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Effectiveness of Multi Sensory Stimulation Program with Median Nerve Stimulation in Post Head Injury Subjects with Decreased Level of Consciousness

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Abstract

Introduction: Traumatic Brain Injury is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force [1]. Traumatic Brain injury is also associated with neurological or neuro psychological abnormalities, skull fracture, intracranial lesions. In India and other developing countries traumatic brain injuries are a leading cause of morbidity, mortality, disability and socioeconomic losses. In India nearly 1.5 to 2 millions are injured and 1 million deaths are occurring [2,3]. Ganesan et al. reported statistical significant improvement in level of consciousness between the groups ($p<0.05$) and there was no significant improvement in the neurobehavioral function between the groups after right median nerve stimulation of traumatic brain injury. There may be relationship between superior levator palpebrae muscle, right median nerve and ascending reticular formulation in improving consciousness of traumatic brain injury subjects. None of the studies documented the relationship between them [22]. *Aim of The Study:* To analyze the effectiveness of sensory stimulation program with median nerve stimulation in post head injury subjects with decreased level of consciousness. *Methods:* The basis of inclusion and exclusion criteria 30 subjects were randomly divided into two groups. 15 subjects in experimental group (Group A) and 15 subjects in controlled group (Group B). A pretreatment scoring was done via Glasgow coma scale (GCS) and coma recovery scale (CRS). Group A is experimental group and received Sensory stimulation program with right median nerve stimulation (SSP) and Group B is controlled group & this group received conventional therapy as chest PT, Passive Movement, PNF and positioning of the patient. *Discussion:* Severe brain injury is a cause of for high morbidity and mortality rates. Individuals who sustained severe acquired brain injury, experience prolonged disorders of consciousness. The current study was conducted to compare the effectiveness of multisensory stimulation program with median nerve stimulation in post head injury subjects with decreased level of consciousness. The present study suggested that the sensory stimulation programme along with median nerve stimulation is associated with higher level of consciousness determined by the GCS when compared to the other group in comatose TBI patients. There is a gradual increase in the level of consciousness in the experimental group during 4 weeks of intervention. These findings demonstrated that the significant changes in the GCS, CRS scores are not representative of single day intervention but are rather related to the effect of collective intervention over the course of 4 weeks. Kater, mitchell et al. The result of this study suggested that implementation of sensory stimulation long with median nerve stimulation can enhance consciousness recovery in comatose traumatic brain injury patients. Samond et al. The changes in the ANS while regaining consciousness could be due to the recovery of higher cortical structures controlling the ANS and nuclei releasing the neuro transmitters involved in the ANS. Johnsons et al. considered other indices such as catecholamine, serotonin, acetylcholine esterase 3-methoxy 4-hydoxyphenylgycol skin conductance and heart rate as evidence of the effects of sensory stimulation. The control group (Group B) showed non- significant result of $p>0.05$. In this group conventional physiotherapy with passive exercise and shows non- significant results after 4 weeks when compared to pre- intervention scores. This states that conventional physiotherapy with passive exercise and chest physiotherapy are not sufficient for speedy and significant outcomes. Clinically, this study demonstrates that sensory stimulation programme along with median nerve stimulation as a treatment tool, improve the level of consciousness post treatment brain injury subjects. *Future Research:* Further studies are recommended to minimize these limitations in such a way that larger sample sizes of both the sexes, the duration of the study can be increased, Sensory stimulation should be applied for more than 4 weeks, sensory stimulation could focus on performing long term follow up to compare cognitive and functional activities outcomes in unconscious patients with traumatic brain injury. *Limitation of the Study:* Duration of the study was short. There was no follow up. Half of the patients were surgically operated on for brain injury and these patients were not uniformly distributed across the sample. It was not ascertained whether the improvement were maintained for a longer period or not due to lack of follow up in the study. *Conclusion:* Sensory stimulation programme with median nerve stimulation was found to be effective in improving levels of consciousness in subjects with traumatic brain injury. When sensory stimulation programme with median nerve stimulation is administered to the patients suffering from traumatic brain injury over a periods of 4 weeks results in improving the levels of consciousness and there by promotes faster recovery due to significant effects on GCS and CRS when compare to patients who did not receive sensory stimulation programme with median nerve stimulation.

Keywords: Head injury; Sensory Stimulation Programme; Glasgow coma scale; Coma Recovery Scale; Median nerve stimulation.

