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Clinical Characteristics and Rehabilitation Results of Traumatic Brain Injury Patients Who Have Early Rehabilitation

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ABSTRACT

AIM: To examine the clinical characteristics and early rehabilitation results and to investigate the relationship between rehabilitation initiation time and rehabilitation-related outcome measurements in traumatic brain injury (TBI) patients who have early rehabilitation.

MATERIAL and METHODS: Forty-seven TBI patients who were referred for rehabilitation in the neurosurgery department were enrolled in the study retrospectively. Clinical characteristics and rehabilitation-related outcome measurements including consciousness, functional outcome, daily living activities, functional mobility, and ambulation of all patients were recorded. The paired samples t-test was used to compare data before and after rehabilitation. The relationship between rehabilitation initiation time and the other outcomes was analyzed with Pearson's correlation test.

RESULTS: Most of the TBI patients were male (83%) and the severities of the trauma were mostly mild (42%). The causes of trauma were mostly falls (53%). Twenty-three (49%) of the patients underwent surgical intervention. The lengths of time between admission and consultation and between surgery and consultation were 19.82±17.9 and 14.24±15.4 days, respectively. The lengths of stay in intensive care and hospital were respectively 27.32±34.93 and 41.35±32.83 days. The rehabilitation time was 21.50±24.32 days. The before and after rehabilitation results showed that all rehabilitation-related outcome measurements improved significantly ($p<0.001$). The relationship between rehabilitation initiation time and the other outcomes was statistically significant ($p<0.05$).

CONCLUSION: This was a descriptive study in terms of demonstrating the demographic and clinical characteristics of TBI patients who need rehabilitation in the neurosurgery department. Early rehabilitation can enhance the rehabilitation-related outcome including consciousness, functional outcome, daily living activities, functional mobility, and ambulation in TBI patients as soon as their medical condition is stable. Early rehabilitation initiation time is important for improving the rehabilitation-related outcomes.

KEYWORDS: Brain injuries, Traumatic, Rehabilitation, Onset time, Prognosis, Rehabilitation, Trauma

ABBREVIATIONS: TBI: Traumatic brain injury, **LOS:** Length of stay, **ADL:** Activities of daily living, **GCS:** Glasgow Coma Scale, **GOSE:** Extended Glasgow Outcome Scale, **BI:** Barthel Index, **DRS:** Disability Rating Scale, **MSAS:** Mobility Scale for Acute Stroke, **FAC:** Functional Ambulation Classification

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INTRODUCTION

Traumatic brain injury (TBI), a neurological injury that causes significant mortality and disability, is the third leading cause of death worldwide (33). The most common causes of TBI are traffic accidents, falls, and gunshot wounds (24). TBI can lead not only to intracranial lesions, but also other injuries such as extremity and vertebral fractures and visceral injuries. Therefore, the treatment of these patients requires a comprehensive approach that includes medical and surgical treatment and rehabilitation (1).

TBI patients frequently present with physical and sensorial impairments, behavioral/emotional and cognitive disorders, activities of daily living limitations, and participation restrictions (10). This reveals the necessity of rehabilitation in the treatment of TBI patients. Rehabilitation is defined as a problem-solving process aimed at reducing disability as a result of illness or injury. The aim of rehabilitation is to help patients return to their previous functional level within the limits of their physical, functional, and cognitive impairments (18). Rehabilitation of TBI patients begins soon after admission to the intensive care unit. Early rehabilitation in this unit prevents the neuromuscular complications of critical illness and improves functional status; early rehabilitation in the intensive care unit is effective, safe, and feasible (29). The early rehabilitation program should begin with the intensive care process and continues throughout the period of follow-up during inpatient care. This acute period can last 1-3 months (5). Rehabilitation initiating from the acute phase is very important for minimizing impairments, preventing complications, and ensuring participation in life as soon as possible in TBI patients (21).

