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Investigation of death examination results of cardiac arrest cases due to multiple trauma

Çoklu travmaya bağlı kardiyak arrest olgularının ölü muayene sonuçlarının araştırılması

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SUMMARY

Objective: This study aimed to examine the demographic characteristics of autopsy cases due to multiple trauma and contribute to the diagnosis and treatment process.
Method: Our study was carried out by examining autopsy reports of multiple trauma cases. Accordingly, two groups were formed: those who died at the scene and those in the emergency department. In addition, the demographic data of the cases, the mechanism of multiple trauma, and the cause/causes of death were recorded.
Results: A total of 278 cases involving 165 deaths at the scene and 113 deaths in the emergency service were included. The most common causes of trauma in both groups were in-vehicle traffic accidents and falling from height. The most common causes of mortality in both groups were hemothorax and subarachnoidal hemorrhage.
Conclusions: Deaths due to multiple trauma were almost four times more common in males (82%); the number of trauma under the age of 65 was approximately four times higher. This result shows that young men are at a much higher risk of trauma, resulting in more fatal consequences. We think our study will help to reveal the prevalence, coexistence, and trauma mechanisms of existing pathologies.
Keywords: Multiple trauma, autopsy, death, forensic medicine

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ÖZET

Amaç: Bu çalışmada çoklu travma nedeniyle ölüm ile sonuçlanan ve otopsi yapılan olguların demografik özelliklerini incelemeyi, çoklu travma olgularının tanı ve tedavi sürecine katkı sağlamayı amaçladık.
Yöntem: Çalışmamız çoklu travmaya bağlı ölüm olgularının otopsi raporları incelenerek gerçekleştirilmiştir. Buna göre olay yerinde ölenler ve acil serviste ölenler olmak üzere iki grup oluşturuldu. Her iki grupta da olguların demografik verileri, çoklu travma mekanizması ve ölüm nedeni/nedenleri kaydedildi.
Bulgular: Çalışmaya olay yerinde ölen 165 ve acil serviste ölen 113 olgu olmak üzere toplam 278 olgu dahil edildi. Her iki grupta da en sık travma nedeni araç içi trafik kazası ve yüksekten düşme olarak bulundu. Her iki grupta da en sık ölüm nedenleri hemotoraks ve subaraknoid kanama olarak saptandı.
Sonuç: Çoklu travmaya bağlı ölümlerin erkeklerde (%82) neredeyse dört kat fazla görülmesi; 65 yaş altı travmalı olguların sayısının yaklaşık dört kat daha fazla olması, genç erkeklerin travma riskinin çok daha yüksek olduğunu ve

travmaların daha ölümcül sonuçlara yol açtığını göstermektedir. Çalışmamızın mevcut patolojilerin sıklığını, birlikteliğini ve travma mekanizmalarını ortaya koymaya yardımcı olacağını düşünüyoruz.
Anahtar sözcükler: Çoklu travma, otopsi, ölüm, adli tıp

INTRODUCTION

"Multiple trauma" is defined as traumas involving more than one system or one system as well as at least two long bones [1]. Multiple trauma is the third most common cause of death in all age groups, after cancer and cardiovascular diseases [2]. In addition, multiple trauma, which is the most common cause of death in the young age group, accounts for approximately 10% of deaths worldwide [3].

Studies examining autopsy results of the multiple trauma cases are limited. In this study, we examined autopsy reports of cases that resulted in death due to multiple trauma at the scene or in the emergency (not hospitalized in any department). According to autopsy results, we planned to evaluate the most common cause or causes of death, trauma mechanisms, and systemic classification of organ injuries, together with demographic characteristics such as age and gender. In addition, we aimed to investigate the trauma mechanisms and organ pathologies that affect pre-hospital mortality by comparing death cases at the scene or in the emergency.

MATERIAL AND METHODS

Our study was carried out retrospectively by examining autopsy reports of deaths due to multiple trauma over 18 in the Council of Forensic Medicine Izmir Group Presidency Morgue Specialization Department. From the data obtained from the investigated reports, two groups were formed as those who died at the scene and those who died in the emergency. Furthermore, the demographic data of the cases in both groups, the mechanism of multiple trauma, and the cause/causes of death due to multiple trauma were recorded in the data form.

Approval was granted by the Local Ethics Committees before beginning the study (Ethics committee approval number of Ministry of Justice Forensic Medicine Institution: 21589509/837, Izmir Bozyaka Training and Research Hospital ethics committee approval: Decision no:2 dated 08.09.2015).