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Introduction

Traumatic Brain Injury is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force [1].

Traumatic Brain injury is also associated with neurological or neuro psychological abnormalities, skull fracture, intracranial lesions. In India and other developing countries traumatic brain injuries are a leading cause of morbidity, mortality, disability and socioeconomic losses. In India nearly 1.5 to 2 millions are injured and 1 million deaths are occurring [2,3].

The incidence of traumatic brain injury in India is around 200 per 100,000 populations. Males are more prone to traumatic brain injury with 75% incidence when compared to females and the male to female ratio of traumatic brain injury in India was 3:1. This includes the very young, young adults and the elderly. Mortality depends on severity of injury and age [4,5].

The most common cause of traumatic brain injury is road traffic accidents. These subjects presents with the signs and symptoms of loss of consciousness, seizures, ear and nose bleeds, nausea, paresis, balance deficits, cognitive-communication and swallowing. Although various treatment protocols for coma in traumatic brain injury are available, persistent coma is still a major clinical problem. Coma is characterized by absent or limited vocal or muscle activity and a severely reduced or abnormal response to noxious stimuli, an absence of sleep wake cycles [6-10].

In traumatic brain injury, massive intracerebal bleeding, hypoxia or other forms of diffuse brain injury, may lead to severe disorders of consciousness (DOC). The consequences for patients and their families are disastrous. Severe DOC range from- coma via vegetative state (VS) also referred to as unresponsiveness wakefulness syndrome, a condition in which the patient is awake but shows no behavioral evidence of conscious awareness- to minimally conscious state (MCS), characterized by one or more minimal but definite behavioral signs of consciousness [11-14].

Coma recovery programs aim to provide multi sensory stimulation to patients in coma or vegetative state. Coma arousal therapy is believed to provide the sensory stimulation needed to activate the reticular system, which is responsible for maintaining consciousness [23]. These procedures are appropriate for any individual who is in coma or vegetative state and is medically stable. It involves repetitive tactile, auditory, visual, taste, proprioception, and olfactory stimulation [24].

Median nerve stimulation brings numerous afferent inputs to the Ascending Reticular Activating System (ARAS) via the spinoreticular component of the median nerve synapsing with the neurons of the Ascending Reticular Activating System [25].

Operational Definations

Traumatic brain injury- It is a non-degenerative, non-congenital injury to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical and psychological function with an associated diminished or altered state of consciousness.

Coma- Coma is a state of unconsciousness in which a person cannot be awakened; fails to respond normally to painful stimuli, light, or sound; lacks a normal wake-sleep cycle; and does not initiate voluntary actions.

Effectiveness– It refers to the significance difference between pre and post score on level of consciousness after administering sensory stimuli and electrical stimulation.

Sensory stimulation– It is a reaction that promotes the physiological or nervous actively in the body which includes auditory, visual, touch and movement.

Level of consciousness- It is define as a state of awareness and essential or assessment of an individual's neurological status. It is an accurate indication for the degree of brain dysfunction.

Objectives

Statement of Question- Will coma stimulation program with right median nerve stimulation improves the conscious level of post head injury subjects ?

Research Hypothesis

Experimental hypothesis – This hypothesis states that sensory stimulation program with median nerve stimulation will improve the conscious level of post head injury patients.

Null hypothesis - This hypothesis states that sensory stimulation program with median nerve stimulation may or may not improve the conscious level of post head injury subjects.

Aim of the Study

To analyze the effectiveness of sensory stimulation program with median nerve stimulation in post head injury subjects with decreased level of consciousness.

Need of the Study

As there is decrease conscious level in post head injury subjects so this study is done to formulate the effective treatment protocol for comatose subjects.

