Int J Burn Trauma 2022;12(4):175-179
www.IJBT.org /ISSN:2160-2026/IJBT0143340

Original Article

Traumatic brain injuries in children during COVID-19 pandemic: a national report from northern Iran

Zoheir Reihanian[1], Nazanin Noori Roodsari[2], Siamak Rimaz[3], Payman Asadi[4], Naghmeh Khoshsima[5], Aryan Rafiee Zadeh[6], Seyyed Mahdi Zia Ziabari[4], Habib Eslami-Kenarsari[7], Elahe Abbaspour[3]

[1]Road Trauma Research Center, Department of Neurosurgery, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran; [2]Clinical Research Development Unit of Poursina Hospital, Department of Emergency Medicine, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran; [3]Guilan Road Trauma Research Center, Guilan University of Medical Sciences, Rasht, Iran; [4]Department of Emergency Medicine, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran; [5]Department of Neurosurgery, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran; [6]School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran; [7]MSc in Biostatistics, Vice-Chancellor for Resaerch and Technology, Guilan University of Medical Sciences, Rasht, Iran

Received April 5, 2022; Accepted August 15, 2022; Epub August 15, 2022; Published August 30, 2022

Abstract: Background: Evidence suggests that referral cases of traumatic injuries have decreased during the COVID-19 pandemic both in childhood and in adulthood. Still we have very little evidence of referrals due to traumatic brain injury among children during the COVID-19 outbreak. The present study aimed to describe epidemiological and clinical features of pediatric traumatic brain injuries. Methods: This cross-sectional study was performed on all patients under 15 years with any evidence of head trauma, referring to Poursina teaching hospital, a referral center for trauma and road accidents in northern Iran. The patients' data were retrospectively collected by reviewing the hospital recorded files and the trauma-specific hospital information system. Results: Of all 543 pediatric traumatic injuries referred to our hospital during the two pointed periods, 166 had any evidence of head and neck injuries leading to an overall prevalence rate of 30.6%. In this regard, the prevalence rate of head/neck injuries was estimated to be 140 out of 436 within a pre-COVID-19 period (32.1%) and 26 out of 107 within the COVID-19 period (24.3%) indicating no significant difference between the two time periods (P = 0.243). However, assessing the rate of head/neck injuries pre-COVID-19 and COVID-19 periods according to patients' age showed a higher rate of such injuries in pre-COVID-19 as compared to COVID-19 periods in patients aged less than two years (55.6% versus 37.5%, P = 0.013) as well as aged 2 to six years (45.8% versus 30.0%, P = 0.036). Conclusion: The rate of admission of children due to traumatic brain injury during the COVID-19 period does not show a significant change compared to before, and only in children under 6 years of age a decrease in referrals due to brain trauma during the COVID-19 period was observed.

Keywords: COVID-19, trauma, brain injury

Introduction

Traumatic brain injury is certainly a leading cause of raised mortality and morbidity among children [1]. Like adults, a wide range of sequels have been identified following brain injury in children but differ in epidemiological, pathophysiological and managerial aspects. Such differences can be due to the differences in mechanisms of injury and skeletal and neurological structural differences in children as compared to adults [2, 3]. As the main difference, children have a highly vascularized scalp predisposed to lethal vascular injuries. Thus, massive blood loss that even a slight blood loss in younger children, may lead to hemorrhagic shock [4]. In addition, types and mechanisms of trauma may also be different that due to the lower presence of children in outdoor or school environments, absence from the scene of conflict, or exposure to workplace injuries, these cases are less in children, but the chances of trauma due to falls from heights or road accidents may be higher [5, 6]. Accordingly, diag-

nosing and managing such traumas in children requires specific instructions and administrators and unique treatment compared to adults.

