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Hemodynamic Monitoring of Brain-Injured Patients at the Lubumbashi University Clinics: Preliminary Study on the Impact of Transcranial Doppler (TCD) versus S100 Beta Protein Assay in Therapeutic Optimization in a Resource-Limited Environment

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Abstract

Introduction: Overcrowding in emergency departments is one of the main public health problems encountered in this sector over the last decade. Aim: This work aims to assess the current state and challenges of neurosurgery in resource-limited settings. **Methodology**: We conducted a prospective interventional study from November 2024 to February 2025, in total 3 months, carried out at the University Clinic of Lubumbashi in the Surgery, Emergency and Intensive care services. A total of 28 patients were included. **Results**: The average age of our patients was 34.86 years, with male predominance, with a male-to-female ratio of 2.3. Altered consciousness was the most common presenting symptom. The average time to consult our patients was 359.1 hours, and the average Glasgow score was 11. The brain CT scan was performed in 81.48% of cases. The average time to perform TCD was 17.23 hours, an IP greater than 1.20 (92.59% of cases). The average time to S100 beta protein dosage was 15.24 hours and a surgical completion rate of 11.11% of cases. **Conclusion**: TCD and S100 β protein assay are two complementary tools in the evaluation of patients with traumatic brain injury.

Keywords

Monitoring, Transcranial Doppler (TCD), PS 100 Beta, Craniocerebral Trauma

1. Introduction

Overcrowding in emergency departments has been one of the main public health issues encountered in this sector over the past decade.

Its etiology is multifactorial; the increase in the volume of patient admissions, the shortage of medical and nursing staff, the increase in the complexity of patient management, the decrease in the capacity of some hospitals, and the budget deficit are forcing more patients to be cared for with fewer resources while remaining as efficient and competent. The significant cost of medical imaging examinations and the frequent impossibility of performing them in emergency (especially in general hospitals) are likely to delay the diagnosis of these traumatic brain pathologies and therefore appropriate medical care) [1] [2].

Faced with this ever-increasing number of patients, the priority of emergency physicians is to quickly detect serious patients requiring immediate care and those at low risk of complications who may leave the department or even the hospital more quickly. One of the solutions for the identification of these subgroups of patients and efficient management lies in the use of biomarkers and transcranial Doppler, especially in resource-limited settings. The objective was to determine whether a reference threshold for S100 Beta protein combined with transcranial Doppler (Pulsatility Index) testing would exclude intracranial lesions in brain-injured patients presenting to the emergency department of the Lubumbashi University Clinics within 6 hours.

2. Methodology

Prospective interventional study from November 2024 to February 2025, *i.e.*, 3 months, carried out at the University Clinic of Lubumbashi in the Surgery, Emergency and Resuscitation departments including 28 patients.

Inclusion criteria

Patients admitted for the management of a neurosurgical pathology with a complete medical record and having previously signed an informed consent.

Exclusion criteria

We excluded, all patients with an incomplete file, patients received for management of other traumas without cranial involvement, medical history of acute brain injury (post-traumatic or vascular within the previous 4 weeks), neurological impairment such as moderate to severe dementia, acute psychosis, or neurodegenerative disease, or patients who had not previously given informed consent.

Study parameters

Dependent variable: Cerebral hemodynamics of brain-injured patients will be

explained by independent variables.

Independent variable: Age, sex, address, time of consultation, treatment received before hospitalization, mechanism of occurrence, type of recruitment, Glasgow coma scale of the patients, condition of pupils, associated lesions, imaging, pulsatility index of the middle brain, S100 beta protein assay, therapeutics, evolution and duration of hospital stay.

Judgment criteria:

- Main (composite): Sensitivity, specificity, Negative Predictive Value and AUC of S100B up to 6 h.

Specificity, sensitivity as well as positive and negative predictive values for TCD in relation to imaging outcome, treatment and prognosis.

