High Energy Trauma Patients Treated in the Department of General Surgery in a Secondary Emergency Facility in Japan

Okuyama, Toshiro
Departments of Emergency Medicine, Fukuoka City Hospital

Matsumoto, Shoiku
Departments of Emergency Medicine, Fukuoka City Hospital

Yoshino, Shinichiro
Departments of Emergency Medicine, Fukuoka City Hospital

Hirakawa, Katsuyuki
Departments of Emergency Medicine, Fukuoka City Hospital

他

https://doi.org/10.15017/27428

出版情報：福岡醫學雜誌. 104 (8), pp.249-256, 2013-08-25. 福岡医学会
バージョン：
権利関係：

Original Article

High Energy Trauma Patients Treated in the Department of General Surgery in a Secondary Emergency Facility in Japan

Toshiro Okuyama[1)], Shoiku Matsumoto[1)], Shinichiro Yoshino[1)], Katsuyuki Hirakawa[1)], Masanobu Kishikawa[1)], Kisaku Yoshida[2)], Taichi Saito[3)], Takahiro Higashi[4)], Kazutoyo Morita[4)], Shigeyuki Nagata[4)], Hideaki Uchiyama[4)], Daihiko Eguchi[4)], Kazuya Endo[4)], Hirofumi Kawanaka[4)], Morimasa Tomikawa[4)], Masahiro Tateishi[4)], Daisuke Korenaga[4)] and Kenji Takenaka[4)]

[1)]Departments of Emergency Medicine, [2)]Radiology
[3)]Orthopaedic Surgery and [4)]Genaral Surgery, Fukuoka City Hospital

Abstract Objective : We clarified the characteristics of the high energy trauma patients that entered the general surgery ward of Fukuoka city hospital (FCH), a 200 bed secondary emergency hospital in Japan.
Patients and Methods : Of the 7,826 total ambulance cases treated from April 2008 to March 2012 in our emergency room, 831 trauma patients who entered our hospital were analyzed. These patients were classified into a non high energy (NHE) and high energy trauma (HE) group based on the mechanisms of injuries.
Results : Of the 831 trauma cases, 741 (89.2%) were in the NHE and 90 (10.8%) were in the HE group. Eleven of the 741 cases (1.5%) in the NHE group and 18 of the 90 cases (20.0%) in the HE group entered the Department of General Surgery as inpatients, with the frequency being significantly higher in the latter group ($p < 0.01$). 11 of the 18 cases (61.1%) of Department of General Surgery in the HE group were diagnosed to have an injury severity score (ISS) of 15 or higher, and the rate of preventable trauma deaths (PTDs) of those 11 cases was 9.1% (1/11).
Conclusions : The proportion of the patients that entered the Department of General Surgery was higher in the HE group than in the NHE group. The surgical departments of secondary emergency facilities are expected to contribute to the local trauma emergency systems.

Key words : High energy trauma・Department of surgery・A secondary facility・Japan

Introduction

Trauma is the leading cause of death for young people, and it remains a major public health problem in every country, regardless of the level of socioeconomic development[1)2)]. In Japan, the total number of deaths caused by trauma was about 20,000–30,000 annually, and the trauma is the main cause of death in people aged one to 30 years[3)].

The concept of 'high energy trauma' has been understood to mean trauma that was expected to be life-threatening due to its mechanism of injury. Such trauma is caused by high kinetic energy accidents, such as vehicle accidents, pedestrian-vehicle accidents, falls from a height, assault or industrial accidents[4)5)].

In Japan, the approaches for treating such injuries have been slow to develop, however, in 2002, the *Japan Association for Acute Medicine (JAAM)* and *Japanese Association for the Surgery of Trauma (JAST)* edited and published *Japan*

Correspondence : Toshiro Okuyama MD
13-1 Yoshizuka-honmachi Hakata-ku Fukuoka city, 812-0046 Japan
Tel : 092-632-1111, Fax : 092-632-0900
E-mail : okuyama929@yahoo. co. jp

Advanced Trauma Evaluation and Care (JATEC) as a textbook to standardize the emergency medical treatment for trauma[6)7)].

Fukuoka City Hospital (FCH) is a 200 bed secondary-care facility located downtown in a city of 1.5 million, with a total of approximately 2,000-2,500 patients taken to the hospital by ambulance annually[8)]. For trauma cases, patients are treated with the *JATEC* technique by emergency room (ER) doctors, and then are treated with definite therapies by specialists from the Department of Orthopedic Surgery, Neurosurgery or General Surgery.

