Prediction of Quality of Life by Helsinki CT Scoring System in Patients with Traumatic Brain Injury

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Abstract

Introduction: Traumatic brain injury (TBI) is an alteration in normally maintained homeostasis and function of the brain owing to any external forces. It is one of the major causes leading to increased disability and morbidity among patients suffering trauma. Hence, we aim to study the association between Helsinki computed tomography CT score on admission to patient's Quality of Life (QoL) following traumatic brain injury in Dhulikhel Hospital, Nepal.

Methods and Materials: A prospective observational study was conducted among 44 patients who suffered traumatic brain injury. Eligible patients over 18 years of age diagnosed with traumatic brain injury which is confirmed with a computed tomography scan on admission were included. Outcomes were assessed using the quality-of-life scale "Project for the Epidemiological Analysis of Critical Care Patients scale (PAEEC)".

Results: Among 44 participants suffering from traumatic brain injury owing to various modes of injury, male to female ratio was 2.3:1. The mean age among participants was 41.07 years with standard deviation of ± 20.13 (Range 18 – 90 years). Correlation analysis showed that quality of life, up to 6 months post-traumatic brain injury, was significantly associated with Helsinki CT classification. Group 1 and group 2 encompassed subjects who sustained traumatic brain injury and are in their scheduled 3 monthly and 6 monthly follow up. And significant correlation was noted between two variables $r^1 = 0.536$, p-value = 0.027 and $r^2 = 0.565$, p-value = 0.001 respectively.

Conclusion: The present study showed that patients with traumatic brain injury experience significant worsening of quality of life up to 6 months post traumatic brain injury. And such worsening can be predicted by the use of Helsinki CT score on admission.

Key words: Computed Tomography, Quality of life, Traumatic brain injury.

Introduction

Traumatic brain injury (TBI) is known as severe and incapacitating injury threatening the global public health.[1,2] Patients with TBI regularly undergo computed tomography (CT) scan upon admission to the emergency department in order to facilitate the assessment and have speedy access to therapeutic intervention. TBI severity depends on several factors such as anatomical location, type of injury and clinical presentation (general or neurological).[3] With increasing severity, mortality or permanent deficits like physical, cognitive, psychosocial and linguistic problems can be noted in patients with head trauma.[4,5]

Several studies assessed various scoring systems ex. Glasgow outcome scale, Helsinki CT score, Rotterdam CT score and have demonstrated that they have good specificity and sensitivity in predicting TBI outcomes, exhibiting a "discriminative power" for morbidity and mortality following TBI.[6,7] However, there is a big gap in regards to QoL post-TBI. QoL scales measure the subjective impression of patients regarding their own health, when compared with objective clinical scales of physical functioning.[5] As QoL post-TBI is heavily influenced by the severity of injury it is deemed probable that on admission CT scores and QoL post TBI are correlated.[8] Only few studies however have considered this issue and have indicated that QoL, following TBI, is impaired.[8,9] Among various QoL scale that is used, The Project for the Epidemiological Analysis of Critical Care Patients (PAEEC) QoL scale[10] is more specifically used among population with brain injury.

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Hence, we intend to study the role of Helsinki CT score on admission in predicting the quality of life among patients who received treatment for traumatic brain injury due to road traffic accident or fall injury within the last 6 months at Dhulikhel Hospital.

Methods and Materials

We did a descriptive cross-sectional study, from 1st February 2021 till 31st January 2022 in Dhulikhel Hospital, Nepal after getting ethical approval from Institutional Review Committee of Kathmandu University School of Medical Sciences, Dhulikhel. Total of 44 patients with TBI were recruited among patients who visited our emergency and OPD services for further management, all deemed normal physically and socially prior to trauma. No pre-trauma QoL assessments were done among the patients. All patients with age 18 years and above, diagnosed with TBI within 6 months and had TBI confirmed with a CT scan on admission were included. In this study, all eligible patients with TBI were recruited despite the cause or severity of the injury. However, those patients who were not able to answer or speak because of language disabilities were not considered.

