Effectiveness of “Coma Stimulation Technique” on conscious Level and Brain functioning among the comatose Patients with traumatic Brain Injury

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ABSTRACT

Objective: To assess the effectiveness of the coma stimulation technique (CST) on consciousness and brain functioning among comatose traumatic brain injury (TBI) patients.

Materials and methods: The study was conducted amongst admitted patients in neurosurgical units of a tertiary care center in North India. A single group was exposed to the intervention of CST, and its effectiveness was observed on the Glasgow Coma Scale (GCS) and Coma Recovery Scale (CRS). A total of 156 TBI patients were assessed for eligibility. The patients above 18 years with GCS between three and eight and patients with stable vital signs were included in the study. Patients having a past history of head injury, cardiac arrest lasting >4 minutes, and history of brain stem injury was excluded. Finally, 40 patients were analyzed. The intervention constituted CST, which involved promoting awakening, maintaining arousal, and enhancing the rehabilitative potential of comatose patients by stimulating all five senses, that is, visual, olfactory, gustatory, tactile, and kinesthetic. CST was administered once a day from day 1 to day 14 or till the discharge of the patients. Postintervention GCS and CRS scores were assessed on days 3rd, 7th, 10th, and 14th/at the time of discharge. The main outcome measures were the GCS and CRS scores.

Statistical analysis: Continuous variables are presented as the median and interquartile range (IQR). McNemar and Wilcoxon's tests were used to analyze the effectiveness of CST on GCS and CRS scores.

Results: Median GCS score of the patients was six at the baseline. After the intervention, it was 10 on day 14th/at the time of discharge. Before the intervention, the median CRS score was five. It increased to 14 on day 14th/at the time of discharge. There was a statistically significant improvement in GCS and CRS scores after the intervention, as per McNemar’s test (p < 0.001) and Wilcoxon's test (p < 0.001).

Conclusion: Early intervention with CST may help in the improvement of the level of consciousness and brain functioning of the comatose patient with TBI.

Keywords: Brain functioning, Coma stimulation technique, Consciousness, Glasgow coma scale, Traumatic brain injury.

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INTRODUCTION

Many survivors of TBI have to spend the rest of their life in the vegetative stage.¹ TBI is the injury to the skull or brain resulting from external mechanical forces which may cause temporary and/or permanently impaired functioning of the brain.² Loss of consciousness is the most common sign of severe TBI. Coma is caused by direct damage or compression to the reticular activating system due to TBI. Walsh has suggested that the effect of an enriched sensory environment had a greater role in recovery from brain damage in rodents.³ CST may help to improve outcomes by reducing the depth and duration of coma. Various components of CST include stimulation of auditory, visual, olfactory, tactile, and gustatory senses along with the range of motion (ROM) exercises of all joints of the body.²

Significant effects of coma arousal therapy (CAT) and sensory stimulation program (SSP) on TBI patients on improving brain functioning have been reported.⁴,⁵ The effect of multisensory stimulation on cognitive functions of comatose TBI patients has also been evaluated.⁶ Karma and Rawat measured the efficacy of early starting the CS program in comatose pediatric patients with non-neurological etiology with improvement in the level of consciousness in the intervention group.⁷ The effectiveness of sensory stimulation to promote consciousness in patients with persistent vegetative states has also been testified.⁸ In another study, the sensory stimulation increased the neural responsiveness to vocal stimuli in language regions.⁹

The present study was carried out with the objective of evaluating the effect of CST on a comatose patient with TBI with...
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respect to consciousness level and changes in brain functioning as per GCS and CRS scales, respectively.

**MATERIALS AND METHODS**

**Study Design**

A single group was exposed to the intervention of CST, and its effectiveness was observed on the GCS and CRS.

**Study Setting**

Neurosurgery units of a tertiary care hospital in North India.

**Ethical Considerations**

Ethical approval for the study was obtained from the institute ethics committee. Formal approval was obtained from the head of the department of neurosurgery. The nursing staff of the unit was informed about the study. Written informed consent was obtained from caregivers of the patients prior to the enrollment of the patient in the study.

**Sample**

A total of 40 patients were enrolled consecutively in the study over a period of 6 months. The patients above 18 years with GCS between three and eight and patients with stable vital signs were included in the study. Patients having a past history of head injury, cardiac arrest lasting >4 minutes, and history of brain stem injury was excluded.

