Research Article / Araştırma Makalesi

Forensic Medical Evaluation of Non-Fatal Traumatic Head Bone Fractures

Ölümle Sonuçlanmayan Travmatik Kafa Kemik Kırıklarının Adli Tıbbi Değerlendirilmesi

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Abstract: Head bone fractures are encountered in forensic medicine practice due to their origin. In the present study, we aimed to evaluate the demographic data, injury characteristics, clinical findings accompanying bone fractures and forensic reports of cases with skull fractures and to share them with the literature. In this study, cases with non-fatal traumatic skull fractures that did not result in death admitted to our department during the 10-year period between 01.01.2014 and 31.12.2023 were included in the study. Hospital documents and investigation documents of the cases were retrospectively analyzed. It was determined that 75.6% of the cases were male and the mean age was 37±9.6 years. It was determined that 56.2% of the skull fractures occurred as a result of traffic accidents, the most common fracture was the frontal bone (n=206, 53.4%) and 54.1% of the cases were linear fractures. In our study, it was determined that skull fractures were most common in males, in the young adult age group, most commonly due to traffic accidents, and in the form of linear fractures in the frontal bone. The findings were consistent with the literature. When preparing a forensic report on skull fractures, the location of the fracture, the type of fracture and the number of fractures are important in terms of determining the life threat and the effect of the fracture on life functions.
Keywords: head bone fracture, forensıc report, traflc accıdent, forensıc medıcıne

Özet: Kafa kemik kırıkları, orijinleri gereği, adli tıp pratiğinde karşılaşılabilen olgulardır. Sunulan çalışmada, kafa kemik kırıklı olgulara ait demografik verilerin, yaralanma özelliklerinin, kemik kırığına eşlik eden klinik bulguların ve olguların adli raporlarının değerlendirilmesi ve litaretürle paylaşılması amaçlanmıştır. Çalışmada, 01.01. 2014- 31.12.2023 tarihleri arasındaki 10 senelik zaman dilimde, Anabilim Dalımıza başvuran ölümle sonuçlanmayan travmatik kafa kemik kırıklı olgular çalışmaya dahil edilmiştir. Olgulara ait, hastane evrakları, soruşturma evrakları retrospektif olarak incelenmiştir. Olguların, % 75,6'sının erkek olduğu, yaş ortalamasının 37±9,6 olduğu belirlenmiştir. Kafa kemik kırıklarının % 56,2'sinin trafik kazası sonucu meydana geldiği, en sık frontal kemiğin kırıldığı (n=206, % 53,4), olguların % 54,1'inin lineer kırık şeklinde olduğu belirlenmiştir. Çalışmamızda, kafa kemik kırıklarının en sık erkeklerde, genç erişkin yaş grubunda, en sık trafik kazası nedeniyle, frontal kemikte lineer kırık şeklinde olduğu belirlenmiştir. Elde edilen bulgular literatürle uyumlu bulunmuştur. Kafa kemik kırıkları ile ilgili adli rapor düzenlenirken, yaşamsal tehlike ve kırığın hayat fonksiyonlarına etkisi ile ilgili belirleyici olması bakımından, kırığın yeri, ne tür bir kırık olduğu, kırığın sayısı önem taşımaktadır.
Anahtar Kelimeler: kafa kemik kırığı, adli rapor, trafik kazası, adli tıp

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1. Introduction

Head trauma is an important cause of mortality and morbidity worldwide (1-5). Head traumas are more fatal than traumas involving other body parts (6). The rate of fatal injury due to head trauma has been reported to be 150-400 per 100.000 in the United States of America and the United Kingdom, and the rate of death due to head trauma has been reported to be 9-32 per 100.000 in the same countries (7). Fractures occur in the skull bones in 80% of fatal head traumas (1,7). In studies related with head traumas, it has been reported that the occurrence of skull bone fracture due to head trauma affects the morbidity, treatment modality and hospitalization time of the patient (8). In our country, there are not enough academic studies presenting data on the incidence and epidemiology of head trauma.

Head trauma and fractures in the skull bones may occur as a result of traffic accidents, effective actions such as fights and beatings, injuries caused by impact with a blunt object or falling from a height, and gunshot wounds (1-3,9,10). In a study conducted by Tsai et al. with 5,430 head trauma patients, it was reported that 52.4% of head bone fractures were caused by traffic accidents (11).

