

Original Article

Therapeutic efficacy for traumatic asphyxia with a focus on cardiac arrest

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Aim: To investigate the clinical features of traumatic asphyxia, specifically the presence of cardiac arrest and therapeutic efficacy. This review will be useful for future emergencies.

Methods: Sixteen traumatic asphyxia cases from our hospital between April 2007 and March 2019 were reviewed and divided into three groups: those experiencing cardiac arrest at the time of rescue (group A, six cases), those experiencing cardiac arrest after rescue (group B, five cases), and those who did not experience cardiac arrest (group C, five cases).

Results: All cases had abnormal findings in the skin or conjunctiva. The total mortality rate reached 56%. Among the 11 cases in groups A and B that resulted in cardiac arrest, 10 had an Injury Severity Score of 16 or higher and an Abbreviated Injury Scale score in the chest of 3 or higher. The patients' injuries included pneumothorax, flail chest, and pericardial hematoma. The heartbeat was restarted in seven cases, and two cases completely recovered.

Conclusion: In some traumatic asphyxia cases, the treatment course was relatively effective even with cardiac arrest; thus, life support efforts should not be spared in such cases.

Key words: Chest injury, disaster medicine, prehospital care, therapeutic efficacy, traumatic asphyxia

INTRODUCTION

TRAUMATIC ASPHYXIA IS a rare condition in which breathing and venous return are impaired due to strong compression on the upper abdomen or chest region; this condition induces swelling, a purplish-red appearance, and petechiae around the face and neck.¹ Various reports describe cases with severe trauma complications that may or may not include cardiac arrest; thus, the mortality rate of traumatic asphyxia varies from 0 to 100%.^{2–7} However, we have an intuition that an outcome of resuscitation against cardiac arrest caused by traumatic asphyxia is not necessarily bad through the daily practice. To our knowledge, no previous reports have described traumatic asphyxia in detail including the clinical course and therapeutic efficacy for cardiac arrest. Therefore, we focused on cardiac arrest in all traumatic asphyxia patients involved in our hospital and

investigated their clinical features and therapeutic efficacy. We hope this review will be useful for future emergencies.

METHODS

THE PREHOSPITAL ACTIVITY records, medical records, and Hyogo prefectural inspection records of 16 traumatic asphyxia cases from our hospital between April 2007 and March 2019 were reviewed. These patients were divided into three groups: those experiencing cardiac arrest at the time of rescue (group A, six cases), those experiencing cardiac arrest after rescue (group B, five cases), and those who did not experience cardiac arrest (group C, five cases).

Based on previous reports,^{2,8} we defined traumatic asphyxia as a condition with a history of a strongly compressed thoracoabdominal region and showing congestion or petechiae of the neck, face, eyeball conjunctiva, or palpebral petechiae. Notation was used as number of cases (%) and median (minimum–maximum value). This study was undertaken with the approval of the Ethics Committee of Hyogo Emergency Medical Center (Hyogo, Japan), and we followed the regulations in our hospital in which patients remained anonymous.

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Received 22 Jun, 2020; accepted 28 Sep, 2020

Funding Information: No funding information provided.

RESULTS

FOURTEEN MEN INVOLVED in industrial accidents, traffic accidents, and agricultural accidents were evaluated; no crowd accidents were included. Time required for releasing was 5 (1–37) min. All cases showed abnormal findings on the skin, and 11 of 12 cases with conjunctiva displayed congestion or petechiae. Prehospital care was carried out by a doctor in 10 cases. The mean Injury Severity Score (ISS) was 26 (0–75), and the in-hospital mortality rate reached 56% (Table 1).

Among the 11 cases of Groups A and B that resulted in cardiac arrest, 10 cases had an ISS of 16 or higher and an Abbreviated Injury Scale (AIS) score in the chest of 3 or higher. Nine cases had pneumothorax, five had flail chest, and two had pericardial hematoma (Table 2).

The initial waveforms identified one case of ventricular fibrillation, three of pulseless electrical activity, and five of asystole. Three cases in group A and four in group B experienced return of spontaneous circulation, and two completely recovered.

Urgent treatment was carried out in cases of cardiac arrest, including tracheal intubation, thoracostomy, and thoracotomy. In group C, all patients were discharged with a Glasgow Coma Scale score of 15 (Table 3).