**Data Collection Tools**

Tools used for the data collection were a sociodemographic profile, clinical profile, GCS score, and CRS score. GCS is an assessment of the level of consciousness based on individuals’ best eye, verbal, and motor responses. The total GCS score is 3–15. A score <8 indicates a coma. CRS scale consists of 23 items comprising six subscales such as visual, motor, oro-motor, communication, and arousal functions which help to assess brain function.

**Intervention**

The CST promotes awakening, maintaining arousal, and enhancing the rehabilitative potential of comatose patients by stimulating all five senses, that is, visual, olfactory, gustatory, tactile, peripheral, central, auditory, and kinesthetic stimulation.

**Visual Stimulation**

- It involves opening the patient’s right eye first with the left hand and stimulating it with bright light on/off for 1 second and repeating it for 10 seconds with the use of a torch in the right hand. The same is to be done for the left eye.

**Olfactory Stimulation**

- For this stimulation, first, we need to clean each nostril with the earbuds. Then one nostril is to be closed with the thumb, and the perfumed swab is kept near the opposite nostril of the patient for 5 seconds, so that patient can smell, and the same is to be repeated in the other nostril.

**Gustatory Stimulation**

- For this, the patient is to be given a left lateral position. Pour chlorhexidine solution into a bowl and dip gauze pieces in it. Open the patient’s mouth with a tongue depressor in the right hand. Hold the gauze piece with artery forceps in the left hand and touch the anterior two-thirds portion of the tongue for 5 seconds. Discard the gauze piece in the kidney tray and take another gauze piece and touch the posterior portion of the tongue. Following the procedure put the patient in a semi-Fowler’s position.

**Tactile Stimulation**

- This involves gently touching all four limbs of the patient from downward to upward for 5 seconds with a wisp of cotton.

**Peripheral Stimulation**

- For peripheral stimulation, hold the patient’s middle finger with your right hand. Hold a pencil or pen with your left hand. Then administer a painful stimulus to the nail bed by putting pressure using the pen or pencil for 5 seconds.

**Central Stimulation**

- This involves gripping the trapezius muscle with the thumb and first finger tightly and twisting it for 5 seconds. Repeat the same for five times.

**Auditory Stimulation**

- This involves making the patient listen to some music or chanting sounds. For this stimulation, first, clean the earplugs with a spirit swab, connect earplugs to the mobile, put earplugs in the patient’s ears, and turn on the Carnatic instrumental theme (Hare Krishna Hare Krishna, Krishna Krishna Hare Hare). It should be continued for 10 minutes.

**Kinesthetic Stimulation**

- This involves performing the ROM exercises of all the joints. These include elbow flexion and extension; shoulder flexion and extension; internal and external rotation of the upper limbs; finger and wrist extension and flexion; hip flexion, rotation, abduction and adduction, ankle rotation, finger and toe flexion and extension, and heel cord stretching.

**Data Collection**

The caregivers were interviewed to note the sociodemographic profile of the patients. After assessing the patients for eligibility, the baseline data regarding the GCS and CRS scores were collected through observation and assessment of the patients. Following this, the CST was implemented as per the above said intervention. On average, it took 20–30 minutes to perform the interventions for each patient. CST was performed once a day. The intervention was continued till the patients were discharged from the hospital or till the 14th day of the study. Baseline data (day 1) of the patients were collected at the time of enrollment in the study. The postinterventional assessment was done on the 3rd, 7th, 10th, and 14th day at the time of discharge. Data were analyzed using Statistical Package for the Social Sciences (version 19 Inc., Chicago, IL). Both descriptive and inferential analysis was done.

**Results**

Flow of the Patients in the Study

A total of 156 TBI patients got admitted from June to December. Of these, 40 patients fulfilling inclusion and exclusion criteria were enrolled in the study. These patients were followed up for subsequent visits. Out of the total enrolled patients, eight patients were discharged, and one expired on the 7th day of follow-up. By the 10th day, 13 patients were...
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Clinical Profile of the Patients
Three-fourths of the patients (75%) were injured due to roadside accidents. Around 56.1% had a mixed type of injury in which they had more than one clinical presentation. The computed tomography findings of the patients suggested contusion (60%) and subdural hematoma (52.5%). Surgery was done in 56.1% of patients. The majority of the patients were getting diuretics (loop and osmotic) and antiepileptic drugs. More than three-fourths of the patients (77.5%) were hospitalized for >8 days.

Effect of CST on GCS Score
All patients were in a coma at the time of enrollment into the study. After intervention with CST, there was an increase in the number of patients with higher GCS scores. The majority of the patients were in the range of 9–12 GCS scores at the time of discharge. The median GCS score at the time of discharge was 10, with a range of 5–14 (Table 1).

