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Case Report
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Rehabilitation of Vegetative State after Operation for Severe Traumatic Brain Injury (TBI) in the Elderly for 6 Months: A Case Report and Literature Review

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Abstract

Background: Traumatic Brain Injury (TBI) often occurs in the wartime and military training, and severe TBI could easily lead to vegetative state and disability. There are few reports focusing on vegetative state rehabilitation after TBI.

Case Report: We reported an elderly case who was in the vegetative state for 6 months after operation for severe TBI due to a fall from a height. After a series of comprehensive rehabilitation treatments (i.e., the awakening, cognition, limbs, swallowing, nutrition, etc.), the recovery effects of consciousness, cognition and limb function were satisfactory.

Conclusion: Significant rehabilitation had been observed in this elderly case in the vegetative state for 6 months after severe TBI.

Keywords: Elderly; Traumatic Brain Injury (TBI); Vegetative state; Rehabilitation

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Abbreviations

TBI: Traumatic Brain Injury; TMS: Transcranial Magnetic Stimulation; TDCS: Transcranial Direct Current Stimulation; MNES: Median Nerve Electrical Stimulation; GCS: Glasgow Coma Scale; CRS-R: Coma Recovery Scale-Revised; NIDA: Neurological Impairment Degree Assessment; DRS: Disability Rating Scale; RLA: Rancho Los Amigos Levels of Cognitive Functioning Scale

Introduction

Traumatic Brain Injury (TBI) not only is the primary cause of wartime casualties [1], but also often occurs in military training during peacetime [2]. TBI cases could be divided into concussion, brain contusion and diffuse axonal injury, etc. TBI has been characterized by acute onset, rapid disease change, high mortality and high disability rate. During 2001-2014, in the two wars led by the United States against the Taliban and Iraq, the incidence of TBI has been reported to be as high as 21.0% to 28.0%, significantly higher than before, representing one of the characteristic injuries during the war [1]. The incidence of severe brain injury is high, and the fatality rate is as high as 25% to 50% [3]. It has been reported that, in only 2% of the cases in the vegetative states for more than 1 month, the consciousness would be recovered after 12 months [4]. Age over 65 years represents the greatest risk factor for the long-term hospitalization and death after brain injury [5]. With the improvement of the comprehensive first aid technology for brain trauma, the treatment success rate has been obviously increased. Therefore, improving the rehabilitation techniques (such as awakening, cognitive function, physical function, emotion and psychology) after brain injury treatment is of great significance and worthy attention. Herein, we reported an elderly case with severe open TBI who fell from a height. The patient was in the vegetative state for 6 months, who was transferred to the hospital for rehabilitation treatment in December 2020. At present, the consciousness and limb function have been significantly improved.

Case Presentation

A 68-year-old male patient, in the vegetative state for 6 months due to TBI, was transferred to the hospital for rehabilitation treatment. Falling from a height in June 2020, the patients underwent unconsciousness and agitation. Emergency head CT showed the unclear boundary between gray

Figure 1: Imaging and functional recovery.
Preoperation (11:30 on June 13): Fractures of left temporal bone, lateral wall of orbit and left wall of sphenoid sinus. **B.** Preoperation (11:30 on June 13): Unclear boundary between gray matter and white matter in both hemispheres, ventricular midline deviation. **C.** Postoperation (22:21 on June 13): Hemorrhage and midline deviation of ventricle. **D.** Raise the head of the bed to support the seat. **E.** Broaching bed bar to sit. **F.** Sit alone. **G.** Standing training. **H.** May 25, left hand writing. **I.** July 22, touch tongue. **J.** July 26, drink water by himself. **K.** September 16, jigsaw puzzle (two pieces).

matter and white matter in both hemispheres, ventricular midline deviation, subarachnoid hemorrhage, the left temporal epidural hematoma, subcutaneous hematoma on the right forehead and the top of the left forehead, multiple fractures of the left temporal bone, maxillary frontal process, lateral wall of maxillary sinus, greater wing of sphenoid bone, left wall of sphenoid sinus, frontal bone, and lateral wall of left orbit (Figures 1A-1C). The patient had been diagnosed as severe open TBI. Operations were as follows: spring coil embolization of left middle meningeal artery and left internal carotid artery, left bone flap decompression + removal of intracerebral hematoma + right ventricle puncture and catheter drainage, right ventricle puncture and Ventriculoperitoneal shunt. The patients had been subjected to the ICU tracheotomy, ventilator-assisted respiration, and nasal feeding, with the GCS score E1V1M3. Moreover, the patient had undergone the anti-epilepsy, anti-infection, aerosol sputum, and bedside acupuncture treatment. The ventilator had been taken off, and the patient had received an artificial nose on October 28th. On December 7th, the patient was transferred to our hospital for further rehabilitation treatment, with *severe open TBI*, in *vegetative state*, who received preventive anti-epilepsy, lowering tension, nourishing nerves, improving circulation and other symptomatic treatments.

