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Original Research Article

EFFACEMENT OF BASAL CISTERNS AS A SINGLE PROGNOSTIC FACTOR IN TRAUMATIC BRAIN INJURY

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Abstract: *Effacement of basal cisterns, a condition characterized by the compression or obliteration of the cerebrospinal fluid (CSF)-filled spaces around the brainstem, is an essential radiological finding in the context of traumatic brain injury (TBI).* ***Objectives:*** *The study's primary purpose is to find the effacement of basal cisterns as a single prognostic factor in traumatic brain injury (TBI).* ***Methods:*** *This prospective observational study was conducted at the Pakistan Institute of Medical Sciences, Islamabad, from June 2023 to May 2024. Data were collected from 250 patients suffering from TBI. For each patient, comprehensive demographic information, including age and gender, was recorded. Additional data included the mechanism of injury, the Glasgow Coma Scale (GCS) score at admission, and the presence of basal cistern effacement as observed on the initial CT scan. Radiological findings, such as midline shift and hematomas, were also documented.* ***Results:*** *The mean age of the patients was 35.6±5.65 years. There were 160 (64%) male and 90 (36%) female patients. Motor vehicle accidents were the most present form of injury 104 (41.6%). The mean GCS score at admission was 7.5 ± 2.1 in the basal cistern group and 12.3 ± 2.8 in the no basal cistern group. The study results revealed a significant association between basal cistern effacement and midline shift, with 61.5% of patients with effacement showing midline shift compared to only 14.8% without effacement (p < 0.01).* ***Conclusion:*** *Basal cistern effacement on initial CT scans is a significant prognostic indicator in traumatic brain injury. Its presence is associated with more severe injury, higher necessity for surgical intervention, and poorer long-term outcomes.*

Keywords: Effacement, Patients, Basal, CT, CSF, TBI

Introduction

Basal cistern effacement is a clinical-radiological sign that illustrates the increased density or the complete disappearance of the cerebrospinal fluid (CSF) surrounding the brainstem in patients with TBI. This usually signals augmented intracranial pressure and massive brain edema, negatively affecting cerebral blood flow and can cause further secondary brain injury (1). Among several individual markers, the loss of basal cisterns has recently emerged as a significant variable that could be used to assess the patient's prognosis after TBI. The evaluation of this condition with neuroimaging, especially with computed tomography scans, offers essential information regarding the extent of the injury and assists in the direction of medical treatment (2).
TBI lesions are evident on CT imaging; however, the significance of this finding is less well understood. There are variations in scoring systems, including the Marshall CT classification, Rotterdam CT score, and Helsinki CT scoring system, among others, deduced to assist in the performance of the objective assessments on the CT scan-derived metrics that are used to predict TBI patient outcomes (3). These scores are not authentic because the observer calculates them and thus can quickly provide wrong estimations. It would help to elucidate the extent to which the brain swells in a patient when arriving at an objective conclusion (4). Relevant aspects of midline shift seen in brain CT scans and the level of intracranial hemorrhage (extradural, subdural) should be helpful in early prognostications because they often lead to increased intracranial pressure (ICP) and death (5).
In TBI, the extent of the basal cisterns is another constituent that can be used in a predictive manner to assess a patient's outcome. Therefore, the measurements of the latter should be accurate, avoiding interobserver variation (6). Intracranial hypertension is the most unnatural cause of death and disability in patients with a traumatic brain injury. A deficit of hemostatic brain function along with pathophysiological regulators remains a specific cause of this increased ICP after TBI (7). In this aspect of conservative medical therapies, the treatment of the raised ICP in patients with TBI is tiered and follows a step-wise approach and entails the following: elevating the head end of the patient, use of osmotic agents such as mannitol and hypertonic saline and the application of anesthetic agents in the form of propofol and barbiturates (8). If these management tools are ineffective, though, little or no DOC is a backup and final tool for lowering ICP immediately (9). Prompt management of TBI can significantly alter the sequelae of injury and the outcome of the patient. Hence, neuroimaging techniques are indispensable in determining the presence and extent of injury (10).

