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Rehabilitation outcome after traumatic brain injury

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Summary

Rehabilitation goals after traumatic brain injury are improving function, increasing the level of independence as high as possible, preventing complications and providing an acceptable environment to the patient. Several complications can be encountered during the rehabilitation period which lead to physical, cognitive and neurobehavioral impairments that cause major delay in functional improvement. This prospective study was designed in order to investigate the complications and their relations with functional recovery in patients that were included in the acute phase of a rehabilitation program.

Thirty traumatic brain injured patients admitted to the Intensive Care Units of Uludag University School of Medicine were included in the study. Rehabilitation program consisted in appropriate positioning, range of motion exercises, postural drainage and respiratory exercises. Complications that were encountered during intensive care rehabilitation program were recorded. All patients were evaluated by Functional Independence Measure, Disability Rating Scale and Ranchos Los Amigos Levels of Cognitive Function Scale at admission and discharge.

Improvement was observed in patients in terms of functional outcome and disability levels. Pneumonia, athelectasis, anemia and meningitis were the most frequent complications. Deterioration in functional outcome and disability levels was noted as the number of these complications increased.

In conclusion, rehabilitation has an important role in the management of traumatic brain injured patients. Reduction of frequency of complications and improvement in functional outcome and disability levels can be achieved through rehabilitation programs. Long-term controlled studies with large number of patients are needed in order to obtain accurate data on factors associated with rehabilitation outcomes.

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KEY WORDS: Traumatic brain injury. Rehabilitation. Complication.

Resultados de la rehabilitacion despues de sufrir un traumatismo craneoencefálico

Resumen

Entre los objetivos de la rehabilitación después de un traumatismo craneoencefálico está la mejoría de la función cerebral el aumento del grado de independencia la prevención de complicaciones y la obtención de un ambiente acceptable para el paciente. Durante el período de la rehabilitación pueden producirse varias complicaciones que conducen a discapacidades físicas, cognitivas y otras neurológicas que causan un importante retraso en la mejoría funcional. Este estudio ha sido diseñado para investigar las complicaciones observadas en los pacientes que se incluyeron en un programa de rehabilitación en fase aguda, sus relaciones con el estado funcional y los factores que tienen impacto en los resultados de la rehabilitación.

Se incluyen en el estudio treinta pacientes con traumatismo craneoencefálico admitidos en la Unidad de Cuidados Intensivos de la Escuela de Medicina de la Universidad de Uludag. El programa de rehabilitación consistió en rehabilitación postural, una serie de ejercicios de movimiento, y ejercicios respiratorios. Se registraron las complicaciones que se encontraron durante el programa de rehabilitación de cuidados intensivos. Todos los pacientes fueron evaluados por una Medida de Independencia Funcional, por el grado de invalidez y mediante los niveles de función cognitiva de la Escala Rancho Los Amigos tras la admisión, y en el momento del alta.

Abreviaturas. CT: computerized tomography. DRS: Disability Rating Scale. DVT: deep venous thrombosis. FIM: Functional Independence Measurement. GCS: Glasgow Come Scale. HO: heterotopic ossification. ICU: intensive care unit. LOS: lengt of stay. RLA: Rancho Los Amigos. ROM: range of motion. TBI: traumatic brain injure.

La mejoria se observó en los pacientes en términos de resultados funcionales y niveles de invalidez. Las complicaciones más frecuentes fueron la neumonía, atelectasia, anemia y meningitis. Se observó una disminución en los niveles de los resultados funcionales y de invalidez a medida que aumentó el número de complicaciones.

En conclusión, la rehabilitación tiene un papel principal en la recuperación de pacientes con traumatismo craneoencefálico. La reducción de la incidencia de complicaciones y la mejora de los niveles de los resultados funcionales y de invalidez se pueden lograr con programas de rehabilitación. Estudios controlados a largo plazo con un gran número de pacientes son necesarios para obtener datos exactos sobre los factores asociados a los resultados de la rehabilitación.

PALABRAS CLAVE: Traumatismo craneoencefálico. Rehabilitación. Complicación.

