ORIGINAL RESEARCH

DOI: 10.4274/globecc.galenos.2025.62634
Glob Emerg Crit Care

Stretcher Angles: Impact on Vital Signs and Optic Nerve Sheath Diameter in Prehospital Stroke Patients

Bektaş Bakırcı[1], Ayhan Özhasenekler[2], Habibe Selmin Özensoy[3], Burak Bekgöz[4], Alp Şener[2]

[1]Merzifon Kara Mustafa Pasha State Hospital, Departmant of Emergency Medicine, Ankara, Türkiye
[2]Yıldırım Beyazıt University Faculty of Medicine, Department of Emergency Medicine, Ankara, Türkiye
[3]Ankara Bilkent City Hospital, Department of Emergency Medicine, Ankara, Türkiye
[4]Ankara Provincial Health Directorate, Ankara Emergency Medical Service Chief Physician Office, Ankara, Türkiye

Abstract

Objective: Post-stroke hypoperfusion of brain tissue often results from increased intracranial pressure, compromising cerebral blood flow. This study investigated the relationships between the stretcher angles, the optic nerve sheath diameter (ONSD), and vital signs of stroke patients brought to the emergency department by emergency medical services (EMS).

Materials and Methods: This was a prospective, cross-sectional, single-center study. The study included individuals over 18 years of age with a stroke according to the Cincinnati Stroke Scale. Patient age, sex, time to hospital arrival with an EMS, the ONSD, vital signs, clinical findings, the stretcher angle, and Glasgow Coma Scale (GCS) scores were recorded. Stretcher angles were adjusted into one of four different Group.

Results: The study included 82 patients, and the average age was 74 years. The mean systolic blood pressure was 163±35 mmHg, the mean diastolic blood pressure was 91±17 mmHg, the mean right ONSD was 0.36±0.07 cm, and the mean left ONSD was 0.37±0.07 cm. The mean GCS of the patients was 13. The GCS was lower in Group 1 than in Group 3 (p=0.002); the DBP was greater in Group 4 than in Group 3 (p=0.023); and the ONSD was more significant in Group 4 than in Group 2 (p=0.007).

Conclusion: We recommend that EMS personnel carry stroke patients at 46-60° at a stretcher angle during transport. Prehospital EMS personnel must pay more attention to the stretcher angle and be informed about it when transporting patients with suspected strokes.

Keywords: Stroke, stretcher angle, intracranial pressure, optic nerve sheath diameter, prehospital, emergency department

Introduction

According to the World Health Organization, "15 million people in the world suffer from stroke every year. Of these, 5 million die and 5 million are permanently disabled, placing a burden on families and society" [1]. Ischemic stroke accounts for 80% of strokes and usually occurs due to factors such as large vessel disease, small vessel disease, or cardioembolism [1].

Studies have shown that neurological pathologies, such as traumatic brain injury, hydrocephalus, intracerebral hemorrhage, and stroke, cause an increase in intracranial pressure (ICP). They have also investigated the underlying mechanisms [2-6]. Changes in ICP are among the markers affecting the prognosis of stroke patients [3, 4].

The sonographic measurement of the optic nerve sheath diameter (ONSD) is a simple, noninvasive tool with reasonable diagnostic accuracy for estimating the ICP [7]. Compared with traditional neuroimaging methods such as computed tomography and magnetic resonance imaging, ONSD measurements have the advantages of low cost, short investigation times, good reproducibility, and bedside usability [7,8].

Address for Correspondence: Habibe Selmin Özensoy, Ankara Bilkent City Hospital, Department of Emergency Medicine, Ankara, Türkiye
E-mail: habibeozensoy@gmail.com **ORCID-ID:** orcid.org/0000-0001-9261-2669
Received: 18.12.2024 **Accepted:** 10.04.2025 **Epub:** 13.08.2025

Cite this article as: Bakırcı B, Özhasenekler A, Özensoy HS, Bekgöz B, Şener A. Stretcher Angles: Impact on vital signs and optic nerve sheath diameter in prehospital stroke patients. Glob Emerg Crit Care. [Epub Ahead of Print].

Stabilization of vital signs is important in patients with suspected stroke and is included in the guidelines [9]. Some studies examine the stabilization of vital signs before hospitalization [10]. Blood pressure balance is multifactorial [11]. The effect of the transportation position on the emergency medical services (EMS) stretcher on vital signs is reversible and needs to be investigated.

The time from symptom onset to hospital arrival is vital in stroke patients. This period changes both patient prognosis and treatment options [9]. Most of these patients apply to prehospital emergency health services and are brought to emergency departments with EMS. No standard carrying angle is specified when transporting these patients in the prehospital period. Patients to the emergency department vary due to local factors, and the EMS transports patients at nonstandard stretcher angles.

