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"Effect Of Music Supported Therapy(Mst) On Upper-Extremity Functions In Subjects With Chronic Stroke"

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ABSTRACT
Introduction*: Music-Supported Therapy (MST) has been developed recently to improve the use of the affected upper extremity after stroke. MST may involve playing musical instruments, to retrain fine and gross movements of the paretic upper extremity. Music-supported therapy has shown to induce improvements in motor skills in stroke survivors Therefore; this research was focused on finding the effect of music supported therapy (MST) on upper extremity function in chronic stroke patients*
Objectives*: To study the effect of Music Supported Therapy (MST) on upper extremity functions in subjects with chronic stroke.*
Methods*: 30 stroke subjects who met the inclusion criteria were enrolled in the study. All the 30 subjects received 20 sessions (5 days/week for 4 weeks) for duration of 30 minutes of music supported therapy which involves playing a musical instrument cabasa. Following a prior demonstration, the subjects were made to shake, roll and twist the cabasa instrument with the affected hand to the beats of metronome for 3/4th rhythm. This training was a four-step programme, which was progressed when the patient was able to perform each step for 60 times within one minute.*
Result*: All participants in both groups showed significant improvements in motor functions of upper limbs after 4weeks of treatment. There were significant differences in the ARAT (P = <0.001), and the FMA (P = <0.001). In short, all participants showed significant improvement after 4 weeks treatment. There was statistically significance with p value <0.05*
Conclusion: *Music-Supported Therapy (MST) has an effect on upper extremity function in subjects with chronic stroke wherein playing musical instrument such as cabasa can lead to meaningful improvements in upper extremity function in chronic stroke survivors.*
KEYWORDS:*music supported therapy, stroke, metronome and cabasa.*

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I. INTRODUCTION

Stroke is defined by World Health Organization as "Rapidly developed clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin".[1]

Stroke is classically characterized as a neurological deficit attributed to an acute focal injury of central nervous system (CNS) by a vascular cause including cerebral infarction, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage (SAH). Cerebrovascular strokes are those diseases in which one or more of the blood vessels of the brain are involved in the pathologic processes. Various pathologic processes commonly implicated in cerebrovascular strokes are: thrombosis, embolism, rupture of a vessel, hypoxia, hypertensive arteriolosclerosis, atherosclerosis, arthritis, trauma, aneurysm and developmental malformations.[1]

The prevalence of stroke in India is estimated at 559/100,000 persons per year. An estimated 20% of people with stroke in developing countries have had a prior stroke, reflecting insufficient secondary prevention.[2]

Upper limb impairment post stroke is highly prevalent, with up to 70% of individuals incurring various forms of upper limb dysfunction, including muscle weakness, inappropriate timing during movement execution, and lack of interjoint coordination.Key factors associated with poor upper limb recovery are: lesion location, initial severity of motor impairment or function, and changes in muscle tone such as the development of spasticity over time.[2] This not only significantly affects the quality of life and performance of various essential daily living activities of stroke survivors, but also imposes tremendous health costs and socioeconomic burdens globally.[3]

Many choose a chronic sedentary lifestyle due to lack of awareness that exercise is feasible or beneficial, limited access and resources, lack of proper post stroke management, and guidance.[4] The effectiveness of traditional treatment on the upper limb rehabilitation of stroke survivors remains largely variable and inconclusive, depending on a wide range of considerations, including the appropriateness, quality, and length of therapeutic intervention, the patient's mental health and motivation.[5]

Spasticity is a complex sensori-motor disorder which has been defined as "impaired sensori-motor control from an upper motor neuron lesion, presenting as intermittent or trained involuntary activation of muscles". Alleviation of spasticity is a rehabilitation focus when it limits activity due to contractures and/or pain. As a result, the cost of healthcare for stroke survivors with spasticity has been estimated as being four-times higher than when spasticity is not a secondary complication. Unfortunately, for many people, upper limb spasticity is common. At day three post stroke, spasticity is present in approximately 25% of people who have upper limb paresis and frequency can increase up to 46% at 12 months.[6]

Effective use of the arm and hand to reach, grasp, release, and manipulate objects is often compromised in individuals with neurologic disorders such as cerebral palsy,[7] stroke[8,9], Parkinson's Disease,[10,11] among others. Impairments of upper extremity function include reduced muscle power, sensory loss, increased muscle spasticity, and lack of motor control,[7,12,13] resulting in significant long-term functional deficits with relevant impact on patients' activities of daily living, independence, and quality of life.[14-17]