DISCUSSION

THE PROGNOSIS OF traumatic asphyxia is first described for the entire population. In group A, all but case 3 showed asystole at the initial rhythm and thus were considered unlikely to be resuscitated. A previous report⁹

Table 1. Characteristics of 16 patients with traumatic asphyxia who experienced cardiac arrest at the time of rescue (group A), experienced cardiac arrest after rescue (group B), or did not experience cardiac arrest (group C)

	Total (n = 16)	Group A (n = 6)	Group B (n = 5)	Group C (n = 5)
Age (years)	43 (17–70)	44 (36–58)	35 (31–59)	43 (17–70)
Male sex	14 (88)	5 (83)	5 (100)	4 (80)
Mechanism of injury				
Type of accident				
Industrial accident	8 (50)	3 (50)	4 (80)	1 (20)
Traffic accident	5 (31)	2 (33)	1 (20)	2 (40)
Agricultural accident	1 (6)	1 (17)	0 (0)	0 (0)
Miscellaneous	2 (13)	0 (0)	0 (0)	2 (40)
Compressed site of body trunk				
Chest	8 (50)	4 (67)	1 (20)	3 (75)
Chest and abdomen	8 (50)	2 (33)	4 (80)	2 (40)
Time of compression (min)	5 (1–37)	15 (3–37)	5 (3–12)	4 (1–20)
Physical appearance				
Skin				
Petechiae	14 (88)	5 (83)	5 (100)	4 (80)
Congestion	13 (81)	5 (83)	4 (80)	4 (80)
Petechiae or congestion	16 (100)	6 (100)	5 (100)	5 (100)
Conjunctiva				
Petechiae	9/12 (75)	3/4 (75)	2/3 (67)	4/5 (80)
Congestion	5/12 (42)	2/4 (50)	0/3 (0)	3/5 (60)
Petechiae or congestion	11/12 (92)	4/4 (100)	2/3 (67)	5/5 (100)
ISS	26 (0–75)	25 (0–32)	34 (26–75)	14 (0–41)
AIS of chest	4 (0–5)	4 (0–5)	5 (4–5)	3 (0–4)
TRISS-Ps	0.41 (0.01–1.00)	0.08 (0.01–0.53)	0.15 (0.01–0.56)	0.99 (0.42–1.00)
Prehospital care by a doctor	10 (63)	4 (67)	3 (60)	3 (60)
ROSC	7/11 (64)	3 (50)	4 (80)	–
In-hospital death	9 (56)	5 (83)	4 (80)	0 (0)

Data are expressed as number (%) or median (minimum–maximum).

AIS, Abbreviated Injury Scale; ISS, Injury Severity Score; ROSC, return of spontaneous circulation; TRISS-Ps, probability of survival by Trauma and Injury Severity Score.

indicated that 90% of cases that survived for 1 h after rescue had good outcomes. Among the 10 patients who were not in cardiac arrest at rescue, four cases in group B except for case 7 fell into cardiac arrest within 1 h after rescue. Furthermore, the ISS in our study was much higher than that in previous reports.^{2,6} Although it is notable that the mortality caused by traumatic asphyxia in this study was approximately 50%, taking into account two survivors with a probability of survival by the Trauma and Injury Severity Score of less than 0.5, our practice did not seem to be inefficient.

Additionally, the therapeutic efficacy and prognosis of patients who experienced cardiac arrest during their clinical course were better than those who experienced general traumatic cardiac arrest. In our study, one patient (17%) in group A and one (20%) in group B survived. When cardiac arrest accompanies multiple trauma, even if resuscitative thoracotomy is carried out, the survival rate is less than 1%.¹⁰ If the cause of cardiac arrest is respiratory failure, both the life prognosis and neurological prognosis are poor.^{11,12} Case 6 seems to meet these conditions. Thus, traumatic asphyxia without damage to the chest and other organs only occurred in one case of groups A and B; all the remaining cases had a pathological condition that could induce ventilatory insufficiency or obstructive shock. The heartbeat was restored in six cases, and two recovered completely from cardiac arrest without brain damage; in other words, the two cases avoided hypoxic encephalopathy. Both surviving cases had a chest AIS score of 5 and an ISS of 26, had only chest injuries, and received tracheal intubation and tube thoracostomy. Based on these findings, surviving cardiac arrest caused by traumatic asphyxia occurs more often when caused by reversible severe chest trauma than by respiratory failure or multiple trauma.