In this study, we aimed to investigate the relationships among the stretcher angle during transportation, vital signs, and the ONSD of stroke patients brought to the emergency department by the EMS.

Materials and Methods

Study Design, Ethical Statements, and Population

This was a prospective, cross-sectional, single-center study. Stroke patients who visited our Emergency Department between 15/01/2024 and 31/03/2024 were included in the study.

Ethics committee approval was received from Ankara Bilkent City Hospital Clinical Research No. 2 Ethics Committee (decision number: E2-23-5911, date: 21.12.2023). The researchers complied with the Declaration of Helsinki. Informed consent was obtained from the patient or their relatives.

The study was conducted at our emergency department, which has approximately 150 EMSs and 2,000 patient admissions daily. This third-level hospital has all the technical equipment to perform surgical and interventional procedures 24 hours a day, seven days a week.

Patient Selection

EMS personnel checked the Cincinnati Pre-hospital Stroke Scale (CPHSS) on the patients included in the study. According to this scale, patients with suspected stroke and patients over 18 were included in the study.

Protocols for transporting stroke patients are recommended for EMS personnel. However, there are no definitive rules. Patient transport varies according to the patient's condition and the personnel's experience. There was no intervention in the angle at which EMS personnel brought the patients.

EMS personnel were asked whether the patient's stretcher angle was changed during the transfer to the hospital. Patients who were verbally confirmed not to have changed were included in the study.

Patients with an intracranial mass, intracranial aneurysm, or intracranial metastasis; diseases that may cause brain edema, such as a postictal seizure, transient ischemic attack (TIA), hydrocephalus, sarcoidosis, ventriculoperitoneal shunt, optic neuritis, head trauma, or prosthetic eye; or diseases that may affect the ONSD by creating increased ICP; and patients who did not agree to participate in the study were excluded.

Sample Size Analysis

Sample size analysis was conducted using data from the study by Maissan et al. [5] Considering a 0.2 mm difference in ONSD between supine and angled positions, it was calculated that at least 16 patients should be included in the group with 80% power, and 5% Type-1 error. Considering data loss, it was planned to include 80 patients, with 16 patients in each angle Group.

Data Collection

The patient's age, sex, time of onset of symptoms, time of patient reaching the EMS phone call, time of reaching the patient, time of reaching the patient to the hospital, time taken by the patient to be brought to the hospital by the EMS, right and left ONSD, vital signs, current clinical findings of the CPHSS (e.g., facial asymmetry, unilateral weakness, and speech impairment), stretcher angle, Glasgow Coma Scale (GCS) score, diagnosis after imaging, and emergency department outcomes were recorded in the study form.

Stretcher Angles of Patients

Stretcher angle Group were made by considering the Group in the reference articles.

The patients were divided into four groups according to the stretcher angles: Group 1, 0-30°; Group 2, 31-45°; Group 3, 46-60°; and Group 4, 61-90°.

ONSD Measurement of Patients and Measurement Technique

Clinical evaluations, stretcher angles, and ONSD measurements of the patients included in our study were performed by a single physician with basic ultrasonography training and experience without changing the stretcher angle. The physician performing the measurement is not blinded to the stretcher angle. The person measuring the stretcher angles and performing the ultrasound is the same. Patient selection is limited to those who applied when the physician worked. Therefore, randomization was not performed.

The patients' stretcher angles were measured with protractor-exa mobile, an iOS digital angle measurement program on an iPhone 14 Plus, and recorded on the patient follow-up form (Figure 1).

The ONSD was measured at least twice in both the transverse and sagittal planes using the Butterfly IQ + Ultrasound System (USB-C), a Guilford USA ultrasound device, at a point 0.30 cm posterior to where the optic nerve enters the eyeball. A linear probe was used. The patient's position was not changed; they were lying on the EMS stretcher with the eyelids closed. The eyes were covered with a transparent material, and gel was applied. The average of these measurements was calculated and evaluated [12].

Outcome Measure

The primary outcome measure was the relationship between the patient's vital signs ONSD with the stretcher angle, while the secondary outcome measure was the patient's ED outcome.

Scoring System

Cincinnati Pre-hospital Stroke Scale

The CPHSS evaluates facial paralysis, asymmetric arm weakness, and speech abnormalities in patients with potential stroke. When applied to patients presenting to the ED, this scale provides high sensitivity and specificity in detecting stroke [13]. EMS personnel calculated the CPHSS before arrival at the hospital and noted it on the patient's follow-up form.