Functional restoration of the upper extremity is thought to be achieved through a combination of neurophysiological and learning-dependent processes that involve targeted training to restore, substitute, and compensate the weakened functions.[17,18] Frequently reported neurorehabilitation approaches for upper limb movement in stroke,[17,19] include standard treatment methods such as general physiotherapy (i.e., muscle strengthening and stretching), constraint-induced movement therapy and bimanual training, as well as technology-based approaches (i.e., virtual reality, games, and robot-assisted training) [20-22] and music-based interventions.[23,24]

The effectiveness of conventional physiotherapeutic approaches in stroke rehabilitation has been found to be quite limited, thus calling for innovative motor rehabilitation approaches.[25] such as Bobath, muscle strengthening, isokinetic muscle strengthening, stretching, bilateral training, forced-use, motor skill learning, constraint induced movement, mirror therapy, motor imagery, motor imitation, movement observation, transcutaneous electrical nerve stimulation, neuromuscular electrical stimulation, positional feedback, repetitive transcranial magnetic stimulation, transcranial direct current stimulation, deep brain stimulation, motor imagery etc.[26]

Music is one of the most powerful elicitors of spontaneous motor actions. It motivates people to adhere to exercise regimens, distracts attention from physical effort, and reduces perceived exertion. In addition, auditory-motor coupling has been shown to facilitate repetitive movements post- live interactive music-making engages individuals to interact spontaneously and promotes relationship building. Several studies have also shown positive effects of music listening on mood, and on cognitive and motor processing post-stroke. Taken together, these studies suggest that music-making activities may be used to integrate physical, psychological and social facets of rehabilitation, creating an enriched environment for post-stroke recovery. Studies have shown that in enriched environments the simultaneous physical and mental activity in socially interactive contexts act synergistically to promote neurogenesis, neuronal integration and recovery.[27]

Effect of music therapy on stroke

Music and sound have significant influences on the efficacy of rehabilitation measures based on the principle of a cognitive strategy. Attempts to study the potential of using music therapy methods in stroke patients to promote recovery of both higher cerebral functions and motor activity have already been made around the world.

The physiological mechanism of the perception of musical sound is somewhat different to that of the perception of sound in general. The human brain is believed not to have a specialized "music center;" processing music involves numerous areas distributed throughout the brain: sound pitch analysis is carried out in the superior temporal gyrus of the right hemisphere, while rhythm analysis is mediated by the superior gyrus of the left hemisphere; the function of the inferior frontal gyrus can be defined as analysis of the relationships between musical sounds and time sequences. There is also hemisphere asymmetry in supporting musical

activity: the right hemisphere is responsible for melodic aspects, analysis of tone pitch, interval duration, intensity, and timbre; the left hemisphere is responsible for rhythm perception and "professional" analysis of music.[28]

The overall action of music on the body is mediated by integration of processes occurring in both hemispheres. The projection cortex, which receives signals from the auditory analyzer, sends excitation to the associative cortex, where sounds are recognized. Excitation then passes to the entorhinal cortex, located on the internal surface of the temporal lobe. This is where the significance of the signal and its relationship with one or another body need are determined. Excitatory impulses are then transmitted to the motivatory centers of the diencephalon, from which they return to the cortex via the diffuse projection system. Thus, circular movement of excitation passes through different parts of the brain, which may be of key importance for neuroplasticity processes during the post stroke period. In addition, some authors have shown that on listening to musical works, a focus of positive induction can compete with the focus of a pathological dominant, significantly weakening the negative influences of the latter on the state of the body.[28]

Music listening improves neuronal connectivity in specific brain regions of healthy participants, and musical activities, such as playing an instrument, promote neural plasticity and induce grey and white matter changes in multiple brain regions, especially frontotemporal area.[29]

Music-Supported Therapy is a prospective new series of therapy programs, and comprehensive research suggests that it could be useful because of its promotion of relaxation and of cognitive and motor improvement in post-stroke rehabilitation. Therefore, Music-Supported Therapy has been developed with the aim of improving motor recovery after stroke.

The definition of music-supported therapy is not only hearing the music but also singing and playing rhythm and musical instruments and is based on four principles: -

- Massive repetition and exercising of simple finger and arm movements
- Auditory-motor coupling and integration and reinforcement of motor effects due to immediate auditory feedback
- Shaping and adapting the training according to individual progress;
- Emotion-motivation effects due to the playfulness and emotional impact of music and the acquisition of a new skill.