- Secondary: sensitivity, specificity, NPV, AUC of S100B up to 24 hours

TECHNIQUE

Transcranial Doppler:

We used a doppler ultrasound available on ultrasound machines. The middle cerebral artery is therefore the most often studied. It is a non-invasive examination that allows the velocimetric study of intracranial vessels through an ultrasound beam. It is a way of studying cerebral hemodynamics at the patient's bedside. It operates in pulse Doppler mode. The measurement of velocities allows for the calculation of the pulsatility index. The Sylvian flow (middle cerebral artery [MCA]) is estimated to account for 70% of the ipsilateral hemispheric circulation. The measurement of velocities allows the calculation of the pulsatility index (PI): PI = (Vs − Vd)/Vm.

Its normal value in adults is 1.0 ± 0.2. Probe Type: 2 HZT.

S100 beta protein assay: It is a protein selectively synthesized by certain cells of the cerebral tissue. Its cerebral specificity is related to the beta-subunit of its structure. The usual values found within a healthy Caucasian population are below 0.10 or 0.15 μg/L. Therefore, this value constitutes the physiological threshold beyond which the obtained value may reveal a tissue injury. The blood test should be performed on serum between 0 and 6 hours after the onset of symptoms. After a venous sample at the crease of the elbow, centrifugation and decantation, the biological sample can be stored at +4˚C for 48 h, at −80˚C for several months without influence on the analytical assay.

Data collection was done using the hospitalization records and register.

The search for evaluated documents extends to the following bibliographic databases: MEDLINE, Embase, Pub Med, Google search. No methodological filter was applied. The search was limited to English and French language documents published in the period from 2000 to 2025

Data analysis was done using Epi info 7.2.5.0. The different frequencies were compared using the Chi-square test.

A small "p" less than 0.05 was considered statistically significant.

In a bivariate analysis, the Chi-square test was used to check the relationship between the independent variables and the dependent variable.

Ethical considerations: we have complied with the current Helsinki standards in terms of confidentiality, non-harm, benefit and distributive justice. Our patients were free to sign an informed consent beforehand.

Limitations of the study

- Preliminary study.
- Self-financing.
- Small sample size.

3. Results

3.1. Age

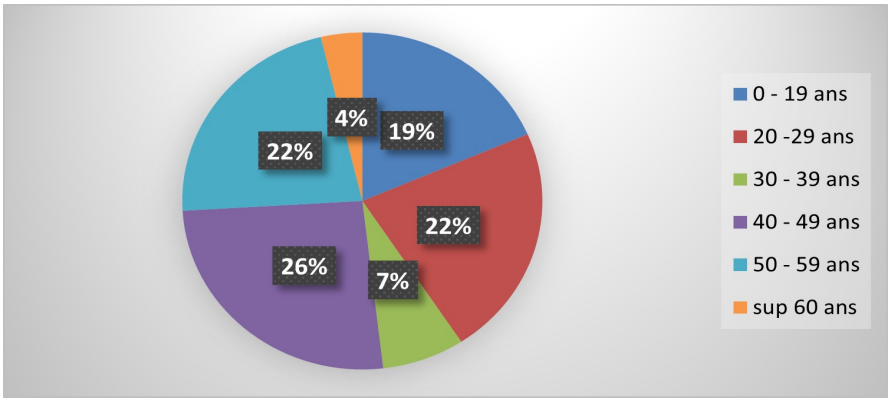

Figure 1. Distribution of patients by age.

Figure 1 shows that the average age of our patients was 34.86 years with a range from 2 months to 78 years.

The range from 40 to 49 years was the most represented with 25.92%.

3.2. Sex

The males were most represented with 70.37%.

3.3. Reason for Consultation

Patients were seen for varying reasons and impaired consciousness was the most frequent reason for consultation, 51.87% of patients were received in the emergency department, followed by headaches with 22.22% of cases (6 patients). Psychomotor agitation, convulsive seizures, functional impotence of the limbs and continuity solutions represent 25.91% of cases (7 patients).

3.4. Method of Admission

In 77.78% of cases, our patients were transferred from other medical structures and only 22.22% of patients consulted directly for their care.

3.5. Distribution of Patients According to Consultation Time

The average time to consult our patients is 359.1 hours (14.96 days) with extremes

between 3 minutes and 5760 hours (8 months).

3.6. Distribution According to the Glasgow Coma Scale

Table 1. Distribution of the Glasgow coma scale ranges of the patients.

