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Efficacy of Differential Diagnostic Markers for Identification of Increased Intracranial Pressure (ICP), and Early Diagnosis is "Life Saving"

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Abstract

Aims

To compare the efficacy of diagnostic markers for the identification of raised Intracranial Pressure, early diagnosis is the life savage.

Methods

A total of 170 patients admitted to the emergency medical unit of the Department of Emergency Medicine, Kerala Institute of Medical Sciences (KIMS), Thiruvananthapuram was observed for till their discharge/deceased and the results were recorded from April 2021 to June 2021.

All the patient's demographic details, duration to the emergency department in hours, and presences of symptoms during admission were recorded. The patient's identified Increased Intracranial Pressure (ICP) was recorded and brain injury was also recorded and classified based on Glasgow Coma Scale (GCS). The recorded data were analyzed and compared the efficacy of differential diagnostic markers for early diagnosis of Increased Intracranial Pressure (ICP). The data on ophthalmoscopy, Optic Nerve Sheath Ultrasonography (ONSU)**,** and Computed Tomography (CT) were analyzed, compared and, reported.

Statistical significance was done using SPSS version 20.0. Frequencies with percentages and Chi-square test were done. A p-value of <0.05 was considered statistically significant.

Results

Among 170 study patients, males were higher (n=128 - 78.3%). The higher number of patients (n=155 - 91.2%) reaching to the emergency department was ≤ 12 hours. The higher symptom found in patients with Increased Intracranial Pressure (ICP) was head injury (n=88 - 51.8%) followed by weakness (n=73 - 42.9%). Based on the Glasgow Coma Scale (GCS), a higher number of patients with moderate brain injury (n=122 - 71.8%). Among 170 study patients with increased intracranial pressure, ophthalmoscopy detected 26 (15.3%) patients, Optic Nerve Sheath Ultrasonography (ONSU) detected 68 (40.0%) patients and Computed Tomography (CT) detected all 170 (100%) study patients.

In comparison between ophthalmoscopy and ONSU, a higher number of males and females were detected for increased intracranial pressure by ONSU, and the duration to reach the emergency department is statistically significant **(Chi-square-16.87, P value-0.0002167).**

In comparison between ONSU and CT, a higher number of patients were detected for increased intracranial pressure by CT, and based on GCS, the head injury was found statistically significant **(Chi-square-8.127, P value-0.004377).** Comparison between ONSU and CT the outcome such as discharged and deceased were also found statistically significant with a **Chi-square** value of **5.452,** and **a P value** of **0.01955**.

In comparison between CT and ophthalmoscopy, higher numbers of patients were detected for increased intracranial pressure by CT, and all age groups were found statistically significant with **a Chi-square** value of **16.45,** and a **P value** of **0.002476.** In comparison between CT and ophthalmoscopy, the duration to reach to the emergency department was also statistically significant **(Chi-square-15.81, P value-0.0003698)**.

Out of 170 study patients with increased intracranial pressure (n=162 - 95.3%) were discharged, and (n=8 - 4.7%) were deceased.

Conclusions

The results of this study show that when an individual is suspected of increased intracranial pressure, the patient has to reach to the emergency department at the earliest, increased intracranial pressure can occur due to any reason to any age group, and CT is the best, precise gold standard diagnostic tool to detect increased intracranial pressure even in children.

Keywords: Increased Intracranial Pressure (ICP), Ophthalmoscopy, Optic Nerve Sheath Ultrasonography (ONSU), Computed Tomography (CT), Glasgow Coma Scale (GCS), Fundoscopy, Papilledema Grading.

Introduction

An Increased Intracranial Pressure (ICP) is known as increased pressure inside the skull due to several reasons such as post-traumatic damage, accidents, brain tumors, large-sized lesions (subdural/epidural hematomas), cerebral hemorrhage, venous sinus thrombosis, hypertensive encephalopathy, brain abscesses, and even some unknown reasons.