Introduction

Traumatic brain injury (TBI) is a condition occurring as a result of the application of an external force to the brain and it is associated to consciousness changes that can cause cognitive, physical and psychosocial functional disorders[3]. It is the most common cause of death and disability among all neurological diseases in early decades of life[3,32].

The frequency of TBI is 95-102/100000[6]. Motor vehicle accidents, falls, fired weapon injuries, occupational accidents and sports injuries are the most common causes of TBI[3]. TBI is most frequent under the age of 45 and two fold more usual in males. The frequency reaches a peak level between 15-30 yr. Low socioeconomic status, previous TBI history, alcohol and substance abuse are other risk factors[3].

Several clinical situations can occur following TBI depending on the degree and type of brain injury. In order to evaluate the severity of the trauma, anticipate the outcomes and choose the most appropriate treatments, prognostic factors such as Glasgow Coma Scale (GCS), age, posttraumatic amnesia duration, coma duration, pupillary light reflex, computerized tomography (CT) findings were defined[3]. Improvement is faster in children and young adults compared to adults over 45 yr. and functional improvement is slower and worse with increasing age[3].

In these patients, the aims of rehabilitation are improving their neurological function, providing patient independence as much as possible, preventing complications and to provide an acceptable environment to the patient. Although treatment is obviously important in order to decrease injury severity, concentrated rehabilitation interventions aimed at improving patients' cognitive and functional status may have a significant impact[5]. Rehabilitation starts during the intensive care period and can last for lifetime in some cases[3]. During the acute period the aim is to prevent complications that may cause later disability. Appropriate positioning, passive range of motion (ROM) exercises can prevent complications like contracture development, pressure wounds or deep venous thrombosis (DVT)[3,42]. Significant functional improvements in many patients can be achieved by acute rehabilitation programs. Environmental arrangements, family education, facilitation of neurological reorganization are also important during this period and prevention of complications depends mostly on spontaneous neurological recovery[8].

Early rehabilitation after TBI has become a worldwide accepted interface. It is a part of intensive care with enhanced approaches to preserve the rehabilitation potential of the brain[21]. In most studies evaluating the effectiveness of rehabilitation it has been reported that patients included in rehabilitation programs show improvements in their neurological status[36,40]. Investigators agree that early rehabilitation intervention for the traumatically brain-injured patient has a generally positive outcome, although well controlled studies are difficult to perform[12].

During the acute rehabilitation period, there can be various complications, which delay functional recovery and lead to physical, cognitive and neurobehavioral disorders. These complications may be life-threatening and also may interfere with the participation of the patient to active rehabilitation, prolong the rehabilitation period and increase the cost[13]. Most complications are apparent within the first days or months following injury[34]. There is a complex relationship among the type of underlying medical impairment, severity of functional limitation, comorbidity, and unanticipated medical or surgical complications that interrupt rehabilitation. Ranka et al studied 36 patients with severe TBI and observed mainly respiratory disorders, pressure sores, DVT and contractures. They stated that these complications developed in the first four weeks and their main objective for the early rehabilitation is to prevent these complications[37]. Lew found low Functional Independence Measurement (FIM) scores in patients with acute medical complications[29]. Early rehabilitation decreases the frequency of the complications and facilitates to take these complications under control easier[21]. Development of complications may also prolong length of stay (LOS) in the intensive care unit (ICU)[11].

As seen in the literature, in the TBI patients it is very important to diagnose complications, take preventitive measures early and rehabilitation in this period has positive effect both on decreasing complication occurence and patients functional outcome.

This study was planned in order to determine the complications that are seen in adult patients included in reha-

bilitation program during the acute period and to evaluate the relationship of complications with the functional status. Also we aimed to determine the effect of the rehabilitation program on patient's disability and functional status; and the factors that effect the rehabilitation and the factors that contribute to develop complications during the ICU stay.

Materials and methods

A total of 38 patients who were accepted to Uludag University Medical School ICU between January 2002 and February 2003 with TBI diagnose were included to an early rehabilitation program. All data were prospectively collected.

Patients included were 17 years or older, started with the rehabilitation program in the ICU during the first 24 hours post injury, and did not have a history of previous TBI, neurological or psychiatric disorders such as mental retardation, cerebral palsy or epilepsy. Informed consent was obtained from all patients' relatives according to the ethical guidelines of our University Hospital. Eight patients (26.7%) included in the study died during the first 4 weeks after TBI. All these patients had a severe injury according to the GCS. They had many complications and were excluded from our study. Thus, the study was performed on the remaining 30 patients.