GLASGOW	Frequency	%	ORa	IC (95%)	*p*
3 - 6	4	14.81	5.9524	0.35 - 4.61	0.4397
7 - 9	5	18.51			
10 - 14	11	40.74			0.3366
15	7	25.92	6.9327	0.41 - 3.99	
Total	27	100			

It can be seen in Table 1 that the average Glasgow score was 11, with extremes between 15 and 3. We observed a clear predominance of patients with a Glasgow score between 10 and 14 with 40.74% of cases (11 patients) followed by those with a Glasgow score of 15 (25.92% of cases).

3.7. Distribution According to the Imaging Results

Table 2. Distribution of the imaging results of the patients.

CT Scan	Frequency	Percentage
Cerebral abscess	1	3.70
Burst dorsal fracture	1	3.70
Oedematohemorrhagic contusion	9	33.33
Pneumencephaly	1	3.70
Non-displaced fracture	2	7.40
Extra dural hematoma	3	11.11
Intraparenchymal hematoma	3	11.11
Acute subdural hematoma	2	7.40
Subarachnoid hemorrhage	5	18.51
Brain tumor	1	3.70
FISHER IV intraventricular hemorrhage	1	3.70
Ischemia	1	3.70
Hydrocephalus	1	3.70
Diffuse axonal injury	2	7.40
Not completed	3	11.11
Normal	1	3.70
Non realized	2	7.41

Table 2 shows that Brain CT scan was performed in 81.48% of cases (22 patients), unlike brain MRI with only 3.70% of cases.

The average consultation time is 16.84 hours with extremes between 1 and 68 hours.

Oedematohemorrhagic contusions were the predominant lesions in our study with 33.33% of cases followed by subarachnoid hemorrhages with 18.51% of cases.

3.8. Distribution According to Completion Time of Transcranial Doppler

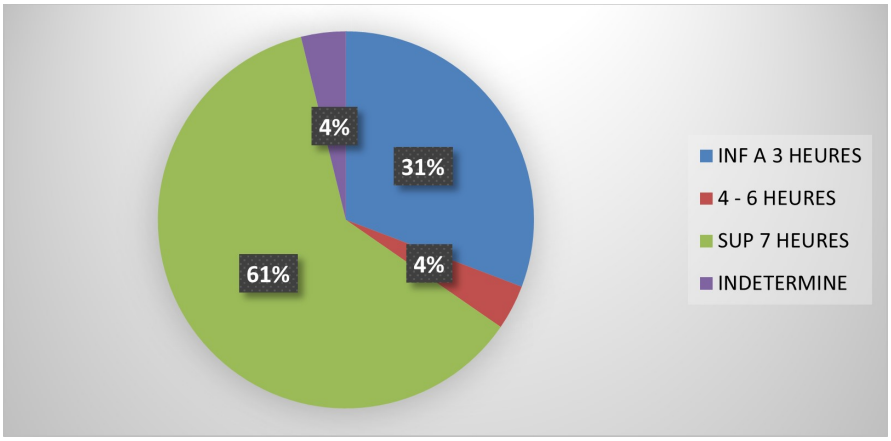

Figure 2. Completion of Transcranial Doppler of patient.

In the majority of cases, the time taken to perform TCD was more than 7 hours with 61.53% of cases (**Figure 2**).

The average time to complete TCD was 17.23 hours, with extremes between 1 and a half hours and 72 hours.

3.9. Distribution According to the Pulsatility Index

Table 3. Distribution of patients following the Pulsatility Index.

PI	Frequency	%	ORa	IC (95%)	p-value
1 - 1.19	2	7.40	11.18	0.65 - 3.99	0.1562
>1.20	25	92.59	9.15	0.58 - 3.86	
Total	27	100			

In our series, there was a clear majority of patients with a PI greater than 1.20 (92.59% of cases). An adjusted Odd ratio (Ora) greater than 1 in both cases (11.18 and 9.15), suggesting a potential association between a high PI and a factor studied.

However, the 95% confidence intervals (CI: 0.65 - 3.99 and 0.58 - 3.86) include 1, indicating that the association was not statistically significant. The value of p = 0.1562 confirms the absence of a significant difference.

