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Case Report

The Assessment of Cognitive Function Determines the Time of Operation of Hydrocephalus Drainage in Severe TBI

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Abbreviations:

TBI: Traumatic Brain Injury

SICU: Surgical Intensive Care Unit

WHO: World Health Organization

EVD : External Ventricular Drain

ICP : Intracranial Pressure

CT: Computed Tomography

GCS : Glasgow Come Scale

FOUR: Full outline of Unresponsiveness

VPS : Ventriculoperitoneal Shunt

ADL: Activities of daily living

WISC: Wechsler Preschool and Primacy Scale of Intelligence

ABSTRACT

The incidence of severe traumatic brain injury (TBI) is gradually increasing, and its integrated treatment and rehabilitation in early-stage is increasingly valued by working together with doctors in surgical intensive care unit (SICU), surgeons and rehabilitation doctors. In this report, we presented a seven-year-old child was hit on the right side of the head by a falling glass from the building, causing severe TBI, starting from emergency room (ER), SICU, neurosurgery, spine surgery, whole–process and intensive rehabilitation. The child functionally regained some of his motor functions and most of his cognitive functions step by step from coma to cognition and was expected to return to his schooling finally. The authors of this report discuss the necessity and effectiveness of multidisciplinary integration and early intervention in rehabilitation. The case exhibited that multiple rehabilitation procedures would be conducted in whole process of patients with trauma. Furthermore, rehabilitation physician and therapist play critical roles in evaluation and handling of treatment strategy for precise movement and cognitive functional recovery. Particularly, the cognitive function assessment and treatment has significantly performed in making decision on the opportunity of operation of hydrocephalus. All above, the case offered the model of the integrated rehabilitation in severe TBI.

Introduction

Severe TBI remains a major health-care problem worldwide. According to the world health organization（WHO）, TBI will surpass other diseases as the leading cause of disability in 2020, with about 10 million people worldwide suffering from TBI each year [1]. The survival rate of patients with TBI was significantly improved due to the development of medical technology, but the patient's remaining functional barriers are not optimistic. The diagnosis of severe TBI mainly depends on the history of the accidents, Glasgow Come Scale（GCS）score,

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radiographic findings and clinical manifestation [2]. Here we described a child who had a severe TBI and fracture of right shoulder peak, and who presented with a GCS of 5 and pupils were dull to the light. The comprehensive treatment of patients with TBI faced great challenge, such as functional outcomes those result in long-term dependence and disability [3]. Today, the integrated model is relatively perfect for whole-process and continuous treatment from acute conscious disorder to stable recovery. But, in china，the part of patients who need intensive rehabilitation of TBI were usually unhelpfully transferred as chronic status to the general rehabilitation hospital or community healthcare center once the patient's vital signs are stable in earlier stage of TBI, thus missing the best monitor and recovery time in earlier stage.

Case reports

A seven-year-old child was hit on the right side of the head by a falling glass, causing severe TBI with coma. When he was sent to the emergency room (ER) of the hospital, the child's vital signs as follows: heart rate, 130 beats/min; blood pressure, 50/40 mmHg; respiratory rate, 20 breaths/min; and oxygen saturation, 100% on room air， afebrile. On physical examination, unconscious, at the right temporal scalp, scalp avulsion, comminuted fracture, part of the brain tissue bulging out, accompanied by active hemorrhage. 3 mm pupil gazing at to the right, light reflex dullness, the limbs examination unable to complete, the left limb appears neurological symptoms. The left Babinski (+). We calculate the GCS score of 5, full outline of unresponsiveness (FOUR) score of 7.

In the course of the injury, the impact of the head CT is shown in (Figure 1, Day 1). In ER, specialists in neurosurgery, orthopedics, pediatric worked together for preoperative preparation. Under general anesthesia, remove the hematoma and fracture fragments, an external ventricular drain (EVD) was placed. Postoperatively， patient was transferred to the SICU with 20 mmHg initial intracranial pressure (ICP). On day 6, rehabilitation unit initiated a series of rehabilitation assessments. Due to the patient's medical condition is unstable, strategy of rehabilitation mainly promoted awake and limb passive activities, and then transition to cognitive training. With the progress of the medical status the cerebral edema caused the midline shift（Figure1, Day 23). It has significant index to confer the efficiency of rehabilitation. The further treatments were performed in SICU with persistent rehabilitation and then the patient was transfer to department of neurosurgery after the vital signs were stable and decreasing dynamic intracranial pressure in day 20.

