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Establishment and Analysis of Ideal Lifting Technique Based on Kinesiological Principles for Outpatient Stroke Patients: An Experimental Study

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ABSTRACT

Background: In Modern society one of the high incidences of diseases is a stroke which causes damage to the cerebral function. Stroke causes various disabilities, one of them is a sensory-motor deficit which will cause functional limitation one of them is STS which is significantly impaired. Stroke patients can experience many of problems with sit-to-stand activity due to muscular weakness, Inappropriate initiation, Muscle imbalance, spasticity, Inappropriate Weight distribution etc. Hence it is very important to rehabilitate the sit-to-stand task after stroke.

Objectives: To develop a new lifting technique to overcome the drawbacks in the conventional method during sit to stand task. To find out the reliability and effect of this lifting technique.

Methods: A total of 20 subjects affected with stroke were selected by Consecutive sampling and allocated randomly in both the groups (group A and B). Group A received Conventional lifting technique of sit to stand and group B received New lifting technique. During these techniques' subjects were analysed with surface EMG in that Mean MUAP was noted.

Results: Results showed extremely significant differences in Patients (Quadriceps & Significant difference in Hamstrings Muscle). In Therapist Biceps & Triceps showed Extremely Significant Difference.

Conclusion: The new lifting technique which is based on kinesiological principles was found to have a significant effect on muscular activation which is needed during sit to stand activity than conventional lifting technique in stroke patients.

Key Words: Stroke, Lifting techniques in stroke, Novel method of Lifting, Surface EMG, Sit to Stand activity

INTRODUCTION

In modern society, one of the high incidences of diseases is a stroke which causes damage to the central nervous system. Stroke is one of the leading cause of death in India, the prevalence of stroke in India is 84-262/1,00,000 in rural and in urban 334-424/1,00,000 individuals¹. Stroke Basically stroke is of 2 types 1st is Ischemic and 2nd is haemorrhagic. Ischemic stroke occurs due to a reduction in the blood supply to brain because of narrowed or blocked arteries. Haemorrhagic stroke is may be due to accumulation of blood in the brain due to trauma or rupture of the blood vessel.

In a stroke, there are various abnormalities, one of them is a sensory-motor deficit which will cause functional limita-

tion. In stroke patients Sit to stand function is significantly impaired it may be due to weight-bearing asymmetry, more load on the non-paretic side and less on the paretic side, foot position, spasticity, in coordination weakness, an insult to the areas of the brain like cerebellum, loss of sensations in the limbs, impaired vision, medications, hypotension, ataxia, damage to the vestibular area, the altered tone will cause alteration in mechanics of STS. Symptoms change from the flaccid stage to the spasticity over Time. Biomechanically STS task requires kinetic and kinematic events which are hampered in stroke. Here deviation during STS task towards the unaffected side is about in 24% individuals and 44% towards the affected side deviation is seen. Also, they lack in the initiation of

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motion extension phase is not complete and there is less isokinetic knee extension⁸.

Starts with Trunkal flexion followed by contraction of hamstring muscle which causes buttock lift & clearance of glutes later Hip and trunk extension with dorsiflexion-at last plantar flexion and completion of isokinetic knee extension. when these all motions are fulfilled then patients acquire the task. Here 3 point base is changed to 2 point base also the eccentric work of hip & trunk muscles is important. After standing centre of gravity moves forward.^{5,6}

In sitting to stand, four muscles which act as stabilizers of motion Tibialis anterior, rectus abdominis, Erector spinae soleus and four other which takes part in sit to stand sequence are Quadriceps, Hamstrings, iliopsoas.⁷

Conventional lifting technique requires 2 therapists. As one therapist sits in front of the patient to initiate movement where he/she actually pulls patient by the arms and simultaneously blocks patients' knees with their knees to avoid knee-buckling and 2nd therapist tries or helps in trunkal flexion from the back. This techniques have dis-advantages like requirement of minimum of 2 people required to complete the task, more load is on the therapist than the patient, as half of the patient's task passive because patients puts more of body weight on the therapist because muscle activation is less established. Muscle activation in the upper trunk or upper extremity muscles is more than the lower limb muscle to compensate or to maintain balance. Patients muscle activation is low especially in the lower extremity. Therapist requires more energy to pull the patient. Also due to all these drawbacks patients' voluntary control is less established.

Therefore, A novel technique of lifting with kinesiological principles was introduced to fulfil sit to stand task.

In a novel method of lifting he therapist uses 3 facilitation points for encouraging or completing sit to stand task. These 3 points are at different anatomical points that will facilitate together to complete the task. As this technique fulfils all 4 phases of sit to stand, patients acquire and learns the task with ease with less load therapist, as patient's lower extremity muscles will get activated which are required during the task. So, the patient uses their energy to complete the task and on the other hand therapist's energy will be conserved.