Thus, although the elevated PI may be a potential risk factor (OR > 1), the results are not statistically significant and do not allow a definitive conclusion to be made (**Table 3**).

3.10. Evaluation of Sensitivity and Specificity of PI of the Middle Cerebral Artery According to the Result of the Brain CT Scan

Table 4. Evaluation of the specificity and sensitibility of PI of the MCA.

	CT Scan (+)	CT Scan (-)	CT Scan not realized	p-value
PI (+)	21	0	4	0.045
PI (-)	0	1	1	

Since cell (0.0) creates division by zero, the OR is infinite (∞). This means that all patients with a positive PI also had a positive CT scan, while no patient with a negative PI had a positive CT scan. Infinite OR indicates a perfect association between a positive PI and a positive CT (Table 4). This means that in this sample, no patients with a negative PI had a positive CT scan, which is a very strong result but potentially biased by the small sample size.

The confidence interval cannot be calculated directly because of the null values, which points to a lack of statistical robustness. In conclusion, it seems that the pulsatility index is a very good indicator of the CT result, but this conclusion should be interpreted with caution, especially because of the small sample size and the risk of selection bias. The significant p-value ($p < 0.05$) suggests that this association is not due to chance, but to a high level of, but a study with a larger sample size is needed to obtain more usable values.

SENSITIVITY: TP/(TP + FN) = 7/7 + 0 = 1(100%) of positive individuals were predicted to be positive.

SPECIFICITY: TN/(TN + FP) = 2/2 + 0 = 1 (perfect test). The specificity of the middle cerebral pulsatility index is 100% for patients with CT (+).

FALSE NEGATIVE RATE: 1 – sensitivity = 1 – 1 = 0% of cases. The false negative rate found was zero.

FALSE POSITIVE RATE: 1 – specificity = 1 – 1 = 0% of cases. The false positive rate of the middle cerebral artery pulsatility index is zero (n = 0).

THE POSITIVE PREDICTIVE VALUE: TP/TP + FP = 21/21 + 0 = 1 (100%). In our series, the positive predictive value of the middle cerebral artery pulsatility index is 1 (100%).

THE NEGATIVE PREDICTIVE VALUE: TN/TN + FN = 2/2 + 0 = 2/2 = 1 = 100%. In our series, the negative predictive value of the S100 beta protein assay dosed before 6 hours is 10%.

3.11. Allocation of Patients According to the Timeframe of the S100 Beta Protein

Table 5 shows that the average time for PS 100 beta dosing is 15.24 hours, with extremes between 1.15 and 48 hours. The mean value of the PS 100 beta dosage is 0.25 with extremes between 0.05 and 1.27. There is no significant difference between the values of PS 100 beta that PI could be a risk factor (OR > 1). The mean value of the S100 protein was 0.25 with extremes between 0.05 and 1.27. There

was no significant difference between the S100 beta protein (OR > 1) values, probably due to the small sample size.

Table 5. Timeframe of the S100 beta protein.

Parameters		Frequency	Percentage	p-value
Timeframe	<3 Hours	5	18.52%	0.262
	>3 Hours	22	81.48%	
	Total	27	100%	
Results	<0.10	2	7.40%	0.39
	>0.10	25	92.59%	
	Total	27	100%	

3.12. Imaging Assessment of the Sensitivity and Specificity of the S100 Beta Protein

There is a difference in sensitivity and specificity depending on the time taken to assay the S100 beta protein (less than or greater than 6 hours) (**Table 6**).

Table 6. Assessment of sensitivity and specificity of the S100 beta protein.

Timing of S100 protein assay	Result	CT-Scan lesions	Frequency	%
≤3 Hours	Positive	Present	5 cases	18.51
4 - 6 Hours	Positive	Present	2 cases	7.40
	Negative	Present	1 case	3.70
	Negative	Negative	2 cases	7.40
>6 Hours	Negative	Present	17 cases	62.96
Total	-	-	27	100

- SENSITIVITY: VP/(VP + FN) = 7/7 + 1 = 87.50% of positive individuals were predicted to be positive.
- SPECIFICITY: TN/(TN + FP) = 2/2 + 0 = 1 (perfect test).