Our study included patients who were 18 and over, who died due to road traffic accidents, motor accidents, train accidents, tractor accidents, occupational accidents, falls from heights, falls from stairs, and physical assault.

Deaths due to firearm injuries and penetrating injuries, patients under the age of 18, patients with a history of hospitalization in any clinic or intensive care unit were excluded from the study.

The obtained data were analyzed using the SPSS® Statistics 20.0 (SPSS Inc. Illinois, USA). Chi-square and Fisher's Exact Chi-Square tests were used for comparisons of qualitative data groups. Results were evaluated at a 95% confidence interval and significance level of $p < 0.05$. The results were expressed as mean ± standard deviation (± SD).

RESULTS

When the files of cases who died due to multiple trauma and underwent autopsy were examined, 410 cases were reached. Of these, 22 were excluded because they were under 18 years of age, 32 were non-traumatic, and 78 were hospitalized in intensive care. A total of 278 cases were included in the study. 165 patients who died at the scene were decided as group 1, while 113 who died in the emergency were named as group 2 (Table 1).

Table 1: Demographic Data of Multiple Trauma-Related Deaths

	Group 1 (at the scene) (n=165)	Group 2 (in the emergency) (n=113)	Total (n=278)
Gender			
Male	141 (85,5%)	87 (77,0%)	228 (82,0%)
Female	24 (14,5%)	26 (23,0%)	50 (18,0%)
Age			
18-24	26 (15,8%)	14 (12,4%)	40 (14,4%)
25-34	36 (21,8%)	25 (22,1%)	**61 (21,9%)**
35-44	30 (18,2%)	21 (18,6%)	51 (18,3%)
45-54	23 (13,9%)	15 (13,3%)	38 (13,7%)
55-64	24 (15,5%)	8 (7,1%)	32 (11,5%)
65 and over	26 (15,8%)	30 (26%)	56 (20,2%)
Mean	44,1(±18,2)	47,5(±20,5)	45,5(±19,2)
Trauma mechanism			
ITA	**59 (35,8%)**	21 (18,6%)	**80 (28,8%)**
Falling from height	40 (24,3%)	**40 (35,4%)**	**80 (28,8%)**
Pedestrian accident	16 (9,7%)	20 (17,7%)	36 (12,9%)
Motorcycle accident	16 (9,7%)	9 (8,0%)	25 (9,0%)
Tractor accident	10 (6,1%)	3 (2,7%)	13 (4,7%)
OA	5 (3,0%)	2 (1,8%)	7 (2,5%)
Train accident	2(1,2%)	1 (0,9%)	3 (1,1%)
Physical assault	1(0,6%)	4 (3,5%)	5 (1,8%)
Falling from stairs	1(0,6%)	3 (2,7%)	4 (1,4%)
TAUC	15 (9,1%)	10 (8,8%)	25 (9,0%)

Abbreviations: ITA (In-Vehicle Traffic Accident), OA (Occupational Accident), TAUC (Traffic Accident with Unknown Cause)

When the demographic data of the cases were examined, it was found that 228 (82%) of 278 cases who died due to multiple trauma were males, and this rate was relatively higher than that of females (Table 1). The number of deaths at the scene was 165 (59.4%), higher than the number of deaths in the emergency department. The mean age of the patients who died due to multiple trauma was found to be 45.5 (± 19.2), and deaths were found to be higher between the ages of 25 and 34 (61 cases-21.9%). Among the causes of death due to multiple trauma, in-vehicle traffic accidents (ITA) and falling from height (FH) were in the first place with 80 cases (28.8%), and pedestrian accident (PA) was the second with 36 (12.9%) cases. (Table 1).

According to the distribution of multiple trauma mechanisms by gender, it was determined that most of the deaths at the scene were caused by ITA (55 cases-39.0%) among males and FH in females (11 cases-45.8%). On the other hand, in the group who died in the emergency service, FH was the first in males (28 cases -32.2%) and females (12 cases-46.2%) (Table 2).

