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Sit-to-Stand Task in Stroke Survivors: A Review Study

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Abstract

Background: Sit-to-stand and stand-to-sit positions is a daily living activity in chronic stroke patients that needs acceptable lower extremity function and good postural control. Therefore, the analysis of available knowledge seems necessary in order to introduce the best method for the treatment of patients and recovery of the sit-to-stand task.

Methods: This study is a non-systematic review in which databases including PubMed, Ovid, Google Scholar, and ScienceDirect were searched for scientific articles of original research published between January 1990 and December 2017. It investigated muscle activity, foot positions, and the effect of exercise on the sit-to-stand task in stroke survivors.

Results: The results showed that there is a delay in the paretic side muscles and asymmetry on the muscle torques between the legs that result from a weakness in the knee joint extensor muscles. Additionally, placing the paretic foot behind the non-paretic foot in sit-to-stand task leads to enhanced muscle activity. Increasing muscle activity leads the legs to be symmetrical and improves the sit-to-stand task.

Conclusions: The legs' muscle strength, foot positions during the task, and different exercises can be useful in achieving independence and improving the sit-to-stand task in stroke survivors.

Keywords: Stroke, Sit-to-Stand, Stand-to-Sit

1. Context

Stroke is one of the major reasons for death in the developed world that may also lead to personal inability. The prevalence of this disease has been reported to be almost a million in the European Union every year (1). Standing up from a seated position is one of the most frequently performed functional tasks, and it is an essential prerequisite to walking (2). A change in the sit-to-stand (STS) position and vice versa is considered to be an essential activity of daily living (3), which is the basis for the transfer activities in the bed-to-chair and the chair-to-toilet (4). In addition, it is a basic need for walking and mobility of the persons; therefore, it needs an acceptable lower extremities function and postural control (5). After the stroke, individuals can experience a number of problems related to the ability to do STS independently. Rehabilitation of the STS movement is, therefore, an important goal after stroke (6). These functional activities are the same as daily living activities for the self-care of a disabled individual in this group of patients (3, 4). Therefore, the analysis of this knowledge seems necessary to provide important strategies for the treatment and improvement of these movements.

2. Evidence Acquisition

This study is a non-systematic review in which, databases including PubMed, Ovid, Google Scholar, and ScienceDirect were searched for scientific articles of original research published between January 1990 and December 2017. The following key terms were used: stroke AND (stroke OR hemiplegia) AND (sit to stand OR stand to sit). Search in these databases was to find English papers. This paper deals with the muscle activity, the position of legs, and the effect of different exercises on the STS task in stroke survivors.

3. Results

3.1. Muscle Activity in the STS Task in Stroke Patients

3.1.1. The Onset of Muscle Timing

Muscle delay on the paretic side has been reported during the STS task. The electromyography scan of the lower limb muscles has been compared during STS between the paretic and non-paretic sides of the hemiplegic subjects. The results have shown that the lower extremity muscles of both sides are active in most stages of the STS task. Muscles start activation before lifting from the chair and reach their maximum electromyographic activity after getting out of the chair. The Hamstring muscle shows a faster and longer acting on the non-paretic side than on the paretic side and additionally, more electromyographic activity is reported in the tibialis anterior, suleous and quadriceps muscles compared to the paretic side. The onset of activity in all of the lower limb muscles of the non-paretic side was similar, while the tibialis anterior muscle was activated earlier than the hamstring and suleous muscles on the paretic side. These results showed that muscle coordination and activity on both sides are impaired in the STS task; however, this impairment is greater on the paretic side. The paretic side muscles are not able to act at the proper time to do their duty to stand off while major compensations occur on the non-paretic side of these patients (7). In addition, the electromyographic activity of other muscles, Transverse and lateral abdominal muscles of the paretic side, shows a delay in the STS position (8).

3.1.2. Effect of Foot Position on Muscle Activity

The next factor that affects muscle activity in these subjects is the position of the paretic foot when they standing up, which can be effective on the amount of muscle activity on the paretic side. The researchers found that by placing the paretic foot behind the non-paretic foot during an STS task in chronic stroke patients, the erector spinae and gluteus maximus muscles are more activated compared to the symmetrical position of the legs (9). These findings can help physiotherapists in assessing and managing the paretic side muscles during transfer activities.

