

The effects of Mobilization and Stimulation of Neuromuscular Tissue on the hemiplegic upper limb: a case report

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Abstract

Introduction. Mobilization and Stimulation of Neuromuscular Tissue (MaSoNT) is a newly-invented technique that aims to trigger functional recovery in stroke patients. This is the first study that applies an intervention with MaSoNT in a patient's hemiplegic hand. The purpose was to investigate the effects of a MaSoNT intervention and to prove the safety of the technique.

Methods. A case study is provided. The patient was a male stroke survivor, aged 71, who underwent a cerebrovascular accident a week before the intervention. He presented zero voluntary movement in the hemiplegic arm and some sensory impairment. The patient had had neither pain nor spasticity before the intervention. The intervention was standard upper limb therapy performed twice per week and MaSoNT application for 15 minutes, 5 times per week. The total duration of the intervention was 3 weeks. The following measurement tools were used: Modified Ashworth Scale, Motricity Index Arm Score, Motor Assessment Scale items 6, 7, and 8, Thumb Localization Test, Nottingham Sensory Assessment.

Results. The patient demonstrated both motor and sensory improvements by the end of the experiment. Pain and spasticity remained absent.

Conclusions. The study possibly proves that MaSoNT is a safe technique to apply in a hemiplegic hand. Moreover, it could lead to functional recovery, although further research is mandated.

Key words: MaSoNT, functional recovery, proof of safety, stroke

Introduction

Every year, there are approximately 100,000 stroke incidents in the UK, with the majority of those patients leaving hospital with disability [1]. The upper limb is most commonly affected by permanent disability [2]; merely less than 2 out of 10 stroke patients experience full recovery of function in the upper extremity [3]. Overall, 6 out of 10 stroke survivors could not manage to recover some dexterity of the hemiplegic hand even after a 6-month intervention [4]. Hence, even though many 'hands-on' techniques are applied in order to trigger functional recovery to the upper limb [5], a vast majority of them failed to establish a standard of usefulness in that regard [6]; there is a necessity for more evidence-based practice as well as a better reasoning for their application [7].

Mobilization and Stimulation of Neuromuscular Tissue (MaSoNT) is a newly-invented sensory facilitatory technique for a hemiplegic upper limb where the therapist offers somatosensory stimuli aiming to trigger functional recovery through cortical reorganization [8]. To further analyse the rationale underpinning MaSoNT in neurorehabilitation, one must note that during the post-stroke stages, there is a sequence of events essential for recovery, and cortical reorganization is its neural basis [8]. Cortical reorganization happens anyway after injury but it can be maladaptive or non-effective [8]. Therefore, the therapist applies sensory facilitatory techniques in order to trigger and guide the reorganizational changes of the cortex in favour of functional recovery [8].

In past years, it was shown that interventions focusing on somatosensory stimulation – similar to MaSoNT – could

cause cortical reorganization in stroke survivors and thus trigger the initiation of this sequence of events that would finally lead to recovery [8]. The safety of the technique has been studied and supported in theory [8], and an exploratory study was conducted in a small number of stroke patients [9]. This case study primarily aims to prove the safety of MaSoNT. Its secondary purpose is to report MaSoNT effects regarding pain, spasticity, and recovery.

Subject and methods

Participant

As the patient was the first one to receive MaSoNT in a monitored and regular manner, the sample had to be of convenience. The final patient was a 71-year-old male stroke survivor classified to have a lacunar circulation ischemic stroke syndrome [10]. The areas of infarct were the pons and the basal ganglia. The dominant side was the hemiplegic, right one. The patient was recruited on the basis of being more suitable for the technique according to evidence [8]. The patient received MaSoNT one week after the cerebrovascular accident, which was his second. The first stroke was mild and ischemic, infarcted the left pons, occurred 2 years before the second one and presented neither motor nor sensory deficits. With the second stroke, which was also ischemic, the patient presented dysarthria, positive (+) Babinski sign on the hemiplegic side, and no aphasia. His body mass index pointed at overweight. Moreover, the patient showed a history of hyperlipidaemia, hypertension, diabetes

