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Effect of Early Coma Arousal Therapy on Conscious Level Recovery and Cognition in Traumatic Brain Injury

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Abstract

Background: Traumatic brain injuries (TBIs) can affect people of all ages and are a major cause of death and disability, with an incidence of ~10 million people worldwide. Coma arousal therapy of sufficient frequency, intensity and duration arise the brain by improving neuronal organization, increased dendritic branching and increased numbers of dendritic spines thus stimulating the reticular activating system and increasing the level of cognitive function. **Purpose of the study:** The purpose of this study was to investigate the effect of adding early comma arousal therapy to the conventional physical therapy program on conscious level recovery and cognition in traumatic brain injury. **Subjects and methods:** Thirty-two patients suffered from traumatic brain injury from both genders participated in this study. They were assigned randomly into two groups. Group A consisted of 16 patients (10 males and 6 females). Group B consisted of 16 patients (11 males and 5 females). Group A received early coma arousal therapy and conventional treatment of TBI. Group B received conventional treatment of TBI only. Glasgow coma scale (GCS) and Rancho los amigos scale (RLAS) were used to measure conscious level recovery and cognition respectively before starting the treatment, after 1 week, and after 2 weeks of interventions. **Results:** There were statistically significant differences in conscious level recovery and cognition after 1 and 2 weeks of intervention in favor of the study group ($p<0.05$). After 1 week of intervention, M±SD for GCS and RLAS were 11.94 ± 0.99 and 8.31 ± 0.70 in the study group, and 9.31±0.95 and 7.06±0.57 in the control group, respectively. After 2 weeks of intervention, M±SD for GCS and RLAS were 14.38±0.72 and 9.81±0.40 for the study group, and 10.31±0.95 and 7.5 ± 0.63 for the control group, respectively. **Conclusion:** early coma arousal therapy combined with the conventional physical therapy program was more beneficial in improving conscious level recovery and cognition than the conventional physical therapy only in traumatic brain injury.

Key Words: traumatic brain injury, Glasgow coma scale, rancho los amigos scale.

Introduction:

Traumatic brain injuries (TBIs) can affect people of all ages and are a major cause of death and disability, with an incidence of ~10 million people worldwide. TBIs can include penetrating injuries (in which an object breaches the skull and dura, with direct damage to the brain parenchyma) and closed-head injuries (in which the skull and dura remain intact). TBIs can be categorized into mild, moderate and severe based on clinical factors, such as the duration and severity of consciousness (if present) **(Kaj Blennow et al., 2016).**

The most common causes of TBIs of any severity are falls and road traffic accidents, which together account for >50% of all cases. The rate of TBIs tends to be higher among men than among women, with the peak incidence among adults in the oldest (>75 years) age groups **(Kaj Blennow et al., 2016).**

While the diagnosis of traumatic brain injury (TBI) is a clinical decision, neuroimaging remains vital for guiding management on the basis of identification of intracranial pathologic conditions. CT is the mainstay of imaging of acute TBI for both initial triage and follow-up, as it is fast and accurate in detecting both primary and secondary injuries that require neurosurgical intervention **(Andrew et al., 2019).**

The Glasgow Coma Score (GCS) has traditionally been used to classify TBI as mild (GCS 13-15), moderate (GCS 9-12), or severe (GCS 3-8) **(Brian et al., 2010).** It was originally developed as a tool to assess level of consciousness and not to predict the outcome of TBI or coma in general **(Olli et al., 2021).**

There is a strong correlation between GCS score and morbidity and/or mortality at the severe end of the spectrum but limited correlation at the mild end of the spectrum. The GCS has been a long-standing clinical tool used to quickly categorize TBI as mild, moderate, or severe solely on the basis of physical examination findings without the need to use specialized tools **(Andrew et al., 2019).**

Consciousness is an awareness of one's self and surroundings. Brain injury can cause disorders of consciousness (DOC). Some injuries are mild; they may cause minor changes in consciousness such as brief confusion. Severe injuries can cause permanent unconsciousness **(Sherer et al., 2020).**

Cognitive impairments due to TBI that include different areas of cognition cause substantial degree of morbidity for the affected individuals and can have impact on their family members and society as well. The most common neurocognitive consequences at all levels of severity of TBI are attention, executive functioning, and memory deficits **(Said et al., 2018).**

Cognitive dysfunction is one of the most frequent consequences in patients suffering from TBI. This covers the deficit of memory, executive skills, attention, memory, language and communication, and visuospatial perception. These dysfunctions vary according to the anatomic location of the lesion **(Said et al., 2018).**