Convenient sampling was done. Germany based software, the G-Power version 3.0.10, was used for the sample size calculation. The required sample size was computed based on the results reported by a previous study.[11] The following parameters were used: an effect size (r) of 0.4, an assumed two-sided significance of 5% and a power of 80%. Upon the recruitment of eligible subjects and after explaining the study objectives, participants were interviewed face-to-face or via phone by principal investigators in a standardized manner. Participants enrolled in the study signed a written informed consent after explaining the aim of the study while emphasizing their right to refuse participation. If the patient was not capable of giving informed consent, caregivers signed the consent. A neurosurgeon reviewed the CT scans of patients with TBI and the Helsinki CT score was calculated on the spot. Moreover, questionnaires including the socio-demographic information, and the PAEEC questionnaires, were filled by principal investigators after interviewing the participants in 3 months and 6 months follow up respectively. However, for numbers of patients with altered awareness and restricted comprehension skills, caregivers were asked to complete the targeted questionnaires.

Even though the outcome after 3 months and after 6 months represents a continuum of recovery process, in this study we intend to check for the impact of head injury in quality of life among normal individuals in different time frames during the recovery process up till 6 months after trauma.

Data entry and analysis were performed using the statistical software Statistical Package for Social Sciences version 16.0. (SPSS version 16.0). Descriptive statistics were reported using means and standard deviations (SD) for continuous variables and frequency with percentages for categorical variables. Normality of data was assessed using the Shapiro-Wilk test. Pearson's correlation was used to study the relationship between the PAEEC score from the Helsinki score. Independent sample T test was used to seek association between means of categories. One way ANOVA along with Post hoc analysis of the result was done to compare the difference between mean PAEEC score to various categories of severity of TBI. All statistical tests were two-sided, and the significant level was set at 0.05.

Tools that were used are:

The Helsinki computed tomography scoring system

The Helsinki CT score was introduced in 2014 by Raj R, et al.[12] It is a trauma scoring system with improved prediction of results in patients with TBI.[6,7] It is designed based on four main variables that include the lesion type and volume, presence of intraventricular hemorrhage and status of suprasellar cisterns, as shown in Table 1.[12] When the score increases, the outcome is worse.[12]

The Project for the Epidemiological Analysis of Critical Care Patients (PAEEC):

PAEEC is a detailed QoL feedback form established for patients in need of "critical care" in The Project for the Epidemiological Analysis of Critical Care Patients. It was proposed in 1996 by Fernandez, et al.[10] PAEEC is a confirmed QoL instrument used in Spanish patients with brain injury.[11,13,14] Studies indicated that the results of the PAEEC feedback form matched those of the Glasgow Outcome Scale and it is recognized to document changes for follow-ups.[10] The PAEEC is composed of three subscales evaluating normal physiologic activities, normal daily activities and emotional states. The first subscale marks for oral communication, feeding process, along with bowel and bladder control. Second subscale assesses effort capacity, ability to dress up, mobility, executing fine movements, fulfilling work or activities and the involvement in social relationships. As for the third subscale, it evaluates emotions and subjective impressions regarding health. The total score of the first, second and third subscales are 0–9, 0–15 and 0–5 respectively; the scores of three categories are added up to establish the baseline QoL score ranging between 0 and 29, with increasing scores indicating worse QoL.[10]

Results

The sample included 44 participants suffering from TBI due to various modes of injury. The mean age of the

participants was 41.07 years with standard deviation of ± 20.13, with a minimum age of 18 years and a maximum age of 90 years. Male to female ratio was noted to be 2.3:1. Majority (n = 24, 54.5%) of the participants had 10 years of education or less, while the remainder had higher secondary level education or above. Concerning the employment status of the participants, the vast majority had home based works – farmers and homemakers (50.00%). Remaining 22.70% were students and 27.3% had a full-time job. Moving on to the mechanism of injury, 47.70% had sustained injury owing to fall, 43.30% following road traffic accidents and 9.10% following physical assault. Mean GCS of the patient population included is 13.68 ± 2.41 (Range 4 – 15). 19 among total considered patients had associated systemic injuries other than traumatic brain injury as well. Mean hospital stay of patients was found to be 7.56 days ± 6.99 (Range 1- 42).