Due to their origin, skull bone fractures can be encountered in forensic medicine practice (10). In a study conducted in Eskişehir and including 306 cases in which all forensic bone fractures were evaluated, it was reported that 57.8% of the cases had skull fractures (12). Article 87 of the Turkish Penal Code (TPC) states that *"if intentional injury causes bone fracture or dislocation in the body, the penalty determined according to the above article is increased by up to half according to the effect of the fracture or dislocation on life functions"* (13,14). In practice, the effect of the fracture on life functions should be defined when preparing a forensic report on patients with skull fractures. In the guideline on the evaluation of injury crimes in terms of forensic medicine in the Turkish Penal Code, the grades of bone fractures and their life-threatening status are included in detail. It is defined as "life-threatening" when the inner and outer plates of the skull bones are fractured together (15). It has been reported that all forms of fractures involving only the outer tabula in regions of the skull with inner and outer tabula are not life-threatening and the effect on life functions is 1 (mild) degree. It was reported that each of the linear bone fracture lines in the skull (even if they cross more than one bone) has a grade 3 (moderate) impact on life functions. It is recorded that the effect of collapse fracture and pedestal fracture in the skull on life functions is 5 (severe) degrees (15). In the same guideline, it is recorded that a deficit of 5-25 cm2 in the skull bones should be considered as weakness of function, and losses of more than 25 cm2 should be considered as loss of function (15).

As in all forensic cases, hospital notes are very important when preparing the forensic report in cases with skull fractures. The relevant clinicians and radiologists must accurately describe the location, size, type and number of the skull fracture. If these data are not recorded regularly in the hospital file, the forensic report cannot be prepared correctly.

In the present study, we aimed to evaluate the demographic data, injury characteristics, clinical findings accompanying bone fracture, forensic reports of the cases admitted to our department and to share them with the literature.

2. Materials and Methods

In this study, the cases of non-fatal traumatic skull fractures that did not result in death who were admitted to our department between 01.01.2014 and 31.12.2023 were included in the study. Hospital documents, radiographs, CT scans, MR images and investigation documents of the cases were retrospectively analyzed. Age, gender, type of event, origin of the event, fractured bone, other accompanying findings and forensic report contents were analyzed. The data were uploaded to a package statistical program, chi-square and percentage analyses were performed and $p<0.05$ was accepted as significant.

The study was approved by the local ethics committee.

3. Results

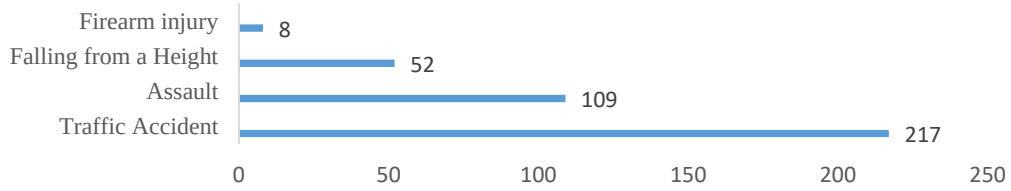
In the 10-year period covered by the study, 386 cases of non-fatal skull fractures were evaluated in our department.

It was determined that 294 (75.6%) of the cases were male and 92 (24.4%) were female, the youngest case was 2 years old and the oldest case was 78 years old, the mean age of the cases was 37±9.6 years and 78 cases (20.2%) were younger than 18 years. The distribution of pediatric and adult cases according to gender and origin of the incident is presented in Table 1. A significant relationship was found between gender and age group (P<0.001). While 24.1% of the male cases were younger than 18 years of age, only 7.6% of the female cases were younger than 18 years of age.

Table 1. Distribution of cases according to age group and gender

		Gender				T^2	p
		Male		Female			
		n	%	n	%		
Age Group	< 18	71	24,1	7	7,6	11,890	<0,001
	18 and over	223	75,9	85	92,4		
Total		294	100,0	92	100,0		

Of the cases, 269 (69.7%) were accidents and 117 (30.3%) were the result of effective actions such as fights, beatings and gunshot wounds. The most common cause of skull fractures was traffic accidents (n=217, 56.2%). 52 cases (13.5%) were injured as a result of accidental fall from a height, 109 cases (28.2%) were injured as a result of assault involving contact with a hard object or ground, and 8 cases (2.1%) were gunshot wounds (Graph 1). All of the firearm cases were assault with a firearm and no suicide attempt or accidental incident was encountered. A significant relationship was found between origin and gender (P<0.001). 29% of male and 15.2% of female patients were injured as a result of effective action.



