Zagazig University Medical Journal
www.zumj.journals.ekb.eg

https://doi.org/10.21608/zumj.2024.272757.3198 **Volume 30, Issue 9.1, December. 2024, Supplement Issue**

Manuscript id: ZUMJ-2402-3198
Doi: 10.21608/ZUMJ.2024.272757.3198

ORIGINAL ARTICLE

The Role of Trans cranial Duplex and Jugular Venous Oxygen Saturation Monitoring as a Predictive Value in Cases of Deep Seated Brain Lesion after Head Trauma

Amr AlBakry[1], Magdy El-Sayed Hassan Rashed[1], Ahmed Hamouda Abdelaziz Mohamed Salem[1*], Wael Abd-Elrahman El-Mesallamy[1]
[1] Neurosurgery Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt

***Corresponding author:**
Ahmed Hamouda Abdelaziz Mohamed Salem
Email:
a.hamoda22@medicine.zu.edu.eg

Submit Date:25-02-2024
Revise Date: 04-03-2024
Accept Date:07-03-2024

ABSTRACT

Background: Head injuries (HI) are a major threat to public health. Initial management should involve careful evaluation and neurological assessment. We aim to evaluate the predictive value of trans cranial duplex and jugular venous oxygen saturation in patients with deep-seated brain lesions after Head Trauma.

Methods: A prospective study on 60 patients with deep-seated brain lesions after head trauma was conducted at the neurosurgical department and intensive care unit in Zagazig University Hospital. Trans cranial duplex and Jugular Venous Oxygen Saturation Monitoring were assessed in all patients.

Results: The best cutoff of TCD (PI) at week 2 that can predict unfavorable outcomes among patients is ≥0.95 cm with area under curve 0.838 with 73.1% sensitivity and 60% specificity. The best cutoff of TCD (MFV) at week 2 that can predict unfavorable outcomes among patients is ≤39.5 cm/sec with area under curve 0.831 with 84.6% sensitivity and 60% specificity. The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is ≥73.5% with an area under curve 0.908 with 80.8% sensitivity and 60% specificity.

Conclusion: There is a statistically significant relation between outcome and SjVO2 at ER admission and at each point of the follow-up period till the end of the second week where all those with favorable outcomes were discharged (higher levels significantly associated with unfavorable outcomes). There is a statistically significant relation between outcome and TCD (MFV) and TCD (PI) at ER admission, first and third week (lower TCD (MFV) and higher TCD (PI) were significantly associated with unfavorable outcome).

Keywords: Head Trauma, trans cranial duplex, Jugular Venous Oxygen Saturation.

INTRODUCTION:

Head injuries (HI) pose a serious hazard to public health, and there are important global risk factors for mortality in all age categories [1]. Any injury that causes harm to the scalp, skull, or brain is classified as a head injury (HI). These injuries can be brought on by falls, sports injuries, road accidents, or gunshot wounds. One of the most common causes of traumatic head injuries (THI) and one of the leading causes of road traffic accidents (RTA) fatalities is vehicle accidents [2,3].

The severity of head injuries varied, ranging from mild to severe due to the possibility of tissue damage, including contusions, hemorrhages, and diffuse axonal injury, as well as alterations in cell structure and function [4,5]. Commonly occurring skull fractures and hemorrhages can coexist with head trauma and have an impact on the case's outcome [6].

There is always a period of unconsciousness following severe head injuries resulting in deep-seated brain lesions. The phrase "disorder of consciousness" is used when this period of time is prolonged. Coma, vegetative state, and minimally conscious state are examples of consciousness disorders. It's critical to diagnose consciousness level precisely. It can assist in making both short- and long-term predictions. It can also assist in early recovery guiding critical decisions and in the planning of treatment. Prognoses for long-term healing made early on are frequently off. The medical staff ought to be skilled in treating severe traumatic brain injury. The numerous complex difficulties that may arise during your loved one's recuperation are best left to the experts [7-10].