Effect of CST on CRS score
All patients had diminished brain functioning at the time of enrollment. After intervention with CST on each follow-up visit, there was an increase in the number of patients with higher CRS scores. Around three-fourths of the patients were in the range of 13–23 CRS score at the time of discharge. The median CRS score at the time of the discharge was 14, with a range of (4–21) (Table 2).

Sociodemographic Profile of the Patients
More than half of the patients (57.5%) were between the age group of 18 and 29 years. The majority (87.5%) were male. A total of 65% were Hindus by religion. Around one-third of patients (35%) had completed their primary education. Laborers were predominantly more (40%). More than half of the patients (57.5%) were married and belonged to an urban area (62.5%).

DISCUSSION
Traumatic brain injury (TBI) may cause temporary or permanent impairment in brain functioning, which may lead to a coma. CST can help to overcome the sensory deprivation of comatose patients. CST involves stimulating the visual, auditory, olfactory, gustatory, and tactile senses along with kinesthetic stimulation to restore the sense of daily rhythm.

A preexperimental study was carried out to assess the effectiveness of CST on comatose patients with TBI with respect to consciousness and changes in brain functioning as per GCS and CRS, respectively.

In the present study, as per the sociodemographic profile of the patients, it was seen that more than half of the patients (57.5%) were aged between 18 and 29 years old, with the mean age being 32 years. Most of the patients (87.5%) were male. The higher incidence of TBI cases in the age group between 21 and 39 and among males has also been reported in many other studies. This is considered the most productive age group of an individual. Sometimes a male member of the family is the only earning member. So, we can imagine the fate of a family where such type of incident has taken place because severe TBI survivors are usually dependent on others for the rest of their life. In the current study, it was seen that 4.5% of the patients died, and 80% were discharged in the dependent stage only. In the majority of such cases, the onus of care lies with the caregivers of patients who face significant stress because of the ill-preparedness to deal with the situation.

The results of the present study suggested that early initiation of CST can enhance consciousness and brain functioning in TBI patients with low GCS. The baseline median GCS of the TBI patients was six at the time of admission and postintervention of CST for 14 days or till the discharge of the patients; the median GCS score improved to 10. A similar study was conducted by Urbenjaphol et al. on 40 patients. Patients were randomized into two groups, with 20 patients in each group. Group I was taken as a control and group II as experimental. In group II SSP was implemented. A study suggested that the mean GCS scores of the two groups at the beginning of the study were 4.75 ± 1.33 vs 4.50 ± 1.15, respectively. Mean GCS scores after commencing the

Effect of CST on Pairing of Preintervention and Postintervention GCS and CRS Scores
Brain functioning and consciousness were improved significantly (p<0.001, Wilcoxon signed-rank test) with the implementation of CST after the pairing of baseline median GCS and CRS scores on days 3rd, 7th, 10th, and 14th until the time of discharge (Table 3).

Effect of CST on GCS and CRS Scores after Pairing the Proportions (Preintervention and Postintervention)
The majority of the patients (86.4%) GCS scores improved after the implementation of CST at the time of discharge. There was a statistically significant increase in the number of conscious patients at each visit as per McNemar’s test (p<0.05). At the time of discharge, the brain functioning of more than half of the patients (59.4%) improved as CRS score improved after the intervention. There was a significant increase in the number of patients with improved brain functioning at each visit as per McNemar’s test (p<0.05) (Table 4).
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Table 1: Effect of CST on GCS score

<table>
<thead>
<tr>
<th>GCS</th>
<th>N = 40</th>
<th>N = 40</th>
<th>N = 31</th>
<th>N = 16</th>
<th>N = 05</th>
<th>N = 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Day 3</td>
<td>Day 7</td>
<td>Day 10</td>
<td>Day 14</td>
<td>Discharge score</td>
<td></td>
</tr>
<tr>
<td>3–8 (Severe)</td>
<td>40 (100)</td>
<td>32 (80.0)</td>
<td>09 (29.0)</td>
<td>01 (06.2)</td>
<td>–</td>
<td>02 (05.4)</td>
</tr>
<tr>
<td>9–12 (Moderate)</td>
<td>–</td>
<td>08 (20.0)</td>
<td>20 (64.5)</td>
<td>15 (93.7)</td>
<td>5 (100)</td>
<td>31 (83.8)</td>
</tr>
<tr>
<td>13–15 (Mild)</td>
<td>–</td>
<td>–</td>
<td>02 (06.4)</td>
<td>–</td>
<td>–</td>
<td>04 (10.8)</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>06 (05–06)</td>
<td>07.5 (06–08)</td>
<td>09 (08–10)</td>
<td>10 (10–10)</td>
<td>10 (9.5–11)</td>
<td>10 (09–12)</td>
</tr>
<tr>
<td>Range</td>
<td>04–08</td>
<td>04–12</td>
<td>04–14</td>
<td>04–11</td>
<td>09–11</td>
<td>05–14</td>
</tr>
</tbody>
</table>