Data from physical examination, follow-up and patient evaluation forms were collected. Age, gender, and educational status, date of injury, cause of injury, associated lesions, alcohol intake, GCS, CT findings, and medical and surgical treatments were also recorded.

The LOS in the ICU was recorded. During their stay in the ICU a rehabilitation program consisting of appropriate positioning, preventive measures, ROM exercises for all extremities, stretching exercises, postural drainage, percussion vibration and respiratory exercises were performed on all patients by a physiotherapist. The same clinical investigator (SBA) evaluated all patients whose rehabilitation program was started. Patients applied a rehabilitation program at home after ICU discharge.

All complications that occurred during their stay in the ICU were recorded. In order to evaluate the relationship of the number of complications with other parameters, patients were grouped into three categories as patients with no complications, patients with single system complication, and patients with multiple system complications. ROM measurements were performed by goniometry and contracture presence was determined. The increase in muscular tonus was evaluated according to the Ashworth Scale[4]. GCS is obtained by assessment of three parameters; eye opening, speech and motor response. It is a widely accepted and understood scale, and allows early classification and ongoing reassessment of injury severity. In general, a GCS of 14-15 indicates a mild injury, 9-13 a moderate injury, while 3-8 is classified as a severe TBI[43]. The highest GCS score within the first 24 hours was selected as a measure of injury severity.

Functional outcome data were also obtained. Patients were evaluated according to the following parameters at admission to and discharge from ICU:

Evaluation Parameters

1). FIM: The FIM, a widely used index of rehabilitation outcome, measures the level of assistance that an individual requires to perform basic life activities. It is an 18-item, 7-level scale that rates the ability of a person to perform independently in self-care, sphincter control, transfers, locomotion, communication, and social activity[19]. Total score is obtained by summing the scores range from 18 (maximally dependent) to 126 (maximally independent). Two motor and cognitive subscales can be obtained by summing the 13 motor items (range, 13-91) and the 5 cognitive items (range, 5-35).

2). Disability Rating Scale (DRS): It was developed for use primarily with persons with TBI[38]. It has 8 items that assess 4 categories; arousal and awareness; cognitive ability to handle self-care functions; physical dependence on others; and psychosocial adaptability for work, housework, and school. DRS scores range from 0 to 30; a lower score indicates a lower level of disability.

3). Rancho Los Amigos (RLA) Levels of Cognitive Functional Scale: The RLA was developed for use in the planning of treatment, tracking of recovery, and classifying outcome levels in TBI[18]. There are 8 classification levels, ranging from no response (level I) to confused and agitated (level IV) to purposeful and appropriate (level VIII). It is an easy and simple to perform test for the global cognitive evaluation of the patients and an appropriate and valid test as it can both provide follow-up and comparison of the patients.

Statistical analysis was performed using SPSS 11.0 version for windows program SPSS Inc., Chicago, IL, USA. Wilcoxon rank sum test has been used for the comparison of distributions of continuous variables among their individual groups. Kruskal-Wallis test and Mann-Whitney U test were used to compare changes from admission to discharge. Correlations were evaluated by Spearman's correlation analysis. Pearson chi-square test, Fisher's exact test, Kolmogorov-Smirnov test, and Log linear analysis were used for comparison of distribution of categorical variables. A p value of less than 0.05 was regarded as a statistically significant difference.