In the current study, researchers analyzed the effect of Novel New lifting technique Vs conventional lifting technique on stroke patients. while performing these two sits to stand techniques, researchers also investigated the muscle activation patterns. Patients have intervened with Electro-

myographic study on patient's muscle activation as well as therapist muscle activation for calculating the energy expenditure during the task. The study was focused on both patients as well as on the therapist's muscle activation during sit to stand task.

MATERIALS AND METHODS

Type of study was Experimental Study, a total of 20 subjects affected stroke were examined, in which 13 were male and 7 female & were selected according to inclusion criteria- All stroke patients with Brunnstrom stage of recovery 2 or more; patients who have achieved sitting milestone but not able to stand independently and both male and female. And they all were selected by Consecutive sampling and allocated randomly in both the groups (group A and B). Group A (n = 20) received conventional lifting technique and Group B (n = 20) received new method of lifting and both were assessed by EMG. In both, the group's Patients Quadriceps and hamstrings & in therapist Biceps and triceps muscle activation were assessed. Patients with severe balance impairment and lower limb deformity, known case of fracture, Any other systemic illness other than stroke were excluded from the study.

Inter Group comparison (within Group) was analyzed statistically by paired 't' test of Surface Electromyography.

RESULTS

In this study, there were 13 male and 7 females subjects, in which the right-side affected individuals were 14 and 6 left side affected. From those 13 male subjects, 9 were right hemiparetic and 4 left hemiparetic & in 7 female subjects, 5 were right and 2 left hemiparetic. Therefore, In the current study right side affected individuals were more than left (70% right side affected > 30% left side affected). Conventional and New lifting technique values were taken during the Activity.

While comparing Conventional and new lifting technique sEMG (Mean Amplitude) Results showed an extremely significant difference in Patients (Quadriceps & Significant difference in Hamstrings Muscle). (P-value of quadriceps muscle- 0.001 and Hamstring muscle- 0.0109). In Therapist Biceps and Triceps, muscle values showed Extremely Significant Difference. (P-Value of Biceps muscle 0.0004 and triceps muscle- <0.0001). The comparison of results between Conventional and new lifting technique of Patient & Therapist is explained in the following table no. 1

Table 1: Comparison between conventional and novel lifting technique

N= 20		Group A (Conventional) Mean+ SD	Group B (New) Mean+ SD	P-Value	T Value	Inference
Patient	Quadriceps	52.175+17.748	66.52+17.221	0.0001	4.726	Extremely Significant
	Hamstrings	46.08+12.306	53.64+11.412	0.0109	2.822	Significant
Therapist	Biceps	70.715 + 2.470	60.315+20.774	0.0004	4.318	Extremely Significant
	Triceps	61.73+15.613	49.42+ 13.575	<0.0001	6.758	Extremely Significant

Points of facilitation in novel techniques

1. Leg of Therapist below patients affected sided thigh (Hamstrings Facilitation)- it will facilitate biceps femoris (Hamstrings) muscle which is required in buttock lift & gluteal clearance (Resolves 1st phase to 2nd phase of sit to stand).
2. One hand on the lower back (Facilitation for lower trunk muscle)- It facilitates lower trunk muscles for forwarding flexion of the trunk which is pre-requisite for Sit to stand (resolves 1st,2nd to 3rd phase of sit to stand).
3. 2nd hand on the paretic knee joint- It blocks buckling of the knee joint and completes isokinetic knee extension. (fulfils 3rd and 4th stage of sit to stand).

DISCUSSION

Sit to stand task is one of the most frequent and important function and it is a pre-requisite for activities of daily living. But stroke patients can experience several problems in achieving functional independence in the sit-to-stand task. Therefore, STS task rehabilitation is very important after stroke.^{2,4}

After the stroke, patients may present with sensorimotor impairments opposite side to the lesion that limits functional activities such as walking, standing and sit-to-stand task. STS function is commonly hampered in post-stroke individuals.^{5,6} Due to this reason we must consider this task during rehabilitation sessions.

Some authors noted that there was the reduced number of STS activity during treatment and their day to day activities and it was calculated by Physical activity monitoring (PAM) placed on patients thigh for 14 consecutive days, by the help of these researchers calculated daily sit to stand activity (25.00, SD 17.24), which was 65% less than normal older adults.¹⁹ Basic pre-requisite for STS activity is coordination between the lower extremity and trunk muscles, muscle of the strength, control over the task and stability.⁶

In the 1st phase of STS 1st. Tibialis anterior muscle activation follows hip and knee extensor muscles (precisely quadriceps). Here iliopsoas muscle initiates hip flexion²² as quadri-

ceps is 2 joint muscle completes hip flexion at the same time it supports knee joint & helps to extend the knee.^{6,12} So now to initiate the second phase after hip flexion it too follows the extension phase where hip extension occurs. During all these phases Quadriceps, Hamstrings, Tibialis anterior, soleus & iliopsoas activation is very important.^{2,6,28}