Statistical Analysis

Statistical analysis were performed with IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp). Distribution analysis of continuous data was performed using the Shapiro–Wilk test and the QQ plot with histogram graphics. One-Way ANOVA was used for mean comparisons between more than two Group for variables with a normal distribution, and the Kruskal-Wallis test was used for distribution comparisons between more than two Group for variables not normally distributed. According to the distribution analysis, continuous data are expressed as either the mean and standard deviation or the median and interquartile range (25-75% quartiles). Proportion comparisons of categorical data were made using the Pearson chi-square test and data are expressed as the number of samples and percentages, depending on availability. Correlations between continuous numerical variables that were not normally distributed were evaluated with Spearman correlation analysis. The results of this analysis were interpreted with the Rho coefficient. A p-value <0.05 was considered to indicate statistical significance.

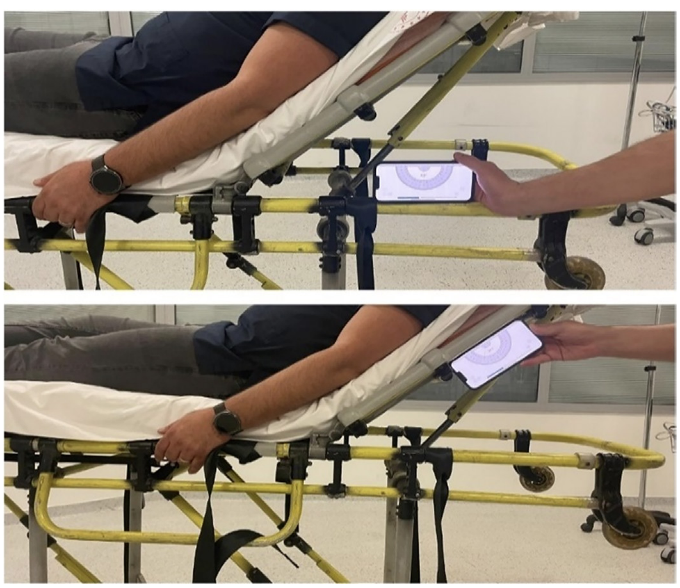

Figure 1. Measuring the angle of transportation of patients on the EMS stretcher

EMS: Emergency medical services

Results

A total of 110 patients who met the CPHSS were included in the study. Among these patients, 18 patients were excluded from the study because they had TIA 2 patients had Seizure-Todd's paralysis 2 patients were started on antihypertensives 3 patients had an intracranial mass 2 patients had aneurysms and 1 patient could not measure ONSD after left eye prosthesis. For these reasons, 82 patients were included in our study.

Patient Demographic and Clinical Characteristics

The average age of the patients included in the study was 74 years (range, 38-95 years). The average time from symptom onset to hospital admission was 203±204 minutes, and the average time from symptom onset to hospital arrival was 40±16 minutes. The average GCS score of patients was 13. Regarding vital signs, the mean SBP was 163±35 mmHg, the DBP was 91±17 mmHg, the average pulse was 79 beats per minute, the respiratory rate (RR) was 16±2/min., and the body temperature was 36.7±0.3 °C. The patient's blood sugar was 154±69 mg/dL. When the patients were evaluated on the EMS stretcher, the average stretcher angle was 44±17°, the average right ONSD was 0.36±0.07 cm, and the left ONSD was 0.37±0.07 cm (Table 1).

Among our patients, 42.7% (n=35) were male, and 57.3% (n=47) were female. According to the CPHSS, the presenting symptoms of the patients were facial paralysis in 73.2% (n=60), upper extremity weakness in 82.9% (n=68), and speech disturbance in 70.7% (n=58) (Table 2).

The distribution of patients according to angle groups was as follows: Group 1 19.5% (n=16); Group 2 32.9% (n=27); Group 3 26.8% (n=22); and Group 4 20.7% (n=17) (Table 2).

Ischemic stroke was detected in 85.4% (n=70) of our patients, and hemorrhagic stroke was detected in 14.6% (n=12) of our patients. After admission to the ED, 73.2% (n=60) of the patients were admitted to the intensive care unit (ICU), while 26.8% (n=22) were admitted to the inpatient service (Table 2).

