

Characteristics of self-inflicted injury among suicidal patients: analysis of nation-wide trauma registry

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Received 27 January 2021

Revised 26 February 2021

Accepted 24 March 2021

ABSTRACT

Purpose Self-inflicted injury is one of the most common causes of suicide. Extremity injury is thought to occur most frequently among penetrating injury; however, epidemiology among patients attempting suicide is unknown. This study aims to find the characteristics of penetrating self-inflicted trauma patients.

Methods This is a retrospective cohort study of Japanese nation-wide trauma registry (the Japan National Trauma Data Bank) between January 1, 2004 and December 31, 2017. Patients who attempted suicide with penetrating injury were eligible. We evaluated the occurrence of injury based on injury site (neck/face, chest, abdomen, extremity) as a dependent variable and aging as an independent variable using a generalized linear model and compare those groups with spline models.

Results 4576 trauma patients were eligible. Excluding patients with missing age, missing survival data, and missing abbreviated injury score, 4183 patients were enrolled in this study. Common injury site is follows: abdomen 1772 patients (42.4%), extremity 1344 patients (32.0%), neck/face 1253 patients (30.0%), and chest 993 patients (23.7%). The occurrence of neck/face injury, chest injury, and abdominal injury increased with age. On contrary, the rate of extremity injury decreased with age.

Conclusions Among self-inflicted trauma patients, abdominal injury was the most common injury, and neck/face injury, chest injury, and abdominal injury were related with aging. On the contrary, the rate of extremity injury decreased as patients' age progressed.

Level of evidence Retrospective cohort study, Level III.

BACKGROUND

Suicide is one of the main causes of death, and globally, self-inflicted injury is a major method of attempted suicide. Worldwide, suicides are second among causes of premature mortality in 15-year-old to 29-year-old people.¹ In the USA, most suicides occur in individuals who are 45 to 64 years old and 85 years and older. Japan has a high suicide rate as well, and suicide is sixth leading cause of death in the nation.² Self-inflicted injury among patients attempting suicide is commonly encountered in the emergency department; therefore, emergency physicians who treat trauma patients need to know the characteristics and demographics of those patients.

Extremity injuries are frequently reported among patients attempting suicide with penetrating injury.³ Since acquisition of a gun is prohibited by law in Japan and due to the easy accessibility of knives, penetrating injury is common among suicidal

patients. Furthermore, it is reported that Japanese people have a unique tendency to cut or penetrate their own trunk at sites such as the neck or abdomen when attempting suicide.⁴ In general, these trends seem prevalent among elderly people. However, the association between age and injury site is not fully understood.

Thus, this study aimed to evaluate the epidemiology of patients who attempted suicide with self-inflicted injuries and find an association between injury site and aging in Japan. We hypothesized that the more elderly these patients become, the more frequently they would have torso injuries.

MATERIALS AND METHODS

Study design

We conducted an analysis of the Japan Trauma Data Bank (JTDB), which is a nationwide, multi-center trauma patient database. We analyzed data from January 2004 and December 2017. Patients who attempted suicide with penetrating injuries were eligible. Exclusion criteria were as follows; unknown age, missing prognosis, and missing Abbreviated Injury Scale (AIS).

Injury sites were categorized as follows: neck/face injury, chest injury, abdominal injury, and extremity injury based on the region defined by AIS, respectively. AIS is an automatic scoring system classified by trauma severity to body regions.

The primary outcome of the study was the frequency and occurrence of injuries to each site and association with aging. The secondary outcome was the detailed characteristics of each injury with identification of the incidence of single site injuries, double site injuries, and mortality.

Data collection

The JTDB includes patients' characteristics, date of injury, vital signs at admission (heart rate, respiratory rate, systolic blood pressure, Glasgow Coma Scale), ISS (Injury Severity Score), AIS, RTS (Revised Trauma Score), hospitalization (ICU (intensive care unit), ward, or other), discharge place (home, hospital transfer, or other), and in-hospital mortality. Missing data were <20% for all variables for trauma patients.

