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The Motor Function Improvement of the Affected Hand after Stroke Induced by Music-supported Therapy: A Randomized Control Clinical Trail

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Abstract

Stroke is the second most common cause of death and major cause of disability worldwide. Hand motor dysfunction is a common impairment in stroke patients, as the cortical projection area of our fingers is large. Once it is damaged, it will be very difficult to restore the function, and has long been the focus and difficulty of stroke rehabilitation. Music- supported therapy in recent study was shown to induce improvements in motor skills in stroke survivors.

Objective: This study aimed at assessing the motor recovery of the affected hand induced by music-supported therapy in chronic stroke patients.

Methods: 14 patients with subcortical stroke, mild to moderately impaired hand function fulfilling the inclusion criteria were randomly assigned to the music group and control group. Both groups received keyboard (Yamaha) training for 30min, 20 times over 4 weeks in addition to conventional treatments. And the only difference between the two groups was that control group's keyboard could not make any sound. They were trained in an intensive step by step training program. Patients were assessed by Wolf Motor Function Test before and after training.

Results: Both groups showed improvement in motor function assessed by Wolf Motor Function Test scores, and the improvement in music group was significantly better than that of the control group.

Conclusions: The music-supported training with sound can enhance the restoration of hand function much better than the training with no sound in which the music played an important role.

Keywords: Stroke; Hand function; Music-supported therapy

Introduction

Stroke is the second most common cause of death and major cause of disability worldwide [1]. The majority of patients suffering from a stroke have motor impairments, preventing them to live independently.

Music therapy has been used to improve patients' health in several domains, such as cognitive functioning, emotional development, social skills, and quality of life, by using music experiences such as free improvisation, singing, and listening to, discussing, and moving to music to achieve treatment goals. Music- supported therapy (MST) in recent studies has been used in the rehabilitation of stroke survivors with mild or moderate motor disfunction [2-7]. Most of the randomized controlled trial studies were interested in the gross motor function of affected upper extremities after stroke, and the results often showed greater improvements compared with other traditional rehabilitation therapies. But the affected hand function was not especially focused on.

Hand motor dysfunction is a common impairment in stroke patients, as the cortical projection area of our fingers is large. Once it is damaged, it will be very difficult to restore the function, and has long been the focus and difficulty of stroke rehabilitation. So we wanted to find out what can music-supported therapy do to the affected hand function after stroke. Since the improvement of the upper extremities after music- supported training was demonstrate, we supposed that the affected hand function would also regain after certain MST programme. It is well known that repetitive practice is one of the basic elements of music supported therapy which can induce the recovery of motor function after stroke, and we would like to find out what the music itself played part in this new therapy.

Methods

Subjects

Patients diagnosed stroke and admitted in Chinese Rehabilitation Research Center from the year 2010 to 2013 were selected according to the following criteria: 3-12 months after onset; 18-80 years old; right-handed (handedness classification for Chinese people [8]); upper limb and hand's Brunnstrom stage [9] > IV period; Muscle tension of affected upper limb and hand (Modified Ashworth) < II level; CT or MRI results showed the subcortical lesion. Exclusion criteria: severe cognitive dysfunction: MMSE <17 (Illiteracy), <20 (Primary school),<22 (Secondary school and above); depression, mania or other mental problems; significant limb tremor; experience of playing electric piano or keyboard operation; the affected hands suffered from

of serious injury or deformity previously, which may affect the training; stroke history.

Finally, 14 patients recruited were randomly divided into two groups: the Music Group (MG), n=7, male/female=6/1, the average age was 54.14 ± 14.30 years, duration of stoke was 6.14 ± 2.88 months; the Control Group (CG), n=7, male/female=5/2, the average age was 52.57 ± 15.77 years, duration of stroke was 6.64 ± 3.00 months. Age and stroke duration of the two groups had no significant difference (P=0.846; 0.756) using independent samples t test. Table 1-1 and Table 1-2 are the basic information of the 14 patients.

