Highlights

・CPR-induced injuries were examined with forensic autopsy victims.

・Serious injuries were defined as Abbreviated injury scale score ≥3 injuries.

・Serious injuries were documented in 48% victims.

・Aging is an only independent factor for CPR-induced injuries.

・Also aging is an independent factor for serious injuries.

Abstract

Background: Cardiopulmonary resuscitation (CPR) sometime cause severe injuries and can affect quality of life, lead to long-term disabilities or death of the patient. The aim of this study is to identify the risk factors causing CPR-induced injuries and those of serious injuries. **Methods:** This was a retrospective forensic autopsy study in a single institution. Among 885 forensic autopsies undertaken between 2011 and 2018, those in which the victim had undergone CPR immediately after cardiac arrest were recorded. 'Serious injuries' were defined as an Abbreviated Injury Scale (AIS) score ≥ 3. CPR-induced injuries were evaluated by three experienced forensic pathologists. With the background and history of the patient, the circumstances of cardiac arrest and risks of causing CPR-induced injuries were determined by multivariate analyses. **Results:** Seventy-five victims comprised the study cohort. CPR-induced injuries were found in 52 victims (69.3%). Rib fracture was the most common (60.0%), followed by sternal fracture (37.3%), heart injury (21.3%) and liver injury (8.0%). Multivariate analysis revealed higher age to be an independent factor causing CPR-induced injuries (odds ratio [OR], 1.07, P < 0.001). Thirty-six victims had 39 serious injuries in the chest or abdomen: fracture of ≥ 3 ribs (35 cases), aortic dissection (two), lung contusion (one) and rupture of the heart (one). Multivariate analysis revealed higher age to be an independent factor causing CPR-induced serious injuries (OR, 1.09; P < 0.001). **Conclusion:** Aging was the significant

factor causing CPR-induced injuries and serious injuries.

Keywords: CPR-induced injury, Abbreviated injury scale score, Serious injury, Visceral injury, Autopsy

1. Introduction

Cardiopulmonary resuscitation (CPR) is a combination of emergency procedures that allows the flow of oxygenated blood to the brain and heart of a person who has had a cardiac arrest. According to guidelines set by the American Heart Association (AHA) in 2015, rescuers should carry out chest compressions at a depth ≥ 5 cm for an 'average' adult, while avoiding excessive chest compression at a depth of ≥ 6 cm [1]. However, CPR can cause iatrogenic injuries owing to the force applied to the chest or deep chest compression [2].

In practical forensic medicine, when evaluating injuries forensic pathologists have to discriminate them as due to CPR or not. To identify CPR complications, autopsy findings are very reliable because they reveal directly the morphologic changes due to CPR. Many autopsy-based studies have been used to investigate CPR complications [3–16]. According to those reports, rib fracture is the most common complication (19.7%–73.7%), followed by sternal fracture (14.0%–66.3%) [3–16]. Although most of these injuries are not life-threatening, severe injuries have often been found in 2.0% of cases [6]. Some autopsy-based reports have focused on CPR-induced severe injuries [6–9]. Therefore, prevention of CPR-induced severe injuries should be promoted. However, severe or life-threatening CPR has not been defined clearly, so the exact prevalence or risk factors leading to CPR-induced severe injuries are not known. Subsequently, different understanding of the risks of CPR-induced severe injuries might complicate the research needed to improve the quality of CPR. For serious and life-threatening injuries, the Abbreviated Injury Scale (AIS) score correlates well with the probability of death [17]. According to a retrospective study for polytrauma patients with chest injuries, fatalities were shown in patients with an AIS score ≥ 3 [18]. Another retrospective analysis for patients who died after rib fractures due to blunt trauma revealed that 84.6% of them had suffered chest injuries and had an AIS score ≥ 3 [19]. Therefore, lethal injuries, injuries necessitating long-term disabilities or affecting the quality of life may correspond closely to injuries with an AIS score ≥ 3. To prevent these CPR-induced injuries, we identified the risk factors associated with CPR-induced injuries and those with an AIS score ≥ 3.

2. Methods

2.1. Ethical approval of the study protocol

The study protocol was approved by the Ethics Committee of Shiga University of Medical Science [R2014-010] in Shiga, Japan.

2.2. Patients and data acquisition

This was a retrospective, forensic autopsy study conducted in a single institution in Japan. This institution is the only one carrying out forensic autopsies in Shiga Prefecture (located in the centre of Japan with a population of approximately 1.41 million).

