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Original article

Functional outcome of surgically treated patients with moderate traumatic brain injury (GCS 9-12) under the fast-track protocol

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Abstract

Background: Traumatic brain injury (TBI) is a major cause of disability, morbidity, and mortality worldwide.
Objective: This study aimed to determine the effect of the fast-track protocol on the clinical outcome of patients with TBI.
Methods: This study evaluated the functional outcomes in surgical groups of the TBI fast-track protocol, with Glasgow coma scale (GCS) scores between 9 and 12. Data were retrospectively collected from 52 patients with TBI who were treated surgically under the fast-track protocol at Sawanpracharak Hospital, Thailand, between September 1, 2016, and February 28, 2024, and compared with 52 patients who underwent routine surgical treatment (non-fast-track). Risk factors, causes of accidents, clinical parameters, and the outcomes were analyzed, which included time from the emergency room (ER) to the operating room (OR), pneumonia, sepsis, pressure sores, tracheostomy, length of hospital stay (LOS), and the Glasgow outcome scale (GOS) score.
Results: Significant associations were observed between the fast-track and non-fast-track groups regarding time from ER to OR ($P < 0.001$), pneumonia ($P < 0.001$), sepsis ($P = 0.027$), pressure sores ($P = 0.016$), tracheostomy ($P = 0.028$), LOS ($P < 0.001$), and GOS score ($P < 0.001$).
Conclusion: The fast-track protocol exhibited improved clinical outcomes, including reduced complication rates, a shorter LOS, and better GOS outcomes. Therefore, timely surgical intervention within 60 minutes of ER admission is critical for optimizing patient outcomes.

Keywords: Glasgow coma scale, Glasgow outcome scale, traumatic brain injury (TBI).

Traumatic brain injury (TBI) is a major cause of disability, morbidity, and mortality worldwide, particularly in children and young adults, with young males being disproportionately affected.[1, 2] Approximately 70.0% of patients with TBI are male[3], and female gender is independently associated with reduced mortality and decreased complications after TBI.[4] In the United States, an estimated 95 per 100,000 individuals sustain severe or fatal TBI that requires hospital admission annually.[5] This resulted in approximately 60,000–75,000 deaths[6] and 70,000–90,000 patients with permanent neurologic disabilities.[7, 8]

The primary causes of TBI include motor vehicle accidents, falls, and sports injuries, with motor vehicle accidents accounting for the most fatal and severe cases. Young adults are the most affected group, followed by a secondary peak in the elderly because of falls. Furthermore, the incidence of TBI predominantly affected males at a 2:1 ratio.

Previous studies indicated that approximately 60.0% of patients with moderate TBI (Glasgow coma scale (GCS) 9–12) show intracranial findings on admission computed tomography (CT) scans[9, 10], with approximately 15.0% requiring surgical intervention for mass lesions. [11] Moreover, the case-fatality rates for moderate TBI range from 0.9% to 8.0%.[10, 12]

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Materials and methods

This retrospective study analyzed 52 patients with TBI who were treated using the fast-track protocol at Sawanpracharak Hospital, Thailand (COE no. 24/2568), between September 1, 2016, and February 28, 2024, and 52 patients who were treated via routine surgical procedures between January 2016 and December 2018. The study was reviewed and approved by the hospital's ethics committee. Patients included in the study had acute epidural or subdural hematomas and underwent surgery, and those with multiple traumatic lesions were excluded. The fast-track protocol aimed to ensure that patients reached the operating room (OR) within 60 minutes of emergency room (ER) admission.

Data collected included demographic information, medical history, causes of the accident, clinical parameters (e.g., GCS, midline shift, and hematoma thickness), complications, and outcomes (e.g., Glasgow outcome scale (GOS) and length of hospital stay (LOS)). The outcome measures classified patients into three GOS groups: 1) good prognosis (GOS 4–5), 2) poor prognosis (GOS 2–3), and 3) death (GOS 1). Statistical analyses were performed using STATA SE18. Data were expressed as the mean ± standard deviation (SD) and percentage. Continuous variables were analyzed using the Student's *t*-test, while categorical variables were compared using the chi-square or Fisher's exact tests. Statistical significance was set at $P < 0.05$.