CBF velocity can be measured non-invasively using transcranial Doppler (TCD). It is being used more frequently in neurocritical care, which includes TBI. The detection of problems such as vasospasm, significant increases of ICP and decreases in CPP, carotid dissection, and cerebral circulatory arrest (brain death) that may occur in patients with TBI can be aided by this clinically valuable technique. Before post-traumatic vasospasm manifests clinically, TCD can anticipate it. TCD has been proposed as a non-invasive substitute method for ICP and CPP measurement because ICP monitoring is an intrusive operation with possible side effects. TCD has an overall specificity of 98% and sensitivity of 75% to 88% for confirming brain death [11].

Jugular venous oxygen saturation (SjvO2), which represents the relationship between cerebral blood flow (CBF) and cerebral metabolic rate of oxygen (CMRO2), is a measure of both cerebral oxygenation and cerebral metabolism. For SjvO2 monitoring, an internal jugular vein (IJV) retrograde catheterization is utilized. Since the right IJV is typically prominent, cannulation to represent global cerebral oxygenation often uses it [10].

METHODS

This work was conducted as a prospective study on 60 patients with deep-seated brain lesions after head trauma at the neurosurgical department and intensive care unit in Zagazig University Hospital.

Inclusion criteria: included age from 18-60 years, traumatic deep-seated (subcortical)brain lesions, and patients managed conservatively. Exclusion criteria included age <18 and > 60 years, post-cardiac arrest patients, and presented GCS 3 (2 + T) for 24 hours.

Management of severe traumatic brain injury

Patients were subjected to the following: history taking, and initial ER management according to Advanced Trauma Life Support (ATLS) **[12].** Assessments of breathing, ventilation, circulation with hemorrhage control, neurologic assessment and exposure, and environmental control were performed as part of a primary survey. Additionally, tertiary and secondary surveys were conducted.

Comprehensive Neurosurgical examination included general physical condition assessment, neurological examination for assessment of Glasgow coma scale (GCS), motor and sensory examination, reflexes, pupils, cranial nerve examination, fundus examination, and signs of lateralization. According to the clinical examination of the patient, abdominal ultrasonography, plain X-ray for the skull, chest, cervical, dorsal, lumbar spine, and others, computed tomography of the spine and CT brain were done. Then the patient was managed conservatively then admitted to the ICU for further management.

Transcranial doppler pulsatility index measurements (on the M1 segment of the middle cerebral artery through the transtemporal window) were done at the time of admission and repeated weekly. There are two methods of measurement: automatic and manual method. Steps are:

- Put the probe P4-2 on the head after placing gel, above the zygomatic arch, anterior to the tragus in the mesencephalic plane to identify the hypoechogenic (butterfly-shaped midbrain).
- Press the C, button (1) and try to change the position of the probe from the mesencephalic plane to the diencephalic plane till the M1 segment of the middle cerebral artery appears (red).
- Press D, button (2) and move the arrow on the screen by trackball, button (3) and bring it to the artery then press D, button (2) again. Here, continuous doppler pulse waves record.
- Then they are two methods of measurement:
  - Automatic: during continuous doppler, pulse waves record roll button (4) twice to the right, till (auto state) mark appears on the screen then move button (5) up. Here, automatic measurements appear on the screen. So after 30 seconds from continuous recording, you can freeze the image button (6) and take the measurements.
  - Manual: after 30 seconds from continuous recording you can freeze the image button (6). Then press button (7), and many marks will

appear on the screen so, move button (8) down to choose (PI manual) then put the mark at the base of the systolic wave by a trackball, button (3) then press set, button (9). After that move the mark along the edge of the systolic wave to the base of the next systolic wave by trackball, button (3) then press set, button (9). Here, measurements appear on the screen (figure 1).

SjVO2 catheter (catheter insertion) was done and samples were taken daily from the onset of trauma till the end of 1st week then weekly until the improvement of the case or end of the study period or become excluded from the criteria**.** The central venous line indwelling catheter is used for jugular bulb catheterization. After the patient is fully sterilized and toweled, they are placed either horizontally or slightly head down. Using a puncture site akin to that of central venous catheterization, the central approach is frequently utilized to insert a pediatric introducer with a luer lock adapter into the internal jugular vein. This can be done either proximally, at the level of the cricoid ring, or distally, between the heads of the sternocleidomastoid. The needle, guidewire, and catheter are advanced in a cephalad direction, in contrast to central venous catheterization. The Seldinger guidewire should be J-shaped and should only be advanced 2-3 cm beyond the needle insertion site due to the potential for vascular injury to the jugular bulb. After that, the catheter should be advanced until resistance is reached at the jugular bulb, which is typically about 15 cm. A lateral or anteroposterior (AP) neck radiograph was used to confirm the catheter tip's location.