Among the 885 forensic autopsies carried out at Shiga University of Medical Science between 2011 and 2018, cases in which the victims had undergone CPR immediately after cardiac arrest were identified. Three experienced forensic pathologists evaluated the CPR-induced injuries. Victims aged < 15 years, or having trunk injuries other than CPR-induced injuries, were excluded for our study.

Nine factors were examined at autopsy: (i) general information (age, sex, body mass index (BMI)); (ii) history of use of anticoagulants or anti-osteoporosis agents; (iii) kyphosis; (iv) location of cardiac arrest (at home or another location); (v) type of chest compression (manual or mechanical); (vi) duration of CPR attempt; (vii) whether a transient return of spontaneous circulation (ROSC) was observed; (viii) injuries caused by CPR attempt; (ix) severity of CPR-induced injuries.

Injury severity was determined using the AIS score. The AIS score of the chest or abdomen was calculated for each victim. The AIS score was used to categorise the injury type and severity in each body region on a scale from 1 (‘minor’) to 6 (‘clinically untreatable’). An injury with an AIS score ≥ 3 was designated as ‘serious’. The Maximum

Abbreviated Injury Scale (MAIS) score denotes the most severe injury in each of the six regions.

2.3 Statistical analyses

Categorical variables are given as proportions or frequencies. Mean ± standard deviation for values that followed a normal distribution and median with the interquartile range for values that did not follow a normal distribution were used to summarise continuous variables. The Student's *t*-test was used to compare continuous variables, and the χ^2 test to compare categorical data. To explore the relationship between the presence of CPR-induced injuries and the risk factors for CPR-induced injuries, we undertook a logistic regression analysis. Data analyses were undertaken using SPSS v23 (IBM, Armonk, NY, USA). $P < 0.05$ was considered significant.

3. Results

3.1. Overview

The cohort of 75 cases consisted of 57 (76.0%) men and 18 (24.0%) women. The age (mean ± SD) was 59.4 ± 21.7 years. The mean BMI was 23.0 ± 4.3 kg/m^2. All victims had been transferred to a hospital in which CPR had been attempted but was unsuccessful, and they were pronounced dead. Forty (53.3%) victims died of disease and 35 (46.7%) died of external causes. CPR duration was determined for 51 victims: 30–59 min for 14 victims, 60–89 min for 22 victims, and ≥ 90 min for 15 victims. Results for the other parameters investigated are shown in Table 1.

3.2. Comparison with and without ROSC cases

Among 75 victims, ROSC was observed in 11 victims. The parameters shown in Table 1 and distribution of the MAIS score were compared between victims with ROSC and those without ROSC (Table 2). A significant difference was not found in any item, including the MAIS score. Also, the prevalence of MAIS score ≥ 2 and MAIS score ≥ 3 was compared. However, a significant difference was not shown between these two groups (P=0.16 and P=0.26, respectively).

3.3. CPR-induced injuries

CPR-induced injuries were found in 52 victims (69.3%). Injuries caused by CPR comprised rib fracture, sternal fracture, mediastinal haemorrhage, mediastinal haematoma, haemothorax, lung contusion, contusion/rupture of the heart, contusion/laceration of the great vessels, and liver injuries. The prevalence of these injuries is shown in Table 3. Rib fracture was the most common (60.0%), followed by sternal fracture (37.3%), heart injury (21.3%) and liver injury (8.0%).

We divided all victims into those who suffered CPR-induced injuries (52 victims) and those who did not (23 victims). Comparison of the backgrounds of these two groups (Table 4) revealed a significantly higher age (67.8 *vs*. 40.4 years, $P < 0.001$) and lower prevalence of men (59.6% *vs*. 100%, $P < 0.001$) in the CPR-induced-injury group. No significant differences were found in the other parameters examined.

To identify the major risk factors for having CPR-induced injuries, we undertook a multivariable logistic regression analysis using having CPR-induced injuries as a dependent variable. According to a comparison in Table 4, age, gender, using anticoagulants and transient ROSC were commonly shown in victims with CPR-induced injuries. Because these factors were considered as contribute to CPR-induce injuries, these factors were used as independent variables. For causing CPR-induced injuries, older age was an independent factor (odds ratio [OR] 1.07; confidence interval [95%CI] 1.03–1.11) (Table 5). This analysis was not affected by multicollinearity with variance inflation factors of less than 1.24.

