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Medicine

The Characteristics of Patients Who Fell Into Open Drains in Rural Japan Short Running Head: Open Drains Related Injury

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Abstract: To clarify the characteristics of injuries caused by falling into an open drain in rural Japan. A medical chart review was retrospectively performed for all patients who were injured due to falling into an open drain and who were subsequently transported to the hospital by ambulance or a physician-staffed helicopter between January 2013 and January 2018 in Shizuoka. The patients were divided into two groups: those treated as outpatients and those who were admitted to the hospital. During the investigation period, there were 94 patients who had accidentally fallen into an open drain. The ages of the subjects ranged from 2 to 95 years, with an average age of 58.3 years. The average age of the subjects, the ratio of females and the average injury severity score in the admission group was higher than those in the outpatient group. Four patients in the admission group died compared to none in the outpatient group, a statistically significant difference. Injuries associated with falls into open drains are especially frequent among elderly people. Furthermore, females and older patients tended to more frequently require admission than males. To prevent injuries of this type, some measures are required to improve the safety of open drains.
Keywords: Trauma; ditch; injury prevention.

INTRODUCTION

A drain is a water tract along one or both sides of the road for the drainage of rain or domestic water. In Japanese cities, drains are covered with concrete to create walking spaces and prevent odor. In rural areas, however, due to budget limits or to reduce the labor of cleaning, such drains are often left open.

Accidental falls into open drains are a constant occurrence in rural areas. However, few reports have investigated the characteristics of injuries caused by accidental falls into open drains, including our previous reports [1-4].

Shizuoka is located in the southeast part of central Japan and faces the Pacific Ocean. Lying halfway between Tokyo and Osaka. Shizuoka prefecture consists of three areas (western, central and eastern). In the east, it becomes a narrower coast bounded in the north by Mount Fuji, until it comes to the Izu Peninsula, boasts of a variety of natural features and has many open drains (Figure-1). Accordingly, we performed a retrospective study in our institute on the nature of the injuries caused by falls into open drains in East Shizuoka.

SUBJECTS AND METHODS

This retrospective study protocol was approved by the review board of Juntendo Shizuoka Hospital, and the examinations were conducted according to the standards of good clinical practice and the Declaration of Helsinki.

A medical chart review was retrospectively performed for all patients who were injured due to falling into an open drain and who were subsequently transported to our hospital by ambulance or a physician-staffed helicopter between January 2013 and January 2018. This study included our previously obtained data[3]. We investigated the following: the patient age, sex, situation of injury, diagnosis, mechanism of injury, injury severity score (ISS), whether the patient was treated as an outpatient or admitted to the hospital and the survival rate. The patients were divided into two groups: those treated as outpatients and those who were admitted to the hospital. The following variables were compared between the two groups: age, sex, situation of injury, ISS and survival rate.

The chi-squared test or an unpaired Student's *t*-test was used for the statistical analyses, as appropriate. A p value of < 0.05 was considered to indicate a

statistically significant difference. All data are presented as the mean ± standard deviation.

RESULTS

During the investigation period, there were 4486 traumatized patients, including those with cardiac arrest. Among them, 94 patients who had accidentally fallen into an open drain were treated as subjects (Figure-2).

The diagnoses of all 94 patients are listed in Figure-3. Head/facial minor injuries were the most frequent injury type, followed by minor injuries of the extremities and thoracic injuries.

The results of the analysis of the subjects are shown in Table-1. The ages of the subjects ranged from 2 to 95 years, with an average age of 58.3. Sixty-nine cases had fallen erroneously, and 13 had fallen due to the influence of alcohol. Thirty-three patients suffered their injury while driving a vehicle. Three cases were pushed into the open drain by strong winds. Two cases had fallen into the open drain while stepping out of the way of a car. The remaining three had fallen into the open drain after being hit by car, running away from a bee to avoid being stung and swerving to miss a rabbit while driving a car (one each). The average age of the subjects, the ratio of females and the average ISS in the admission group was significantly higher than in the outpatient group. Four patients in the admission group died compared to none in the outpatient group, a statistically significant difference.

There are many open drains in East Shizuoka.

Fig-1: Open drains in East Shizuoka

A driver underwent a hepatic rupture by this accident.