Rehabilitation Treatment

At admission

The patient had been in the vegetative state for 6 months; with the GCS score E4VTM5, no follow-up, no response to name calling, right space neglect, artificial nose, nasal feeding, complete bed rest, passive position, who was unable to raise head. Left upper limb muscle strength was grade 3^{+}, left lower limb muscle strength was grade 2, right lower limb muscle strength was grade 1, and right upper limb muscle tone modified Ashworth was grade 2, indicating muscle atrophy. The patient was with double ankle joint contracture and foot droop. The modified Barthel index was 0 point. The primary goal of the rehabilitation treatment was to awaken: The Median Nerve Electrical Stimulation, sound stimulation, and limb rehabilitation movement had been given. For the comprehensive rehabilitation and prevention of complications: Raising the head on a bed to support the sitting position (Figure 1D). Passive movement of limbs was performed to maintain the range of motion of joints, and the Achilles tendon was elongated, with airway management and nutrition management. Median Nerve Electrical Stimulation was performed at the most superficial position of the median nerve on the palmar surface of wrist joint, with the following conditions: current intensity, 15 mA to 20 mA; frequency, 40 Hz; stimulation time, 20 sec; intermittent time, 40 sec; and pulse width, 300 μs. Considering the neglectance of the space on the patient's right side, to increase the attention and perception of the affected side, the therapist and nurses tried to communicate with the patient on the right side. After three months of rehabilitation treatment, on March 11th, the patient chased familiar people; on March 18th, recognized family photos;

Table 1: Summary of literature in recent ten years.

First Author/ Year	Place/Number	Age	Vegetative State Time	Control Group	Intervention Group	Duration	Conclusions
Zhu Xi/2020	Guangxi/30 cases	Control Group: 28~76, 57.4 ± 11.8 Intervention Group: 24~78, 57.5 ± 11.2	Control Group: 33~85 days Intervention Group: 35~84 days	Acupuncture, massage, light stimulation, speech stimulation	Control group treatment + TMS	4 weeks	The CRS-R and EEG grades of the intervention group were better than those of the control group after treatment (P<0.05), and the score of the CRS-R increased by 2 points
Chi Lin/ 2017	Shijiazhuang/38 cases	Control Group: 24~79, 45.37 ± 13.04 Intervention Group: 18~74, 42.68 ± 14.81	1 day	Hyperbaric Oxygen, cerebellar top nuclear stimulation, limb electrical stimulation, lower limb intelligent rehabilitation training system	Control group treatment + TDCS	10~45 days	The scores of GCS, PVS, EEG, BAEP and USEP in the intervention group were 6.11, 8.9, 0.94, 1.05 and 1.05 points higher than those before treatment and in the control group (P<0.05). The total effective rate in the intervention group was 89.47%, and the total effective rate in the control group was 84.21%
Yang Chuyan/2016	Nanchang/60 cases	18~65 Control Group: 35.34 ± 11.11 Intervention Group: 36.72 ± 12.53	Coma days: Control Group: 25.66 ± 2.12 days Intervention Group: 25.72 ± 1.98 days	Audio, visual, olfactory, touch and motor stimulation, hyperbaric oxygen	Control group treatment + MNES	4 weeks	The GCS score of the intervention group was improved by 4.77 points, which was significantly higher than that of the control group (1.19 points) (P<0.05). In the intervention group, the δ/θ activity and α wave amplitude of EEG lesion side decreased, and the cerebral blood flow in the lesion area was significantly increased by SPECT visual analysis compared with before treatment
Alessio Baricich/2017	Italy/49 cases	25.34 ± 19.12	1 day	None	Passive activity, upright bed training	4 years	5 vegetative states, 6 minimally conscious states, 1 locked-in syndrome, 29 deaths, 8 shedding
Zhang Rongguo/2014	Heilongjiang/90 cases	Unknown	Unknown	Blank control	Good limb placement, passive limb movement, bed turning training, sitting and standing training, walking training, ADL training	3 months	The GCS score, NIDA, Fugl-Meyer score and modified Barthel index in the intervention group were significantly better than those in the control group, and the incidence of complications in the control group was significantly higher than that in the intervention group (P<0.05).
Bao Yingcun/2021	Lanzhou/100 cases	Control Group: 17~74, 45 ± 15 Intervention Group: 24~67, 44 ± 12	Control Group: 2~81 days Intervention Group: 12~56 days	Passive movement, sound, light, pain, temperature, taste, olfactory, proprioceptive stimulation, respiratory training, MNES, TDCS, hyperbaric oxygen	Control group treatment + "Xingnao kaiqiao" acupuncture	30 days	The scores of GCS and CRS-R in the intervention group were increased by 2.76 and 3.78 points respectively, which were higher than those in the control group. In the intervention group, 8 cases were awake, and the awake rate was 16.7%, while in the control group, 6 cases were awake, and the awake rate was 12.0% (P<0.01).
Bao Yingcun/2020	Lanzhou/100 cases	Control Group: 17~74, 45 ± 15 Intervention Group: 8~74, 43 ± 16	Control Group: 2~81 days Intervention Group: 5~56 days	Passive movement, sound, light, pain, temperature, taste, olfactory, proprioceptive stimulation, respiratory training, MNES, TDCS, hyperbaric oxygen	Control group treatment + "midnight-noon ebb-flow" acupuncture	30 days	The scores of GCS and CRS-R in the intervention group were 3.86 and 4.52 points higher than those in the control group, respectively. In the intervention group, 10 cases were awake, and the awake rate was 20.0%, while in the control group, 6 cases were awake, and the awake rate was 12.0% (P<0.01).

