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Modified Fisher Scale Distribution and In-Hospital Outcomes in Moderate and Severe Traumatic Brain Injury With Traumatic Subarachnoid Hemorrhage: A Retrospective Single-Center Study

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ABSTRACT

Traumatic subarachnoid hemorrhage (tSAH) is a frequent imaging finding after traumatic brain injury (TBI) and has been associated with adverse clinical outcomes. The modified Fisher (mFisher) scale was developed for nontraumatic subarachnoid hemorrhage, and its descriptive distribution in patients with tSAH may help characterize radiographic injury burden.

OBJECTIVE:
To describe the distribution of mFisher grades and in-hospital outcomes among patients with moderate and severe TBI and tSAH treated at a tertiary neurosurgical service.

METHODS:
We conducted a retrospective, descriptive, single-center review of medical records from the Neurosurgery Service of Hospital Central de Maracay between 2015 and 2017. Of 205 records reviewed, 100 patients with documented moderate or severe TBI and tSAH comprised the analytic cohort. Demographic, clinical, imaging, treatment, and discharge-status variables were summarized using descriptive statistics. No inferential hypothesis testing or multivariable prognostic modeling was performed.

RESULTS:
Seventy-one patients had moderate TBI and 29 had severe TBI. The cohort was 87% male, with a mean age of 37.66 years. Overall mFisher grades were I in 48%, II in 13%, III in 34%, and IV in 5%. In the moderate-TBI group, grade I was most frequent (52.1%), whereas grade III was most frequent in the severe-TBI group (41.3%). Overall, 58% of patients were discharged alive and 42% died during hospitalization. Mortality was 26.8% among patients with moderate TBI and 79.3% among those with severe TBI. The Marshall CT classification was not documented in 60% of records.

CONCLUSION:
In this retrospective cohort, higher mFisher grades were proportionally more common among patients with severe TBI than among those with moderate TBI, and in-hospital mortality was substantially higher in the severe-TBI group. Because the analysis was descriptive and did not adjust for injury severity or other confounders, these findings should not be interpreted as demonstrating independent prognostic performance of the mFisher scale. Further studies using prespecified inferential and multivariable methods are needed to evaluate its prognostic utility in tSAH.

KEYWORDS

traumatic brain injury; traumatic subarachnoid hemorrhage; modified Fisher scale; computed tomography; mortality; neurosurgery

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The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and design of the study, data collection and curation, analysis and interpretation of the data, literature review, manuscript drafting, critical revision, and final approval of the manuscript. All authors agree to be accountable for the work.

DATA AVAILABILITY

The data were derived from retrospective hospital medical records and are not publicly available because of patient confidentiality.

ETHICS

Exempt

CONSENT

Not Applicable

ORIGINAL RESEARCH

Modified Fisher Scale Distribution and In-Hospital Outcomes in Moderate and Severe Traumatic Brain Injury With Traumatic Subarachnoid Hemorrhage: A Retrospective Single-Center Study

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ABSTRACT

Background: Traumatic subarachnoid hemorrhage (tSAH) is a frequent imaging finding after traumatic brain injury (TBI) and has been associated with adverse clinical outcomes. The modified Fisher (mFisher) scale was developed for nontraumatic subarachnoid hemorrhage, and its descriptive distribution in patients with tSAH may help characterize radiographic injury burden.

Objective: To describe the distribution of mFisher grades and in-hospital outcomes among patients with moderate and severe TBI and tSAH treated at a tertiary neurosurgical service.

Methods: We conducted a retrospective, descriptive, single-center review of medical records from the Neurosurgery Service of Hospital Central de Maracay between 2015 and 2017. Of 205 records screened, 100 met the study definition of moderate or severe TBI with traumatic subarachnoid hemorrhage (tSAH); the remaining 105 did not document both qualifying conditions and were excluded. TBI severity and admission Glasgow Coma Scale (GCS) were abstracted as recorded in the medical record. Because the source records did not specify the exact GCS thresholds used to assign the recorded moderate and severe categories, patients were not retrospectively reclassified. Modified Fisher grades were taken from the existing study dataset and were not reassessed from CT images for this analysis. Demographic, clinical, imaging, treatment, and discharge-status variables were summarized descriptively. No inferential hypothesis testing or multivariable prognostic modeling was performed.