Results

There were 52 surgically treated patients with TBI who were admitted to the Department of Surgery at Sawanpracharak Hospital between September 1, 2016, and February 28, 2024, who were included in the TBI fast-track protocol. In addition, 52 surgical patients with TBI who were admitted to the Department of Surgery at Sawanpracharak Hospital, Nakhonsawan province, had previously undergone routine surgical treatment and were included as part of the non-fast-track group.

The study included 52 patients in each group. The age range was 14–89 years in the non-fast-track group and 12–85 years in the fast-track group. Males comprised 74.0% of the cohort, with a mean age of 41.4 ± 20.7 years in the non-fast-track group and 40.9 ± 18.7 years in the fast-track group. Hypertension was the most common comorbidity (41.4%), followed by hyperlipidemia (11.5%), diabetes mellitus (7.7%), and smoking (48.1%), and alcoholic consumption accounted for 60.6% of cases. Motorcycle accidents were the leading cause of injury (72.1%), followed by falls (11.5%) and falls from a height (10.6%). The GCS score on admission was GCS = 9 (53.9%), GCS = 10 (10.6%), GCS = 11 (13.5%), and GCS = 12 (22.1%). The mean GCS score on admission was similar between groups, with 10.0 ± 1.2 for the non-fast-track group and 10.0 ± 1.3 for the fast-track group **(Table 1)**.

Significant differences were observed in several parameters, including mean systolic blood pressure ($P = 0.03$), mean heart rate ($P = 0.002$), hematoma thickness ($P = 0.035$), time from ER to OR ($P < 0.001$), and operative time ($P = 0.044$) **(Table 2).**

The fast-track group exhibited significantly lower rates of pneumonia (13.5% *vs*. 42.3%, $P < 0.001$), sepsis (1.9% *vs*. 13.5%, $P = 0.027$), and pressure sores (0.0% *vs.* 13.5%, $P = 0.016$). Moreover, tracheostomy was less frequent in the fast-track group (11.5% *vs*. 28.9%, $P = 0.028$). The GOS scores were better in the fast-track group, with 90.4% achieving good outcomes compared to 55.8% in the non-fast-track group ($P < 0.001$). The LOS was also shorter in the fast-track group (8.2 ± 4.2 *vs*. 12.6 ± 4.8 days, $P < 0.001$) **(Table 3).**

Table 1. Demographic features, clinical characteristics, and disease factors of TBI (GCS 9-12) fast track and non-fast track (routine surgical treatment) groups (n = 104).

Demographic features	Non-fast track (n = 52)	Fast track (n = 52)	*P*-value
Gender			
Male	38 (73.1%)	39 (75.0%)	0.823
Female	14 (26.9%)	13 (25.0%)	
Mean age (years)	41.4 ± 20.7	40.9 ± 18.6	0.897
Age range (years)	14–89	12–85	
Underlying disease			
No	30 (57.7%)	29 (55.8%)	0.843
Yes	22 (42.3%)	23 (44.2%)	
Underlying disease *			
Hypertension	20 (38.5%)	23 (44.2%)	0.550
Hyperlipidemia	3 (5.8%)	9 (17.3%)	0.066
Diabetes mellitus	5 (9.6%)	3 (5.8%)	0.462
Others	3 (5.8%)	4 (7.7%)	0.315
Smoking	21 (40.4%)	29 (55.8%)	0.116
Alcoholic consumption	26 (50.0%)	37 (71.2%)	0.067
Cause of accident			
Motorcycle accident	37 (71.2%)	38 (73.1%)	0.358
Others (fall, falling from a height, car accident, hit)	8 (15.4%)	14 (26.9%)	
Fall	8 (15.4%)	4 (7.7%)	
Falling from a height	4 (7.7%)	7 (13.5%)	
Others (car accident,hit)	3 (5.8%)	3 (5.8%)	
GCS on admission			
9	27 (51.9%)	29 (55.8%)	
10	5 (9.6%)	6 (11.5%)	
11	12 (23.1%)	2 (3.9%)	
12	8 (15.4%)	15 (28.8%)	
Mean GCS	10.0 ± 1.2	10.1 ±1.3	0.877

* Underlying disease more than 1
GCS, Glasgow coma scale; TBI, traumatic brain injury.