Patients were followed up clinically by Glasgow coma scale, blood pressure, and radiologically by CT scan that was repeated 24 hours to check for any new pathology orincrease of the initial pathology. CT scan was also repeated weekly. Also, patients were followed up by laboratory investigations by daily follow-up of jugular venous oxygen saturation by SIEMENS ABG analyzer machine. TCD was done at the time of admission and followed up weekly.

RESULTS

There is a statistically significant relation between outcome and each of age (increasing age significantly associated with the poor outcome), mode of trauma (the unfavorable outcome was associated with RTA), associated injuries and lateralization (associated with the unfavorable outcome), SO2 (low SO2 is associated with the unfavorable outcome) (Table 1).

There is a statistically significant relation between outcome and TCD (PI) at ER admission, first and third week (increasing TCD (PI) significantly associated with unfavorable outcome) (Table 2).

There is a statistically significant relation between outcome and TCD (MFV) at ER admission, first and third week (lower TCD (MFV) significantly associated with unfavorable outcome) (Table 3).

There is a statistically significant relation between outcome and SjVO2 at ER admission and at each point of the follow-up period till the end of the second week where all those with favorable outcomes were discharged (higher levels significantly associated with unfavorable outcomes) (Table 4).

The best cutoff of baseline TCD (PI) that can predict unfavorable outcomes among patients is ≥0.95 cm with area under curve 0.99 (CI 0.973 – 1) with 100% sensitivity and 88.9% specificity. The best cutoff of TCD (PI) at week 1 that can predict unfavorable outcomes among patients is ≥0.95 cm with area under curve 0.971 (CI 0.934 – 1) with 95% sensitivity and 85.7% specificity. The best cutoff of TCD (PI) at week 2 that can predict unfavorable outcomes among patients is ≥0.95 cm with area under curve 0.838 (CI 0.672 – 1) with 73.1% sensitivity and 60% specificity (Table 5).

The best cutoff of baseline TCD (MFV) that can predict unfavorable outcomes among patients is ≤43 cm/sec with the area under curve 0.932 (CI 0.863 – 1) with 95.3% sensitivity and 76.5% specificity. The best cutoff of TCD (MFV) at week 1 that can predict unfavorable outcomes among patients is ≤39.5 cm/sec with area under curve 0.9 (CI 0.805 – 0.995) with 95% sensitivity and 85.7% specificity. The best cutoff of TCD (MFV) at week 2 that can predict unfavorable outcomes among patients is ≤39.5 cm/sec with area under curve 0.831 (CI 0.626 – 1) with 84.6% sensitivity and 60% specificity (Table 5).

The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥75%** with an area under curve 0.953 (CI 0.891–1) with 95.3% sensitivity and 88.9% specificity. The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥76.5%** with an area under curve 0.888 (CI 0.801 – 0.974) with 82.5% sensitivity and 85.7% specificity. The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥73.5%** with an area under curve 0.908 (CI 0.784 – 1) with 80.8% sensitivity and 60% specificity (Table 5).

Table 1: Relation between outcome and baseline data of studied patients

	Unfavorable outcome	Favorable outcome	χ^2	p
	N=43 (%)	N=17 (%)		
Gender:			1.103	0.294
Female	14 (32.6%)	8 (47.1%)		
Male	29 (67.4%)	9 (52.9%)		
Residence			2.838	0.092
Rural	23 (53.5%)	5 (29.4%)		
Urban	20 (46.5%)	12 (70.6%)		
Mode of trauma			MC	<0.001**
Direct	0 (0%)	5 (29.4%)		
FFH	5 (11.6%)	5 (29.4%)		
RTA	38 (88.4%)	7 (41.2%)		
Associated injury:			20.858	<0.001**
No	5 (11.6%)	12 (70.6%)		
Yes	38 (88.4%)	5 (29.4%)		
Lateralization:			13.733	<0.001**
No	21 (48.8%)	17 (100%)		
Yes	22 (51.2%)	0 (0%)		
	Mean ± SD	**Mean ± SD**	**t**	**p**
Age (year)	39.05 ± 15.47	28.82 ± 10.81	2.899	0.006*
SO2 (ER)	89.47 ± 6.09	93.82 ± 2.86	-3.763	<0.001**

t independent sample t-test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant χ^2Chi square test

