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Original Article

Rehabilitation of Stroke-Induced Spastic Paralysis using Stretching-resisting Modality Combined with LFEA (Low-Frequency Electric Acupuncture) Stimulation

Un-Sung Paek*, Se-Il Song

ABSTRACT

Background and Aim: In order to establish the method of rehabiliting the stroke-induced spastic paralysis, we tried stretching-resisting modality, combining with LFEA (low-frequency electric acupuncture) stimulation on the muscle. **Methods:** A total of 137 patients were devided into two groups-trial group (n=75) and compared group (n=62). Two groups of patients were given stretching-resisting modalities on paralysed muscles respectively, and LFEA (low-frequency electric acupuncture) stimulation was combined in the trial group, but not in the compared group. We have evaluated the paralysis using well-known scores as Ashworth Scales and Barthel Indices (BI) in the early days of admission and after we have finished the treatment. Then, we compared improved variances of the measures between two groups statistically. **Results:** We found that Ashworth Scale in trial group significantly reduced than in compared group, and more quickly reduced. Barthel Indice were significantly changed in both groups, but total BI and 2 BI items (transferring between bed and wheel-chair, mobility on surface level) were increased significantly in trial group than in combined group. **Conclusion:** The combination of LFEA stimulation might increase the therapeutic effects for rehabilitation of stroke-induced spastic paralysis than simple stretching-resisting modality, and reduces the length of time to recovery. And the mostly changed ADLs (activities of daily life) might be transferring between bed and wheelchair and mobility on surface level.
Key words: Stroke, Spastic paralysis, Low-frequency electric acupuncture, Strectching modality, Stretching-resisting modality.

INTRODUCTION

Stroke-induced spastic paralysis is the velocity-dependent stretch hyperreflexity caused by the higher motor nerve disturbance, which is accompanied with tendon hyperrefeflexity of affected muscles.[1-3] Typical form of central motorius paralysis develops flaccid hemiplegia during the acute phase, but after several hours or 3 weeks of time, it evolves into spastic hemiplegia.[1-3] Spastic paralysis commonly develops during synergy. The longer is the length of time of paralysis, the more easily follows the contracture and deformation, which limits the range of articular motion (ROM) and bothers the patient even in rest.[1-4]

The goal of most therapeutic modalities of spastic paralysis rehabilition is to normalize the tone of muscles. Several methods are widely used to facilitate the recovery of spastic paralysis as stretch maintenance, slow ice-fomentation, exercise, fixture to normal posture, repeated ROM movement, neurological stimulation, electrical stimulation, acupuncture, anti-spastic medications, operation, etc. Streatching modality on the paralysed muscle has been regarded as the most effected modality these days.[2,3,5,6]

Muscle stretching modality acts therapeutic role by irritation of the muscle spindle.[3,5] Muscular functions are controlled not only by central nervous system (spinal cord anterior motor neurons) but also by two special muscle sensory receptors-muscle spindle and Golgi tendon organs. Spindle is excited by lengthening the whole muscle or by contraction of end portions of the spindle's intrafusal fibers and Golgi tendon organ is excited by the muscle's tension. The excitation of these receptors transmit signals to the spinal cord(even to cerebral cortex) throughout their own pathways and produce inhibitory negative feedback signals-which provides the possibility of releasing muscle tone.

Low-frequency electric acupuncturing (LFEA) is the combination of acupuncturing and electricity stimulating therapy that has been widely used in clinics. Two needles are acupunctured on the surfaces of distal ends of the paralysed muscle and two electrodes are connected to the needles. LFEA stimulation on paralysed muscle induces the contant contraction, which is followed by stimulation fatigue of the muscle and irritation of Golgi tendon organs. Stimulation

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fatigue lowers the threshold of excitation, which provides easier condition of the receptors' excitation.[3,6,7]

Weakness of the muscle strength is one of the main features of the spastic paralysis. The patients are unable to lead independent activities without muscle strength despite of the normalized muscle tone.[6] Resisting action of a patient during stretching modality is aimed to improve physical strength of muscles.

We have applied stretching-resisting modality combined with LFEA stimulation in spastic paralysis patients on trial. The aim of this study is to validate the effectiveness of the stretching-resisting modality combined with low-frequency electric acupuncture for the rehabilitation of the spastic paralysis after stroke.

MATERIALS AND METHODS

Study Cohort

We prospectively included 137 consecutive patients (83.9% male, 48.9% office workers, 75.2% aged from 55 to 65) admitted to Pyongyang Medical College Hospital from January 2015 to December 2019 because of the spastic paralysis after stroke.

Modalities

Total patients were randomly devided into two groups: firstly, the conventional treatment group (compared group, *n*=62); and secondly the conventional treatment plus the LWEA (low-frequency electric acupuncture) treatment group (trial group, *n*=75).