Review of Literature

1. *Michelangelo Bartolo, et al.,* Conducted a study on "Mobilization in early rehabilitation in ICU patients with severe acquired brain injury: an observational study". Concluded that early mobilization appears to favour the clinical and functional recovery of patients with severe acquired brain injury in the intensive care unit.
2. *Sirisha Nekkanti et al.;* conducted a study on 'Effect of right median nerve stimulation on level of consciousness in traumatic brain injury subjects'. 20 subjects were selected for study based on inclusion and exclusion criteria and the treatment was given for 30 mins per day for one month. Concluded that right median nerve stimulation have positive role in improving the level of consciousness in subjects with traumatic brain injury and there by promotes faster recovery.
3. *Marzieh Moattari, et al.,* conducted a study on "effects of a sensory stimulation by nurses and families on level of cognitive function and basic cognitive sensory recovery o comatose patients with severe traumatic brain injury; A randomized control trial" concluded that the application of sensory stimulation by families led to significant increase in the consciousness, level of cognitive sensory recovery of comatose sensory recovery of comatose patients with severe injuries.
4. *Carmen Krewer et al.;* Conducted a study on "tilt table therapies for patients with severe disorders of consciousness: a randomized, controlled trail". Concluded that the verticalization itself seems to be beneficial though and should be administered to patient in disorder of consciousness in early rehabilitation.
5. *M. Megha, S. Harpreet, et al.,* Conducted a study on "Effect of frequency of multimodal coma stimulation on the consciousness levels of traumatic brain injury comatose patients". Concluded that short sessions of high frequency are more beneficial.
6. *Hyunsoo oh, Whasook Seo, et al.,* Conducted a study on " Sensory stimulation programme to improve recovery in comatose patients". Concluded that significant alterations in consciousness levels were revealed 2 weeks after starting the intervention.
7. *Sara Bos, MS, BSN, et al.,* Conducted a study on "coma stimulation". Concluded that a coma stimulation program should be initiated as soon as the patient is medically stable.
8. *Haibo DI, Caroline Schnakers et al.,* conducted a study on 'sensory stimulation program'. Concluded that the sensory stimulation are useful interventions for patients with disorders of consciousness.
9. *J Bryan Cooper, T Johna A. et al.,* conducted a study on "Right median nerve electrical stimulation to hasten awakening from coma" concluded that non invasive Right median nerve stimulation impulses conscious level and it's early employed, carried little risk and coast effectiveness treatment.

Methodology

30 subjects of TBI (7-14 days) with GCS 4-8, admitted in neurosurgery ICU and their care takers or relatives were willing for treatment of 4 weeks session. The study was conducted in the Department of Physiotherapy, Shri Mahant Indiresh Hospital, Patel Nagar , Dehradun (Uttrakhand). 30 subjects with age group 20-60 years. 15 subjects in experimental (group A) and 15 subjects in control group (Group B) according to inclusion and exclusion criteria. Inclusion criteria- GCS score ≤ 8, Both male and female subjects., Age group 20 to 60 years, Medically stable patients (stable vitals signs, CVP, ICP) and Closed TBI patients (7 to 14 days) Exclusion criteria – Medically unstable patients(vital signs unstable), Past history of brain injury or any other cerebral pathology, Patients with seizure history, blindness, hearing loss or color blindness, Patients with penetrating cranial injury, Pregnancy, Cardiac arrest lasting longer than 4 minutes and Cardiac arrhythmia, pacemaker Instrumentation - Brush, Wet towels, Soap, Soft tooth brush, Lemon, Coffee, Hot and cold water, Perfume, Ear phone, Color card, Pencil, pen,

Mirror, Electrical stimulation machine, Electrodes, Pads 1.5 inch, Straps and Gel. (Fig. 1).

Fig. 1: Showing instrument used in the study

Procedure

On the basis of inclusion and exclusion criteria 30 subjects were randomly divided into two groups. 15 subjects in experimental group (Group A) and 15 subjects in controlled group (Group B). Written Consent form was taken from the patient's relatives after explanation of the procedure and its outcomes. A pretreatment scoring was done via Glasgow coma scale (GCS) and coma recovery scale (CRS). Group A (experimental group) received Sensory stimulation program with right median nerve stimulation (SSP) and Group B (controlled group) received conventional therapy as chest PT, Passive Movement, PNF and positioning of the patient.

In experimental group a pre scoring was done via GCS and after scoring each patient receive stimulation of six sensory modalities.

1. Kinesthetic Stimulation

Each movement two times, allowing 1 minute to respond, one extremity at a time.

Lying on Bed

a. Movement of arms**:** Patient's arm was supported at the elbow and hand. And then arm was slowly moved above the head as far as it goes. Then it was held for 3 seconds then arm was lowered, keeping the elbow as straight as possible.
b. Movement of legs**:** Patient's leg was supported at the knee and ankle. Then it was slowly bended toward the chest as far as it goes. Then it was held for 3 seconds then leg was lowered down, attempted to straighten out the knee.
c. Movement of head**:** Head was turned side-to-side, stretching as far as it goes.
d. Patient's knees were bent, placing the feet flat on the bed. Keeping the knees together, knees were slowly stretched side-to-side, held for 3 seconds in each position.