Table 2: Relation between outcome and TCD (PI) among studied patients over the follow-up period:

TCD (PI)	Unfavorable outcome	Favorable outcome	t	p
	Mean ± SD	Mean ± SD		
At ER	1.37 ± 0.3	0.77 ± 0.12	11.173	<0.001**
Day 7	1.35 ± 0.32	0.83 ± 0.11	8.833	<0.001**
Week 2	1.15 ± 0.28	0.88 ± 0.11	2.09	0.046*
Week 3	0.99 ± 0.15			
Week 4	1.07 ± 0.11			

t independent sample t-test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table 3: Relation between outcome and TCD (MFV) among studied patients over the follow-up period:

TCD (MFV)	Unfavorable outcome	Favorable outcome	t	p
	Mean ± SD	Mean ± SD		
At ER	34.09 ± 4.24	43.41 ± 3.76	-7.914	<0.001**
Day 7	34.63 ± 3.41	40.86 ± 2.74	-6.165	<0.001**
Week 2	35.5 ± 3.06	39.0 ± 2.73	-2.373	0.024*
Week 3	36.4 ± 2.54			
Week 4	35.54 ± 2.57			
Week 4	1.07 ± 0.11			

t independent sample t-test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table 4: Relation between outcome and SjVO2 of studied patients over the follow-up period:

SjVO2	Unfavorable outcome	Favorable outcome	t	p
	Mean ± SD	Mean ± SD		
At ER	83.6 ± 5.07	71.59 ± 2.67	9.25	<0.001**
Day 1	83.6 ± 5.07	71.41 ± 2.53	9.434	<0.001**
Day 2	83.23 ± 4.91	71.41 ± 1.84	9.616	<0.001**
Day 3	82.84 ± 5.06	72.29 ± 2.62	8.147	<0.001**

Day 4	82.35 ± 5.09	72.35 ± 2.53	9.923	<0.001**
Day 5	82.67 ± 4.48	72.35 ± 3.3	9.818	<0.001**
Day 6	82.28 ± 4.46	73.65 ± 3.64	7.032	<0.001**
Day 7	82.48 ± 5.47	73.43 ± 3.32	5.801	<0.001**
Week 2	79.85 ± 5.32	68.6 ± 4.93	4.372	<0.001**
Week 3	77.85 ± 5.44			
Week 4	80.08 ± 4.97			

t independent sample t-test *p<0.05 is statistically significant **p≤0.001 is statistically highly significant

Table 5: Performance of TCD (PI), TCD (MFV), and SJVO2 in the prediction of unfavorable outcomes among studied participants:

TCD (PI)	Cutoff	AUC	95% CI	Sensitivity	Specificity	p
Baseline	**≥0.95**	0.99	0.973 – 1	100%	88.9%	<0.001**
Week 1	≥0.95	0.971	0.934 – 1	95%	85.7%	<0.001**
Week 2	≥0.95	0.838	0.672 – 1	73.1%	60%	0.018*
TCD (MFV)	**Cutoff**	**AUC**	**95% CI**	**Sensitivity**	**Specificity**	**p**
Baseline	≤43	0.932	0.863 – 1	95.3%	76.5%	<0.001**
Week 1	≤39.5	0.9	0.805 – 0.995	95%	85.7%	<0.001**
Week 2	≤39.5	0.831	0.626 – 1	84.6%	60%	0.021*
SjVO2	**Cutoff**	**AUC**	**95% CI**	**Sensitivity**	**Specificity**	**p**
Baseline	**≥75**	0.953	0.891 – 1	95.3%	88.9%	<0.001**
Week 1	≥76.5	0.888	0.801 – 0.974	82.5%	85.7%	<0.001**
Week 2	≥73.5%	0.908	0.784 – 1	80.8%	60%	0.004*

AUC area under curve **p≤0.001 is statistically highly significant

Figure 1: Steps of transcranial doppler pulsatility index measurement

DISCUSSION

Our study showed that there is a statistically significant relation between outcome and each age (increasing age significantly associated with the poor outcome), mode of trauma (the unfavorable outcome was associated with RTA), associated injuries, and lateralization (associated with the unfavorable outcome), SO2 (low SO2 is associated with the unfavorable outcome).