Statistical analysis

We characterized the study population with descriptive statistics. Continuous variables were described using means with SD. Ordinal variables were described using medians with IQR. Categorical variables were described using percentages.

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To cite: Nishimura T, Naito H, Nakao A, et al. *Trauma Surg Acute Care Open* 2021;**6**:e000694.

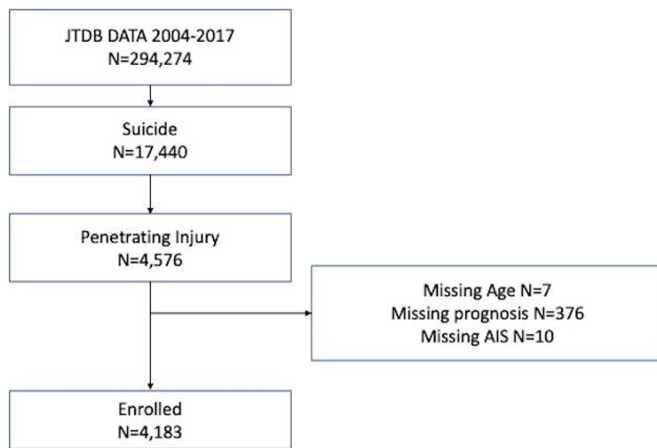


Figure 1 Study population flowchart. AIS, Abbreviated Injury Scale.

We evaluated the incidence of injury based on injury site (neck/face, chest, abdomen, extremity). Then, we estimated the effect of aging (independent variable) on injury site (dependent variable) using a generalized linear model. The results of the generalized linear model were described using OR and 95% CI. ORs of each injury site were described with spline models. Furthermore, the rate of occurrence with single site injury and double site injury and mortality rate were shown with numbers and percentages. Statistical analysis was performed using Stata/IC V.15 (Stata, Lakeway, TX). A *p* value below 0.05 was considered statistically significant.

RESULTS

Baseline characteristics

Among 294 272 available patient records from the JTDB, 17 440 patients had attempted suicide and 4 576 patients with penetrating injuries were eligible. After excluding patients with missing age (*n*=7), missing survival data (*n*=376), and missing AIS (*n*=10), a total of 4 183 patients were enrolled in this study (figure 1).

Table 1 shows characteristics among patients attempting suicide with penetrating injures. Male rate was 61.8%, and mean age was 49.9±17.6 years old. Date of suicidal attempt was divided into four categories based on seasons in Japan (March to May, June to August, September to November, December to February); penetrating suicidal injuries occurred mostly in June to August (1144 patients, 27.3%). Median ISS was 9 (IQR: 4 to 13) and median RTS was 7.84 (IQR: 6.34 to 7.84). Hospitalization occurred for 91.9% of patients, with 80.9% of patients admitted to the ICU; 11.0% of those were in ward. Injury sites were as follows; neck/face, 1253 patients (30.0%); chest, 993 patients (23.7%); abdomen, 1772 patients (42.4%); and extremity, 1344 patients (32.0%). A total of 55.9% of enrolled patients were discharged to home, and 32.4% of those were transferred to another hospital. In-hospital mortality was 9.1%.

Comparison of characteristics stratified by injury site

Characteristics of patients stratified by each injury site are shown in table 2. Neck/face injuries had the highest male rate (71.5%) and extremity injuries had the lowest male rate (58.4%). Mean age in the extremity injury group was the lowest (49.0±17.9), followed by 50.3±17.5 for abdomen injuries, 50.6±17.4 for chest injuries, and 52.4±17.3 for neck/face injuries. ISS tended to be higher among those in the chest injury group, and 80.2% (796 patients) had severe injuries with chest AIS 3 or higher. In