We analyzed the clinical features and the treatments applied for high energy trauma patients that finally entered the Department of General Surgery after they had been transported and treated under the *JATEC* technique in the ER.

Patients and methods

Patients

This study included 7, 826 cases that were admitted to the ER of FCH by ambulance from April 2008 to March 2012.

These 7,826 patients were divided into groups with endogenous and traumatic diseases. The trauma patients that entered the hospital were then divided into a non high energy trauma (NHE) trauma group and a high energy trauma (HE) group based on the mechanism of injury. The actual cases that were predicted to be high energy trauma cases that caused severe injuries for patients are indicated in Table 1[9)10)].

Patients that needed emergency treatments were finally hospitalized in the Department of Orthopedic Surgery, Neurosurgery or General Surgery. The clinical features of the patients in the HE group that were finally treated in the Department of General Surgery were analyzed. To describe the injury severity, The Trauma and Injury Severity Score (TRISS) was used based on the *Registration on Japan Trauma Data Bank (JTDB)*[7)11)12)]. The Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), Probability of Survival (Ps) for each patient and the rate of preventable trauma death (PTD) were calculated.

An ISS of more than 15 was generally regarded to indicate a severe injury, and PTD is defined as the death caused by trauma of which Ps is 50% or higher. The cases in cardiopulmonary arrest on arrival (CPAOA) due to the trauma were excluded from the present study.

Statistical analysis

The statistical analyses were performed among the groups using the chi-square test. A P value < 0.05 was considered to be significant.

Results

Numbers of trauma patients and their classifications

The number of patients transported to FCH by ambulance is shown in Figure 1. Of all 7, 826

Table 1 Criteria related to the mechanism of injury for high energy trauma that predict the severity of patient injuries

1. Falls
2. Automobile accidents Death in the same compartment Rollover Ejection from automobile High level of damage to the vehicle
3. Pedestrian or cyclist hit by a vehicle
4. Pedestrian thrown or run over by a vehicle
5. Motor cycle accident with separation of the rider and bike
6. Patient caught by the torso by machinery
7. Assault

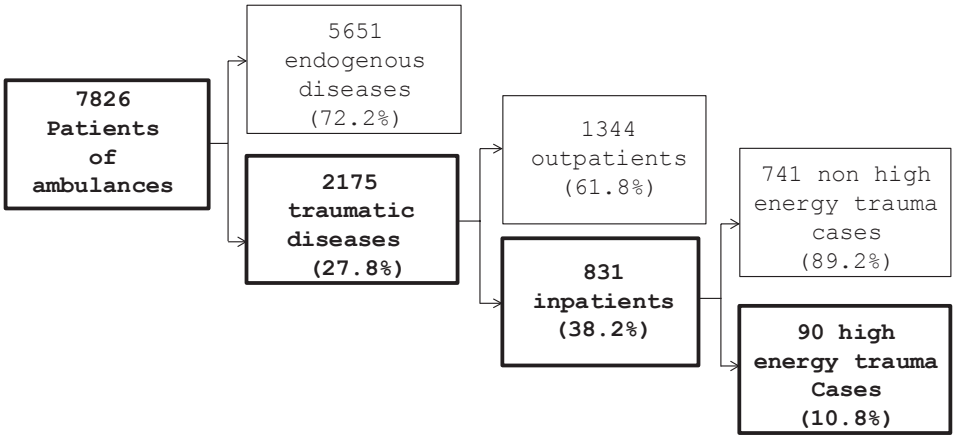

Fig. 1 Classification of the patients transported to our emergency room

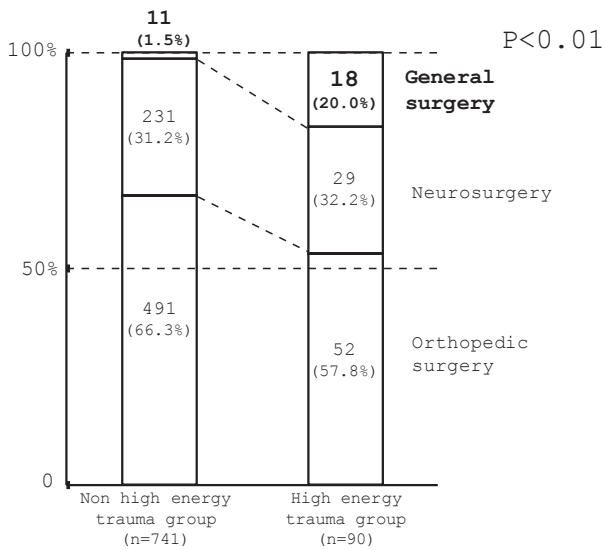

Fig. 2 Comparison of the departments where the non-high energy trauma and high energy trauma patients were hospitalized

ambulance cases, 2,175 cases (27.8%) were due to traumatic causes, and of these 2,175, 831 patients (38.2%) entered our hospital. Of these 831 cases, 741 (89.2%) were classified as being in the NHE group and 90 (10.8%) were classified as being in the HE group.