Table 1. The time from the onset of symptoms until the patients reach the hospital and the time they are transported in EMS, GCS, vital signs, EMS stretcher angles, Right and left ONSD values

	Mean ± SD	Median	Min.-max.	95.0% Confidence interval for the mean
Age, year	74±12	75	38-95	71-76
Time elapsed from symptom onset to hospital admission, minute	203±204	124	45-931	159-248
Ambulance transport time, minute	40±16	38	16-92	37-44
GCS	13±3	13	3-15	12-13
SBP, (mmHg)	167±35	165	92-238	160-175
DBP, (mmHg)	91±17	92	45-136	88-95
Pulse (beats/minute)	79±20	76	41-142	74-83
RR (breath/minute)	16±2	16	12-22	16-17
BT, (°C)	36.7±0.3	36.7	36.0-37.3	36.6-36.7
BS, (mg/dL)	154±69	137	88-531	139-169
Stretcher angle, degree	44±17	44	0-90	
Right ONSD, cm	0.36±0.07	0.36	0.19-0.53	
Left ONSD, cm	0.37±0.07	0.36	0.18-0.58	

GCS: Glasgow Coma Scale, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RR: Respiratory rate, BT: Body temperature, BS: Blood sugar, Min.-max.: Minimum-maximum

Table 2. Distribution table of patients' gender, presenting symptoms, stretcher angle group, stroke type, and emergency department outcome

		n, %
Gender	Man	35, 42.7
	Woman	47, 57.3
Presenting symptom	Facial paralysis	60, 73.2
	Upper extremity weakness	68, 82.9
	Speech disorder	58, 70.7
Stretcher angle group	Group 1 (0-30°)	16, 19.5
	Group 2 (31-45°)	27, 32.9
	Group 3 (46-60°)	22, 26.8
	Group 4 (61-90°)	17, 20.7
Stroke type	Ischemic stroke	70, 85.4
	Hemorrhagic stroke	12, 14.6
Emergency department outcome	Inpatient service	22, 26.8
	Intensive care unit	60, 73.2

Outcomes

Comparison of the Stretcher Angle Group with the Vital Signs, GCS, and ONSD

A significant difference was found among the stroke type (ischemic or hemorrhagic) Group and the stretcher angle Group ($p<0.001$) (Table 3). Ischemic stroke was more frequently detected in Group 2, 3, and 4. A statistically significant difference was found between the stretcher angle Group and the inpatient service-ICU admission Group ($p=0.020$) (Table 3). The rate of ICU admission was greater in Group 1, 2, and 4 compared to Group 3.

A significant difference was found between the GCS and stretcher angle Group, specifically between Group 1 and Group 3 ($p=0.002$). GCS was lower in Group 1 than in Group 3 (Table 4).

A statistically significant difference was found between the RR and stretcher Group, but no significant difference was observed in specific subGroup analyses ($p=0.037$ may refer to general Group comparison). When comparing DBP between the stretcher angle Group, a statistically significant difference was found between Group 3 and Group 4 ($p=0.028$). DBP was higher in Group 4 than in Group 3. When comparing the right and left ONSD with the stretcher angle Group, a significant difference was found between Group 2, 3, and 4 (right ONSD $p=0.007$, left ONSD $p=0.043$) (Table 4). ONSD was wider in Group 4 compared to Group 2 and 3.

Comparison of Stretcher Angle and Emergency Department Outcomes

A statistically significant difference was found when comparing the stretcher angle Group with the inpatient service-ICU admission Group. The rate of ICU admission was higher in Group 1, 2, and 4 (Table 3).

Correlation Analysis

No correlation was found between the Group in our study on the relationship between stretcher angle Group, and between vital signs and ONSD. A weak correlation was found between stretcher angle and GCS ($p=0.003$; Rho=0.324). A weak correlation was found between DBP and right and left ONSD (right ONSD $p=0.13$, Rho=0.274/left ONSD $p=0.45$, Rho=0.222). A high correlation was found between right ONSD and left ONSD ($p<0.001$) (Rho=0.729) (Table 5).

Table 3. This table shows the relationship between patients' gender, emergency department admission symptoms, stroke type, and emergency department outcome with stretcher angle group

		Stretcher angle group				
		Group 1	Group 2	Group 3	Group 4	p
		n, %	n, %	n, %	n, %	
Gender	Man	6, 37.5	13, 48.1	8, 36.4	8, 47.1	0.802
	Woman	10, 62.5	14, 51.9	14, 63.6	9, 52.9	
Emergency department presenting symptom	Facial paralysis	13, 81.3	15, 55.6	19, 86.4	13, 76.5	0.077*
	Upper extremity weakness	16, 100.0	23, 85.2	17, 77.3	12, 70.6	0.126*
	Speech disorder	8, 50.0	23, 85.2	14, 63.6	13, 76.5	0.077*
Stroke type	Ischemic	8, 50.0	26, 96.3	21, 95.5	15, 88.2	<0.001*
	Hemorrhagic	8, 50.0	1, 3.7	1, 4.5	2, 11.8	
Hospitalization	Inpatient service	0, 0.0	7, 25.9	10, 45.5	5, 29.4	0.020*
	Intensive care unit	16, 100.0	20, 74.1	12, 54.5	12, 70.6	

Pearson chi-square test.

