

A case study in upper limb stroke rehabilitation.

BACKGROUND

Strong evidence that FES treatment improves upper extremity function in acute stroke. Isometric strength of the wrist extensors was significantly greater at 8 and 32 weeks in the ES group and grasp/grip score on the ARAT had increased significantly at 8weeks (patients 2-4weeks post stroke) [1].

Tablet technology allows the application of the rehabilitation concepts repetition, intensity and task oriented training of the paretic extremity and may provide a less labour intensive option than conventional upper limb therapy post stroke [2]. Tablet technology is also a viable option for patients when they return home, allowing increased opportunity for task specific upper limb retraining.

Music-supported therapy (utilising a music instrument for gross upper limb rehab) has been shown to induce profound neural changes via TMS and MRI in the contralateral sensorimotor cortex in chronic stroke [3]. It has been postulated that increased connectivity between the auditory and premotor cortices or "audio-motor coupling" may be contributing to neuroplastic changes resulting in the improvements in motor function with Music-supported therapy [4].

In music therapy the patient is receiving immediate auditory feedback as they execute a template tone or melody and this may help to overcome sensory and proprioceptive deficits by giving an alternate mechanism for the patient to modify motor output [5].

Clinical improvisation is stimulated and guided by patient-centred feelings, ideas, images, fantasies, memories, events and situations [6]. This emotional expression results in the patient accessing affective/motivational systems in the brain thus enhancing cognition, language and motor learning [7]. Music also offers a motivating medium for practicing repetitive tasks [8].

THE PATIENT

74year old retired pianist and Professor of Music with a left pontine stroke. On admission she presented with flickers of activity in right finger flexors but had no hand function; sensation and proprioception were intact; tone was normal.

Short Term Goal: to be able to eat an apple.

Long Term Goal: to play the piano.

FES & THUMB JAM PROTOCOL

FES was via Verity Neurotrac wrist/finger extensors 50Hz, 200µS Intensity ranged from 20-30mA; 30second/5secs off.

ThumbJam by Sonosaurus LLC is a musical performance application for iPhone, iPad and iPod Touch. Selecting from a variety of instruments and scales / combinations of notes, the player is able to produce sound that emulates the chosen instrument by the tactile touch of the skin or fingertip. The flute instrument setting in ThumbJam was chosen because the action of one finger corresponds to the playing of one note.

From Week 4 onwards, FES in isolation was also provided each weekday alongside the 1x weekly FES + ThumbJam intervention by the music therapist. Other upper limb therapy provided was mirror box, active assisted ROM, PADL retraining, functional retraining, weightbearing and scapular retraining. The FES & ThumbJam protocol and treatment progression is shown below:

WEEK 2/3 FES

Wrist/finger extensors;
30-60 mins 1-2x per
weekday

WEEK 4 FES + ThumbJam

Selected scale/
combination of notes;
45 mins per week with
Music Therapist (MT)

WEEK 5 FES + ThumbJam

Wrist support + free
improvisation; 45 mins
per week with MT

WEEK 6 FES + ThumbJam

Wrist support + directed
improvisation (finger
focus); 45 mins per
week with MT

WEEK 7 FES + ThumbJam

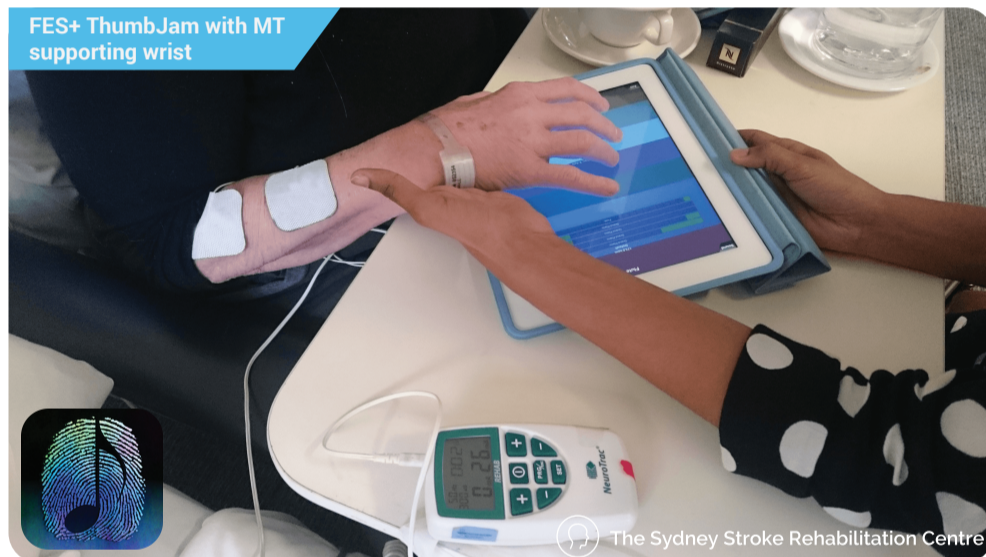
Improvisation (NO
WRIST SUPPORT); 45
mins per week with MT

WEEK 8 FES + Keyboard

45 mins per week
with MT

WEEK 9-10 Keyboard (no FES)

Independent practise
with keyboard at
bedside



OUTCOMES

Right Upper Limb	Initial Assessment	Week Eight	Discharge Week Ten	Seven Month Follow Up
9 Hole Peg Test	Unable	1 min, 19 sec	54.08 sec	43.57 sec
Pinch (kg/F) Dynamometer	Unable	2	3.66	4
Grip (kg/F) Dynamometer	Unable	6.3	4.16 (* ↓ due to shoulder Pain)	8.33
Functional Use	Nil	Could drink from cup independently	Using utensils for mealtimes	Can tie shoelaces
Musical Function	Nil	Scales on keyboard with FES once set up	Keyboard independent scales practice	Bach on the piano

CONCLUSIONS

FES + ThumbJam is a innovative new treatment protocol for retraining the upper limb post stroke.

This protocol facilitated task repetition which is an essential component of neural plasticity and motor recovery. Task progression was achieved easily by reducing the bar width within the application, then transition to a keyboard and as wrist and finger control improved the withdrawal of the FES component.

The immediate auditory feedback provides "musical encouragement" for the player [9]. Auditory feedback may also assist to overcome sensory and proprioceptive impairments.

As procedural memory stores entire motor patterns during improvisational learning (for musicians), it becomes easily accessible during improvisation [10]. It needs to be established whether improvisational learning in non musicians will lead to improvements in accessing motor patterns. Then whether these motor patterns are useful for retraining other functional upper limb tasks.

Success in this case study was certainly related to the patient's music background. The approach may need to be adapted in non musicians which the authors have commenced trialling.

Once trained, the patient could easily undertake this protocol without the need for therapist supervision (self management) and it would be a low cost option for upper limb retraining on discharge for those patients who already possess tablet technology.

"Once the FES started I had an impetus to get things started"

"I got some feedback....the sound I made and the feeling that I could move in a small increment was better than nothing and got better over time"

"-- getting the brain unstuck and getting it to remember what it used to do"

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