The reflux of the internal jugular vein system is less likely to be disturbed than the external jugular vein system because of the anatomical features of their valves. Consequently, intracranial hemorrhage rarely occurs in traumatic asphyxia patients.¹³ Jongewaard *et al.*⁶ reported that no specific pathologic alterations were detected in the brains of 22 (61%) of 36 autopsies with traumatic asphyxia. In this study, only one case was associated with intracranial injury that could be identified by head computed tomography examination, and this finding did not contradict the above discussion.^{6,13} The prognosis of traumatic asphyxia could be misunderstood to have a very poor outcome because of impairments in consciousness, appearance, and the term asphyxia. However, there is a possibility that brain function could be maintained, so we should not easily give up on life-saving procedures. Therefore, the necessary treatment differs between general blunt trauma and traumatic asphyxia. The former condition often leads to hemorrhagic shock,

and the latter could be mainly composed of respiratory failure or obstructive shock. In cases of severe blunt trauma due to falls from a height or traffic accidents without torso compression, fundamental treatments in the hospital include massive transfusion, definitive hemostasis, or craniotomy. Conversely, in cases of traumatic asphyxia, simple procedures such as tracheal intubation, thoracic drainage, pericardial drainage, and rescue itself may be necessary and effective. Therefore, prehospital care theoretically affects the management of traumatic asphyxia. In this study, although two survivors recovered from cardiac arrest without prehospital care, heartbeat resumption was achieved in six of seven cases using immediate procedures.

Early recognition and diagnosis of traumatic asphyxia is necessary for urgent and appropriate treatment, because it is often overlooked in multiple trauma.¹⁴ Because physical examinations revealed petechiae or congestion of the skin and the conjunctiva in almost all cases, these signs could be indicative of traumatic asphyxia, even if a typical episode, that the body trunk was intensively compressed for a certain duration, was lacking. Although the time required for the onset of traumatic asphyxia is typically 2–5 min,⁹ onset occurred in as little as 1 min for one case in our study.

In the 1995 Great Hanshin-Awaji Earthquake, 1,956 patients (54%) suffered from traumatic asphyxia among 3,651 autopsies.¹⁵ Many occurrences of this condition are also reported from mass gatherings. In stampedes, the proportion of traumatic asphyxia in seriously injured individuals is extremely high (59–85%).^{16,17} Although the mechanism underlying cardiac arrest is different between traumatic asphyxia and poisoning cases, lessons from the Tokyo Subway Sarin Attack, in which several cardiac arrest patients survived, recommend in Japan that even cases of respiratory arrest that are normally classified as “black” with normal triage should be classified as “red” in extreme circumstances.¹⁸ Based on high return of spontaneous circulation and survival rates in our study, and depending on the balance between demand and supply, such as medical resources and the number of injured people, if cardiac arrest due to traumatic asphyxia is suspected, these patients should not automatically be classified as “black.” Instead, one must determine whether resuscitation should be continued by considering the therapeutic efficacy with comprehensive emergency treatment. Considering that heartbeat resumption occurred in five of six cases in which the initial waveform was something other than asystole and that all cases of asystole had been dead, the absence of asystole at the time of rescue might be one method of classifying cardiac arrest patients as eligible for treatment. However, each case in this study was an independent case, so it is unclear whether we can generalize their features for disaster or emergency

Table 2. Details focused on chest injury of 16 patients with traumatic asphyxia who experienced cardiac arrest at the time of rescue (group A), experienced cardiac arrest after rescue (group B), or did not experience cardiac arrest (group C)

Group	Case	Age (years)/sex	ISS	AIS of chest	Chest injury				Hemothorax	Hemopericardium	Other major injury
					Multiple rib fracture	Flail chest	Pulmonary contusion	Pneumothorax			
A	1	38/M	32	4	Rt.	Rt.	Bil.	No	Bil.	Yes	Innominate artery injury, sternal fracture, traumatic cerebral infarction
	2	36/F	27	3	No	No	No	Lt.	No	No	Cervical spine fracture, epistaxis, mediastinal hematoma, spleen injury
	3	58/M	26	5	Bil.	Bil.	Bil.	Bil.	Bil.	No	Thoracic spine fracture, cardiac injury
	4	57/M	25	5	Rt.	No	No	Rt.	No	No	None
	5	43/M	16	4	Bil.	Bil.	No	Lt.	Lt.	No	None
	6	44/M	0	0	No	No	No	No	No	No	None
	7	35/M	75	5	Bil.	Bil.	Bil.	Bil.	Bil.	No	Spleen injury, pelvic fracture, traumatic subarachnoid hemorrhage
B	8	31/M	35	5	Bil.	No	Bil.	Bil.	Bil.	Yes	Sternal fracture, internal thoracic artery injury, tracheobronchial injury
	9	59/M	34	5	Bil.	No	Bil.	Bil.	No	No	Pulmonary artery injury, sternal fracture, thoracic spine fracture, burn
	10	62/M	26	5	Bil.	Lt.	Bil.	Bil.	Lt.	No	Aortic injury, sternal fracture
C	11	34/M	26	4	Rt.	No	Rt.	Bil.	Rt.	No	Diaphragmatic injury
	12	46/M	41	4	Bil.	No	Bil.	Bil.	No	No	Spleen injury, mesenteric injury, lumbar spine fracture, femur fracture
	13	70/M	17	4	Lt.	No	Rt.	No	No	Yes	Inferior vena cava injury, liver injury
	14	48/M	14	3	Lt.	No	No	No	No	No	Facial bone fracture, sternal fracture, laryngeal edema
	15	37/F	5	2	Rt.	No	No	No	No	No	Thoracic spine fracture
	16	17/M	0	0	No	No	No	No	No	No	Epistaxis