Fig-2: A car falling into an open ditch

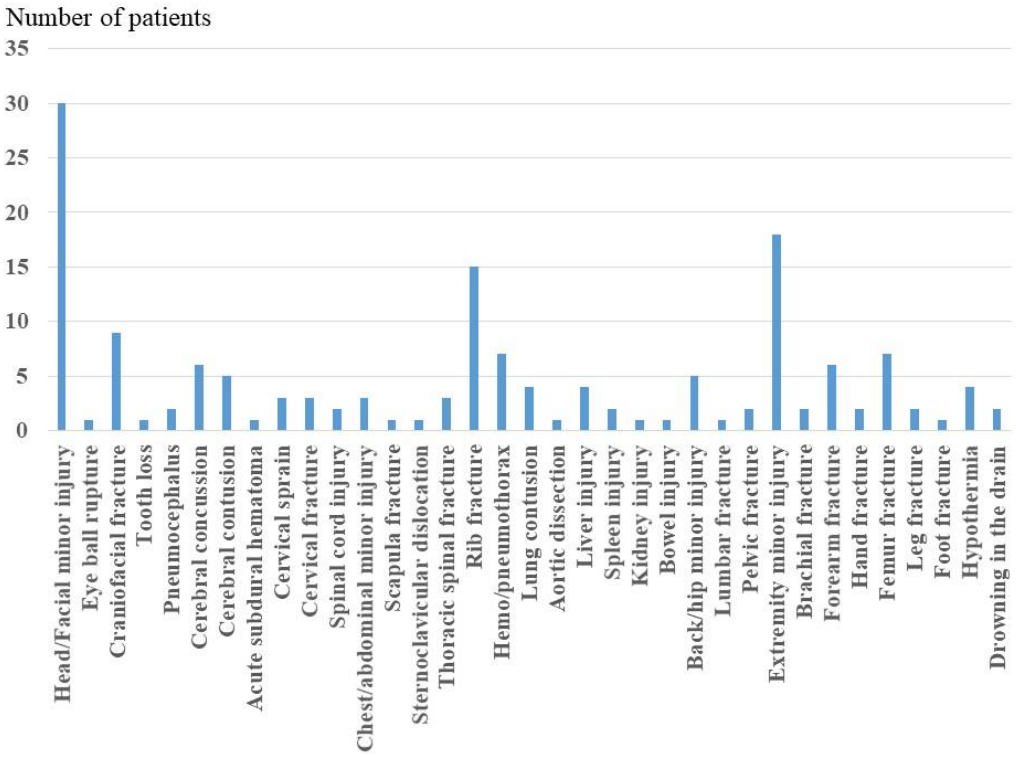

Fig-3: A diagnostic list of all 91 patients

Table-1: Results of analysis

	Outpatients	Admission	p value
	n=43	n= 51	
Sex (Male/Female)	34/9	30/21	p<0.05
Age (years)	50.4 ± 25.2	64.7 ± 18.6	p<0.01
Alcohol	4	4	n.s.
Vehicle (yes/no)	18/25	17/34	n.s.
None	26	35	
Bicycle	4	8	
Car	11	3	
Tractor	0	1	
Motorcycle	2	4	
Mechanism			n.s.
Erroneously	36	33	
Fall	2	10	
Wind push	3	0	
Avoiding a car	0	2	
Hit by car	0	1	
Avoiding bee sting	1	0	
Avoiding a rabbit	1	0	
Unknown	0	5	
Injury severity score	2.4 ± 2.7	11.0 ± 14.1	p<0.0001
Number of death	0	4	p<0.05

n.s.: not significant

DISCUSSION

This report showed that the injuries associated with falls into open drains are especially frequent in elderly people who are walking or driving a vehicle. A total of 54% (51/94) of the patients in this study required admission due to the severity of their injuries, which on some occasions (4/94 = 4.3%) were lethal. This report also showed that older and female patients tended to more frequently require admission than younger and male ones. Our previous study failed to show a significant difference in the age and survival between admitted and outpatient; however, in the present study, we obtained significant results after increasing the number of subjects.

Failure to detect an open drain due to cognitive decline might explain the reason for the high frequency of injuries among elderly patients. [5-7]. Functional manifestations of morphological changes, such as the weakening of sensory-motor and cognitive abilities, tend to appear from 40 to 50 years of age, progressively becoming more pronounced [6]. Elderly individuals also tend to have poor defensive reactions during falls in comparison with males and young patients [5-7]. Furthermore, elderly people and females tend to exhibit conditions that involve fragility of tissue, such as osteoporosis, compared with males and young people [5-8]. These tendencies might explain why older and female patients tended to more frequently require admission due to severe injury than younger and male patients.

The results of this study and previous reports [1-4] suggest that falling into an open drain can more easily result in severe or lethal consequences due to injury severity or drowning than a simple fall to the ground. Kanchan and Sato also reported fatal cases due to falls into open drains [9, 10]. Our hypothesis for this discrepancy in fall severity is as follows: when a person falls into an open drain, they may hit the concrete corner of the drain with part of their body. The transfer of energy from this concrete corner, with its small cross-sectional area, to a small field on the body may lead to more severe injuries of the internal organs than one might predict, similar to a handlebar or horse kick injury\ [11, 12]. Based on our hypothesis, we advocate that injuries caused by falls into open drains be treated as high-energy injuries and that patients select an appropriate trauma center in the prehospital setting, especially when they have head, neck or truncal injuries [4].

From the perspective of drain- or ditch-related injury prevention, open drains or ditches should be covered. However, if drains are covered, several issues may remain to be resolved regarding agricultural water use and ecological or biological system damage [3]. While such an approach may result in slight narrowing of a roadway, building a fence may be one preventive measure to consider.

Limitations

The present study is associated with several limitations, including retrospective study and the small number of patients. Future studies involving prospective and a larger number of patients are therefore needed to further examine this issue.

CONCLUSION

Injuries associated with falls into open drains are especially frequent among elderly people. Furthermore, females and older patients tended to more frequently require admission than males. To prevent injuries of this type, some measures are required to improve the safety of open drains.

Author Contributions

All authors have made substantive contributions to the study, and all authors endorse the data and conclusions.

Disclosure statement

We do not have any financial support or relationships that might pose a conflict of interest to disclose in relation to this manuscript.

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