The proportion of NHE and HE patients

Eleven of the 741 cases (1.5%) in the NHE group entered the Department of General Surgery, whereas 18 of the 90 cases (20.0%) in the HE group entered the Department of General Surgery for definitive therapy, in the latter, which was a significantly higher frequency ($p < 0.01$, Fig. 2). Eleven of the NHE patients suffered only bruises in the chest and/or abdominal wall without visceral injury, whereas 18 cases in the HE group had thoracic and/or intra-abdominal visceral organ injuries.

The characteristics of the patients in the Department of General Surgery in the HE group

The features of the 18 patients in the Department of General Surgery in the HE group are shown in Table 2 and are summarized in Table 3. For these 18 cases, the mean age was 45.8 ± 20.6 and the mean ISS was 16.2 ± 6.8, with eleven of the 18 cases (61.1%) being diagnosed with an ISS of 15 or more. Six of the 18 patients (33.3%) had thoracic organ injuries, another six had abdominal organs injuries, and the other six patients (33.3%) had both. The main injury sites of the 18 cases were such as follows ; the lungs in 12 cases, the liver and spleen in four cases each, and the small intestine and kidneys in two patients each, with nine patients having multiple injuries.

With regard to the treatments, six cases were treated by the insertion of chest tubes, four underwent interventional radiological (IVR) therapy and three underwent emergency abdominal surgery. All of the patients were treated based on the *JATEC* techniques, primarily in the ER, with subsequent definitive therapy. The range of the Ps values of the 18 patients was 84.9–99.6% (mean,

Table 2 All 18 high energy trauma cases that became inpatients of the Department of General Surgery

Age	Sex	Mechanism of injury	S. I.	RCC Trans-fusion (units)	AIS				ISS	Ps	Treatment(s)	Outcome
					Head	Thorax	Abdomen	Pelvis				
77	M	traffic accident	1.02	6		3	liver 4	2	29	84.9	anti-DIC therapy	died
21	M	traffic accident	0.59	8		3	spleen 4	2	29	88.6	chest tube, splenectomy	survived
60	F	traffic accident	0.57	none	1	4		2	25	89.6	chest tube	survived
26	M	traffic accident	0.92	none	1	4	kidney 1		21	98.4	chest tube	survived
82	M	traffic accident	0.91	4		4	omentum 2		20	86.8	Observation	survived
51	M	fall	1.50	8			liver 2 spleen 4		20	95.4	abdominal IVR	survived
13	M	traffic accident	0.47	none		1	spleen 3		17	98.9	abdominal IVR	survived
51	M	fall	0.40	none		4			16	98.9	chest tube	survived
61	M	traffic accident	0.80	none		4			16	92.9	chest tube	survived
64	M	assault	0.51	none		4			16	94.3	observation	survived
61	M	traffic accident	0.64	none		4			16	94.3	chest tube	survived
31	M	fall	0.51	none			small intestine 3	2	13	98.9	observation	survived
48	F	fall	0.86	none		2	liver 3		13	99.2	abdominal IVR	survived
33	M	traffic accident	1.16	12			spleen 3		10	92.9	splenectomy	survived
31	F	traffic accident	0.75	none			small intestine 3		9	99.3	closure of the perforation	survived
36	M	traffic accident	0.64	none			kidney 3		9	99.4	observation	survived
62	M	fall	0.48	none		3			9	96.8	observation	survived
17	M	assault	0.54	none			liver 2		4	99.6	abdominal IVR	survived

*Abbrevations ;
S.I. : Shock index = heart rates (beats per minute)/systolic blood pressure (mmHg)
RCC : red blood cells, AIS : abbreviated injury scale, ISS : injury severity score,
Ps : probability of survival, DIC : disseminated intravascular coagulation,
IVR : interventional radiology

Table 3 Summary of the 18 high energy trauma cases that became inpatients of the Department of General Surgery