Investigation of the clinical characteristics of TBI and early rehabilitation results and obtaining further data on this subject are important in terms of managing the post-trauma process (15). It is important to investigate the clinical features and early rehabilitation results of TBI and to increase the data on this subject in terms of managing the post-traumatic process. This issue is also important in terms of revealing the great burden of TBI on health services and society. Initiating rehabilitation programs in TBI patients in the early period can minimize the disorders that may develop and increase awareness about initiating them early (8). It can also reduce the length of stay (LOS) in hospital and health care costs (4).

Based on this information, the aims of the present study were 1) to examine the clinical characteristics of TBI patients who have early rehabilitation, 2) to compare the results obtained before and after rehabilitation in hospital, 3) to investigate the relationship between rehabilitation initiation time ($Length_{Admission\text{-}consultation}$) and other variables.

MATERIAL and METHODS

Study Design

The study was conducted retrospectively by including TBI patients who were admitted to the Neurosurgery Department at Hacettepe University and were referred for the inpatient rehabilitation program between January 2012 and June 2022. The study was approved by the Ethics Board of Hacettepe University (Decision Number: GO 22/793, 06.09.2022).

Participants

The medical and rehabilitation assessment records of 47 patients with TBI who were hospitalized in the Department of Neurosurgery at Hacettepe University between January 2012 and June 2022 and were referred for a rehabilitation program in the meantime were analyzed. The details of the patients who were included in the study and a flow diagram of the patients are given in Figure 1. The inclusion criteria were having a TBI, being older than 18 years, and being referred by the surgeon. Individuals with mental and functional disability due to any reason before the trauma or who had additional spinal trauma or vertebral fracture affecting the spinal cord were excluded from the study.

Assessment

The patients' demographic data, clinical features, and medical

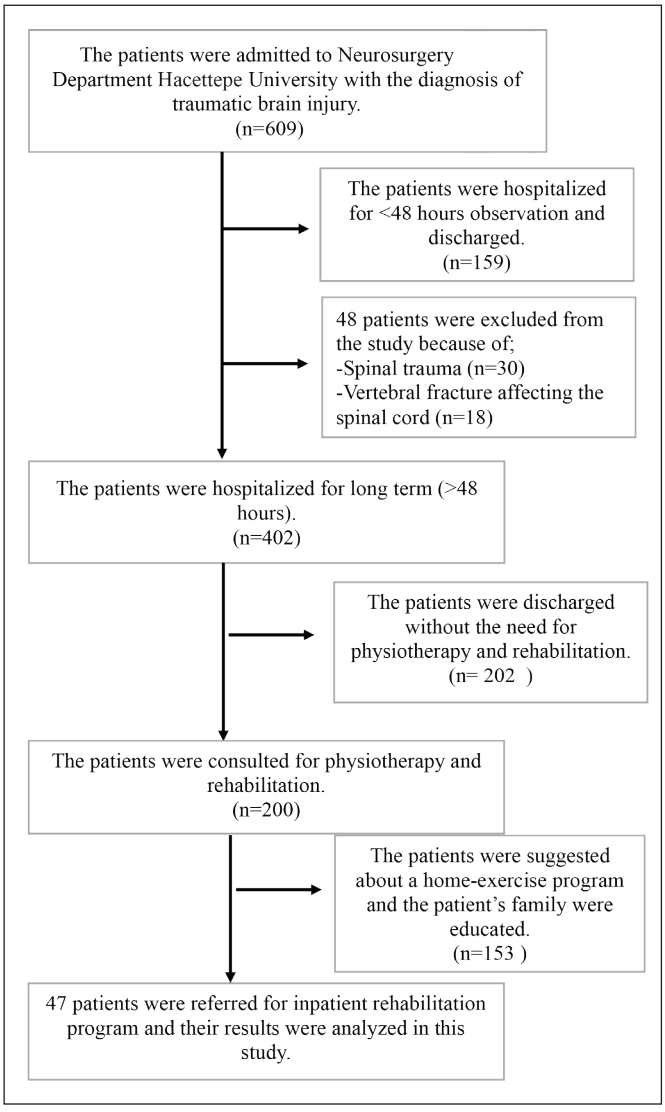

Figure 1: The identification of TBI patients included in the study.

and rehabilitation details were obtained from their files and other electronic system data and recorded.