Chen Xing/2018	Guangdong/40 cases	Control Group: 27~48, 32.94 ± 7.93 Intervention Group: 28~49, 33.21 ± 8.84	Unknown	Routine treatment	Routine treatment, Traditional Chinese medicine prescription, acupuncture	90 days	The CRS-R score of the intervention group was increased by 0.35 points, higher than that before treatment and control group (P<0.05).
Shi Sujuan/2014	Jiangsu/1 case	54	2 months	None	Xingnaojing, anethacetam, acupuncture and PT showed no improvement after 2 months, and active music therapy was given	4 months	From no response to active cooperation, from bed to walking assisted by one person, active expression of emotion
Xu Guoxing/2018	Jilin/29 cases	Control Group: 49.86 ± 11.24 Intervention Group: 46.93 ± 12.71	4~16 weeks	Good limb placement, range of motion maintenance, passive drafting of limbs, olfaction, taste, vision, touch stimulation, physical factor therapy, acupuncture	Control group treatment + amantadine	10 weeks	The DRS score of the intervention group decreased by 4.13 points, CRS-R and RLA scores were improved by 8.4 points and 1 grade respectively, which were better than those in the control group (P<0.05).
Mauro Mancuso/2017	Italy/9 cases	52~86, 71.7 ± 10.0	1~4 months	Simulation control	Passive limb movement, transcranial random noise stimulation	1 week	Have no effect.

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on April 8th, turned the book page by page with the left hand, and when asking questions, nodded or shacked head after thinking for a moment; on April 2nd, inserted a board with the left hand; and on May 25th, wrote with the left hand (Figures 1E-1H). For the muscle strength assessment, the left upper limb was grade 4^+, left lower limb was grade 3^+, right lower limb was grade 2^-, while the muscle strength and muscle tension of right upper limb were not improved. Fever occurred 3 times during this period.

Five months in the hospital

Rehabilitation treatment was as follows: cognitive training, swallowing training, and body training. The independent sitting balance training was performed to practice the patient's bedside sitting position, and the auxiliary support had been gradually reduced: Initially assisted by two people, to sitting alone on the bedside without assistance. Rehabilitation progress, the condition of the patient's cognition developed, from only chasing others when they entered and left the ward in the past, to now also chasing when others moved in and out of the room. Moreover, the reaction speed of nodding or shaking head became faster. For the sitting position, from pulling the own bed bar to sit on June 4th (Figure 1E), to sitting alone for 1 h on June 30th (Figure 1F). Moreover, from sitting down to head fully raised.