Variables	Outcomes	
Mean age	45.8 ± 20.6	
Male : Female	15 : 3	
Mean ISS	16.2 ± 6.8	
Mechanism of injury	Traffic accident	11 (60%)
	Fall	5 (28%)
	Assault	2 (12%)
Injury sites	Thorax	6 (33%)
	Abdomen	6 (33%)
	Both	6 (34%)
Treatments performed	Chest tube Insertion	6 (46%)
	Abdominal IVR	4 (31%)
	Abdominal Surgery	3 (23%)

95.0 ± 4.6) and only one patient, a 77-year-old male with an ISS of 29 and a Ps of 84.9% died of accelerated disseminated intravascular coagulation (DIC), which was being regarded as a PTD. Therefore, the rates of PTD were 5.6% (1/18) for all 18 patients and 9.1% (1/11) for those with an ISS of 15 or more, respectively.

Discussion

Trauma has been reported to be a leading cause of death in young people worldwide[13]. PTDs are included in such deaths caused by trauma and supposed as diseases which could be avoided if optimal care is delivered. The incidence of PTDs is also regarded as an index that can be used to evaluate the ability of a trauma emergency system to treat patients[14].

In Japan, the peer reviewed value of PTDs in patients with an ISS of more than 15 in trauma care centers was approximately 40% in 2000,

which was very high and was comparable to the level in the 1960's in the USA[15]. In response to such situation, efforts were made to establish a better trauma system in Japan. The *Registration on Japan Trauma Data Bank (JTDB)*, one branch of *Japanese Trauma Care Registry (JTCR)* commenced collecting and analyzing the national statistics on traumatic diseases in 2003 to evaluate the details of traumatic diseases statistically[6)7)]. The registration is still ongoing in 2013.

The Japanese emergency medical service centers are classified as tertiary facilities. Primary-and secondary-care facilities are designated to treat ambulatory patients and moderate-acuity patients, respectively. Tertiary-care facilities were specifically developed to treat highly critical patients requiring emergency surgery or admission to the intensive care unit[16]. Therefore, severely injured patients are generally transported to tertiary hospitals. As FCH is a secondary hospital, critically-ill trauma patients are not admitted frequently, however, during a 48-month period, 90 high energy trauma patients with severe injuries were transported. Eighteen (20.0%) of these patients entered the Department of General Surgery due to injuries to thoracic and/or abdominal visceral organs.

Generally, the level of kinetic energy is influenced by both the magnitude and duration of exposure. That is to say a large energy transfer in a very short period brings about a strong external force on the body[5]. The current causes of high energy trauma treated at our hospital were due to unexpected accidents, such as traffic accidents, falls from a height and interpersonal violence, which was similar to the previous reports[17)18)].

The abdominal cavity has only a musculature-based guard against external force, so compression acutely increases the intra-abdominal pressure, resulting in a rupture of the intra-abdominal viscera, which requires surgery in approximately 20-40% of cases[19)20)]. In contrast, the chest cavity is more compartmentalized with the bony chest wall, so only 10-15% of patients with chest injuries require thoracotomy or sternotomy[21]. Among the 12 patients with abdominal visceral injuries in our present series, three cases (25%) required emergency surgery, but for six patients who had lung injuries, chest tube insertion was sufficient for therapy, and no surgery was required (0%), which was also compatible with the previous reports.

In the transition zone between the abdomen and chest, the lower ribs overlie the intra-thoracic abdomen, including the spleen, liver and biliary apparatus, for protection. This means that the exposure of this area to strong forces often bring about simultaneous injuries of the lungs and these abdominal organs[5]. Among the 18 cases in the present series, six (33.3%) had injuries in the both thoracic and abdominal cavities, simultaneously.

To make a rapid clinical diagnosis, a physical examination has traditionally been an important method for evaluating patients[19)20)]. For example, auscultation for a hemithorax should be performed to note whether there are diminished or absent breath sounds, and patients with abdominal injuries who have significant blood loss will demonstrate systemic signs of hypovolemia, such as hypotension, tachycardia and tachypnea.

Although a physical examination remains the first-line method and will not be replaced in the near future, diagnostic imaging can facilitate the diagnosis. A chest X-ray should be obtained early for thoracic injuries, and Focused Assessment with Sonography for Trauma (FAST) is supposed to be an effective screening tool for the detection of intraabdominal injuries, and has been reported to have high sensitivity[22]. Computed tomography (CT) scans are now frequently used for the initial diagnosis of trunk injuries, as well as head injuries[23]. CT should be performed to completely evaluate patients for intra-abdominal injuries, while concurrently pursuing possible extra-abdominal injury as a cause of patient instability[24]. In our faculty, CT scanning has been actively used to make a definite diagnosis.