Demographic information such as age, gender, body mass index (BMI), and occupation; medical history; trauma causes, severities, and locations; other trauma findings (fractures of the extremities, vertebrae, and ribs and visceral trauma); and the results of motor examinations (hemiparesis, hemiplegia, quadriparesis, quadriplegia, and monoparesis) were recorded. In addition, surgical procedures, complications (meningitis, hydrocephalus, pulmonary thromboembolism, and epilepsy), respiratory functions (tracheostomy and oxygen support), and nutrition level (oral, nasogastric tube, and percutaneous endoscopic gastrostomy) were investigated. Moreover, the length of time between admission to hospital and referral for rehabilitation ($Length_{Admission\text{-}consultation}$), the length of time between surgery and referral for rehabilitation ($Length_{Surgery\text{-}consultation}$) (only for patients who underwent surgery), the lengths of stay (LOS) in intensive care and hospital, and rehabilitation time were recorded.

Rehabilitation-Related Outcome Measurements

The evaluation results of the patients before and after rehabilitation were examined and recorded. These assessments include the Glasgow Coma Scale (GCS), Extended Glasgow Outcome Scale (GOSE), Barthel Index (BI), Disability Rating Scale (DRS), Mobility Scale for Acute Stroke (MSAS), and Functional Ambulation Classification (FAC).

Glasgow Coma Scale: This scale, which is used to evaluate the level of consciousness, consists of three tests: eye opening, motor response, and verbal response. The total score varies between 3 and 15 (3 to 8 points: severe coma; 9 to 12 points: moderate coma; 13-15 points: mild coma) (32).

Glasgow Outcome Scale-Extended: The GOSE is a global scale for functional outcome that divides TBI patient status into one of eight categories (1: Death, 2: Vegetative state, 3: Lower severe disability, 4: Upper severe disability, 5: Lower moderate disability, 6: Upper moderate disability – some disability but can potentially return to some form of employment, 7: Lower good recovery – minor physical or mental defect, 8: Upper good recovery – full recovery) (16).

Barthel Index: The BI measures the extent to which somebody can function independently and has mobility in their activities of daily living (ADL), i.e., feeding, bathing, grooming, dressing, bowel control, bladder control, toilet use, chair transfer, ambulation, and stair climbing. Items are rated in terms of whether individuals can perform activities independently, with some assistance, or are dependent (scored as 10, 5, or 0, respectively). The index yields a total score out of 100 and the higher the score, the greater the degree of functional independence (0-20 suggests total dependence, 21-60 severe dependence, 61-90 moderate dependence, and 91-99 slight dependence) (20).

Disability Rating Scale: This scale, which was developed for individuals with TBI, consists of 8 items. These items address the three original World Health Organization categories of impairment, disability, and handicap. The maximum score a patient can obtain on the DRS is 29, which correlates with an extreme vegetative state. A person without disability would score 0 (0: no disability; 7-11: moderate injuries; 25-29: severe coma) (11,17).

The Mobility Scale for Acute Stroke: The MSAS comprises 6 items: bridging in a supine position, moving from a supine to sitting position and back, performing sit to stand transfer, and assessment of sitting balance, standing balance, and gait. Each item is scored on a 6-point ordinal scale (1–6) based on the amount of physical assistance required to complete the task. A higher score indicates that less assistance is required to perform the task. Total scores range from 6 to 36 (28).

