ORIGINAL ARTICLE

Evaluation of clinical parameters of patients with aneurysmal subarachnoid hemorrhage during long-distance interhospital transport

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ABSTRACT

BACKGROUND: The objective of the study was to investigate the changes in Glasgow Coma Scale (GCS) score, Fisher's grade, and World Federation of Neurological Surgeons (WFNS) grade that occur during transport of patients with aneurysmal subarachnoid hemorrhage (aSAH) from secondary hospitals to a tertiary care center.

METHODS: Seventy-five patients with aSAH who were transported through ground ambulance from secondary hospitals to our tertiary care centers between December 1, 2016, and December 1, 2019, were enrolled in this retrospective study. Data regarding GCS, Fisher's grade, and WFNS grade from both hospitals, patient demographics, and duration and distance of transport were analyzed.

RESULTS: The female-to-male ratio was 46:29 and median patient age was 55.0 years. Median transport time was 3.0 h and median distance traveled was 161.0 kilometers. GCS significantly decreased (p=0.004) and Fisher and WFNS grade significantly increased during transport (p=0.003 and p=0.003, respectively). The change in the WFNS grade during transport, but not GCS score or Fisher's grade, was significantly different between non-intubated patients and intubated patients (p=0.036).

CONCLUSION: Significant changes in Fisher's grade, GCS, and WFNS grade occurred during ground transport of patients with aSAH from secondary hospitals to tertiary care centers. These changes in the parameters may affect and change patients future prognoses.

Keywords: Aneurysmal subarachnoid haemorrhage; long distance; transport.

INTRODUCTION

Aneurysmal subarachnoid hemorrhage (aSAH) is a low-incidence disease with a high mortality rate.[1,2] Overall mortality is approximately 40%, with 10–15% of patients dying before hospital arrival.[3] Aneurysmal rehemorrhage and vasospasm are the main causes of poor prognosis.[4–6] Rehemorrhage usually develops within the first 6 h of the initial rupture[7,8] and has a mortality rate ranging between 50% and 70%.[5,9]

Although mortality and morbidity are not significantly affected by the timing of surgical intervention,[10] rapid aneurysm treatment can prevent complications, including rehemorrhage. The timing of rehemorrhage is difficult to determine, although many studies have tried.[11] The European Stroke Organization guidelines emphasize prompt treatment as soon as logistically and technically possible.[11,12]

Most patients with aSAH present to secondary hospitals which lack the capability to properly treat cerebral aneurysms. These patients should be transferred to the nearest tertiary care center that can provide adequate comprehensive care.[13] Although several studies have reported that patient transfer negatively affects clinical outcomes,[14,15] large-scale epidemiological studies have shown that transfer has no outcome effect.[16,17] Since it is impractical to establish aSAH treatment capability in most secondary hospitals, the procedure for patient transfer and its associated clinical effects is important.

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Delayed transport of high-grade aSAH patients to a tertiary care center increases mortality.[18] In addition, transportation time affects prognostically important measurements of clinical and radiographic status associated with survival, such as the Glasgow Coma Scale (GCS) score, World Federation of Neurological Surgeons (WFNS) grade, and Fisher's grade. Therefore, this study aimed to examine the effect of transport on changes in clinical and radiographic status parameters in aSAH patients.

MATERIALS AND METHODS

In Turkey, the emergency system sequence of events for aSAH patients typically proceeds as follows: The patient is immediately transported to the nearest healthcare facility after an emergency ambulance unit is called by a bystander. In that facility, emergency computed tomography of the head is performed and the diagnosis of SAH is made. A physician then transfers the patient to a tertiary care center capable of treating the aneurysm through ground ambulance. Tertiary-secondary hospital communication is generally conducted using smartphone mobile communication applications under the control of emergency command centers. This allows direct peer-to-peer communication between an accepting neurosurgeon and referring physician who reports the time of ambulance departure from the secondary hospital, distance to the tertiary care center (km), anticipated duration of transport, and the patient's clinical and imaging findings. If the patient is in poor clinical condition or unstable, the patient is hospitalized by a neurosurgeon in the intensive care unit of the secondary hospital, who follows the patient closely using established monitoring and treatment protocols. Sedation, intubation, ventricular drainage, and other medically necessary interventions are performed at the secondary hospital as indicated. If the patient later becomes stable, the patient is then transferred and late surgical aneurysm treatment is performed.