2. Auditory Stimulation

One second was used per sequence. The stimulus was presented for 5 to 10 seconds, two times, with a 3-second break between each stimulus, on right side, then on left side. Materials used were ring bell and familiar voices. (Fig. 4).

3. Tactile Stimulation

Stimulus was presented for 5 seconds, two times, with a 3-second break between each stimulus. It was repeated to right and left upper extremities; then right and left lower extremities. Materials used were brush, various cloth textures, sandpapers, cotton balls.

4. Visual Stimulation

Stimulus was presented for 5 seconds, two times, with a 3-second break between each stimulus in front. It was repeated as above, to right and left sides then up and down. Materials used were, brightly colored block, familiar photo, functional object (Fig. 3).

5. Gustatory stimulation-

The protocol included an irrigation of the oral cavity with cool water for 3 minutes, gum massage for 2 minutes, and brushing of the teeth and tongue with a soft toothbrush for 5 minutes. A 2-ml lemon juice was applied to the lateral side of tongue. Sweet taste stimulation was not applied because it was difficult to manage subsequently increased oral secretions.

6. Olfactory stimulation-

Aromatic stimuli with fragrance to which patients had been accustomed were applied. Examples of these stimuli were patients' favorite aromas such as eucalyptus, herbs, orange or lemon peels, coffee or hot tea, flavor extract (i.e. vanilla), fragrances of soap, cologne, or perfume. The duration of stimulation lasted no longer than 10 minutes.

On the other hand during median nerve stimulation the electrical treatment will be delivered via a pair of lubricated 1 inch apart on the volar aspect of the distal forearm over the median nerve. An electrical neuromuscular stimulator will supply trains of asymmetric biphasic pulse at an amplitude

of 15-20 mA (as tolerated) with pulse width 300 μs at 40 Hz ON for 20s and OFF 40s, which has been proven to be well tolerated without causing pain or skin irritation. The electrical stimulation treatment will last for 30 mint per day 4 weeks. (Fig. 2)

While in controlled group conventional physiotherapy was given which includes passive exercises, positioning two hourly and chest physiotherapy.

Fig. 2: showing right median nerve electrical stimulation .

Fig. 3: shown color card for visual stimulation

Fig. 4: showing auditory stimulation via Earphone.

Result and Interpretations

Staticals Analysis

Outcome measures of all the individual were analyzed on day one before the start of the therapy and at the end of four weeks.

Comparison between pre and post treatment and between groups was done by using paired t-test. Graphpad Prism Software (in Stat 3 trial) was used for data analysis.

Hypothesis Testing for Comparing two Related Samples

Paired t-test is away to test for comparing two related samples, involving small values of n that does not require the variances of the two populations to be equal, but the assumption that the two populations are normal must continue to apply. For paired t - test, it is necessary that the observations in the two samples be collected in the form of what is called matched pairs i.e., "each observation in the one sample must be paired with an observation in the other sample in such a manner that these observation are somehow "matched" or related, in an attempt to eliminate extraneous factors which are not interest in test." Such a test is generally considered appropriate in a before and after treatment study. For instance, we may test a group of certain students before and after training in order to know whether the training is effective, in which situation we may use paired t - test.

Those who receive the sensory stimulation program with median nerve stimulation had a significantly higher GCS and CRS after 4 weeks than the other group (0.001) as shown in [Table 3].

The trend of changes in the level of consciousness in the level of consciousness in two groups is shown in figure. which indicates that the conscious level determined by the GCS increase in the experimental group from the first through the 4 weeks of admission. This chapter deals with the result of the data analysis of the two measures- GCS and CRS between group A and group B. The scores were analyzed and interpreted to determine whether "post head injury with decreased level of consciousness is improved by Sensory Stimulation with median nerve stimulation".

This chapter deals with the result of the data analysis of the two measures- GCS and CRS between group A and group B. The scores were analyzed and interpreted to determine whether "post head injury with decreased level of consciousness is improved by Sensory Stimulation with median nerve stimulation". Paired t-test was used to analyze and compare the scores between group A and group B. Significance level of 0.001 was used for data analysis.