Functional Ambulation Classification: The FAC is a tool for clinical assessment of walking ability in stroke patients (0: patient cannot walk; 1: patient requires firm continuous support from 1 person; 2: patient needs continuous or intermittent support from 1 person; 3: patient requires verbal supervision or stand-by help from 1 person without physical contact; 4: patient can walk independently on level ground; and 5: patient can walk independently) (13).

Treatment

Surgical Treatment

Twenty-three (49%) of the patients underwent surgical intervention. Of the procedures, 15 were for cranial, 5 were for spinal, and 3 were for orthopedic pathology. Decompressive craniectomy and/or hematoma evacuation was performed during cranial surgery, and decompression and stabilization surgery was performed during spinal surgery. Orthopedic procedures were applied for the reduction of extremity fractures. Neurosurgeons decided whether the patient would be operated on according to the severity of trauma and the level of brain influence. For example, if the patient had diffused axonal injury and did not expect functional return, the patient was not operated on, or if the hematoma level was minimized, the patient was treated with pharmacological treatment. Surgery was performed in patients who needed hematoma evacuation or other surgical procedures.

Pharmacological Treatment

Antiepileptic treatment was administered to patients with severe head trauma, cerebral cortical contusion, intracerebral and subdural hematoma, and seizures, while phenytoin or levetiracetam was administered according to the additional morbidity of the patient. Dexamethasone treatment was avoided in severe head trauma and hypersaline fluid was used for antiedema treatment. Serum glucose was regulated to be 120-200 mg/dL, and all blood parameters were managed to ensure they were normal.

Inpatient Rehabilitation Program

All patients were assigned individual rehabilitation programs by physiotherapists with 10 years of experience in their fields. The programs were specifically designed for each patient. They were administrated five days a week from consultation to discharge. Each rehabilitation session lasted 60 min. The aims of the programs were to prevent complications,

minimize impairments in body structure and function, and increase independence in ADL. Range of motion, positioning, manipulative, and mobilization techniques were applied to all TBI patients to prevent secondary complications such as decubitus ulcer, pulmonary complications, pulmonary thromboembolism, and contractures. Additionally, deep friction massage was performed on the bottom of the foot, and a sensory ball and different sensory stimuli were used to increase proprioceptive input. Approximations were applied during the exercises to increase sensory input. The family and patient received education and simple exercises were taught to prevent the complications mentioned above during the hospital stay. A functional wrist splint and AFO were recommended to regulate spasticity and prevent contractures for patients who needed it.

The treatment program varied depending on the patient's consciousness. The treatment approaches are summarized in detail in Table I. The exercises were selected based on their suitability for the patient. Since active participation of the patients is an important indicator when creating the treatment program, we designed the treatment program according to their level of consciousness (19). While performing the rehabilitation programs, the physiotherapists took care to ensure that the patient's normal vital signs were monitored by the neurosurgeon.

Statistical Analysis

The statistical analyses were performed using SPSS Version 26.0 (IBM Corp., Armonk, NY, USA). The normal distribution of the variables was evaluated using visual (histograms/probability graphs) and analytical (Kolmogorov–Smirnov/Shapiro–Wilk test) methods. The demographic and clinical features data were presented as mean, median, standard deviation, or number and frequency. The Wilcoxon paired test was used to compare non-parametric quantitative variables and the paired samples t-test was used to compare parametric quantitative data. The Pearson correlation test was used for analyzing the relationship between $Length_{Admission\text{-}consultation}$ and the other measurements. The Pearson correlation coefficients were as follows: 0.0-0.2 indicated very weak correlation, 0.20-0.40 indicated weak correlation, 0.40-0.60 indicated moderate correlation, 0.60-0.80 indicated strong correlation, and 0.80-1.0 indicated very strong correlation (27). In all the analyses, $p < 0.05$ was considered statistically significant.

RESULTS

The demographic data such as age, BMI, gender, and occupation and medical history are shown in Table II. The descriptive statistics for the demographic data were as follows: the mean age and standard deviation of the 47 TBI patients were 54.72±21.08. Most of the TBI patients were male (83%).

