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Initial inferior vena cava diameter predicts massive transfusion requirements in blunt trauma patients: A retrospective cohort study☆

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ABSTRACT

Objectives: The inferior vena cava (IVC) diameter is associated with shock and increased mortality in trauma patients. However, there are no reports examining the association between the IVC diameter and massive transfusion (MT) requirements in trauma patients. The aim of this study was to evaluate the association between IVC diameter and MT requirements in patients with blunt trauma.
Methods: We retrospectively reviewed all patients who were consecutively hospitalized with blunt trauma (Injury Severity Score [ISS] ≥16) between from November 1, 2011 to March 30, 2016. Univariate and multivariate analyzes were performed to identify the independent predictors of MT (defined as >10 units of red cell concentrate transfusions within 24 h of admission). Receiver operating characteristic curve and the area under the curve (AUC) were estimated.
Results: Of the 222 patients included in this study, MT occurred in 22.5% patients. On multiple regression analysis, IVC diameter [Odds ratio (OR), 0.88; 95% confidence interval (CI), 0.80–0.96; $p < 0.01$], fibrin degradation product (FDP; OR, 1.01; 95% CI, 1.00–1.01; $p < 0.01$), and fibrinogen level (OR, 0.99; 95% CI, 0.98–1.00; $p < 0.01$) were strong predictors of MT. IVC diameter demonstrated moderate accuracy (AUC, 0.74; cutoff level, 13.0 mm; sensitivity, 67%; specificity, 73%). Combined cutoff levels of FDP <80.5 μg/ml, fibrinogen ≥165 mg/dl, and IVC diameter ≥13 mm could also determine how unnecessary a MT was with 100% accuracy.
Conclusions: Initial IVC diameter is a predictor of MT in blunt trauma patients.

1. Introduction

Massive hemorrhage is a major cause of death because of traumatic injury [1]. Uncontrolled hemorrhage after injury is the leading cause of potentially preventable death [2].

The diameter of inferior vena cava (IVC) is associated with the intravascular volume status and respiratory variations of IVC diameter have been used as a predictor of fluid responsiveness in critically ill patients [3,4]. Whole-body computed tomography (CT) has played a central role in trauma resuscitation [5,6], and the exact diameter of IVC can be obtained promptly and universally. In particular, IVC diameter can be measured more quickly than laboratory data in the era of hybrid emergency rooms [7]. The IVC diameter is associated with shock and increased mortality in trauma patients [8-10], particularly in elderly trauma patients [11]. However, there are no reports examining the association between the IVC diameter and massive transfusion (MT) requirements in trauma patients.

Earlier recognition of massive transfusion requirements is more useful than the prediction of death in the clinical setting. Several studies have demonstrated that the earlier an appropriate transfusion is given, the better the outcome in trauma patients [8,12,13].

The aim of this study was to evaluate the association between IVC diameter and MT requirements in with blunt trauma.

2. Materials and methods

2.1. Study design and setting

We retrospectively analyzed the medical records of trauma patients from November 1, 2011 to March 30, 2016. This facility is a tertiary healthcare center with a total of 455 beds, of which 34 are intensive

☆ Initial inferior vena cava diameter in trauma.
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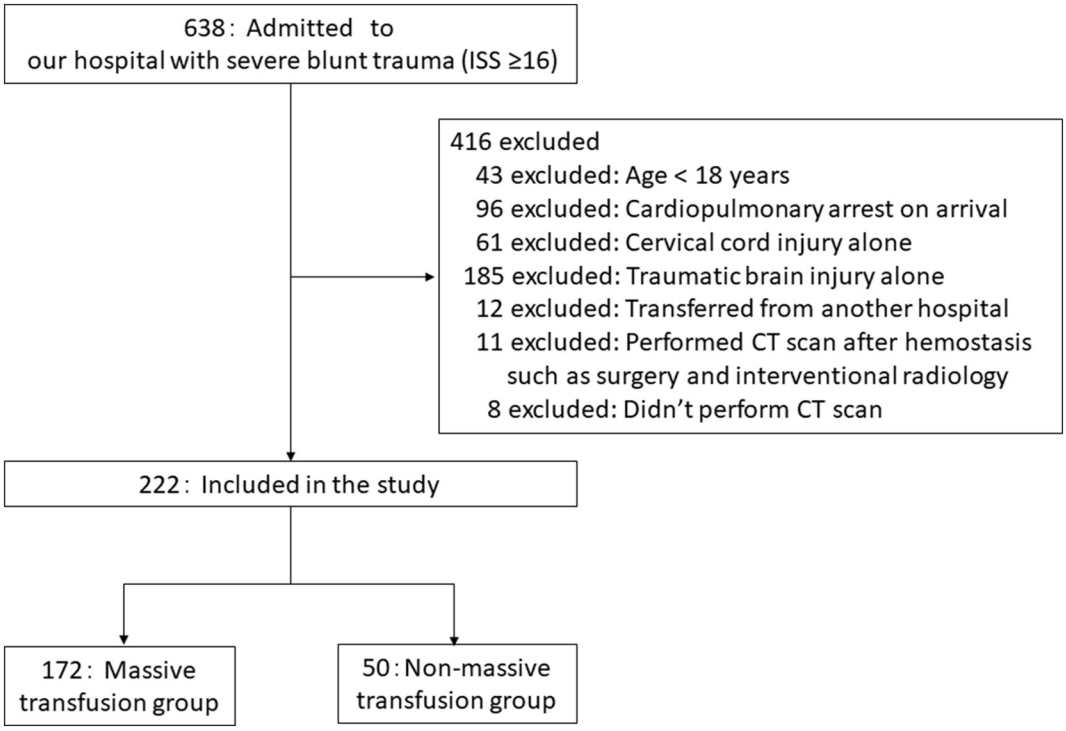