A review of reports presented in different communities reveals significant differences in the rate of traumatic brain injury in different drawers, which can be rooted in racial characteristics (skeletal structure) and different social and cultural conditions of communities [7]. According to the recent reports of the U.S. Centers for Disease Prevention and Control, about 475,000 children aged lower than 15 years sustain a traumatic brain injury each year, 90% are discharged with mild sequels, 37,000 require hospitalization and 2600 die due to severity of injuries [8]. In this regard, the global death rate due to trauma in children has been estimated to be 5 per 100,000 annually, even higher in younger children [9]. The mechanisms of brain injuries can also be variants according to the patient's age so that falling from a height seems to be higher among children younger than 4 years, transportation-related injuries are higher in children 10 to 18 years, and abusive head trauma in children less than two years [10].

The prevalence, mechanism and outcome of head trauma can also be affected by social and environmental conditions. These differences are quite noticeable in certain health conditions. For example, in the event of pandemics, due to exceptional quarantine conditions and reduced intra-city traffic, another layer of traumatic brain injury is depicted in both children and adults [11]. In the context of infectious pandemics and due to the increased risk of nosocomial and opportunistic infections, complications from traumatic brain injuries especially in hospitalized patients may also considerably increase [12].

The COVID-19 pandemic significantly changed healthcare regulations, diagnostic and therapeutic approaches, patient admission rate for treatment or selection of invasive methods and total healthcare utilization patterns and clinical practice. Trauma injuries are no exception to this rule, and this issue has received much more attention, especially in the case of children [11]. Which extent the onset of the COVID-19 pandemic has changed the epidemiological patterns of traumatic brain injuries remains unclear. Thus, the present study aimed to describe epidemiological and clinical features of pediatric traumatic brain injuries in patients referring to a great referral center in northern Iran.

Methods and material

Study design

This cross-sectional study was performed on all patients aged lower than 15 years with any evidence of head trauma, referring to Poursina teaching hospital, a referral center for trauma and road accidents in northern Iran. The study protocol was approved by the Research Committee of Guilan University of Medical Sciences and the Ethics committee has confirmed it (Ethics code: IR.GUMS.REC.1400.099).

Inclusion and exclusion criteria

Inclusion criteria were age under 15 years, traumatic head events of any kind leading to hospitalization, and signing the written informed consent by the parents to participate in this study. The exclusion criteria were previous traumatic evets, patient's will to exit the study, defect in patient's data of more than 20%, and unavailability of the patient for further assessments and follow-up.

Study population

Overall, of 543 children with traumatic injuries, 166 (30.6%) had evidence that brain injuries (head and/or neck trauma) were ultimately included in the study. Of those, 140 children were referred before the COVID-19 pandemic period (the first six months of 2019) and 26 within the pandemic period (the first six months of 2020). Most of The children we studied were male (70.5%) and between 2 to 6 years old. Falling was the highest causes and of head trauma (45.5%) and also mechanism of trauma was blunt mostly. The BMI was in normal Range in 73.3% of cases.

Data collection

The patients' data were retrospectively collected by reviewing the hospital recorded files and the hospital information system, especially the

Table 1. Baseline characteristics of in patients in the two-time periods

Item	Before pandemic (n = 140)	Within pandemic (n = 26)	*P* value
Age subgroups			
Less than 2 years	28 (20.0)	5 (19.2)	0.778
2 to 6 years	42 (30.0)	8 (30.8)	
7 to 12 years	42 (30.0)	8 (30.8)	
13 to 15 years	28 (20.0)	5 (19.2)	
Gender			
Male	98 (70.0)	18 (69.2)	0.891
Female	42 (30.0)	8 (30.8)	
Body mass index			
Less than 18.5 kg/m^2	11 (7.8)	2 (7.7)	0.786
19 to 25.9 kg/m^2	104 (74.3)	19 (73.1)	
26 to 29.9 kg/m^2	11 (7.8)	3 (11.5)	
≥ 30 kg/m^2	14 (10.1)	2 (7.7)	
Mechanisms of trauma			
Falling from a height	45 (32.1)	8 (30.8)	0.665
Accidents	84 (60.0)	15 (57.7)	
Quarrel	5 (3.7)	2 (7.7)	
Sport trauma	3 (2.1)	1 (3.8)	
Cutting	3 (2.1)	0 (0.0)	
Type of trauma			
Penetrating	14 (10.0)	5 (19.2)	0.456
Blunt	126 (90.0)	21 (80.8)	