Table I: Detailed Rehabilitation Program according to the Consciousness Level of Patient

Consciousness level	The details of rehabilitation program
If GCS score was 13-15 and 9-12 (mild and moderate trauma)	▪ Active or active assistive range of motion of all extremities ▪ Functional extremity patterns (touching the hair with the hand, combing the hair, trying to reach different targets, etc.) ▪ Scapular and pelvic mobilization ▪ Rolling ▪ From lying to sitting ▪ Sitting with placing techniques for trunk control ▪ Balance training in sitting ▪ Weight transfer in sitting ▪ Functional reaching exercises ▪ Sit to stand ▪ Standing and weight transfer to either side ▪ Static and dynamic balance training ▪ Stance and swing phases training ▪ Walking (with and without walking aid)
If GCS score was 3-8 (severe trauma)	▪ Passive range of motion of all extremities ▪ Classic massage for edema (if any) ▪ Scapular mobilization ▪ Trunk rotation with lower extremities for pelvic mobility ▪ Stretching of the latissimus dorsi muscle If there is spasticity; ▪ Gently shaking the bed for relaxation (vibration effect) ▪ Coldpack (20 minutes) ▪ Functional extremity patterns passive in antispastic positions ▪ Antispastic positioning

Examination of the trauma causes revealed that the cause of 53% was falls, of 10% was traffic accidents, of 12% was gunshot wounds, of 4% was explosions, and of 2% was excessive alcohol use. The severity of trauma was mild in 42%, moderate in 28%, and severe in 30%. Trauma locations were 95% supratentorial and 5% infratentorial. Moreover, 15% of them had extremity fractures, 19% had vertebra fractures, 21% had costa fractures, and 21% had visceral trauma in the present study. Patients with vertebral fractures had no radiological spinal cord damage or compression and no spinal column instability. The motor examination results indicated that 6% of them had monoparesis/monoplegia, 38% had hemiparesis/hemiplegia, 38% had quadriparesis/quadriplegia, and 18% had other impairments (Table II).

While 23 patients underwent surgical interventions, 24 patients did not. The surgical procedures for the 23 patients were as follows: hematoma evacuation in 10 patients, decompressive craniectomy in 4 patients, hematoma evacuation and decompressive craniectomy in 6 patients, and orthopedic surgery in 3 patients. According to the analysis of the complications, 1 patient had meningitis, 4 patients had hydrocephalus, 4 patients had pulmonary thromboembolism, and 7 patients had epilepsy. While 26% of all patients had a tracheostomy, 30% needed oxygen support. The feeding in the patients was as follows: oral in 55%, percutaneous endoscopic gastrostomy in 36%, and nasogastric tube in 9%. The lengths of time between admission and consultation and between surgery and consultation were 19.82 ± 17.9 and 14.24 ± 15.4 days, respectively. The LOS in intensive care and hospital were respectively 27.32 ± 34.93 and 41.35±32.83 days. And the rehabilitation time was 21.50 ± 24.32 days (Table III).

Rehabilitation Results

The before and after rehabilitation results showed that GCS, BI, DRS, MSAS, GOSE, and FAC scores improved significantly ($p< 0.001$) (Table IV).

The relationship between $Length_{Admission\text{-}consultation}$ and the other outcomes

The relationship between $Length_{Admission\text{-}consultation}$ and the other outcomes (except GOSE) was statistically significant ($p< 0.05$). The correlation coefficient between $Length_{Admission\text{-}consultation}$ and GCS showed a weak negative relationship ($r= -0.351$). On the other hand, the correlation coefficients between $Length_{Admission\text{-}consultation}$ and BI, MSAS, and FAS showed moderate negative relationships (respectively r values -0.512, -0.467, -0.491, and -0.471). Contrary to these results, the r value (0.402) between $Length_{Admission\text{-}consultation}$ and DRS indicated a moderate positive relationship (Table V).

