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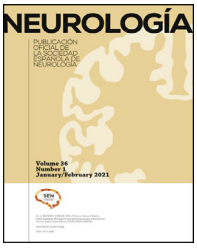

ORIGINAL ARTICLE

Ultrasound diagnosis of Terson syndrome as an indicator of extreme severity in neurocritical care patients☆

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KEYWORDS
Traumatic brain injury;
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Terson syndrome;
Intraocular haemorrhage

Abstract
Introduction: Terson syndrome (TS) is defined as any intraocular haemorrhage identified in patients with acute intracranial pathology. TS appears to be associated with clinical severity in patients with subarachnoid haemorrhage (SAH), but the association is yet to be defined in patients with traumatic brain injury (TBI) and intracerebral haemorrhage (ICH). This study aimed to evaluate the diagnostic performance of ocular ultrasound (OU) and its usefulness in clinical practice.
Material and methods: We performed an observational, prospective, single-centre study of neurocritical care patients. We analysed cases and controls, defined according to indirect ophthalmoscopy (IO) and OU findings. We determined the diagnostic characteristics of OU. A multivariate analysis was performed to identify clinically relevant associations.
Results: The sample included 91 patients diagnosed with ICH (41.76%), SAH (29.67%), and TBI (28.57%). TS was identified by OU in 8 patients (8.79%) and by IO in 24 (24.37%). The adjusted mortality rate in patients with TS showed an odds ratio (OR) of 4.15 (95% confidence interval [CI], 1.52-11.33). All patients with TS detected by OU presented Glasgow Coma Scale scores < 9, with an elevated risk of needing decompressive craniectomy (OR: 9.84; 95% CI, 1.64-59). OU presented an overall sensitivity of 30.43%, specificity of 98.53%, and diagnostic accuracy of 81.32%. For the detection of vitreous haemorrhage, sensitivity and specificity were 87.5% and 98.5%, respectively.

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Conclusions: OU diagnosis of TS identifies extremely critical patients, who may require the highest level of care; TS is an independent risk factor for in-hospital mortality.

PALABRAS CLAVE
Trauma craneoencefálico;
Hemorragia subaracnoidea;
Hemorragia intracerebral;
Síndrome de Terson;
Hemorragia intraocular

El síndrome de Terson diagnosticado por ecografía como indicador de extrema gravedad en pacientes neurocríticos

Resumen
Introducción: Se denomina Síndrome de Terson (ST) a cualquier tipo de hemorragia intraocular (HIO), identificada en pacientes con patología aguda intracraneal. El ST parece estar relacionado con la gravedad clínica en la hemorragia subaracnoidea (HSA), pero en pacientes con trauma craneoencefálico (TCE) y hemorragia intracerebral (HIC), su asociación está por definir. Diseñamos este estudio para evaluar el rendimiento de la ecografía ocular (EO) y su utilidad en la práctica clínica.
Materiales y métodos: Realizamos un estudio observacional prospectivo, unicéntrico en pacientes neurocríticos. Analizamos los casos con respecto a los controles, identificados con oftalmoscopia indirecta (OI), y por EO. Determinamos las características diagnósticas de la EO. Hicimos un análisis multivariante para determinar asociaciones clínicamente relevantes.
Resultados: Se incluyeron 91 pacientes con diagnósticos de HIC (41,76%), HSA (29,67%) y TCE (28,57%). El ST fue identificado por EO en ocho pacientes (8,79%) y en 24 pacientes (24,37%) por OI. La mortalidad ajustada para los pacientes con ST tuvo una OR 4,15 con IC 95% (1,52-11,33). Todos los pacientes con ST identificados por EO presentaron una escala de coma de Glasgow <9 y tuvieron un riesgo elevado de precisar craniectomía descompresiva, una OR 9,84 (1,64-59). La EO alcanzó una sensibilidad global de 30,43%, una especificidad del 98,53%, con una precisión diagnóstica de 81,32. Para la detección de la hemorragia vítrea, una sensibilidad y especificidad del 87,5%, y 98,5% respectivamente.
Conclusiones: El ST diagnosticado por EO discrimina pacientes neurocríticos de extrema gravedad que pueden requerir el máximo escalón terapéutico y es un factor independiente de mortalidad intrahospitalaria.

