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EFFECT OF VIBRATION STIMULUS ON SPASTICITY IN POST STROKE HEMIPLEGIC PATIENTS

Physiotherapy

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ABSTRACT

Physical treatment such as vibration has been proposed as possible non-pharmacological way to control spasticity. The aim of the study was 1) can a selective vibration of the lower limb Dorsiflexors of foot and quadriceps, reduce the spasticity of the plantar flexors and hamstrings muscle; 2) is vibrations association with physiotherapy better than physiotherapy alone in reducing spasticity. This was a Pre Post study design wherein all the patients were taken from OPD in Govt. Medical College & Hospital, Sector 32 Chandigarh, India. A total of Sixty post stroke hemiplegic patients were taken for the study. Method. (VIB + PT) group A received physiotherapy plus vibration by means of a hand held vibrator applied over the belly of the Dorsiflexors of leg and belly of Quadriceps muscle of the spastic side (contact surface 2 cm2; frequency 100 Hz; amplitude 2 mm; mean pressure 250 mBar). Control group B received conventional physiotherapy treatment alone. Both groups had 45 minutes of physiotherapy including Bobath therapy, muscle lengthening stretching exercises for 5 days a week for 2 weeks.Main Outcome Measure was Spasticity measurement by Modified Ashworth scale for both the groups before starting treatment and after the end of 2 weeks. Results: Fisher's exact test showed a statistically non significant improvements in the (VIB + PT) group ($p \geq 0.05$) compared to in the (PT) group after 2 weeks of treatment for the Modified Ashworth scale. AlthoughStuart Maxwell Test showed that there was a statistically significant difference within Group A i.e. Vibration plus Conventional physiotherapy with ($p \leq 0.05$) Conclusion. 1) 100 Hz vibration applied to the Dorsiflexors of foot and Quadriceps muscle of a spastic lower limb in association with physiotherapy is able to reduce the spasticity of the flexor agonist i.e. plantar flexors and hamstrings 2) this association is not better than physiotherapy alone in controlling spasticity. Clinical Rehabilitation Impact :100 Hz antagonist muscle vibration, a non-pharmacological treatment, can help physiotherapy to reduce flexors spasticity in the rehabilitation of lower limb spasticity.

KEYWORDS

Hemiplegia, Muscle spasticity, Rehabilitation, Vibration Stimulus.

INTRODUCTION

The control of excessive tone or spasticity in hemiplegic patients is one of the major task and an utmost priority in neurorehabilitation, not only because of the worldwide importance of cerebrovascular diseases and the progressing number of survivors of stroke with severe persistent sequel,[1-4] but also due to the substantial lack of motor enhancement in patients with a severe spasticity, especially when involving the upper limbs and lower limbs.[5-7]

Post stroke Rehabilitation programs are, therefore, often linked with the use of pharmaceutical drugs, given systemically or injected locally, to control the levels of spasticity. These are generally effective, but when they are given orally, such drugs often induce overall weakness, drowsiness, lethargy and sedation [8] and, when injected in the thecal space or intrathecally, they might cause more severe complications[9,10]that often lead to reduction in their usage.

The localized treatment of spastic muscles with Botox[11] also has some limitations. It is considered a first-line treatment majorly,[12] but their cost/ benefit ratio, and side effects, including unexpected loss of strength and varied muscle weakness, can hinder the use of botulin toxin in daily practice.[13-15]