The most common cause of death due to trauma at the scene and in the emergency room was hemothorax (hmx) (n = 112 (67.9%), n = 71 (62.8%), respectively), the second most common cause was subarachnoid hemorrhage (SAH) (n = 100 (60.6%,), n = 65 (57.5%), respectively), and the third was lung laceration (n = 92 (55.8%), n = 46 (40.7%), respectively) (Table 3). When we examined the distribution of causes of death by gender, hmx was the most common cause of death in females both at the scene and in the emergency (n = 21 (87.5%), n = 21 (80.8%), respectively), while the most common cause among males was hmx at the scene and SAH in the emergeny service (n = 91 (64.5%), n = 53 (60.9%), respectively) (Table 3).

Table 2: Distribution of Trauma Mechanism by Gender

Trauma Mechanism	Group 1 (n=165)			Group 2 (n=113)			Total (n=278)
	Male (n=141)	Female (n=24)	Total (n=165)	Male (n=87)	Female (n=26)	Total (n=113)	
ITA	55(39,0%)	4(16,7%)	59 (35,8%)	14(16,1%)	7(29,6%)	21 (18,6%)	80 (28,8%)
FH	29(20,6%)	11(45,8%)	40 (24,3%)	28(32,2%)	12(46,2%)	40 (35,4%)	80 (28,8%)
PA	12(8,5%)	4(16,7%)	16 (9,7%)	20(23,0%)	0	20 (17,7%)	36 (12,9%)
MA	15(10,6%)	1(4,2%)	16 (9,7%)	6(11,5%)	3(11,5%)	9 (8%)	25 (9%)
TRC	9(6,4%)	1(4,2%)	10 (6,1%)	2(2,3%)	1(3,8%)	3 (2,7%)	13 (4,7%)
OA	5(3,5%)	0	5 (3%)	2(2,3%)	0	2 (1,8%)	7 (2,5%)
Train Accident	2(1,4%)	0	2(1,2%)	1(1,1%)	0	1 (0,9%)	3 (1,1%)
Physical assault	1(0,7%)	0	1(0,6%)	3(3,4%)	1(3,8%)	4 (3,5%)	5 (1,8%)
FS	1(0,7%)	0	1(0,6%)	3(3,4%)	0	3 (2,7%)	4 (1,4%)
TAUC	12(8,5%)	3(9,1%)	15 (9,1%)	8(9,2%)	2(7,7%)	10 (8,8%)	25 (9%)

Abbreviations: ITA (In-Vehicle Traffic Accident), FH (Falling from Height), PA (Pedestrian Accident), MA (Motorcycle Accident), TRC (Tractor Accident), OA (Occupational Accident), FS (Falling from stairs), TAUC (Traffic Accident with Unknown Cause

When the distribution of mortality causes according to age ranges was examined, hmx and SAH were the most common causes of mortality in all age groups at the scene and the emergency service. While the rate of SAH was higher than hmx in young age groups, hmx came to the fore with the increase of age (Table 3).

When the distribution of causes of death by the system was examined, the most common cause of intracranial pathologies in both groups was SAH, the most common cause of cervical pathology was C3 (cervical) vertebral fracture in the group who died at the scene, and C1 vertebral fracture in the group who died in the emergency department. Hmx was the most common cause in both groups in terms of thoracic pathologies, liver laceration was the most common cause in both groups in terms of intraabdominal pathologies, femur fracture was the most common cause in the group who died at the scene in terms of major bone fracture, and the pelvic fracture was the most common cause in the group who died in the hospital (Table 4)

Our study determined that 32 (19.4%) of 165 cases who died at the scene and 9 (8%) of 113 cases in the emergency department had a liver laceration and splenic laceration. A significant relationship was found between the presence of liver and splenic lacerations in both groups (Table 5).

Pelvic fracture and retroperitoneal hematoma were seen in 17 (10.3%) of 165 cases who died at the scene and 22 (19.5%) of 113 cases in the emergency service. A significant relationship was found between pelvic fracture and retroperitoneal hematoma in both groups (Table 5).

When the data of 113 patients who died in the emergency were examined, it was found that computed tomography (CT) was performed in 28 cases (24.8%). However, when CT and autopsy reports of these cases were compared, although the CT was normal, hmx was found in 11 cases, retroperitoneal hematoma in 3 cases, liver laceration in two cases, splenic laceration in two cases, SAH in two cases, lung laceration in one case, subdural hematoma (SDH) in one case, and fat embolism in one case.