In addition, intracranial hypertension can also be caused by venous blood flow obstructions, such as venous sinus thrombosis and hypoxia-ischemia, increased cerebral volume, inflammatory processes infections, and hepatic or hypertensive encephalopathy [1].

(Idiopathic) intracranial hypertension (IIH) is called in the absence of any brain lesion or any secondary etiology called Idiopathic intracranial pressure[2]. However, Robba, C et al described that the increased intracranial pressure can be managed by osmotic therapy, neurosurgery, and other therapeutic approaches[3].

Besides, the therapeutic approaches, bringing the patient in time for diagnosis, and precise diagnostic tools play a significant role in recovering patients who suffer from increased cranial pressure. There are several diagnostic tools some are non-invasive such as Opthalmoscopy, Optic Nerve Sheath Ultrasonography (ONSU), Computed Tomography (CT), and invasive Elevated Intracranial Pressure (EICP).

A diagnostic tool like optic nerve sheath ultrasonography was recently invented diagnostic tool to detect increased intracranial pressure in patients, this tool has several advantages like non-invasive, safe, can be tested at the bedside of the patient, and optic nerve sheath ultrasonography diagnostic tool has a disadvantage that well-trained technologists are required to perform this diagnostic test[4-6].

One of the best tools of ultrasonography is B-scan ultrasound, and this diagnostic tool is the most diffused testing tool, direct visualization, and highly sensitive, with few limitations in B-scan-optic nerve sheath ultrasonography is during edema or hemorrhage or “blooming effect” this tool does not give accurate results[7-9].

The other best tool for detecting increased intracranial pressure beating the limitation of B-scan ultrasonography is A-scan-optic nerve sheath ultrasonography,

and this tool does not produce a blooming effect, is very precise in optic nerve sheath measurements, and with increased reflective (arachnoid spikes)[10-11].

Olson D.M et al reported that based on the severity of brain injuries and as there are fewer routine data (as a periodic diagnostic test for increased intracranial pressure) performing CT scans, still means legitimate diagnostic approaches in patients with severe Traumatic brain injury (TBI)[12].

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Gerber, N et al explained that children with head injuries reaching the emergency department are immediately sent for the CT for diagnosis, Gerber, N et al feel that CT is the standard method of diagnosis[13].

Studies reported by Lumba-Brown, A et al, Ohana, O et al, Cheng, C. Y et al, and Zou, L et al reported that CT is the first choice of diagnostic tool for increased intracranial injuries in children with head injuries[14-17].

As there are several controversies on the best diagnostic tools for detecting increased intracranial pressure in patients, hence we have conducted this study to identify the precise and best gold standard diagnostic tool for increased intracranial pressure.

Ethical Clearance

This study was approved by the Institutional Ethical Committee and provided with a clearance certificate to conduct the study.

Conflicts-None

Funding-None

Inclusion Criteria

1. Patients above 18 years of age.
2. Patients presented with suspected symptoms of raised ICP.
3. Patients presented to the emergency department with head injuries.

Exclusion Criteria

1. Patients presented with suspected intra or extra-ocular injury.
2. Patient with drugs-alter intracranial pressure.

Materials And Methods

Methodology

Study Subjects

For 3 months, at the Kerala Institute of Medical Sciences (KIMS), Thiruvananthapuram, 170 patients admitted to the Emergency Department (EM) for increased intracranial pressure were observed and the data were collected for this study.

Informed consent Form

Informed consent was obtained from the patient's relatives before including the patient in the study.

Clinical details and sample collection

All the 170 patients with increased intracranial pressure in the emergency department were observed, and the data for demographic details such as age, gender, the approximate duration of time reached to the emergency department, symptoms observed during admission to the emergency department such as head injury, vomiting, headache, blurred vision, and weakness were recorded.

Investigations and Analysis

The investigations such as fundoscopic evidence by Ophthalmoscopy[18], Optic Nerve Sheath Ultrasonography (ONSU)[19] were done on both right eyes and left eye for papilledema. Computed Tomography (CT)[20] was done for all the patients with increased intracranial pressure. The results of ophthalmoscopy, ONSU, on both right eyes, and left eyes were recorded. CT results such as Infarct, Bleed, Midline shift, and Mass effect were recorded. To ensure the quality of the investigation, standard operating protocols were followed.