Introduction

Terson syndrome is defined as any type of intraocular haemorrhage developing in the context of an acute intracranial event; its pathophysiology frequently involves acute elevation of intracranial pressure. Intraocular haemorrhages may present at different locations (preretinal, retinal, subhyaloid, and vitreous), and the same patient may present several intraocular haemorrhages at different locations.[1] Terson syndrome was first described in 1881 by Moritz Litten, who reported an association with subarachnoid haemorrhage (SAH). However, it was not until 1900 that the syndrome received its current name, when the French ophthalmologist Albert Terson reported a clinical case.[2]

The incidence of Terson syndrome in neurocritical care patients and its association with severity and prognosis are not well defined. Most studies of Terson syndrome have been conducted in patients with SAH, reporting incidence rates ranging from 18% to 29%. These patients frequently present poorer scores on such clinical severity scales as the Hunt & Hess scale and the Glasgow Coma Scale (GCS), and display clinical signs of intracranial hypertension (eg, papilloedema) and higher mortality rates.[3-5] In the context of traumatic brain injury (TBI), the study with the greatest statistical power described an incidence of Terson syndrome of 3% in patients with moderate TBI.[2,6] In patients with intracranial haemorrhage (ICH), incidence reaches 9.1%; however, this rate was reported in a series of 22 patients, most of whom scored 11 points on the GCS at admission.[2]

The gold standard for diagnosis of Terson syndrome is indirect ophthalmoscopy (IO) with pharmacological mydriasis. However, in the context of acute intracranial haemorrhage, pupillary changes may indicate acute episodes of intracranial hypertension requiring immediate diagnosis and treatment. Therefore, pharmacological mydriasis is contraindicated in the early phases of monitoring and treatment of acute intracranial haemorrhage.[1,7]

In this context, ocular ultrasound (OU) may represent an alternative for early detection of Terson syndrome. Although OU was described over 30 years ago, the only study conducted to date that has determined its internal validity and external validity between OU and IO with mydriasis was that performed by Czorlich et al.[8] In that study, OU was calculated to have a sensitivity of 81.8%, a specificity of 100%, a

positive predictive value (PPV) of 63.6%, and a negative predictive value (NPV) of 95.7%. Patients with Terson syndrome scored lower on the GCS and presented higher Hunt & Hess scores at admission.[2,8]

Seeking an alternative diagnostic method to IO, Baüerle et al.[9] found that the diagnostic accuracy of OU for identifying Terson syndrome was superior to that of standard head CT in patients with SAH. According to the authors, the radiation dose needed for identifying Terson syndrome with CT involves greater risks than benefits.

The purpose of our study is to determine the diagnostic accuracy and clinical value of OU for identifying Terson syndrome in the 3 most prevalent disorders in neurocritical care patients (SAH, TBI, and ICH), and to contribute data on its value as a prognostic indicator.

Material and methods

We conducted a prospective observational study at the intensive care unit (ICU) of Hospital Universitario La Paz, in Madrid. We recruited neurocritical care patients admitted over 16 consecutive months to the ICU with a diagnosis of SAH, TBI, or ICH confirmed by imaging studies. The study was approved by our hospital's medical research ethics committee. All patients or their legal representatives gave written informed consent.

The patient group included neurocritical care patients with a diagnosis of SAH, TBI, or ICH in whom OU or IO had detected intraocular haemorrhage, and the control group included patients with a diagnosis of SAH, TBI, or ICH in whom OU or IO had not detected intraocular haemorrhage. All participants met the inclusion criteria and gave informed consent to participate.

We gathered demographic data, GCS scores, and Acute Physiology and Chronic Health Evaluation II (APACHE II) scores. Patients with SAH were evaluated with the Hunt & Hess scale and the Fisher scale. In patients with ICH, haematoma volume was calculated using the ABC/2 formula. We recorded ICU and in-hospital mortality rates, number of days in hospital and in the ICU, need for decompressive craniectomy, and need for intracranial pressure monitoring. We excluded patients with history of eye disease, glaucoma, ocular trauma, or younger than 18 years of age.