Table 1 Patient characteristics

	N=4183
Sex	
Male	2584 (61.8)
Age	
Mean	49.9 (17.6)
–29	581 (13.9)
30–49	1598 (38.2)
50–69	1343 (32.1)
70–	661 (15.8)
Seasons	
Mar–May	1080 (25.8)
Jun–Aug	1144 (27.3)
Sep–Nov	964 (23.0)
Dec–Feb	977 (23.4)
Unknown	18
ISS	9 (4–13)
RTS	7.84 (6.34–7.84)
SBP	112 (86–134)
HR	93 (77–112)
RR	20 (16–25)
GCS	14 (11–15)
Injury site	
Neck/face	1253 (30.0)
Chest	993 (23.7)
Abdomen	1772 (42.4)
Extremity	1344 (32.0)
Hospitalization	
ICU	3385 (80.9)
Ward	459 (11.0)
Discharge place	
Home	2338 (55.9)
Other hospital	1356 (32.4)
In-hospital mortality	382 (9.1)

GCS, Glasgow Coma Scale; HR, heart rate; ICU, intensive care unit; ISS, Injury Severity Score; RR, respiratory rate; RTS, Revised Trauma Score; SBP, systolic blood pressure.

addition, in-hospital mortality had the highest rate (16.3%) in the chest injury group.

Results of generalized linear regression models showing injury as a dependent variable and aging as an independent variable based on injury sites are shown (figure 2). Although the occurrence of extremity injury decreased as age progressed, neck/face injury, chest injury, and abdominal injury occurred more frequently as patients' age progressed, peaking among patients with neck/face injury and chest injury in their 60s to 80s. Abdominal injuries were found to peak among patients in their 30s to 40s, and plateau in patients older than 40.

Occurrence of single, double site injury and mortality

Table 3 demonstrates the number of injuries that occurred in single or double sites. Mortality of each injury site is shown using percentages. Single abdominal injury occurred most frequently (1112 patients), followed by extremity injury (802 patients), neck/face injury (506 patients), and chest injury (435 patients). Chest single injury had the highest mortality (18.2%). Among double site injuries, neck/face injury accompanied by extremity

Table 2 Patient characteristics stratified by injury site

	Neck/face N=1253	Chest N=993	Abdomen N=1772	Extremity N=1478
Sex				
Male	896 (71.5)	626 (63.0)	1094 (61.7)	863 (58.4)
Age				
Mean	52.4 (17.3)	50.6 (17.4)	50.3 (17.5)	49.0 (17.9)
-29	128 (10.2)	126 (12.7)	234 (13.2)	239 (16.2)
30-49	450 (35.9)	369 (37.2)	678 (38.3)	556 (37.6)
50-69	431 (34.4)	336 (33.8)	576 (32.5)	456 (30.9)
70+	244 (19.5)	162 (16.3)	284 (16.0)	227 (15.4)
Season				
Mar-May	333 (26.6)	274 (27.6)	456 (25.7)	359 (24.3)
Jun-Aug	352 (28.1)	259 (26.1)	434 (24.5)	446 (30.2)
Sep-Nov	287 (22.9)	216 (21.8)	414 (23.4)	349 (23.6)
Dec-Feb	276 (22.0)	238 (24.0)	462 (26.1)	317 (21.4)
Unknown	5	6	6	7
ISS	9 (4-14)	13 (9-25)	9 (4-14)	9 (2-10)
RTS	7.55 (5.97-7.84)	7.55 (5.97-7.84)	7.84 (6.90-7.84)	7.10 (6.08-7.84)
AIS \geq 3	449 (35.8)	796 (80.2)	855 (48.3)	548 (37.1)
SBP	110 (80-135)	112 (82-137)	118 (94-137)	105 (78-128)
HR	97 (80-117)	97 (77-117)	90 (75-109)	97 (80-118)
RR	20 (16-24)	20 (16-26)	20 (17-25)	20 (17-24)
GCS	14 (10-15)	14 (9-15)	14 (13-15)	14 (11-15)
In-hospital mortality	125 (10.0)	162 (16.3)	130 (7.3)	106 (7.2)

AIS, Abbreviated Injury Scale; GCS, Glasgow Coma Scale; HR, heart rate; ISS, Injury Severity Score; RR, respiratory rate; RTS, Revised Trauma Score; SBP, systolic blood pressure.

injury occurred most frequently (240 patients). The mortality rate in the chest injury accompanied by extremity injury group was the highest (27.4%).