Graph 1. Distribution of cases according to the way the events occurred

Table 2. Distribution of the origin of the cases according to gender

		Gender				T^2	p
		Male		Female			
		n	%	n	%		
Origin of the incident	Accident (Traffic accident=217, Fall from Height=52)	191	71,0	78	84,8	13,027	<0,001
	Effective action (Assault=109, Firearm injury=8)	103	29,0	14	15,2		

Total	294	100,0	92	100,0

The most common fracture was the frontal bone (n=206, 53.4%). In 112 cases (29.0%), the frontal bone was fractured in isolation, in 76 cases (19.7%) the frontal and parietal bones were fractured together, in 18 cases (4.7%) the temporal and frontal bones were fractured together, and in 27 cases (7.0%) the temporal and parietal bones were fractured together. In 94 cases (24.4%) parietal bone, in 45 cases (11.6%) temporal bone and in 14 cases (3.6%) occipital bone were fractured in isolation. The distribution of fractured skull bones according to event types is presented in Table 3. It was determined that there was no significant correlation between the fractured bones and event types (P>0.05).

Table 3. Distribution of broken bones according to event types

Fractured Bone	**Event Type**								**Total**
	Traffic Accident		**Falling**		**Assault**		**Firearm injury**		
	n	%	n	%	n	%	n	%	
Frontal	60	27,6	17	32,7	31	28,4	4	50,0	112
Parietal	51	23,5	13	25,0	28	25,7	2	25,0	94
Frontoparietal	51	23,5	7	13,5	18	16,5	0	0	76
Temporal	26	12,0	6	11,5	11	10,1	2	25,0	45
Temporoparietal	14	6,5	4	7,7	9	8,3	0	0	27
Frontotemporal	8	3,7	3	5,7	7	6,4	0	0	18
Oksipital	7	3,2	2	3,9	5	4,6	0	0	14
Total	217	100,0	52	100,0	109	100,0	8	100,0	386

I^2 = 38,276, P>0,05

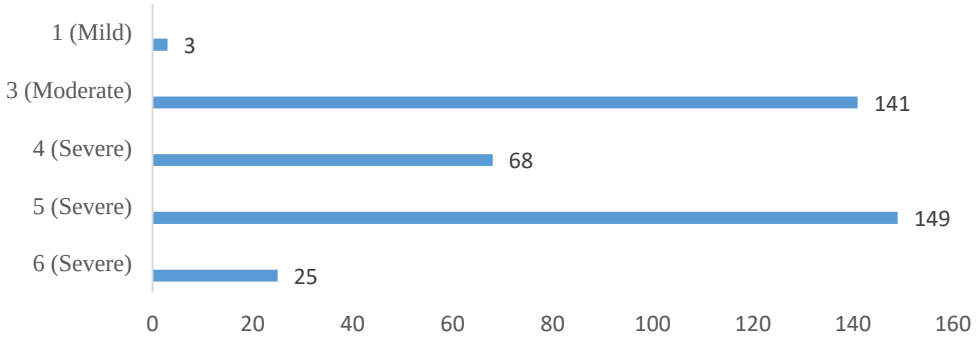
It was determined that 209 (54.1%) of the cases had linear fractures, 174 (45.1%) had comminuted and/or collapse fractures, and 3 (0.8%) had only external tabular fractures. The distribution of fractured skull bones according to fracture types is presented in Table 4. It was determined that there was no significant relationship between the fractured bone and fracture types (P>0.05). When it was evaluated whether the inner and outer tabula were fractured together in bones with tabula, it was determined that the outer tabula of the frontal bone was fractured isolated in only 3 cases (0.8%). It was reported that these 3 cases did not cause life-threatening injuries, but caused injuries that could not be treated with simple medical intervention. In all other cases (n=383, 99.3%), it was reported as life-threatening and could not be treated with simple medical intervention.

Table 4. Distribution of fractured bones according to fracture types

Fractured Bone	**Fracture Type**						**Total**
	Linear Fracture		**Fragmented / Collapse Fracture**		**Fracture of the outer tabula**		
	n	%	n	%	n	%	
Frontal	61	29,2	48	27,6	3	100,0	112
Parietal	44	21,1	50	28,7	0	0	94
Frontoparietal	43	20,6	33	19,0	0	0	76
Temporal	33	15,7	12	6,9	0	0	45
Temporoparietal	11	5,3	16	9,2	0	0	27
Frontotemporal	9	4,3	9	5,2	0	0	18
Occipital	8	3,8	6	3,4	0	0	14
Total	209	100,0	174	100,0	3	100,0	386