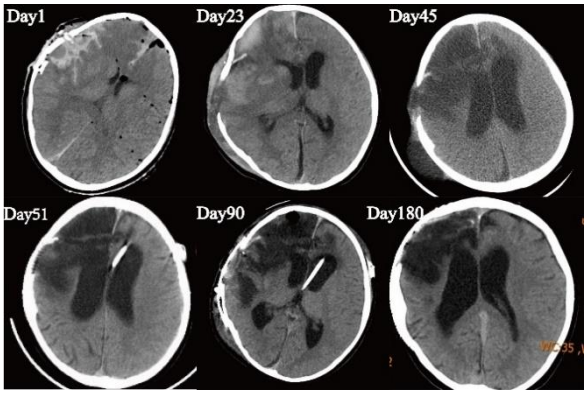

Figure 1: Imaging pathologically changed during integrated treatment and rehabilitation.

Day 1， CT showed right skull comminuted fracture, right frontal intracranial hemorrhage, traumatic subarachnoid haemorrhage and intracranial multiple gas; Day 23, CT showed right frontal and temporal subdural hematoma. Cerebral edema worse in right hemisphere with 0.44 cm of right to left midline shift, and the brain drain to disappear ; Day 45，CT showed hydrocephalus, the ventricles were enlarged and the gutter disappeared ; Day 51，CT showed hydrocephalus was better than before, and brain drain was saw after ventriculoperitoneal shunt (VPS) and cranioplasty; Day 90, one month after VPS surgery , three months after the injury, CT revealed that the cerebral hemorrhage had been fully absorbed ; Day 180，four month after VPS surgery, six months after the injury, CT revealed that the cerebral hemorrhage had been fully absorbed. The brain drain was clearly.

Secondary hydrocephalus was found after day 20 (Figure 1，Day 45) . The rehabilitation was necessary in earlier period but inappropriate because of the secondary hydrocephalus with increasing of dynamic intracranial pressure caused by hydrocephalus and second disturbance of consciousness. Delayed treatment maybe induced irreversible brain dysfunction within three months. In order to continuing rehabilitation for coma disorder, cognitive damage and speech problem, rehabilitation team strongly recommended neurosurgeon to solve chronic secondary hydrocephalus as soon as possible. The strategy was that the ventriculoperitoneal shunt (VPS) has to be conducted for induction of intracranial pressure. After VPS and cranioplasty was performed in Day 50. Head CT examinations are shown in (Figure 1 Day 51，90，180. The patient's cognition, limb, and sphincter disorder were significantly improved with the decreasing of stable and adaptable intracranial pressure. After two months, the patients started to accept second-stage rehabilitation in the rehabilitation center.

During the whole-process of rehabilitation (Figure 2), we regularly conduct rehabilitation assessments and adjust the treatment plan according to the corresponding assessment results to achieve precise therapy and rehabilitation. The specific assessment results are shown in (Figure 3).

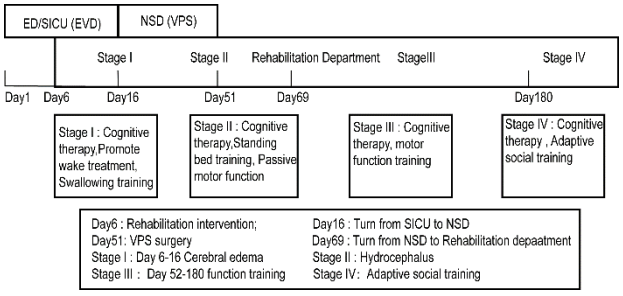

Figure 2: The patient's precise rehabilitation workflow.

The patient accepted multidisciplinary surgical treatment and integrated whole process rehabilitation. The integrated rehabilitations had different strategies at different stages. Particularly, cognitive training was consistent throughout whole rehabilitation. In the stage I, Rehabilitation mainly focused on promoting awakening and passive motion; In the stage II, because of the severe hydrocephalus, rehabilitation, especially cognitive function recovery is slow; But in the stage III, the patient's motor and cognitive function recovered significantly after VPS; In the stage IV, Rehabilitation focused more on patients' social adaptability training, including returning to school.

At present, the rehabilitation evaluation was as follows: Glasgow Outcome Scale(GOS) score of 4, Activities of daily living (ADL) score of 80/100, Berg balance score of 54/56 , Wechsler Preschool and Primacy Scale of Intelligence（WISC)- the language part score is 66. The child now legacy obstacle is: a little attention disorder, unilateral spatial neglect, which was improved significantly after treatment, and the left hemiplegia, upper severe extremity. He can walk without help and hopes to return to school.