(TN = True Negative, FP = False Positive)

The specificity of PS 100 beta is 100% for patients dosed between 3 and 6 hours with a clear predominance of patients before 3 hours.

- FALSE NEGATIVE RATE: 1 – sensitivity = 1 – 0.875 = 0.13.

The false negative rate in the S100 beta protein assay is 13%.

- FALSE POSITIVE RATE: 1 – specificity = 2/2 = 0% of cases.

The false positive rate in the S100 beta protein assay before 3 hours is zero (n = 0).

- THE POSITIVE PREDICTIVE VALUE: TP/(TP + FP) = 7/7 + 0 = 1

(TP = True Positive, FP = False Positive)

In our series, the positive predictive value of the S100 beta protein assay dosed before 6 hours is 1 (100%).

- THE NEGATIVE PREDICTIVE VALUE: TN/(TN + FN) = 2/2 + 18 = 2/20 = 0.1 = 10%.

In our series, the negative predictive value of the S 100 beta protein assay dosed before 6 hours is 10%.

(TN = True Negative, FN = False Negative)

3.13. Distribution of Patients According to Biology

- The blood glucose realization rate is 70.37% of cases (19 patients) with hyperglycemia in 66.66% of cases (18 patients). The average blood sugar level is 156.52 g/l with extremes between 260 and 111 g/l.
- The rate of realization of serum calcium is 44.44% of cases, *i.e.*, 12 patients with an average serum calcium of 2.43.
- The haematocrit rate is 44.44% of cases, *i.e.*, 12 patients with a mean value of 40.83 with extremes between 57 and 23.

3.14. Distribution of Patients According to the Type of Treatment

The management was generally medical with a surgical performance rate of 11.11% of cases (3 patients).

3.15. Distribution According to the Evolution

Table 7. Evolution of patients' state.

Evolution	Frequency	%	ORa	CI (95%)	*p*
Good evolution	15	55.56	1.2500	0.2188 - 1.8725	0.2157
Dead	12	44.44	0.8000	0.5341 - 4.5714	
Total	27	100			

In 55.55% of cases, as shows Table 7, the evolution was satisfactory compared to a death rate of 45.45% of cases. The average length of hospitalization is 116.96 hours with extremes between 4 and 288 hours (12 days). There was no significant difference between the S100 beta protein values (OR > 1).

3.16. Distribution According to the Complications

Table 8. Complications.

Complications	Frequency	Percentage
Secondary brain injury of systemic origin	7	25.92
Infection	1	3.70
Ischemia	1	3.70
Cardiorespiratory arrest	4	7.41
Infection	1	3.70
None	17	62.96
Total	27	100

In our series, 37.03% of patients presented complications, Secondary brain injury of systemic origin was the most frequent with 25.92% of cases (6 patients) followed by cardiorespiratory arrest with 7.41% of cases (4 patients) (Table 8).

Table 9. Average of the S100 beta protein value, PI and the survival rate according to the Glasgow coma score range.

Glasgow	PS 100 β average value	Average Pulsatility Index	Death	Frequency	Percentage
3 - 6	0.42	3	4	4	14.81
7 - 9	0.39	2.81	4	5	18.51
10 - 14	2.91	0.11	4	11	40.74
15	2.315	0.33	0	7	25.92
Total				**27**	**100**

In our series, there is no particular variation in the value of the S100 beta protein as a function of the Glasgow score, unlike the value of the pulsatility index (PI) (Table 9).

1) Glasgow score and mortality:

- Patients with a Glasgow ≤ 9 (3 - 6 and 7 - 9) have a higher IP (≈2.81 - 3) and high mortality (4 deaths in each group).
- Patients with a Glasgow ≥ 10 have a lower mortality, or even no mortality for Glasgow 15.

2) Pulsatility Index (PI) and Glasgow:

- The PI is higher for patients with low Glasgow (≤9), suggesting a link between increased cerebrovascular resistance and neurological deterioration.
- Conversely, patients with a Glasgow 15 have a low IP (0.33), indicating better brain perfusion.