Results: Seventy-one patients had moderate TBI and 29 had severe TBI. The cohort was 87% male, with a mean age of 37.66 years. Overall mFisher grades were I in 48%, II in 13%, III in 34%, and IV in 5%. In the moderate-TBI group, grade I was most frequent (52.1%), whereas grade III was most frequent in the severe-TBI group (41.3%). Overall, 58% of patients were discharged alive and 42% died during hospitalization. Mortality was 26.8% among patients with moderate TBI and 79.3% among those with severe TBI. The Marshall CT classification was not documented in 60% of records.

Conclusion: In this retrospective cohort, higher mFisher grades were proportionally more common among patients with severe TBI than among those with moderate TBI, and in-hospital mortality was substantially higher in the severe-TBI group. Because the analysis was descriptive and did not adjust for injury severity or other confounders, these findings should not be interpreted as demonstrating independent prognostic performance of the mFisher scale. Further studies using prespecified inferential and multivariable methods are needed to evaluate its prognostic utility in tSAH.

Keywords: *traumatic brain injury; traumatic subarachnoid hemorrhage; modified Fisher scale; computed tomography; mortality; neurosurgery.*

INTRODUCTION

Traumatic brain injury (TBI) remains an important cause of morbidity and mortality worldwide. Traumatic subarachnoid hemorrhage (tSAH) is a common intracranial finding after TBI and has been associated with increased mortality, unfavorable neurologic outcome, and progression of intracranial injury in prior observational studies [1,2,4,5,10,17]. The extent and thickness of subarachnoid blood on computed tomography (CT) may carry clinically relevant information regarding injury burden [5,10,22].

Several CT-based grading systems are used in neurotrauma. The Marshall classification is widely used to categorize structural findings after TBI, whereas the Fisher and modified Fisher scales were developed primarily to grade subarachnoid blood in spontaneous aneurysmal hemorrhage and estimate vasospasm risk [7,8]. Their application to traumatic subarachnoid hemorrhage has been explored, but the role of the mFisher scale in routine prognostic assessment of tSAH remains uncertain.

The source dataset for the present study was collected at the Neurosurgery Service of Hospital Central de Maracay and included patients with moderate or severe TBI and documented tSAH. The original analysis was descriptive. Accordingly, rather than claiming prognostic validation, this revised report focuses on the observed distribution of mFisher grades, in-hospital outcomes, and management patterns according to recorded TBI severity.

The objective of this study was to describe mFisher grade distribution and in-hospital outcomes among patients with moderate and severe TBI and tSAH treated between 2015 and 2017.

MATERIALS AND METHODS

Study design and setting

This was a retrospective, descriptive, single-center medical-record review conducted in the Neurosurgery Service of Hospital Central de Maracay, Maracay, Venezuela. The study period covered 2015 through 2017.

Study population

A total of 205 medical records were screened. The analytic cohort included 100 records documenting both moderate or severe TBI and traumatic subarachnoid hemorrhage. The remaining 105 records were excluded because both qualifying conditions were not documented. A more detailed reason-by-reason breakdown of these exclusions was not available in the source dataset. TBI severity was retained as recorded in the medical record. Although admission GCS was available as a separate variable, the exact GCS thresholds used to assign the recorded moderate and severe categories were not documented; therefore, patients were not retrospectively reclassified. No additional eligibility criteria were specified in the source manuscript.

Variables and data collection

Data were abstracted into a researcher-designed database. Available variables included age, sex, mechanism of injury, admission Glasgow Coma Scale (GCS) score, TBI severity, mFisher grade, Marshall CT classification when documented, surgical versus non-surgical management, and in-hospital disposition (discharged alive or died). Admission GCS was abstracted from the value identified as the admission score in the medical record. The timing of this score relative to sedation, intubation, or other acute interventions could not be confirmed consistently across records. The source dataset did not include a complete variable-by-variable report of missing data; the main documented missing variable was the Marshall CT classification, which was unavailable in 60% of records.