This study retrospectively reviewed all patients with aSAH who were transported from a secondary hospital to our tertiary care centers through ground ambulance between December 1, 2016, and December 1, 2019. The distance traveled ranged between 112 and 300 km. We included aSAH patients who had an aneurysm detected at our tertiary center and available data regarding transportation duration and distance, and GCS score, WFNS grade, and Fisher's grade from both hospitals. Data from the secondary hospitals were obtained from the medical and radiographic records delivered to us with the patient by the ground ambulance teams. Ground transport distance was calculated assuming that the fastest route was taken. The time of transport was obtained from transfer notes which documented departure, arrival, and total transport times. Transfers through air ambulance, those not directly made from secondary hospitals, and patients transferred from a >300 km distance were excluded. We also excluded patients with ventricular drainage requirement; acute subdural hematoma; acute hydrocephalus; GCS score <6; Fisher's grade 4; WFNS score 5; traumatic SAH; head trauma; pregnancy; age <18 years; drug overdose or addiction; the history of cancer, cardiac, hepatic, and renal diseases, severe infection, or previous ischemic or hemorrhagic stroke; and those whose transport was delayed for any reason.

Statistical analyses were performed using SPSS version 20 software (IBM Corp., Armonk, NY, USA). Shapiro-Wilk and Kolmogorov-Smirnov tests were used to evaluate the distribution of numeric data. Descriptive data are presented as means with standard deviation and medians with interquartile range (IQR) for numerical variables and frequencies with percentage for categorical variables. The related samples Wilcoxon signed-rank test was used to compare data from the first and last evaluations during transport. The Spearman rank-order correlation was used to analyze the correlation between the distance to hospital and changes in GCS score, Fisher's grade, and WFNS grade. The Mann-Whitney U-test was used to compare scale score and grade changes according to patient intubation status and aneurysm location. $P<0.05$ was considered statistically significant.

RESULTS

Seventy-five patients were included for analysis. The female-to-male ratio was 46:29 and the median age was 55.0 years (IQR, 48.0–64.0). The median transport time was 3.0 h and the median travel distance was 161.0 km. Nineteen patients were intubated at the secondary hospital before transfer. Intracranial aneurysms were located in the anterior cerebral circulation in 64 patients and the posterior cerebral circulation in 11 patients (Table 1). Most of the patients who transferred from long-distance hospitals are in territory of Adiyaman University (Fig. 1).

GCS score significantly decreased ($p=0.004$) and Fisher and WFNS grades significantly increased during transport ($p=0.003$ and $p=0.003$, respectively) (Table 2 and Fig. 2). The changes in GCS score and Fisher's grade during transport

Table 1. Patient characteristics

Characteristic (n=75)	
Sex, (F/M)	46/29
Age (years), median (IQR)	64.0 (60.0–68.0)
Transport time (h), median (IQR)	3.0 (3.0–5.0)
Distance to hospital (km), median (IQR)	161.0 (161.0–296.0)
Endotracheal intubation, n (%)	19 (29.2)
Intracranial aneurysm location, n (%)	
Anterior cerebral circulation	64 (83.1)
Posterior cerebral circulation	11 (16.9)

F: Female; M: Male; IQR: Interquartile range.