3.4. CPR-induced serious injuries

Among all CPR-induced injuries, serious injuries were defined as those having an AIS score ≥ 3. Thirty-six victims had 39 serious injuries in the chest or abdomen: fracture of ≥ 3 ribs (35 cases); aortic dissection (two); lung contusion (one); rupture of the heart (one). One victim with an aortic dissection and a victim with a lung contusion had suffered from both a sternal fracture and rib fracture of ≥ 3. One victim with an aortic dissection and a cardiac rupture suffered two rib fractures.

Then, we divided the victims into those who had serious injuries and those who did not, and compared the backgrounds of these two groups (Table 6). For the seriously injured group, the victims were significantly older; more of them were women; had the cardiac arrest at home; and showed a higher prevalence of use of anticoagulants/anti-osteoporosis agents.

To identify the major risk factors for having CPR-induced serious injuries (AIS score ≥ 3), we undertook a multivariable logistic regression analysis using the presence of CPR-induced serious injuries as a dependent variable. According to a comparison in Table 6, age, gender, location, using anticoagulants, using antiosteoporosis medicines and kyphosis were commonly shown in victims with CPR-induced serious injuries. Because these factors were considered as contribute to CPR-induce serious injuries, these factors were used as independent variables. Only older age was an independent factor for causing

CPR-induced serious injuries (OR, 1.09; 95%CI, 1.04–1.13) (Table 7). This analysis was not affected by multicollinearity with variance inflation factors of less than 1.70.

4. Discussion

Despite scientific advances in the care of cardiac-arrest victims, survival rates for cardiac arrest out of hospital and within hospital are very low [1]. Therefore, greater intervention to facilitate basic life support (BLS) by laypersons has been recommended. As CPR can cause injuries, the deeper compression by the revision of 2010 guidelines increased proportion of rib fractures and retrosternal and mediastinal haematoma [20]. Before 2015, AHA guidelines for CPR suggested a target depth of chest compression of ≥ 5.0 cm with no upper limit. However, CPR with a compression depth > 6.0 cm resulted in a higher prevalence of complications [10], so the upper limit of compression depth was set as 6.0 cm in revised guidelines published in 2015 [1]. After guideline revision, CPR-induced injuries continued to occur. Therefore, detailed evaluation of CPR-induced injuries and feedback of this information to rescuers are required to improve the quality of CPR. Autopsy is the 'gold standard' for detecting injuries, so our forensic pathologists determined CPR-induced injuries on victims. In this way, we clarified the distribution, appearance and prevalence of CPR-induced injuries.

Previously, severe injuries by CPR have been reported often. Intra-thoracic injuries classified as 'life-threatening' might pose a significant clinical problem (could be lethal) if ROSC has been achieved [8]. Yamaguchi and colleagues examined the risk factors for ≥ 3 rib fractures: older age was the only independent risk factor, data that are similar to our results [11]. In the present study, intra-thoracic injuries considered to be life-threatening were observed in three victims: lung contusion, ascending aortic injury, and rupture of the heart. The prevalence was 4.0% for all victims. Kaldırım and colleagues suggested that 19.2% of victims undergoing CPR suffered life-threatening injuries [7]. Setälä et al. revealed the prevalence of severe injuries caused by CPR to be 2.0% [6]. The studies mentioned above reported the prevalence of severe, serious, or life-threatening injuries by CPR, but the definitions of these terms varied between reports, so comparing the prevalence was hampered. Therefore, the definition of CPR-induced lethal injuries or injuries that influence the survival or quality of life is required. Hence, we defined these injuries as having an AIS score ≥ 3 and called them 'CPR-induced serious injuries'. This definition was objective and easy to understand for all paramedics or emergency room staff. According to the present study, 36 victims (48.0%) had serious injuries to the chest or abdomen. In the future, this prevalence might be compared with the prevalence in studies carried out in other institutions. To our knowledge, there have been no reports examining the risk factor of CPR-induced AIS score ≥ 3 injuries. Furthermore, aging is a nationwide problem in Japan (which has the highest average life expectancy in the world), so the parameters of "kyphosis" and "using antiosteoporosis medicines" were listed in this study. The relationship between CPR-induced injuries and these parameter has not been investigated, so our analyses are novel.