Imaging classifications

Traumatic subarachnoid hemorrhage was categorized using the modified Fisher scale as documented in the source study dataset. For the present analysis, mFisher grades were abstracted from the existing records/database; CT images were not independently reread by the current study team. Information on the number of imaging raters, inter-rater agreement, and the exact timing of CT acquisition relative to injury was not available. Marshall CT classification was also recorded when available. Because Marshall classification was missing in a substantial proportion of records, it was summarized descriptively and was not used for adjusted analyses.

Statistical analysis

Univariate and bivariate descriptive analyses were performed using frequency tables, percentages, and summary statistics. Excel for Windows and SPSS Statistics were used in the original analysis. No inferential hypothesis testing, receiver-operating-characteristic analysis, survival analysis, or multivariable regression was reported. Therefore, the present manuscript does not estimate an independent association between mFisher grade and mortality and does not present the mFisher scale as a validated prognostic model in this cohort.

Ethics

This retrospective medical-record review was exempt from formal ethics review. No prospective intervention or direct patient contact was performed.

RESULTS

Cohort characteristics

Among 100 included patients, 71% had moderate TBI and 29% had severe TBI. The cohort was predominantly male (87%). Mean age was 37.66 years; 37% of patients were 20–29 years old, 17% were 30–39 years old, and 12% were younger than 19 years. Motor vehicle collision was the most frequently reported mechanism of injury (35%), followed by firearm injury (26%) and pedestrian-related trauma (11%). The mean admission GCS score was 9.52 (range, 3–13).

Table 1. Cohort characteristics and in-hospital outcomes (n=100)

Variable	Value
Moderate TBI	71 (71.0%)
Severe TBI	29 (29.0%)
Male sex	87 (87.0%)
Female sex	13 (13.0%)
Mean age, years	37.66
Motor vehicle collision	35 (35.0%)
Firearm injury	26 (26.0%)
Pedestrian-related trauma	11 (11.0%)
Mean admission GCS (range)	9.52 (3–13)
Non-surgical management	70 (70.0%)
Surgical management	30 (30.0%)
Discharged alive	58 (58.0%)
In-hospital death	42 (42.0%)

GCS, Glasgow Coma Scale; TBI, traumatic brain injury.

Modified Fisher scale distribution

Across the full cohort, 48% of patients were classified as mFisher grade I, 13% as grade II, 34% as grade III, and 5% as grade IV; no patient was classified as grade 0. Grade I predominated in the moderate-TBI group, whereas grade III was the most frequent grade in the severe-TBI group. Grades III and IV together accounted for 35.2% of the moderate-TBI group and 48.3% of the severe-TBI group.

Table 2. Modified Fisher grade distribution overall and according to TBI severity

mFisher grade	Overall, n (%)	Moderate TBI, n (%)	Severe TBI, n (%)
I	48 (48.0)	37 (52.1)	11 (37.9)
II	13 (13.0)	9 (12.7)	4 (13.8)
III	34 (34.0)	22 (31.0)	12 (41.3)
IV	5 (5.0)	3 (4.2)	2 (6.9)
Total	100 (100)	71 (100)	29 (100)

In-hospital outcomes and management by TBI severity

Among patients with moderate TBI, 52 of 71 (73.2%) were discharged alive and 19 (26.8%) died. Among those with severe TBI, 6 of 29 (20.7%) were discharged alive and 23 (79.3%) died. Non-surgical management was recorded in 73.2% of the moderate-TBI group and 62.1% of the severe-TBI group.

Table 3. In-hospital outcomes and management according to TBI severity

Outcome / management	Moderate TBI (n=71)	Severe TBI (n=29)
Discharged alive	52 (73.2%)	6 (20.7%)
In-hospital death	19 (26.8%)	23 (79.3%)
Non-surgical management	52 (73.2%)	18 (62.1%)
Surgical management	19 (26.8%)	11 (37.9%)

Marshall CT classification

Marshall CT classification was not documented in 60% of records. Among documented classifications, grade 2 was the most frequent (24% of the total cohort), followed by grade 3 (8%), grade 4 (4%), grade 5 (2%), and grade 6 (2%).