OU was performed within 72 hours of admission, using the SonoSite® MicroMaxx® portable ultrasound system and a 7-13 MHz transducer. Images were stored on compact flash cards and downloaded to a computer with the SiteLink Image Manager® 3.5 software installed. Pharmacological mydriasis was induced after neurological stabilisation; therefore, IO was performed by the ophthalmology department one week after admission.

Statistical analysis of data was performed with the Stata® software version 14.2. Quantitative data are expressed as means and standard deviations (SD), or medians and quartiles 1 and 3 (Q_1-Q_3). Categorical data are expressed as absolute and relative frequencies (percentages).

We performed 2 different analyses to compare qualitative variables between cases and controls. The first analysis compared the patients with intraocular haemorrhage detected by OU against controls, whereas the second analysis compared patients with intraocular haemorrhage detected by IO against controls. To this end, we used contingency tables and the chi-square test or the Fisher exact test. To analyse quantitative variables we used the *t* test for independent samples, Mann-Whitney U test, one-factor ANOVA, or Kruskal-Wallis test, depending on the distribution of the data. We tested for normal distribution using the Kolmogorov-Smirnov test. We calculated the sensitivity, specificity, PPV, and NPV of diagnosis of Terson syndrome by OU as compared to IO. Multivariate logistic regression with forward conditional selection was used to identify the relationship between detection of Terson syndrome and clinical severity, and to determine whether presence of Terson syndrome is an independent factor for presence of intracranial hypertension, need for decompressive craniectomy, or mortality.

The results of the multivariate model are presented as adjusted odds ratios (OR) with population estimations and 95% confidence intervals (CI). All statistical tests were two-tailed. Statistical significance was set at $P < .05$.

Results

A total of 91 neurocritical care patients were included in our study. Men accounted for 62.64% of the sample, and the median age (Q_1-Q_3) was 57 years (42-65). Regarding diagnosis at admission, 41.76% of patients had ICH, 29.67% had SAH, and 28.57% had TBI. Terson syndrome was detected by IO in 24 patients (26%) and by OU in 8 (9%). Table 1 presents the characteristics of our sample, including the distribution of patients with Terson syndrome identified with OU or IO, by diagnosis at admission; Terson syndrome was more frequent in patients with SAH and TBI.

As shown in Table 1, no significant differences were observed between patients with SAH, TBI, and ICH in severity scale scores, APACHE II score, proportion of patients with GCS score < 9, percentage of patients with intracranial hypertension, hospitalisation time, or mortality. However, we did find statistically significant differences in age, sex, use of muscle relaxants, and the percentage of patients with Terson syndrome diagnosed by IO.

Table 2 presents the location of ocular lesions identified with OU and IO; some patients presented several ocular haemorrhages at different locations at the same time. Regarding the diagnostic capacity of OU as compared to IO, we found an overall sensitivity of 30.43%, specificity of 98.53%, diagnostic accuracy of 81.32%, PPV of 87.5%, and NPV of 80.72%. However, when evaluating the technique's diagnostic capacity for detecting subhyaloid or vitreous haemorrhages per eye examined, sensitivity increased to 56.67%, with 98.68% specificity, a PPV of 89.47%, and an NPV of 92.02%; its capacity to detect vitreous haemorrhages only reached a sensitivity of 87.5%, with 98.85% specificity, a PPV of 77.78%, and an NPV of 99.42%.

The analysis of risk factors for Terson syndrome identified by OU found that all the patients with Terson syndrome presented GCS scores < 9; risk decreased with each one-point increase in GCS score (OR: 0.65; 95% CI, 0.44-0.95). Furthermore, diagnosis by OU was associated with increased

Table 1 Characteristics of the patients included in the study, by neurocritical care condition.