The most common injury was rib fracture (60.0%), followed by sternal fracture (37.3%). These findings are in accordance with autopsy studies showing the prevalence of rib fracture to occur in 19.7%–73.7% of victims, and sternal fracture in 14.0%–66.3% of victims [3–16]. With regard to visceral injuries, heart injury was the most common (21.3%) followed by aortic injury (5.3%). Some autopsy-based studies have reported the prevalence of CPR-induced visceral injuries [6–9, 14, 15]. Ondruschka and colleagues suggested that, in CPR-induced injuries, heart laceration was found in 8.6% of manual-compression cases, and 17.7% of mechanical-compression cases [14]. According to Rudinská et al., lung contusion was the most common (32.8% in males and 26.3% in females), followed by heart contusion (18.0% in males and 15.8% in females) [8]. The higher prevalence of heart injury in our study (21.3%) suggests that inappropriate compression of the chest was carried out. In the comparison of cases with ROSC and patients without ROSC, a significant difference was not found for the background or the

MAIS score. Furthermore, there was no association between CPR-induced injuries or those of serious injuries and ROSC. Therefore, CPR-induced injuries might be due to the resuscitation method of the provider. Greater use of the correct CPR method with a simulator is needed; AHA guidelines state that frequent BLS training is needed to maintain the appropriate skills for carrying out CPR [1].

In our study, age was a significant factor causing CPR-induced injuries. Scholars have reported risk factors for CPR-induced injuries to be older age, sex, CPR duration, increased compression depth and rate, transient ROSC, and out-of-hospital cardiac arrest [4, 12, 16, 20, 21, 22]. According to Setälä and colleagues, older age, being male, and CPR carried out in a public location are associated independently with CPR-induced injuries, but CPR carried out by a bystander and the duration of 'bystander CPR' are not associated with CPR-induced injuries [1]. Studies have suggested older age to be a strong risk factor for CPR-induced injuries, data that are in accordance with our results [9, 16, 20, 21]. However, other parameters tested in our study that were not independent factors caused CPR-induced injuries. This difference might have been due to differences in the background of each study carried out. In addition to well-known factors, we included novel factors, such as suffering from kyphosis or osteoporosis, because these factors are considered to affect CPR performance. Although these factors did not influence the occurrence of CPR-induced injuries, more variables related to personal health status might be considered in further studies. The present study, carried out in Japan, suggested that special attention should be paid when undertaking CPR for older persons.

In particular, for serious injuries (AIS score ≥ 3), age was also the only independent causative factor according to multivariate analysis. Risk factors for intra-thoracic injuries by CPR have been examined by Rudinská and coworkers [8]. They found no significant association between intra-thoracic injuries and the basic characteristics of the study population (age, sex, BMI, cause of death, and location where body was found) [8]. Similarly, Setälä and colleagues found no correlation between intra-thoracic injuries and CPR duration, type of CPR provided (BLS *vs*. advanced life support) or type of rescuer (amateur *vs*. professional) [6]. Kaldırım and coworkers revealed that the risk factors affecting life-threatening injuries were age, being male, and CPR duration > 60 min [7]. These differences were also due to differences in dependent factors, such as intra-thoracic injuries, life-threatening injuries, or severe injuries. Serious injuries in the present study included skeletal injuries (≥ 3 rib fractures) and intra-thoracic or abdominal visceral injuries, but age was the only significant factor causing serious injuries.

For CPR-induced injures and those of serious injuries, age was the only significant factor. This result suggests the importance of considering age-related changes in the structural properties of the human rib cage. Agnew and colleagues suggested that, for frontal chest impact, structural stiffness decreases linearly with age [23]. The compliance of the chest wall is considered to decrease progressively with age [24]. Therefore, for older patients, whose rib cages are more fragile, the chest may be compressed more readily than that of younger individuals. To prevent CPR-induced serious injuries, we recommend use of a specific simulator for older people in BLS training. The trainer may acquire adequate power to compress the chest of older people, so such training may contribute to a reduction in the prevalence of CPR-induced serious injuries.