NO.	Sex	Age(Y)	Duration(M)	Affected side	Stoke	Location
1	M	47	3.5	R	Ischemic	Left basal ganglia
2	M	59	11	L	Ischemic	Right corona radiata
3	F	66	6.5	L	Hemorrhage	Right basal ganglia
4	M	64	5	L	Ischemic	Right corona radiate,basal ganglia
5	M	32	4.5	R	Hemorrhage	Left basal ganglia
6	M	70	9	R	Ischemic	Left basal ganglia
7	M	41	3.5	L	Ischemic	Right corona radiata

Table 1: Information of MG patients

NO.	Sex	Age(Y)	Duration(M)	Affected side	Stroke	Location
1	M	52	5	R	Hemorrhage	Left corona radiate, basal ganglia
2	F	74	3	R	Ischemic	Left basal ganglia
3	M	38	7.5	L	Ischemic	Right corona radiate
4	M	46	4.5	R	Hemorrhage	Left corona radiate, basal ganglia
5	M	73	8.5	L	Hemorrhage	Right basal ganglia
6	M	37	12	R	Ischemic	Left corona radiate, basal ganglia
7	F	48	6	R	Ischemic	Left basal ganglia

Table 2: Information of CG patients

Music-supported training

In music group, patients were trained with MST 30 minutes per time, and 20 times over four weeks in addition to traditional treatment. And in control group, the patients got the same training but the keyboard could not make any sound, which played as a shame therapy versus MST. They were trained in an intensive step by step training program. First, the patients were taught to play each key in the keyboard. Second, they were asked to play tunes with certain sequence *do-re-mi-fa-sol-la-si-do* and *do-si-la-so-fa-mi-re-do*. Third, the patients were trained to play simple songs including *Ode to joy, The painting carpenter and Brother John*. Patients were given passive traction relaxation exercises every five minutes during the training process. All the training was completed by the same therapist in the same therapeutic environment. The purpose and procedures of the treatment were explained to the patient and informed consent was signed before the treatment. The patient was accompanied by a family member to ensure his/her safety during the treatment.

Evaluation of Affected Hand Motor Function

Wolf Motor Function Test (WMFT) [10] was used to assess the velocity and quality of the affected upper limb's movements before and after training. The WMFT version contains 15 function-based, measured using time to completion, which include the Forearm to table (side), Forearm to box (side), Extend elbow (side), Extend elbow (weight), Hand to table (front), Hand to box (front), Reach and retrieve, Lift can, Lift pencil, Lift paper clip, Stack checkers, Flip cards, Turn the key in lock, Fold towel, Lift basket. According to task completion, functional ability scale (FAS) is assessed from 0 to 5 points. 0 = Does not attempt with upper extremity (UE) being tested; 1 = UE being tested does not participate functionally; however, an attempt is made to use the UE. In unilateral tasks, the UE not being tested may be used to move the UE being tested. 2 = Does, but requires assistance of the UE not being tested for minor readjustments or change of position, or requires more than 2 attempts to complete, or accomplishes very slowly. In bilateral tasks, the UE being tested may serve only as a helper. 3 = Does, but movement is influenced to some degree by synergy or is performed slowly or with effort. 4 = Does; movement is close to normal but slightly slower; may lack precision, fine coordination, or fluidity. 5 = Does; movement appears to be normal. The tests were completed in a quiet, bright room by the same therapist who did not participate in trainings.

Statistics

The analysis's were made with SPSS 17.0. The independent samples t-test was used to determine if there were significant differences between the music group and the control group both before and after training. Data accorded with normal distribution and homogeneity of variance was compared by t-test, or by rank sum test. Paired samples t-test was used to value the change of the motor function in the same group. A p-value <0.05 was considered to be statistically significant.

Results

Before and after training

Functional ability scale (FAS) and time of the patients were tested both in music group and control group before and after training. Before training, there was no significant difference between the two groups (P=0.809; 0.736, P> 0.05). Both the quality and time of WMFT in the two groups changed. There were both significant differences (P <0.01). WMFT-Q: the quality of Wolf Motor Function Test; WMFT-T: the time of Wolf Motor Function Test.