MST was also shown to yield enhanced motor skills and neuroplastic changes of auditory-motor network in chronic stroke participants.[30]

There is growing evidence that music-based interventions are a promising therapeutic approach for the restoration of upper extremity functional abilities in neurologic conditions including stroke.[31,32] Furthermore, consistent evidence indicates that interventions using rhythmic auditory cues or rhythmically-enhanced music are effective to increase muscle activation symmetry[33], improve range of motion and isometric strength[34], enhance spatiotemporal motor control[35], and decrease compensatory reaching movements.[33]

Music-based movement rehabilitation for upper limb training is particularly interesting because playing a musical instrument provides real-time multisensory information that enhances online motor error-correction mechanisms and supplements possible perceptual deficits.[30,36,37] Research has also shown that the engagement of multisensory and motor networks during active music playing promotes neuroplastic changes in functional networks and structural components of the brain, which are crucial neurophysiological processes for neurologic recovery.[38-41]

In addition, there is robust evidence that the use of metronome or beat-enhanced music is important to support movement training as the continuous-time reference provided by the rhythmic cues allow for movement anticipation and motor preparation, bypassing the movement timing dysfunction through the activation of alternate or spared neural pathways[42,43]. Finally, emotional-motivational aspects of music-making also play a significant role in the rehabilitating effects of music-based intervention through music-induced changes in mood, arousal, and motivation[29,44], with potential effects on perceived physical endurance and fatigue.[45,46]

Traditionally, music-based interventions for the rehabilitation of upper extremity generally involve the use of acoustic musical instruments such as guitar, piano, and pitched and non-pitched percussive instruments.[47,48]

Music-supported therapy may involve, rhythmic auditory stimulation, the use of a MusicGlove or listening to music. However, the differences between these music-supported techniques have not been comprehensively considered. Music-supported therapy has been shown to be effective in post-stroke rehabilitation of motor function in some clinical trials. However, little research has focused on the potential therapeutic mechanisms by which music-supported therapy improves the motor functions of post-stroke patients. Although many researchers suggest that improvement induced by music-supported therapy is due to the combined effects of intensive repetitive practice and musical stimulation, evidence to support these propositions has been unavailable.[49]

II. Discussion

The study was conducted to evaluate the effect of music-supported therapy on upper extremity function in chronic stroke subjects. The intervention was to playing a cabasa instrument as stated by the stepwise program protocol. The treatment was given for 20 sessions, 5 days/week for 4-week for a duration of 30 minutes. A metronome for being used for the timing and frequency was set at $3/4^{th}$ rhythm. Pre and post-test assessments were done using Action Research Arm Test (ARAT) and Fugl Meyer Upper Extremity Assessment (FMA-UE) components A-D.[87]

Statistical analysis was done using, Wilcoxon test where a p-value less than 0.05 was considered significant. More than 60% of stroke survivors suffering from hemiparesis have to cope with marked limitations in arm function or dexterity 6 months post-stroke, often compromising activities of daily life.[71]

30 subjects of chronic stroke subjects between the age group of 47-71 years, both genders. Of which 19 were males and 11 of them were females. Historically, it has been noted that stroke incidence is higher in males than females. Thus, resulting in greater sexually dimorphic epidemiology.[72] This difference in the ratio was mainly due to education, occupation, income, eating habits. Likewise, another study showed that women tend to have higher rates of hypertension and arterial fibrillation whereas men are more likely to have a history of alcohol or tobacco use, or diabetes resulting in the greater prevalence of stroke.[73]

The Mean age was 60 in males and 62 in females. Although the subject's age range was from 47-71, most of the subjects fall under the 50-70 years of age group. The study by E. S Merel and et.al concluded that incidence of ischemic stroke increases with age showing more prevalence in the age group 54-69 years. A Significant increase in stroke incidence was found only after 35 years in their study.[73]In this study the subjects were 80%of ischemic stroke and 20% of hemorrhagic stroke which supports my findings of greater ischemic subjects.

There were 23 subjects with ischemic stroke out of which 8 subjects were females and 15 subjects were male. Women aged 45–74 years old showed a lower risk of stroke incidence compared to age-matched men this is due to the long-term estrogen maintenance which contributes to stroke prevention. Also, it is reported that in the premenopausal year's women benefit from the reproductive hormone that prevents the risk of ischemic stroke. Numerous studies reported gender differences in both mortality and morbidity. Another study has shown that post-stroke women experience more mental impairment, depression, fatigue, low functional outcome, and overall lower quality of life.[74] Above studies support the finding of the more male population included than females.