DISCUSSION

The aims of the present study were 1) to examine the clinical characteristics of TBI patients, 2) to compare the results of before and after early rehabilitation, 3) to investigate the relationship between rehabilitation initiation time and other variables. According to the results obtained, the majority of the patients were male, the majority of trauma causes were

Table II: The Demographic and Clinical Features of Patients and TBI-Related Results

	Mean ± SD (min-max)	
Age	54.72 ± 21.08 (18-90)	
Body Mass Index	26.96 ± 3.00 (19.56-36.16)	
	n (%)	
Gender		
Male	39 (83)	
Female	8 (17)	
Occupation		
Workers	26 (55)	
Retired	17 (36)	
Housewife	4 (9)	
Medical history		
None	31 (66)	
Hypertension	11 (23)	
Diabetes mellitus	1 (2)	
Cranial pathology	3 (7)	
Chronic lung disease	1 (2)	
Trauma cause		
Fall	25 (53)	
Traffic accident	16 (34)	
Gunshot wound	3 (7)	
Explosion	2 (4)	
Excessive alcohol use	1 (2)	
Trauma severity		
Mild (GCS: 13-15)	20 (42)	
Moderate (GCS: 9-12)	13 (28)	
Severe (GCS: 3-8)	14 (30)	
Trauma location		
Supratentorial	45 (95)	
Infratentorial	2 (5)	
	Yes	**No**
Other		
Extremity fracture	7 (15)	40 (85)
Trauma findings		
Vertebral fracture	9 (19)	38 (81)
Rib fracture	10 (21)	37 (79)
Visceral trauma	10 (21)	37 (79)
Motor examination		
Monoparesis/Monoplegia	3 (7)	
Hemiparesis/Hemiplegia	17 (36)	
Quadriparesis/Quadriplegia	17 (36)	
Normal	10 (21)	

GCS: *Glasgow Coma Scale*

Table III: The Medical Information of Patients, Lengths of Hospitalization and Rehabilitation Time

Variables	**n (%)**	
Surgical intervention		
Surgery	23 (49)	
No surgery	24 (51)	
Surgical procedure		
Hematoma evacuation (HE)	10 (21)	
Decompressive craniectomy (DCC)	4 (8)	
HE+DCC	6 (12)	
Orthopedic surgery	3 (6)	
Complications	**Yes**	**No**
Meningitis	1 (2)	46 (98)
Hydrocephalus	4 (8.5)	43 (91.5)
Pulmonary thromboembolism	4 (8.5)	43 (91.5)
Epilepsy	7 (15)	40 (85)
Respiratory functions		
Mechanical ventilation	12 (26)	35 (74)
Oxygen support	14 (30)	33 (70)
Nutrition level		
Oral	24 (51)	
PEG	17 (36)	
Nasogastric tube	6 (13)	
	Mean ± SD (min-max)	
$Length_{Admission\text{-}consultation\ (day)}$	19.82 ± 17.90 (1-93)	
$Length_{Surgery\text{-}consultation\ (day)}$	14.24 ± 15.48 (1-56)	
LOS in intensive care $_{(day)}$	27.32 ± 34.93 (0-156)	
Rehabilitation time $_{(day)}$	21.50 ± 24.32 (3- 125)	
LOS in hospital $_{(day)}$	41.35 ± 32.83 (4-156)	

PEG: *Percutaneous endoscopic gastrostomy,* ***LOS:*** *Length of stay.*

falls, the majority of trauma severities were mild, and the majority of trauma locations were supratentorial; and about half of the patients underwent surgery. The after-rehabilitation results indicated that the rehabilitation-related outcome measurements consciousness, functional outcome, daily living activities, functional mobility, and ambulation were improved. Early rehabilitation can reduce disability levels and improve consciousness, functional outcome, daily living activities, functional mobility, and ambulation in TBI patients during hospitalization, since the relationship between rehabilitation initiation time and these outcomes was significant.