The rancho los amigos scale (RLAS), also known as the Ranchos Scale, is a widely accepted medical scale used to describe the cognitive and behavioral patterns found in brain injury patients as they recover from injury. It was originally developed by the head injury team at the Rancho Los Amigos Hospital in Downey, California to assess patients emerging from a coma. It takes into account state of consciousness as well as their reliance on assistance to carry out their cognitive and physical functions. This activity describes the clinical use of the Ranchos Los Amigos scale to assess patients with a head injury **(Lin et al., 2022).**

Standards of care to stimulate coma arousal and to guide rehabilitative treatment have not been established. Pharmacological interventions, right median nerve stimulation (RMNS), sensory stimulation (SS), dorsal column stimulation

(DCS), transcranial magnetic stimulation (TMS), deep brain stimulation (DBS), hyperbaric oxygen (HBO) therapy and cell transplantation (CT) have all been utilized to better achieve rehabilitation goals **(Giulia Cossu, 2013).**

Sensory stimulation of sufficient frequency, intensity and duration has shown to arouse the brain by improving neuronal organization, increased dendritic branching and increased numbers of dendritic spines; stimulating the reticular activating system and increasing the level of cognitive function **(Mandeep and Kumar, 2012)**.

So, this study may be considered as a new conjugated way alongside the conventional rehabilitation program of TBI, which may help physiotherapists and physicians to treat these conditions and improve their quality of life.

Materials and Methods:

The study was conducted in Kasr el Aini emergency hospital intensive care unit and neurosurgery ward from June 2022 to December 2023. The purpose of the study was to investigate the effect of early coma arousal therapy on conscious level recovery and cognition in traumatic brain injury.

This study was conducted on thirty-two patients diagnosed with moderate traumatic brain injury, based on GCS, CT diagnosis and the neurosurgeon referral. Patients were recruited from the neurosurgical intensive care unit of the Cairo University Hospitals.

They were selected from both gender and their ages ranged from 18-40 years **(Wykes et al., 2009)**. Physical therapy was initiated 2–12 days following injury as soon as the patient clinical status was stable **(Li J et al., 2020)**. Sessions were done 6 days / week except on Fridays. at morning shift (10 am) and afternoon shift (5 pm). The demographic data and medical history was collected on the first session **(Appendix II).**

All patients' relative's signed a written informed consent after they were informed of the contents, the purpose of this study, and the benefits and risks associated with it **(Appendix I)**. The current study was approved by the Faculty of Physical Therapy, Cairo University ethical committee board (P.T.REC/012/003941). This study was registered at Clinical Trials.gov with the reference number: NCT05521815.

Group (A) Study Group

This group contained 16 patients of traumatic brain injury (10 males, 6 females) received coma arousal therapy in addition to the conventional physical therapy program which included positioning, chest physiotherapy and early mobilization.

Group (B) Control Group.

This group contained 16 patients of traumatic brain injury (11 males, 5 females) received the conventional physical therapy program only.

Inclusion criteria:

1) Thirty-two moderate TBI comatose patients.
2) Both genders.
3) Age range from 18-40 **(Wykes et al., 2009).**
4) GCS range (9-12).

Exclusion criteria

Patients were excluded if they had any of the following **(Tavangar et al., 2015):**

1) History of brain injury.
2) Impaired hearing.
3) Blood excretion from ears and nose.

4) Skull base fractures.
5) History of drug addiction.
6) Comatose patients on ventilation **(Mandeep and Pravin, 2012).**

Procedures:

Instrumentations and materials

Instruments and materials for evaluation:

- **Glasgow coma scale (GCS**
- **Rancho Los Amigos Scale (RLAS)**

Instruments and Materials for treatment

- **Positioning**
- **Early mobilization**
- **Chest physiotherapy**
- **Coma arousal therapy**

Treatment Procedure

Group A: comma arousal therapy

Patients in group A received comma arousal therapy in addition to the conventional physical therapy treatment for comatose patients (positioning, chest physiotherapy and early mobilization). The program started with coma arousal therapy program followed by chest physiotherapy, early mobilization and then positioning.

Group B: Control group

Every patient in the control group received the conventional treatment only as which was illustrated in group (A). The conventional treatment consisted of the following:

1) Positioning
2) Chest physiotherapy
3) Early mobilization

Data Collection and Statistical analysis:

- The data was collected before and after 1 and 2 weeks for each patient in the two groups.
- Unpaired t-test was conducted for comparison of subjects' characteristics between groups.
- Chi squared test was conducted for comparison of sex distribution between group
- Mixed MANOVA was conducted to compare the effect of time (pre versus post I versus post II) and the effect of treatment (between groups), as well as the interaction between time and treatment on GCS and RLAS. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison.
- The level of significance for all statistical tests was set at $p < 0.05$.
- All statistical measures were performed through the statistical package for social studies (SPSS) version 25 for windows.