Results

Our study group was composed from three women and

Table 1
Clinical and socio-demographic characteristics of the patients

Variables		n	(%)
Age (years)	< 45	21	70.0
	≥ 45	9	30.0
Sex	Male	27	90.0
	Female	3	10.0
Educational level	Primary school	11	36.7
	Middle school	4	13.3
	High school	7	23.3
	University	8	26.7
Cause of injury	Motor vehicle accident	17	56.7
	Falls	12	40.0
	Fire gun wounds	1	06.7
Alcohol	Normal	22	73.3
	High level	4	13.3
	Unknown	4	13.3
Glasgow Coma Scale	Severe (3-8)	22	73.3
	Moderate (9-12)	6	20.0
	Mild (13-15)	2	06.7
CT findings	Contusion	4	13.3
	Fracture + contusion	1	3.3
	Epidural hematoma	5	16.7
	Subdural hematoma	2	6.7
	Subarachnoid hemorrhage	2	6.7
	More than one finding	16	53.3
LOS in ICU	0-4 weeks	20	66,7
	>4 weeks	10	33.3
Spasticity (Ashworth scale)	0	4	13.3
	1	19	63.3
	2	5	16.7
	3	2	6.7
	4	-	0
	5	-	0
Associated lesions			
Fractures		18	60
Extremity		12	40
Rib		2	6.7
Pelvis		2	6.7
Vertebral		2	6.7
Hemothorax		3	10
Spleen laceration		2	6.7

Table 2
Complications observed during the rehabilitation period

Complication	n	%
Pneumonia	14	46.7
Athelectasis	13	43.3
Anemia	12	40.0
Meningitis	9	30.0
Spasticity	7	23.4
Urinary infection	6	20.0
Pressure ulcer	6	20.0
Rhythm disorder	5	16.7
Hypertension	4	13.3
Contracture	3	10.0
Hepatic dysfunctions	3	10.0
Posttraumatic hydrocephalus	2	6.7
Hypotension	2	6.7
ARDS	2	6.7
Hepatitis	1	3.3
Bleeding diastases	1	3.3

27 men who were accepted to the ICU with a TBI diagnose. The range of ages of these patients was 17 to 83 whereas the mean age was 39.9±16.6 years. Of 74.1% males (n=20) were under the age of 45.

The clinical and socio-demographic characteristics of the patients are presented in Table 1 and distribution of the complications determined during the rehabilitation program is shown in Table 2. The LOS in the ICU was 0 to 4 weeks for 20 (66.7%) of the patients, and longer than 4 weeks for 10 (33.3%) of them. The muscle tonus of 5 patients (16.7%) was two and in two of them were 3 (6.7%). However a part from the TBI, 18 patients had various bone fractures. (Table 1).

The most common complications were pneumonia (46.7%), athelectasis (43.3%), anemia (40.0%), meningitis (30.0%) and spasticity (23.3%). (Table 2). None of the patients had heterotopic ossification (HO), posttraumatic epilepsy, gastrointestinal bleeding, pulmonary edema and DVT. Six patients (20%) had no complications, nine (30%) had a single system complication (3 neurological, 4 respiratory, 1 hematological, 1 urinary system infection) and 15 patients (50%) had multiple system complications. The median complication number was 3. The number of complications increased with the increasing age of patients (Spearman's correlation coefficient 0.524, p = 0.003).

The mean age of patients (50.2±20.7, median=48 years) whose LOS was over 4 weeks was significantly higher than the mean age of the patients whose LOS was equal or less than 4 weeks (34.9±11.8 median=34 years) (p=0.036).

The relationship of the different complication groups with LOS, age, cause of injury, concomitant fractures, GCS, and CT findings was evaluated. While nine of the patients (60%) with multiple system complications had a LOS longer than 4 weeks, all patients (100%) with single system complication and five of the patients (83.3%) without any complication, were followed up in ICU for 4 weeks or less (p=0.016).

There was a significant relationship between the different complication categories and the age of the patients (p=0.018). Patients with multiple system complications were significantly older than the patients without complications (respectively 47.5±18.4 median=42 years and 26.8±5.3 median=25 years). Although there were no significant difference between complication groups regarding GCS groups, CT findings, associated fractures and causes of injury (p>0.05). Furthermore, in patients with concomitant fractures, no negative effects of fractures on functional status and disability evaluation were determined.

There was a statistically significant difference between the three complication groups regarding cognitive FIM (p=0.011), total FIM (p=0.003), DRS (p=0.023), and Rancho (p=0.009) scores of the patients at admission to ICU. The group without any complication had significantly higher cognitive FIM, total FIM, and Rancho scores and lower DRS scores at admission. (Table 3).