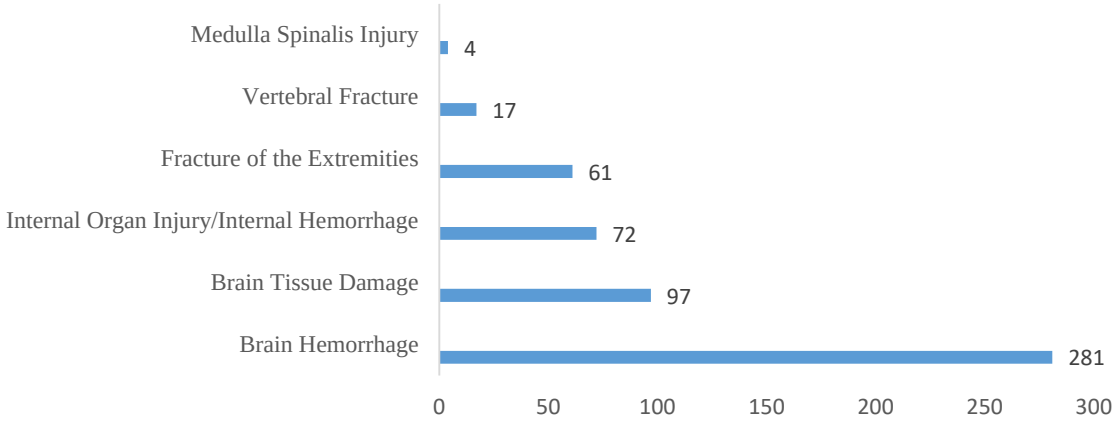
X2 = 20,850 P>0,05

The evaluation of skull bone fractures according to the grades of bone fractures in the guideline for forensic evaluation of injury crimes in the Turkish Penal Code is presented in graph 2. In 3 cases (0.8%) where only the outer tabula was fractured, the effect of the bone fracture on life functions was evaluated as 1 (Mild), in 141 cases (36.5%) as 3 (Moderate), in 68 cases (17.6%) as 4 (Severe), in 149 cases (38.6%) as 5 (Severe), in 25 cases (6.5%) as 6 (Severe). Only skull fractures were evaluated during grading. Other accompanying bone fractures were excluded except for skull fractures. 6 cases (1.6%) were reported to have impaired function due to a 5-25 cm2 defect after skull fracture. No patient with loss of function due to skull fracture was found.



Graph 2. Distribution of the effects of head bone fractures on life functions

In 105 cases (27.2%), the injury was an isolated skull fracture. In 281 cases (72.8%), cerebral hemorrhage accompanied the skull fracture. In 97 cases (25.1%), brain tissue was damaged in addition to cerebral hemorrhage. In 72 cases (18.7%) internal organ injury and internal bleeding, in 61 cases (15.8%) fractures of the extremities, in 17 cases (4.4%) vertebral fractures, and in 4 cases (1.0%) damage to the medulla spinalis were seen in addition to skull fractures (Graph 3). In 224 cases (58%), bone fractures were surgically intervened. In 162 cases (42%), non-surgical treatments were applied.



Graph 3. Findings Accompanying Head Bone Fracture

Of the cases, 269 (69.7%) were accidents and 117 (30.3%) were the result of effective actions such as fights, beatings and gunshot wounds. The most common cause of skull fractures was traffic accidents (n=217, 56.2%). 52 cases (13.5%) were injured as a

result of accidental fall from a height, 109 cases (28.2%) were injured as a result of assault involving contact with a hard object or ground, and 8 cases (2.1%) were gunshot wounds (Graph 1). All of the firearm cases were assault with a firearm and no suicide attempt or accidental incident was encountered. A significant relationship was found between origin and gender (P<0.001). 29% of male and 15.2% of female patients were injured as a result of effective action.

The most common fracture was the frontal bone (n=206, 53.4%). In 112 cases (29.0%), the frontal bone was fractured in isolation, in 76 cases (19.7%) the frontal and parietal bones were fractured together, in 18 cases (4.7%) the temporal and frontal bones were fractured together, and in 27 cases (7.0%) the temporal and parietal bones were fractured together. In 94 cases (24.4%) parietal bone, in 45 cases (11.6%) temporal bone and in 14 cases (3.6%) occipital bone were fractured in isolation. The distribution of fractured skull bones according to event types is presented in Table 3. It was determined that there was no significant correlation between the fractured bones and event types (P>0.05).