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Table 1. The patient's baseline features

Gender	male
Age (years)	71
Days since stroke	7
Hemiplegic side	right
Dominant side	right
Pain / No pain	no pain
National Institutes of Health Stroke Scale	14
Functional Independence Measure	33
Mini-Mental State Examination	25
Modified Ashworth Scale	0
Motricity Index Arm Score	0
Motor Assessment Scale items 6, 7, and 8	0
Thumb Localization Test	6
Nottingham Sensory Assessment	tactile sensation: 1 kinaesthetic sensations: 1 stereognosis: 2

mellitus type 2, chronic kidney disease, and deep vein thrombosis at the superficial femoral vein and the popliteal vein. The pharmaceutical treatment included: Actrapid, Lantus, Ivor 2500 IU, TBS Salospir, omeprazole, Amlopen, Coaprovel, TBS Atorstat 20, TBS Hytrin. Furthermore, the subject had received intravenous injections of recombinant tissue plasminogen activator (tPA) when in acute phase. The shoulder abduction and finger extension (SAFE) score showed no voluntary motor control within 72 hours after the cerebrovascular accident, which shows low predictability of regaining dexterity at 6 months [11]. The physiotherapy intervention was the first one that the patient received after the stroke. The patient's clinical features are presented in Table 1.

Study design

As evidenced elsewhere [8], the intervention offered was standard upper limb therapy applied twice per week for a quarter of an hour, along with MaSoNT. The standard upper limb therapy included passive/active movement exercises and static/dynamic stretching. No electrically generated stimuli were offered (device-free). MaSoNT was applied for 15 minutes, 5 times per week. The experiment lasted 3 weeks. The positioning of the hemiplegic upper limb was offered twice a day for 30 minutes [12]. The study design abides by the CARE guidelines [13] for case reports.

Measurement tools

In order to assess pain, visual analogue scale was not preferred owing to the criticism on its use in stroke survivors [14]. Pain dichotomous evaluation was used instead (pain versus no pain) as inspired by other studies on stroke survivors [15]. Pain was assessed both at rest and at the moment of the hemiplegic arm movement. To assess spasticity at the shoulder, elbow, and wrist, the Modified Ashworth Scale [16] was used; its psychometric application among stroke patients is supported [17–22] but it also has some limitations [23–25]. Moreover, to assess motor function, the

Motricity Index [26] was used, which is widely evidence-based [27–31], along with items 6, 7, and 8 of the Motor Assessment Scale [32], again supported by evidence [33–36]. Lastly, the Thumb Localization Test was utilized to assess proprioception [37, 38], and the Nottingham Sensory Assessment to determine the somatosensory effects [39, 40]. The independent assessor was a physiotherapist who was blinded to the intervention. However, there was no blinding for the patient.

MaSoNT application procedure

MaSoNT is a concept that, at its basic form, involves the application of a transverse stretch across the muscle belly, either in the upper or in the lower limb. Moreover, there should be a progression in the way to apply the MaSoNT basic technique, depending on the attendance and functional level of the patient [41].

A basic rule for MaSoNT – which also applies to other forms of therapeutic approaches – is that the patient must be deprived of any other form of external stimuli [41]. It is necessary to keep the patient focused on the application and on what the therapist is trying to achieve by stimulating the limb. Also, as a general rule, MaSoNT techniques are recommended to be used in combination with one another, in accordance with the patient's condition and treatment goals [41].

In the presented study, the patient received 4 different MaSoNT techniques: the basic facilitatory technique for the upper limb, twisting of the upper limb, finger swiping, and pinching [41]. For the basic facilitatory technique, the upper limb was lifted by the therapist with specific handling and brought towards the patient's field of view in order to gain his full attention. The position acquired through the therapists' handling was: shoulder in flexion, adduction, mid-rotation, elbow in mid-flexion, and forearm in pronation. The wrist, along with the fingers, was free of handling, and thus placed relaxingly by gravity force in flexion. The application dosage was 4 times per minute with 15-second interval.