Behzadnia et al. [13] revealed that several age-related factors, including glycemia, arterial gasometry readings, convulsions, otorrhagia, sex, and the presence of accompanying lesions, had no statistically significant correlation with unfavorable outcomes.

Cormio et al. [14] revealed that compared to patients who died or went into a vegetative state, those who recovered to a GOS score of good recovery or mild disability were younger and had a higher entry GCS score. The distribution of genders and the kind of damage did not differ substantially between the result groups. Compared to patients who were severely damaged, died, or went into a vegetative state, those who had a better result also showed a greater CMRO2. Compared to patients who recovered with a significant disability, they had a lower CVR and mean arterial blood pressure, as well as a lower ICP than the patients who passed away or went into a vegetative state. Patients with favorable outcomes tended to have greater CBFs, however, the difference was not quite statistically significant (p = 0.085).

Our study showed that there is a statistically significant relation between outcome and TCD (PI) at ER admission, first and third week (increasing TCD (PI) significantly associated with unfavorable outcome).

Ali et al. [15] revealed that the values of transcranial Doppler ultrasonography (PI and blood flow velocity), which are known to be significant in severe neurological conditions, particularly in the identification of brain death and the diagnosis of vasospasm linked to spontaneous aneurysmal SAH show a high degree of sensitivity in both uni- and multivariate analyses when predicting the prognosis of patients with severe brain injuries.

Sharma et al. [16] showed that a standard procedure was adhered to to verify the validity of the desaturation and determine its cause whenever SjvO2 fell to less than 50%. After in vivo calibration when there was sufficient light intensity at the catheter tip, there was an excellent correlation between the SjvO2 values obtained by the catheter and the direct measurement of O2 saturation by a co-oximeter on venous blood withdrawn through the catheter. A total of 60 episodes of jugular venous oxygen desaturation occurred in 45 patients.

Imen et al. [17] revealed that jugular venous desaturation was strongly associated with a poor neurological outcome; the incidence of desaturation remained significantly associated with a poor outcome even after controlling for all covariates found to be significant, such as age, Glasgow coma score, papillary reactivity, type of injury, lowest recorded cerebral perfusion pressure, and highest recorded temperature. While this study was unable to establish a cause-and-effect relationship with the outcome, the data suggest that monitoring SvO2 might allow early identification and, consequently, treatment of numerous types of secondary brain injury.

Our study showed that there the best cutoff of baseline TCD (MFV) that can predict unfavorable outcomes among patients is **≤43 cm/sec** with area under curve 0.932 (CI 0.863 – 1) with 95.3% sensitivity and 76.5% specificity. The best cutoff of TCD (MFV) at week 1 that can predict unfavorable outcomes among patients is **≤39.5 cm/sec** with area under curve 0.9 (CI 0.805 – 0.995) with 95% sensitivity and 85.7% specificity. The best cutoff of TCD (MFV) at week 2 that can predict unfavorable outcomes among patients is **≤39.5 cm/sec** with the area under curve 0.831 (CI 0.626 – 1) with 84.6% sensitivity and 60% specificity.

In addition, **Fatima et al. [18]** The use of meta-analysis is an additional measure in assessing TCD's effectiveness in TBI cases. It has been demonstrated that a negative result at 6 months (Glasgow outcome score [GOS] score 1-3: death, vegetative state, or severe impairment) can be predicted by a low flow velocity, defined as MCA MFV of <35 cm/s within 72 hours of head injury, with an OR of 3.9 (CI 1.2–13).

Pulsatilite et al. [19] indicated a correlation between the MCA PI and the TBI outcome. A low PI of ≤1 indicated 71% of patients with a good result (GOS 4–5), while a high PI of ≥1.56 suggested approximately 83% risk of poor outcome at 6 months.