The liver and spleen are the most commonly injured organs following blunt abdominal trauma[20)24)]. IVR techniques have been widely accepted for both the diagnosis and management of hemorrhage from injuries of these organs[25)]. We performed IVR for two of the four cases with liver injuries and all four of the cases with spleen injuries. Although the IVR treatments for the two patients with liver injuries were successfully performed, the treatment in two of the four spleen cases was inadequate, leading to an unstable hemodynamic state. These two cases with splenic injuries underwent a subsequent splenectomy and successfully recovered.

The rate of PTDs in our series was 9.1% (1/11) for the patients with an ISS of 15 or more (range 16–29), and according to the *JTDB* data, the PTDs rate of the registered cases with scores ranging from 16–24 was about 9%[7)]. Although our total number of cases was small, these results suggest that the clinical level for FCH was similar to those of facilities registered in the *JTDB*.

As a high volume trauma center which specializes in the treatment of patients with traumatic diseases has not yet been established in Japan, tertiary-hospitals are obliged to accept highly injured cases. As of 2012, *JATEC* courses were provided for more than 8, 000 Japanese physicians, and the trauma registry system of the *JTDB* also tracked 100,000 patients spread over 170 mainly tertiary-care facilities[7)].

In conclusion, our findings suggest that the secondary emergency facilities in Japan are expected to contribute to the present trauma medical care system in Japan, and should therefore be prepared to accept severely injured patients, at least until a fully-developed trauma care system is in place.

Acknowledgement

The authors report no financial supports or relationships concerning this research.

Competing interests

None declared.

References

1) Adrian S, Nau T, Koenig F and Vacsei V. Geriatric polytrauma. Wien Klin Wochenschr. 117 : 145–149, 2005.
2) Aldemir M, Tacyildiz I and Girgin S. Predicting factors for mortality in the penetrating abdominal trauma. Acta Chir Belg. 104 : 429–434, 2004.
3) Annual report of the Ministry of Health, Labor and Welfare. 2011.
4) The text book of Japan Advanced Trauma Evaluation and Care, the 4th edition. Health Publication, Tokyo, Japan. 2012.
5) Trauma Care Manual, the 2nd edition. HODDER ARNOLD Ltd., London, UK. 2009.
6) Mashiko K. Trauma systems in Japan : History, present status and future perspectives. J Nippon Med Sch. 72 : 194–202, 2005.
7) Japan Trauma Care and Research. www.jtcr-jatec.org. 2012.
8) Okuyama T, Hirakawa K, Kishikawa M, Uchiyama H, Kawanaka H, Korenaga D and Takenaka K. The practice of emergency medicine in Fukuoka City Hospital, a secondary emergency facility in Japan. Fukuoka Acta Medica. 103 : 241–247, 2012.
9) Royal College of Surgeons of England and the British orthopedic association. Better Care for the Severely Injured. London : Royal College of Surgeons of England. July, 2000.
10) Mechanism of injury-related triage criteria from the USA. The Committee on Trauma of the American College of Surgeons. Advanced trauma life support. Chicago : American College of Surgeons. 2004.
11) Nakahara S and Yokota J. Revision of the International Classification of Diseases to include standardized descriptions of multiple injuries and injury severity. Bull World Health Organ. 89 : 238–240, 2011.
12) AIS90 Update 98 : a Japanese-language version. Health Publication. Tokyo, Japan. 2003.
13) Baradaran H, Salimi J, Nassaji-Zavareh M, Khaji A and Rabbani A. Epidemiological study of patients with penetrating abdominal trauma in Tehran-Iran. Acta Med Iran. 45 : 305–308, 2007.
14) Chiara1 O, Cimbanassi1 S, Pitidis A and Vesconi S. Review : Preventable trauma deaths-from

panel review to population based-studies. World Journal of Emergency Surgery. 1 : 12 doi : 10. 1186/1749-7922-1-12, 2006.

15) Otomo Y, Hemmi H, Honma M, Mashiko K, KosekiK, Yokota J, Murata A and Shimazaki S. Quality of trauma care in each hospital should be evaluated fordeciding receiving hospital. J Jpn Assoc Surg Trauma. 16 : 319-323, 2002.

