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EFFECT OF THERMAL STIMULATION IN SENSORIMOTOR RECOVERY OF UPPER LIMB AND LOWER LIMB IN PATIENTS WITH STROKE: A SYSTEMATIC REVIEW

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ABSTRACT:

BACKGROUND AND AIM : The aim of the study was to present a review of studies that investigate the effects of thermal stimulation intervention on sensorimotor recovery in patients with stroke. **METHOD:** A database of articles published up to the year 2016 were compiled using the following pubmed key words: stroke, thermal stimulation, sensorimotor recovery. References listed in relevant publications were also screened. Studies that satisfied the following selection criteria were included: (1) patients were diagnosed with stroke;(2) effects of thermal stimulation in any form were investigated; (3) the outcome was measured in terms of sensory, motor and functional recovery; and (4) the study was a randomized clinical trial (RCT) or an experimental study. **RESULT:** The results were that thermal stimulation in any form is effective in improving the sensorimotor function of both upper as well as lower extremity as thermal stimulation enhances the corticomotor excitability and promotes neuroplasticity. **CONCLUSION:** This review of 5 studies provides support for the potential of thermal stimulation on sensorimotor recovery in stroke

KEYWORDS: Thermal stimulation, stroke, sensorimotor

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INTRODUCTION

Stroke is the disease that primarily leads to motor or sensory impairment or loss of function.[1] Stroke is a leading cause of disability worldwide. Stroke survivors may have impairments in sensorimotor function. Activities of daily living and quality of life are thus negatively affected. [2]

Tactile sensory impairment is seen more extensively than the proprioceptive loss and it is in association to the degree of weakness and degree of stroke severity. It has negative impact on recovery functionally and lengthens the duration of the rehabilitation.[3] Simultaneous activation of motor and sensory function during therapy may lead to improvement in the recovery of function in rehabilitation.[4]

Thermal stimulation is being applied in different ways to induce cortical reorganization.[5] Functional magnetic resonance imaging shows that thermal stimulation (TS) activates larger areas of the brain when compared with tactile or mechanical stimulation, and the degree of activation is similar to that of motor tasks. TS has the potential of facilitating paretic upper and lower limb recovery after acute stroke. Wu et al have also conducted a study and reported that thermal stimulation has beneficial effects on the paretic upper limbs of chronic stroke patients.[6]

Different interventions available for sensorimotor impairment in stroke include range of motion exercises (passive and active assisted), functional electrical stimulation, traditional and modern constraint induced movement therapy, mirror therapy, virtual reality, strength training, bilateral arm training, PNF.[7 8]

These emphasize on the motor outcomes but no attention is given to the sensory outcome. One reason for this discrepancy is that the clinical demands of motor recovery are greater than those of sensory recovery. In addition, clinically available assessments for sensory dysfunction are less reliable and reproducible than those for motor dysfunction.[9]

A study conducted by Chen.et al in which they used thermal stimulation by using hot ($\approx$75º) and cold (<0º) pack wrapped with two towels applied 15 and 30 seconds respectively 10 times for 6 weeks.[10] Hung-Chia wu et. al studied the effect of applying hot (46-47º) and cold(7-8º) stimulation through a closed loop system for 15 seconds and 30 seconds 10 times interleaving 30 seconds pause alternatively for 8 weeks. Hsen- Wen Hsu studied the effect of noxious TS (46-47º) and cold TS (2-3º) versus innocuous hot TS (40-41º) and cold TS (23-24º) for 8 weeks. And few more studies have been conducted to study the effect of thermal stimulation on the recovery post stroke.[11]

All these studies have showed that thermal stimulation has a positive effect on the sensorimotor recovery in patients with stroke. The mechanism of this effect is not clearly defined and has not been studied extensively. The effect, dosage and mechanism is not clearly defined and has not been studied extensively. The aim of this systemic review is to provide an overview of the available evidence on thermal interventions for motor recovery after stroke and to explore the parameters in detail so that more experimental studies can be carried out.

MATERIAL AND METHOD

This review was restricted to published research articles, abstracts and letters of patients with clinical diagnosis of stroke receiving Thermal Stimulation as a treatment intervention either alone or in combination. The review included experimental and randomized control trials that had patient recruitment within time defined boundaries. No restrictions on sample size, or duration of follow up. Articles written in English were only included. Exclusion of studies with mixed population.