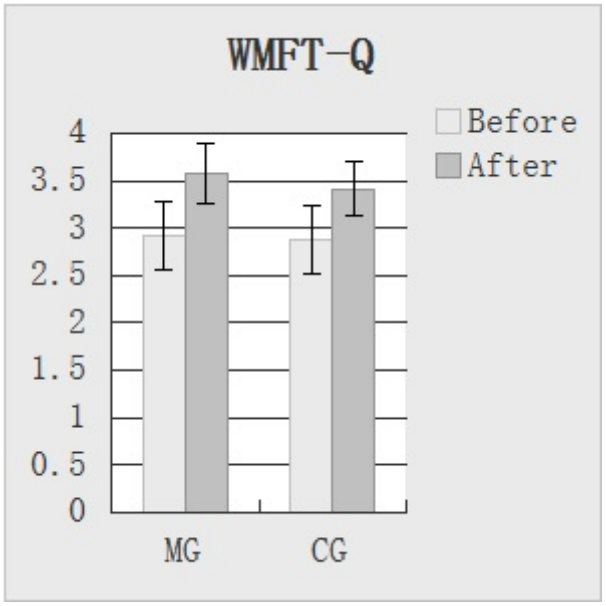

Figure 1: WMFT-Q of patients in MG and CG before and after training

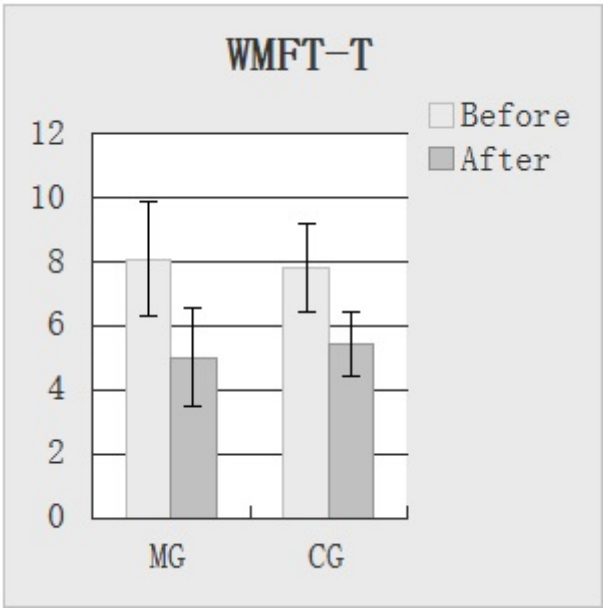

Figure 2: WMFT-T of patients in MG and CG before and after training

The change in both groups

The improvement of FAS in MC is more than that in control group (P = 0.039). The change of time was also significantly different (P = 0.043).

Discussion

Music-supported therapy (MST)

Current research suggests that music therapy improves success rates significantly when used in conjunction with traditional therapy. MST uses musical instruments, an electronic piano and an electronic drum set emitting piano sounds, to retrain fine and gross movements of the paretic upper extremity. Rojo N [3] studied a stroke patient of 20 months, after drums and piano training for 20 times, the patient showed a significant improvement in 3D motion analysis suggesting that the upper limb motor function improved a lot compared with the previous. S.Schneider [4] also found that patients trained with active music therapy made significant progress in the motion frequency, velocity, motion coherence compared with the patients only accept the traditional rehabilitation trainers. What's more, Altenmuller E [5] got the same conclusion in his study. After intervention of a 3-week piano training programme, all the three participants showed improvements in their fine and gross manual dexterity, as well as in the functional use of the upper extremity, and the improvements were maintained at follow-up [6]. Piano training can result in sustainable improvements in upper extremity function in chronic stroke survivors [7], and individuals with a higher initial level of motor recovery at baseline appear to benefit the most from this intervention.