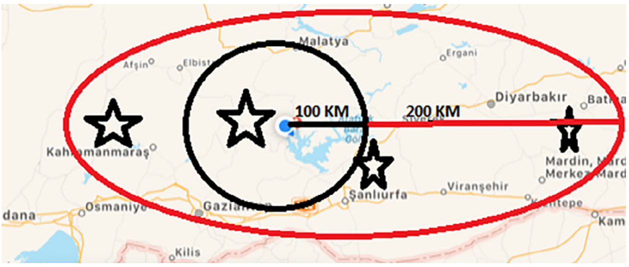

Figure 1. The map showing the study area where patients transported to Adiyaman University.

between intubated and non-intubated patients did not significantly differ. However, the change in WFNS grade during transport between the non-intubated and intubated patients was significantly different (p=0.036) (Table 3 and Fig. 3). The changes in GCS score, Fisher's grade, and WFNS grade during transport did not significantly differ between the patients according to aneurysm location (Table 4 and Fig. 4). No mortality occurred during transport.

DISCUSSION

Few studies have examined patient clinical parameters during long-distance medical transport. This study analyzed relevant parameters used to predict aSAH mortality and morbidity in patients during transport from secondary to tertiary care hospitals and found that these parameters deteriorated. There is a strong relationship between aSAH prognosis and GCS score, Fisher's grade, and WFNS grade at admission and all three were negatively affected by patient transport.

Although there are multiple factors that influence mortality in aSAH, delay in transport of high-grade aSAH patients to a center capable of providing treatment correlates with mortality.[6] Our findings are in agreement: Significant changes occurred in GCS score, Fisher's grade, and WFNS grade during transport that correlates with poor prognosis.

The previous studies have reported that lengthy transport time has a negative effect on the prognosis of low-grade aSAH patients[13,18] and the mortality rate increases as the time increases.[18] Although the hourly rehemorrhage risk is low among aSAH patients with low Hunt-Hess grade, no relationship between transport time and rehemorrhage has been reported.[19] Other studies have emphasized that patients with a GCS score of 15 can be safely transported for up to 3 h, having found no relationship between transportation distance and transfer time.[11,20] In this study, although the Fisher's grade increased and GCS decreased during transport, no rehemorrhage, decrease in GCS score that required intubation, or mortality occurred.

Table 2. Comparison of GCS score, Fisher grade, and WFNS grade before and after transport

Scale (n=65)		Before transport	After transport	p*
GCS score	Mean±SD	12.23±2.93	11.92±2.93	0.004
	Median (IQR)	14.00 (9.00–14.00)	13.00 (9.00–14.00)	
Fisher grade	Mean±SD	1.26±0.54	1.40±0.61	0.003
	Median (IQR)	1.00 (1.00–1.00)	1.00 (1.00–2.00)	
WFNS grade	Mean±SD	2.51±1.19	2.77±1.18	0.003
	Median (IQR)	2.00 (2.00–4.00)	3.00 (2.00–4.00)	

*Related-samples Wilcoxon signed rank test. SD: Standard deviation; IQR: Interquartile range; GCS: Glasgow Coma Scale; WFNS: World Federation of Neurological Surgeons.

Table 3. Comparison of changes in GCS score, Fisher grade, and WFNS grade during transport between intubated and non-intubated patients

Variable (n=75)		Intubated patients (n=22)	Non-intubated patients (n=53)	p*
Change in GCS score	Mean±SD	−0.30±0.76	−0.32±1.00	0.639
	Median (IQR)	0.00 (−1.00–0.00)	0.00 (0.00–0.00)	
Change in Fisher grade	Mean±SD	0.26±0.45	0.28±0.09	0.063
	Median (IQR)	0.00 (0.00–1.00)	0.00 (0.00–0.00)	
Change in WFNS grade	Mean±SD	0.00±0.00	0.37±0.77	0.036
	Median (IQR)	0.00 (0.00–0.00)	0.00 (0.00–1.00)	

*Mann-Whitney U test. SD: Standard deviation; IQR: Interquartile range; GCS: Glasgow Coma Scale; WFNS: World Federation of Neurological Surgeons.