Our study had two main limitations. First, several incomplete and 'buckle' rib or sternal fractures, such as those without separation of cortical plates, were identified only on computed tomography (CT). Therefore, because a few fractures were diagnosable only by CT and not by autopsy, there may have been underestimation of the prevalence of rib or sternal fractures. In the future, a dual method (CT + autopsy) should be applied on these types of studies [11]. Second, manual chest compression was carried out for most victims (86.7%), and mechanical-compression cases were also included. Previously, mechanical chest compression as an adjunct to manual chest compression was associated strongly with potentially life-threatening visceral injuries [15]. Therefore, in the future, similar studies might involve dividing manual-compression or mechanical-compression cases.

Japan has the highest average life expectancy in the world: 81.3 years for men and 87.3 years for women. Therefore, of all decedents 65 years old or more accounted for 90.5% in 2018. Therefore, CPR-induced serious injuries might occur more often in Japan than in other countries. The present study might be useful for forensic pathologists who determine the CPR-induced injuries in other countries in which an ageing population is increasing.

5. Conclusion

CPR-induced injuries were observed in 69.3% of victims. CPR-induced serious injuries (defined on AIS score ≥ 3) were documented in 48.0% of victims; fracture of ≥ 3 ribs was the most common, followed by aortic dissection, lung contusion, and rupture of the heart. Multivariate analysis revealed aging to be an independent factor causing CPR-induced injuries and CPR-induced serious injuries.

Abbreviations

CPR: Cardiopulmonary resuscitation; AIS: Abbreviated injury scale score; AHA: American heart association; BMI: Body mass index; ROSC: Return of spontaneous circulation; OR: Odds ration; CI: Confidence interval; BLS: Basic life support; CT: Computed tomography

Competing interests

The authors declare that they have no competing interests.

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Table 1. Background of the study victims

Parameter	n (%)
Age (years, mean ± SD)	59.4 ± 21.7
Gender	
Male	57 (76.0)
Female	18 (24.0)
BMI (kg/m^2, mean ± SD)	23.0 ± 4.3
CPR duration	
< 30 min	0 (0)
30-59 min	14 (18.7)
60-89 min	22 (29.3)
≧ 90 min	15 (20)
Location of the cardiac arrest	
Home	25 (33.3)
Others	50 (66.7)
Using anticoagulants	7 (9.3)
Using antiosteoporosis medicines	4 (5.3)
Kyphosis	3 (4.0)
Type of chest compression	
Mechanical chest compression	10 (13.3)
Manual chest compression	65 (86.7)
Transient ROSC	11 (14.7)
Cause of death	
Disease	40 (53.3)
External	35 (46.7)

BMI: body mass index, CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation

Table2 . Comparison with and without ROSC cases

Parameter	ROSC(+) n (%)	ROSC(-) n (%)	P-value
Age (years, mean ± SD)	58.0 ± 20.3	59.6 ± 21.7	0.82
Gender			0.30
Male	7 (63.6)	50 (78.1)	
Female	4 (36.4)	14 (21.9)	
BMI (kg/m^2, mean ± SD)	22.5 ± 5.4	22.6 ± 4.1	0.97
CPR duration			0.93
< 30min	0 (0)	0 (0)	
30-59min	1 (9.1)	13 (20.3)	
60-89min	1 (9.1)	21 (32.8)	
≧ 90min	1 (9.1)	14 (21.9)	
Location of the cardiac arrest			0.81
Home	4 (36.4)	21(32.8)	
Others	7 (63.6)	43 (67.2)	
Using anticoagulants	0 (0)	7 (10.9)	0.07
Using antiosteoporosis medicines	0 (0)	4 (6.2)	0.17
Kyphosis	0 (0)	3 (4.7)	0.24
Type of chest compression			0.65
Mechanical chest compression	1 (9.1)	9 (14.1)	
Manual chest compression	10 (90.9)	55 (85.9)	
Cause of death			0.22
Disease	4 (36.4)	36 (56.3)	
External	7 (63.6)	28 (43.7)	
MAIS			0.09
0	1(9.1)	22(34.4)	
1	1(9.1)	4(6.2)	
2	2(18.2)	9(14.1)	
3	6(54.5)	28(43.7)	
4	0(0)	1(1.6)	
5	1(9.1)	0(0)	

BMI: body mass index, CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation, MAIS: Maximum Abbreviated Injury Scale score

Table 3. Distribution of the CPR-induced injuries (except for skin injurries)