DATA SOURCES:

A systematic literature search of cochrane database of Systematic reviews, pubmed/ medline, Psycho INFO,Google scholar, Pedro, Rehadat and Rehab trials. Eligible studies published through 2008 were selected.

Keywords: Thermal stimulation, Sensorimotor, Stroke

RESULTS:

Data was available from 25 studies out of which 20 articles were excluded due to reasons mentioned in the flow chart (Fig 1, Page 39) and 5 articles were significant for the systemic review.

Table 1 : shows main characteristics of 4 studies that were included in this review

Reference	Type of intervention	Daily (min) EG	Daily (min) CT	Stroke parameter characteristics	Outcome measure	Author and conclusion
American Heart association journal (2005)	Alternate cycle of heating and cooling+ Standard rehabilitation and Standard rehabilitation only	30 minutes thermal stimulation	20 minutes of standard therapy	Acute Stroke patients N=29	Brunnstorm staging, Modified motor assessment scale, Wrist flexion, Wrist extension, Sensation, Grasping	Jia Ching Chen, TS on paretic hand significantly enhances the recovery of sensorimotor functions in hemiplegic stroke patients. Brunnstorm score of recovery at 4 weeks for EG and CG was 0.49 and 0.19 respectively and at 6 weeks was 0.39 and 0.20 respectively.
American Heart association (2010)	UE Thermal stimulation+ Standard rehabilitation and standard rehabilitation only to UE.	30 minutes Thermal stimulation UE	30 minutes therma stimulation LE	Subacute and chronic Stroke patients N= 23	UE STREAM, ARAT, Modified ashworth scale Elbow, Modified ashworth scale Wrist	Hung Chia Wu, 8 week addition TS protocol improved upper extremity motor recovery 3 months after stroke onset. Values for ARAT for experiemntal group before treatment and at 1 month follow up are 14.8 and 25.3 respectively and control group is 12.2 and 16.7 respectively.
American Congress of Rehabilitation Medicine (2012)	Standard rehabilitation+ Thermal stimulation V/S only standard rehabilitation	40 minutes of alternating hot and cold stimulation . 40 min of physiotherapy	40 minutes of physiotherapy	Acute Stroke Patients. N= 30	FMA-LE, MRC-LE, FAC, BBS, Modified motor assessment scale, BI	Chung-Chao Liang, The long-term benefits of TS for patients with acute stroke may be sustained for 3 months but disappear by the 6-month and 1-year follow-up. Values of FMA for LE for EG at 1 week and 1 year foolow up was 8.9 and 26.2 respectively and for CG was 9.2 and 21.9 respectively.
Archives of physical medicine and rehabilitation (2013)	Noxious+Traditional rehabilitation and Innocuous+ Traditional rehabilitation	30 min noxious	30 min innocuous	Subacute and Chronic stroke patients 18-80 years N= 23	LE STREAM, Mobility STREAM, FAC, Barthel Index, Postural assessment scale for stroke, Modified ashworth scale	H W Hsu, A 8 week noxious thermal stimulation combined with traditional rehabilitation can improve LE movement and function in patients with stroke for more than 3 months. Mobility STREAM score for EG and CG was 2.8 and 0.3 respectively and at follow up was 4.2 and 1.3 respectively.
Journal of injury, function and rehabilitation(2016)	Noxious thermal stimulation+ Traditional rehabilitation and Innocuous thermal stimulation + Traditional rehabilitation	30 minutes noxious thermal stimulation	30 minutes innocuous thermal stimulation	Acute Stroke Patients 18-80 years of age	FMA- UE, ARAT, Motricity index, Barthel index, Modified ashworth scale	Roxane Lin, Effectiveness of combining noxious heat along with traditional rehabilitation did not provide better short term and long term results than combining innocuous thermal stimulation with traditional rehabilitation on upper extremity functional recovery for individuals with acute stroke. FMA score for UE for Noxious group at 1 month and 6 month follow up was 43.0 and 45.6 and for innocuous group it was 41.6 and 44.3 respectively.