Two groups of patients were given stretching-resisting modalities on paralysed muscles respectively, and LFEA stimulation was combined in the trial group, but not in the compared group.

Stretching-resisting Modality

A therapist continued stretching targeted muscle with the hand on the distal point of muscle and the other hand on the central point, until the patient complained sickness. First duration of stretching was 12 sec, but it had been increased gradually.

For the duration of stretching, the patient tried the resistive exercise to the therapist's action.

Low-frequency Electric Acupuncture Stimulation Treatment

We acupunctured 2 needles on distal endpoints of the paralysed muscle where tendons are attatched and connected the electrodes of the low-frequency electric stimulator to the needles. 100Hz of frequency, 10ms of wavelength and 10~20mA of amperage is the standard of current we applied first, but they could have been regulated according to the endurance of a patient and the contractibility of muscles. A patient was given such stimulus for 30 min per time, 2 times per day, 6 days per week. After a day of rest, a cycle was repeated.

Validation of Therapeutic Effects

Spastic paralysis was evaluated by the Ashworth Scale, and the activity limitation was evaluated by Barthel Index (BI).

Ashworth Scales were calculated at the first day of admission and once per 10 days. We compared mean scales between two groups (compared group vs trial group).

Barthel Indices were assessed at the first day of admission and the last day of modality. We compared these parameters (before vs after the modalities) to assess therapeutic effects of both modalities. In order to compare the effectiveness of modalities, we declared a parameter called improved variance of BI as follows:

<Improved variance of BI> = <BI after modality> – <BI before modality>

We compared improved variances of BI between two groups (compared group vs trial group) to confirm the significant difference of therapeutic effects.

Assessments of Muscular Tension and Activity Limitation

The Ashworth Scale is the most widely used assessment tool to measure resistance to limb movement in clinic setting as it reflects the muscular tension.[7] The scale is as follows;

0. No increase in muscle tone.

1. Slight increase in tone giving a catch when the limb is moved.

2. More marked increase in tone but limb easily moved.

3. Considerable increase in tone – passive movement difficult.

4. Limb is rigid in flexion or extension.

The BI consists of 10 common ADLs (feeding, bathing, grooming, dressing, bowels, bladder, toilet use, bed-to-chair and chair-to-bed transfers, mobility, stairs), 8 of which represent activities related to personal care while 2 are related to mobility and the total amount of BI varies between 0-100 (Table 1).[8]

All the variables (Ashworth Scale, Barthel Index items, total Barthel Index) were expressed as mean±standard deviation, and were compared using Student's test. P value of <0.05 was considered significant.

RESULTS

Changes in Ashworth Scale

As shown in Table 2, significant changes in Ashworth scale were expressed since 20 days after admission in compared group, and since 10 days in trial group (P<0.05). Difference of scales between compared group versus trial group was obvious in 30 days after admission (P=0.012).

Changes in Barthel Indices

Table 3 depicts the effects of both modalities (compared, trial) affecting on the rehabilitation of paralysis. In total, both methods had significant effects in total BI improvements. (P<0.0001) All the BI items tended to be increased after either of modalities and some (compared - dressing, transferring, mobility on surface level, stairing; trial-bathing, dressing, transferring, mobility on surface level, staring) of them showed significant changes respectively (P<0.05).

Comparison of Both Modalities for Rehabilitation

Table 4 depicts the improved variences in two groups, reflecting the difference of effects between two modalities. Total BI and 2 items (transfer, mobility on surface level) were significantly increased in trial group than in compared group (P<0.01).

DISCUSSION

Spastic paralysis after stroke is the higher motor nerve disturbance characterized by muscle tone and weakness of the physical strength, which limits the range of articular motion. The goal of previous modalities to rehabilite the spastic paralysis has been to normalize the muscle tone and weakness of strength.

Several methods have been widely used to facilitate the recovery of spastic paralysis as stretch maintenance, slow ice-fomentation, exercise, fixture to normal posture, repeated ROM movement, neurological stimulation, electrical stimulation, acupuncture, anti-spastic medications, operation, etc.

The aim of this study is to validate the effectiveness of stretching-resisting modality combined with LFEA stimulation for the rehabilitation of the spastic paralysis after stroke.

Table 1: Barthel Index.

Score	0	5	10	15
Feeding	Unable	Needs to Help Cutting, Spreading Butter, etc, or request modified diet	Independent	
Bathing	Dependent	Independent (or in shower)		
Grooming	Needs to help with personal care	Independent face/hair/teeth/ shaving		
Dressing	Dependent	Needs help but can do about half unaided	Independent (including buttons, zips, laces, etc)	
Bowels	Incontinent (or needs to be given enemas)	Occasional accident	Continent	
Bladder	Incontinent or catheterized and unable to manage alone	Occasional accident	Continent	
Toilet use	Dependent	Needs some help, but can do something alone	Independent (on and off, dressing, wiping)	
Transfer (bed-to-chair and back)	Unable, no sitting balance	Major help(one or two people, physical), can sit	Minor help (verbal or physical)	Independent
Mobility(on level surfaces)	Immobile or <50 yards	Wheelchair independent, including corners, >50 yards	Walks with help of one person (verbal or physical) >50 yards	Independent (but may use any aid like stick) >50 yards
Stairs	Unable	Needs help (verbal, physical, carrying aid)	Independent	
Total amount	0-100			

Table 2: Changes in Ashworth Scale according to the days after admission.