In the analysis, the categorical variables were calculated and expressed as numbers and percentages, and for the comparison of differential diagnostic tools, the results of ophthalmoscopy in both the right eye and left eye were calculated together and used for comparison analysis. Likewise for ONSU and CT also the results were calculated together and then compared with each other diagnostic tools.

Based on the Glasgow Coma Scale (GCS) [21], brain injuries were classified as mild brain injury (13 – 15), moderate brain injury (9 – 12), and severe brain injury (≤8)[22].

The outcome of the study patients was observed, recorded, and expressed as discharged or deceased.

Statistical Analysis

The data was analyzed using SPSS version 20.0[23]. The median (min, max) was given for continuous variables. Frequency and proportions were given for categorical variables. The comparisons were expressed with Chi-square tests, and a p-value of <0.05 was considered statistically significant.

Results

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A total of 170 patients admitted to the emergency department were observed for increased intracranial pressure and the data collected were analyzed for differential diagnostic tools for identification of increased intracranial pressure.

The basic characteristic of study patients with increased intracranial pressure was described in **Table 1.** Out of 170 patients males were 128 (75.3%), and females were 42 (24.7). In the age categorization ≤15- years were 2 (1.2%), 16-30 years were 45 (26.5%), 31-45 years were 41 (24.0%), 46-60 years were 45 (26.5%), and >61 years were 37 (21.8%).

In **Table 1** we have described the time patients reached the emergency department, and we found ≤12- hours were 155 (91.2%) patiets reached EM, 13-24 hours were 6 (3.5%), and >25 hours were 9 (5.3%) patients reached EM. The symptoms during the admission were observed and found vomiting in 30 (17.6%) patients, headache in 21 (12.4%), the none of the patient showed blurred vision (0%), weakness in 73 (42.9%) patients, and head injury in 88 (51.8%) of patients. We have recorded head injury based on the Glasgow Coma Scale (GCS) and found mild brain injury (13 – 15) in 48 (28.2%) patients, moderate brain injury (9 – 12) in 122 (71.8) patients, and none were found with severe brain injury (≤8) in our study patients.

We have recorded the different diagnostic tools used to identify the increased intracranial pressure in the admitted patients and found ophthalmoscopy was done for 26 patients, among them in 12 (7.1%) patients ophthalmoscopy was done in the right eye, and for 14 (8.2%) patients ophthalmoscopy was done in the left eye (**Table 1)**.

We have recorded that the Optic Nerve Sheath Ultrasonography (ONSU) was done in 68 patients among them 32 (18.8%) patients ONSU was done in the right eye, 36 (21.2%) patients ONSU was done in the left eye (**Table 1)**.

We have recorded that Computed Tomography (CT) was done in 170 patients among them infarct was identified in 24 (14.1%) patients, bleeding was identified in 128 (75.3%), midline shift was identified in 15 (8.8%), and the mass effect was identified in 36 (21.2%) by computed tomography in study subjects. In our study, we found out of 170 patients admitted for increased intracranial pressure 162 (95.3%) were recovered and discharged. 8 (4.7%) patients were deceased **(Table 1)**.

Table 1 Basic Characteristic of Study Patients with Increased Intracranial Pressure

Variables	No (%)
Gender (n=170)	
Males	128 (75.3)
Females	42 (24.7)
Age Categories (in years)	
≤15- years	2 (1.2)
16-30 years	45 (26.5)
31-45 years	41 (24.0)
46-60 years	45 (26.5)
>61 years	37 (21.8)
Duration to Emergency Department (ED) (hours)	
≤12- hours	155 (91.2)
13-24 hours	6 (3.5)
>25 hours	9 (5.3)
Symptoms	

