



## Evaluation of Children with Extremity Fracture Occurred as a Result of Motor Vehicle Injury

### Motorlu Taşıt Yaralanması Nedeniyle Ekstremitte Kırığı Gelişen Çocukların Değerlendirilmesi

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#### ABSTRACT

**Aim:** The aim of the study was to examine and evaluate patients with extremity fractures who admitted to the Pediatric emergency service due to a motor vehicle accident, whether there was any accompanying additional organ injury, and fracture patterns according to the severity of the trauma.

**Material and Method:** The study was conducted between January 2015 and 2020 retrospectively. Relevant data were analyzed with IBM SPSS V23 statistics.

**Results:** Of the 205.710 patients who admitted to Pediatric emergency service in the course of this study, 1.378 (0.66%) experienced motor vehicle injuries. 161 (0.08%) of these cases were evaluated on the grounds of extremity fractures. Mean age of the cases were 133 months (minimum: 3, maximum: 2018 months) and 90 (56%) cases were male. Trauma type was mostly outside-vehicle traffic accident (50%). 55% of the cases were severe mechanism of injury. The most common lower extremity fracture type was the tibia (26%) fracture. The most common fractures in the upper extremity were humerus (16%) and radius (16%) fractures. Of the patients with pelvis fracture, 65% had other types of organ injuries ( $p<0.05$ ). Surgical treatment was admitted to 68% of those with femoral fractures and 43% of those with tibia fractures ( $p <0.05$ ). While lower extremity fractures were more common in outside-vehicle traffic accident (66%) and motorcycle accident (60%), upper extremity fracture was more common in intra-vehicle traffic accident (54%) ( $p <0.05$ ).

**Conclusion:** Since the literature evaluating the extremity fractures in motor vehicle accidents is very limited, relevant data are also very limited. Extremity fractures that occur especially after motor vehicles are an important cause of injuries and deaths, and impose a heavy burden upon both families and the government in terms of hospital stay and hospital costs.

**Keywords:** Pediatric emergency, motor vehicle injury, extremity fractures

#### ÖZ

**Amaç:** Çocuk Acil Servise motorlu araç kazası nedeniyle başvuran ekstremitte kırığı mevcut olan hastaları, beraberinde ek organ yaralanması olup olmadığını, travmanın şiddetine göre kırık paternlerini inceleyip değerlendirmeyi amaçladık.

**Gereç ve Yöntem:** Ocak 2015 ve Ocak 2020 tarihleri arasında motorlu araç kazasıyla başvuran ekstremitte kırığı olan hastalarda retrospektif olarak yapılmıştır. Veriler IBM SPSS V23 ile analiz edildi.

**Bulgular:** Çalışma süresince Çocuk Acil Servise 205.710 hasta başvurmuş olup, 1.378 (% 0,66)'i motorlu taşıt yaralanmasıdır. Bu olgularında 161 (%0,08)'i ekstremitte kırığı nedeniyle değerlendirilmiştir. Olguların yaş ortalaması 133 ay (minimum:3; maksimum:218ay) dir ve 90 (%56) olgu erkektir. Travma şekli daha çok ADTK (%50) idi. %55 i yüksek enerjili travmaydı. Alt ekstremitte kırıklarından en sık görüleni tibia (%26) kırığıydı. Üst ekstremitede kırıklarından en sık görüleni humerus (%16) ve radius (%16) kırıklarıydı. Pelvis kırığı olan hastaların %65 inde başka organ yaralanması vardı ( $p<0,05$ ). Hastaların büyük kısmına (%66) tedavide atel uygulanırken, %26 sına cerrahi operasyon yapılmıştır. Femur kırığı olanların %68 ine, tibia kırığı olanların %43 üne cerrahi tedavi uygulandı ( $p<0,05$ ). Hastaların %50,3 ü acilden taburcu edildi. Alt ekstremitte kırığı ADTK (%66) ve motosiklet kazası (%60) sonucu daha çok görülürken, Üst ekstremitte kırığı AİTK (%54) sonucu daha çok görüldü ( $p<0,05$ ).

**Sonuç:** Motorlu taşıt kazalarında ekstremitte kırıklarının incelendiği literatür çok kısıtlı olduğundan, verilerde çok sınırlıdır. Özellikle motorlu araç sonrası gelişen ekstremitte kırıkları sakatlıklar ve ölümlerin önemli bir nedeni ve hastanede kalış ve hastane maliyeti açısından da hem ailelere hem de devlete ağır bir yük oluşturur.