Table 4. Comparison of changes in GCS score, Fisher grade, and WFNS grade during transport according to aneurysm location

Variable (n=75)		Location of aneurysm		p*
		Anterior cerebral circulation	Posterior cerebral circulation	
Change in GCS score	Mean±SD	−0.28±0.86	−0.45±0.69	0.345
	Median (IQR)	0.00 (−1.00–0.00)	0.00 (−1.00–0.00)	
Change in Fisher grade	Mean±SD	0.13±0.34	0.18±0.40	0.650
	Median (IQR)	0.00 (0.00–0.00)	0.00 (0.00–0.00)	
Change in WFNS grade	Mean±SD	0.20±0.66	0.55±0.69	0.062
	Median (IQR)	0.00 (0.00–0.00)	0.00 (0.00–1.00)	

*Mann-Whitney U test. SD: Standard deviation; IQR: Interquartile range; GCS: Glasgow Coma Scale; WFNS: World Federation of Neurological Surgeons.

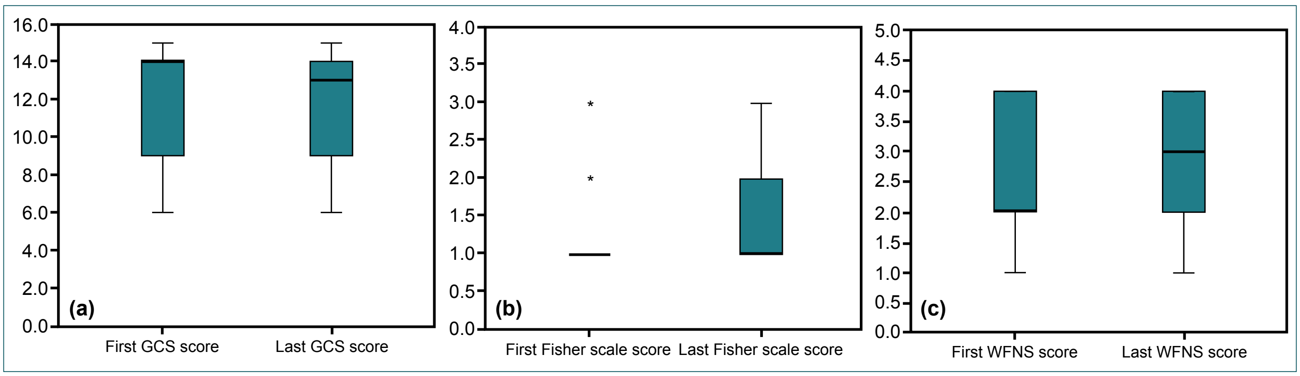

Figure 2. Boxplots of the first and last evaluations of **(a)** Glasgow Coma Scale score, **(b)** Fisher scale grade, and **(c)** World federation of neurological surgeons scale grade during transport.