DISCUSSION

As far as we know, this is the first report to describe the association between incidence of self-inflicted suicide and age progression based on injury site in Japan. Our study showed that abdominal injury occurred most frequently among self-inflicted suicidal patients and was sometimes accompanied by another site injury. Neck/face injury, chest injury, and abdominal injury increased with age, whereas extremity injury was more common in younger patients. Suicidal injury occurred mostly in

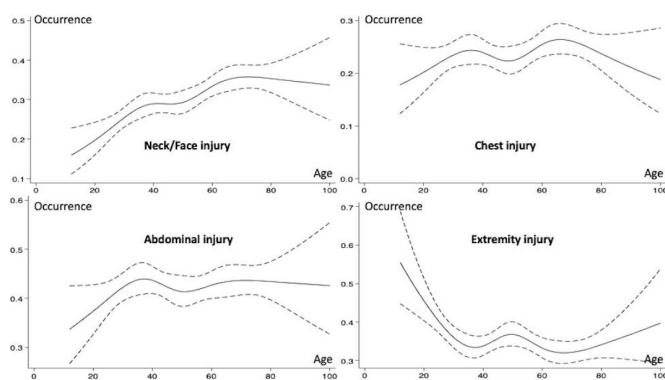


Figure 2 Results of the generalized linear model with prediction of incidence of each injury site (neck/face, chest, abdomen, extremity) as a dependent variable and aging as an independent variable described in spline models.

Table 3 Incidence and mortality of injury to different sites

	Patients	Mortality (%)
Single site injury		
Neck/face	506	51 (10.1)
Chest	435	79 (18.2)
Abdomen	1112	69 (6.2)
Extremity	802	35 (4.4)
Double site injury		
Neck/face and chest	116	15 (12.9)
Neck/face and abdomen	136	13 (9.6)
Neck/face and extremity	240	16 (6.7)
Chest and abdomen	162	14 (8.6)
Chest and extremity	84	23 (27.4)
Abdomen and extremity	128	8 (6.3)

Patients and mortality with single and double site injuries were shown.

June to August, which is the summer vacation season in Japan. It is reported that school students were higher as likely to die by suicide when summer break ended and new semester began, which is consistent with our results.⁵ Emergency physicians and trauma surgeons should know the characteristics of self-inflicted injury when treating these patients.

The characteristics of traumatic suicidal attempts at a Level I trauma center in the USA were reported previously, revealing that most patients were men and had a mean age of 35 years old, and the most common suicide mechanism was stab wound, followed by jump, gunshot wound, and motor vehicle-related suicide.⁶ Since gun ownership is relatively prevalent in the USA, even among ordinary people, and gunshot wounds are often critical, many previous reviews and reports analyzed wound location or types of injury with gunshots.^{7,8} However, stab wounds or suicide by jump are more common than gunshots because of easier access to those methods, even in the USA. Despite their easy availability, analyses of location with self-inflicted stab patients have not been sufficiently published. A previous study in Japan showed the characteristics of penetrating injuries.³ Including injuries with accidental causes, the most frequent device used was kitchen knives and the most common penetrating site was the extremities. However, the abdomen was the most commonly injured site among self-inflicted suicidal injuries, which is consistent with our results.

In a previous study, patterns of abdominal injury in patients with self-inflicted injury and assaulted patients were considered to differ.⁹ Patients with self-inflicted wounds had less symptomatic, hemodynamic abdominal wounds and less direct transport to the operating room from the emergency department.^{10,11} ISS and mortality tended to be higher in the assaulted wound group than in the self-inflicted wound group, and the most prevalent regions of abdominal wounds in the self-inflicted wound group were the periumbilical and epigastric areas.¹² Additionally, the right side of the abdomen was also a common area for self-inflicted abdominal wounds because most people are right-handed and it is easy to stab the right part of abdomen.¹³