Seven months in the hospital

Rehabilitation treatment: Cognitive training; swallowing training; body training; and standing training (Figure 1G). Rehabilitation progress: For the cognition, on July 22nd, the patient touched his tongue (Figure 1I); on July 26th, took the spoon and drank water when feeding (Figure 1J); and on September 16th, used left hand to puzzle (Figure 1K). For the swallowing function, the half scoop of water or drink could be swallowed with the head back later, without choking and aspiration. For the right upper limb, on July 26th, the right hand could be opened at a wide angle and could shake hands, and the right shoulder joint could extend about 30°; and on July 29th, the right elbow joint could flex to 45°. One seizure and three fevers had been reported during this period.

Discussion

The PubMed and CNKI had been searched, with the themes of "brain injury" OR "traumatic brain injury" AND "vegetation state" AND "rehabilitation", from 2011 to 2021. A total of 11 articles, including 1 case report has been attained, involving totally 546 patients, aged from 8 to 86 years, mostly under 60 years old. The duration of vegetative state has been short, ranging from 1 day to 4 months, mostly 1 to 3 months. Most of them have improved consciousness and cognitive function after rehabilitation (Table 1). The primary task of the treatment for vegetative state after TBI is to induce awakening. A prospective cohort study has shown that the male youth, short duration of vegetative state, diffuse brain injury, and epilepsy state are variables increasing the possibility of the vegetative state transitioning to the minimally conscious state. This study has included 49 patients in vegetative state, receiving passive activity and upright bed training, which have been followed-up for 4 years, with the consciousness recovery rate of 14.29%. Among these patients, 5 cases have developed vegetative state, 6 patients have become minimally conscious state, 1 patient have locked-in syndrome, and 29 patients die [6]. Zhang et al. [7] have shown that early rehabilitation treatment can promote the recovery of patients' neurological function, including good limb placement, passive limb movement, bed turning training, and sitting and standing training. In this study, 90 patients after 3 months of trial, GCS score, neurological impairment evaluation, Fugl-Meyer score and modified Barthel index in the intervention group are clearly better than those subjects in the control group, and the incidence of complications in the control group is significantly higher than the intervention group [7]. Traditional Chinese medicine studies have shown that, on the basis of rehabilitation treatment, combined acupuncture therapy (such as *midnight-noon ebb-flow* acupuncture) can effectively promote the

recovery of consciousness of patients with vegetative state. Moreover, the GCS and CRS-R scores have been increased by 3.86 and 4.52 points respectively, and the awake rates of the intervention and control groups are 20% and 12%, respectively [8]. Active music therapy has also shown the effect of improving consciousness in a case report [9]. After 4 months of music therapy, patient in vegetative state for 2 months change from unresponsive to active cooperation, from bed rest to walking with the assistance of one person, and could actively express emotions [9]. The prognosis of coma after TBI is mostly seen in young patients, and imaging examination plays an indispensable role in the evaluation of rehabilitation efficacy of patients in vegetative state. PET-CT, MRI and continuous EEG monitoring can help to observe the progress of patients' rehabilitation and to predict the prognosis to a certain extent [7,10,11]. This case herein provided three hints. First, the goal of rehabilitation for elderly patients in vegetative state due to severe TBI should be to promote the recovery of consciousness and cognitive function. This case was a 68-year-old patient who had been in vegetative state for 6 months when admitted to the hospital, and the recovery probability was very small. However, the family members and doctors insisted on treatment, and the Neurology Department and the Rehabilitation Team in our hospital actively gave the treatment. At present, the patient's cognitive, physical and emotional functions have been well recovered. Second, the patient's consciousness has been well recovered, suggesting that in the absence of hyperbaric oxygen, Transcranial Magnetic Stimulation (TMS), Transcranial Direct Current Stimulation (TDCS) and other advanced equipment's, the application of Median Nerve Electrical Stimulation (MNES) would also represent an effective treatment option, which could be commonly found in most hospitals. Third, the passive movement of limbs should be emphasized in the early stage of coma after TBI to maintain the normal range of motion of joints and prevent muscle atrophy, avoiding disuse and joint contracture, which would cause difficulties for rehabilitation treatment in the late stage. The independent sitting and standing training should be performed as early as possible to prevent and reduce the occurrence of various complications. Meanwhile, whether there is weight loss should be paid attention to, ensuring the adequate intake of calories and nutrition, improving immunity, and avoiding infection.

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