Significant improvements in FIM, DRS, and Rancho scores of patients were observed at discharge compared to admission scores both in the total group and in each complication group (p<0.05). Comparison of later on improvement in FIM, DRS and Rancho scores in each complication group was also analyzed. There were no significant differences in follow-up for cognitive FIM, DRS and Rancho scores in the different complication groups (p>0.05). The improvement in total FIM and motor FIM scores of patients with multiple system complications at discharge compared to their status at admission was significantly lower than in patients' without complications or with single system complications (p<0.05). (Table 3).

Spearman's correlation analysis results of LOS, GCS and number of complication and the FIM, DRS, and Rancho scores are presented in Table 4. There was a significant negative correlation with LOS and admission–discharge FIM and Rancho scores (p<0.05); with increasing LOS, FIM and Rancho scores decrease. There was a significant positive correlation with GCS and FIM and Rancho scores (p<0.05). FIM and Rancho scores increase parallel to increasing GCS. FIM and Rancho scores were negatively correlated with the total number of complication (p<0.05). FIM and Rancho scores decrease with an increasing total

Table 3
The FIM, DRS and Rancho scores at admission to and discharge from ICU according to complication groups

			Complications Groups			*p-value
		Total (N=30)	None (n=6)	Single (n=9)	Multiple (n=15)	
FIM-Motor	Admission	13,03±0,18 13	13±0 13	13±0 13	13,07±0,26 13	p=0,013
	Discharge	38,57±29,62 25,5	55,83±29,42 68	53,11±34,35 46	22,93±17,55 13	
	**p-value	p<0,001	p=0,043	p=0,017	p=0,043	
FIM-Cognitive	Admission	6,73±6,12 5	13,33±12,31 6	5±0 5	5,13±0,52 5	p>0,05
	Discharge	18,83±12,55 19	29,5±6,98 30,5	20,67±12,79 27	13,47±11,55 5	
	**p-value	p<0,001	p=0,028	p=0,018	p=0,018	
FIM-Total	Admission	20,83±8,18 18	31,67±14,54 30	18±0 18	18,2±0,56 18	p=0,026
	Discharge	57,57±40,33 44,5	86,17±34,97 104,5	73,78±45,89 74	36,4±27,02 18	
	**p-value	p<0,001	p=0,028	p=0,018	p=0,018	
DRS	Admission	8,67±0,71 9	8±1,1 8	8,89±0,33 9	8,8±0,56 9	p>0,05
	Discharge	5,7±2,77 6	5,67±1,21 5	5,89±1,69 6	5,6±3,7 7	
	**p-value	p<0,001	p=0.028	p=0.011	p=0,004	
Rancho	Admission	2,1±1,03 2	3,17±0,98 3,5	2,22±0,83 2	1,6±0,83 1	p>0,05
	Discharge	4,13±2 5	5,33±0,52 5	5±1,8 5	3,13±2,03 3	
	**p-value	p<0,001	p=0,027	p=0,011	p=0,011	

*mean ± standart deviation, median. *p: comparison of the improvement over the time (from admission to discharge) among the complication groups. †p: comparison of discharge scores with admission*

Table 4
The Spearman correlation analysis of LOS, GCS, and total complication number with FIM, DRS, and Rancho scores at admission and discharge

		Total number of complications	LOS	GCS
FIM-motor	Admission	-0.011	-0.239	0.277
	Discharge	-0.543†	-0.684‡	0.551†
FIM-cognitive	Admission	-0.359	-0.260	0.448*
	Discharge	-0.507†	-0.525 †	0.599‡
FIM-total	Admission	-0.436 *	-0.433*	0.447*
	Discharge	-0.581‡	-0.648‡	0.572 ‡
DRS	Admission	0.414*	0.208	-0.413*
	Discharge	0.161	0.246	-0.251
Rancho	Admission	-0.585‡	-0.418 *	0.449*
	Discharge	-0.489†	-0.401*	0.572‡

*p < 0.05; †p < 0.01; ‡p ≤ 0.001

number of complication. On the other hand, DRS scores were correlated negatively with GCS and positively with the total number of complication (p<0.05).

The cognitive FIM and motor FIM scores of patients at discharge from ICU are presented in Figure 1. There was a significant positive and strong correlation between cognitive FIM and motor FIM scores at discharge from ICU (Spearman's correlation coefficient 0.798, p < 0.001).