Interestingly, in our study, abdominal injuries happened most frequently (42.4%), but mortality was 6.2% with the second lowest rate, followed by the extremity injury rate (4.4%, the lowest). The higher mortality rate for injuries to the neck/face and chest area could be explained by the physical characteristics of the cardiovascular organs; they are close to the surface, and major vascular structures such as the aorta are located in the

retroperitoneal space. However, abdominal injuries occupied 48.3% of severe cases: AIS (AIS \geq 3). Although the mortality rate in the abdominal injury group was lower compared with those rates in the neck/face and chest injury groups, we should be aware that suicidal abdominal injury involves severe injury to the abdominal wall and the viscera, which might cause a severe, but rescuable condition with definitive operation.

Japan has a unique concept called the *hara-kiri* and *jigai* rituals derived from samurai spirits, where soldiers are supposed to cut or penetrate their own trunk in places such as the neck or abdomen when attempting suicide.^{14–16} Hara-kiri is supposed to cut their abdomen horizontal, injure visceral, and perform disembowelment, which would lead patients' condition critical. Therefore, these concepts are thought to possibly affect the suicide methods and results of torso injury among self-inflicted patients in Japan. It is reported *hara-kiri* wound patients might have a higher mortality rate than those with normal stab wounds. On the other hand, Matsumoto *et al*¹⁷ reported that self-inflicted abdominal wounds were associated with psychiatric illness and lower rate of laparotomy due to the hesitation with self-injury, following by less severity injury. Since reports about Japanese unique suicidal methods are lacking, the characteristics and prognosis of these patients are not fully elucidated. The differing results of these previous studies and our results indicates the need for more detailed research.

It is reported that psychiatric illness is associated with suicide and self-inflicted abdominal stab injury.^{18–19} Comparison between non-suicidal self-injuries, which is defined self-wrist cutting without suicidal ideation, and suicide attempts among self-wrist cutting patients has shown that suicide attempt patients were more male-dominant and associated with past psychiatric histories than non-suicidal patients.²⁰ In a medical-psychiatric unit in Europe, the most common psychiatric diagnosis was substance abuse, followed by psychotic disorders. The incidence of penetrating injuries was 24%, and 33% had ISS \geq 16. The most common injury sites were the head and neck.²¹ We could not detect a relationship between psychiatric disorders and penetrating trauma because our database did not contain types/history of psychiatric disorders, nor did it include patients' drug use data. The situation around drug consumption differs among Japan, Europe, and the USA. Further studies are necessary to establish the association between drug abuse and injury site.

Our study has several limitations. First, this is a retrospective study, which may cause information bias. In addition, not all hospitals participate in the JTDB program. Less-severe penetrating injuries might not be registered in the JTDB. The incidence of suicide may have regional differences, which might be affected by participating hospitals' location. Second, this study was analyzed using JTDB data with mostly Japanese patients. Although stab wound is a common method among trauma patients attempting suicide all over the world, the trends of the study might be affected by Japanese philosophy and culture. However, our results will help inform clinicians about the characteristics of patients with suicidal penetrating injury. Third, our trauma patient database's small sample size compared with those in the USA and Europe might limit interpretation of our results. For future studies, further analyses of patients among multiple nations and races are needed. Finally, the registration of AIS score is up to each hospital admitting patients, which might account for differences between regions in which patients are injured.

In conclusion, our study analyzing JTDB data showed that abdominal injuries were most common among critical patients

with self-inflicted injuries who attempted suicide. Neck/face injury, chest injury, and abdominal injury were strongly associated with aging. On the other hand, the rate of extremity injury decreased as patients' age progressed.

Acknowledgements We thank Christine Barr for editing the article.

Contributors TN, HN, AN, and SN all participated in the study design, data acquisition, analysis, and interpretation of data. All authors were actively involved in the drafting and critical revision of the article.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study obtained from ethics approval from the Ethics Committee of the Okayama University, Okayama, Japan, (K2009-024). Informed consent was waived.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. None.

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