**Anahtar kelimeler:** Çocuk acil, motorlu araç yaralanması, ekstremitte kırıkları

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## INTRODUCTION

Motor vehicle injuries are caused by motor-driven motorcycles, automobiles, trucks, minibuses, trains, trams, tractors, and land vehicles. Motor vehicle injuries play critical role in casualties and labor loss in developed and developing countries (1). Across the globe, due to trauma caused by motor vehicle injuries, more than 3.000 people die every day, and about 1.2 million people each year (2,3).

Of the emergency service applications in developing countries, 30-86% are due to trauma caused by motor vehicle injuries. Current data on injuries indicate that driving motor vehicle without helmet and seat belt accounts for more than 50% of driver casualties (4).

Serious injuries caused by motor vehicle accident are traumatic brain injury, spinal cord injury, generalized burns in the body, amputation and blindness (5). Fractures occur at a ratio of 10-25% among all childhood traumas. Occurrence frequency is 50% in boys and 30% in girls. Fracture pattern has a changeability depending on the countries, climatic characteristics and cultural features (6). Extremity fractures constitute 80-90% of all fractures. The type and pattern of extremity fractures also vary as per the age, mechanism of injury, and involvement of surrounding tissues (7). Bone periosteum of children are thicker, stronger, has a significant osteogenic potential, and are more active metabolically. In regard of these characteristics, children fractures are easier to heal. Thicker periosteum prevents fracture displacement and compound fractures (8).

Extremity fractures caused by motor vehicle accidents are essential as they can lead to morbidity and disabilities. Lower extremity fractures, upon which limited number of studies were conducted in literature, were analyzed in one of the studies evaluating few adult and pediatric patients. Of the samples, most of them were adults between the ages of 20-40, stressing the fact that this is due to population being consisted of actively working adults who have a higher potential to use motor vehicles.

In this study, we conducted a retrospective analysis regarding the patients with extremity fractures who admitted to the Pediatric emergency service due to a motor vehicle accident, whether there was any accompanying additional organ injury, and fracture patterns according to the severity of the injury, and aimed to emphasize the importance of protective and preventive measures and equipment and traffic rules to prevent mortality and disabilities.

## MATERIAL AND METHOD

### Study Design

This study was conducted retrospectively between January 2015 and 2020 at urban, tertiary pediatric emergency service. Ethics committee approval was

received by the medical faculty scientific research ethics committee prior to the study (No: 09.05.2020/ 91610558-604.01.02-).

### Patient Selection and Data Collection

All patients younger than 18 years old with a fracture of an extremity due to a motor vehicle accident who admitted directly or brought by ambulance to the pediatric emergency service were included in the study. Demographic data of the patients such as age, gender, type of trauma, fracture extremity, fracture type, number of fractures, treatment and follow-up were recorded.

### Definitions

Motor vehicle injuries are injuries caused by motor-driven motorcycles, automobiles, trucks, minibuses, trains, trams, tractors, and land vehicles (9).

Severe mechanism of injury is defined as overturning as a result of a motor vehicle accident, ejection from the vehicle, having a casualty inside the vehicle, collapse failure of more than 50 cm on the driver's side, collapse failure of more than 30 cm on the passenger side, being stuck the vehicle for more than 20 minutes, motorcycle accident without helmet, running down a pedestrian with a vehicle or a motorcycle, and speeding up to 65 km/h (10).

Multiple fractures are evaluated as the presence of more than one long bone fracture in the patient.

### Statistical Analysis

Data were analyzed with IBM SPSS V23 statistics. Chi-square and One-way Anova tests were used in the comparison of categorical data. T test was used in the comparison of ages of the patients. Analysis results were presented as frequency (percentage) for categorical data, mean and standard deviation for numerical data. Significance level was taken as  $p < 0.05$

## RESULTS

Of the 205.710 patients who admitted to Pediatric emergency service in the course of this study, 1.378 (0.66%) were motor vehicle injuries. 161 (0.08%) of these cases were evaluated on the grounds of extremity fractures (**Figure 1**). Mean age of the cases were 133 months (minimum: 3, maximum: 2018 months) and 90 (56%) cases were male. Demographic information of the patients who constitute the study group were presented in **Table 1**.