Results

Effect of treatment on GCS

Comparison between groups

Pre treatment

The mean difference in GCS between groups pretreatment was 0.18. There was no significant difference in GCS between study and control groups pretreatment (p = 0.41).

Post I

The mean difference in GCS between groups at post I was 2.63. There was a significant increase in GCS of study group compared with that of control group at post I (p = 0.001).

Post II

The mean difference in GCS between groups at post II was 4.07. There was a significant increase in GCS of study group compared with that of control group at post II (p = 0.001).

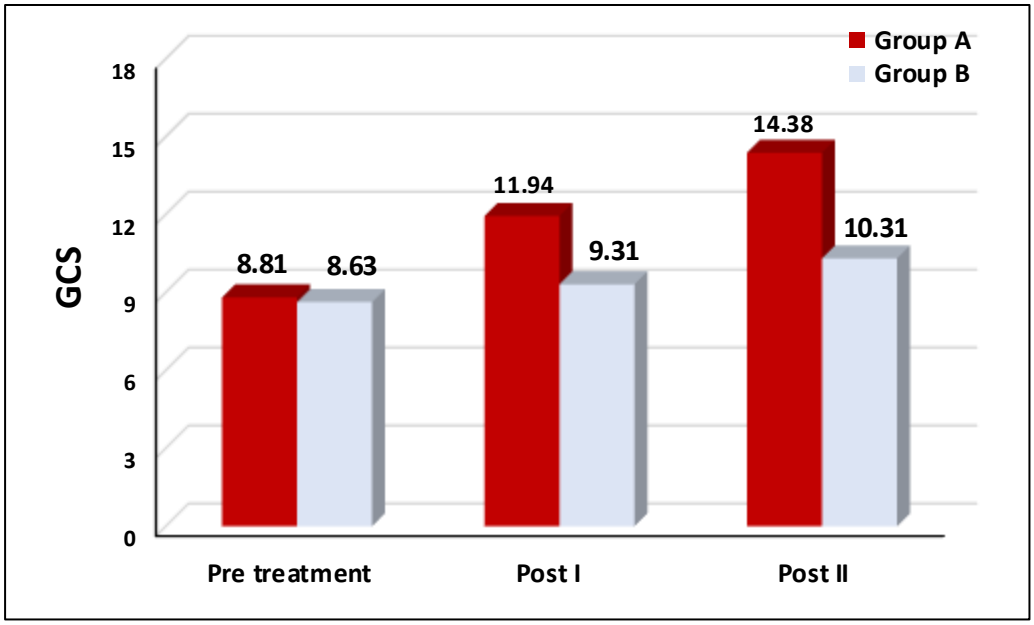

Fig (1) Mean GCS at pre treatment, post I and post II of study and control groups.

Effect of treatment on RLAS:

Comparison between groups

Pre treatment

The mean difference in RLAS between groups pretreatment was 0.06. There was no significant difference in RLAS between study and control groups pretreatment (p = 0.75).

Post I

The mean difference in RLAS between groups at post I was 1.25. There was a significant increase in RLAS of study group compared with that of control group at post I (p = 0.001).

Post II

The mean difference in RLAS between groups at post II was 2.31. There was a significant increase in RLAS of study group compared with that of control group at post II (p = 0.001).