We divided our outcomes into two segments on the basis of the time duration from date of injury, with group 1 and 2 representing outcomes after the history of TBI 3 months and 6 months respectively. For the QoL assessment, the PAEEC questions were utilized. Among all, there were isolated as well as combined issues concerning traumatic brain conditions. 27.3% among total cases had extradural hematoma, 25% had subdural hematoma, 38.6% had intracerebral hemorrhage and 11.4 % had intraventricular hemorrhage. The mean total of the PAEEC score were 6.50 ± 7.24 (Range 0 – 28) and 4.34 ± 6.70 (Range 0 – 22) points for groups 1 and 2, respectively, which indicates notable deterioration in QoL among both groups in the early post traumatic stage. Concerning the basic physiological activities, both groups 1 and 2 showed minimal decline, with mean scores of 0.75 ± 1.63 (Range 0 – 8) and 0.66 ± 1.44 (Range 0 – 6) respectively. Similarly, the emotional states of both groups revealed some impairment in function, with a greater mean score among group 1, 1.70 ± 1.47 (range 0 - 5) compared to 1.00 ± 1.47 (Range 0 – 5). However, mean scores on normal daily activities revealed marked reduced performance among both groups, with scores of 4.05 ± 4.66 (Range 0 – 15) and 2.70 ± 4.36 (Range 0 – 14).

The relationship between the Helsinki CT score and the PAEEC QoL score among group 1 demonstrated statistically significant correlation, with r = 0.726, p-value = 0.000. Moreover, the results also indicated a strong relationship between CT findings and basic physiological activities subscale (r = 0.670, p-value = 0.000), normal daily activities subscale (r = 0.692, p-value = 0.000) and emotional state subscale (r = 0.640, p-value = 0.000) individually among participants living with sequelae of TBI for last 3months. Similarly, in group 2 among participants living with sequelae of TBI for the last 6 months, association between the Helsinki CT score and PAEEC QoL score showed significant correlation as well (r = 0.647, p-value = 0.000). Similar significant correlation was noted among individual subscales as well, basic physiological activities subscale (r = 0.635, p-value = 0.000), normal daily activities subscale (r = 0.600, p-value = 0.000) and emotional state subscale (r = 0.655, p-value = 0.000) respectively.

Mean PAEEC score among patients less than or equal to 40 years of age at 3 months post trauma was 3.84 ± 6.36 in comparison to 10.33 ± 6.83 among patients more than 40 years of age (p = 0.002). Similarly, the mean PAECC score among patients less than or equal to 40 years of age at 6 months post trauma was 2.35 ± 5.663 in comparison to 7.22 ± 7.86 among patients more than 40 years of age (p = 0.021). Comparing among gender, mean PAEEC score in either of the time frame post trauma didn't show statistically significant data. In regards to education level while comparing patients with education level of HSEB and above with SEE and below, at 3 months patients with HSEB and above education had PAEEC score of 3.85 ± 3.63 while patients with SEE and below education had PAECC score of 8.70 ± 8.71 (p = 0.02). Further at 6 months, PAEEC score was 1.6 ± 3.35 for HSEB and above in comparison to 6.62 ± 8.38 for SEE and below (p = 0.016). Considering the employment status, at 3 months, patients with home-based work had a mean PAEEC score of 8.11 ± 7.85 compared to 3.94 ± 5.43 for patients who had office-based work (p = 0.05). however, at 6 months score between 2 groups (5.51 ± 7. 70 vs 2.47 ± 5.41) did not appear statistically significant.