trauma-specific hospital information system. The data collected included demographic characteristics, anthropometric parameters, and the causes and mechanisms of trauma. The study endpoint assessed and compared different epidemiological and clinical aspects of traumatic brain injuries in children between the COVID-19 pandemic area and before.

Statistical analysis

The quantitative variables were presented as mean ± standard deviation and categorical parameters as number (percentage). The quantitative data of trauma at the different time points were assessed by t test or Man-Whitney U test and the qualitative variables by the Chi-Squares test. *P* values of ≤ 0.05 were considered statistically significant. For the statistical analysis, the statistical software SPSS version 23.0 for windows (IBM, Armonk, New York) was used.

Results

Injury distribution

Of all 543 pediatric traumatic injuries referred to our hospital during the two pointed periods, 166 had any evidence of head and neck injuries leading to an overall prevalence rate of 30.6%. In this regard, the prevalence rate of head/neck injuries was estimated to be 140 out of 436 within a pre-COVID-19 period (32.1%) and 26 out of 107 within the COVID-19 period (24.3%), indicating no significant difference between the two time periods (P = 0.243). Comparing baseline characteristics (including gender, age, and body mass index) of patients with head/neck injuries between the two time periods showed no difference (P > 0.05) (**Table 1**).

Injury rates before and after COVID-19

Assessing the rate of head/neck injuries pre-COVID-19 and COVID-19 periods according to patients' age showed a higher rate of such injuries in pre-COVID-19 as compared to COVID-19 periods in patients aged less than two years (55.6% versus 37.5%, P = 0.013) as well as aged 2 to 6 years (45.8% versus 30.0%, P = 0.036), but without any difference in higher ages (**Table 2**).

Further assessments

No difference was revealed in the head/neck injuries before and during COVID-19 period in both male and female patients (**Table 2**). We showed also no difference in the rate of head/neck injuries between the two time periods of study considering patients' body mass index (**Table 2**).

Discussion

Evidence suggests that referral cases of traumatic injuries have decreased, both in childhood and in adulthood during the COVID-19 pandemic [13-15]. Still we have very little evidence of referrals due to trauma to the brain and nervous system particularly among children. We mentioned in the present study that, firstly, despite the decrease in the total number of traumatic injuries, it seems that the number of referrals due to traumatic brain injury in children during the COVID-19 period did not change

Table 2. The prevalence of head/neck injuries according to baseline variables

Item	Before pandemic (n = 140)	Within pandemic (n = 26)	*P* value
Age subgroups			
Less than 2 years	63 (55.6)	9 (34.6)	0.013
2 to 6 years	59 (45.8)	9 (34.6)	0.036
7 to 12 years	13 (20.3)	7 (26.9)	0.779
13 to 15 years	5 (3.5)	1 (3.9)	0.852
Gender			
Male	93 (66.4)	17 (65.4)	0.226
Female	47 (33.6)	9 (34.6)	0.508
Body mass index			
Less than 18.5 kg/m^2	12 (8.6)	2 (7.7)	0.753
19 to 25.9 kg/m^2	106 (75.7)	19 (73.1)	0.126
26 to 29.9 kg/m^2	20 (14.3)	4 (15.4)	0.786
≥ 30 kg/m^2	2 (1.4)	1 (3.8)	0.287

significantly compared to the pre-COVID-19 period.

In order to find more sequela related to traumatic brain injury in children, we are following our patients yet and visiting them in clinics in regular periods, and will release these data soon. These evaluated sequela include cognitive deficits, changes in personality and psychiatric disorders like insomnia, anxiety, aggression, depression. However, our findings until now shows no significant difference in comparison with other studies.