Groups	Before modality	After modality		
		10d	20d	30d
Compared group (n=62)	3.24±0.84	3.02±0.89	2.79±0.87*	2.56±0.76*
Trial group (n=75)	3.21±0.81	2.94±0.82*	2.61±0.73*	2.27±0.76*
P value	0.420	0.318	0.099	0.012

*: P<0.05 (compared against the scales before modality)

Table 3: Barthel indices before and after the modalities.

Group	Compared Group (n=62)			Trial Group (n=75)		
	Before modality	After modality	P	Before modality	After modality	P
Feeding	4.92±3.45	5.48±3.92	0.198	4.93±3.44	5.80±3.77	0.072
Bathing	3.23±2.41	3.95±2.05	0.037	3.20±2.42	3.93±2.06	0.024
Grooming	2.98±2.47	3.39±2.36	0.177	2.93±2.48	3.33±2.37	0.157
Dressing	4.76±3.67	5.89±3.68	0.045	4.80±3.12	6.00±3.29	0.012
Bowels	5.32±2.84	5.65±2.93	0.268	5.40±3.26	5.73±3.15	0.263
Bladder	4.92±2.64	5.40±2.76	0.160	4.93±2.79	5.33±2.89	0.195
Toilet use	5.16±2.99	5.57±3.15	0.233	5.07±3.63	5.60±3.58	0.183
Transfering	7.74±5.10	9.19±4.45	0.047	7.80±4.81	10.47±3.96	0.000
Mobility…	7.58±5.34	9.11±4.48	0.043	7.67±4.60	10.33±3.97	0.000
Stairs	5.08±3.56	6.21±3.47	0.038	5.07±3.24	6.27±3.40	0.014
Total BI	51.69±10.44	59.84±10.12	0.000	51.80±9.43	62.80±10.88	0.000

The mechanism of therapeutic effects of our algorithm is thought as follows:

Stretching modality acts therapeutic role by irritation of the muscle spindle. Lengthening of the muscle spindle transmits signals to the spinal cord (even to cerebral cortex) throughout their own pathway and accordingly produce inhibitory negative feedback signals which release the muscular tone.

Table 4: Improved Variences in two groups.

Group	Improved Varience		P
	Compared group (*n*=62)	Trial group (*n*=75)	
Feeding	0.57±1.59	0.87±1.91	0.161
Bathing	0.72±1.78	0.73±1.96	0.491
Grooming	0.40±1.37	0.40±1.37	0.495
Dressing	1.13±2.29	1.20±2.44	0.431
Bowels	0.32±1.23	0.33±1.26	0.480
Bladder	0.48±1.49	0.40±1.37	0.366
Toilet use	0.40±1.64	0.53±1.55	0.318
Transfer	1.45±2.46	2.66±3.21	0.008
Mobility	1.53±2.95	2.67±3.22	0.002
Stairs	1.13±2.29	1.20±2.30	0.429
Total BI	8.15±6.22	11.01±6.78	0.006

LFEA stimulation on paralysed muscle induces the constant contraction, which is followed by stimulation fatigue of the muscle and irritation of Golgi tendon organs. Stimulation fatigue lowers the threshold of excitation, which provides easier condition of the receptors' excitation.

Resisting action of a patient during stretching modality is aimed to improve physical strength of muscles.

As results, we found that Ashworth Scale in trial group significantly reduced than in compared group, and more quickly reduced (Table 2). Barthel Indices were significantly changed in both groups, but 2 Barthel Index items (transferring between bed and wheelchair, mobility on surface level) were increased significantly in trial group than in combined group (Tables 3,4).

Limitations of the Study

In view of this study's limitations, further investigation including much more patients is needed to clearly validate the effectiveness of our modality.

CONCLUSION

Combination of LFEA stimulation might increase the therapeutic effects for rehabilitation of stroke-induced paralysis than simple stretching-resisting modality, and reduces the length of time to recovery. And the mostly changed ADLs by modality might be transferring between bed and wheelchair and mobility on surface level.

CONFLICT OF INTEREST

The authros declare no conflict of interest.

ABBREVIATIONS

LFEA: Low-frequency Electric Acupuncture; **ADL:** Activities of Daily Lives; **BI:** Barthel Index; **ROM:** Range of Motion.

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