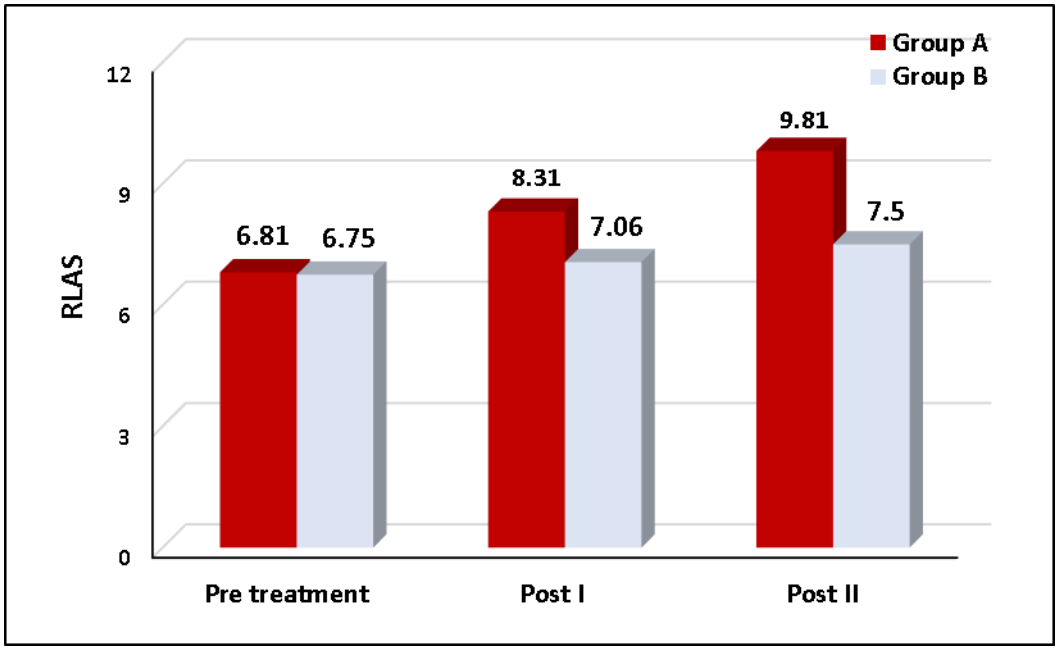

Fig (2) Mean RLAS at pretreatment, post I and post II of study and control groups.

Discussion:

Although traumatic brain injury is a significant cause of mortality and morbidity worldwide resulting from falls, car accidents, sports, and blast injuries. Unfortunately, no therapy or drug protocol currently addresses the complex pathophysiology of TBI, leading to the long-term chronic neuro inflammatory assaults **(Datta et al., 2023).**

While the majority of TBIs are mild (approximately 80%), there is still a significant number of people who sustain a moderate or severe TBI and survive. The presentation of an individual with moderate-to-severe TBI varies considerably depending on the site and severity of the brain injury. The person with TBI may present with cognitive, language impairments, behavioral disturbances, primary and secondary physical impairments. Cognitive and language impairments include slowed processing speed, reduced short-term memory, deficits in executive functioning and aphasia **(Leanne Hassett, 2023).**

The field of neurorehabilitation after TBI is vast and multifaceted, encompassing everything from initial rehabilitation of persons with reduced consciousness through assistance and companionship as patients reintegrate into their social and occupational situations. Due to the wide range of behavioral, cognitive, physical, and psychosocial consequences of TBI, rehabilitation must be individualized and concentrated on the patients' needs, goals, strengths, and deficiencies in order to be effective. Furthermore, early rehabilitation might have a positive impact on the results of individual **(Akira M et al., 2022).**

Research has shown that physical therapy can be an effective tool in regaining and relearning some critical motor functions as well as beneficial for increased cognition. Therefore, physical therapy has been deemed an essential part in early TBI rehabilitation **(Kayla Praino, 2021).** However there are no studies on adding early

coma arousal therapy on conscious level recovery and cognition in traumatic brain injury.

Coma arousal technique also known as coma arousal program has evidence, It's an approach mainly based on sensory stimulation of unconscious persons, it suggest that early and regular administration of coma arousal technique helps to improve sensory function of unconscious patients. It involves tactile, auditory, verbal and motor sensory stimulation **(Subin S. et al, 2022).**

The current study was designed to investigate the efficacy of adding early coma arousal therapy to the conventional physical therapy treatment on conscious level recovery and cognition in traumatic brain injury.

According to the data analysis of the current study, the findings revealed that both groups showed a statistical significant difference in the mean values of all outcome measures (Glascow coma scale and Rancho los amigos scale) after 1 and 2 weeks of the treatment, ($p< 0.05$) in favor of the study group. The best improvement was after 2 weeks from starting treatment intervention for both groups.

Findings of this study showed that conscious level recovery and cognition were significantly improved after 1 and 2 weeks of early coma arousal therapy when added to the conventional physical therapy in traumatic brain injury ($p< 0.05$). Coma arousal technique is one of the important method that is useful to improve the level of consciousness and sensory stimulation in unconscious patients, the Effect of applying the coma arousal technique can improve the health of individual and it also reduces the stay of hospital thus we can save the patients going into deep coma as it stimulates the patient's auditory, visual, tactile and kinetic functions **(Subin et al, 2022).**

Sensory stimulation is simple and easy to apply and considered as an attractive intervention for unconscious patients **(Park and Davis A., 2016).** Sensory stimulation is a safe method which enhances the Reticular Activating System in the brain and facilitates the reorganization of brain activities through creating new neural connection and allows people to interact with the environment **(Naglaa et al, 2023).**

There is a gap in literature covering early coma arousal therapy, as there is no published research that studied the effect of early coma arousal therapy on conscious level recovery and cognition in traumatic brain injury. The revealed results of this study were discussed as the following:

The findings of this study were in line with **Li et al., (2020)** who conducted that multimodal sensory stimulation may be a facilitator of arousal in minimally conscious or comatose states following severe TBI. Furthermore **Padilla and Domina (2016)** also suggest that frequent stimulation is more effective. It has also been suggested that stimulation must start early.