According to GCS at admission, we found 6 severe, 10 moderate and 28 mild head injury cases in our study. Mean PAEEC score for group with mild head injury was 3.5 ± 2.95 at 3 months post TBI and 1.25 ± 2.45 at 6 months post TBI. Similarly for moderate head injury groups mean PAEEC score for 3- and 6-month post TBI was 8.0 ± 9.28 and 6.6 ± 9.22 respectively. Further in severe head injury group mean PAEEC score was 18.0 ± 5.93 and 15.0 ± 5.93 at 3- and 6-months post TBI respectively. with severe injuries scored higher on PAEEC. Upon one way ANOVA test, considering Brown - Forsythe test, it is known that there was statistically significant difference between the mean PAEEC scores between groups attained both at 3 months (p =0.001) as well as 6 months (p =0.002). However, upon post hoc analysis using Dunnett T3, it was noted that patients with severe head injury and mild head injury had significant difference in mean PAEEC score (p = 0.04) at 3 months. However, no statistically significant difference was noted between mean PAEEC scores of moderate head injury to severe head injury (p=0.394) as well as mild to moderate head injury (p=0.057). Similar results were noted upon considering mean PAEEC score between mild to moderately (p=0.121) and moderate to severely (p=0.259) head injured patient at 6 months post TBI. Yet mean PAEEC score significantly differed from mild to severely head injured patient at 6 months (p=0.006).

The Helsinki CT scoring system	
Variable	**Score**
Mass Lesion types	
Subdural hematoma	2
Intracerebral hematoma	2
Epidural hematoma	-3
Intraventricular hemorrhage	3
Mass lesion volume >25cm^3	2
Status of suprasellar cisterns	
Normal	0
Compressed	1
Obliterated	5
Sum Score	-3 to 14

Table 1: Helsinki CT scoring system.

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
PAECC SCORE 3MNT	Brown-Forsythe	10.660	2	14.796	.001
PAECC SCORE 6MNT	Brown-Forsythe	10.165	2	14.536	.002
a. Asymptotically F distributed.					

Table 2: Brown-Forsythe test of equality of means upon ANOVA analysis of PAEEC score between 3 groups of head injury (mild, moderate, severe).

Dunnett T3					
Dependent Variable	**(I)**	**(J)**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**
PAECC SCORE 3MNT	1	2	10.00000	3.80643	.057
		3	14.50000*	2.48546	.004
	2	1	-10.00000	3.80643	.057
		3	4.50000	2.98882	.394
	3	1	-14.50000*	2.48546	.004
		2	-4.50000	2.98882	.394
PAECC SCORE 6MNT	1	2	8.40000	3.79239	.121
		3	13.75000*	2.46629	.006
	2	1	-8.40000	3.79239	.121
		3	5.35000	2.95491	.259
	3	1	-13.75000*	2.46629	.006
		2	-5.35000	2.95491	.259
*. The mean difference is significant at the 0.05 level.					

Table 3: Dunnett T3 Post hoc test upon ANOVA analysis of PAECC score between 3 groups of head injury (mild, moderate, severe).

Discussion

Several consequences of traumatic brain injury are well elaborated in various literatures. And to prognosticate the outcome amidst all the issues is a herculean task. Traditionally, GOSE and its prototype, the Glasgow Outcome Scale, have been used as the single primary outcome measure for patients with TBI, and it is often dichotomized into favorable and unfavorable outcomes for analysis.[15]

However, GOSE has been criticized for its failure to capture the multifaceted effects of TBI and its insensitivity to subtle changes, especially in the cognitive dimension; hence, some have questioned its suitability as the sole primary outcome for TBI treatment trials. Apart from functional physical disabilities,[16] significant issues with intellectual deterioration and psychiatric ailments[17] which ultimately affects public integration, socio-economic status[18] and eventually life satisfaction and QoL[19] that is not much explored. Therefore, the application of a tool

for early estimation of outcome is critical to encourage identification of possible consequences.

In the present study, the correlation between Helsinki CT score and QoL post-TBI using the PAEEC questionnaires was investigated. Results elaborated in its favor, in view that 'QoL outcomes among patients with TBI were strongly correlated to CT findings on admission'. with increasing severity of abnormalities reflecting worse QoL.