*Expected values in cells are insufficient; analysis is not reliable

Table 4. Comparison of vital signs, EMS duration, ONSD, age, GCS with Stretcher angle group of patients

	Stretcher Angle								p
	Group 1		Group 2		Group 3		Group 4		
	Med	25-75%	Med	25-75%	Med	25-75%	Med	25-75%	
Age,year	74	65-85	76	68-82	75	66-83	73	67-87	0.887*
TSHA	159	78-358	130	77-275	117	75-215	114	74-162	0.0607**
ATT	40	30-47	43	31-53	34	26-41	38	32-42	0.112**
GCS	11	8-14	13	11-15	15	14-15	13	12-15	0.002**
SBP, mmHg	159	132-189	161	132-193	165	144-180	188	149-193	0.389*
DBP, mmHg	88	76-108	90	80-100	82	76-96	98	93-110	0.028*
Pulse, beath/minute	82	75-96	74	63-85	73	64-88	80	65-97	0.264**
RR/minute	17	16-18	16	16-17	15	14-16	16	15-18	0.037**
BT, °C	36.7	36.5-36.8	36.7	36.3-36.9	36.7	36.3-36.9	36.7	36.4-36.9	0.939**
Blood Sugar	154	137-184	130	104-176	142	113-162	119	110-153	0.374**
Right ONSD	0.39	0.33-0.42	0.33	0.27-0.37	0.35	0.33-0.39	0.41	0.37-0.44	0.007**
Left ONSD	0.39	0.32-0.42	0.33	0.30-0.38	0.35	0.33-0.41			0.043**

*One-Way ANOVA, **Kruskall-Wallis test. The difference in the DKB parameter is due to the difference between Group 3 and 4. The difference in the GCS parameter is due to the difference between Group 1 and 3. No difference was found in the sub Group analysis for the SS parameter. The differences in both right and left ONSD parameters are due to the differences between Group 2, 3, and 4.

TSHA: Time elapsed from symptom onset to hospital admission, ATT: Ambulance transport time, GCS: Glasgow Coma Scale, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RR: Respiratory rate, BT: Body temperature

Discussion

This study investigated the effects of prehospital stretcher angle on vital signs and ONSD in patients with suspected stroke, a subject that remains underrepresented in the current literature. A total of 82 patients were included. The mean time from symptom onset to hospital arrival was 203 minutes, with an average EMS transport duration of 40 minutes. The average initial GCS score was 13, SBP was 167 mmHg, and DBP was 91 mmHg. A statistically significant relationship was observed between stretcher angle and several clinical parameters. ICU admission rates were higher in Group 1, 2, and 4 compared to Group 3. Notably, GCS was significantly lower in Group 1 than in Group 3, suggesting that flatter transport positions may be associated with reduced consciousness. Additionally, DBP was significantly higher in Group 4 than in Group 3, and ONSD was significantly larger in Group 4 compared to Group 2. Although the correlations between stretcher angle and GCS (Rho=0.324) and DBP and ONSD (Rho<0.30) were statistically significant, they were weak, implying limited clinical relevance. However, the strong correlation between right and left ONSD (Rho=0.729) supports the internal consistency of ultrasonographic measurements.

Table 5. Vital signs, stretcher angle, and ONSD correlation table

		GCS	SBP	DBP	Pulse	Respiratory Rate	Fever	Stretcher Angle	Right ONSD	Left ONSD
Age	Rho	-.0293**	0.066	-0.144	0.027	0.025	-0.002	-0.095	-0.145	-0.119
	p	0.007	0.559	0.197	0.807	0.824	0.982	0.397	0.193	0.289
GCSa	Rho		0.003	-0.074	-0.158	-0.382**	-0.028	0.324**	-0.074	0.006
	p		0.982	0.509	0.156	0.000	0.799	0.003	0.507	0.955
SBPb	Rho			0.700**	-0.104	0.039	-0.016	0.136	0.140	0.042
	p			0.000	0.354	0.727	0.884	0.225	0.209	0.708
DBPc	Rho				0.014	0.130	0.112	0.163	0.274*	0.222*
	p				0.904	0.245	0.317	0.142	0.013	0.045
Pulse	Rho					0.025	0.120	-0.046	0.058	0.219*
	p					0.820	0.282	0.678	0.607	0.048
Respiratory Rate	Rho						-0.040	-0.118	-0.124	-0.172
	p						0.719	0.290	0.268	0.122
Fever	Rho							0.030	0.140	0.153
	p							0.790	0.209	0.169
Stretcher Angle	Rho								0.164	0.154
	p								0.141	0.168
Right ONSDd	Rho									0.729**
	p									0.000