Methodology

This prospective observational study was conducted at the Pakistan Institute of Medical Sciences, Islamabad, from June 2023 to May 2024. Data were collected from 250 patients suffering from TBI.
Participants 18 or older and having undergone a CT scan within 24 hours of the injury were eligible for inclusion in the study. Patients with any pre-existing neurological

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disorder and non-traumatic cause of intracranial hemorrhage were excluded from the study.
For each patient, comprehensive demographic information, including age and gender, was recorded. Other variables comprised the mechanism of injury, the GCS score on admission, and the basal cistern effacement indicated in the admission computed tomography (CT) scan. Other radiological abnormalities like midline shift and the presence of hematoma have also been reported. Information about the performed intercessions, like surgical decompression of patients and ICP monitorization, was highlighted here. Neurological and functional disability were evaluated at discharge and for six months using the Glasgow Outcome Scale (GOS). Such a systematic approach to data gathering was introduced to provide a comprehensive assessment of the value of basal cistern effacement for prognosis in TBI patients.
Data were analyzed using SPSS v26. Baseline characteristics and clinical outcomes were compared between patients with and without basal cistern effacement using chi-square tests for categorical variables and t-tests for continuous variables. Logistic regression analysis determined the association between basal cistern effacement and poor outcome (GOS score ≤ 3), adjusting for potential confounders such as age, GCS score, and other significant radiological findings.

Results

Data were collected from 250 patients according to the criteria of the study. The mean age of the patients was 35.6±5.65 years. There were 160 (64%) male and 90 (36%) female patients. Motor vehicle accidents were the most present form of injury 104 (41.6%). The mean GCS score at admission was 7.5 ± 2.1 in the basal cistern group and 12.3 ± 2.8 in the no basal cistern group.
The study results revealed a significant association between basal cistern effacement and midline shift, with 61.5% of patients with effacement showing midline shift compared to only 14.8% without effacement ($p < 0.01$). Additionally, hematomas were more prevalent in patients with basal cistern effacement (73.1%) than in those without (37.0%) ($p < 0.05$).
Patients with basal cistern effacement underwent surgical decompression at a significantly higher rate (73.1%) compared to those without effacement (29.6%) ($p < 0.01$). Similarly, intracranial pressure (ICP) monitoring was performed more frequently in patients with effacement (80.8%) than in those without (33.3%) ($p < 0.01$).
Patients with basal cistern effacement exhibited a significantly higher proportion of severe disability or death, with 69.2% having a Glasgow Outcome Scale (GOS) score of ≤ 3, compared to only 22.2% in patients without effacement ($p < 0.001$).
In the logistic regression analysis, basal cistern effacement emerged as a strong independent predictor of poor outcome, with an odds ratio (OR) of 4.5 (95% CI: 2.1 - 9.8, $p < 0.001$). Additionally, older age was associated with slightly higher odds of poor outcome (OR: 1.1, 95% CI: 1.0 - 1.2, $p = 0.05$), while higher Glasgow Coma Scale (GCS) scores at admission were associated with lower odds (OR: 0.7, 95% CI: 0.6 - 0.9, $p = 0.01$)

Table 01: Demographic data of patients

Characteristic	Total (N=250)	Basal Cistern Effacement (N=125)	No Basal Cistern Effacement (N=125)
Mean Age (years)	35.6 ± 5.65	34.8 ± 3.45	36.4 ± 4.23
Gender			
- Male	160 (64.0%)	82 (65.6%)	78 (62.4%)
- Female	90 (36.0%)	43 (34.4%)	47 (37.6%)
Mechanism of Injury			
- Motor Vehicle Accidents	104 (41.6%)	53 (42.4%)	51 (40.8%)
- Falls	75 (30.0%)	38 (30.4%)	37 (29.6%)
- Assaults	50 (20.0%)	25 (20.0%)	25 (20.0%)
- Others	21 (8.4%)	9 (7.2%)	12 (9.6%)
Mean GCS Score at Admission	-	7.5 ± 2.1	12.3 ± 2.8

Table 2: Radiological Findings in Patients

Finding	Basal Cistern Effacement (N=125)	No Basal Cistern Effacement (N=125)	p-value
Midline Shift			< 0.01
Present	77 (61.5%)	18 (14.8%)	
Absent	48 (38.5%)	107 (85.2%)	
Hematomas			< 0.05
Present	91 (73.1%)	46 (37.0%)	
Absent	34 (26.9%)	79 (63.0%)	