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Vomiting	30 (17.6)
Headache	21 (12.4)
Blurred Vision	0 (00.0)
Weakness	73 (42.9)
Head Injury	88 (51.8)
Brain Injury based on Glasgow Coma Scale (GCS)	
Mild Brain Injury (13 – 15)	48 (28.2)
Moderate Brain Injury (9 – 12)	122 (71.8)
Severe Brain Injury (≤8)	0 (00.0)
Ophthalmoscopy (Positive)	
Right Eye	12 (7.1)
Left Eye	14 (8.2)
Optic Nerve Sheath Ultrasonography (ONSU) (Positive)	
Right Eye	32 (18.8)
Left Eye	36 (21.2)
Computed Tomography (CT) (Positive)	
Infarct	24 (14.1)
Bleed	128 (75.3)
Midline shift	15 (8.8)
Mass effect	36 (21.2)
Outcome	
Discharged	162 (95.3)
Deceased	8 (4.7)

We have further analyzed and compared the features of differential diagnostic tools performed to identify the increased intracranial pressure. We have compared ophthalmoscopy and optic nerve sheath ultrasonography (ONSU) and explained in **Table 2**.

In the comparison of ophthalmoscopy and optic nerve sheath ultrasonography, 18 (69.2%) male patients were identified with increased intracranial pressure by ophthalmoscopy, 8 (30.8%) were females whereas 54 (79.4%) males and 14 (20.6%) were females identified with increased intracranial pressure by ONSU. 4 (15.4%) patients were identified with increased intracranial pressure by ophthalmoscopy in the ≤15 years of age, and 8 (30.8%) were in 16-30 years, 2 (7.7%) were in 31-45 years, 9 (34.6%) were in 46-60 years and 3 (11.5%) were in > 61 years age groups, whereas 4 (5.9%) patients were identified with increased intracranial pressure by ONSU in the age groups of ≤15 years, and 24 (35.3%) were in 16-30 years, 12 (17.6%) were in 31-45 years, 15 (22.1%) were in 46-60 years and 13 (19.1%) were in > 61 years age groups (**Table 2)**.

During our analysis, we found who reached the emergency department within ≤12 hours were 17 (65.4%) patients who were identified with increased intracranial pressure by ophthalmoscopy,

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4 (15.4%) patients within 13-24 hours, and 5 (19.2%) patients reached emergency department >25 hours, whereas in 64 (94.1%) patients increased intracranial pressure was identified by ONSU who reached the emergency department within ≤12 hours, 4 (5.9%) patients within 13-24 hours, and none in >25 hours to reach to EM with the statistical significance of **0.0002167 (Chi-square - 16.87)** (**Table 2**).

The symptoms during the admission were observed in both patients whose increased intracranial pressure was identified by **o**phthalmoscopy and ONSU, headache in 4 (13.3%) patients, weakness in 14 (46.7%) patients, and head injury in 12 (40.0%) patients, whose increased intracranial pressure was identified by **o**phthalmoscopy, whereas in the patients whose increased intracranial pressure was identified by ONSU, vomiting found in 3 (3.9%) patients, in 6 (7.8%) patients headache was found, in 19 (24.7%) patients weakness was found, and in 49 (63.6%) patients head injury was found (**Table 2**).

The brain injury based on Glasgow Coma Scale was observed in both patients whose increased intracranial pressures were identified by **o**phthalmoscopy and ONSU. Mild brain injury (13– 15) was in 2 (7.7%) patients whose increased intracranial pressure was identified by ophthalmoscopy, 24 (92.3%) were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8), whereas mild brain injury (13– 15) was in 3 (4.4%) patients whose increased intracranial pressure was identified by ONSU, 65 (95.6%) patients were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8). The recovery after admission for increased intracranial pressure was observed in both patients who were identified by **o**phthalmoscopy and ONSU and found 24 (92.3%) patients were discharged after ophthalmoscopy, 2 (7.7%) were deceased, whereas 60 (88.2%) were discharged after ONSU, and 8 (11.8%) were deceased **(Table 2)**.