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4. Discussion

It is known that forensic injuries are mostly seen in males and in the young age group (16-19). Two different studies conducted in Çanakkale and Erzurum showed that boys were more frequently exposed to forensic injuries in childhood (20,21). In a study conducted in Sakarya in which 6,412 forensic cases were evaluated, it was reported that 72% of the cases were male and the mean age of the cases was 31.9 years (22). In a study conducted in Edirne, it was found that 78% of the forensic cases admitted to the emergency department were male and the mean age of the cases was 30.5 years (23). In a study by Adeleye et al. on head traumas, it was reported that males were exposed to head trauma three times more than females (24). Çırak et al. reported that 70% of the patients hospitalized in the Neurosurgery Clinic due to head trauma were male (25). In a study conducted in Taiwan, it was reported that 60% of patients with traumatic head bone fractures

were male (11). Akgül et al. reported that 75.5% of head trauma patients admitted to the emergency department were male and the mean age was 34 years (26). In the present study, in accordance with the literature, 294 (75.6%) of the cases were male and 92 (24.4%) were female and the mean age of the cases was 37±9.6 years. A significant relationship was found between gender and age group (P<0.001). While 24.1% of the male cases were under 18 years of age, only 7.6% of the female cases were under 18 years of age. It is thought that the reason for this is that boys are more involved in social life and are exposed to forensic injuries more than girls in our society.

In general, it is known that traffic accidents are the most common type of injury in forensic injuries involving all systems and body parts (6-18). It has also been reported that traffic accidents are one of the most common causes of head traumas (3,9,27-30). In a study conducted by Jha et al. in Nepal, it was reported that head trauma was the cause of death in 77 (62.1%) of 124 patients who died due to traffic accidents (31). In a study conducted in Ankara, it was found that the fatal injury was in the head region in 80.9% of the patients who died due to traffic accidents (32). In a study conducted in Eskişehir, it was reported that 72.4% of the patients who died due to traffic accidents had head trauma (33). In a study conducted by Işık et al. in Samsun, it was reported that 75% of the patients with head trauma evaluated in the Neurosurgery Clinic were admitted due to traffic accidents (9). In the present study, the most common cause of skull fractures was determined to be traffic accidents in accordance with the literature. In our study, 56.2% (n=217) of the patients had skull fractures as a result of traffic accidents. While 269 (69.7%) of the cases were accidents, 117 (30.3%) were the result of effective actions such as fights, beatings and gunshot wounds. 52 cases (13.5%) were injured as a result of a fall from a height, 109 cases (28.2%) were injured as a result of a beating involving contact with a hard object or floor, and 8 cases (2.1%) had gunshot wounds. A significant relationship was found between origin and gender (P<0.001). 29 % of the male and 15.2 % of the female cases were injured as a result of effective action. Injuries of males as a result of fight and effective action were found to be compatible with the forensic literature (13,14,16-18).

Assault has an important place in injuries related to forensic traumatology (16-19,34). In a study by Keleş et al. it was reported that 64% of 1280 patients who presented to the emergency department due to assault had head trauma (35). Injury may occur with many different mechanisms during assault. Fatal injuries may occur by hitting with a hard object or hitting a hard surface (34,36). Fractures in the skull bones, cerebral hemorrhage and brain tissue destruction may occur by hitting the head with a hard object or hitting the head with a hard object with kinetic energy (37). In the present study, 109 cases (28.2%) were found to have been injured as a result of beating involving contact with a hard object or the ground. In our study, a significant correlation was found between origin and gender (P<0.001). 29% of the male and 15.2% of the female patients were injured as a result of effective action. In a study in Kırıkkale in which emergency department admissions due to head trauma were evaluated, it was reported that 11% of male and 3.2% of female patients with head trauma presented due to assault (26). As in other forensic cases, assault injuries are more common in males.

One of the common causes of head trauma and skull fractures is falls (25,26,38). Factors such as the height of the fall, age of the person and body structure determine the damage to occur due to the fall (3). In a study conducted in Kahramanmaraş in which cases of death due to falling from a tree were evaluated, it was found that 76% of the cases had signs of head trauma and 57.1% had fractures in the skull bones (39). In a meta-analysis study conducted by Ongel et al. on falls, it was reported that the head region was injured most frequently (45.1%) due to falls (40). In a study conducted in Van, 44% of the patients admitted to the Neurosurgery Clinic because of head trauma were injured due to falls (25). In a study conducted in Minnesota in which head bone fractures were evaluated, it was reported that 36% of the cases were injured

due to falls (41). In the present study, it was found that 52 cases (13.5%) were injured as a result of falling from a height, fractures occurred in the skull bones and the origin of all fall cases was accidental.