Of the patients, 52% (80) had low extremity fracture localization. The most common lower extremity fracture type was the tibia (26%) fracture, followed by femoral ( $n=28$ , 17%), fibula ( $n=28$ , 17%), and pelvis fractures ( $n=20$ , 12%) respectively. The most common upper



Table 1: Demographic data of the patients		
Age (months) min-max	130±59.6 (3-218)	
<b>Gender</b>	<b>n (%)</b>	
Male	90 (56)	
Female	71 (44)	
<b>Application time</b>		
08:00-16:00	63 (39)	
16:00-00:00	79 (49)	
00:01-07:59	15 (9)	
<b>Trauma types</b>		
Intra-vehicle traffic accident	71 (44)	
Outside-vehicle traffic accident	80 (50)	
Motorcycle	10 (6)	
<b>Severe mechanism of injury</b>		
Yes	89 (55)	
No	72 (45)	
<b>Type of Severe mechanism of injury</b>		
Overturing as a Result of a Motor Vehicle Accident	21 (13)	
Ejection from the vehicle	7 (4)	
Casualty status	12 (8)	
Collapse failure of more than 50 cm	3 (2)	
Collapse failure of more than 30 cm on the passenger side	2 (1)	
Being stuck in the vehicle for more than 20 minutes	4 (3)	
Motorcycle Accident without Helmet	4 (3)	
Running Down a Pedestrian With a Vehicle or a Motorcycle	15 (9)	
Speeding up to 65 km/h	21 (13)	
<b>Fracture Localization</b>		
Upper	67 (42)	
Lower	84 (52)	
Upper and lower extremity	10 (6)	
<b>Fracture Type</b>		
Compound Fracture	6 (4)	
Closed Fracture	153 (95)	
Compound+closed fracture	2 (1)	
<b>Checkup</b>		
Discharged from emergency department		
Yes	81 (50.3)	
No	80 (49.7)	
<b>Follow-up in other units</b>		
Pediatrics	4 (3)	
Pediatric intensive care	13 (8)	
Orthopedics	34 (21)	
Pediatric surgery	17 (11)	
<b>Treatment</b>	<b>Yes n (%)</b>	<b>No n (%)</b>
Air Splint	106 (66)	55 (34)
Plaster	22 (14)	139 (86)
Surgery	42 (26)	119 (74)
<b>Other organ injury</b>	<b>Yes n (%)</b>	<b>No n (%)</b>
Liver	14 (9)	147 (91)
Spleen	4 (2.5)	157 (97.5)
Lungs	23 (14)	138 (86)
Intestines	1 (1)	160 (99)
Stomach	0 (0)	161 (100)
Pancreas	7 (4)	154 (96)
Kidney	1 (1)	160 (99)
Central Nervous System	4 (2.5)	157 (97.5)

extremity fracture type was humerus (n=26, 16%) and radius (n=26, 16%) fractures, followed by clavícula (n=23, 14%) and ulna (n=8, 5%) fractures respectively. While shaft fractures were more common in femoral fracture type, distal fractures were more common in the tibia and fibula fracture types, and proximal fractures were more common in the humerus fracture types (Figure 2, 3).

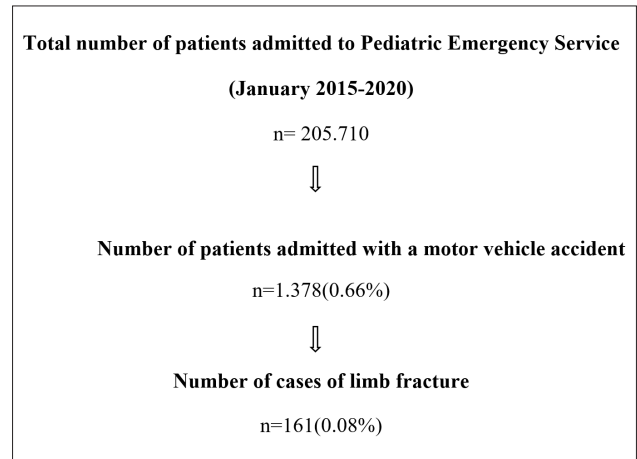


Figure 1. Patients Admitted to Pediatric Emergency Service

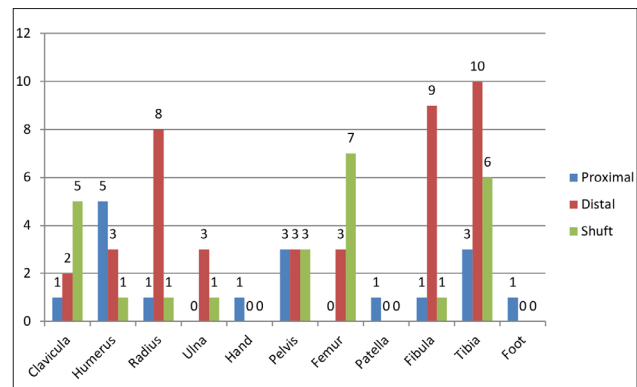


Figure 2. Extremity bone fracture incidence ratio for the right side (%)