DISCUSSION:

Thermal stimulation is an intervention that is recently developed to promote the sensorimotor recovery in stroke patients. It is a low cost and practicable intervention. Numerous types of techniques are used to improve the functional impairment in stroke patients but they are found to be complicated and expensive. Thermal stimulation is common, practicable and convenient treatment protocol. It is easy to apply in both home based setting as well as clinical setting. It has been used to promote recovery both in upper extremity as well as lower extremity.[10]

The purpose of this review was to evaluate sensory-based interventions to improve sensation and/or sensorimotor function of individuals following stroke. This forms an important question as sensory-based interventions have largely been overlooked despite the indication that they are likely to form a critical component of stroke recover-Data was available from 25 studies out of which 20 articles were excluded and 5 articles were significant for the systemic review. This review found 5 full-text manuscripts that investigated Thermal stimulation interventions in people with stroke. All studies included were randomized controlled trials which are considered the 'gold standard as this methodological design minimizes the effects of bias.The key findings from the systemic review suggest that there is some evidence to support improved outcomes following thermal stimulation.The results of this study showed that thermal stimulation in any form is effective in improving the sensorimotor function of both upper as well as lower extremity as thermal stimulation enhances the corticomotor excitability and promotes neuroplasticity. Findings continue to suggest Thermal stimulation may enhance the effects of conventional training and may be a useful adjunct when combined with standard rehabilitation. Several mechanisms on neuronal plasticity have been proposed to explain brain damage in stroke patients. [7 8 9 10]

Mechanism underlying the sensorimotor recovery varies depending on the form of thermal stimulation application. Heating and cooling can stimulate specific and non specific neuronal pathways. Functional imaging studies demonstrated that the heating/cooling stimulation activates a large brain area, which is almost identical to that of motor task. The simultaneous activation of many brain areas may be helpful for facilitating the sensorimotor interaction then accomplishing the desired rewiring of the brain. Noxious TS providing repeated heat-pain and cold-pain stimulations on an affected LE could induce reflexive movements and facilitate active movements by encouraging the subjects to move their affected LE. Repeated reflexive and active movements of the affected LE may induce the reorganization of sensorimotor functions in the cortex of the brain and thus contribute to improvements in movement and functional recovery in patients with stroke. Noxious TS provides strong sensory stimulations necessary for neural induction techniques. Innocuous TS activates the primary somatosensory cortex, secondary somatosensory cortex, thalamus, and insula, whereas the areas activated by noxious TS include the primary motor cortex, the anterior cingulate cortex, and the thalamus, and more defined activation is achieved in the posterior region of the anterior cingulate cortex. [7 8 9 10]

In this review it was found out that thermal stimulation can be administered in various ways. A comparison of noxious thermal heat stimulation was done with the innocuous thermal stimulation in two of the studies. Other studies showed the effect of thermal stimulation by alternating hot and cold stimulation to improve the upper extremity function in stroke patients.[7 8 9 10]

The current review involved 5 studies and total of 179 participants were included in the study out of which 28.49% (51) of participants were dropouts. Dropouts were mainly due to refusal to participate, discharge from hospital or due to contraction of pulmonary infections etc. In two of the studies participants included were in the acute stage that is onset of stroke was less than three months back before rehabilitation was started mainly because patients in acute stage show spontaneous recovery as compared to patients in the chronic stage of stroke.Nearly all studies on the recovery of motor function in stroke survivors have found that the most rapid recovery occurs during the first few weeks after stroke.Early initiation of rehabilitation for stroke patients was related to improved motor and functional outcomes.[20]

In remaining studies participants in whom onset of stroke was post three months and less than 3 years before rehabilitation were included to see whether thermal stimulation had any effect on the sensorimotor recovery in the subacute and chronic stage. [7 8 9 10]

In this study the assessment tools to compare the recovery using thermal stimulation is mainly done with the help of outcome measures such as STREAM, modified ashworth scale, ARAT, Barthel index, Brunnstorm staging taking care of all the aspects of sensorimotor improvement. Tools used to asses the sensorimotor recovery help us to determine the improvemnet in the mobility, spasticity, function and recovery staging taking care of the variety of aspects in the recovery. Brunnstorm staging tool assesses the level of motor recovery. Modified Ashworth scale is used to check for the spasticity of the muscles. STREAM is used to determine the recovery in movement and functional mobility in stroke. Action Research Arm Test has been used to test upper extremity performance of the participant. Fugyl Mayer assessment is used to assess motor functioning, balance, sensation and joint functioning in patients with post-stroke hemiplegia. Reliability and validity of measures used were strong. Assessment Tools used were used to assess overall all aspects of recovery in stroke patients. [7 8 9 10]