Most of the TBI patients were male in the present study. A previous study demonstrated that TBI of all severities was consistently reported with a higher incidence in men (2). The results were similar in the study by Bilgin et al. (3). Furthermore, falls were the most common cause of trauma followed by traffic accidents in the present study. Falls are one of the most common causes of major injuries and are responsible for many hospital admissions (23). A review study reported that traffic accidents are one of the main causes, especially in low- and middle-income countries (7). The severity of trauma in the patients was mostly mild in the present study. The majority of hospital-admitted brain injuries are classified as “mild” (6). This result may show that the TBI patients had severe trauma and lost their lives before arriving at the hospital, and those needing hospital care mostly had mild trauma severity. Some of the patients (21%) had rib fractures and visceral injuries in the present study. A retrospective cohort study indicated that 24.3% of all patients underwent surgery because of rib fracture after TBI (26). In the study by Pieracci et al., approximately 30% of patients had visceral injury with traumatic intracranial hemorrhage after falls (25). Most of the patients had motor impairment after TBI and since brain injury mainly causes permanent neurological damage as well due to the nature of the damage to several organs (neurological, muscular, cognitive damage), it is considered devastating (35). All these results contribute to the literature in terms of demonstrating the clinical features of TBI patients needing rehabilitation.

According to surgical intervention analyses, 49% of the patients in our study underwent surgery. Patients with TBI may also require spinal and orthopedic operations in addition to intracranial surgery. Of the TBI patients in our study, 11% underwent spinal surgery and 6% orthopedic surgery. For this reason, we included approaches to orthopedic and spinal problems in the treatment programs of the patients. These results emphasized other surgical requirements in addition to cranial surgery. Furthermore, complications such as meningitis, hydrocephalus, pulmonary thromboembolism, and epilepsy can be observed after TBI. Epilepsy was the most common complication in our study. TBI has long been recognized as a cause of epilepsy, and it remains one of the most common and important causes of acquired epilepsy (22). Therefore, it is important to review the rehabilitation programs of TBI patients due to epilepsy. When nutritional levels were analyzed, most of the patients fed orally. In the literature, if the GCS score is <12 PEG feeding is recommended (34). The rate of PEG feeding might have been low since fewer patients had severe TBI in the present study. The mean rehabilitation time in our study was 3 weeks and the mean LOS in hospital was 6 weeks. Studies defined 0 to 7 days post-TBI as the immediate period and 1 to 6 weeks as the acute period (30). This shows that after TBI the patients were hospitalized during the acute period, but they had rehabilitation for a small part of the acute period. This may indicate that they received rehabilitation for less time because their medical condition was not suitable. In our study, the mean $Length_{Admission\text{-}consultation}$ was smaller than the mean LOS in intensive care, meaning that the rehabilitation of the patients was initiated during the intensive care period. The results showed that the relationship between $Length_{Admission\text{-}consultation}$ and the other outcomes was statistically significant in our study. This implies that the earlier rehabilitation is started, the more positive outcomes will be achieved.

Table IV: Outcome Measurements of Patients Before and After Rehabilitation

Variables	Before	After	
	Mean ± SD (min-max)	**Mean ± SD (min-max)**	**p [a]**
Glasgow Coma Scale (3-15)	11.32 ± 4.11 (3-15)	12.47 ± 3.74 (4-15)	**<0.001**
Barthel Index (0-100)	25.53 ± 23.59 (70-0)	33.72 ± 26.99 (80-0)	**<0.001**
Disability Rating Scale (0-29)	19.30 ± 5.17 (5-29)	16.32 ± 6.33 (1-29)	**<0.001**
The Mobility Scale for Acute Stroke (6-36)	11.38 ± 5.82 (6-24)	15.53 ± 7.81 (6-30)	**<0.001**
	Median (min-max)	**Median (min-max)**	**p [b]**
Glasgow Outcome Scale-Extended (1-8)	4 (2-5)	5 (2-6)	**<0.001**
Functional Ambulation Classification (0-5)	0 (0-2)	0 (0-3)	**0.003**

[a]: Paired Sample T-Test, [b]: Wilcoxon Signed-Rank Test.