Discussion

It has been reported in many studies an improvement in TBI prognosis with rehabilitation programs[36,40]. However, there are many prognostic factors affecting the results. The duration of coma, duration of hospitalization, age, GCS, education level, medical complications, and concomitant injuries are some of the factors that negatively affect rehabilitation results[6,17,47]. In this study we aimed to evaluate the contribution of a rehabilitation program to the final outcome, especially during the early period and during their hospitalization in the ICU.

TBI is most common under the age of 45 and twice more frequent in males. The median age of our patients was 35.5 years and 23 of the 30 patients were males (90%). As a result, the patients of this study were young and mostly men. The most common reasons of TBI are motor vehicle accidents, falls and fire gun injuries[3,7,35,47]. In this study the most common reasons of TBI were motor vehicle accidents (56.7%) and falls (40%), which is in accordance with the previous findings in the literature.

The hospitalization period after TBI during the acute and post-acute rehabilitation phases are long and there are numerous factors affecting the duration of hospitalization[17,36,44]. In the study of Zafonte et al, mean ± SD acute care LOS was 30,70 ± 20,43 days[57]. Harrison-Felix et al reported an average length of acute care stay of 23 days[20]. Of our patients, 20 (66.7%) stayed in the ICU for 0-4 weeks, and 10 (33.3%) longer than 4 weeks.

Several complications that can end with physical, cognitive and neurobehavioral disorders can be seen during the TBI rehabilitation period. In this population, surgical complications and infections dominated overall, with cardiac and thromboembolic complications also playing a large role. Siegler et al. reported as the most common complications infections, cardiac disorders, DVT and respiratory system disorders[41]. Kalisky et al. reported that pneumonia,