16) Shiga T and Sato T. Current emergency medical systems in Japan. Jpn Hosp. 27 : 71-73, 2008.

17) Howes N, Walker T, Allorto NL, Oosthuizen GV and Clarke DL. Laparotomy for blunt abdominal trauma in a civilian trauma service. South African Journal of Surgery. 50 : 30-32, 2012.

18) Gad MA, Saber A, Farrag S, Shams ME and Ellabban GM. Incidence, patterns, and factors predicting mortality of abdominal injuries in trauma patients. N Am J Med Sci. 4 : 129-134, 2012.

19) Manual of Definitive Surgical Trauma Care, the 3rd edition. HODDER ARNOLD Ltd., London, UK. 2011.

20) Malhotra AK, Ivatury RR and Latifi R. Blunt abdominal trauma : evaluation and indications for laparotomy. Scand J Surg. 91 : 52-57, 2002.

21) The Trauma Manual : Trauma and Acute Care Surgery. Lippincott Manual Series, the 4th edition. Lippincott W and W. Philadelphia, USA. 2013.

22) Farahmand N, Sirlin CB, Brown MA, Shragg GP, Fortlage D, Hoyt DB and Casola G. Hypotensive patients with blunt abdominal trauma : performance of screening US. Radiology. 235 : 436-443, 2005.

23) Probst C, Pape HC, Hildebrand F, Regel G, Mahlke L, Giannoudis P, Krettek C and Grotz MR. 30 years of polytrauma care : An analysis of the change in strategies and results of 4849 cases treated at a single institution. Injury. 40 : 77-83, 2009.

24) Isenhour JL and Marx J. Advances in Abdominal Trauma. Emerg Med Clin N Am. 25 : 713-733, 2007.

25) Bergeron E, Lavoie A, Belcaid A, Moore L, Clas D, Razek T, Lessard J, Ratte S. Surgical management of blunt thoracic and abdominal injuries in Quebec : a limited volume. J Trauma. 62 : 1421-1426, 2007.

(Received for publication June 26, 2013)

（和文抄録）

二次救急病院一般外科に入院となった高エネルギー外傷患者の解析

福岡市立病院機構 福岡市民病院
救急科[1)]，放射線科[2)]，整形外科[3)]，外科[4)]

奥山稔朗[1)]，松本松昱[1)]，吉野慎一郎[1)]，平川勝之[1)]，岸川政信[1)]，吉田喜策[2)]
齊藤太一[3)]，東　貴寛[4)]，森田和豊[4)]，永田茂行[4)]，内山秀昭[4)]，江口大彦[4)]
遠藤和也[4)]，川中博文[4)]，富川盛雅[4)]，立石雅宏[4)]，是永大輔[4)]，竹中賢治[4)]

【目的】当院は200床の二次救急病院である．救急搬送された外傷症例中，一般外科に入院となった高エネルギー外傷症例の臨床学的特徴を明らかにした．

【対象と方法】‘08．4月-‘12．3月の4年間の全救急搬送症例7,826例中，外科系各科に入院となった外傷症例831例を対象とした．対象を非高エネルギー外傷群（非高エ群），高エネルギー外傷群（高エ群）に分類し，各々につき一般外科入院となった症例を解析した．

【結果】(1)対象831症例は非高エ群741例（89.2%），高エ群は90例（10.8%）であった．(2)一般外科入院は非高エ群で741例中11例（1.5%），高エ群で90例中18例（20.0%）と後者において高頻度であった（$p < 0.01$）．(3)非高エ群9例は内臓損傷を伴わない症例であったのに対し，高エ群18例は胸腔，腹腔内臓器損傷を伴う症例であった．(4)高エ群18例においてISS 15以上の重症患者は11例（61.1%）で，多発外傷は9例（50.0%）であった．(5)胸部，腹部各単独損傷は6例ずつであり，残り6例が胸腹部同時受傷であった．(6)治療法は胸腔ドレーン挿入6例，血管造影下止血術4例，腹部手術3例であった．(7)ISS 15以上の症例の防ぎ得た外傷死は9.1%（1/11）で，症例数は少ないものの，三次救急病院を中心とした日本外傷データバンクの報告とほぼ同じ成績であった．

【結論】高エネルギー外傷群では，胸腹腔内臓器損傷を来たしたために一般外科への入院となった症例が高頻度に認められた．治療成績は概ね良好であり，二次救急病院は地域の外傷診療体制において一定の貢献を成し得ると考えられた．