Table 2 Comparison of Diagnostic Tool Ophthalmoscopy vs Optic Nerve Sheath Ultrasonography (ONSU) in Detecting Increased Intracranial Pressure

Variables	Categories	Ophthalmoscopy (n=26)	Optic Nerve Sheath Ultrasonography (ONSU) (n=68)	Chi-square	P value
Gender	Males	18 (69.2)	54 (79.4)	1.088	0.2987
	Females	8 (30.8)	14 (20.6)		
Age in years	≤15	4 (15.4)	4 (5.9)	5.156	0.2716
	16-30	8 (30.8)	24 (35.3)		
	31-45	2 (7.7)	12 (17.6)		
	46-60	9 (34.6)	15 (22.1)		
	>61	3 (11.5)	13 (19.1)		
Duration to Emergency Department (ED) (hours)	≤12	17 (65.4)	64 (94.1)	16.87	0.0002167 *
	13-24	4 (15.4)	4 (5.9)		
	>25	5 (19.2)	0 (0.0)		
Symptoms	Vomiting	0 (0.0)	3 (3.9)	7.379	0.06075
	Headache	4 (13.3)	6 (7.8)		
	Blurred Vision	0 (0.0)	0 (0.0)		
	Weakness	14 (46.7)	19 (24.7)		

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	Head Injury	12 (40.0)	49 (63.6)		
Brain Injury based on Glasgow Coma Scale (GCS)	Mild Brain Injury (13– 15)	2 (7.7)	3 (4.4)	0.4019	0.5261
	Moderate Brain Injury (9–12)	24 (92.3)	65 (95.6)		
	Severe Brain Injury (≤8)	0 (0.0)	0 (0.0)		
Outcome	Discharged	24 (92.3)	60 (88.2)	0.3522	0.5529
	Deceased	2 (7.7)	8 (11.8)		

We also compared Optic Nerve Sheath Ultrasonography (ONSU) and Computed Tomography (CT) and described in **Table 3**.

In the comparison of ONSU and CT, 54 (79.4%) male patients were identified with increased intracranial pressure by ONSU, 14 (20.6%) were females whereas 150 (88.2%) males were identified with increased intracranial pressure by CT, and 20 (11.8%) were females. 4 (5.9%) patients were identified with increased intracranial pressure by ONSU in the ≤15 years of age, 24 (35.3%) were in 16-30 years, 12 (17.6%) were in 31-45 years, 15 (22.1%) were in 46-60 years and 13 (19.1%) were in > 61 years of age groups, whereas 3 (1.8%) patients were identified with increased intracranial pressure by CT in the age groups of ≤15 years of age, and 45 (26.5%) were in 16-30 years, 39 (22.9%) were in 31-45 years, 42 (24.7%) were in 46-60 years and 41 (24.1%) were in > 61 years age groups (**Table 3)**.

We also found the patients who reached the emergency department within ≤12 hours were 64 (94.1%) patients who were identified with increased intracranial pressure by ONSU, 4 (5.9%) patients within 13-24 hours, and none of the patients took > 25 hours to reach to EM, whereas the 159 (93.5%) patients in which the increased intracranial pressure was identified by CT who have reached the emergency department within ≤12 hours, 8 (4.7%) patients reached EM within 13-24 hours, and 3 (1.8%) patients took > 25 hours to reach to emergency department (**Table 3**).

The symptoms during the admission were observed in both patients whose increased intracranial pressure was identified by ONSU and CT, vomiting found in 3 (3.9%) patients, headache in 6 (7.8%) patients, weakness in 19 (24.7%) patients, and head injury was in 49 (63.6%), whose increased intracranial pressure was identified by ophthalmoscopy, whereas in the patients whose increased intracranial pressure identified by CT, vomiting found in 26 (10.4%) patients, in 24 (9.6%) patients headache was found, in 82 (32.6%) patients weakness found, and 119 (47.4%) patients head injury was found (**Table 3**).