Table 3: Distribution of causes of mortality by gender and age

	HMX	SAH	LngL	LiL	BPI	SpL	FemF	PelF	TAI
Gender									
Group 1									
• Female	**21**	16	15	11	7	6	6	8	5
(n:24)	**87,5%**	66,7%	62,5%	45,8%	29,2%	25%	25%	33,3%	20,8%
• Male	**91**	84	77	67	48	35	35	30	30
(n:141)	**64,5%**	59,2%	54,6%	47,5%	34%	24,8%	24,8%	21,3%	21,3%
Group 2									
• Female	**21**	12	13	10	5	0	4	10	1
(n:26)	**80,8%**	46,2%	50%	38,5%	19,2%		15,4%	38,5%	3,8%
• Male	50	**53**	33	28	20	14	14	25	7
(n:87)	57,5%	**60,9%**	37,9%	32,2%	23%	16,1%	16,1%	28,7%	8%
Age									
Group 1									
• 18-24	16	17	13	11	13	6	5	3	5
(n:26)	61,5%	65,4%	50%	42,3%	50%	23,1%	19,2%	11,5%	19,2%
• 25-34	24	25	16	16	13	10	11	8	3
(n:36)	66,7%	69,4%	44,4%	44,4%	36,1%	27,8%	30,6%	22,2%	8,3%
• 35-44	19	19	16	16	8	9	8	8	5
(n:30)	63,3%	63,3%	53,3%	53,3%	26,7%	30%	26,7%	26,7%	16,7%
• 45-54	15	12	15	14	9	6	8	8	9
(n:23)	65,2%	52,2%	65,2%	60,9%	39,2%	26,1%	34,8%	34,8%	39,1%
• 55-64	17	15	14	12	9	8	5	5	10
(n:24)	70,8%	62,5%	58,3%	50%	37,5%	33,3%	20,8%	20,8%	41,7%
• >65	21	12	18	9	3	2	4	6	3
(n:26)	80,8%	46,2%	69,2%	34,6%	11,5%	7,7%	15,4%	23,1%	11,5%
Group 2									
• 18-24	9	11	5	4	3	2	1	3	1
• (n:14)	64,3%	78,6%	35,7%	28,6%	21,4%	14,3%	7,1%	21,4%	7,1%
• 25-34	17	16	12	14	7	3	4	4	2
(n:25)	68%	64%	48%	56%	28%	12%	16%	16%	8%
• 35-44	13	13	11	9	5	2	3	6	1
(n:21)	61,9%	61,9%	52,4%	42,9%	23,8%	9,5%	14,3%	28,6%	4,8%
• 45-54	7	8	5	4	3	1	1	5	2
(n:15)	46,7%	53,3%	33,3%	26,7%	20%	6,7%	6,7%	33,3%	13,3%
• 55-64	6	2	3	3	0	1	4	3	1
(n:8)	75%	25%	37,5%	37,5%		12,5%	50%	37,5%	12,5%
• >65	19	15	10	4	7	5	5	14	1
(n:30)	63,3%	50%	33,3%	13,3%	23,3%	16,7%	16,7%	46,7%	3,3%

Abbreviations: HMX (hemothorax), SAH (subarachnoidal hemorrhage), LngL (lung laceration), LiL (liver laceration), BPI (brain parenchymal injury), SpL (splenic laceration), FemF (femur fracture), PelF (pelvic fracture), TAI (thoracic aortic injury)

Table 4: Distribution of causes of mortality by systems

	Causes of Mortality	At the scene (n=165)	At the Emergency Service (n=113)
Intracranial pathologies	Subarachnoid Hemorrhage	**100 (60,6%)**	**65 (57,5%)**
	Brain Parenchyma injury	55 (33,3%)	25 (22,1%)
	Subdural Hematoma	18 (10,9%)	22 (19,5%)
	Epidural Hematoma	3 (1,8%)	0
Cervical pathologies	C3 fracture	**10 (6,1%**)	1 (0,9%)
	C1 fracture	9 (5,5%)	**8 (7,1%)**
	C2 fracture	9 (5,5%)	4 (3,5%)
	C4 fracture	3 (1,8%)	1 (0,9%)
Thoracic pathologies	Hemothorax	**112 (67,9%)**	**71 (62,8%)**
	Lung Laceration	92 (55,8%)	46 (40,7%)
	Thoracic Aortic Injury	35 (21,2%)	8 (7,1%)
	Cardiac Contusion	26 (15,8%)	8 (7,1%)
	Venae Cavae Laceration	15 (9,1%)	0
	Tamponade	2 (1,2%)	1 (0,9%)
	Fat Embolism	1 (0,6%)	3 (2,7%)
Intra-abdominal pathologies	Liver Laceration	**78 (47,3%)**	**38 (33,6%)**
	Splenic Laceration	41 (24,8%)	14 (12,4%)
	Bowel-Mesenteric Injury	26 (15,8%)	9 (8%)
	Retroperitoneal Bleeding	21 (12,7%)	36 (31,9%)
	Kidney Laceration	17 (10,3%)	9 (8%)
	Diaphragm Rupture	11 (6,7%)	3 (2,7%)
	Bladder Injury	6 (3,6%)	1 (0,9%)
	Stomach Injury	2 (1,2%)	0
	Abdominal Aortic Injury	1 (0,6%)	0
Major bone fracture	Femur Fracture	**41 (24,8%)**	18 (15,9%)
	Pelvic Fracture	38 (23%)	**35 (31%)**
	Tibia Fracture	36 (21,8%)	16 (14,2%)
	Radius Fracture	31 (18,8%)	8 (7,1%)
	Humerus Fracture	27 (16,4%)	12 (10,6%)