AIS, Abbreviated Injury Scale; Bil., bilateral; F, female; ISS, injury severity score; Lt., left; M, male; Rt., right.

Table 3. Overview of 16 patients with traumatic asphyxia who experienced cardiac arrest at the time of rescue (group A), experienced cardiac arrest after rescue (group B), or did not experience cardiac arrest (group C)

Group	Case	Age (years)/sex	Time of compression (min)	Initial rhythm of cardiac arrest	Prehospital care by a doctor	Major treatment	ROSC	GCS at rescue	GCS at discharge	TRISS-Ps	Outcome
A	1	38/M	20	Asystole	No	Intubation, tube thoracostomy, thoracotomy	Yes	E1V1M1	–	0.53	Dead
	2	36/F	37	Asystole	Yes	Intubation	No	E1V1M1	–	0.09	Dead
	3	58/M	10	PEA	No	Intubation, tube thoracostomy, defibrillation	Yes	E1V1M1	E4V5M6	0.01	Survived
	4	57/M	3	Asystole	Yes	None	No	E1V1M1	–	0.01	Dead
	5	43/M	25	Asystole	Yes	Intubation	No	E1V1M1	–	0.07	Dead
	6	44/M	6	Asystole	Yes	Intubation	Yes	E1V1M1	–	0.39	Dead
	7	35/M	5	PEA	Yes	Intubation, tube thoracostomy, thoracotomy, laparotomy	Yes	E4V5M6	–	0.01	Dead
B	8	31/M	3	VF	Yes	Intubation, tube thoracostomy, thoracotomy, ECMO	Yes	E1V1M1	–	0.43	Dead
	9	59/M	NA	NA	Yes	Intubation, tube thoracostomy, thoracotomy	Yes	NA	–	0.15	Dead
	10	62/M	5	NA	No	Intubation, tube thoracostomy, TEVAR	Yes	E1V2M4	E4V5M6	0.56	Survived
C	11	34/M	12	PEA	No	Intubation, tube thoracostomy	No	E1V1M1	–	0.07	Dead
	12	46/M	20	–	Yes	Intubation, laparotomy	–	E2V4M6	E4V5M6	0.42	Survived
	13	70/M	1	–	Yes	Intubation, thoracotomy, laparotomy	–	NA	E4V5M6	0.94	Survived
	14	48/M	3	–	No	None	–	E4V1M5	E4V5M6	0.99	Survived
	15	37/F	5	–	Yes	None	–	E1V1M1	E4V5M6	0.99	Survived
	16	17/M	5	–	No	None	–	E4V5M6	E4V5M6	1.00	Survived

ECMO, extracorporeal membrane oxygenation; F, female; GCS, Glasgow Coma Scale; M, male; NA, not available; PEA, pulseless electrical activity; ROSC, return of spontaneous circulation; TEVAR, thoracic endovascular aortic repair; TRISS-Ps, probability of survival by Trauma and Injury Severity Score; VF, ventricular fibrillation.

situations. In addition, the differences between compression caused by heavy machinery or vehicles and compression caused by earthquakes or stampede are unknown. Furthermore, there is significant disparity in the difficulty of rescuing patients between independent cases and disaster cases.

CONCLUSION

IN CASES OF traumatic asphyxia, aggressive and urgent treatment should be indicated, because successful resuscitation could be expected more than other traumatic cardiac arrest.

ACKNOWLEDGMENTS

THE AUTHORS ARE grateful to Yasushi Nagasaki from the Medical Examiner's Office of Hyogo Prefecture for his instruction.

DISCLOSURE

APPROVAL OF THE research protocol: Approved by the ethics committee of Hyogo Emergency Medical Center.

Informed consent: N/A.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of interest: None.

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