The brain injury based on Glasgow Coma Scale was observed in both patients whose increased intracranial pressures were identified by ONSU and CT. Mild brain injury (13– 15) was in 3 (4.4%) patients whose increased intracranial pressure was identified by ONSU, whereas 65 (95.6%) patients were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8), whereas mild brain injury (13– 15) was in 5 (2.9%) patients whose increased intracranial pressure was identified by CT, 165 (97.1%) patients were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8) with the statistical significance of **0.004377 (Chi-square- 8.121).** The recovery after admission for increased intracranial pressure was observed in both patients who were identified by ONSU and CT and found 60 (88.2%) were discharged after ONSU, 8 (11.8%) were deceased, whereas 162 (95.3%) were discharged after CT, and 8 (4.7%) were deceased with the statistical significance of **0.01955 (Chi-square - 5.452) (Table 3)**.

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Table 3 Comparison of Diagnostic Tool Optic Nerve Sheath Ultrasonography (ONSU) vs Computed Tomography (CT) in Detecting Increased Intracranial Pressure

Variables	Categories	Optic Nerve Sheath Ultrasonography (ONSU) (n=68)	Computed Tomography (CT) (n=170)	Chi-square	P value
Gender	Males	54 (79.4)	150 (88.2)	0.834	0.3611
	Females	14 (20.6)	20 (11.8)		
Age in years	≤15	4 (5.9)	3 (1.8)	4.94	0.2935
	16-30	24 (35.3)	45 (26.5)		
	31-45	12 (17.6)	39 (22.9)		
	46-60	15 (22.1)	42 (24.7)		
	>61	13 (19.1)	41 (24.1)		
Duration to Emergency Department (ED) (hours)	≤12	64 (94.1)	159 (93.5)	3.483	0.1753
	13-24	4 (5.9)	8 (4.7)		
	>25	0 (0.0)	3 (1.8)		
Symptoms	Vomiting	3 (3.9)	26 (10.4)	7.237	0.06472
	Headache	6 (7.8)	24 (9.6)		
	Blurred Vision	0 (0.0)	0 (0.0)		
	Weakness	19 (24.7)	82 (32.6)		
	Head Injury	49 (63.6)	119 (47.4)		
Brain Injury based on Glasgow Coma Scale (GCS)	Mild Brain Injury (13 – 15)	3 (4.4)	5 (2.9)	8.121	0.004377*
	Moderate Brain Injury (9 – 12)	65 (95.6)	165 (97.1)		
	Severe Brain Injury (≤8)	0 (0.0)	0 (0.0)		
Outcome	Discharged	60 (88.2)	162 (95.3)	5.452	0.01955*
	Deceased	8 (11.8)	8 (4.7)		

***Statistical significance**

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We also compared Computed Tomography (CT), and Ophthalmoscopy described in **Table 4**. In the comparison of CT, and Ophthalmoscopy**,** 150 (88.2%) male patients were identified with increased intracranial pressure by CT, 20 (11.8%) were females, whereas 18 (69.2%) males were identified with increased intracranial pressure by Ophthalmoscopy**,** and 8 (30.8%) were females. 3 (1.8%) patients were identified with increased intracranial pressure by CT in the ≤15 years of age, 45 (26.5%) were in 16-30 years, 39 (22.9%) were in 31-45 years, 42 (24.7%) were in 46-60 years and 41 (24.1%) patients were in > 61 years age groups, whereas 4 (15.4%) patients were identified with increased intracranial pressure by CT in the age groups of ≤15 years of age, and 8 (30.8%) were in 16-30 years, 2 (7.7%) were in 31-45 years, 9 (34.6%) were in 46-60 years and 3 (11.5%) were in > 61 years age groups with the statistical significance of **0.002476 (Chi-square - 16.45).**

We found who reached the emergency department within ≤12 hours were 159 (93.5%) patients who were identified with increased intracranial pressure by CT, 8 (4.7%) patients within 13-24 hours, and 3 (1.8%) patients who reached > 25 hours, whereas in 17 (65.4%) patients increased intracranial pressure was identified by **o**phthalmoscopy who reached the emergency department within ≤12 hours, 4 (15.4%) patients within 13-24 hours, and 5 (19.2%) reached to emergency department in >25 hours with the statistical significance of **0.00003698 (Chi-square - 15.81) (Table 4)**.