Table 5: Coexistence of liver laceration with splenic laceration and pelvic fracture with retroperitoneal hematoma in the group who died at the scene and in the emergency room

	Group 1		Group 2	
	Yes n(%)	**No n(%)**	**Yes n(%)**	**No n(%)**
Liver laceration	78 (47,3%)	87 (52,7%)	38 (33,6%)	75 (66,4%)
Splenic laceration	41 (24,8%)	124 (75,2%)	14 (12,4%)	99 (87,6%)
L+S laceration	32 (19,4%)	133 (80,6%)	9 (8%)	104 (92%)
p value	p<0,001		p=0,015	
Pelvic fracture	38 (23%)	127 (77%)	35 (31%)	78 (69%)
Retroperitoneal hematoma	21 (12,7%)	144 (87,3%)	36 (31,9%)	77 (68,1%)
Pelvic fracture + Retro. Hem.	17 (10,3%)	148 (89,7%)	22 (19,5%)	91 (80,5%)
p value	p<0,001		p<0,001	

Abbreviations: L (liver), S (splenic), Retro. Hem (Retroperitoneal hematoma)

DISCUSSION

Mortality and morbidity rates are high because multiple traumas cause injuries in more than one system. Particularly by affecting the young population with a high rate of social mobility, multiple traumas may cause loss of workforce and psychological, social, and economic problems [4-6]. Baker et al. in 1980 and Trunkey in 1983 defined the classical tri-modal distribution of trauma-related deaths [7-8]. Accordingly, deaths after trauma peak in 3 time periods. Post-traumatic deaths are classified as sudden, early, and late deaths, which is still accepted as a three-mode (tri-modal) distribution. The first peak after trauma is sudden deaths occurring a few minutes after injury, accounting for approximately 45% of deaths. In this early period, deaths usually occur due to severe brain or upper spinal cord injury and apnea caused by rupture of the heart, aorta, or other major blood vessels. Few of these patients can be saved due to the severity of the injuries. This peak of trauma-related deaths can be significantly reduced with prevention activities only. The second peak includes early deaths occurring within an average of 1-4 hours, from minutes to a few hours following the injury, accounting for approximately 34% of all deaths. Deaths that occur during this period are usually due to SDH and many other injuries associated with epidural hematomas (EDH), hemopneumothorax, splenic rupture, liver ruptures, pelvic fractures, and/or significant blood loss. This period, defined as the "golden hour" after injury, is characterized by the need for rapid assessment and resuscitation, one of the basic principles of Advanced Trauma Life Support. The third peak occurs a few days to a few weeks after the injury and mostly includes sepsis and multiple organ failure [9]. In our study, consistent with these definitions, immediate death was defined as death at the scene and early death as a death in the emergency department. Autopsies performed in trauma cases contribute to the detection of preventable deaths, the development of trauma protocols, and the management process of traumatic cases. In this respect, in our study, the causes of mortality, the distribution of traumas that caused death at the scene and in the emergency department within the first 24 hours were evaluated according to the autopsy report results of 278 patients who died due to multiple trauma.