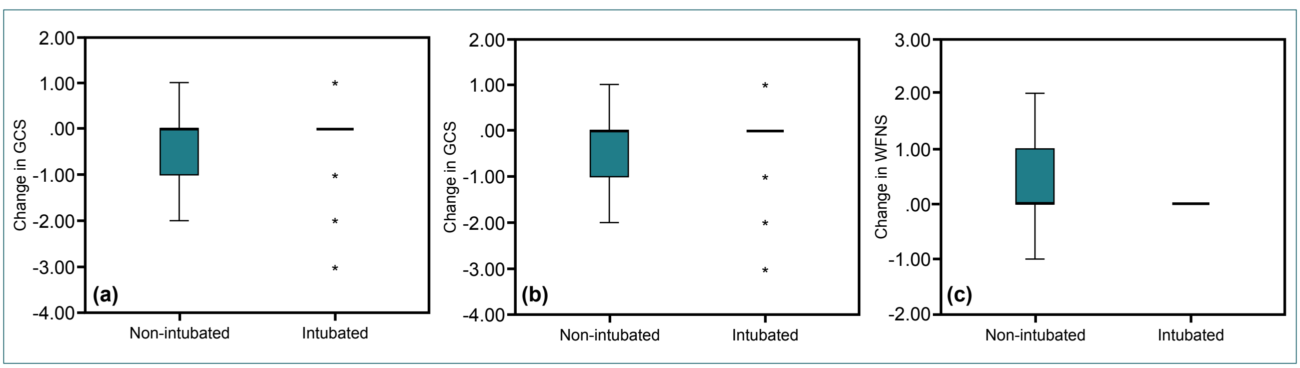

Figure 3. Boxplots of **(a)** change in Glasgow Coma Scale score, **(b)** change in Fisher's grade, and **(c)** change in World federation of neurological surgeons grade in intubated and non-intubated patients.

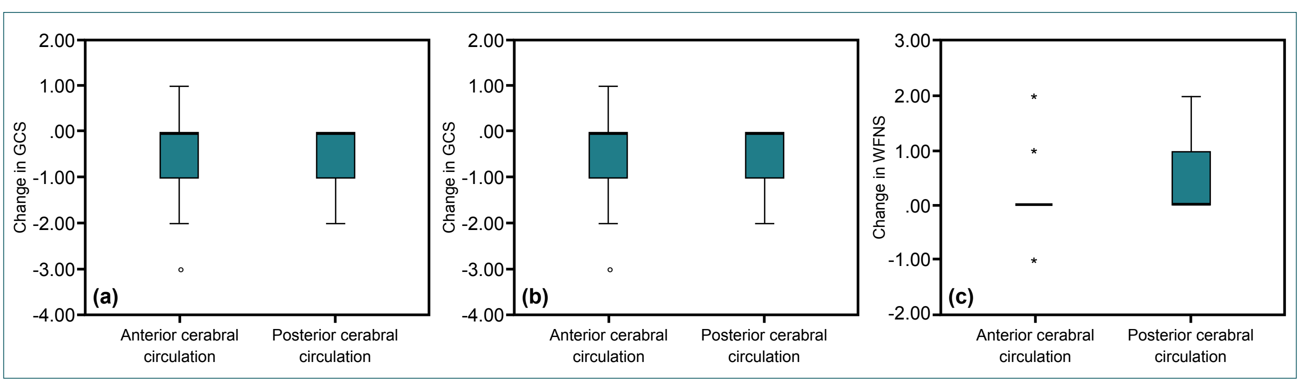

Figure 4. Boxplots of **(a)** change in Glasgow Coma Scale, **(b)** change in Fisher's grade, and **(c)** change in World federation of neurological surgeons grade according to aneurysm location.

Air transportation may be faster than ground at distances less than 50 km.[11] However, air transportation is dependent on weather conditions and is expensive. In addition, the United States Federal Aviation Administration reported 125 deaths in 62 accidents during helicopter air ambulance transportation over 19 years,[20] and coordination of helicopter transportation is difficult and time consuming. Physiologic effects of air transport must also be considered: The noise, vibration, and air pressure change effects may cause an increase in patient heart rate and blood pressure. In a previous study, these effects were similar between helicopter and ground transport, and helicopter transport was recommended for patients with a low GCS score.[21] Helicopter transportation was not evaluated in this study because of an insufficient number of patients.

Since hemodynamic control is important in aSAH due to the risk of rehemorrhage and other complications, the importance of patient intubation before transport has been emphasized.[22] In this study, patients with Fisher's grade 2–3, GCS score 7–12, confusion, agitation, unstable blood pressure, or unstable cardiac and respiratory conditions were intubated in the secondary hospital before transfer. This allows easier control of hemodynamics and protection from the physiologic effects of outside factors such as weather and road conditions during ground transport. However, in this study, the changes in Fisher's grade and GCS score between intubated and non-intubated patients during transport were not significant.