Also **Norwood et al., (2023)** suggest that high frequency stimulation targeting physical movement may promote better outcomes and may be beneficial for patients in a coma aiming to improve conscious state, the more senses stimulated the better for coma arousal.

Another agreement with the study conducted by **Grüner and Terhaag, (2000)** which focused on 16 patients suffering from severe brain injury and in coma from at least 48 h. GCS scores at baseline were between 3 and 9, and the stimulation therapy was administered daily in two units of 1 h in a dynamic manner for a mean period of time of 10 days (range, 1 – 30 days). Significant changes were identified in vital sign parameters (heart and respiratory frequencies) in deep comatose patients (GCS score of 3 or 4), whilst standardized behavioral assessment turned out to be particularly useful with medium coma (GCS score of 5 or 6). In both cases, the most important changes were found after tactile and acoustic stimulations.

Although the results of this study are in conflict with **Lombardi et al., (2010)** who conducted a systematic review that indicates that there is no reliable evidence to support the effectiveness of multisensory stimulation programs in patients in coma following brain injury. **Padilla and Domina (2016)** conducted a review in 2016 focusing on coma studies and found positive results.

On the contrary, the current study results are in contrast with **Davis and Gimenez A, (2003).** Their study examines the efficacy of a structured sensory stimulation program in nine male patients with severe TBI, while three patients with similar characteristics were used as controls. The program started 3 days after injury and lasted for 7 days. In the intervention group, a non significant improvement was noted in evaluating GCS and RLA scores when compared with baseline levels.

The current study findings were supported by **Oh and Seo, (2003)**, there was a single experimental group (seven patients enrolled within 3 months from the traumatic event, with a GCS score between 3 and 10). Subjects enrolled were TBI patients who received twice a multisensory stimulation program lasting 4 weeks with a recession period of 4 weeks. Responsiveness was evaluated using GCS score: significant improvements in consciousness levels were registered with a permanent effect achieved after the stimulation program was applied for more than one month.

Another agreement with the research of **Sindhubhai et al., (2023)** who reported that all patients were in a coma at the time of enrollment into the study. After intervention with coma stimulation technique, 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 as a result it can be concluded that early intervention of coma stimulation technique helps in the improvement of consciousness and brain functioning among comatose patients with TBI.

Furthermore, the current study findings went parallel to **Sharma A, (2023)** who studied the effectiveness of coma stimulation program in traumatic brain injury. A total of 15 traumatic head injury patients who were diagnosed as specified types of traumatic brain injury were purposively selected from the in-door patient department at Sri Aurobindo institute of medical sciences. To all the subjects one session of coma stimulation program with two sessions of conventional physiotherapy were given for 4 weeks. Statistical analysis results showed significant improvement in level of consciousness in all the cases of traumatic brain injury received coma stimulation program.

Also, there is agreement between the findings of this study and the finding of **Huang et al., (2023)** who provided a pilot study to appraise the current evidence assessing the effect of Post-Acute Care (PAC) for Traumatic Brain Injury Patients in Taiwan. The results in this study showed significant improvement in RLAS scores after the patients with TBI completed the PAC program, suggesting the patients had significant improvements in cognitive and language functions.

The results of the study are in conflict with **Cossu , (2013)** who investigated the efficacy of multisensory stimulation in patients with TBI. This randomized controlled trial included 14 male TBI patients with GCS $\leq$ 8. Seven patients were allocated to the active intervention group with therapeutic sessions of 20 min daily, and seven patients received the usual care during their ICU permanence (admission within 24 h post injury). There was not a significant difference in outcomes between the two groups (evaluated daily as: GCS score, state of ventilation, spontaneous eye movements, oculocephalic (OC) response and oculovestibular (OV) response).

Conclusion:

From the finding of the current study, it was concluded that early coma arousal therapy combined with the conventional physical therapy program for traumatic brain injury was more beneficial in improving conscious level recovery and cognition than the conventional physical therapy alone. It might be considered a useful adjunctive therapy in treating patients with traumatic brain injury.

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