The symptoms during the admission were observed in both patients whose increased intracranial pressure was identified by CT and **o**phthalmoscopy, vomiting was found in 26 (10.4%) patients, headache in 24 (9.6%) patients, weakness in 82 (32.6%) patients, and head injury were in 119 (47.4%), whose increased intracranial pressure was identified by CT, whereas in the patients whose increased intracranial pressure was identified by **o**phthalmoscopy, the headache was found in 4 (13.3%) patients, in 14 (46.7%) patients weakness was found, in 12 (40.0%) patients head injury was found (**Table 4**).

The brain injury based on Glasgow Coma Scale was observed in both patients whose increased intracranial pressures were identified by CT and **o**phthalmoscopy. Mild brain injury (13– 15) was in 5 (2.9%) patients whose increased intracranial pressure was identified by CT, whereas 165 (97.1%) patients were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8), whereas mild brain injury (13–15) was in 2 (7.7%) patients whose increased intracranial pressure was identified by **o**phthalmoscopy, 24 (92.3%) patients were found with moderate brain injury (9–12), and none was found with severe brain injury (≤8) (**Table 4**).

The recovery after admission for increased intracranial pressure was observed in both patients who were identified by CT and **o**phthalmoscopy, and found 162 (95.3%) patients were discharged by CT, 8 (4.7%) were deceased, whereas 24 (92.3%) were discharged by **o**phthalmoscopy, and 2 (7.7%) were deceased (**Table 4**).

Table 4 Comparison of Diagnostic Tool Computed Tomography (CT) vs Ophthalmoscopy in Detecting Increased Intracranial Pressure

Variables	Categories	Computed Tomography (CT) (n=170)	Ophthalmoscopy (n=26)	Chi-square	P value
Gender	Males	150 (88.2)	18 (69.2)	0.2562	0.6127
	Females	20 (11.8)	8 (30.8)		
Age in years	≤15	3 (1.8)	4 (15.4)	16.45	0.002476*
	16-30	45 (26.5)	8 (30.8)		
	31-45	39 (22.9)	2 (7.7)		
	46-60	42 (24.7)	9 (34.6)		
	>61	41 (24.1)	3 (11.5)		

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Duration to Emergency Department (ED) (hours)	≤12	159 (93.5)	17 (65.4)	15.81	0.0003698 *
	13-24	8 (4.7)	4 (15.4)		
	>25	3 (1.8)	5 (19.2)		
Symptoms	Vomiting	26 (10.4)	0 (0.0)	5.343	0.1484
	Headache	24 (9.6)	4 (13.3)		
	Blurred Vision	0 (0.0)	0 (0.0)		
	Weakness	82 (32.6)	14 (46.7)		
	Head Injury	119 (47.4)	12 (40.0)		
Brain Injury based on Glasgow Coma Scale (GCS)	Mild Brain Injury (13 – 15)	5 (2.9)	2 (7.7)	1.944	0.1634
	Moderate Brain Injury (9 – 12)	165 (97.1)	24 (92.3)		
	Severe Brain Injury (≤8)	0 (0.0)	0 (0.0)		
Outcome	Discharged	162 (95.3)	24 (92.3)	0.7072	0.4004
	Deceased	8 (4.7)	2 (7.7)		

Discussion

Mollan, S. P et al reported that elevated intracranial pressure was most commonly present in brain injury patients, but in our present study, we have encountered patients who have symptoms such as patients with vomiting also had intracranial pressure[24].

The headache in ICP will vary in clinical presentation with different scenarios some of the headaches are defined as migraine, some are non-specific, and we in our study patients found that patients with increased intracranial pressure experienced headache[25].