In studies evaluating deaths due to trauma, it is seen that there are different results regarding the mean age. For instance, the mean age was found to be 28 in the study of Durusu et al., 35 in the study of Eyi et al., 32 in the study of İnce et al., 48.9 ± 20.1 in the study of Avcı et al., 23.5 ± 17.5 in the study of Ceylan et al., and 57 in the study of Arslan et al. [4-6,10-12]. In our study, the mean age of 278 patients who died due to multiple trauma was found to be 45.5 (± 19.2). The mean age of 165 patients who died at the scene was 44.1 (± 18.2), while the mean age of 113 patients who died in the emergency department was 47.5 (± 20.5). According to age groups, the mortality rate was observed mostly between the ages of 25 and 34. The fact that the mean age is higher than other studies conducted in our country can be explained by excluding cases under 18 years of age in our study. When further studies conducted abroad are examined, there are different mean ages as in the studies in our country. In their study conducted in the same trauma center in different years, Cothren et al. found the mean age in trauma-related deaths as 41.7 and 47.3, respectively, while Gunst et al. identified it as 33 [13-14]. In most studies abroad, the mean age was consistent with our study [15-17].

Many studies are showing that deaths due to multiple trauma are higher in males [4-6,18-20]. In the study of Lansink et al., the mortality rate at the scene, defined as immediate death, was reported as 81.8%, while the mortality rate in the emergency department, described as early death, was 67.1% in males [21]. In our study, males (82%) were affected by traumas more than females (18%), and the mortality rate was higher at the scene (85.5%) and in the emergency service (77%).

It is seen in studies that trauma mechanisms are generally divided into blunt and penetrating injuries. In the study conducted by Lansink et al., it was reported that 94.7% of deaths occurred due to blunt trauma following trauma and traffic accidents, and falling from height accounted for 88.2% of trauma-related deaths in total [21]. In their study, including 747 cases, Durusu et al. reported the rate of injury resulting from blunt trauma as 74.17% [4]. As the causes of blunt trauma, they found that pedestrian accident (PA) (16.8%) was in the first place, in-vehicle traffic accident (ITA) (15.8%) was in the second place and falling from height (FH) (13.71%) was in the third place. In another study, the rate of blunt trauma was reported as 81.9% in 386 cases, 34.5% developed due to traffic accidents (TA), and 15.5% due to FH [5]. In another study examining the causes of deaths due to trauma with 13100 cases, a very high number of cases, TA's most common cause of death in the pre-hospital period. In contrast, the most common cause of death in the hospital was FH [19]. In a study of only 19 cases in which autopsy reports due to multiple trauma were examined, the most common cause of death was TA, and the second most common cause was FH [20]. We did not include

penetrating injuries in our study. When the multiple trauma mechanisms were examined according to autopsy reports of 278 cases, ITA (28.8%) and FH (28.8%) ranked first. When evaluated in terms of death times due to multiple trauma, the most common cause was ITA (35.8%) in 165 cases who died at the scene, and the most common cause was FH (35.4%) in 113 cases died in the emergency service. When the distribution of trauma mechanisms by gender was examined, the most common cause was ITA (39%) among males at the scene, while it was falling from height (45.8%) in females. In addition, the most common cause was FH in males (32.2%) and females (46.2%) in the emergency department. The results of our study were found to be compatible with the literature regarding the causes of death due to trauma [4-5,19-20].

In our study, the most common organ injuries in both groups were hmx (67.9% -62.8%), SAH (60.6% -57.5%), lung laceration (55.8% -40.7%), and liver laceration (47.3% -33.6%). While the most common cause of death was SAH in males in the emergency department, the most common cause was hmx in both males and females at the scene. While SAH was the most common cause in the scene and the emergency service at young ages, hmx came to the fore as the age progressed.

In studies conducted on the distribution of causes of death according to the affected regions, it has been stated that the most frequently injured areas are head-neck, thorax, and abdomen, respectively [4-5]. In the study of Lansink et al., the rate of head trauma was 66.0%, thoracic trauma was 21.5%, abdominal trauma was 6.7%, and extremities were 4.7% [21]. In a study primarily related to head trauma, the most common head trauma causes resulting in death were SAH, SDH, and EDH, respectively [22]. In our study, the most common cause of mortality was SAH in both groups, genders, and all trauma mechanisms in terms of intracranial pathologies.

In terms of cervical pathologies, C3 fracture was the most common cause in males at the scene, while C1 fracture was the most common in males and females in the emergency department. In the group who died at the scene, C3 fracture due to ITA and PA was the most common cause, C1 fracture in FH and motorcycle accident (MA), C2 fracture in falling from stairs (FS) and TA, and C4 fracture in occupational accidents (OA). C1 fracture was detected most frequently in ITA, PA, FH, and FS in the group who died in the emergency service.