Table 2. Demographic features, clinical characteristics, disease factors and treatment factors TBI (GCS 9-12) fast track and non-fast track (routine surgical treatment) groups (n = 104).

Demographic and treatment factors	Non-fast track (n = 52)	Fast track (n = 52)	*P*-value
Mean SBP (mmHg)	142.0 ± 30.6	145.2 ± 28.7	0.579
Mean DBP (mmHg)	80.9 ± 14.4	89.0 ± 22.6	0.03
Mean HR (bpm)	91.9 ± 19.1	81.4 ± 15.0	0.002
Type			
EDH	29 (55.8%)	27 (51.9%)	0.694
SDH	23 (44.2%)	25 (48.1%)	
Midline shift (mm)	8.1 ± 3.3	8.7 ± 3.6	0.368
Hematoma thickness (mean, SD)	19.6 ± 9.4	23.5 ± 9.2	0.035
Hydrocephalus	0 (0.0%)	2 (3.9%)	0.153
Brain infarct	0 (0.0%)	1 (1.9%)	0.315
Time from ER to OR (minutes)	430.7 ± 272.8	54.9 ± 24.1	< 0.001
Operative time (minutes)	69.0 ± 24.5	79.6 ± 28.3	0.044
Intraoperative blood loss (mL)	375.0 ± 213.6	404.8 ± 204.9	0.469
Thrombocytopenia	4 (7.7%)	5 (9.6%)	0.727

DBP, diastolic blood pressure; EDH, epidural hematoma; ER, emergency room; GCS, Glasgow coma scale; HR, heart rate; OR, operating room; SBP, systolic blood pressure; SD, standard deviation; SDH, subdural hematoma; TBI, traumatic brain injury.

Table 3. Demographic features, clinical characteristics, disease factors and treatment factors, GCS, GOS, and LOS for TBI (GCS 9-12) fast track and non-fast track (routine surgical treatment) groups (n = 104).

Demographic and treatment factors	Non-fast track (n = 52)	Fast track (n = 52)	*P*-value
Brain edema	8 (15.4%)	7 (13.5%)	0.780
Convulsions	11 (21.2%)	7 (13.5%)	0.300
Re-bleeding	6 (11.5%)	11 (21.2%)	0.185
Renal failure	2 (2.9%)	0 (0.0%)	0.153
Pneumonia	22 (42.3%)	7 (13.5%)	<0.001
Sepsis	7 (13.5%)	1 (1.9%)	0.027
Pressure sore	7 (13.5%)	0 (0.0%)	0.016
Re-craniotomy	3 (5.8%)	6 (11.5%)	0.295
Tracheostomy	15 (28.9%)	6 (11.5%)	0.028
GCS admit (mean, SD)	10.0 ± 1.0	10.2 ± 1.2	0.368
GOS			
Good	29 (55.8%)	47 (90.4%)	<0.001
Poor	16 (30.8%)	5 (9.6%)	
Dead	7 (13.5%)	0 (0.0%)	
LOS (days)	12.6 ± 4.8	8.2 ± 4.2	<0.001

GCS, Glasgow coma scale; GOS, Glasgow outcome scale; LOS, length of stay; TBI, traumatic brain injury.

Discussion

TBI is a critical public health issue and a leading cause of mortality and morbidity worldwide in children and young adults, especially in young males.[1, 2, 13-15] The time to surgical intervention substantially impacts patient outcomes, with the "golden hour" being critical for reducing mortality and morbidity when resuscitation, stabilization, and rapid transport are considered to be most beneficial to the patients **(Figure 1).**[16] In this brief window of time, with the time interval kept to a minimum, mortality and morbidity of the trauma patients can be reduced.[17]