\*Total ratio for Patella, Hand, and Foot were indicated in the proximal part, without distinction of proximal, distal, shaft fractures.

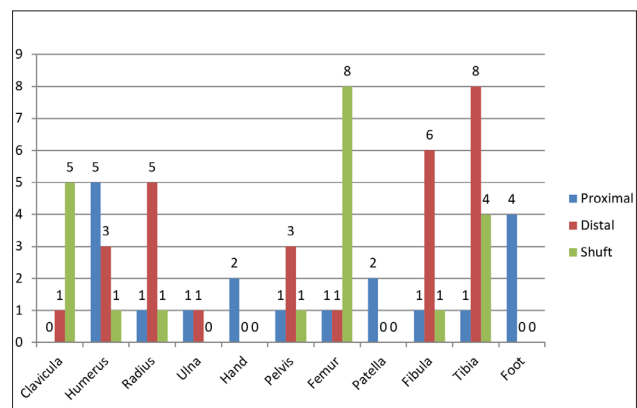


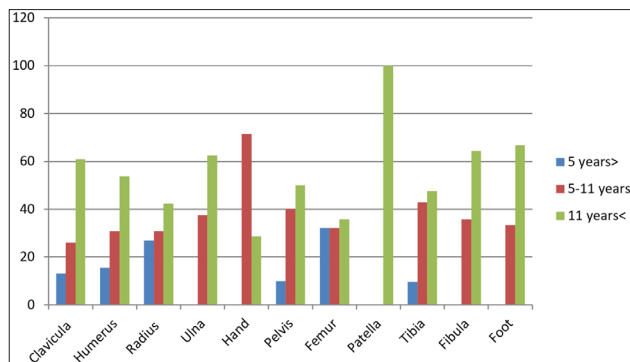
Figure 3. Extremity bone fracture incidence ratio for the left side (%)

\*Total ratio for Patella, Hand, and Foot were indicated in the proximal part, without distinction of proximal, distal, shaft fractures.



Evaluating the fracture localization as per the age groups, it was observed that the upper extremity fractures in 13 (50%) patients under the age of 5 were more common while lower extremity fractures in 29 (54.7%) patients aged 5-11 and 44 (53.4%) patients over the age of 11 were more common. Of the patients with lower extremity fractures, 44 (52.4%) consisted of children over the age of 11 (**Table 2**). The ratio of all the fracture types were more common in children over the age of 11 (**Figure 4**).

Age Groups	Fracture localization			p
	Upper Extremity n (%)	Lower Extremity n (%)	Both n (%)	
5 years >				0.109
yes	13(19.4)	11(13.1)	2(20)	
no	54(80.6)	73(86.9)	8(80)	
5-11 y				0.080
yes	20(29.9)	29(34.5)	4(40)	
no	47(69.1)	55(65.5)	6(60)	
11y<				0.076
yes	34(50.7)	44(52.4)	4(40)	
no	33(49.3)	40(47.6)	6(60)	



**Figure 4.** Extremity bone fractures by age groups (%)

Femoral, pelvis, fibular fractures and other organ injuries were statistically significantly high in the patients who admitted hospitals due to severe mechanism of injury ( $p < 0.05$ ). Additionally, 83% of the compound fractures occurred due to severe mechanism of injury (**Table 3**).

While upper extremity fractures were statistically significantly high in severe mechanism of injury patient group who experienced overturning as a result of a motor vehicle accident, ejection from the vehicle, and those who had a casualty inside the vehicle; lower extremity fractures were more common in the patient groups who experienced motorcycle accident without helmet, pedestrian versus motor vehicle accident and

those speeding up to 65 km/h ( $p < 0.05$ ). While most of the patients who had upper extremity fractures were treated with air splint or encased in plaster, lower extremity fracture cases required surgical treatment (**Table 4**).