Based on the findings of our study, there were no differences between pre and post-COVID-19 pandemics regarding prevalence rate of head/neck injuries. We also showed that distribution of our pediatric patients due to brain injury were completely independent of the patient's gender, age, or body mass index. However, we find out another important point: among patients under two years, the number of referrals to medical centers due to traumatic brain injuries in the pre-COVID-19 period was significantly higher in comparison with similar cases in the COVID-19 pandemic. This can be due to the fact that families pay attention to preschool children during the Covid era. The inactivity of many parents outside the home is significantly reduced trauma injuries. In general, due to the lack of reduction in the rate of referrals due to traumatic brain injury during the COVID-19 period, an increase in pediatric referrals due to such injuries during the COVID-19 and post-COVID-19 periods is still expected and steps should be taken to establish guidelines related to managing these injuries.

This study should be considered the first study on the epidemiology of traumatic brain injury among children during an epidemic in a community with a high prevalence of COVID-19 and its successive waves. Similar studies in adults could show changes in neurosurgical referrals for traumatic brain injuries during the pandemic worldwide. The studies could report lowering referral volumes of traumatic brain injuries during the lockdown compared with previous years and months [16, 17]. For instance, studies on adults showed a significant decrease in brain traumas due to road accidents during lockdowns as compared to pre-COVID-19 periods [11, 18, 19].

As a final point, and of course, a significant point about brain trauma in children, special attention has been paid to the increase in trauma caused by abuse among children during the COVID-19 period, which was not the subject of our study. As an interesting observation, Christopher De Boer and colleagues [20] indicated that although the number of children with physical child abuse presenting to children's hospitals significantly declined during the COVID-19 pandemic, those that did were more likely to be severe. However, Mark L Kovler and others [21] indicated an increase in the proportion of traumatic injuries caused by physical child abuse during the COVID-19 pandemic. Even in this particular case, the information is completely contradictory, and the need for further studies is essential.

The shortcomings of this study were limited study population and conducting this study in a single center. Multi-centric studies on larger populations could provide data with higher significance.

Conclusion

The rate of traumatic brain injury in children does not show a significant change during the COVID-19 period, but in children under six years of age a decrease in referrals was observed. This can be due to parents keeping pre-school children at home and more supervision of the family due to the limitation of parents' work outside the home.

Disclosure of conflict of interest

None.

Address correspondence to: Seyyed Mahdi Zia Ziabari, School of Medicine, Guilan University of Medical Sciences, No. 8 Imam Reza Blvd., Rasht, Guilan, Iran. Tel: +989111375056; Fax: +98-3137265007; E-mail: smzz102186@gmail.com