3) S100 beta protein (PS 100 β):

- Unlike the PI, the value of the PS 100 β does not show a clear trend based on the Glasgow score.

Table 10. Distribution of the pulsatility index according to the Glasgow Coma Scale range.

Glasgo Coma Scale	Average Pulsatility Index	ORa	IC (95%)	p
3 - 6	3	2.517	1.66 - 30.10	**0.00058**
7 - 9	2.81			
10 - 14	0.11	1.456	1.42 - 35.32	
15	0.33			

Table 10 shows that a Glasgow score ≤ 9 is a major risk factor for death in this population. The high pulsatility index in these patients suggests impaired cerebral blood flow. A larger sample size is needed to refine these results and obtain a us-

able confidence interval. The very low p-value ($p < 0.001$) indicates that this association is highly significant and not due to chance. However, the sample is too small to obtain an interpretable OR with a realistic confidence interval. Depending on the Glasgow, we subdivide patients into 2 risk groups:

- Glasgow ≤ 9 (3 - 6 and 7 - 9) → "Risk group"
- Glasgow ≥ 10 (10 - 14 and 15) → "Less at risk group"

3.17. Correlation between Specificity, Sensitivity, True Positive Predictive Value, False Negative Predictive Value of the S100 Beta Protein and Middle Cerebral Artery Pulsatility Index

Table 11. Correlation between specificity, sensitivity, TPPV, FNPV of s100 beta protein and MCA PI.

	Sensibility	Specificity	NPV	PPV
Pulsatility Index	100	100	100	100
PS 100 Beta	85.5	100	10	100

This study highlights specificity and proportional positive predictivity values between the PS 100 beta before 3 hours (sometimes before 6 hours) and the transcranial Doppler PI despite the small difference in sensitivity (Table 11). Overall, the combination of tests in brain-injured patients is very promising in diagnosing severity.

3.18. Factors Associated with Poor Prognosis

Table 12. Factors associated with the poor prognosis.

	Average value
Age	40.58 years
Transfered	-
Long consultation delay	10.35 Hours
Low Glasgow Coma Scale	8.3
Timeframe for realization of PS100 BETA	12.94
PS 100 Beta results	0.24
Delay in performing Brain Imaging	12.75 Hours
Multiple lesions on CT Scan	-
Delay in performing TCD	16.52 Hours
Pulsatility Index at the Middle Cerebral artery	2.99
Capillary blood glucose	172.62
ACSOS. Cardiorespiratory arrest	-
Long hospital stay	114 Hours

It can be seen in Table 12 that among the factors of poor prognosis of the patients received we have age (young adult), patients transferred, long consultation time, low Glasgow, mean PS 100 beta values of 0.24; multiple CT scans, hyperglycemia, long hospitalization, ACSOS, cardiorespiratory arrest, ...

4. Discussion

4.1. General Background

Assay in biological fluids (blood, CSF) revealed an increase in the concentrations of the S-100B protein during different pathologies. This increase can have two origins [3].:

- Gene overexpression with increased release by brain cells (trisomy 21, Alzheimer's disease) or tumor tissue (malignant melanoma),
- A release of the intracellular S-100B protein following brain cell lysis (TC, HIC, STROKE, etc.) [4].

Transcranial Doppler non-invasively measures the velocity of red blood cells in the large arterial trunks of the brain. This measurement is easily obtained in the middle cerebral arteries, which account for 70% of the flow of internal carotid arteries [5].

4.2. Diagnosis

- Several authors highlight a variability in the sensitivity and specificity in the diagnostic time of the S100 beta protein according to the etiology. In this literature, we note a delay ranging from 0 to 14 days depending on the pathologies (cerebrovascular accident, traumatic, tumor, malformative, etc.) [6]-[11].