Therefore it has been postulated that another possible way to control levels of spasticity is to use physical modalities, such as vibration therapy. However, the clinical reports on the use of vibration in the management of spasticity are very less and very old [16,17] and only recently was vibration therapy proposed to decrease upper limb levels of spasticity in post-stroke hemiplegic patients suggesting a modification of cortical structure and functioning induced by vibration therapy.[18,19]The Vibration stimulus has been used extensively as a stretch reflex conditioning tool in investigations of spasticity extensively [20,21] Previous studies have demonstrated that upper limb agonists and antagonists show reciprocal inhibition, which is, when agonist muscle contracts the antagonist activity is inhibited and therefore enhanced motor excitability of a given muscle group can lead to reduced motor excitability in its antagonistic muscle group.[22,23]
The main aim of this research was to find out, in a group of post stroke hemiplegic patients, that: 1) The effect of conventional physiotherapy on levels of spasticity in post stroke hemiplegic patients.2) The effect of conventional physiotherapy and vibration stimulus on levels of spasticity in post stroke hemiplegic patients. Sixty patients of both the genders were selected for the research after the inclusion/exclusion criteria. Inclusion criteria included:1) Both male and female post stroke hemiplegic patients; 2) Age: 40 – 70 years; 3)Increased muscle tone of the affected lower limb hamstring and plantar flexor muscles (Modified Ashworth Scale score between grades 1+ and 2); 4) Receiving constant medications throughout the treatment; 5) No peripheral nerve injury of lower limbs; 6) Patient not having uncontrolled diabetes mellitus; 7) Is able to follow and obey commands; 8) Is able to stand. [24] The exclusion criteria included 1) Onset of stroke < 4 weeks previously till 1 year ; 2) Patient present with perceptual and cognitive disorder and 3) Dementia.[25]

METHODOLOGY

Study design

This was a Pre-post Study design wherein the Subjects were randomly divided in two different groups as group A and group B with 30 subjects in group A and 30 subjects in Group B. The group A received vibration stimulus in addition to physiotherapy (VIB + PT). The control group i.e. Group B received conventional physiotherapy alone.

Physiotherapy

All The Subjects incorporated in the treatment underwent pre treatment assessment of spasticity by Modified Ashworth Scale. After a brief introduction about study, treatment commenced in both groups. The conventional physiotherapy was given for 45-55 minutes to both the groups i.e. Group A and B, whereas the vibration therapy was only given in Group A for 5 minutes, 6 times /week for 2 weeks over the affected side Quadriceps and Dorsiflexors muscles. A 100 Hz vibration thus was produced by a hand held vibrator and applied over the belly of the Quadriceps muscle and Dorsiflexors muscle of the spastic side so that the amplitude of vibration was approximately 2 mm with a mean pressure of 250 mBar. The patients in the VIB+ PT group received vibration sessions of 5 minutes each for 5 consecutive days for 2 weeks. After the end of the two weeks of treatment protocol, both the groups again were assessed for spasticity by using Modified Ashworths Scale.

Spasticity evaluation

In both groups the spasticity of the Hamstring muscle and Plantar flexor muscle was evaluated using the modified Ashworth scale

(MAS)[24] .The level of spasticity was evaluated before starting treatment (T0) and after the last session of vibration (T2).

Statistical analysis

The statistical analysis was done by Stata / SE 16.1 version. Kappa statistic was used to test the normality of the distribution of all variables. Descriptive statistics are given as mean ± SD.

Between groups analysis was done using Fisher Exact test with spasticity measurement by MAS at (T0) and after treatment by (T2) that investigated the primary end points Within-group analysis comparison i.e. Group A and Group B were carried out by Stuart Maxwell test. A p value <0.05 was considered statistically significant.

Ethical issues

The treatment protocol followed the Helsinki recommendations on non-pharmacological biomedical research involving human subjects and that was approved by the Institute's Ethical Committee. All the found a non-significant (P≥0.01) interaction in the Fischer Exact test for Group A and Group B (p=0.34).