References

[1] Ahmad FB and Anderson RN. The leading causes of death in the US for 2020. JAMA 2021; 325: 1829-1830.
[2] Miller GF, DePadilla L and Xu L. Costs of nonfatal traumatic brain injury in the United States, 2016. Med Care 2021; 59: 451-455.
[3] Peterson AB and Thomas KE. Incidence of nonfatal traumatic brain injury-related hospitalizations-United States, 2018. Morb Mortal Wkly Rep 2021; 70: 1664.
[4] Misrahi S and Reuter-Rice K. Transcranial Doppler ultrasound use in pediatric patients with penetrating traumatic brain injuries. J Radiol Nurs 2020; 39: 39-43.
[5] Baumgartner JE, Baumgartner LS, Baumgartner ME, Moore EJ, Messina SA, Seidman MD and Shook DR. Progenitor cell therapy for acquired pediatric nervous system injury: traumatic brain injury and acquired sensorineural hearing loss. Stem Cells Transl Med 2021; 10: 164-180.
[6] Serpa RO, Ferguson L, Larson C, Bailard J, Cooke S, Greco T and Prins ML. Pathophysiology of pediatric traumatic brain injury. Front Neurol 2021; 12: 696510.
[7] Sarnaik A, Ferguson NM, O'Meara A, Agrawal S, Deep A, Buttram S, Bell MJ, Wisniewski SR, Luther JF and Hartman AL. Age and mortality in pediatric severe traumatic brain injury: results from an international study. Neurocrit Care 2018; 28: 302-313.
[8] Bandyopadhyay S, Kawka M, Marks K, Richards GC, Taylor EH, Sravanam S, Petrinic T, Thango N, Figaji A and Peter N. Traumatic brain injury-related pediatric mortality and morbidity in low-and middle-income countries: a systematic review. World Neurosurg 2021; 153: 109-130, e123.
[9] Dewan MC, Mummareddy N, Wellons JC 3rd and Bonfield CM. Epidemiology of global pediatric traumatic brain injury: qualitative review. World Neurosurg 2016; 91: 497-509, e491.
[10] Chen C, Peng J, Sribnick EA, Zhu M and Xiang H. Trend of age-adjusted rates of pediatric traumatic brain injury in US emergency departments from 2006 to 2013. Int J Environ Res Public Health 2018; 15: 1171.
[11] Keays G, Friedman D and Gagnon I. Injuries in the time of COVID-19. Health Promot Chronic Dis Prev Can 2020; 40: 336-341.
[12] Pinggera D, Klein B, Thomé C and Grassner L. The influence of the COVID-19 pandemic on traumatic brain injuries in Tyrol: experiences from a state under lockdown. Eur J Trauma Emerg Surg 2021; 47: 653-658.
[13] Lester A, Leach P and Zaben M. The impact of the COVID-19 pandemic on traumatic brain injury management: lessons learned over the first year. World Neurosurg 2021; 156: 28-32.
[14] Abdulazim A, Ebert A, Etminan N, Szabo K and Alonso A. Negative impact of the COVID-19 pandemic on admissions for intracranial hemorrhage. Front Neurol 2020; 11: 584522.
[15] Figueroa JM, Boddu J, Kader M, Berry K, Kumar V, Ayala V, Vanni S and Jagid J. The effects of lockdown during the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic on neurotrauma-related hospital admissions. World Neurosurg 2021; 146: e1-e5.
[16] Jayakumar N, Kennion O, Villabona AR, Paranathala M and Holliman D. Neurosurgical referral patterns during the coronavirus disease 2019 pandemic: a United Kingdom experience. World Neurosurg 2020; 144: e414-e420.
[17] Coimbra R, Edwards S, Kurihara H, Bass GA, Balogh ZJ, Tilsed J, Faccincani R, Carlucci M, Martínez Casas I and Gaarder C. European Society of Trauma and Emergency Surgery (ESTES) recommendations for trauma and emergency surgery preparation during times of COVID-19 infection. Eur J Trauma Emerg Surg 2020; 46: 505-510.
[18] Murphy T, Akehurst H and Mutimer J. Impact of the 2020 COVID-19 pandemic on the workload of the orthopaedic service in a busy UK district general hospital. Injury 2020; 51: 2142-2147.
[19] Lund EM, Forber-Pratt AJ, Wilson C and Mona LR. The COVID-19 pandemic, stress, and trauma in the disability community: a call to action. Rehabil Psychol 2020; 65: 313.
[20] De Boer C, Ghomrawi HM, Bouchard ME, Linton SC, Tian Y and Abdullah F. Effect of the COVID-19 pandemic on presentation and severity of traumatic injury due to physical child abuse across US children's hospitals. J Pediatr Surg 2022; 57: 726-731.
[21] Kovler ML, Ziegfeld S, Ryan LM, Goldstein MA, Gardner R, Garcia AV and Nasr IW. Increased proportion of physical child abuse injuries at a level I pediatric trauma center during the Covid-19 pandemic. Child Abuse Negl 2021; 116: 104756.