Gunshot wounds to the head are usually fatal (42,43). In a study in which 21 cases of firearm injuries affecting the head region were evaluated, it was reported that 5 of the cases died, 5 remained bedridden and 11 recovered (44). In a study conducted in Erzurum in which gunshot wounds resulting in death were evaluated, it was reported that the most common injury occurred in the head region (45). In a study conducted in Şanlıurfa, it was reported that the fatal injury was in the head region in 48.2% of the patients who died due to firearm injuries (46). Bullets cause skull fracture, brain destruction and cerebral hemorrhage together (47). Since these injuries usually result in death, only 8 cases (2.1%) were found to have gunshot wounds in the present study. In the present study, fatal cases could not be included. These 8 cases had skull fractures due to gunshot wounds and recovered afterwards.

In the forensic report, it should be written in detail whether the injury causes life-threatening danger, whether it can be eliminated by simple medical intervention, the degree of bone fracture and its effect on life functions, whether it causes weakness or loss of function (48). These matters are important in terms of constituting the basis for the penalty to be imposed on the person who caused the injury. All these issues are included in the guideline for the evaluation of injury crimes in terms of forensic medicine in the Turkish Penal Code (15). In the present study, isolated fracture of the outer tabula of the frontal bone was found in 3 cases (0.8%). It was reported that these 3 cases were not life-threatening and caused injuries that could not be treated with simple medical intervention. In all other cases (n=383, 99.3%), it was reported that the injury was life-threatening and could not be treated with simple medical intervention. In 3 cases (0.8%) the effect of bone fracture on life functions was evaluated as 1 (Mild), in 141 cases (36.5%) as 3 (Moderate), in 68 cases (17.6%) as 4 (Severe), in 149 cases (38.6%) as 5 (Severe), in 25 cases (6.5%) as 6 (Severe). 6 cases (1.6%) were reported to have impaired function due to a 5-25 cm2 defect after skull fracture. No patient with loss of function due to skull fracture was found.

In studies on skull bone fractures, it has been reported that linear fractures are the most common fracture type in skull bone fractures because they require lower kinetic energy (3,41,49). In a study conducted in Minnesota in which 1097 cases with skull fracture were evaluated, it was reported that 585 (53%) of the cases had linear fractures (41). In a study conducted by Şimşek et al. with 152 patients with skull bone fractures, it was reported that 99 (65.1%) of the cases had linear fractures (3). In the present study, 54.1% (n=209) of the cases had linear fractures in accordance with the literature. There was no significant correlation between fractured bone and fracture types (P>0.05).

It was determined that the frontal bone was fractured most frequently (n=206, 53.4%). In 112 cases (29.0%), the frontal bone was fractured in isolation, in 76 cases (19.7%) the frontal and parietal bones were fractured together, and in 18 cases (4.7%) the temporal and frontal bones were fractured together. In a study by Şimşek et al. on head traumas, it was reported that the frontal bone was fractured most frequently (3). In a study by Dumitru et al. on frontal bone fractures, it was emphasized that frontal bones were more frequently affected by high-energy traumas such as traffic accidents (37). In the present study, 53.6% (60/112) of isolated frontal bone fractures occurred due to traffic accidents.

In our study, it was determined that skull bone fractures occurred most frequently in males, in the young adult age group, most frequently due to traffic accidents and in the form of linear fractures in the frontal bone. The findings were consistent with the literature. When preparing a forensic report on skull fractures, the location of the fracture, the type of fracture and the number of fractures are important in terms of determining the risk to life and the effect of the fracture on life functions. It is important for the relevant clinicians and radiologists to keep detailed

hospital notes in terms of forensic investigation. In forensic cases, it is important to perform a detailed examination, to perform the necessary examinations and to write an understandable forensic report in accordance with the guidelines as a result of the findings obtained, in terms of the rapid and correct functioning of the justice system. In life-threatening forensic cases such as skull fractures, the rapid and accurate preparation of forensic reports is an important part of a fair trial, which is the most fundamental right of individuals.

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Ethics

Ethics Committee Approval: The study was approved by Eskisehir Osmangazi University Noninterventional Clinical Research Ethical Committee (Decision no: 53, Date: 02.05.2024).
Informed Consent: This study did not require informed consent.
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