Spearman's Rho, *Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed). GCM: Glascow Coma Scale, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, ONSD: Optic nerve sheath diameter

Our onset-to-hospital time was shorter than the 674 to 775 minutes reported by Ikramuddin et al.[14], and Anees et al. [15], likely due to our inclusion of only EMS-transported patients. EMS transport durations in the literature range from 26.5 minutes [16] to 99 minutes [17]. A local report indicated an EMS response time of 6 minutes and 12 seconds in 2019 [18]. The 40-minute EMS time in our study may reflect urban traffic, interfacility referrals, and local protocols prioritizing transport to the nearest equipped hospital.

Blood pressure management plays a critical role in the prognosis of stroke patients. Studies have linked elevated blood pressure to increased mortality within 90 days post-stroke [19,20]. While most Western guidelines emphasize SBP control, some Asian studies have demonstrated associations with both SBP and DBP [21]. In the study by Gregori-Pla et al. [22] head-of-bed (HOB) elevations between -5° and 30° affected mean arterial pressure in patients with carotid stenosis. Although we found no significant correlation between SBP and stretcher angle, DBP was significantly higher in group 4 compared to group 3. These findings suggest that stretcher positioning may influence diastolic pressure during prehospital care.

When the ONSD values were compared with the literature, Patel et al. [23] reported mean values of 0.59 cm (right) and 0.60 cm (left) in stroke patients, and Geeraerts et al. [24] found a mean of 0.59 cm in critically ill individuals with elevated ICP. Seyedhosseini et al. [3] reported a mean ONSD of 3.89±0.59 mm, which aligns closely with our findings. Differences in reported ONSD may stem from variations in patient age, measurement timing, race, stroke subtype, and patient positioning during ultrasonography.

73.2% of our patients were admitted to the ICU and 26.8% to the neurology inpatient ward, which is consistent with previous reports on stroke patient dispositions [25,26].

In their study on patients with traumatic brain injury and other intracranial pathologies, Altun Uğraş et al. [27] demonstrated that changes in HOB angle significantly influenced ICP and cerebral perfusion pressure, especially in patients with low GCS scores. In another study, Momtaz et al. [28] observed an inverse correlation between GCS and ONSD in confused patients positioned supine. In contrast, we did not find a significant relationship between GCS and ONSD. However, GCS was significantly associated with stretcher angle, particularly lower in the 0-30° Group compared to the 46-60° Group. As EMS personnel did not receive positioning instructions, it is unclear whether flatter positioning was selected due to altered consciousness or if the positioning itself contributed to lower GCS. This bidirectionality highlights the need for prospective, randomized studies to clarify causal relationships.

Favilla et al. [29] examined the relationship between HOB positioning and cerebral blood flow (CBF) in acute ischemic stroke patients and found significant, individualized effects of positioning on CBF [30]. While our study did not involve serial measurements of ONSD at different angles, our findings suggest that stretcher positioning may influence ICP-related parameters such as ONSD and GCS, warranting further investigation.

Taken together, our results indicate that stretcher angle may have important prognostic implications in acute stroke patients. The significantly lower GCS scores and higher ICU admission rates observed in patients transported at flatter angles (0-30°) may reflect either more severe neurological compromise or a potential physiological disadvantage associated with this position. Although causality cannot be determined from this observational study, it is possible that flatter positions may impair cerebral venous drainage or contribute to elevated ICP, thereby worsening clinical status. Conversely, the 46-60° Group showed relatively better neurological scores and lower ICU admission rates, suggesting that this angle range may provide an optimal balance for cerebral perfusion during prehospital transport. While higher ONSD values in more upright Group (61-90°) might indicate either compensatory ICP responses or selection bias toward more severe cases, previous research has demonstrated that head-of-bed elevation significantly influences CBF and arterial pressure [22,30]. Therefore, stretcher positioning during EMS care may not only reflect a patient's clinical severity but also play a role in modifying early outcomes. Further prospective studies are needed to determine whether standardized stretcher angles can contribute to improved neurological prognosis and long-term recovery in stroke patients.

Study Limitations

This study has several limitations that should be considered when interpreting the results. It was conducted as a single-center study, which may limit the generalizability of the findings. Future multicenter studies with larger sample sizes are needed to confirm our results and increase the strength of the evidence.

A single physician performed ONSD and HOB measurements. Although this approach reduced interobserver variability, it introduced potential operator bias. Furthermore, the physician performing the ONSD measurements was not blinded to HOB, which may have introduced measurement bias.

Patient inclusion was limited to the time periods when the designated physician was on duty. As a result, random sampling was not possible, which may have introduced selection bias and influenced the distribution of patient characteristics.