In a study by Vande Vyvere, T et al reported out of 3325 patients, 415 patients suffered from midline shift, in our present study, we found 15 (8.8%) patients with increased intracranial pressure suffered from midline shift[26].

Küchler et al describes that when head injuries occur in a patients, need to prevent Intra-Hospital Transports (IHT) within 8 hours to prevent the second incidence of further injuries[27], and in our present study, we found that 155 (91.2%) of our patients reached to emergency department ≤12-hours, and in the comparison of diagnostic tools between CT and ophthalmoscopy, and ophthalmoscopy and ONSU, the former statistical significance was **(Chi-square** value of **15.81**, and the **P value** is **0.0003698),** and the later was **(Chi-square** value of **16.87**, and the **P value** is **0.0002167),** indicating reaching at the earliest to the emergency department, supports to save the patients, along with the precise diagnostic tools.

Gao et al reports show that intracranial pressure tested after 6 hours of hemicraniectomy surgery found that the ONSU was an unreliable diagnostic tool[28], Huo, S. C et al finds in their study conducted in lumbar puncture patients, that the ONSU is the best surrogate marker for detecting increased intracranial pressure[29] but we in our study found that

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out of 170 study patients, 68 (40%) patient's increased intracranial pressure were identified by ONSU.

Other study published by Ebraheim, A. M et al, supports that the ONSU is a good diagnostic tool for increased intracranial pressure, and also describes that in post- (lumbar puncture) headaches the ONSU will not be enlarged, thus differentiating the different types of headaches, by different reasons[30], and an author Aslan, N et al's study shows in pseudotumor cerebri syndrome patients ONSU is the best diagnostic tool for detecting increased intracranial pressure[31].

Vitiello, L et al published data describes in patients with increased intracranial pressure, ONSU prescription increased, indicating that, ONSU is one of the best tools for detecting increased intracranial pressure[32]. Kerscher, S. R et al, Robba, C et al, and Fontanel, L., et al also reported that the ONSU is the best diagnostic tool for detecting increased intracranial pressure in children[33-35].

Since there are controversial diagnostic tools for detecting increased intracranial pressure, we tried to identify the best diagnostic tool for increased intracranial pressure, and when children are facing increased intracranial pressure, our burden for choosing the best diagnostic tool also increases. Kochanek, P. M et al reports that increased intracranial pressure due to traumatic brain injury in children is the leading cause of their morbidity and mortality[36].

To prevent morbidity and mortality in patients with ICP, choosing a diagnostic tool must be appropriate; Computed Tomography (CT) is a widely accepted and appropriate tool for detecting increased intracranial pressure. Preuss, C. V et al describes that to prevent herniation and mortality in the younger population, all the patients presented with increased intracranial pressure needs to do Computed Tomography (CT), and as CT can show enhanced images of the visible areas of lower density, and even areas of loss of white and grey matter. CT scans can also reveal the causes of the incidence, and CT scans were used to monitor the progression of edema [37]. In our present study, out of 170 increased intracranial pressure patients, 26 patients were identified by ophthalmoscopy, 68 patients' was identified by ONSU, and 100% of patients with increased intracranial pressure were detected by CT.

The published data shows one of the CT scan widely used is point-of-care ultrasound (POCUS) in emergency department, pediatric emergencies, and critical care units. Studies reported that the POCUS is a rapid, bedside useable CT scan that can be used even in remote places. POCUS is one of the neuro-intensivi's most validated diagnostic tools [38-40]. Our present study also shows that CT is the best tool with a statistical significance of **Chi-square** value of **16.45** with a **P value** of **0.002476,** and Computed Tomography (CT) is the best and most precise tool for detecting increased intracranial pressure tool for children, young, adults, and in elderly.

In conclusion, even though, there are several diagnostic tools for identifying increased intracranial pressure, choosing precise diagnostic tools such as Computed Tomography (CT), early transport to the emergency department, treating immediately, and close observation are the gold standard approaches for fast recovery of patients from increased intracranial pressure.

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