

Original article

Clinical significance of the level of fibrin degradation products in drowning patients without cardiac arrest

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Abstract

Objective: This study aimed to retrospectively investigate the clinical significance of the level of fibrin degradation products in drowning patients without cardiac arrest.

Patients and Methods: All drowning patients who were transported to our department from January 2011 to December 2019 were retrospectively investigated through a medical chart review and included as subjects in the present study. The exclusion criteria were the occurrence of cardiac arrest before patient arrival to our department and lack of measurement of the fibrin degradation product level on arrival. The subjects were divided into two groups: early discharge group, which included patients who were discharged within 3 days, and late discharge group, which included patients who were discharged after 3 days.

Results: The early discharge group included 10 subjects and the late discharge group included 39 subjects. No significant differences were observed in age, sex, proportion of freshwater drowning cases, proportion of alcohol drinkers, vital signs, blood gas analysis findings, proportion of lung lesions, or survival rate between the two groups. The levels of glucose and fibrin degradation products on arrival were significantly greater in the early discharge group than in the late discharge group. A multivariate analysis showed that the only significant predictor of early discharge was the fibrin degradation product level among variables identified in a univariate analysis.

Conclusion: This is the first study to show that the level of fibrin degradation products on arrival can predict early or late discharge in drowning patients without cardiac arrest before arriving to the hospital.

Key words: drowning, prognosis, fibrin degradation products, discharge

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Introduction

Our hospital, which is an acute critical care center and the base of a physician-staffed helicopter emergency medical service, is located in the Izu Peninsula in eastern Shizuoka. Most severely ill or trauma patients are transported to our hospital via ground or air ambulance^{1,2}.

Fibrin degradation products (FDPs) are fragments re-

leased after the plasmin-mediated degradation of fibrinogen or fibrin³. The FDP level is very sensitive to intravascular thrombus and may be markedly elevated in cases of inflammation, disseminated intravascular coagulation, acute aortic dissection, pulmonary embolus, and trauma^{2,4}. In addition, a previous study investigated the FDP level among patients with out-of-hospital cardiac arrest and found that the FDP level was negatively correlated with favorable survival outcomes⁵. Endothelial cells secrete tissue plasminogen activator in response to whole-body ischemia and reperfusion due to cardiac arrest, following increased fibrinolysis⁵. Drowning also results in whole-body ischemia and hypoxia.

In this study, we aimed to retrospectively investigate the clinical significance of the FDP level in drowning patients without cardiac arrest.

Patients and Methods

The authors attest that this clinical investigation was de-

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Table 1 Results of the analysis

	Early discharge n=10	Late discharge n=39	<i>P</i> value
Sex (male/female)	9/1	25/14	0.08
Age (years)	50.7 ± 21.7	62.4 ± 24.1	n.s.
Sea/Fresh water	7/3	17/21	n.s.
Alcohol (yes/no)	1/9	4/24	n.s.
Glasgow Coma Scale	15 (13.25, 15)	12 (7, 14)	n.s.
Systolic blood pressure (mmHg)	123.5 ± 15.6	132.3 ± 36.7	n.s.
Heart rate (beats per minute)	84.2 ± 18.0	95.0 ± 24.0	n.s.
SpO ₂ (%)	94.0 ± 4.5	94.7 ± 4.6	n.s.
Oxygen (L/minute)	4.4 ± 5.7	7.7 ± 4.0	n.s.
pH	7.31 ± 0.14	7.29 ± 0.1	n.s.
Base excess (mmol/L)	-4.2 ± 8.2	-4.4 ± 4.8	n.s.
Lactate (mmol/L)	5.3 ± 6.5	4.1 ± 2.8	n.s.
Sodium (mEq/L)	142.8 ± 3.7	139.1 ± 7.2	0.08
Glucose (mg/dL)	124.5 ± 23.8	157.9 ± 52.5	<0.05
FDP (μg/mL)	2.7 ± 1.3	20.3 ± 25.2	<0.001
Lung lesion on CT (yes/no)	(7/3)	(33/3) (n=36)	0.09
Survival rate	100%	94.8%	n.s.

SpO₂: percutaneous oxygen saturation, FDP: fibrinogen degradation product, CT: computed tomography.

terminated to require institutional review board/ethics committee review. The corresponding protocol/approval number is 298.

All drowning patients who were transported to our department from January 2011 to December 2019 were retrospectively investigated through a medical chart review and included as subjects in the present study. The exclusion criteria were the occurrence of cardiac arrest before patient arrival to our department and lack of measurement of the FDP level on arrival.