We did not intervene in the HOB chosen by EMS personnel during patient transport. The rationale behind the angle choices was not systematically evaluated, and the possibility that EMS personnel chose certain angles based on the clinical status of the patients (e.g., lower GCS) cannot be excluded. This makes it difficult to establish causality between HOB and patient outcomes.

This study included only stroke patients, and the results may not apply to other conditions that may affect vital signs or ONSD. Therefore, the findings should be interpreted in the context of acute stroke management. HOB was recorded as a single measurement upon arrival at the ED, and measurements were not repeated at different angles. Assessing dynamic changes in ONSD and vital signs in response to HOB adjustments would provide more robust evidence of a causal relationship.

Despite these limitations, our study provides important preliminary data suggesting that HOB during EMS transport may affect neurologic and physiologic parameters in stroke patients and warrants further investigation.

Conclusion

Rapid intervention can reduce stroke morbidity and mortality. The prehospital period is one of the most critical intervention periods. Our study revealed that the angles of the stretcher while in EMS affect ICP, DBP, GCS, and ONSD in patients brought to the emergency department. In line with this finding, we concluded that the angle of the stretcher of 46° to 60° during the time spent in both EMS and during hospital follow-up may have a positive relationship with the patient's ICP, DBP, GCS, and ONSD values. We recommend that prehospital EMS personnel be informed to provide more effective patient care.

Ethics

Ethics Committee Approval: Ethics committee approval was received from Ankara Bilkent City Hospital Clinical Research No. 2 Ethics Committee (decision number: E2-23-5911, date: 21.12.2023).

Informed Consent: The patient and his/her relatives provided informed consent, and their consent was obtained.

Footnotes

Authorship Contributions

Surgical and Medical Practices: B.B., H.S.Ö., Concept: B.B., A.Ö., B.B., A.Ş., Design: B.B., A.Ö., H.S.Ö., B.B., Data Collection or Processing: B.B., H.S.Ö., Analysis or Interpretation: H.S.Ö., B.B., A.Ş., Literature Search: B.B., A.Ö., A.Ş., Writing: B.B., A.Ö., H.S.Ö., B.B., A.Ş.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Stroke, Cerebrovascular accident: WHO; 2024. Available from: https://www.emro.who.int/health-topics/stroke-cerebrovascular-accident/index.html Last accessed date: 01.10.2024.
2. Manouchehrifar M, Lakestani M, Kashani P, Safari S. Sonographic diameter of optic nerve sheath in differentiation of ischemic and hemorrhagic strokes; a diagnostic accuracy study. Am J Emerg Med. 2018;36:2064-7.

3. Seyedhosseini J, Aghili M, Vahidi E, Shirani F. Association of optic nerve sheath diameter in ocular ultrasound with prognosis in patients presenting with acute stroke symptoms. Turk J Emerg Med. 2019;19:132-5.

4. Vaiman M, Sigal T, Kimiagar I, Bekerman I. Noninvasive assessment of the intracranial pressure in non-traumatic intracranial hemorrhage. J Clin Neurosci. 2016;34:177-81.

5. Maissan IM, Vlottes B, Hoeks S, Bosch J, Stolker RJ, den Hartog D. Ambulance deceleration causes increased intra cranial pressure in supine position: a prospective observational prove of principle study. Scand J Trauma Resusc Emerg Med. 2021;29:87.

6. Fichtner J, Ulrich CT, Fung C, Knüppel C, Veitweber M, Jilch A, et al. Management of spontaneous intracranial hypotension - Transorbital ultrasound as discriminator. J Neurol Neurosurg Psychiatry. 2016;87:650-5.

7. Lochner P, Czosnyka M, Naldi A, Lyros E, Pelosi P, Mathur S, et al. Optic nerve sheath diameter: present and future perspectives for neurologists and critical care physicians. Neurol Sci. 2019;40:2447-57.

8. Yavaşi Ö, Metin NO, Metin Y, Çelik A, Tüfekçi A, Çeliker FB. The role of optic nerve sheath diameter measurement on CT in differentiating transient ischemic attack and acute ischemic stroke. Clin Neurol Neurosurg. 2022;212:107094.

9. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ıschemic stroke: a guideline for healthcare professionals from the American heart association/American stroke association. Stroke. 2019;50:e344-418.

10. Shaw L, Price C, McLure S, Howel D, McColl E, Younger P, et al. Paramedic initiated lisinopril for acute stroke treatment (PIL-FAST): results from the pilot randomised controlled trial. Emerg Med J. 2014;31:994-9.