Table 3: Interventions and monitoring

Intervention	Basal Cistern Effacement (N=125)	No Basal Cistern Effacement (N=125)	p-value
Surgical Decompression			< 0.01
- Performed	91 (73.1%)	37 (29.6%)	

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- Not Performed	34 (26.9%)	88 (70.4%)	
ICP Monitoring			< 0.01
- Performed	101 (80.8%)	42 (33.3%)	
- Not Performed	24 (19.2%)	83 (66.7%)	

Table 4: Clinical Outcomes and Follow-up

Outcome (GOS Score)	Basal Cistern Effacement (N=125)	No Basal Cistern Effacement (N=125)	p-value
GOS Score ≤ 3			< 0.001
- Severe Disability or Death	69.2%	22.2%	
GOS Score > 3			
- Moderate Disability or Good Recovery	30.8%	77.8%	

Table 5: Logistic Regression Analysis for Poor Outcome (GOS Score ≤ 3)

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Basal Cistern Effacement	4.5	2.1 - 9.8	< 0.001
Age	1.1	1.0 - 1.2	0.05
GCS Score at Admission	0.7	0.6 - 0.9	0.01
Midline Shift	2.8	1.3 - 6.2	0.01
Presence of Hematomas	1.5	0.7 - 3.2	0.25

Discussion

The results of this study highlight the significant prognostic value of basal cistern effacement in patients with traumatic brain injury (TBI). It was further observed that 49% of the study population had basal cisterns effaced at presentation with a CT scan, and previous literature has shown that this is a marker of severe injury and a worse prognosis (11). Patients with basal cistern effacement had lower median admission GCS scores than those without basal cistern effacement, indicating the severity of brain injury on admission is higher in patients with basal cistern effacement (12). This was evident from the increased midline shift and hematomas among the patients in this group, signifying that basal cistern effacement is closely related to critical intracranial pathology. These are radiological signs of raised intracranial pressure and brain edema, which could lead to decreased blood flow and harmful effects on the brain (13). There was a need for surgical procedures and ICP monitoring models for patients with basal cistern effacement. This concurs with clinical interventions to counter the consequences of raised intracranial pressure and avoid additional cerebral injuries (14). These patients exhibited a higher rate of surgical decompression and ICP monitoring, which confirms that basal cistern effacement can serve as an essential marker, indicating that such patients require more intense therapeutic interventions. As in previous results, poor prognostic indicators were prominent in this study: patients with basal cistern effacement scored notably lower on the Glasgow Outcome Scale (GOS) at six months. Many of these patients were evaluated to have a severe disability or had died, but patients without effacement indicated a better prognosis. Statistical analysis of the logistic regression has corroborated the evidence; basal cistern effacement remained a significant predictor of outcomes in the multivariate analysis alongside age, GCS score, midline shift, and hematomas (15). This result directly affects clinical practice as Brown and Norczynski (2007) indicated that patients with this particular radiological sign might warrant increased clinical attention and pharmacotherapy (16). The study also has several strengths, including defining an appropriate patient population constitution and an exhaustive data retrieval process. However, like any research, it has its limitations worth noting (17, 18). A limitation in this study could be the perpetration of selection bias due to the use of a cross-sectional research design that only allows for data collection at one point in time; thus, subject selection might be based on decisions made by the participants at a specific point in time, and this could have influenced the findings. Also, the ability to assess basal cistern effacement was derived from the CT scans, and the inter-observer reliability was reduced by coming to a consensus. Still, the variability of this could have affected the results.

Conclusion

Basal cistern effacement on initial CT scans is a significant prognostic indicator in traumatic brain injury. Its presence is associated with more severe injury, higher necessity for surgical intervention, and poorer long-term outcomes. Early identification of this radiological sign can inform clinical decision-making and improve patient management strategies.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRB-PIMSISB_0138/22)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

***NAVEED AHMED* (Resident)**
Conception of Study, Development of Research Methodology Design, Study Design, manuscript Review, and final approval of manuscript.
***LAL REHMAN (HOD* Neurosurgery)**
Final approval of the manuscript.
***MUHAMMAD MUJAHID SHARIF* (Assistant Professor)**
Data entry and data analysis, as well as drafting the article.
***ALI RAZA* (Resident)**
Coordination of collaborative efforts.
***NAVEED KHAN* (Resident)**
The conception of Study.

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