Characteristics	SAH (n = 27)	TBI (n = 26)	ICH (n = 38)	*P*
Age in years, median (Q_1-Q_3)	55 (44-62)	34 (28-53)	60 (50-69)	.00
Women, n (%)	16 (59.26%)	6 (23.08%)	12 (31.58%)	.01
White ethnicity, n (%)	25 (92.59%)	23 (88.46%)	33 (86.84%)	.83
Treatment with muscle relaxants, n (%)	3 (11.11%)	11 (42.31%)	4 (10.53%)	.00
Treatment with barbiturates, n (%)	3 (11.11%)	2 (7.69%)	1 (2.63%)	.42
Decompressive craniectomy, n (%)	5 (18.52%)	9 (34.62%)	6 (15.79%)	.19
Days at ICU, median (Q_1-Q_3)	9 (6-26)	12 (4-30)	21 (6-31)	.49
Days at hospital, median (Q_1-Q_3)	18 (9-35)	25.5 (7-43)	38 (10-59)	.14
Terson syndrome by IO, n (%)	9 (33.33%)	10 (38.46%)	5 (13.16%)	.04
Terson syndrome by OU, n (%)	3 (15.38%)	4 (11.11%)	1 (2.63%)	.20
Mortality at ICU, n (%)	5 (18.52%)	7 (26.92%)	10 (26.32%)	.78
Overall mortality, n (%)	6 (26.92%)	7 (22.22%)	12 (31.58%)	.74
APACHE II score, mean (SD)	14.37 (7.83)	18.4 (8.7)	17.3 (6.21)	.16
GCS score < 9, n (%)	11 (40.74%)	16 (61.54%)	20 (52.63%)	.31
Fisher grade, n (%)		NA	NA	
I-II	6 (22%)			
III-IV	21 (78%)			
Hunt & Hess score > 3, n (%)	11 (41%)	NA	NA	
WFNS scale score, mean (SD)	3.1 (1.6)	NA	NA	
Vasospasm, n (%)	4 (14.8%)	NA	NA	
Intracranial hypertension, n (%)	17 (62.96%)	15 (57.69%)	23 (60.53%)	.96

APACHE II: Acute Physiology and Chronic Health Evaluation II; GCS: Glasgow Coma Scale; ICH: intracranial haemorrhage; ICU: intensive care unit; IO: indirect ophthalmoscopy; NA: not applicable; OU: ocular ultrasound; Q_1-Q_3: quartile 1-quartile 3; SAH: subarachnoid haemorrhage; SD: standard deviation; TBI: traumatic brain injury; WFNS: World Federation of Neurosurgical Societies.

risk of requiring decompressive craniectomy to control ICH (OR: 9.84; 95% CI, 1.64-59) and risk of in-hospital mortality (OR: 7.96; 95% CI, 1.27-49.33) (Table 3).

According to the analysis of risk factors for Terson syndrome identified by IO, male sex (OR: 6.027; 95% CI, 1.64-22.15), TBI (OR: 4.12; 95% CI, 1.20-14.08), and SAH (OR: 12.81; 95% CI, 2.50-65.49) were associated with increased risk of being diagnosed with the syndrome. GCS scores < 9 (OR: 6.166; 95% CI, 1.90-19.99) and APACHE II scores > 15 (OR: 5.030; 95% CI, 1.35-18.73) were also found to increase the risk of Terson syndrome. Diagnosis of Terson syndrome by IO was also associated with increased risk of presenting ICH (OR: 3.87; 95% CI, 1.11-13.04) and in-hospital mortality (OR: 4.15; 95% CI, 1.52-11.33). Table 4 includes data on all the variables analysed.

Table 2 Indirect ophthalmoscopy and ocular ultrasound findings in patients diagnosed with Terson syndrome.

Indirect ophthalmoscopy*	Patients	Eyes affected
Total number of cases	24	46
Retinal haemorrhages, n (%)	17 (70%)	26
Subhyaloid haemorrhages, n (%)	12 (50%)	22
Vitreous haemorrhages, n (%)	5 (20%)	8
Ocular ultrasound*	**Patients**	**Eyes affected**
Total number of cases	8	16
Subhyaloid haemorrhages, n (%)	6 (75%)	10
Vitreous haemorrhages, n (%)	4 (50%)	7

* A single patient may present several haemorrhages at different locations; unilateral involvement is also possible.