Thermal stimulation helps in the sensorimotor recovery by inducing cortical reorganization by simultaneous activation of both sensory and motor functions during therapy which is vital during rehabilitation. Frequently used modalities to improve function in stroke are mirror therapy, constrained induced movement therapy, ROM activities, Functional electrical stimulator which focus on only the motor recovery. Thermal stimulation can be considered better than these rehabilitation tools as it helps in both sensory as well as the motor recovery. Another frequently used stroke rehabilitation therapy is robot assisted therapy which is very expensive and difficult to use in rural clinical setup. Thermal stimulation being convenient, less expensive and easy in application is more advantageous over the robot assisted therapy.

Limitation of the study were that there were limited studies on thermal stimulation interventions. Overall the sample size for the studies was small, with no mention of power calculations for sample size in most of the studies. When designing this review, we made the intent to include studies that were directly aimed at improving sensorimotor impairments. We found out that most of the studies that were included focussed only on the motor outcomes but used sensory stimulation as the intervention but did not have sensory outcome measures to assess the sensory recovery in patients. So future studies can be conducted with sensory outcome measures.

CONCLUSION:

This review of 5 studies provides support for the potential of thermal stimulation on sensorimotor recovery in stroke with a suggestion to conduct more systematically designed RCTs with sensory outcome measure.

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REFERENCES:

1. Bonita R. Epidemiology of stroke. The Lancet. 1992 Feb 8;339(8789):342-4.
2. Nowak DA, Grefkes C, Dafotakis M, Küst J, Karbe H, Fink GR. Dexterity is impaired at both hands following unilateral subcortical middle cerebral artery stroke. European Journal of Neuroscience. 2007 May;25 (10):3173-84.
3. Wu CY, Huang PC, Chen YT, Lin KC, Yang HW. Effects of mirror therapy on motor and sensory recovery in chronic stroke: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2013 Jun 1;94 (6):1023-30.

4. Hsu HW, Lee CL, Hsu MJ, Wu HC, Lin R, Hsieh CL, Lin JH. Effects of noxious versus innocuous thermal stimulation on lower extremity motor recovery 3 months after stroke. Archives of physical medicine and rehabilitation. 2013 Apr 1;94(4):633-41.

5. Bai Z, Fong KN, Zhang J, Hu Z. Cortical mapping of mirror visual feedback training for unilateral upper extremity: A functional near-infrared spectroscopy study. Brain and Behavior. 2019 Dec 5.

6. Gandolfi M, Valè N, Dimitrova E, Zanolin ME, Mattiuz N, Battistuzzi E, Beccari M, Geroin C, Picelli A, Waldner A, Smania N. Robot-assisted stair climbing training on postural control and sensory integration processes in chronic post-stroke patients: a randomized controlled clinical trial. Frontiers in neuroscience. 2019 Oct 24;13:1143.

7. Wu HC, Lin YC, Hsu MJ, Liu SM, Hsieh CL, Lin JH. Effect of thermal stimulation on upper extremity motor recovery 3 months after stroke. Stroke. 2010 Oct 1;41 (10):2378-80.

8. Waghavkar SN, Ganvir SS. Effectiveness of mirror therapy to improve hand functions in acute and subacute stroke patients. Int J Neurorehabilitation. 2015;2 (184):2376-0281.

9. Tai I, Lai CL, Hsu MJ, Lin RT, Huang MH, Lin CL, Hsieh CL, Lin JH. Effect of thermal stimulation on corticomotor excitability in patients with stroke. American journal of physical medicine & rehabilitation. 2014 Sep 1;93(9):801-8.

10. Yan T, Hui-Chan CW, Li LS. Functional electrical stimulation improves motor recovery of the lower extremity and walking ability of subjects with first acute stroke: a randomized placebo-controlled trial. Stroke. 2005 Jan 1;36(1):80-5.

11. Chen JC, Liang CC, Shaw FZ. Facilitation of sensory and motor recovery by thermal intervention for the hemiplegic upper limb in acute stroke patients: a single-blind randomized clinical trial. Stroke. 2005 Dec 1;36 (12):2665-9

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