Table 4. Marshall CT classification in the study cohort

Marshall grade	n	% of cohort
2	24	24.0
3	8	8.0
4	4	4.0
5	2	2.0
6	2	2.0
Not documented	60	60.0
Total	100	100.0

DISCUSSION

This retrospective cohort describes the clinical and CT characteristics of 100 patients with moderate or severe TBI and tSAH treated at a neurosurgical referral center. Three observations are central. First, the cohort was predominantly young and male, with road-traffic trauma representing the most frequently reported mechanism. Second, mFisher grade I was the most common grade in moderate TBI, whereas grade III was the most common grade in severe TBI. Third, in-hospital mortality was markedly higher in the severe-TBI group than in the moderate-TBI group.

The higher proportion of mFisher grades III and IV in patients classified as having severe TBI is clinically plausible as a marker of greater radiographic injury burden. Prior studies have reported associations between tSAH burden, CT patterns, and unfavorable outcomes [2,4,5,10,22]. However, the present dataset does not establish that the mFisher scale independently predicts mortality. TBI severity itself was strongly related to outcome in this cohort, and no multivariable model was performed to determine whether mFisher grade contributed prognostic information beyond baseline injury severity.

The observed mortality difference between moderate and severe TBI was substantial: 26.8% versus 79.3%, respectively. This finding underscores the dominant role of global injury severity in short-term outcome interpretation. Admission GCS is an established component of TBI assessment and prognostic frameworks [13]. Consequently, any future evaluation of the mFisher scale as a prognostic tool should adjust at minimum for admission neurologic severity and other available clinical covariates rather than relying on unadjusted descriptive comparisons.

The study also highlights limitations in routine imaging documentation. Marshall CT classification was absent from 60% of the records. Missing imaging-grade documentation reduces the ability to compare or combine CT-based prognostic frameworks and limits retrospective risk adjustment. More standardized radiographic reporting would improve both clinical communication and the quality of future observational research. These documentation limitations should be considered when interpreting differences across the recorded TBI-severity and mFisher categories.

Most patients in this cohort were managed non-surgically. This finding should not be interpreted as evidence favoring conservative treatment, because treatment selection depended on the individual injury pattern and clinical status and was not evaluated comparatively in this study. The data simply describe management as recorded in the source cohort.

Limitations

This study has several important limitations. Its retrospective, single-center design limits generalizability and introduces the possibility of selection and information bias. The sample size was modest, and no prespecified multivariable prognostic analysis was available. The mFisher distribution was compared descriptively across recorded TBI-severity groups, so confounding by overall injury severity cannot be excluded. The exact GCS thresholds used in the source records to define moderate versus severe TBI were not documented, and the timing of admission GCS relative to sedation, intubation, or other acute interventions could not be confirmed consistently. The 105 excluded records could not be separated into more specific exclusion categories from the available data. Modified Fisher grades were abstracted from the existing dataset rather than independently reassessed from CT images, and information on inter-rater agreement and exact CT timing was unavailable. Marshall CT classification was missing in 60% of records, while complete variable-specific missingness information was not available for the remaining fields. Finally, the cohort reflects care delivered between 2015 and 2017 and may not capture subsequent changes in neurotrauma practice.

CONCLUSION

Among patients with moderate and severe TBI complicated by traumatic subarachnoid hemorrhage, higher mFisher grades were proportionally more frequent in the severe-TBI group, which also experienced substantially higher in-hospital mortality. These findings describe an imaging and outcome pattern but do not establish independent prognostic validity of the mFisher scale. Prospective or well-designed retrospective studies using prespecified multivariable modeling are required before the mFisher scale can be considered an independent prognostic tool for traumatic subarachnoid hemorrhage.

DECLARATIONS

Ethics approval and consent to participate: This retrospective medical-record review was exempt from formal ethics review. No prospective intervention or direct patient contact was performed.

Funding: No funding was received for this study.

Conflicts of interest: The authors declare no conflicts of interest.

Data availability: The data were derived from retrospective hospital medical records and are not publicly available because of patient confidentiality.

Author contributions: All authors contributed to the conception and design of the study, data collection and curation, analysis and interpretation of the data, literature review, manuscript drafting, critical revision, and final approval of the manuscript. All authors agree to be accountable for the work.

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