Severe head injury (HI) had a poor clinical status and a poor clinical outcome, whereas minor HI had a good clinical status and a good clinical outcome. Therefore, this study primarily focused on patients with moderate TBI. In this study, the patients with moderate TBI who came to the ER of Sawanpracharak Hospital, who were diagnosed with epidural hematoma or subdural hematoma (SDH), and who consulted a neurosurgeon to undergo craniotomy were included. This study aimed to ensure that patients reached the OR within 60 minutes of ER admission. In this study, no patients in the TBI fast-track group died, whereas 13.5% of patients in the non-fast-track groups died. Several factors, including older age (> 75 years), fever during hospitalization, acute SDH, more pronounced midline shift, alcohol intoxication, lower GCS score, premorbid disability, pneumonia, history of smoking, being on mechanical ventilation (MV), post-op craniotomy, and use of antithrombotic medication, were prognostic factors that were associated with clinical outcome.[18-21]

Age is a well-known prognostic factor for outcome in patients with TBI.[22, 23] In addition, the GCS is a reliable and reproducible test that can easily be performed at the patient's bedside. The GCS can be used to assess the HI severity and to determine the patient's prognosis. In patients with HI, TBI severity was classified into three groups: 1 mild or minor HI (GCS 13–15), 2 moderate HI (GCS 9–12), and 3 severe HI (GCS ≤ 8).

Diabetes mellitus is an important predictor of mortality after moderate to severe TBI.[24] Borkar SA, *et al.*[25] reported that the presence of comorbid illnesses, including diabetes mellitus, hypertension, ischemic heart disease, cirrhosis, chronic renal disease, and anemia, was a factor that contributed to poor outcomes. The study confirmed that alcohol consumption was common among patients with HI; most of the patients who had consumed alcohol had blood alcohol concentrations at intoxication levels. Alcohol abuse has long been recognized as a predisposing factor for TBI.[26, 27] The increased degree of midline shift was also significantly related to poor clinical outcome (e.g., GOS).[28]