Table I: Table showing Age, Gender and Affected side in Group A and Group B

	AGE	MALE	FEMALE	RIGHT AFFECTED SIDE	LEFT AFFECTED SIDE
GROUP A	54.7	14	16	18	12
GROUP B	52.8	13	17	23	7

Table II: Table Showing Modified Ashworths Scale Scores before and After Therapy in Group A and Group B

	GROUP A			GROUP B		
	MAS post 1	MAS post 1+	MAS post 2	MAS post 1	MAS post 1+	MAS post 2
MAS pre 1	0	0	0	1	0	0
MAS pre 1+	3	4	0	7	2	0
MAS pre 2+	6	15	2	0	14	6

Table II: Table Showing Modified Ashworths Scale Scores before and After Therapy in Group A and Group B

In subjects who underwent physiotherapy + vibration, the values of MAS significantly improved at TO and T2 with (p≤0.0001), and in patients who took conventional physiotherapy alone also showed significant improvement at TO and T2 with (p≤0.0001).

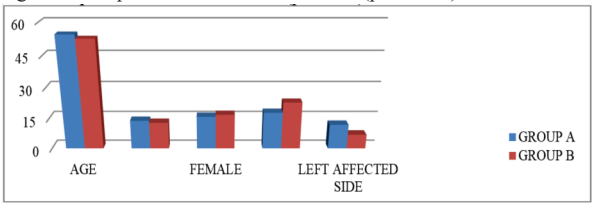

Figure I: Graph showing Age, Gender and Side affected in Group A and Group B

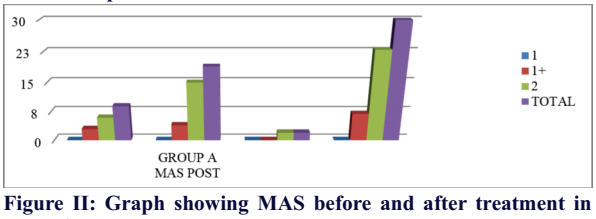

Figure II: Graph showing MAS before and after treatment in group A

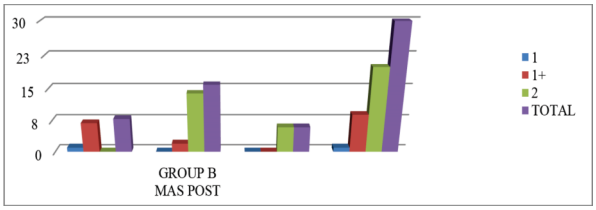

Figure III: Graph showing MAS before and after treatment in group B

DISCUSSION

The spasticity pathophysiology in post stroke hemiplegic patients is not completely understood and this dearth of complete knowledge is reflected in the field of rehabilitation by the management of spasticity. In particular, lower limb rehabilitation of hemiplegic patients is all too often not satisfactory because of various degrees of spasticity masking any possible outcomes in motor recovery. Several ways of controlling spasticity are used, including and local infusion of antispastic drugs such as botulin toxin and systemic management,[8-12] but their side effects, low cost/benefit ratio and the absence of controlled study in lower limb function can limit their clinical utility.[13-15] . In this study an effort was made to overcome the lack of knowledge present in review of literature on the use of the MAS for spasticity.[5,24,28,29]In this context modified ashworths scale for spasticity assessment and the management of the spastic lower limb in hemiplegic patients has been taken into consideration.[5,7]

It is worth noting that the literature on vibration is indeed quite diffused and not complete, encompassing whole body vibration(WBV) or localized applications of different devices. Localized vibration ranges from application by mechanical (or "ball" stimulator,[18,19] use of cylinder[20-23] to mechano-acoustic devices that use sound waves to activate the mechanoreceptors.[26] Differences in frequencies were also used in the treatment by vibrations. Moreover the sites of application both in normal and in pathological conditions are most important differences between techniques i.e. either on belly of muscle or tendinous part of muscle. Application exists where vibration was applied to the antagonist muscle group [23, 33] as well as to the agonist/spastic muscle group[18,34,35] showing very different mechanisms of action, but almost equal clinical results were found.

This present clinical study had as a primary endpoint to assess whether in a group of post stroke hemiplegic patients, the application of localized 100 Hz vibration to the lower limb antagonist (*i.e.*, the Quadriceps and Dorsiflexors muscle) associated with physiotherapy was able to reduce the spasticity of the flexor agonist (*i.e.*, the Hamstrings and Plantar flexor muscle). Moreover, other and more important was to assess if its association with physiotherapy was better than physiotherapy alone in reducing spasticity.