Analyzing Glasgow Coma Scale (GCS) revealed significant improvement in group A post treatment (Mean and Std. Error of Mean)(9.13±0.60) when

compared with group A pre treatment (Mean and Std. Error of Mean)(6.8±0.38). [Fig. 5]

Analyzing Coma Recovery Scale (CRS) showed significant improvement in group A post treatment (Mean and Std. Error of Mean)(11.2±0.66) compared to group A pre treatment (Mean and Std Error of Mean)(8±0.44). as shown in [Table1 & Fig. 6].

Analyzing Glasgow Coma Scale revealed significant differences in group B post treatment (Mean and Std. Error of Mean)(6.66±0.39) when compared with group B pre treatment (Mean and Std. Error of Mean)(5.33±0.38). [Fig. 7]

Analyzing Coma Recovery Scale revealed significant difference in group B post treatment (Mean and Std. Error of Mean)(7±0.51) when compared with group B pre treatment (Mean and Std. Error of Mean) (4.6±0.47). as shown in [Table 2 & Fig. 8].

Analyzing Glasgow Coma Scale revealed a significant improvements in group A (Mean and Std. Error of Mean)(9.13±0.60) compared to group B (Mean and Std. Error of Mean)(6.66±0.39). [Fig. 9]

Analyzing Coma Recovery Scale group A and group B were compared and it showed a significant improvement in group A (Mean and Std. Error of Mean)(11.2±0.66) compared to group B (Mean and Std. Error of Mean)(7±0.51). as shown in [Table 3 & Fig. 10]. Therefore the results suggest that after completion of 4 weeks there would be significant improvement in outcomes measures of group A (Experimental group) when compared with group B (control group)

Table 1: Descriptive statistics of GCS and CRS pre and post treatment (group A)

Outcomes measure	Pre Rx (Mean±SEM)	Post Rx(Mean±SEM)	P value
GCS	6.8 ± 0.38	9.13 ± 0.60	0.0002
CRS	8± 0.44	11.2± 0.66	0.0001

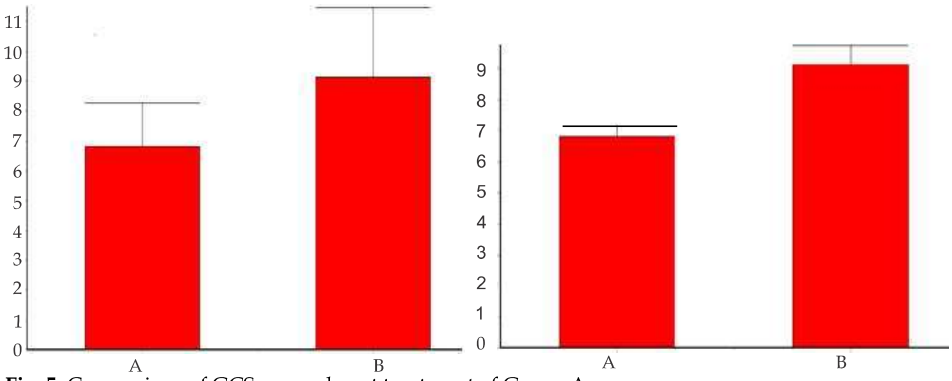

Fig. 5: Comparison of GCS pre and post treatment of Group A.

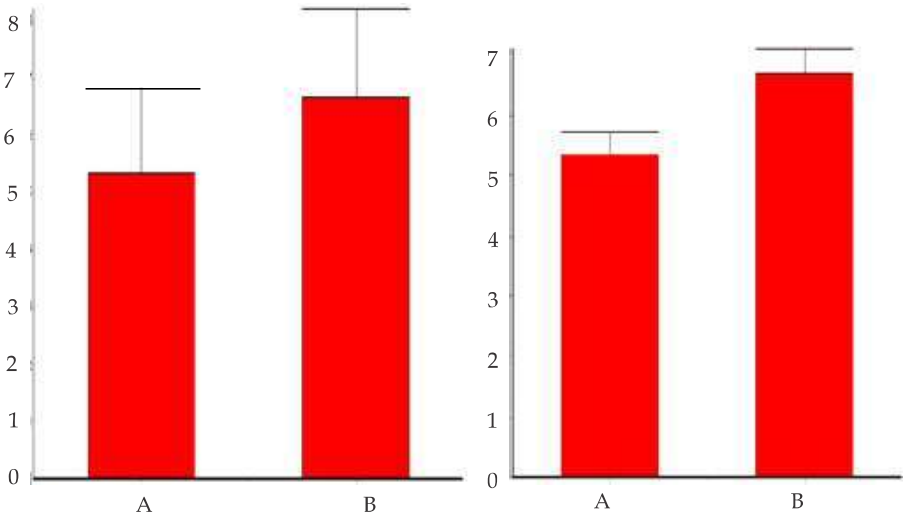

Fig. 6: Comparison of GCS pre and post treatment of Group B.