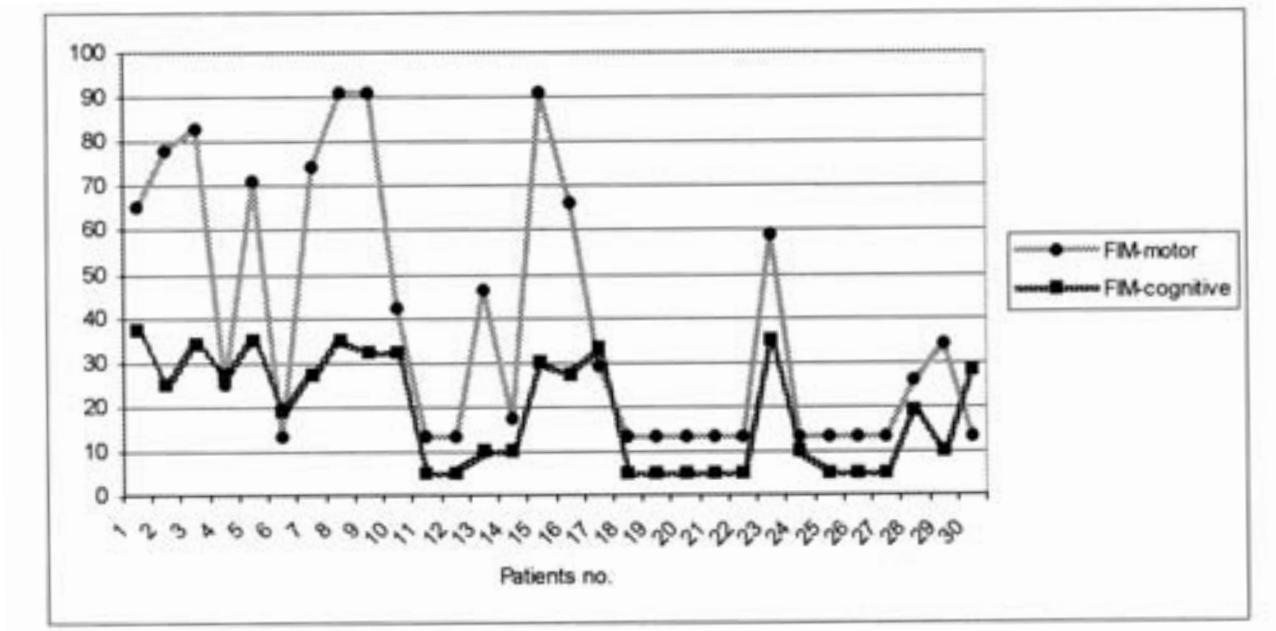

Figure 1. *FIM-motor and FIM-cognitive scores of patients at discharge from ICU*

pulmonary edema, thrombophlebitis, epilepsy, pressure wounds, gastrointestinal bleedings and HO are common during the post acute rehabilitation period[23]. The results of their study suggest that patients with severe head trauma undergoing rehabilitation may present with several medical and neurologic complications, some of which may not be identified in the referral hospital[23]. In another study, spasticity, contractures, pressure wounds, depression, epilepsy and HO are reported as the most common complications[37]. Respiratory system disorders are also important complications affecting LOS[31].

In our study six patients (20%) had no complications. The mean complication number of the patients was 3. The total complication number increased parallel to age.

Pulmonary infections in TBI patients are a major source of morbidity and the most common infections in this group. The incidence of pneumonia has been reported to be 35% to 70% [25]. Many of these patients develop significant athelectasis. Respiratory rehabilitation is an important component of the ICU patients' rehabilitation program[9,33]. The key to prevention is aggressive use of pulmonary toilet and postural drainage and early weaning. Although a respiratory rehabilitation program was applied to all patients in our study, pneumonia (46.7%) and athelectasis (43.3%) were the most common complications observed. Our result is in accordance with the literature, however, we think that controlled studies with bigger sample sizes, evaluating the effect of respiratory rehabilitation are needed to clarify this point. Anemia, the second most common complication, can be seen as a result of multiple trauma, repeated blood transfusions or gastrointestinal bleedings due to stress ulcers[3,45].

Another serious complication of TBI is meningitis. All patients in our series had their intracranial pressure monitored, and meningitis developed in 30% of them.

Spasticity is a common problem in TBI patients and we observed mild degree spasticity in 7 cases (23.3%). Appropriate positioning at the early period, splinting and ROM exercises can prevent the development of serious spasticity.

Pressure wounds are seen especially in patients with poor prognosis and with long coma duration, with increasing rates parallel to hospitalization duration[3,15,45]. In our study we determined grade 1 and 2 pressure wounds in 6 cases (20%). There was a significant relationship with pressure wounds and LOS. As we performed an intensive care service to our patients, only mild pressure wounds were seen in the early period in a small number of patients and more serious pressure wounds were prevented.

HO is quite common in patients with severe TBI, especially in those with prolonged coma [23]. The HO frequency in TBI patients varies from 10-22.5%[10,16]. DVT and secondary pulmonary emboli also occur frequently in TBI patients[26,32]. None of our patients presented with HO or DVT. DVT prophylaxis and regular monitoring may have a role, but the small number of patients prevents us from a concrete conclusion.

Fractures because of associated trauma increase morbidity and mortality. Fractures can restrict the ROM and affect the functional level[42]. Eighteen of our patients had fractures. Fractures did not have a negative affect on functional and disability evaluation of our patients. Appropriate reduction and fixation methods and early ROM preventive

precautions may be effective.

According to the literature, complications such as pneumonia, anemia, DVT prolong the duration of LOS[46]. In our study, we determined a significant relationship between LOS and number of complication. This was in accordance with the literature. However, although patients with moderate or severe GCS had more complications, this was not statistically significant.

GCS, FIM, DRS and Rancho scores are frequently used for the evaluation of functional status and specify of TBI patients[3,12,13,17,27,46]. In this study, patients were evaluated according to these parameters. There were significant improvements in FIM, DRS and Rancho scores in patients that initiate rehabilitation during their stay in the ICU both in the whole group and when they were classified according to the three complication groups. All patients showed improvement from admission to discharge. There were no significant differences between the different complication groups regarding cognitive FIM, DRS and Rancho scores when compared at follow-up. Improvement in functional level and disability with standard rehabilitation is reported in many studies[13,27,36,40]. In a retrospective study, it was pointed out that gains made during primary rehabilitation by patients with severe TBI are generally maintained at long-term follow up[39]. Another study showed that the DRS scores at admission and upon discharge were significant predictors that correctly classified 72% of the cases[28]. A sample of Turkish TBI survivors has showed significant functional improvements after rehabilitation[2]. The improvement in FIM, DRS and Rancho scores in our patient group was in accordance to the literature. In addition, we suggest that FIM and DRS scores may be appropriate to assess changes from rehabilitation at admission and discharge.

