mm cushion.

Shigeru Usuda conducted a study on Kinematic motion analysis of the sit-to-stand motion-the influence of chair height, in which it was stated that the maximum ranges of motion of the trunk and lower limb were significantly increased with decreasing in chair height.[17]As the chair height decreases there was increase in lower limb motion, therefore the activation of biceps femoris muscle was more on 30 mm cushion thickness as compare to 60 mm cushion thickness and 90 mm cushion thickness.

Conclusion: This study suggests, the electromyographic activity of biceps femoris muscle during sit to stand motion was more on 30 mm cushion thickness followed by 90 mm cushion thickness and 60 mm cushion thickness.

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