Table 2: Descriptive statistics of GCS and CRS pre and post treatment (group B)

Outcomes measure	Pre Rx (Mean±SEM)	Post Rx(Mean±SEM)	P value
GCS	5.33± 0.38	6.66± 0.39	<0.0001
CRS	4.66± 0.47	7± 0.51	<0.0001

Table 3: correlation of GCS and CRS pre and post treatment between group A and group B

Outcomes measure	GroupA (Mean±SEM)	GroupB (Mean ±SEM)	P value
GCS	9.13± 0.60	6.66± 0.39	0.0073
CRS	11.2± 0.66	7± 0.51	<0.0001

Discussion

Severe brain injury is a cause of for high morbidity and mortality rates. Individuals who sustained severe acquired brain injury, experience prolonged disorders of consciousness. The current study was conducted to compare the effectiveness of multisensory stimulation program with median nerve stimulation in post head injury subjects with decreased level of consciousness.

The present study suggested that the sensory stimulation programme along with median nerve stimulation is associated with higher level

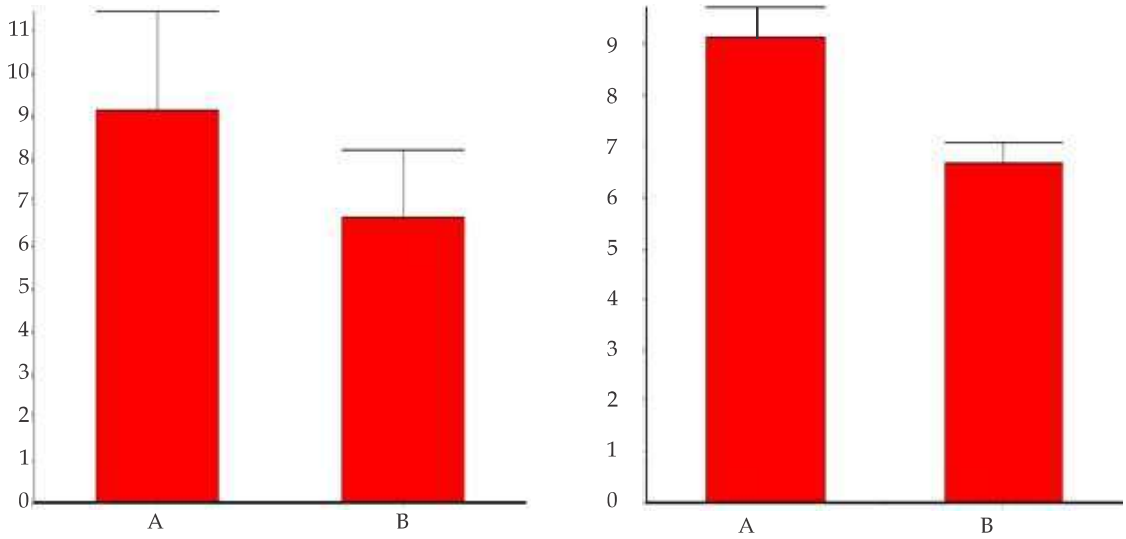

Fig. 7: Comparison of GCS post treatments between group A and group B.