3.1.3. Effect of Muscle Torque

At the knee joint, the extensor muscles torque was lower on the paretic side during an STS task, which was affected by the position of the feet (10). However, the muscular torque in the hip joint of these patients did not show a significant difference between both sides and it was slightly affected by the feet position. There is also a strong correlation between asymmetry in the knee extensor muscle torque and power; however, no relationship has been reported in the hip joint (10). Strengthening both lower limbs (weaker and stronger sides) plays a significant role in the independent performance of the STS task with or without using hands. However, the single-variable analysis does not indicate the importance of body weight, height, age, and gender. By considering the relation of these variables with both knees extension force, body weight (with or without using hands) can be a key element in performing the independent STS task. Therefore, focusing on both legs power and the loss of weight can be helpful in patients with overweight in order to improve autonomy in the STS task following stroke (11). The strength of the knee extensors is a factor associated with inaccurate gaining weight and is not related to the perception of the patient (12). This evidence suggests that paretic muscle strength and the ability to load the paretic limb are important factors underlying the ability to rise from a chair in individuals with chronic stroke (13). Stroke patients exhibit poorer sitting performance than healthy subjects do since they do the larger flexion in the trunk in the fast execution of this movement, as well as they have lower peak flexor momentum at both fast and comfortable speeds. In general, the correlations were positive to maximum forward flexion and negative to peak flexor momentum. It has been shown that the poorer STS performance in stroke survivors depends on trunk kinematic changes associated with the poorer ability to produce and transmit the flexor torque of the trunk (14). Moreover, the angle of pelvic anteversion has been reported less in stroke patients who are unable to stand up during sit-up (15).

3.2. The Feet Position and Its Effect on the Symmetrical Distribution of Weight and Balance

The performance of an STS task improves during the first year following a stroke, usually during the 12 weeks' post-stroke (16). Studies have shown that the asymmetrical position of feet during the STS task is a good intervention to improve the static and dynamic postural balance in stroke patients. Particularly, using the step model, in which the paretic foot is placed on the floor and the non-paretic foot on the step, has been reported to be effective in improving STS task (17). Repetitive sit-to-stand training that involves positioning the non-paretic leg upward can be considered a significant form of training to improve the symmetric posture adjustment and balance of hemiplegic patients following a stroke (18). In addition, the asymmetrical foot position during STS training results in improved balance and upright mobility in patients with chronic stroke as compared to the symmetrical foot position (19). Using a seat with a higher height than normal can be a useful exercise for patients who are unable to maintain the paretic foot behind while sitting. Moreover, constraint-induced movement increases weigh bearing of the paretic limb, and with this method, the center of pressure and the center of mass of the body will tend to the paretic limb (20). However, allowing the subjects to adopt the spontaneous strategy or training of the symmetric strategy could result in greater benefits for subjects with higher chronicity and higher functional levels (21). We conclude that standardizing the foot placement in the training procedure is essential (22).

Interestingly, the improvement of the symmetry of STS task, by placing the paretic foot behind the non-paretic foot, does not reduce the mediolateral stability that is associated with the level and severity of the disease but not to the position of feet (23). The duration of the STS task is considerably longer for patients, and the anterior-posterior, mediolateral, and vertical acceleration range was significantly limited during sit-ups for stroke patients compared to healthy subjects. In addition, the range of mediolateral acceleration is significantly different between healthy and stroke subjects during sitting from a standing position. It has been mentioned that during exercises to stand up from sitting, it should be concentrated on all three dimensions of balance indices, but during the workout to sit down from a standing position, the focus should only be on improving the mediolateral balance index (24). Stroke patients with hemiparesis had a compensated STS pattern according to the knee flexion angle. This indicates that the peak value of plantar pressure increases and the trajectory of the center of pressure widens as the angle of knee flexion increases. It is suggested that hemiparesis patients should be more concerned about the proper knee angle for the symmetrical STS pattern (25).

Generally, asymmetric vertical force is reported in the midst of moving STS task. If the paretic foot is placed behind the non-paretic foot, it reduces the asymmetric force; however, if the non-paretic foot is placed back, it increases the asymmetric force. Therefore, the posture of the foot should be considered when the therapist performs the exercise (26). A modified sit-to-stand training improves the balance function in hemiplegic subjects (27). STS task in patients with and without a risk of falling and healthy subjects was compared and the fluctuation of the center of pressure in mediolateral direction was reported high in the subgroup with a risk of falling compared to other groups. Transmission of body weight to both legs has been presented asymmetrically in stroke patients, and it has been reported that a low rate of force and a large displacement during STS are helpful in determining the high-risk patients (28).