Fig. 1. Flow chart of enrolment of study participants. ISS, Injury Severity Score; CT, computed tomography.

care beds. It is also a referral center supporting a region with a population of approximately one million people. The study was approved by the local ethics committee and performed in accordance with the ethical standards stated in the Declaration of Helsinki. Patient consent was not required because of the retrospective study design.

2.2. Study participants and inclusion criteria

We included consecutive patients aged 18 years or older who presented with a severe injury (Injury Severity Score [ISS] ≥16) because of blunt trauma. All patients underwent a trauma pan scan within the emergency department. Exclusion criteria included patients aged

Table 1
Baseline characteristics.

	All patients (n = 222)	MT group (n = 50)	Non-MT group (n = 172)	p value
Age (year)	53.0 ± 22.0	53.4 ± 23.7	52.8 ± 21.6	0.87
Sex (male/female)	157/66	37/14	120/52	0.86
ISS	24.0 (18.0–30.0)	29.0 (24.0–40.3)	22.0 (17.0–29.0)	<0.01
Head injury ≥3 (%)	111 (50.0)	29 (58.0)	82 (47.7)	0.26
Chest injury ≥3 (%)	147 (66.2)	33 (66.0)	114 (66.3)	1.00
Abdominal injury ≥3 (%)	30 (13.5)	13 (26.0)	17 (9.9)	0.01
Pelvic injury ≥3 (%)	44 (19.8)	23 (46.0)	21 (12.2)	<0.01
Extremities injury ≥3 (%)	39 (17.6)	17 (34.0)	22 (12.8)	<0.01
Glasgow Coma Scale	14.0 (12.0–15.0)	14.0 (9.0–15.0)	14.0 (13.0–15.0)	<0.01
Body temperature (°C)	36.4 (35.9–36.5)	36.2 (35.6–36.5)	36.5 (35.9–36.9)	0.02
Heart rate (beats/min)	85.0 (72.0–100.0)	102.0 (83.0–124.0)	83.0 (72.0–95.0)	<0.01
MAP (mm Hg)	102.0 (86.0–115.0)	81.0 (70.0–104.0)	104.0 (91.0–118.0)	<0.01
Respiratory rate (breath/min)	20.0 (17.0–25.0)	22.0 (19.0–29.0)	20.0 (17.0–24.0)	0.01
BE (mmol/l)	−1.4 (−3.6–0.5)	−2.9 (−7.0–0.1)	−0.9 (−2.8–0.5)	<0.01
Hb (g/dl)	13.4 (11.9–14.6)	12.0 (11.3–13.7)	13.8 (12.5–14.7)	<0.01
Plt ($\times 10^3$/μl)	21.9 (18.0–25.9)	21.2 (18.0–26.0)	22.2 (17.7–25.8)	0.73
FDP (μg/ml)	93.5 (36.1–181.5)	182.5 (103.9–304.3)	53.2 (23.5–29.6)	<0.01
D-dimer (ng/ml)	28.8 (15.2–59.3)	61.9 (30.9–104.8)	26.4 (23.5–29.6)	<0.01
Fibrinogen (mg/dl)	2219.5 (180.8–267.0)	186.0 (148.0–229.0)	232.0 (186.5–278.5)	<0.01
APTT (sec)	26.4 (23.6–30.4)	26.2 (23.5–29.6)	27.7 (25.2–32.5)	0.02
PT-INR	1.1 (1.0–1.2)	1.0 (1.0–1.1)	1.1 (1.1–1.3)	<0.01
RCC (unit)	0.0 (0.0–0.0)	14.0 (10.0–20.0)	0.0 (0.0–0.0)	<0.01
FFP (unit)	0.0 (0.0–8.0)	15.0 (10.0–26.0)	0.0 (0.0–0.0)	<0.01
PC (unit)	0.0 (0.0–0.0)	10.0 (0.0–20.0)	0.0 (0.0–0.0)	<0.01
IVC diameter (mm)	15.1 (10.7–19.1)	11.1 (6.7–14.0)	15.9 (12.8–19.9)	<0.01
Outcome (survived/dead)	201/22	44/7	157/15	0.29

Data are presented as mean (standard deviation) or medians (interquartile range, IQR) for continuous variables and *N* (percentage) for categorical variables. MT, massive transfusion; ISS, Injury Severity Score; MAP, mean arterial pressure; RCC, red cell count; FFP, fresh frozen plasma; PC, platelet concentrates; BE, base excess; Hb, hemoglobin; Plt, platelet count; FDP, fibrin/fibrinogen degradation products; APTT, activated partial thromboplastin time; PT-INR, international normalized ratio of prothrombin time; IVC, inferior vena cava.

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