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Original Research Article

A Study of Paediatric Head Injuries and Its Outcome

Raje Vinayak, Raje Vaishali, Pednekar Akshay, Vekariya Mayank, Mahna Abhishek, Patankar Ritvij, Gupta Vaibhav

Krishna Institute of Medical Sciences, Karad, Maharashtra, India- 415110

Corresponding Author: Raje Vinayak

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ABSTRACT

Aims and Objectives: To know the epidemiology, types of head injuries and outcome of paediatric head injury in hospitalized patients.

Methodology: In this hospital based cross-sectional study 96 patients aged 0-15 years were studied. All pediatric patients admitted and managed for head injury in the Neurosurgery department of Krishna Hospital and Research Centre, Karad from 1st January, 2013 to 31st December, 2013 were included. Information was recorded in a pre-structured proforma which included age, sex, details of head injury, clinical, Computerized Tomography scan or Magnetic Resonance Imaging findings and outcome of head injuries among paediatric patients.

Results: The prevalence of head injury in children up to 15 years of age in the hospital was 10.7%. Maximum head injuries were found in 0-5 year's age group (36.5%). Road traffic accident was the most common cause of injury observed in 52% patients. Frontal region was most commonly affected site and diffuse cerebral edema was the most common type of injury found in 41.6% patients.

Conclusion: As head injury is multifactorial in causation, a multifactorial approach is most appropriate for the prevention of head injuries. There is a need for population based researches to know the epidemiological pattern of head injuries which will help in planning for prevention. Even though, head injuries are treatable, it is best to adopt preventive measures because residual chances of head injury are higher.

Keywords: Pediatric head injury; Road traffic accident; diffuse cerebral edema.

INTRODUCTION

Head injuries are a major cause of paediatric hospital emergency room visits and frequently require extensive treatment. [(1)] Every year head injury results in many hospital admissions and this problem is not unique to USA [(1-3)] alone. But commonly reported from India, [(4,5)] UK [(6)] and Nepal. [(7)] In India, injuries are the 7th leading cause of mortality contributing to 11% of total deaths, 78% due to motor vehicle related head injuries alone. [(4)] Almost half of the deaths in 10-25 years age group are due to injuries and head trauma is the most common injury leading to death. [(8)] Every year many children aged 0-15 years are admitted to emergency department with head injuries like linear skull fracture, depressed fracture, haemorrhagic contusions, subdural and extradural

hematoma, subarachnoid haemorrhage, whose etiology varies with age. [2] The most common mode of head injury in children is fall at home or from height or fall during playing activities. [2,4] Falls alone account for 78% of the total head injuries in children aged 0-5 years. [6] Also road traffic accidents are amongst the second leading cause of death in 10-15 years age group and third leading cause of death in 5-10 years age group as per the 2002 World Health Organization mortality database. [9] There are certain predisposing factors which make the children vulnerable to head injuries. Thus current study attempted to know the etiology, severity and immediate outcome of paediatric head injury.

MATERIALS AND METHODS

This Hospital based cross-sectional study was conducted in the Department of Neurosurgery, Krishna Hospital and Research Centre, Karad, Maharashtra. All paediatric patients (aged 0-15 years) admitted and managed for head injury in the Neurosurgery department during 1st January, 2013 to 31st December, 2013 were included in this study. Information regarding age, sex, mode of injury, was collected from the parents. Head injuries in paediatric patients were classified on the bases of site of injury, type of injury, clinical findings, Computerised Tomography (CT) Scan / Magnetic Resonance Imaging (MRI) findings of all paediatric patients managed under Neurosurgery department. Various types of head injuries like concussion, skull fracture, subdural hematoma (SDH), extradural hematomas (EDH),and contusion were studied. [10] Glasgow coma score (GCS) was used to classify the severity of the head injury and to assess outcome. [2,4,5] The CT scan / MRI findings of the patients were reviewed for the confirmation of clinical diagnosis. The outcome of the patients on discharge was classified according to the GCS into good recovery, moderate recovery (some amount of disability and requiring parental help in performing daily activities) and poor outcome (vegetative state or death). [5] Statistical analysis of data was done using Chi square test and Paired t test. The level of significance at *p* value of <0.05 was considered significant.