3.3. Exercise Affecting the Sit-to-Stand Task

3.3.1. Exercise Parameters

The ability to stand up is reduced following a stroke. Therefore, rehabilitation of the sit-to-stand task is an important goal following the stroke. To facilitate evidence-based practice, it is necessary to know the effectiveness of interventions aiming at improving the ability to perform sit-to-stand after stroke. The frequency of the STS task is almost reported 18 times per day in chronic stroke patients. A 30-minute sit-up practice leads to 50 times STS movement per day. One week after the intervention, standing exercise can cause to bear 10% of the body weight on the paretic leg. In addition, task-specific exercises seem to be promising for 30 minutes a day to learn the STS task (29). It was reported that each participant repeated more than 750 times of sit up to be able to do it without dependency in 8 to 11 sessions. Sit-up training also leads to speeding up walking, increasing the ability to stand off from a sitting position, and reducing the time of this task (30). In addition, information feedback about foot placement during training of standing up is reported to be useful (31).

3.3.2. Type of Exercise

Sit-down exercises seem to be dependent on the speed of movement and are a promising way to achieve a steady, independent, and fast sitting position for chronic stroke patients (30). Stand-up exercises were not effective on supportable levels than on the unstable positions; however, it can be a simple and stable exercise with less risk of injury during training and practice. Therefore, it can be used as a useful exercise performed alone by the patient outside the treatment room (32). Practicing sit-up for stroke patients is useful because of its effect on dynamic stability and extensor muscle strength (33). Sit-to-stand training combined with TENS may be used to improve the spasticity, balance function, and muscle strength in stroke patients (34).

Moreover, task-specific exercises can be useful in improving STS movement. In general, it can be concluded that task-oriented practice has a significant effect on the balance of stroke patients with a change in sensory input. This is while this result has not been found in the task-oriented practice without changing the sensory input. By performing this exercise, the speed of walking has progressed greatly (35). Using of cane also was effective in the STS task. Not only doing STS associated with using the cane results in shortening the duration of movement but also increases the extensor torque of the knee muscles and improves the symmetrical weight bearing when compared to those who do not use the cane. Additionally, the sequence of using the muscles on the paretic side is improved with the use of a cane and finally, the use of the cane improves the symmetrical movement (36). A study showed that weight-bearing exercises, if accompanied by biofeedback, would have a greater effect on the progression of STS and stability in patients with stroke (37).

4. Discussion

Studies indicate that muscle activity changes on both the paretic and non-paretic sides and these changes are usually associated with delayed action on the paretic side and compensatory behavior of the non-paretic side. These findings can be helpful to physiotherapists in evaluating and managing muscles during transitional activity. A weakness in the knee extensor muscles results in the asymmetry of knee extensor torque on the STS task in this group of patients (10). Therefore, focusing on the muscle strength of both lower extremities can help improve autonomy in the STS task in stroke survivors (11). Patients do not perceive themselves during the transition from STS following a stroke, and the strength of the knee extensors is a factor associated with inaccurate weight bearing and is not related to the perception skills of the patient (12). In fact, the strength of paralysis muscles and the ability to weigh out on the paretic side are very important factors in the ability to perform an STS task (13). In these patients, the kinematics of the joints also changes. The weaker STS of the patients is related to the kinematic changes of the trunk that result from the poorer ability of trunk muscle in producing flexor torque (14).

In hemiplegic subjects, the symmetry on the STS task is achieved by placing the paretic foot behind the non-paretic foot, which does not reduce the mediolateral stability since stability is related to the level and severity of the disease (23). During exercises to get off from sitting, the focus should be on all three dimensions of balance, but during the exercises to sit down from a standing position, the focus should be on improving the mediolateral balance and the asymmetrical position of the legs (24). In addition, the placement of the paretic foot behind the non-paretic foot during STS will cause more activity on the paretic muscles when compared to the symmetrical position of the legs or the non-paretic foot placement behind (9). Meanwhile, the position of the asymmetric feet while standing up from a sitting position improves the static and dynamic postural balance in patients with stroke (17). In addition, the use of the step model, motion limiting strategies, repetition of sitting motion, repetitive task-oriented practice with sensory input changes, exercise on unstable surfaces, and the use of a cane and weight-bearing exercises along with biofeedback have been reported to improve the STS task in this group of patients (18, 20, 30, 32, 35-38). Interventions or training focusing on the sit-to-stand task improves the time taken to sit-to-stand and the lateral symmetry (weight distribution between the legs) during the sit-to-stand task (6).

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