Discussion

In our study, the global incidence of Terson syndrome in the group of neurocritical conditions studied was 24.37% for IO and 8.79% for OU. Regarding the diagnostic accuracy of OU, the technique's low overall sensitivity as compared to IO may partly be explained by the characteristics of the ultrasound probe used (a standard 7-13 MHz linear transducer), which has poor sensitivity for detecting retinal haemorrhages: in our series, this was the most frequent location of intraocular haemorrhage detected by IO (70%). However, OU detected vitreous and subhyaloid haemorrhages, with 87.5% sensitivity for detecting vitreous haemorrhages and a PPV approaching 80%.

Our findings are consistent with those reported by Bäuerle et al.[9] in patients with SAH. In that study, B-scan OU was found to have 100% sensitivity and specificity for detecting vitreous and subhyaloid haemorrhages as compared to IO, presenting poorer reliability in detecting retinal haemorrhages, with 44% sensitivity and 100% specificity. Czorlich et al.[10] report similar performance of B-scan OU for identifying vitreous and retinal haemorrhages, with sensitivity ranging from 81.8% to 100% and a PPV

Table 3 Multivariate analysis of cases of Terson syndrome detected by ocular ultrasound.

Terson syndrome	Cases (n = 8)	Controls (n = 83)	OR (95% CI)	*P*
Age in years, median (Q_1-Q_3)	50.5 (46-60)	55 (41-66)	0.99 (0.95-1.04)	.85
Men, n (%)	7 (87.50%)	50 (60.24%)	4.62 (0.54-39.30)	.25
GCS score < 9, n (%)	8 (100%)	42 (50.60%)	NA	.00
APACHE II score, median (Q_1-Q_3)	24 (18-28)	17 (12-21)	1.13 (1.01-1.26)*	.03
Decompressive craniectomy, n (%)	6 (75%)	14 (16.87%)	9.84 (1.64-59)**	.00
Intracranial hypertension, n (%)	8 (100%)	47 (56.63%)	2.48 (0.27-22.53)	.26
Mortality at ICU, n (%)	10 (41.67%)	12 (17.91%)	5.00 (0.93-26.22)*	.061
In-hospital mortality, n (%)*	6 (75%)	19 (22.89%)	7.96 (1.27-49.33)*	.026

APACHE II: Acute Physiology and Chronic Health Evaluation II; GCS: Glasgow Coma Scale; ICU: intensive care unit; NA: not applicable; OR: odds ratio; Q_1-Q_3: quartile 1-quartile 3.
* OR adjusted for diagnosis, age, and sex.
** OR adjusted for diagnosis, sex, APACHE II score, and age.

Table 4 Multivariate analysis of cases of Terson syndrome detected by indirect ophthalmoscopy.