RESULTS

During the period of one year a total of 28,115 patients were admitted to the hospital. Of these, 896(3.2%) patients were admitted for head injury and from that a subset of 96 paediatric head injuries were found. Hence the prevalence of head injury in children below 15 years of age in the hospital during the study period was 10.7%. From the total 96 patients, 93 (96.8%) were discharged alive from the hospital. The mean age of the patients admitted was 7.90 years.

Maximum head injuries were found in 0-5 years age group (36.5%). There were 52.1% males and 47.9% females (M:F = 1.08:1). Females were commonly affected in the 6-10 years age group whereas males were more commonly affected in 0-5 years and 11-15 years age groups. The observed difference of male and female head injuries in various age groups was not significant.

Road traffic accidents was the most commonly reported cause in 50 (52%) patients, followed by falls in 39 (40.6%) and hit (by stone, wall, slab at construction site, intentional injury) in 7 (7.29%). Most of the fall related head injury (61.5%) occurred in males in comparison to females (38.5%). Road traffic accidents occurred more often in females (52%) than males. Hit subgroup comprised of injuries which occurred when the child was accidently hit by stone, wall, construction site slab or intentionally hit. 71.4% of these were seen in females. There was intentional injury in 2 female children

who were in 0-2 years age group. One child had associated rib fractures along with acute subdural hematoma and the other child had diffuse cerebral edema (Table 1).

Table 1: Distribution of Head Injury in paediatric patients according to Age, Sex, Site of Injury:

Variables	Falls N=39 (40.6%)	RTA N=50 (52%)	Hit N=7 (7.29%)	Total N=96	*p* value
Age					
0-5 yrs	15 (38.5%)	17 (34%)	3 (42.9%)	35 (36.5%)	
6-10 yrs	15 (38.5%)	18 (36%)	0	33 (34.4%)	0.265
11-15 yrs	9 (23.1%)	15 (30%)	4 (57.1%)	28 (29.2%)	
Sex					
Males	24 (61.5%)	24 (48%)	2 (28.6%)	50 (52.1%)	0.194
Females	15 (38.5%)	26 (52%)	5 (71.4%)	46 (47.9%)	
Site of injury					
Frontal	13 (33.3%)	17 (34%)	1 (14.3%)	31 (32.3%)	0.5
Parietal	18 (46.2%)	8 (16%)	3 (42.9%)	29 (30.2%)	0.007
Temporal	8 (20.5%)	12 (24%)	3 (42.9%)	23 (24%)	0.4
Occipital	5 (12.8%)	5 (10%)	1 (14.3%)	11 (11.5%)	0.891
Other sites:					
Face	5 (12.8%)	17 (34%)	0	22 (22.9%)	0.031
Limbs/chest	13 (33.3%)	15 (30%)	1 (14.3%)	29 (30.2%)	

Road traffic accidents maximally affected the frontal region and face (34%) followed by temporal region (24%). Falls commonly caused injury over the parietal region (46.2%). Children in the hit group most commonly sustained injuries over the parieto-temporal region. Amongst the various sites of injury, frontal region on the scalp was most commonly affected and had significant association with diffuse cerebral edema ($p<0.001$), haemorrhagic contusion ($p<0.05$) and subarachnoid haemorrhage ($p<0.005$); whereas the parietal region was the second most common site of injury and had significant association with extradural hematoma ($p=0.001$) and skull fracture ($p<0.05$). Associated injuries over face were commonly seen with road traffic accidents and limbs/ chest were more affected with fall related injuries (Table 1).

Diffuse cerebral edema (DCE) was the most common type of injury; found in 41.6% patients followed by concussion in 30.2%, skull fracture in 22.9%, extradural hematoma (EDH) in 11.4%, hemorrhagic contusion in 10.4%, subdural hematoma (SDH) in 9.4% and subarachnoid haemorrhage (SAH) in 4.2% patients (Figure 1).