Of the patients with femoral fracture, 68% were surgically treated ( $p < 0.05$ ). The ratio of other organ injuries occurred in the patients with pelvis fracture were 65 % ( $p < 0.05$ ) (**Table 5**).

**Table 3. The relationship between severe mechanism of injury and fracture location, fracture type, and other organ injury**

	Severe mechanism of injury		p
	Yes n (%)	No n (%)	
Femoral fracture			0.006
Yes	22(25)	6 (8)	
No	67(75)	66 (92)	
Pelvis fracture			0.001
Yes	18(20)	2 (3)	
No	71(80)	70 (97)	
Other organ injury			<0.001
Yes	42(47)	9 (13)	
No	47(53)	63 (87)	
Tibia fracture			0.060
Yes	18(20)	24(33)	
No	71(80)	48(67)	
Fibula fracture			0.007
Yes	9(10)	19(26)	
No	80(90)	53(74)	
Humerus fracture			0.118
Yes	18(20)	8(11)	
No	71(80)	64(89)	
Radius fracture			0.483
Yes	16(18)	10(14)	
No	73 (82)	62(86)	
Ulna fracture			0.299
Yes	3(3)	5(7)	
No	86(97)	67(93)	
Multiple fracture			0.332
Yes	35(39)	23(32)	
No	54(61)	49(68)	
Compound Fracture	5(6)	1(1)	0.574
Closed Fracture	82(92)	71(99)	
Compound+closed fracture	2 (2)	0(0)	
Total	89	72	



**Table 4. Comparison of fracture location and severe mechanism of injury type and treatment modality**

Type of severe mechanism of injury	Fracture localization Upper ext.	Lower ext.	Upper+lower ext.	p
Overturning as a result of a motor vehicle accident	11(52)	9(43)	1(5)	0.028
Ejection from the vehicle,	4(57)	3(43)	0(0)	
Casualty status	7(58)	3(25)	2(17)	
Collapse failure of more than 50 cm	1(33)	1(33)	1(33)	
Collapse failure of more than 30 cm on the passenger side	1(50)	0	1(50)	
Being stuck in the vehicle for more than 20 minutes	0	2(50)	2(50)	
Motorcycle accident without helmet	1(25)	3(75)	0	
Running down a pedestrian with a vehicle or a motorcycle	6(40)	8(53)	1(7)	
Speeding up to 65 km/h	3(14)	17(81)	1(5)	
Treatment modality				
Air Splint				
Yes	51(76)	47(56)	8(80)	
No	16(24)	37(44)	2(20)	
Plaster				
Yes	6(9)	14(17)	2(20)	
No	61(91)	70(83)	8(80)	
Surgical Treatment		29(35)		
Yes	6(9)	55(65)	7(70)	
No	61(91)		3(30)	

**Table 5. Correlation of fracture location and surgical treatment.**

Fracture localization	Surgical Treatment		p
	Yes n (%)	No n (%)	
Femoral fracture			<0.001
Yes	19(68)	9(32)	
No	23(17)	110(83)	
Tibia fracture			0.004
Yes	18(43)	24(57)	
No	24(20)	95(80)	
Pelvis fracture			0.670
Yes	4(20)	16(80)	
No	3(2)	138(98)	

## DISCUSSION

Motor vehicle accidents have an important place among childhood traumas and they are the leading cause of death in children aged 2-14 years in developed countries (11). Motor vehicle accidents consist of 30% of the trauma-related casualties aged between 0-19 (12). Fractures are common among injuries in the childhood age group (13). Extremity fractures are among the most common reasons for hospitalization in children (14). While there were not many articles previously studying extremity fractures occur in motor vehicle accidents, in the present study, male dominance (56%) was observed in line with the results of studies evaluating childhood fractures (15,6).

Lower extremity fractures constitute approximately 20% of all fractures occur in children and may cause significant mortality and morbidity (16). In the study of Ngunde et al., the incidence ratio of lower extremity fractures in

patients experienced a motor vehicle accident was found to be 35% (4). In a study conducted with adult patients, the lower extremity fracture was detected 3 times more than the upper extremity fracture occurred in motor vehicle accident (3). Of the patients included in this study, 52% had lower extremity fracture. Evaluating the age groups, lower extremity fracture was mostly seen in the patient group over 11 years of age. We can conclude that in conjunction with the growth, children will be as tall as the vehicles and along with it, lower extremity risk also increases.