Injury	**n (%)**
Rib fractures	45 (60.0)
≦ 3	35 (46.7)
< 3	10 (13.3)
Sternal fractures	28 (37.3)
Lung contusion	2 (2.7)
Mediastinal haematoma	4 (2.7)
Aortic injury	4 (5.3)
Aortic dissection	2 (2.7)
Adventitial injury	2 (2.7)
Heart injury	16 (21.3)
Myocardial contusion	12 (16.0)
Rupture of heart	1 (1.3)
Endocardial injury	1 (1.3)
Epicardial injury	2 (2.7)
Liver injury	6 (8.0)

Table 4. Comparison of the backgrounds of the victims between having CPR-induced injuries and not

Parameter	**Injuries n (%)**	**No injuries n (%)**	**P-value**
Age (years, mean ± SD)	67.8 ± 15.7	40.4 ± 21.5	< 0.001
Gender			< 0.001
Male	34 (65.4)	23 (100)	
Female	18 (34.6)	0 (0)	
BMI (kg/m^2, mean ± SD)	22.3 ± 4.4	23.1 ± 4.1	0.46
CPR duration			0.63
< 30min	0 (0)	0 (0)	
30-59min	12 (23.1)	2 (8.7)	
60-89min	16 (30.8)	6 (26.1)	
≧ 90min	11 (21.2)	4 (17.4)	
Location of the cardiac arrest			0.72
Home	18 (34.6)	7 (30.4)	
Others	34 (65.4)	16 (69.6)	
Using anticoagulants	7 (13.5)	0 (0)	0.07
Using antiosteoporosis medicines	4 (7.7)	0 (0)	0.17
Kyphosis	3 (5.8)	0 (0)	0.24
Type of chest compression			0.96
Mechanical chest compression	7 (13.5)	3 (13.0)	
Manual chest compression	45 (86.5)	20 (87.0)	
Transient ROSC	10 (19.2)	1 (4.3)	0.09
Cause of death			0.70
Disease	26 (50.0)	14 (60.9)	
External	26 (50.0)	9 (39.1)	

BMI: body mass index, CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation

Table 5. Result of the multivariable logistic regression analysis for CPR-induced injuries as a dependent variable

Parameter	Odds ratio	95% Confidence interval	P-value
Age	1.07	1.03-1.11	< 0.001
Gender	> 100	–	0.99
Using anticoagulants	> 100	–	0.99
Transient ROSC	13.63	0.96-193.38	0.05

ROSC: return of spontaneous circulation

Table 6. Comparison of the backgrounds of the victims between having CPR-induced serious injuries or not

Parameter	AIS3 ≧ n (%)	AIS2 ≦ n (%)	P-value
Age (years, mean ± SD)	73.3 ± 10.9	46.5 ± 21.2	< 0.001
Gender			0.004
Male	22 (61.1)	35 (89.7)	
Female	14 (38.9)	4 (10.3)	
BMI (kg/m^2, mean ± SD)	22.0 ± 4.6	23.1 ± 4.0	0.30
CPR duration			0.61
< 30min	0 (0)	0 (0)	
30-59min	9 (25.0)	5 (12.8)	
60-89min	13 (36.1)	9 (23.1)	
≧ 90min	7 (19.4)	8 (20.5)	
Location			0.05
Home	16 (44.4)	9 (23.1)	
Others	20 (55.6)	30 (76.9)	
Using anticoagulants	6 (16.7)	1 (2.6)	0.04
Using antiosteoporosis medicines	4 (11.1)	0 (0)	0.03
Kyphosis	3 (8.3)	0 (0)	0.07
Type of chest cpmression			0.89
Mechanical chest compression	5 (13.9)	5 (12.8)	
Manual chest compression	31 (86.1)	34 (87.2)	
Transient ROSC	7 (19.4)	4 (10.3)	0.26
Cause of death			0.63
Desease	20 (55.6)	20 (51.3)	
External	16 (44.4)	19 (48.7)	

AIS: Abbreviated Injury Scale score, BMI: body mass index, CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation

Table 7. Result of a multivariable logistic regression analysis for CPR-induced serious injuries as a dependent variable

Parameter	Odds ratio	95% Confidence interval	P-value
Age	1.09	1.04-1.13	< 0.001
Gender	1.85	0.37-9.30	0.45
Location	0.26	0.06-1.19	0.08
Using anticoagulants	1.96	0.16-24.21	0.60
Using antiosteoporosis medicines	> 100	−	0.99
Kyphosis	> 100	−	0.99