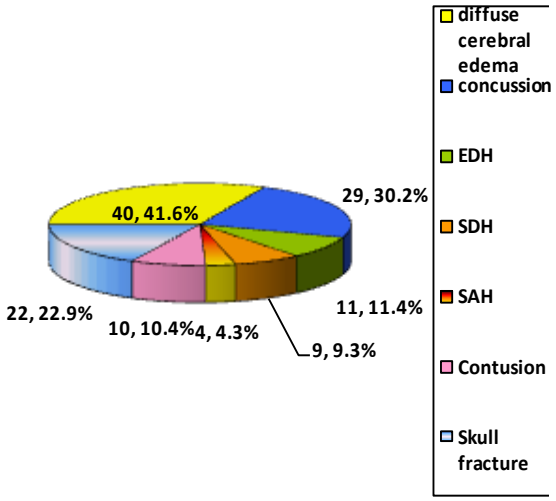

Figure 1: Pie Diagram showing Different Types of Injuries:

The presence of skull fracture increased the risk for developing subdural / extradural hematoma in children which was statistically significant. There were 55.6% patients of Subdural Hematoma ($p<0.05$) and 54.5% patients of Extradural Hematoma ($p<0.05$) who had accompanying skull fracture (Table 2).

Table 2: Association of Extradural / subdural hematoma with skull fracture:

Variables	Skull Fracture		Total N=96	P value
	present	Absent		
Extradural hematoma	6(54.5%)	5(45.4%)	11(11.45%)	0.01
Subdural hematoma	5(55.5%)	4(44.4%)	9(9.3%)	0.008

It was observed that, on admission according to Glasgow coma scores, 77(80.2%) children had mild head injuries, 13 (13.5%) had moderate head injuries, and 6 (6.25%) had severe head injuries. Amongst the types of injuries, cerebral edema, subdural hematoma and subarachnoid haemorrhage had p values <0.05 and were significantly associated with the initial Glasgow coma scores (Table 3).

Table 3: Distribution of Head injury cases according to the Severity of Injury:

Type Of Head Injury	**Mild** [GCS13-15] **N=77**	**Moderate** [GCS: 9-12] **N=13**	**Severe** [GCS: <8] **N = 6**	**Total N = 96**	***p* value**
DCE	27 (35.1%)	10 (76.9%)	3 (50%)	40 (41.7%)	0.017
SDH	4 (5.2%)	2 (15.4%)	3 (50%)	9 (9.4%)	0.001
EDH	7 (9.1%)	4 (30.8%)	0	11 (11.5%)	0.05
Skull Fracture	14 (18.2%)	6 (46.2%)	2 (33.3%)	22 (22.9%)	0.07
SAH	1 (1.3%)	3 (23.1%)	0	4 (4.2%)	0.001
Contusion	6 (7.8%)	3 (23.1%)	1 (16.7%)	10 (10.4%)	0.22
Concussion	25 (32.5%)	2 (15.4%)	2 (33.3%)	29 (30.2%)	0.45

Table 4: Outcome of the various types of head injury cases:

Type Of Injury	**Good recovery N=92 (95.8%)**	**Moderate Recovery N=1(1.04%)**	**Poor outcome (death) N=3 (3.125%)**	**Total N=96**	***p* value**
DCE	39 (42.4%)	0	1 (33.3%)	40 (41.7%)	0.66
SDH	8 (8.7%)	1 (100%)	0	9 (9.4%)	0.007
EDH	11 (12%)	0	0	11 (11.5%)	0.7
Skull Fracture	21 (22.8%)	0	1 (33.3%)	22 (22.9%)	0.78
Contusion	9 (9.8%)	0	1 (33.3%)	10 (10.4%)	0.3
SAH	4 (4.3%)	0	0	4 (4.2%)	0.9
Concussion	29 (31.5%)	0	0	29 (30.2%)	0.7

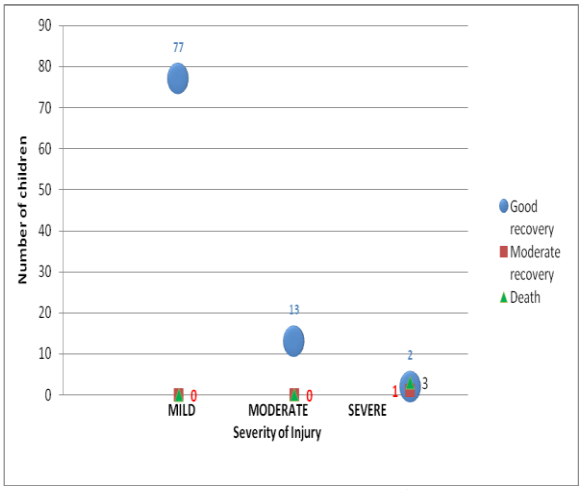

Figure 2: Scatter Chart showing the outcome of patients according to the severity of injury