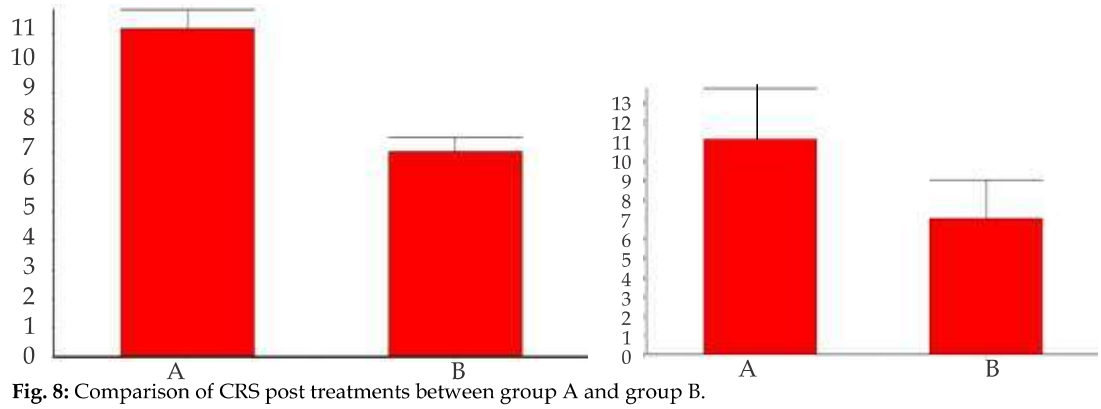

Fig. 8: Comparison of CRS post treatments between group A and group B.

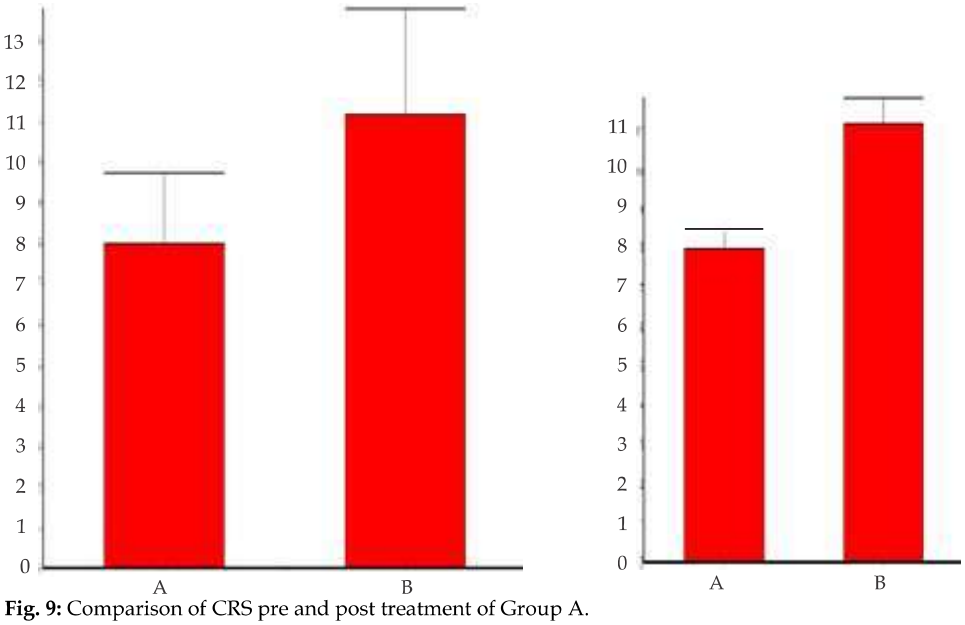

Fig. 9: Comparison of CRS pre and post treatment of Group A.

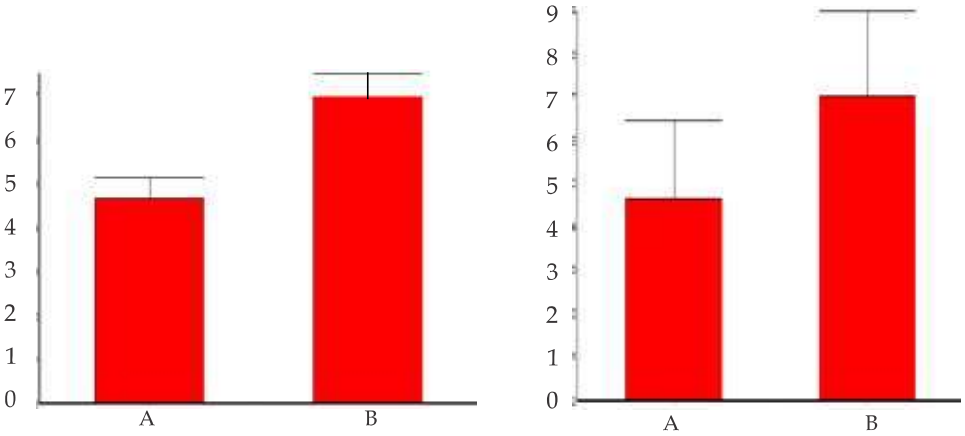

Fig. 10: Comparison of CRS pre and post treatment of Group B.

of consciousness determined by the GCS when compared to the other group in comatose TBI patients. There is a gradual increase in the level of consciousness in the experimental group during 4 weeks of intervention. These findings demonstrated that the significant changes in the GCS, CRS scores are not representative of single day intervention but are rather related to the effect of collective intervention over the course of 4 weeks.