When it was examined in terms of thoracic pathologies, hmx and lung laceration were the most common causes in both groups. When grouped according to trauma mechanisms, the most common thoracic pathology was found to be hmx. In the group who died at the scene, the most common injuries were thoracic aortic injury (12.4%) and Vena Cava injury (5.3%).

Abdominal injuries are the third most common cause of death due to multiple trauma [4-5]. In our study, liver laceration was the most common cause of mortality in all trauma mechanisms in both groups in terms of intra-abdominal pathologies. The liver laceration was the most common cause in males and females in the group who died at the scene. At the same time, the retroperitoneal hematoma was the most common cause in females who died in the emergency department. The splenic laceration was the second most common cause of death at the scene, while the emergency department's retroperitoneal bleeding was the second most common cause of death. Although liver laceration was found to be in the first place and splenic laceration in the second place, a statistically significant relationship was found in terms of being together both at the scene ($p < 0.001$) and in the emergency department ($p = 0.015$). Therefore, it should not be forgotten that both can coexist. Thus, whether there is splenic laceration or vice versa for accurate diagnosis and treatment must be clarified if the liver laceration is detected.

Femur fracture was the most common cause in the group who died at the scene, while pelvic fracture was the most common cause in the group who died in the emergency. The presence of pelvic fracture in patients with multiple trauma indicates a high-energy trauma. Retroperitoneal hematomas due to pelvic fracture increase mortality to the severity of bleeding. To reduce mortality in unstable pelvic fractures, follow-up and treatment of the patient by the trauma surgeon, early erythrocyte suspension and coagulation factors (fresh frozen plasma and thrombocyte suspension), treatment of accompanying injuries, stabilization of the pelvic ring, pelvic angiography, and embolization are the five main principles [23]. It has been reported that mortality can be reduced from 31% to 15% in trauma centers where this treatment approach is applied [16]. In our study, a statistically significant result was found in the association of pelvic fracture and retroperitoneal hematoma among the causes of mortality due to multiple trauma ($p < 0.001$ in group 1 and $p < 0.001$ in group 2).

When evaluated in terms of pathologies with a high rate of coexistence according to autopsy results in cases with polytrauma, in both groups, together with intracranial pathology, the most common cervical pathology was C1 fracture, the most common thoracic pathology was hmx, and the most

common intraabdominal pathology was liver laceration.

CT imaging was performed in only 28 of 113 patients who died in the emergency department. We think that the rate of CT imaging was low due to the need for cardiopulmonary resuscitation (CPR) in the critical time interval. In the autopsy report of 23 cases who were performed CT imaging in the emergency department and reported as radiologically normal, pathologies defined were hmx in 11 cases, retroperitoneal bleeding in 3 cases, liver laceration in two cases, splenic laceration in two cases, SAH in two cases, lung laceration in one case, SDH in one case, and fat embolism in one case. The difference between CT imaging reports and autopsy reports in the emergency may be due to pathologies related to CPR and the increase in pathologies during and after CPR that are minimal at first arrival. Especially, hmx that was detected in 11 cases is thought to be due to CPR. Many variables affect thoracic bone structure injuries due to CPR, such as CPR quality, the area where CPR is applied (hospital and/or pre-hospital), age, and gender [24]. Rib and sternum fractures are the most frequently reported complications related to chest compression applied during CPR in adult patients. It has been reported that fractures of the rib and sternum cause hemothorax-pneumothorax, very rarely, cardiac rupture and liver injury [25-26].

In our study, where we focused on the first two stages of post-traumatic deaths with a tri-modal distribution, and we conducted with the information obtained from autopsy reports, it is seen that deaths were higher in the first peak period. At this stage, even prevention activities may contribute to reducing deaths. It is thought that the lower number of deaths in the second peak period is related to timely, effective, and correct medical interventions. In short, medical intervention with effective trauma management in each period contributes positively to the next period and, therefore, to the prognosis. The tri-modal distribution of deaths reflects the functioning and development of trauma systems across the region and country.

As a result, similar and broader studies on determining the causes of death due to multiple trauma will enable the review, renewal, and improvement of the quality of care provided to trauma patients. We believe that pre-hospital and hospital-level trauma teams and developed trauma protocols, along with up-to-date and standard trauma trainings that are repeated periodically, will contribute to the diagnosis / treatment process of multiple trauma cases and reduce deaths in the first two peak periods.

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