Terson syndrome	Patients (n = 24)	Controls (n = 67)	OR (95% CI)	*P*
Diagnosis:				
ICH/	5 (20.83%)	33 (49.25%)	Reference variable	
TBI/	10 (41.67%)	16 (23.88%)	6.44 (1.37-30.19)*	.018
SAH	9 (37.50%)	18 (26.87%)	12.81 (2.50-65.49)*	.002
Age in years, median (Q_1-Q_3)	54 (47.5-61)	54 (40-66)	1.010 (0.98-1.040)	.512
Men, n (%)	21 (87.5%)	36 (53.73%)	6.027 (1.64-22.15)*	.003
Ethnicity:				
White	21 (25.93%)	60 (74.07%)	0.816 (0.19-3.45)	.721
Other	3 (30%)	7 (70%)		
GCS score < 9, n (%)	20 (83.33%)	30 (44.78%)	6.166 (1.90-19.99)**	.001
APACHE II score > 15	20 (79.17%)	33 (49.25%)	5.030 (1.35-18.73)**	.012
Fisher grade, n (%)				
I-II	0 (0%)	10 (14.93%)		
III-IV	4 (100%)	57 (85.07%)	1.223 (0.85-30.99)*	.054
Hunt & Hess score > 3, n (%)				
	7 (29.16%)	4 (5.9%)	12.25 (1.78-83.94)	.013
Intracranial hypertension, n (%)	18 (75.00%)	37 (55.22%)	3.87 (1.11-13.04)**	.033
Treatment with muscle relaxants, n (%)	8 (33.33%)	10 (14.93%)	2.85 (0.96-8.41)	.053
Decompressive craniectomy, n (%)	8 (33.33%)	12 (17.91%)	2.29 (0.79-6.57)	.152
Days at ICU, median (Q_1-Q_3)	10 (2-29)	19 (7-30)	1.00 (0.98-1.01)	.955
Days at hospital, median (Q_1-Q_3)	14.5 (2-49)	26 (10-45)	1.00 (0.98-1.01)	.793
Mortality at ICU, n (%)	10 (41.67%)	12 (17.91%)	3.16 (0.89-11.22)*	.056
In-hospital mortality, n (%)	12 (50%)	13 (19.40%)	4.15 (1.52-11.33)*	.022

APACHE II: Acute Physiology and Chronic Health Evaluation II; ICH: intracranial haemorrhage; ICU: intensive care unit; GCS: Glasgow Coma Scale; OR: odds ratio; Q_1-Q_3: quartile 1-quartile 3; SAH: subarachnoid haemorrhage; TBI: traumatic brain injury.
* Adjusted for diagnosis, APACHE II score, and age.
** Adjusted for diagnosis, sex, and age.

ranging from 63.6% to 95.7%. Diagnostic yield improved as the authors' experience increased. OU also showed greater sensitivity in more severe patients, that is patients with lower GCS scores and higher Hunt & Hess scale scores.

In our study, Terson syndrome was more frequently detected in patients with more severe clinical conditions and those with TBI or SAH. Case series of SAH and Terson syndrome published to date show great variability in terms of incidence, with rates ranging from 15% to 50%. The most widely accepted explanation for this is the different definitions of Terson syndrome used and methodological differences between studies; however, our results are in line with this incidence range (33.3%).[2,6] Regarding patients with TBI, we are less able to compare our results with those of other studies, since only 2 studies and isolated case reports have been published to date. The study with the largest number of participants was conducted by Czorlich et al.,[2] who detected one case of Terson syndrome among 32 patients with TBI. However, their sample presented moderate severity, with a mean (SD) GCS score of 11 (4.24) points at admission; therefore, their population cannot be compared to our own, in which 61.54% presented an initial GCS score < 9, with a mean (SD) of 7.8 (4.58) points. Medele et al.[6] included 9 patients with severe TBI (GCS < 9) and intracranial hypertension (> 20 mm Hg in the first 72 hours), detecting Terson syndrome in 44% using IO. Based on the results of these 2 studies and our own, we may conclude

that the severity of head trauma plays a role in the risk of developing Terson syndrome. As is the case with TBI, very few studies have been conducted in patients with ICH. The most recent data are from the study by Czorlich et al.,[2] who reported incidence of 9.1% among 22 patients with ICH, and were unable to establish a correlation with haemorrhage volume. We identified Terson syndrome in 13.16% of 35 patients with ICH, finding no significant association between median haemorrhage volume and presence of Terson syndrome. Therefore, we hypothesise that Terson syndrome is less frequent in the context of ICH than in patients with TBI or SAH, and may even present different pathophysiological mechanisms.