Figure 3. rehabilitation assessment

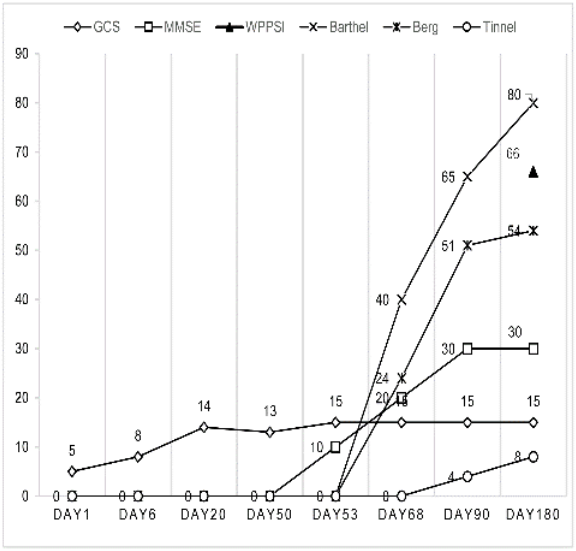

Figure 3: Rehabilitation assessments during the therapy.

The abscissa indicates the assessment time and the ordinate indicated the value. The curve suggested that after the patient passed the acute cerebral edema, the patient's function gradually improved, but in the hydrocephalus stage, the patient's state of consciousness became worse and the function became worse. However, after the brain hydrocephalus was relieved by VPS, the score was increased, and the patient's function is obviously restored.

Discussion

In many cases in severe TBI, the patients are treated in ER/SICU and related surgery department without earlier intensive rehabilitation. The patients received physical recovery but left dysfunctional problems when they went back to home and work place. Finally, prognosis and treatment of patients are a heavy physiological, psychological and economic burden on patients themselves, families and society [4]. Patients with severe TBI management need pre-hospital emergency, neurosurgery, SICU and intensive rehabilitation medicine on the whole-process [4]. In the premise of adequate consideration of indications and contraindications, we should combine the condition of patients with intracranial pressure and general condition to get the rehabilitation treatment as early as possible. However, there has been not suitable unification on the timing of rehabilitation intervention，especially in the case of unstable intracranial pressure.

A multidisciplinary combination or unit was beneficial for guiding patient's precise treatment and rehabilitation [7]. Rehabilitation department is capable to involve early treatment process, including promoting wakefulness, passive activities and other treatments. The rehabilitation significantly positively affected consciousness recovery and stable vital signs gradually in earlier stage.

As neurosurgery, the secondary chronic hydrocephalus increased risk accompanied by unstable intracranial pressure, but VPS do not have to be conducted immediately due to slow progress and age in such cases [8]. As neurorehabilitation, it is important to perform cognitive training and movement training in earlier stage without high intracranial pressure. In this case, precise cognitive function assessments played critical role in decision of VPS operation immediately [9]. VPS showed that with the suppressed ICP, the patient's consciousness and multiple rehabilitation effect were significantly better than that of the patients with higher intracranial pressure. Furthermore, during the whole process of rehabilitation, special attention to brain protection and cognitive function training was performed. The recovery of cognitive function is more conducive to the rehabilitation of motor function and the prognosis of patients [10, 11].

Although the concept of early integrated rehabilitation treatment was gradually accepted by surgeons and patients, it was difficult to implement case to different medical condition in China. Actually, in most of cases, the treatment of severe TBI in China is concentrated in the middle and late stage and therefore missed the best time for recovery. This case can provide a reference for the integration model of surgical and rehabilitation in Shanghai, China, which can guide our early recovery not only in the rehabilitation ward, but also in the neurosurgical ward and even the ICU. Furthermore, rehabilitation physician and physical therapist would play critical roles in evaluation and handling of treatment strategy for precise movement and cognitive functional recovery，and cognitive function assessments have significantly performed in making decision on the opportunity of operation of hydrocephalus.

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Chunya Gu and Naisheng Zhai was the therapists of the patient, Lijuan Zhao was the attending doctor of the patient, they collected data. Chengcheng Sun collected data and wrote articles. Jian Hai, Dongsheng Xu are the director of rehabilitation medicine, they designed the study, provided help for the final version of the manuscript.

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Declaration of interest

The authors declare that they have no conflicts of interest concerning this article.

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