Our results indicate that a 100 Hz vibration applied to the Quadriceps and Dorsiflexors muscle of a spastic lower limb in association with physiotherapy is able to reduce the spasticity of the flexor agonist i.e. Hamstrings and Plantar flexors in a group of hemiplegic patients 2) Both Conventional physiotherapy and physiotherapy along with vibration stimulus has almost equal results in reducing levels of spasticity. We also suggest that, among other more centrally located mechanisms,[33] vibration applied to an antagonistic muscle may exert its action also by means of the agonist/antagonist reciprocal inhibition at a spinal level.

Reflex transmission changes in the pathways having or involved in the maintenance of the motor drive as well as in the altered pathological changes that occurs in hypertonicity or spasticity, may depend both on an altered supraspinal control over lower centres and on changes at cellular level in the spinal cord.[34] It was recently found that the application of a vibratory stimulation on a muscle produces an enhanced inhibition/ reduced excitability of corticospinal activity causing in a reduction of flexor muscle spasticity[18,19] reconfirming thereby that the important role of the motor cortex in the treatment of spasticity is present. But in case of a cortical lesion with a reduction of the signals or cortical motor drive, the spinal cord becomes the most important or pivotal structure in the genesis/ maintenance of an altered muscle tone.[34] Moreover, before reaching the cortical level, where it enhances the cortical silent period,[33] vibration impinges the spinal cord where agonists and antagonists muscles control are linked by the so-called reciprocal inhibition.[22,34,35]In case of a spinal cord injury also Reciprocal inhibition happens were the application of a vibratory stimulus is still able to modify reflexes without the involvement of supra spinal structures.[36] The smooth execution of movements are present in the normal subject as combined clinical consequence of this reciprocal inhibition while in the presence of a upper motor neurone lesion, *i.e.*, in presence of a flexor spasticity, residual movements can be further blunted and the movement becomes impossible or not graded in the strength of the muscular contraction.[37] In present research when a vibration is applied to the antagonist muscle, the enhanced sensory barrage, inhibits the activity of the spastic agonist muscle and better regulates reciprocal Ia inhibition according to the requirements of a voluntary movement.[37] In the present study this is clinically shown by the decrement of spasticity and by the unveiling of possible remaining voluntary

movement of the antagonist with a functional improvement better than physiotherapy alone.

CONCLUSION

The results concluded that Vibration therapy along with Physiotherapy reduces muscle tone in post stroke hemiplegic patients but there is no significant difference in using vibration along with physiotherapy over conventional physiotherapy alone in reducing the levels of spasticity.

Future Scope Minerva Medica

The present research paper should be viewed as providing supporting evidence of a functional improvement of the spastic lower limb when 100 Hz vibration, applied to the antagonistic muscle, is associated with conventional physiotherapy and to a possible use of a hand held vibratory device to help the clinician to evaluate the results of a treatment. [32]Although we used the MAS, other important aspects such as personal and environmental factors were not considered in this study. [39]. This is certainly a point of weakness that should be amended with further studies. Moreover even if Modified Ashworths Scale assessments is "a good supplement to standard clinical assessments as they provide objective and detailed information about a subject's muscle tone" a mechanical evaluation like H-reflex as well as an ICF evaluation is needed that might be sensitive also in measurement of musle tone.[32] The parallel recording of any improvements in muscle tone, which could be assessed by mechanical devices like H-Reflex and ICF participation, personal and environmental factors scales, would improve the possibility to have objective as well as ecologic parameters in the evaluation of lower limb rehabilitation in hemiplegia . These results should be confirmed by further studies for longer period of observation — data herein reported are limited to a 2 weeks of treatment span. Moreover, due to different sites of application,[18,23,33,34,35] further studies with specific experimental models are needed to ascertain the best frequency and site of application.

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Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

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