Our study found that patients with Terson syndrome diagnosed by either IO or OU presented greater severity, as more patients presented GCS scores < 9 and higher median APACHE II score than controls. The subgroup of patients with Terson syndrome and SAH included a higher percentage of patients with Hunt & Hess scores > 3 and Fisher grades > II. The multivariate analysis confirmed these findings, both for OU and for IO. A review of the literature showed that the association between neurological severity and development of Terson syndrome is more evident in studies of patients with SAH evaluated with IO. Recent studies reveal more severe neurological involvement in patients with Terson syndrome. An example of this trend is the study by Czorlich et al.[2]: in their sample of 16 patients diagnosed with Terson syndrome by IO, 46.2% of patients presented an initial GCS score < 9, and 93.8% displayed Fisher grade III on CT images taken at admission. Joswig et al.[11] reported similar results in their sample of 36 patients with SAH, with 16.7% of patients diagnosed with Terson syndrome by IO. All patients presented initial GCS scores < 9, Fisher grade III, and Hunt & Hess scale scores > 3. Seif et al.[12] included 46 patients with SAH and reported 10 cases of Terson syndrome diagnosed by IO. Patients with Terson syndrome presented significantly greater clinical severity according to GCS and Hunt & Hess scale scores ($P < .05$). Multivariate analysis results revealed that every one-point increase in GCS scores decreased the risk of presenting Terson syndrome, with an OR of 0.8; these results are consistent with our findings.

An analysis of mortality revealed that presence of Terson syndrome, diagnosed either by IO or by OU, is associated with increased in-hospital mortality independently of the underlying condition, age, sex, and severity scale scores. In the case of SAH, other studies confirm our results: for example, the 1973 study by Fahmy[5] reported a mortality rate of 54% in patients with SAH and Terson syndrome; this rate was higher than in patients with SAH but not Terson syndrome. In a more recent study, Joswig et al.[11] conclude that patients with SAH and Terson syndrome present a higher risk of mortality, with an OR of 45 (95% CI, 3.86-524.7). However, the small size of their sample may have biased their results. In the study by Shinoda et al.,[4] conducted in a Japanese population, 31.3% of patients with SAH and Terson syndrome died; the mortality rate in this subgroup was significantly higher than in the group of patients with SAH without Terson syndrome (11.4%; $P < .05$). McCarron et al.[13] conducted a systematic review of prospective and retrospective observational studies including patients with SAH and Terson syndrome published until 2004, concluding that these patients are 4.8 times more likely to die than patients without Terson syndrome; these results are similar to our own. We did not find any studies analysing mortality in patients with TBI or ICH and Terson syndrome; therefore, our results are the first to be published on this topic, and should be confirmed by studies with greater statistical power.

The main limitation of our study is its observational design. Being a case-control study, we cannot rule out the possibility of survivorship bias, which we attempted to minimise by including incident cases and performing a multivariate analysis to control for bias and interaction effects and to adjust for confounding variables. The small size of our sample constitutes another limitation, as it reduces the statistical power of our results, with large 95% confidence intervals, hindering the analysis of functional status at 6 months. Furthermore, the study's single-centre design limits the possibility of extrapolating our results, although these are consistent with the available literature in some aspects, and our patients presented similar characteristics to those of patients attended at other reference centres.

On the other hand, our study also has several strengths, including its analytic design, which focuses on the conditions that most frequently lead to ICU admission and places particular emphasis on neurocritical care. Furthermore, it evaluates the diagnostic performance of OU, a useful diagnostic tool that is widely available in all ICUs, hospital emergency departments, and pre-hospital emergency services, and that enables detection of particularly severe cases.

Conclusion

Ocular ultrasound is a useful, accessible, and highly accurate diagnostic tool for the detection of Terson syndrome, and particularly vitreous and subhyaloid haemorrhages. In clinical practice, this tool may be used in 2 different scenarios. Firstly, it may be used in the initial assessment of comatose patients to identify particularly severe cases requiring immediate therapeutic intervention. Secondly, it may also be useful at ICUs in clinically stable patients, as detection of Terson syndrome would signal the need for multidisciplinary management involving the intensive care, ophthalmology, and rehabilitation departments. Terson syndrome is an independent risk factor for in-hospital mortality, regardless of whether it is diagnosed by IO or OU. Studies with greater statistical power should be conducted to determine the association between OU and functional outcomes at discharge.

Conflicts of interest

The authors have no conflicts of interest to declare.

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