We observed that the improvement in total FIM and motor FIM scores inpatients with single system or without complications was significantly higher than in patients with multiple system complications. This result can be an indicator of the negative effects of complications on functional results. Complications prevent the patient from taking part to an active rehabilitation program and decrease its gains[21]. Demir et al, stated that disability levels and functional dependence increases parallel to the increasing complication numbers[13]. Another result of our study was that there was a negative significant correlation between the number of complications and FIM and Rancho scores. On the other hand, there was a positive significant correlation between DRS scores and number of complications. Based on these results, we suggest that, in order to prevent complications or to control them, early rehabilitation programs may be important.

FIM evaluates two different modalities of disability: motor and cognitive functions. In our study, there was a statistically significant positive correlation between cognitive FIM and motor FIM scores at time of discharge from ICU. This shows that functional and cognitive improvement develops simultaneously. Kaplan also evaluated functional and cognitive status by FIM and showed a relationship between cognitive and motor level[24].

Acute medical and rehabilitative care may have a more profound impact shortly after injury. It has also been reported in the literature that prolonged LOS negatively affects the FIM scores[14]. Davis reported that basal GCS and duration of hospitalization are related with acute rehabilitation results[12]. In a study, it has been shown that decreased duration of hospitalization significantly affects the functional results[22]. In this study we observed a positive correlation between GCS and FIM and Rancho scores. Opposite to an increasing LOS, FIM and Rancho scores found to be decreased. These results show that LOS and GCS are important factors affecting functional status.

The mortality and morbidity with TBI has decreased with modern neurosurgical care. But mortality rate is still high among patients with severe TBI. According to a study, despite intensive rehabilitation treatment, severe TBI is still burdened with significant mortality and morbidity[30]. Most persons with severe penetrating head injury still die before, during, or shortly after emergency treatment. The mortality rate in severely injured patients with GCS 3-5 is over 90%, and 70% with GCS 6-8[1]. Zafonte et al. reported high mortality rates in severely injured patients which is more common during the acute period[47]. In accordance with these results, 8 of our patients (20%) died during their stay in ICU and all of these patients were severely injured according to the GCS, suffering with complications.

Recovery of cognitive functions is more difficult compared to other neurological deficits. The idea that starting cognitive rehabilitation as soon as possible in patients with impaired cognition is becoming more and more accepted. We could not perform a cognitive rehabilitation in this study because of the difficulties in the application of special cognitive rehabilitation programs, and because our patients were in the ICU. We think that cognitive programs and psychosocial measurements should be developed in our language and in accordance with our cultural and social factors.

Conclusion

Despite of all these restrictions, we determined significant improvements in our patients that received rehabilitation treatment in the acute period. This study indicated a high incidence of various abnormal conditions in patients undergoing rehabilitation in the ICU after TBI. The most common complications were pneumonia, athelectasis, anemia, meningitis, and spasticity. While there was a sig-

nificant relationship between the different complication categories and age, there was no significant relationship with GCS, cause of injury and CT findings. Although the number of complication, LOS and GCS are the factors determining functional and disability levels, we think that long-term studies with a higher number of patients are needed in order to obtain more reliable results. Initiation of proper rehabilitation approaches in the ICUs decrease the frequency of complications and helps to control easier the current complications. We think that continuation of the rehabilitation programs after intensive care period positively affects the results. Together with the prevention of complications and standard rehabilitation programs in patients with TBI, cognitive and behavioral rehabilitation approaches and continuation of rehabilitation programs during post acute period will help to reach the goals of rehabilitation.

Patients undergoing medical rehabilitation in acute intensive care unit are at risk of presenting complications of different degree. Determining the nature of those complications and the risk factors for developing them can allow providers to cut early and prevent significant morbidity and functional decline.

As a result, diagnosis and preventive treatments of complications that may be seen during the course of rehabilitation can positively affect the functional results in patients with TBI in this study.

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