11. Bath PM, Song L, Silva GS, Mistry E, Petersen N, Tsivgoulis G, et al. Blood pressure management for ischemic stroke in the first 24 hours. Stroke. 2022;53:1074-84.

12. Hirzallah MI, Lochner P, Hafeez MU, Lee AG, Krogias C, Dongarwar D, et al. Quality assessment of optic nerve sheath diameter ultrasonography: scoping literature review and Delphi protocol. J Neuroimaging. 2022;32:808-24.

13. Kothari RU, Pancioli A, Liu T, Brott T, Broderick J. Cincinnati prehospital stroke scale: reproducibility and validity. Ann Emerg Med. 1999;33:373-8.

14. Ikramuddin SS, Coburn JA, Ramezani S, Streib C. Artery of percheron infarction: clinical presentation and outcomes. Neurol Clin Pract. 2024;14:e200266.

15. Anees A, Panicker P, Iype T, Sreelekha KR. Assessment of onset-to-door time in acute ischemic stroke and factors associated with delay at a tertiary care center in South India. J Neurosci Rural Pract. 2024;15:86-94.

16. Burton E, Quinn R, Crosbie-Staunton K, Deasy C, Masterson S, O'Donnell C, et al. Temporal trends of ambulance time intervals for suspected stroke/transient ischaemic attack (TIA) before and during the COVID-19 pandemic in Ireland: a quasi-experimental study. BMJ Open. 2024;14:e078168.

17. Vuorinen P, Setala P, Ollikainen J, Hoppu S. A hybrid strategy using an ambulance and a helicopter to convey thrombectomy candidates to definite care: a prospective observational study. BMC Emerg Med. 2024;24:17.

18. Bekgöz B, Akkaya M, Bozer M, Akçaalan S, Şan İ. Analysis of response times to cases by Ankara 112 Provincial Ambulance and Call Service in the last five years. Anatolian J Emerg Med. 2022;5:1-6.

19. Sogunuru GP, Kario K, Shin J, Chen CH, Buranakitjaroen P, Chia YC, et al. Morning surge in blood pressure and blood pressure variability in Asia: evidence and statement from the HOPE Asia Network. J Clin Hypertens (Greenwich). 2019;21:324-34.

20. Stead LG, Gilmore RM, Vedula KC, Weaver AL, Decker WW, Brown RD Jr. Impact of acute blood pressure variability on ischemic stroke outcome. Neurology. 2006;66:1878-81.

21. Turana Y, Tengkawan J, Chia YC, Nathaniel M, Wang JG, Sukonthasarn A, et al. Hypertension and stroke in Asia: a comprehensive review from HOPE Asia. J Clin Hypertens (Greenwich). 2021;23:513-21.

22. Gregori-Pla C, Mesquita RC, Favilla CG, Busch DR, Blanco I, Zirak P, et al. Blood flow response to orthostatic challenge identifies signatures of the failure of static cerebral autoregulation in patients with cerebrovascular disease. BMC Neurol. 2021;21:154.

23. Patel R, Chowdhury MAB, Gul S, Fahy BG, Gonzalez A, Fitzpatrick D, et al. Ultrasound of optic nerve sheath diameter and stroke outcomes. Crit Care Explor. 2021;3:e0565.

24. Geeraerts T, Merceron S, Benhamou D, Vigué B, Duranteau J. Non-invasive assessment of intracranial pressure using ocular sonography in neurocritical care patients. Intensive Care Med. 2008;34:2062-7.

25. Kanda M, Sato T, Yoshida Y, Kuwabara H, Kobayashi Y, Inoue T. Effect of admission in the stroke care unit versus intensive care unit on in-hospital mortality in patients with acute ischemic stroke. BMC Neurol. 2023;23:402.

26. Santos D, Maillie L, Dhamoon MS. Patterns and outcomes of intensive care on acute ischemic stroke patients in the US. Circ Cardiovasc Qual Outcomes. 2023;16:e008961.

27. Altun Uğraş G, Yüksel S, Temiz Z, Eroğlu S, Şirin K, Turan Y. Effects of different head-of-bed elevations and body positions on intracranial pressure and cerebral perfusion pressure in neurosurgical patients. J Neurosci Nurs. 2018;50:247-51.

28. Momtaz OM, Said OM, Mohamed AM, Abdel Mawla TS. Value of optic nerve sheath diameter in diagnosis and follow up of patients with disturbed conscious level. Eye Brain. 2022;14:115-26.

29. Favilla CG, Mesquita RC, Mullen M, Durduran T, Lu X, Kim MN, et al. Optical bedside monitoring of cerebral blood flow in acute ischemic stroke patients during head-of-bed manipulation. Stroke. 2014;45:1269-74.