Seconds before applying the basic facilitatory technique, the therapist instructed the patient to focus on the hand and the contraction that was going to occur. The therapist targeted the muscle belly and applied a transverse stretch. A brisk contraction was seen as a result of this application. If a contraction was not elicited once applied over a particular spot, an additional application was offered in another spot that would trigger it. If even an additional application could not elicit a contraction, no other effort was attempted because of safety reasons for the biomechanical infrastructure of the neuromusculature.

The application was offered at 4 different spots and included several areas of the forearm dorsal surface, aiming to trigger the extensors muscle group. One application spot also included the brachioradialis muscle belly area, with the purpose to trigger this particular muscle, which could elicit contraction with regard to the elbow. Such an application spot could not be detected for the triceps brachii insertion close to the olecranon.

For the twisting technique, in the starting position, the therapist supported the forearm with the left hand in a relaxed position and placed the thumb of the right hand over the muscle belly. Afterwards, the therapist applied a continuing transverse stretch on the muscle belly with the right hand and supinated the patient's hand. The therapist held this position for a longer time period, about 30 seconds, and then tried it again after a while, in an area located lower or higher than that of the initial application. Tapping and some

light joint compression was offered during the application intervals.

In the finger swiping technique, the therapist brought the limb to a relaxed position. At first, the therapist closed 2 of their fingers (or 3, if needed), the index and the middle finger, and aimed diagonally to swipe over the muscle belly of the desired area of facilitation. The therapist hit abruptly and in short intervals along the desired area that needed to be facilitated, and a brisk contraction was apparent.

When applying the pinching technique, the therapist supported the patient's hand and supinated it. With the patient's palmar surface exposed and supported, the therapist brought the hand close to the visual field of the patient and stimulated several areas of the palmar surface by slightly pinching them. The therapist asked the patient to inform about the quality of the sensation – if there was any – in order to make him focus on the sensation and practise on it. The therapist pinched several spots on the palmar surface and the fingers for about 5 minutes in total.

Additionally, it must be mentioned that vulnerable application spots of the radial nerve were avoided in all applications.

Ethical approval

The research related to human use has been complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the authors' institutional review board.

Informed consent

Informed consent has been obtained from the individual included in this study.

Results

The outcomes of the intervention are summarized in Table 2. Regarding pain, no increase was noticed in week 3 either at rest or at movement in the whole upper limb (including the shoulder). Spasticity was not raised. The Motricity Index showed an increase of 47%, while the Motor Assessment Scale revealed a 28% improvement compared with baseline. Lastly, the Thumb Localization Test presented a 25% increase, and the Nottingham Sensory Assessment demonstrated a 33% increase in tactile sensation and 25% in kinaesthesia. No harmful effect was present with regards to stereognosis, which was unaltered.

Early during the experiment, while the thumb, index, and middle finger presented voluntary movement, no such effect was shown in the ring or little finger. Consequently, the ther-

apist started aiming more laterally and distantly to the elbow in order to trigger the respective neuromusculature. Small movements of the index and middle finger were apparent within week 1.

Moreover, in the middle of week 2 of the experiment, a taut band appeared medially at the surface of application on the forearm. No tenderness or pain pattern was apparent under palpation, under ischemic compression, or in calm. It was speculated to be a latent (silent) trigger point [42] and it was never used as an application spot again. This clinical sign disappeared by the end of week 3.

Contractures were not apparent. Evidence indicates that the earliest contractures can be apparent 2 months after stroke [43]. Moreover, given that early functional recovery was achieved at week 3, the patient was not likely to present any contractures in the future [44].