IQR, interquartile range

Table 2: Effect of CST on CRS score. Maximum attainable score: 23

<table>
<thead>
<tr>
<th>CRS score (Brain function)</th>
<th>N = 40</th>
<th>N = 40</th>
<th>N = 31</th>
<th>N = 16</th>
<th>N = 05</th>
<th>N = 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor (0–12)</td>
<td>40 (100)</td>
<td>35 (87.5)</td>
<td>18 (58.1)</td>
<td>02 (12.5)</td>
<td>01 (20)</td>
<td>15 (40.5)</td>
</tr>
<tr>
<td>Somewhat (13–23)</td>
<td>–</td>
<td>05 (12.5)</td>
<td>13 (41.9)</td>
<td>14 (87.5)</td>
<td>04 (80.0)</td>
<td>22 (59.5)</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>05 (04–06)</td>
<td>09 (06–11)</td>
<td>11 (08–15)</td>
<td>13 (12–15.7)</td>
<td>16 (11–17)</td>
<td>14 (10.5–16)</td>
</tr>
<tr>
<td>Range</td>
<td>02–09</td>
<td>04–16</td>
<td>02–21</td>
<td>02–18</td>
<td>08–17</td>
<td>04–21</td>
</tr>
</tbody>
</table>

IQR, interquartile range

Table 3: Effect of CST on pairing of preintervention and postintervention GCS and CRS scores

<table>
<thead>
<tr>
<th>Score</th>
<th>Day 1 (median score)</th>
<th>Paired (median score)</th>
<th>N</th>
<th>Z-score#, p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS score</td>
<td>Day 1 (06) (N = 40)</td>
<td>Day 3 (7.5)</td>
<td>40</td>
<td>4.83, &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 7 (09)</td>
<td>31</td>
<td>4.84, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 10 (10)</td>
<td>16</td>
<td>3.53, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 14 (10)</td>
<td>05</td>
<td>2.07, &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At discharge (10)</td>
<td>37</td>
<td>5.32, &lt;0.001</td>
</tr>
<tr>
<td>CRS score</td>
<td>Day 1 (05) (N = 40)</td>
<td>Day 3 (09)</td>
<td>40</td>
<td>5.32, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 7 (11)</td>
<td>31</td>
<td>4.80, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 10 (18)</td>
<td>16</td>
<td>3.38, &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Day 14 (16)</td>
<td>05</td>
<td>2.03, &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At discharge (14)</td>
<td>37</td>
<td>5.46, &lt;0.001</td>
</tr>
</tbody>
</table>

#Wilcoxon test

Table 4: Effect of CST on GCS and CRS scores after pairing the proportions (preintervention and postintervention)

<table>
<thead>
<tr>
<th>Paired</th>
<th>N</th>
<th>GCS score</th>
<th>X2, (df), and p-value*</th>
<th>CRS score</th>
<th>X2, (df), and p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 3</td>
<td>40</td>
<td>03–08</td>
<td>33 (82.5), &lt;0.05</td>
<td>0–12</td>
<td>35 (87.5), 03.20 (1), &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>09–15</td>
<td>07 (17.5)</td>
<td>13–23</td>
<td>05 (12.5)</td>
</tr>
<tr>
<td>Day 7</td>
<td>31</td>
<td>03–08</td>
<td>09 (29.0), 20.04 (1), &lt;0.001</td>
<td>0–12</td>
<td>18 (58.0), 11.07 (1), &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>09–15</td>
<td>22 (70.9)</td>
<td>13–23</td>
<td>13 (41.9)</td>
</tr>
<tr>
<td>Day 10</td>
<td>16</td>
<td>03–08</td>
<td>01 (06.2), 13.06 (1), &lt;0.001</td>
<td>0–12</td>
<td>02 (12.5), 12.07 (1), &lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>09–15</td>
<td>15 (93.7)</td>
<td>13–23</td>
<td>14 (87.5)</td>
</tr>
<tr>
<td>At discharge</td>
<td>37</td>
<td>03–08</td>
<td>05 (13.5), 30.03 (1), &lt;0.001</td>
<td>0–12</td>
<td>15 (40.5), 20.04 (1), &lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>09–15</td>
<td>32 (86.4)</td>
<td>13–23</td>
<td>22 (59.4)</td>
</tr>
</tbody>
</table>

*McNemar’s test

SSP of group II were significantly higher than that of group I, 10.45 ± 1.82 vs 5.9 ± 1.77, respectively, p < 0.05.