Another study by Tapas Kumar on stroke in the Indian population found that the major risk factors of stroke were hypertension, hyperglycemia, tobacco use, elevated level of cholesterol, triglycerides, low HDL, sedentary lifestyles, and psychological stress as major contributory factors around the mean age of 41.5year which correlates to our finding where the majority of subjects had a stroke due to hypertension and cholesterol.[73,75]

The occurrence of stroke was observed more in the dominant hand i.e. the right upper extremity up to 53.3%. The propensity to use the dominant hand may lead to a better pre-stroke neuromuscular condition of the dominant hand (e.g., stronger muscles, more efficient motor unit recruitment) compared to the non-dominant hand. , if the dominant hand is affected by the stroke, it may demonstrate less impairment immediately following the stroke owing to its protective effect. Additionally, if the dominant hand has been affected by the stroke, individuals may be more motivated to use their dominant hand during recovery because they are not used to using their non-dominant hand for daily tasks. There will be a preference to utilize the dominant arm more often during daily activities, and this is reflected by better arm-pointing accuracy, movement speed, and precision when using the dominant hand in healthy adults. In contrast, if the nondominant hand is affected, individuals may have little motivation to use this hand in daily tasks, making it difficult to promote the use of the non-dominant hand in therapy.[76]

Among the subjects with the duration of stroke between 6 months-12 months, 25 subjects showed less significant improvement in the score when compared to subjects with a duration of 12months and above. A study conducted by Kong, Keng-He showed 31.6% of patients recovered upper extremity dexterity at 12 months after stroke[77]. This gives a reference for my study wherein patients at 12 and above also had a slight improvement in the upper-extremity function.

According to the statistical analysis, there were 50.7% of subjects with Brunnstrom score of 4(IV) and 43.3% of subjects with Brunnstrom score of 5(V), suggesting that subjects already having some motor function of the arm and hand benefit more from playing cabasa instrument as part of music supported therapy. And, MMSE score of 24 and above were in majority and the average score were between 24-29 which showed a better cognition among patients. This made patients understand the instruction and follow as per the steps explained.

MST relies on key principles of motor learning, including repeated and task-specific practice as well as the involvement of multisensory feedback, which gives instantaneous knowledge of results and performance.Subjects after a stroke usually exhibit awkward and inefficient finger movements of the affected hands, which could affect the activity of daily life in some ways, especially when the dominant hand was affected. MST was conducted through cabasa training in an intensive step-by-step program. Subjects were first taught to play cabasa and practice each movement at least 25 times before performing for a time limit of one minute, subjects had to play the cabasa 60 times within a minute for $3/4^{th}$ rhythm using a metronome after which they were progressed to the next step. [27,61,88] The music was separated from music-supported therapy and left repetitive motor training.

The intervention involved playing the musical instrument cabasa based on the stepwise program which included training to improve upper extremity function and to improve finger movement coordination. It was found that Upper limb motor impairment decreased during the treatment period, as revealed by significant increases in the FMA and ARAT scores, indicating a noticeable improvement of arm and hand function.

The severity of motor impairment is likely a key factor in rehabilitation outcomes and the choice of a rehabilitation protocol. Severely impaired subjects may require longer or more intensive therapy to first strengthen the muscles, decrease spasticity and reduce other impairments that limit their performance. There was an improvement in patient's mood which helped them to perform better. The patient felt motivated as progressing to each step and accomplishing the step. The auditory feedback from the musical instrument cabasa would make patients more enthusiastic and determinant towards the therapy given. Therefore, it was observed that music therapy could help a victim of stroke recover faster and with more success by increasing the patient's positive emotions and motivation, allowing him or her to be more successful and feel more driven to participate.

During the initial days of the intervention, there were compensatory movements observed and the movements were initiated from the shoulder and the scapular, there was excessive shrugging of the shoulder and protraction of the scapula. As the intervention was practiced there was an increase in the use of their elbow and the wrist joint.As observed there were around 19 patients who could complete all the steps within the 3^{rd} week of intervention out of which 3 patients could complete early within 12 days of intervention after which these patients repeated all the steps for the rest of the session with three sets 60times/min. And there were around 11 patients who could complete all the steps in their 4^{th} week among them there were patients who completed early and were made to perform all the steps for the rest of the sessions with three sets 60times/min.

No adverse reactions to the intervention were seen, except for patients displaying occasional "hand stiffness" typical of spasticity during the intervention, as well as fatigue described as a "general fatigue" after the training sessions. The stiffness was going away with frequent breaks, and the fatigue resolved within a few hours after the sessions.

III. LIMITATION

The ability of the patient to perform activities of daily living with the affected hand was not assessed. Grip strength not assessed

IV. RECOMMENDATION

Future studies can include a fatigue assessment scale

V. CONCLUSION

This study indicates that music-supported therapy (MST) involving playing a musical instrument such as cabasa can lead to meaningful improvements in manual dexterity, finger movement coordination extremity in chronic stroke survivors. It has the potential to be self-managed and pursued in the long term, outside the rehabilitation setting, and lead to further and sustainable improvements in upper extremity function. Therefore,alternate hypothesis was accepted which stated that there is a significant effect of music supported therapy on the upper extremity function in subjects with chronic stroke.

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