Patients after 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. In this study, we wanted to find out what MST especially the music can do to the hand function of the patients suffered from stroke. MST was conducted through keyboard training in an intensive step by step programme. Patients were firstly taught to play keys to be familiar with each note, and at the same time, each finger of affected hand was trained to make flexions and extension. Then certain rhythm was taught, so that patients of MG could hear the rhythm with intensive training on finger movements as well as arm control. Third, the simple songs were taught including *Ode to joy, The painting carpenter and Brother John*, and the last song was most difficult to play, as all the joints of the affected upper limb were recruited. In the control group, all patients were taught to play the keyboard with no sound but only finger movements. We separated the music from music-supported therapy and left repetitive motor training that conventional therapy could make. We found that both groups showed significant progress in the quality of WMFT as well as the time, but the improvement of MG was greater than the silent group, which showed that the music itself played an important role in improving affected hand motor function.

Due to the limitations of clinical work, in fact it was difficult to achieve randomization. Nevertheless, general information, neurological deficits and motor function status of the patients of two groups were comparable, thereby reducing the bias to ensure the credibility of the results.

Mechanism of Music- supported Therapy

The effect of MST has been approved by many studies as stated above, but the mechanism of this new therapy is still unclear.

Some researchers found that MST can increase a patient's motivation and positive emotions [11,12]. Nayak et al. [13] found that rehabilitation staff rated participants in the music therapy group more actively involved and cooperative in therapy than those in the control group. Another study found the incorporation of music with

therapeutic upper extremity exercises gave patients more positive emotional effects than exercise alone [12]. Their findings supported that music therapy could be used in rehabilitation with a trend toward improvement in mood during training. Therefore, it was hypothesized 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 in traditional therapies.

MST leads to neuroplastic changes in the motor cortex of stroke patients which may explain its efficacy. Grau-Sanchez's [14] result revealed that participants obtained significant motor improvements in the paretic hand and those changes were accompanied by changes in the excitability of the motor cortex. Rodriguez-Fornells [15] focused on understanding the dynamics involved in the neural circuit underlying audio-motor coupling and how functional connectivity could help to explain the neuroplastic changes observed after therapy in stroke patients. Amengual JL and his colleagues found that the music-supported therapy produced changes in cortical plasticity leading the improvement of the subjects' motor performance [16].

Listening to rhythmic sound sequences activates not only the auditory system but also the sensorimotor system. Bangert [17] found that pianists and non-pianists showed different cortical activation when playing silent MRI-compatible keyboard, and the main differences were the dorsolateral and lower of frontal lobe, superior temporal gyrus, supramarginal gyrus, supplementary motor area and premotor area, indicating integration of auditory and sensory-motor cortex. Functional MRI in a music listening task suggests that one of the effects of MST is the task-dependent coupling of auditory and motor cortical areas [3]. Fujioka examined three chronic patients who received MST, and they made the conclusion that the data gave insight into the neural underpinnings of rehabilitation with music making and rhythmic auditory stimulation [18].

Conclusion

Due to the stringent recruit conditions, limited cases were selected. According to the data analysis presently, the improvement of upper limb and hand motor function of music group was more than that in control group. MST could be used as a complementary therapy in the recovery of motor function in the patients after stroke as proved out by many other recent studies, and the keyboard could be applied to improve the affected hand and finger function for a better recovery. Considering the small sample size, firm conclusions were difficult to draw. Larger samples and longitudinal evaluation are required to corroborate the findings of this study. The mechanism of MST is stilling being researched, and further studies are needed.

Prospects

The contribution the music-supported therapy made to the recovery of motor function in stroke patients is affirmative, but this new therapy is still immature in many respects, such as the instruments, procedures, intensity, evaluation methods, which are worth farther exploration. With the deepening of rehabilitation theory and the raising level of rehabilitation therapy, music-supported therapy is bound to achieve the perfect combination of science and art, as a new effective rehabilitation method used in clinical to improve the motor function and the quality of life in stroke patients.

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