The present study demonstrated that patients surviving TBI (n = 44) experienced QoL deterioration from their pre-trauma normal daily living with a mean PAEEC score of 6.50 ± 7.24 at 3 months and mean PAEEC score of 4.34 ± 6.70 at 6 months. Similar outcomes in deterioration of PAECC score were noted by Arias – Verdú et al. when assessing the relationship between CT findings and QoL at 1 year among a population of 531 patients with TBI. They reported mean 9.44 points of deterioration on total PAEEC score.[11] It appeared that compared to our study, Arias – Verdú et al.'s paper noted significant worsening of QoL 1 year post TBI. However, these findings might be because of the increased number of moderate to severe TBI cases involved in Arias – Verdú et al.'s study. Further in our study, we noted the differences in PAEEC score between the time frames considered. As recovery from TBI is a continuous process, these results provide evidence that supports the possibility of gradual improvement in QoL with time even after significant early decline in QoL post TBI. However, this improvement was not found to be statistically significant in the current study (6.50 ± 7.24 in group 1 vs 4.34 ± 6.70 in group 2, p = 0.159). More so, on detailed analysis improvement was notable in normal daily activity subscale, yet statistically significant association was not attained there too (4.04 ± 4.66 in group 1 vs 2.70 ± 4.35 in group 2, p = 0.167).

Many other literature from Europe showed concordant results as ours considering decline in QoL post-TBI. However, they have used different QoL indices like SF 36[20] in comparison to ours. Further few have also used different CT scoring systems like Rotterdam CT scoring system and Marshall's CT scoring system in their articles.[21] However, the end outcome was similar to ours. Additionally, Scholten et al. and Mata et al. proposed these declines in QoL were significantly related to age, gender, unemployment and educational level.[22,23] Similar results were also noted in our study when we compared age of the patient (below 40 with 40 years and above, p = 0.002), educational level of the patient (SEE and below with HSEB and above, p = 0.025) and employment status of the patient (office based with home based, p = 0.05) to QoL at 3 months post TBI. Similar results were appreciated even after 6 months post TBI with age, p = 0.021 and educational level, p = 0.016. However, no statistically significant associations were noted between QoL and employment status of the participants in group 2. Gender differences didn't show statistically significant association in either of the groups.

In Spain, Arias – Verdu, et al. aimed to assess QoL after TBI, using PAEEC questionnaire, among 238 participants and concluded that survivors with TBI experienced moderate deterioration in QoL, with a PAEEC mean score of 6.77 points.[14] However, they have assessed their results after 4 years in comparison to 3 – 6 months in our study. Upon stratification of the cases, according to injury severity, groups with severe injuries scored higher on PAEEC. Concordant results were noted in our study too. There was significant statistical difference when PAEEC score at 3 and 6 months were compared between groups categorized according to severity of TBI as per Glasgow coma scale score on admission. Groups with moderate and severe head injury result in high PAEEC score showing statistically significant decline in comparison to mild head injury group, p < 0.005.

Taken together, these results provide strong evidence in support of the fact that valuable information regarding QoL among the population with TBI can be assumed by on admission CT score. In Nepal, where medicine is rapidly evolving yet insufficient, this prognostic tool will definitely help medical professionals to counsel the patients regarding the course of recovery process and treatment ahead. Also, it will help in predicting TBI's impact on the life of the patient and their social functioning.

It is a limitation that this study was restricted to TBI patients of one hospital. The results do not necessarily apply to patients treated at other Nepalese hospitals. A national multi-center study comparing the outcome of TBI patients could possibly improve the understanding of QoL and the impact of all severities of TBI over time. also, this study doesn't account for pediatric patients with TBI and patients who had TBI more than 7 months prior to the proposed date of study. Patients with severe disability (those with disability involving speech) were also not considered in this study owing to difficulty in conducting the interview for assessment of QoL.

Conclusion

The present study showed that patients with traumatic brain injury experience significant quality of life deterioration up to 3-6 months post-TBI. Such deterioration among patients with TBI can be predicted by use of Helsinki CT score on admission.

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