This study has several limitations. First, it was retrospective in nature. However, it is very difficult to evaluate a non-projectable disease such as aSAH over the patients. Second, the time from symptom onset to patient arrival at the secondary hospital could not be measured. However, this study aimed to investigate parameter changes during transport between two hospitals through ground ambulance. This study presented data for aSAH patient's transportations, and their parameter changes with the time, distance, and our findings may help future studies about transportations of aSAH patients. Finally, although the use of medical helicopter transportation is increasing worldwide, it was not examined in this study.

Conclusion

Significant changes in Fisher's grade, GCS score, and WFNS grade occurred during ground transport of aSAH patients from secondary hospitals to tertiary care centers. These parameters change in a way that negatively affects patient prognosis. Future large-scale multicenter studies to investigate methods to prevent these changes during transport are warranted.

Ethics Committee Approval: This study was approved by the Akdeniz University Clinical Research Ethics Committee (Date: 05.05.2021, Decision No: 306).

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: H.Ç., N.Ü., Ö.E.; Design: H.Ç., N.Ü., Ö.E.; Supervision: H.Ç., N.Ü., Ö.E.; Resource: H.Ç., N.Ü., Ö.E.; Materials: H.Ç., N.Ü., Ö.E.; Data: H.Ç., N.Ü., Ö.E.; Analysis: H.Ç., N.Ü., Ö.E.; Literature search: H.Ç., N.Ü., Ö.E.; Writing: H.Ç., N.Ü., Ö.E.; Critical revision: H.Ç., N.Ü.

Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Uzun mesafeli hastaneler arası nakil sırasında, anevrizmal subaraknoid kanamalı hastaların klinik parametrelerinin değerlendirilmesi

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AMAÇ: Anevrizmal subaraknoid kanaması olan hastaların ikinci basamak hastanelerden, üçüncü basamak hastanelere sevk edilmesi sırasında ortaya çıkan; Glaskow Koma Skalası skoru (GKS), Fisher evrelemesi ve World Federation of Neurological Surgeons (WFNS) derecesi değişiklikleri araştırmak.

GEREÇ VE YÖNTEM: Bu geriye dönük çalışmaya, 1 Aralık 2016 ile 1 Aralık 2019 tarihleri arasında ikinci basamak hastanelerden, üçüncü basamak olan merkezlerimize kara ambulansı ile nakledilen ve anevrizmal subaraknoid kanaması olan 75 hasta alındı. Her iki hastanede, GKS skoru, Fisher evrelemesi ve WFNS derecesi, hasta demografileri, nakil süresi ve mesafesi ile ilgili veriler analiz edildi.

BULGULAR: Kadın/erkek oranı 46: 29 ve ortanca hasta yaşı 55 yıldı. Median taşıma süresi üç saat ve yapılan mesafe 161 kilometre idi. Taşıma sırasında GKS anlamlı olarak azaldı (p=0.004), Fisher ve WFNS skorları anlamlı olarak arttı (sırasıyla, p=0.003 ve p=0.003). Nakil sırasında GKS veya Fisher evreleme sistemi değil ama WFNS değerlendirme derecesi, entübe olan ve olmayan hastalar arasında anlamlı derecede farklıydı (p=0.036).

TARTIŞMA: Anevrizmal subaraknoid kanaması olan hastaların ikinci basamak hastanelerden, üçüncü basamak hastanelere sevk edilmesi sırasında ortaya çıkan; GKS, Fisher evrelemesi ve WFNS derecesinde önemli değişiklikler meydana geldiği tespit edildi. Parametrelerdeki bu değişiklikler, hastaların gelecekteki prognozlarını etkileyebilir ve değiştirebilir.

Anahtar sözcükler: Anevrizmal subaraknoid kanama; nakil; uzun mesafe.

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