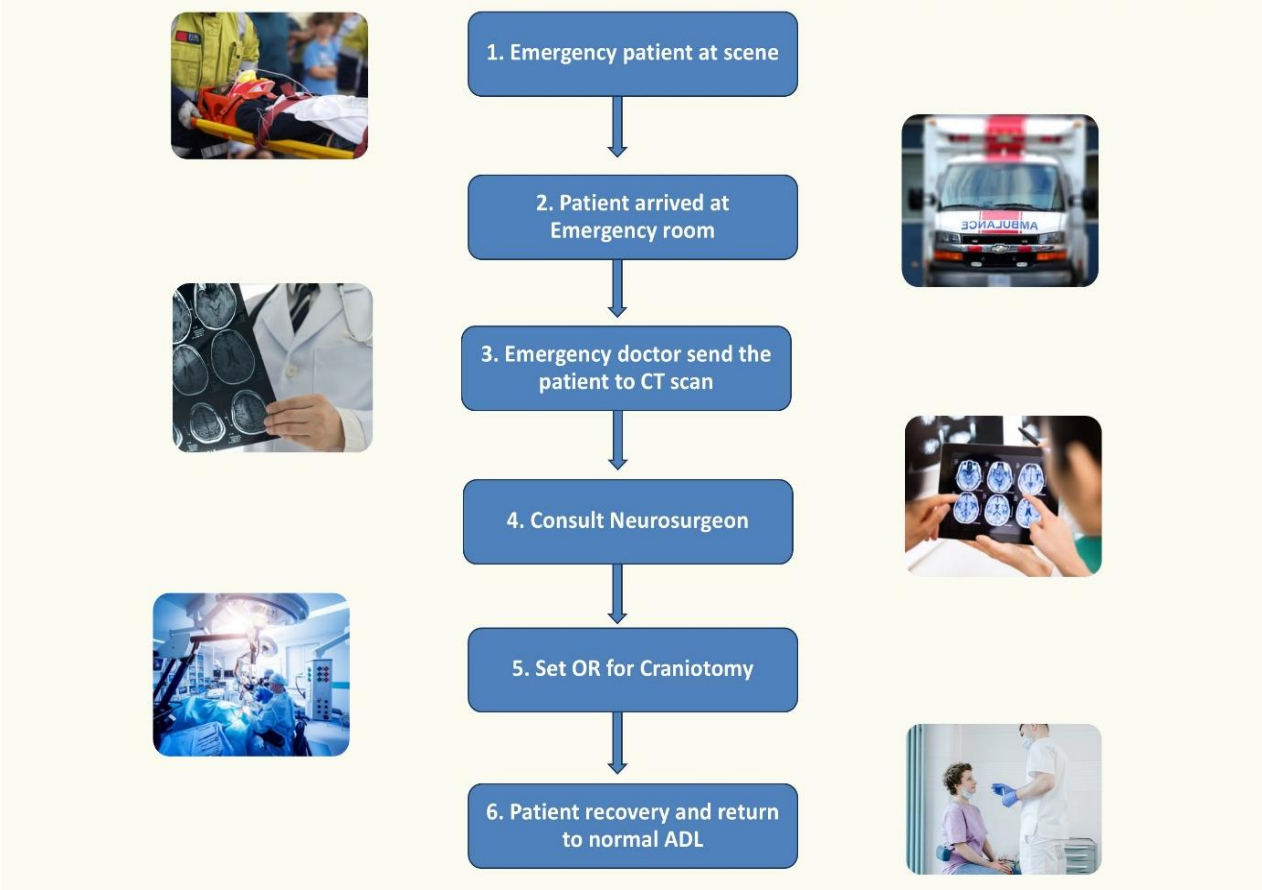

Figure 1. Pathway of emergency traumatic brain injury fast tract.

Complications such as pneumonia, sepsis, and pressure sores were significantly reduced in the fast-track group. However, factors such as older age, lower GCS score, comorbidities (e.g., diabetes and hypertension), and prolonged MV were associated with poorer outcomes. Moreover, the fast-track protocol led to a shorter LOS and better GOS outcomes, thus emphasizing the importance of prompt surgical care in improving prognosis for patients with TBI.

Pneumonia is a common problem among patients with TBI undergoing prolonged MV. There is an increased risk of developing pneumonia among ventilated patients less than 45 years of age, male patients, patients with a lower GCS, and patients with preexisting comorbid conditions. Previous studies have demonstrated that approximately 24.0% of patients with TBI undergoing MV developed hospital-acquired pneumonia[29,30], and prolonged MV increased the risk of developing pneumonia by 7.0% per day.[31] Several measures designed to reduce the risk of ventilator-associated pneumonia in patients on MV include keeping the head of patients elevated to 30°[32], treatment of underlying gastroesophageal reflux[33], suctioning of subglottic secretions[34], and avoiding the use of sedatives or hypnotics where possible.[35] Patients with hospital-acquired pneumonia had a longer LOS and decreased efficiency in attaining functional rehabilitation gains compared to those without hospital-acquired pneumonia.[36]

Tracheostomy is a surgical procedure that is commonly performed in patients who are admitted to the neurosurgical unit. It is frequently required in patients with moderate TBI, patients with prolonged unconsciousness, and those who may require an extended period of MV. In a multicenter cohort study, early tracheostomy was associated with decreased mortality (shorter duration of MV and LOS) when compared to those with prolonged endotracheal intubation.[37,38]

The mortality rate and outcomes were better in the fast-track group, although the brain CT scans showed an increase in the severity of pathologic hematoma thickness.

Conclusion

TBI remains a considerable cause of disability and mortality. The fast-track protocol demonstrated improved clinical outcomes, including reduced complication rates, shorter LOS, and a better GOS score. Timely surgical intervention within 60 minutes of ER admission is essential for optimizing patient outcomes. Hospitals worldwide should consider implementing similar protocols to enhance care for patients with TBI and decrease preventable death and disability.

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Conflicts of interest statement

The authors have completed the International Committee of Medical Journal Editors Form for Uniform Disclosure of Potential Conflicts of Interest. The authors have no potential conflict of interest to disclose.

Data sharing statement

All data generated or analyzed during the present study are included in this published article. Further details are available for non-commercial purposes from the corresponding author on reasonable request.

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