Also, these patients lack in activating their paretic lower extremity muscles at the proper time to get full control over the task.^{6,8} Hence they might extend the knee while their hips were still extending, so this lack in co-ordination between hip and knee musculature can be seen. Impaired muscle activation was recorded in paretic side especially in TA, hamstrings, and quadriceps.⁶

According to a researcher after stroke, individuals put less weight on the paretic limb during STS. On the paretic limb was 37% of body weight^{17,20}. knee moment errors are maybe due to trunk deviation and improper muscle strength, activation and projection of Center of Motion through the less affected foot region to reduce the over efforts on the knee joint.^{6,17} To compensate lack of balance patient over activates quadriceps and erector spinae muscles rather activating hamstrings and hip flexors as they have difficulty in implementing required muscles during STS task.⁷

The main purpose of this study was to analyze the muscle activation during STS task and to compare the Conventional lifting technique with the New lifting technique. The objective was to establish a new advance lifting technique based on kinesiological principles. The sample size was 20 and they all were selected and allocated in both the groups (A and B). Group A Conventional lifting technique and Group B New lifting technique. Participants were included according to the selection criteria.

Here, we compared Conventional lifting technique with New lifting technique and Both were investigated with the help of Surface Electromyography (Mean Amplitude). After results, we came to know that There was a significant improvement in patients muscle activation of lower extremity muscle (Quadriceps and Hamstring). And also, we tested therapists Biceps and triceps muscle for calculating their energy expenditure while doing sit to stand technique. Surprisingly we

came to know that there was significantly low energy used in new lifting technique compared to conventional lifting technique. So, the therapist's energy was conserved in the new lifting technique.

Biomechanically there are 4 phases of sitting to standing that should be fulfilled during the task or activity - The first phase is the flexion momentum phase, which starts with the initiation of movement and ends before the thighs off. 2nd phase begins with thigh-off and continues with the anterior and forward motion displacement. The third phase is the extension phase. It is from ankle dorsiflexion to hip and complete knee extension. The stabilization phase is the last phase of STS it is just after the hip and complete knee extension.^{6,11,27}

In conventional lifting, technique therapist tries to pull the subject upward to make him stand in an erect position with the help of another therapist. This manual assistance was given to stabilize and support the patient & to prevent him from fall. Also, in this method patient over-activates upper limb muscle / Upper trunk musculatures as it was a compensation for poor balance rather than activating Lower limb musculature for sit to stand. The patient also transfers more weight to the therapist & in turn therapist has to put more effort to pull patient & make patient stand. Sometimes in conventional method phase, 3 and phase 4 is incomplete and phase 1 and 2 is partially fulfilled because therapist assistance is more or patient is depending more on the therapist or patient over activates his/her upper trunk or Upper limb muscles. All these drawbacks were resolved in the new lifting technique, as the therapist uses 3 key points to facilitate movement.

According to some researcher, Early stimulation to key points may enhance to learn the task more efficiently and with less effort.^{2,3,6} Sit to stand task often initiated during the early phase of rehabilitation. The practice of this movement through strategies that promote more weight-bear on the paretic leg and fulfilment of all four phases of STS also can provide benefits for the return of more functional movements and prevention of falls.^{26,28} So during rehabilitation time we should try to fulfil all biomechanical requirements to carry out the task, As this task requires Activation of lower extremity muscles precisely Quadriceps, Hamstrings and tibialis anterior muscle.²⁷ One possible mechanism may enhance recovery of trunkal control and balance is repeated sit to stand activity.²⁷

At last, after comparing the results, we conclude that the new lifting technique gives better results in activating patients (Quadriceps and hamstrings) muscles and it also conserves the energy of the therapist, compared to conventional lifting technique. As in new technique, only one therapist is required to assist the task, also patients' voluntary control was established as patient tries to activate only those muscles which are required during STS activity, Also load or stress over the therapist was reduced as the patient was not leaning

on therapist and therapist was sitting and supporting from affected side and simultaneously facilitates STS activity by using 3 Key points to complete the task with ease, Hence therapist's energy was also conserved.

CONCLUSION

Based on the statistical presentation, analysis and interpretation it can be concluded that New lifting technique found to have more effective than conventional lifting technique in stroke patients, as well as on therapist. The present study provided the evidence to support that the New lifting technique with 3-point facilitation shows improvement in muscle activation than the conventional lifting technique. Also, the therapist workload was significantly reduced in the new lifting technique compared to the conventional lifting technique.

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Ethical clearance: The study was approved by the institutional ethics committee of KIMSDU (KIMSDU/IEC/05/2019).

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