D'Andrea et al. [20] revealed that the presence of severe BA VSP (MFV >85 cm/s) was linked to a vegetative state, while moderate BA VSP (MFV >60 cm/s) was related to a permanent neurological disability in a study of 116 SAH patients. These findings suggest that the severity of VSP may predict the result of the GOS.

According to a different study by **Kalanuria et al. [21],** individuals with TBI who had hyperemia or VSP were more likely than those who did not have a major FV change to have a bad outcome (GOS: 1-3). According to one study by **Hawthorne et al. [22],** 10 head-injured patients were examined and showed a positive exponential correlation between PI and epidural pressure. An elevated PI (PI 1.56) indicates a poor outcome, and an additional correlation between ICP and PI was discovered. According to **Bellner et al. [23],** there is a highly significant correlation between ICP and PI, independent of intracranial pathology.

Our study showed that there the best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥75%** with an area under curve 0.953 (CI 0.891 – 1) with 95.3% sensitivity and 88.9% specificity. The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥76.5%** with an area under curve 0.888 (CI 0.801 – 0.974) with 82.5% sensitivity and 85.7% specificity. The best cutoff of baseline SjVO2 that can predict unfavorable outcomes among patients is **≥73.5%** with area under curve 0.908 (CI 0.784 – 1) with 80.8% sensitivity and 60% specificity.

Imen et al. [17] revealed that the proportion of patients with a poor neurological outcome was 55% in patients without any episodes of desaturation, compared to 90% in patients with many episodes and 74% in patients with one desaturation.

CONCLUSION

Transcranial Doppler ultrasonography is a bloodless technique that is easily performed at the patient’s bedside to determine the mean blood flow velocity and PI values of the MCA. Monitoring of SjvO2 is commonly used to judge the adequacy of cerebral oxygenation because it provides an assessment of the overall balance between cerebral metabolism and CBF.

There is a statistically significant relation between outcome and SjVO2 at ER admission, and at each point of the follow-up period till the end of the second week where all those with favorable outcomes were discharged (higher levels significantly associated with unfavorable outcomes). There is a statistically significant relation between outcome and TCD (MFV) at ER admission, first and third week (lower TCD (MFV) significantly associated with unfavorable outcome). There is a statistically significant relation between outcome and TCD (PI) at ER admission, first and third week (increasing TCD (PI) significantly associated with unfavorable outcome).

Conflict of interest: None
Financial Disclosure: None
Funding information: None

REFERENCES

1. Abdelgeleel NM, Salama KM, Ali MA, and Elsagher AN. Assessment of management of polytrauma patients in the emergency department in Suez Canal University hospital. Int. Surg. J., 2019; 6(6), 1844-1850.
2. Alnaami I, Alshehri S, Alghamdi S, Ogran M, Qasem A, Medawi A, et al. Patterns, types, and outcomes of head injury in Aseer Region, Kingdom of Saudi Arabia. Neurosci J, 2019; e2782146-e2782146.
3. Dawson B, Trapp RG. Basic and clinical biostatistics. Singapore, 2004, 141-142.
4. El Shehaby DM, Farahat MA, Shahine MS, Mohammed HM. Medico-legal evaluation and trend of the different patterns of maxillofacial fractures concomitant with a closed head injury in Upper Egypt: a retrospective study. Egypt. J. Forensic Sci., 2020; 10 (1), 1-9.
5. El-Farouny RH, Habib N. Evaluation of Relation Between Interpersonal Violence and Drug Abuse on Cases Attended to Menoufia University Hospital (A Prospective Study). Egypt. J. Forensic Sci., 2019; 19(1), 17-37.
6. Eshete A, Taye F. Magnitude of severe head injury and its associated factors among head injury patients in Gedeo zone, southern Ethiopia: a two-year retrospective study. Ethiop. J. Health Sci., 2018; 28(3), 323-330.
7. Maegele M, Lefering R, Sakowitz O, Kopp MA, Schwab JM, Steudel WI, et al. The Incidence and Management of Moderate to Severe Head Injury: A Retrospective Analysis of Data From the Trauma Register of the German Trauma Society. Dtsch Arztebl Int, 2019; 116(10), 167.
8. Mahran DG, Farouk OA, Qayed MH, Berraud AF. Hospitalized injuries and deaths in a trauma unit in upper Egypt. Int. J. Crit. Illn. Inj. Sci., 2013; 3(4), 235.
9. Mahran DG, Farouk O, Qayed MH, Berraud A. Pattern and trend of injuries among trauma unit attendants in Upper Egypt. Trauma Mon., 2016; 21(2).
10. Mostafa ES, Abouhashem NS, Hussein HS. Timing of Traumatic Brain Injury And Its Systemic Effects On The Lungs Of Adult Male Albino Rats. Egypt. J. Forensic Sci. Appl. Toxicol., 2016; 16(2), 169-191.
11. Pearn ML, Niesman IR, Egawa J, Sawada A,