For Walae E. Abdel-Ghaffar *et al.* in 2019, the main finding of the study was that the S100B protein measured on day 3 after acute stroke was significantly correlated with short-term functional change on day 14, as determined by MRS and NIHSS scores, with a high sensitivity of 91% and a specificity of 80%, as shown by the ROC curve. The S100B protein at day 1 was not significantly correlated [8]. In line with their study, Wunderlich *et al.* found that serum concentrations and S100B protein kinetics are highly predictive of early neurobehavioral outcomes in patients after acute stroke, and that S100B protein concentrations at days 2 and 4 after acute stroke can provide valuable information on neurological status and functional impairment upon discharge from acute hospital care. Neurological status was assessed by NIHSS at admission, on days 1 and 4 in the stroke unit, on day 10, and at the hospital discharge. These results are consistent with the present study in terms of the importance of the correlation between S100B day 3 and short-term functional outcome [12].

- Within 6 hours of cranial trauma, the sensitivity of S100B was 93.8% (95% CI: 69.8% to 99.8%) and the specificity was 30.8% (22.6% to 40.0%). The negative predictive value (NPV) was 97.3% (95% CI: 84.2% to 99.6%) and the area under the curve (AUC) was 0.73 (95% CI 0.61 to 0.85; p = 0.003) [3].
- Within 24 hours of cranial trauma, sensitivity was 82.9% (95% CI: 66.4% to

93.44%) and specificity was 43.0% (95% CI: 36.6% to 49.7%). NPV was 94.29% (95% CI: 88.7% to 97.2%) and AUC was 0.65 (95% CI: 0.56 to 0.74 valuable information on neurological status and functional impairment upon discharge from acute care hospital. Neurological status was assessed by NIHSS at admission, days 1 and 4 in the stroke unit, day 10, and hospital discharge. These results are consistent with the present study in terms of the importance of the correlation between S100B day 3 and short-term functional outcome [13].

- Within 6 hours of cranial trauma, the sensitivity of S100B was 93.8% (95% CI: 69.8% to 99.8%) and the specificity was 30.8% (22.6% to 40.0%). The negative predictive value (NPV) was 97.3% (95% CI: 84.2% to 99.6%) and the area under the curve (AUC) was 0.73 (95% CI 0.61 to 0.85; p = 0.003) [3].
- Within 24 hours of cranial trauma, sensitivity was 82.9% (95% CI: 66.4% to 93.44%) and specificity was 43.0% (95% CI: 36.6% to 49.7%). NPV was 94.29% (95% CI: 88.7% to 97.2%) and AUC was 0.65 (95% CI: 0.56 to 0.74).

The SENSITIVITY is 1 (100%) of positive individuals were predicted to be positive. The specificity of the middle brain pulsatility index is 100% for patients with MDD (+) and the false negative rate found was zero.

The false positive rate of the middle cerebral artery pulsatility index is zero (n = 0). The positive predictive value of the middle cerebral artery pulsatility index is 1 (100%) and the negative predictive value of the S 100 beta protein assay measured before 6 hours is 10%.

Classification of Patients According to the Pulsatility Index (PI)

This table shows how patients can be classified based on Middle Cerebral Artery Pulsatility Index and Cranio-cerebral Trauma severity levels

This table shows how patients can be classified based on the PI of ACM and the severity levels of TCE.

4.3. Prognosis

- ♣ The plasma concentration of the S-100B protein is significantly increased after severe cranial trauma (Glasgow score < 9), at admission of patients to hospital [14]. A prognostic interest of the plasma S-100B protein has also been demonstrated: the increase in the S-100B protein is an excellent predictive biomarker of patient death or survival with major irreversible sequelae [5]. However, this requires a repeated evaluation in order to determine the curve of the values and thus, correlate it with the various parameters, both clinical and paraclinical, in order to determine the patient's prognosis.
- ♣ A relationship between the clinical course of patients at three months and the plasma concentration of the S-100B protein in the days following the onset of the cerebral hemorrhage was also reported: patients with the highest S-100B protein concentrations had an unfavorable outcome in terms of mortality or irreversible sequelae. For these patients with a poor prognosis, the elevated plasma concentration of the protein on the first day was maintained for at least 4 days after the onset of bleeding. Similarly, elevated systemic concentrations

of the S-100B protein (remaining elevated after the initial bleeding event or increasing again after partial or total normalization) indicate the onset of cerebral vasospasm, a frequent complication of meningeal hemorrhages, and give this marker a prognostic value for the evolution of brain damage [15].