The subjects were divided into two groups: early discharge (ED) group, which included patients discharged within 3 days, and late discharge (LD) group, which included patients discharged after 3 days. We collected data on each patient's sex, age, drowning water type (ocean water or freshwater), alcohol drinking status, blood gas analysis results on arrival (pH, base excess, lactate, sodium, and glucose levels), FDP level on arrival, lung lesions on computed tomography, and survival rate.

We used the JMP 12.0 statistical software program (SAS Japan Incorporation, Tokyo, Japan) for statistical analyses. The analyses were performed using a non-paired Student's *t*-test, a median test, or the χ^2 test, as appropriate. A value of $P < 0.05$ was considered to indicate a statistically significant difference. All data are presented as mean ± standard deviation. The variables included in the multivariate analysis to evaluate independent predictors of early discharge (within 3 days) were those with significance levels of $P < 0.1$ based on the univariate analysis. In addition, the optimal cutoff values for discharge within 3 days were determined using a

receiver operating characteristic curve analysis.

Results

During the investigation period, a total of 146 patients were treated for drowning in our department. Among these patients, 91 experienced cardiac arrest before hospital arrival. These 91 individuals were excluded from the study. Additionally, six patients whose FDP level was not measured on arrival were also excluded. Finally, a total of 39 patients were included as study subjects. Of them, 10 subjects were classified into the ED group and 39 patients were categorized into the LD group. The LD group included three subjects with trauma due to a fall and one patient with subarachnoid hemorrhage due to rupture of a cerebral aneurysm.

Table 1 shows the results of the analysis of the two groups. No significant differences were found in age, proportion of freshwater drowning cases, proportion of alcohol drinkers, Glasgow Coma Scale score, systolic blood pressure, heart rate, percutaneous saturated oxygen, oxygen flow rate, pH, base excess, lactate, or survival rate between the groups. The proportion of men and the sodium level were greater, whereas the proportion of lung lesions was lower, in the ED group than in the LD group. However, these differences were not significant ($P < 0.1$). The levels of glucose and FDPs on arrival were significantly greater in the ED group than in the LD group.

A multivariate analysis showed that the only significant predictor of ED was the FDP level (LogWorth 2.1, $P < 0.01$), among the variables (proportion of men, sodium level, pro-

portion of lung lesions, and glucose or FDP level) identified in a univariate analysis.

For discharge within 3 days, the cutoff level of FDPs was 4.0 µg/mL.

Discussion

This is the first study to show that the FDP level on arrival is able to predict ED or LD in drowning patients without cardiac arrest before arriving to the hospital.

Massive aspiration of water in drowning hampers gas exchange in the lung, resulting in hypoxia, shock, and cardiac arrest. Prolonged and severe tissue hypoxia results in the generation of large quantities of lactate from anaerobic glycolysis⁶. Lactic acidosis often occurs as a severe complication in patients experiencing hypotension, as with hemorrhage, trauma and sepsis, and cardiac arrest, as well as in patients with weakened oxygenation. A high lactate level or base deficit is closely correlated with a poor prognosis in patients with cardiac arrest^{7–9}. In cases of drowning with cardiac arrest, a high lactate level or base deficit is also correlated with a poor prognosis¹⁰. However, the present study excluded patients who experienced cardiac arrest before hospital arrival. This exclusion of the most severe hypoxia cases and the small number of patients may explain the discrepancy in the results between previous studies and the present study.

The present study demonstrated that the level of FDPs on arrival was the only prognostic factor predicting ED in drowning patients without cardiac arrest. The FDP level is very sensitive to intravascular thrombus and may be markedly elevated in cases of inflammation, trauma, or stroke,

including subarachnoid hemorrhage. Massive aspiration of unsterilized water may cause aspiration pneumonia. The complication of pneumonia may be one of the reasons for a delayed discharge, along with trauma or subarachnoid hemorrhage. Not only the severity of hypoxia but also the severity of complications may be responsible for the high levels of FDPs on arrival^{2, 11}. Likely for these reasons, the FDP level was identified as the only good prognostic factor in the present study.

This study was limited by its retrospective nature and the small patient population. Accordingly, future prospective studies involving a greater number of patients are needed to confirm these findings.

Conclusion

This is the first study to show that the FDP level on arrival is able to predict ED or LD in drowning patients without cardiac arrest before arriving to the hospital.

Conflicts of interest: All authors do not have conflicts of interest to declare.

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