Almenar-Queralt A, Shah SB, et al. Pathophysiology Associated with traumatic brain injuries in North Texas children. Rural Remote Health., 2017; 11(1), 1521-1521.

12. Kusuma AA, Bunawan R, Siagian A. General Practitioner's Level of Survey on Trauma Cases in Dustira Level II Hospital. In 12th Annual Scientific Meeting, Medical Faculty, Universitas Jenderal Achmad Yani, International Symposium on" Emergency Preparedness and Disaster Response during COVID 19 Pandemic"(ASMC 2021)) (pp. 279-290). Atlantis Press. 2021.
13. Behzadnia MJ, Anbarlouei M, Hosseini SM, Boroumand AB. Prognostic factors in traumatic brain injuries in emergency department. Journal of Research in Medical Sciences: J. Res. Med. Sci., 2022; 27**.**
14. Cormio M, Valadka AB, Robertson CS. Elevated jugular venous oxygen saturation after severe head injury. Neurosurg. Focus, 2011; 11(4), 9-15.
15. Ali MF. Transcranial Doppler ultrasonography (uses, limitations, and potentials): a review article. Egypt j. neurosurg., 2021; 36(1), 1-9.
16. Sharma D, Lele A. Monitoring of jugular venous oxygen saturation. Monitoring the nervous system for anesthesiologists and other health care professionals, 2017; 229-242.
17. Imen RB, Olfa C, Kamilia C, Meriam B, Hichem K, Adel C, et al. Factors predicting early outcome in patients admitted at emergency department with severe head trauma. J. Acute Dis., 2015; 4(1), 68-72.
18. Fatima N, Shuaib A, Chughtai TS, Ayyad A, Saqqur M. The Role of Transcranial Doppler in Traumatic Brain Injury: A Systemic Review and Meta-Analysis. Asian J Neurosurg. 2019 Jul-Sep;14(3):626-633.
19. Pulsatilite İ.B, Korelasyonu İ. Correlation of pulsatility index with intracranial pressure in traumatic brain injury. Turk. Neurosurg., 2011; 21(2), 210-215.30
20. D'Andrea A, Conte M, Scarafile R, Riegler L, Cocchia R, Pezzullo E, et al. Transcranial Doppler ultrasound: physical principles and principal applications in neurocritical care unit. Journal of cardiovascular echography, 2016; 26(2), 28.
21. Kalanuria A, Nyquist PA, Armonda RA, Razumovsky A. Use of transcranial Doppler (TCD) ultrasound in the neurocritical care unit. Neurosurgery Clinics, 2013; 24(3), 441-456.
22. Hawthorne C, Piper I. Monitoring of intracranial pressure in patients with traumatic brain injury. Front Neurol, 2014; 5, 121.
23. Bellner J, Romner B, Reinstrup P, Kristiansson KA, Ryding E, Brandt L. Transcranial Doppler sonography pulsatility index (PI) reflects intracranial pressure (ICP). Surg. Neurol., 2004; 62(1), 45-51.

Citation

AlBakry, A., Rashed, M., Salem, A., El-Mesallamy, W. The role of trans cranial duplex and Jugular Venous Oxygen Saturation Monitoring as a Predictive Value in Cases of Deep Seated Brain Lesion After Head Trauma. *Zagazig University Medical Journal,* 2024; (5059-5066): -. doi: 10.21608/zumj.2024.272757.3198

AlBakry, A., et al **5066** | Page