The results of this study have concluded that experimental group shows significant changes ($p= 0.001$) when level of consciousness was measured by GCS.

There is a significant change in post intervention in group A $p<0.05$ which approves improvement in the levels of consciousness according to GCS.

Experimental group showed improved level of consciousness, this might be due to, median nerve stimulation brings numerous afferent inputs to the ascending reticular activating system(ARAS) via the spinoreticular component of the median nerve synapsing with the neurons of the of the ARAS [27].

Median nerve stimulation will lead to activation of the entire central nervous system. It is proposed that this peripheral stimulus reaches the ARAS, which further connects with the intralamina nuclei of the thalamus and then cortical layers are stimulated improvement in the level of consciousness is driven by the electrically induced elevation of dopamine and norepinephrine [28,29].

Increase in cerebral blood flow is another important factor in neuro stimulation for re-awakening due to inhibition of levator palpebrae muscle in unconscious patient which elevates the

upper eyelids, median nerve stimulation will modulate the levatore palpabrae muscle activity.

The median nerve stimulation not only stimulate the brain stem and cerebrum to increase awareness but also better pattern of speech due to activation of Broca's area in the left fronto-temporal region [30].

The result of this study suggested that implementation of sensory stimulation long with median nerve stimulation can enhance consciousness recovery in comatose traumatic brain injury patients. Supported by (kater 1989, mitchell et al. 1990, Sosnowski and ustik, 1994).

The rationale is that sensory stimulation programme of sufficient frequency intensity and duration arise brain by improving neuronal organization, increased dendritic spines, stimulating the increasing the level of cognitive fuction. The rationce is that exposure to frequent fascilitates both dendritic growth and improves synaptic connectivity in those with damaged nervous system [31].

The changes in the ANS while regaining consciousness could be due to the recovery of higher cortical structures contro`lling the ANS and nuclei releasing the neuro transmitters involved in the ANS (Samond et al.).

In another study Johnsons et al. considered other indices such as catecholamine, serotonin, acetylcholine eslerase, 3-methoxy 4-hydoxyphenylgycol skin conductance and heart rate as evidence of the effects of sensory stimulation.

Sensory stimulation alone with median nerve stimulation improves the consciousness after 4 weeks but continued improvement was not found and need to be considered as lack of supervision and follow up.

The control group (Group B) showed non- significant result of $p > 0.05$. In this group conventional physiotherapy with passive exercise and shows non- significant results after 4 weeks when compared to pre- intervention scores. This states that conventional physiotherapy with passive exercise and chest physiotherapy are not sufficient for speedy and significant outcomes.

Clinically, this study demonstrates that sensory stimulation programme along with median nerve stimulation as a treatment tool, improve the level of consciousness post treatment brain injury subjects.

Future Research

1. Further studies are recommended to minimize these limitations in such a way that larger sample sizes of both the sexes that include various age groups of peoples are studies.
2. Sensory stimulation should be applied for more than 4 weeks to achieve optimal outcomes and additional measurements to evaluate more cognitive functions.
3. The duration of the study can be increased.
4. Future research related to sensory stimulation could focus on performing long term follow up to compare cognitive and functional activities outcomes in unconscious patients with traumatic brain injury.
5. Future research in this area is important as better and more effective interventions are needed.

Since this study includes only TBI patients, the efficacy of treatment can be investigated with non traumatic comatose patients as well.

Limitation of the Study

- Duration of the study was short.
- There was no follow up.
- Half of the patients were surgically operated on for brain injury and these patients were not uniformly distributed across the sample.
- It was not ascertained whether the improvement were maintained for a longer period or not due to lack of follow up in the study.

Conclusion

Sensory stimulation programme with median nerve stimulation was found to be effective in improving levels of consciousness in subjects with traumatic brain injury. When sensory stimulation programme with median nerve stimulation is administered to the patients suffering from traumatic brain injury over a periods of 4 weeks results in improving the levels of consciousness and there by promotes faster recovery due to significant effects on GCS and CRS when compare to patients who did not receive sensory stimulation programme with median nerve stimulation.

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