Table V: The Correlations Between $Length_{Admission\text{-}consultation\ (day)}$ and the Other Measurements

	$Length_{Admission\text{-}consultation\ (day)}$	**Glasgow Coma Scale**	**Barthel Index**	**Disability Rating Scale**	**Mobility Scale for Acute Stroke**	**Glasgow Outcome Scale**	**Functional Ambulation Scale**
Glasgow Coma Scale	r=-0.351 **p=0.017**						
Barthel Index	r= -0.512 **p< 0.001**	r=0.713 **p<0.001**					
Disability Rating Scale	r=0.402 **p=0.006**	r=-0.813 **p<0.001**	r=-0.785 **p <0.001**				
Mobility Scale for Acute Stroke	r=-0.491 **p= 0.001**	r=0.692 **p<0.001**	r=0.908 **p<0.001**	r=-0.797 **p<0.001**			
Glasgow Outcome Scale	r=-0.080 p=0.599	r=0.513 **p<0.001**	r=0.514 **p<0.001**	r=-0.533 **p<0.001**	r=0.559 **p<0.001**		
Functional Ambulation Scale	r=-0.471 **p=0.001**	r=0.533 **p<0.001**	r=0.765 **p<0.001**	r=-0.713 **p<0.001**	r=0.815 **p<0.001**	r=0.403 **p<0.005**	

Rehabilitation-related outcome measurements were improved at hospital discharge in the present study. It would be incorrect to interpret this as the effects of only the rehabilitation program. It is undeniable that medical treatment and surgical treatments influence recovery. Pharmacological treatment can enhance functional recovery after brain injury (12). If the hemodynamic and intracranial conditions are stable, an earlier start of rehabilitation therapy will result in better functional recovery (9). Early rehabilitation is one of the most important phases of rehabilitation and it is crucial in order to maintain and improve brain function and quality of life, and prepare the patient to return to their daily activities and community participation (14). In fact, patients with severe TBI who received early rehabilitation interventions experienced a shorter acute phase and hospital stay and fewer disorders, and better performance at hospital discharge (8,31). Our study and literature studies indicated that initiating rehabilitation in the early period in addition to medical treatment and surgical treatments can improve rehabilitation-related outcome measurements.

The results of this study are important in terms of both epidemiology and rehabilitation in a small sample size in Turkey. However, the study has several limitations. The adaptation of the family to the rehabilitation and their participation are crucial in a rehabilitation program. We did not collect data about the socioeconomic or educational levels of the families. Moreover, the socio-demographic characteristics of the patients were not determined. Another limitation was the LOS in intensive care, rehabilitation, and hospital was in a wide range. Presumably, this was related to trauma severity.

CONCLUSION

This study was a descriptive study in terms of demographic and clinical characteristics, medical and rehabilitation information, and hospital-related duration in patients with TBI during their hospitalization in the neurosurgery department. Early rehabilitation can enhance the rehabilitation-related outcome including consciousness, functional outcome, daily living activities, functional mobility, and ambulation in TBI patients as soon as their medical condition allows. Further studies investigating the effects of more homogeneous patient populations, socio-demographic characteristics of patients, and family characteristics on this subject are needed, and the present study will be informative for future studies.

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Declarations

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Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: Authors declare no conflict of interest.

AUTHORSHIP CONTRIBUTION

Study conception and design: HC, BO
Data collection: HC, BO, ED, SK, BB
Analysis and interpretation of results: HC, BO
Draft manuscript preparation: HC, BO
Critical revision of the article: NK, SB, İI
All authors (HC, BO, BB, SK, ED, SB, II, NK) reviewed the results and approved the final version of the manuscript.

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