Lower extremity fractures were also significantly higher in patients who admitted to hospital for severe mechanism of injury (particularly a motorcycle accident without a helmet, running off a pedestrian, speeding up to 65 km / h). In line with the literature, mostly tibia fracture (26%) was observed in the lower extremity (15,17).

In accordance with the literature (18), shaft fractures were more common in the femur, while distal fractures were prominent in the tibia and fibula. In addition, femoral fractures caused by a motor vehicle accident were mostly treated surgically in this study, as was detected in other studies conducted (19).

43% of tibia fractures required surgical operation. For that reason, it is of great importance that the parents adhere to the traffic rules, display sensitivity as regards the safety equipment such as safety belt, helmet, and bring them to bear on their children without compromising.

Pediatric pelvic fractures occur in 0.2% to 2% of all pediatric fractures and usually occur due to severe mechanism of injury (20). Of the patients included in





this study, 12% had pelvis fracture, and pelvis fractures occurred in 90% of the patients as a result of severe mechanism of injury in accordance with the literature (21,22). Pediatric pelvis fractures usually heal without needing a surgical operation (23,24). Of the patients included in a study evaluating pelvis fractures, 94% healed without needing a surgical operation. In this study, in line with the literature, 80% of the patients were treated without surgical operation (25). Although it is a common fact that pelvis fractures heals itself without needing a surgical operation, it should not be forgotten that bleeding risk is considerably high and usually conveys other organ injuries (26). In the present study, in line with the literature (27), the ratio of other organ injuries was found 65% while multiple fracture ratio was found 25%.

In other studies evaluating childhood extremity fractures, the upper extremity fracture was more prominent than the lower extremity fracture. It can be concluded that this is because not only motor vehicle accidents but all traumas were evaluated in the study (16). In this study, it was found that most common upper extremity fractures (with a ratio of 42%) were humerus (26%) and radius (26%) fractures, followed by clavicle (14%) and ulna (5%) fractures respectively. In another study evaluating other motor vehicle accidents<sup>6</sup>, clavicle was more common, while in another study evaluating upper extremity fractures (3), it was found that radius (27%) was the most common fracture type, followed by humerus (25%), ulna (18%), and clavicle (17%) fractures respectively. In a study evaluating upper extremity fractures with adult patient groups (28), humerus (44%) and ulna (28%) fractures were the most common fracture types.

Multiple fractures are mostly associated with severe mechanism of injury, and their incidence ratio varies between 1.7 to 23% in the pediatric age group.<sup>3</sup> In this study, approximately 1/3 of the patients had multiple fractures and of this cases, 60% had severe mechanism of injury. Patients with upper extremity fractures were mostly treated with plaster and air splint, while patients with lower extremity and multiple fractures were treated mostly with surgical operations.

Compound fractures have considerably high morbidity and mortality possibilities requiring patient to be hospitalized longer along with the high hospitalization costs. Of the compound fractures, 90% occur as a result of traffic accident. Risk of contamination, infection, nonunion of the fracture, risk of delayed union, neurovascular complications and increased amputation rate increase the significance of the compound fractures for the childhood age group (29). In this study, the ratio of compound fractures was found to be 4%. Of these fracture incidences, 83% occurred as a result of severe mechanism of injury.

The most substantial limitation is that the study was conducted in a single center. Multi-centered studies are required.

## CONCLUSION

Since the literature analyzing extremity fractures in motor vehicle accidents is very limited, relevant data are also very limited in this regard. In particular, extremity fractures, injuries and additional organ injuries that develop after motor vehicles create a heavy burden on both families and the government in terms of hospitalization and hospital costs, resulted by a critical ratio of casualties. On that account, collecting relevant data of this group of patients is of very high concern in terms of the management of this group of patients, taking precautions to prevent traffic accidents and narrating traffic rules to parents and children via their parents.

## ETHICAL DECLARATIONS

**Ethics Committee Approval:** Ethics committee approval was received by the medical faculty of Gazi University scientific research ethics committee prior to the study (No: 09.05.2020/ 91610558-604.01.02-).

**Informed Consent:** Informed consent forms were obtained from the parents of the patients and controls included in this study.

**Referee Evaluation Process:** Externally peer-reviewed.

**Conflict of Interest Statement:** The authors have no conflicts of interest to declare.

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**Author Contributions:** All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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