Another similar study was carried out on the efficacy of coma arousal procedure (CAP) by Mitchell in which CAP was introduced to 12 TBI patients, and the response was assessed by GCS on a weekly basis. Mean GCS in the experimental group on the 1st, 2nd, 3rd, and 4th week was 5.16 (0.58), 7.6 (1.6), 11.4 (1.7), and 14 (0.9), and compared to the control group mean GCS was 5.08 (1.9), 6.4 (1.7), 9 (1.3), and 13.08 (1.5), respectively. The result showed a significant difference in mean GCS scores.

A pilot study was conducted by Hall et al. on six comatose patients in a neurosurgical intensive care unit. Each patient was given alternating weeks of specific directed multisensory stimulation (SDS), which was the subject’s level of responding...
and non-directed stimulation (NDS), which was not the subject’s level of responding for half an hour a day for 5 weeks. SDS involved visual, gustatory, auditory, and olfactory stimulation. NDS involved impersonal and unfamiliar and contained lengthy and complex information. There was an improvement in GCS from an average score of four at the beginning of stimulation to an average score of 14 at the end of the study. Similar findings have been reported by Mandeep et al. that early initiation of CAT in comatose TBI patients showed significant improvement in GCS and CRS scores.2

Oh et al. adopted the time analysis series for assessing the effect of SSP to improve recovery in comatose patients. Prior to intervention mean GCS of the patients was five. After the sensory stimulation for 1 month, the mean GCS reached 10. During the recession period of 1 month, the general condition of the patients deteriorated. The second intervention was implemented after a 1-month recession. At the end of the study, the mean GCS score of the patients was 14.17 In the present study; stimulation was administered for 14 days or till the time of discharge. It was revealed that after CST, patients recovered their level of consciousness moderately.

In the present study, coma recovery scale-revised (CRS-R) was used as an assessment tool. The result revealed that the preinterventional CRS-R score was five. It was increased to 14 on day 14 or the time of discharge. The results are supported by the findings of a study by Mandeep et al. in which CAT was administered on group A patients, and the response was assessed by CRS on the 1st, 7th, and 14th days of admission. The study revealed that in group A, the mean CRS on the 1st, 7th, and 14th days of CAT was 2.05 (±1.02), 4.78 (±1.14), and 8.66 (±1.36), respectively, and for group B it was 2.06 (±1.01), 2.87 (±1.07), and 4.63 (±2.12), respectively. It showed statistically significant improvement (p < 0.5) in the experimental group.4

The results of the present study concluded that the median CRS and GCS of TBI patients were 05 (04–06) and 06 (05–06), respectively, at the time of enrollment of patients in the study, and the response was assessed by CRS on the 1st, 7th, and 14th days of admission. The study revealed that in group A, the mean CRS on the 1st, 7th, and 14th days of CST intervention to 14 (10.5–16) and 10 (09–12) at the time of discharge. Implementation of CST for 14 days can enhance consciousness recovery and improve brain functioning in severe TBI patients with low GCS. The results confirmed that sensory stimulation implemented at an early stage of trauma is beneficial to TBI patients.

**Conclusion**

There was a significant effect of the CST in a patient with TBI with respect to change in GCS and CSR scale. It can be concluded that early intervention of CST helps in the improvement of consciousness and brain functioning among comatose patients with TBI.

**Limitations**

- Lack of control group and small sample size.

**Implications for Practice**

- The study has further strengthened the evidence on the effectiveness of CST in improving consciousness and brain functioning in comatose patients.
- These are simple interventions that may be utilized by the health care professionals and the patient’s carers.

- It may help in formulating guidelines in the management of comatose severe TBI patients.

**References**

12. CDC | Rates of TBI-related Emergency Department Visits, Hospitalizations, and Deaths | Traumatic Brain Injury | Injury Center [Internet]. Available from: http://www.cdc.gov/traumaticbraininjury/data/rates.html