- Patients for whom cerebral ischemia is detected early by brain CT are also those with the highest peak concentrations of S-100B protein, thus associating the elevation of the biomarker with the severity of stroke. Similarly, there is a negative correlation between neurological evolution scores and the maximum value of the concentration of the S-100B protein, which is not found with other neurospecific biomarkers, such as Neuron Specific Enolase. The determination of plasma S-100B protein levels can therefore contribute combined with clinical and neuroradiological data, to assessing the extent of stroke brain damage, as well as the patient's functional recovery in the short, medium and long term.
- In our series, patients with Glasgow ≤ 9 (3 - 6 and 7 - 9) have a higher PI (≈2.81 - 3) and high mortality (4 deaths in each group). Patients with Glasgow ≥ 10 have lower or no mortality. The PI is higher for patients with low Glasgow (≤9), suggesting a link between increased cerebrovascular resistance and neurological deterioration.

Conversely, patients with a Glasgow 15 have a low PI (0.33), indicating better cerebral perfusion. In contrast to the PI, the value of the PS-100 β does not show a trend according to the Glasgow score.

5. Iconography

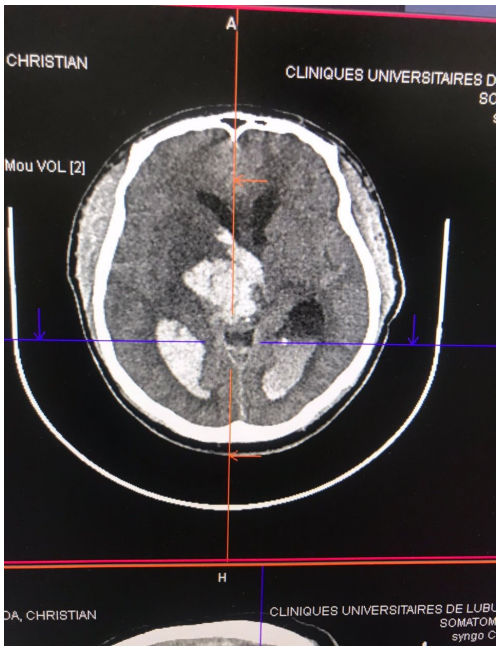

Figure 3. Intraoperative image of a decompressive flap and evacuation of an epidural hematoma in an infant at the university Clinic of Lubumbashi.

It is seen in Figure 3 a decompressive flap of an epidural hematoma in an infant.

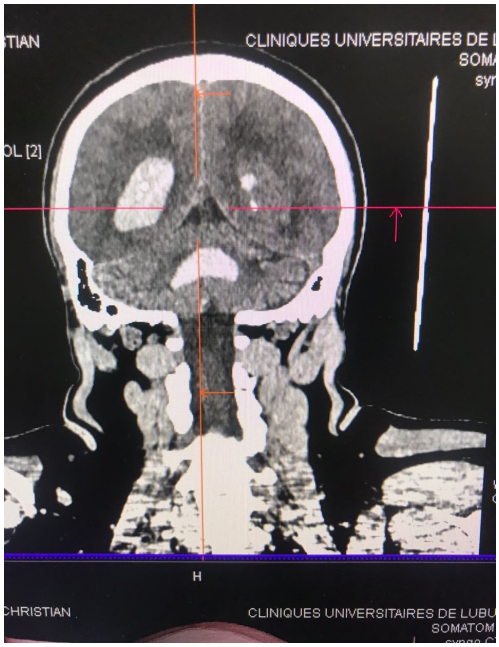

Figure 4. Axial slice and coronal reconstruction of a CT-Scan without contrast injection, revealing intraventricular hemorrhage (Fisher grade 4).

Figure 4 shows an axial slice and coronal reconstruction of a CT scan without contrast injection that revealed an intraventricular hemorrhage.

6. Conclusions

In summary, DTC and S100 β protein assay are two complementary tools in the evaluation of patients with TCE. DTC offers real-time assessment of brain hemodynamics, while the S100 β protein assay can help identify patients at low risk of complications, although its specificity is limited.

A multicentric study with a larger population would be necessary for the validation of a protocol.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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