Discussion

This is the first clinical study on MaSoNT and the effects of its use in a hemiplegic arm. MaSoNT belongs to a group of sensory facilitatory techniques that can be applied in everyday clinical practice in order to assist functional recovery. The group of techniques could be named 'zero-to-one' techniques as they aim to improve function of a flaccid hemiplegic hand from no voluntary movement (zero condition) to at least some movement (one condition) upon which another therapeutic approach can build on and improve to an even better condition. The study showed that the effect MaSoNT had on the patient was positive, even though the SAFE score predicted otherwise [11].

Previous studies implemented similar interventions of somatosensory stimulation. Sensorimotor training improved the functional recovery of 2 chronic stroke survivors in a 2-week intervention with neural reorganization being induced [45]. Moreover, a program of stretching, range of motion exercises, and soft tissue mobilization techniques offered to 5 chronic stroke patients in a 3-week intervention managed to provide functional improvement along with cortical reorganization [46]. Noteworthy, the current study is the first to apply such a sensorimotor intervention in a hemiplegic hand so early after stroke.

Regarding cortical reorganization measurements, the rationale of MaSoNT use is to offer functional recovery by eliciting cortical reorganization [8]. As no imaging scanning device was implemented in the study owing to financial reasons, no information on the effect of the intervention on cortical reorganization could be granted. It could be speculated that neuroplastic reorganizational alterations did occur in the pa-

Table 2. Scores at baseline and week 3

Outcome measures	Baseline	Week 3
Pain / No pain at the whole upper limb	no pain	no pain
Modified Ashworth Scale	0	0
Motricity Index Arm Score	0	total: 47 (test 1: 19; test 2: 14; test 3: 14)
Motor Assessment Scale items 6, 7, and 8	0	total: 5 (item 6: 1; item 7: 2; item 8: 2)
Thumb Localization Test	6	9
Nottingham Sensory Assessment	tactile sensation: 1 kinaesthetic sensations: 1 stereognosis: 2	tactile sensation: 2 kinaesthetic sensations: 2 stereognosis: 2

tient's brain; otherwise, no functional recovery would be seen at all [47]. However, whether these cortical reorganizational changes and their extent are to be attributed to the intervention is questionable as some physiological neuroplastic changes would occur naturally [48]. Unknown mechanisms can trigger motor recovery through cortical reorganization when a sensorimotor technique is applied [49]. Evidence strongly indicates that therapeutic interventions can enhance functional recovery through cortical reorganization in stroke patients [8]. Notably, passive movement alone is able to trigger changes in cortical representation and excitability among healthy individuals [8].

Apart from the effects, the study can support the safety of the technique. Pain, both at rest and in movement, remained absent before and after the intervention. Certainly, this does not imply that pain will not be apparent for the patient in the future as this phenomenon is highly prevalent 6 months after stroke [50]. Additionally, there was no negative effect regarding the development of spasticity. Again, spasticity may appear as early as 2 weeks after stroke [51] and its prevalence increases at 3 [52] and 6 [53] weeks after stroke. However, given the low degree of motor and sensory deficit, as well as the absence of spasticity at this early stage, one can expect that the patient probably will not be seriously affected by spasticity [51, 53, 54]. Thus, some proof of the MaSoNT intervention safety can be granted by the current study.

Limitations

More assessment scales on functional recovery could have been included but the study did not primarily aim to it. Even with more such scales, in a convenience sample such as the one recruited, no spherical generalized conclusion could be reached. That was the second limitation of the study. Lastly, no blinding of the patients was implemented. This risk of bias diminishes the credibility of the results but when studying alternative innovative interventions, full blinding becomes almost impossible [55].

Conclusions

This study was the first one to offer MaSoNT early in a stroke patient's upper limb. The major conclusion is that MaSoNT possibly cannot cause any harmful effects on the recovery of the hemiplegic hand. Additionally, it might bring about motor and sensory improvement. Hence, it could be recommended in combination with the conventional treatment approach. Future research with a larger number of subjects is needed to validate the duration and doses and generalize the efficacy of the intervention in a greater stroke population.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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