All the patients of Concussion (31.5%), Extradural hematoma (12%) and sub-arachnoid haemorrhage (4.3%) had good outcome of head injuries in the children. Morbidity and mortality in children with head injury was related to injuries like diffuse cerebral edema (DCE), contusion and skull fracture. Subdural hematoma significantly affected the outcome of children and one child out of 9 cases of Subdural Haemorrhage had 100% moderate recovery (needed parents' help to perform daily activities). Poor outcome in the form of death was observed in 3.1% patients (Table 4).

It was seen that, on admission Glasgow coma score was significantly

associated with the outcome of children (p<0.001). All 77 (80.2%) patients with mild head injury showed good recovery. All 13 (13.5%) patients with moderate head injury showed good recovery and were able to go to school. Out of 6 patients, 2(33.33%) children of severe head injury had good recovery, 1(16.66%) had moderate disability (able to perform daily activities with parents' support) and 3(50%) had poor outcome (death) on discharge (Figure 2).

The comparison of the mean of Glasgow coma score values at the time of admission and at the time of discharge shows, a minimum score of 3 and maximum score of 15 was recorded on admission. The mean Glasgow Coma Score on admission was 13.40 with a standard deviation of 2.519. The mean Glasgow Coma Score at discharge was 14.59 with a standard deviation of 2.115. It was observed in all types of injury, the GCS score significantly improved at the time of discharge as compared to the GCS at admission (Table 5).

Table 5: Variation in the Glasgow coma scores on admission and on discharge among various types Of Injuries:

Type of injury	Glasgow coma score admission		Glasgow coma score (discharge)		**t** value	***p*** value
	Mean	standard deviation	Mean	Standard deviation		
DCE	12.58	2.500	14.70	1.8	-6.284	<0.001
SDH	11.33	3.202	14.67	1.000	-3.714	0.006
EDH	12.82	1.601	15.00	0.000	-4.519	0.001
Fracture	11.70	2.824	14.45	2.558	-4.78	<0.001
Contusion	10.75	3.622	13.80	3.795	-2.512	0.033
SAH	13.59	2.872	15.00	0.000	-2.95	0.060
Concussion	12.86	2.244	14.59	2.228	-2.878	0.008

DISCUSSION

The present study highlights the various epidemiological factors causing head injury and its outcome in children. Almost 1/3rd head injuries (36.5%) were sustained in 0-5 years age group followed by (34.4%) in 6-10 years and (29.2%) in 11-15 years. The mean age of paediatric head injury patients was 7.60 years. As mentioned by Suresh HS et al [(11)] reported slightly higher proportion of children (18.8%) in 0-5 years age group, (41.1%) in 6-10 years age group and (45.8%) were aged 11-15 years. In his study maximum numbers of children were in 11-15 years age, probably due to high levels of motorization and urbanization in Bangalore predisposing children to head injuries.

Agarwal's study concluded that fall (65.11%) was the most common mode of injury followed by road traffic accidents (25.6%). [(12)] However, current study has labeled falls as a second leading cause and road traffic accidents as the predominant cause of head injury in paediatric age. The proportion of road traffic accidents is in the range 27 - 75% - Gururaj et al, [(4)] Jennett et al, [(13)] Atabaki et al. [(14)] In the present study, road traffic accidents (52.1%) were the leading cause of paediatric head trauma followed by falls (40.6%) of total admissions. This probably was due to the easy approach of road traffic accidents to the hospital as Krishna Hospital is located on National Highway No.4. Among fall related injuries, maximum were due to fall from height 84.6% and remaining 15.3% due to fall at play. Amongst fall from height, 10%, 12%, 8%, 38% were due to fall from bed, ladder, bullock cart and trees respectively. Gururaj [(4)] reported the occurrence of domestic falls from height to be 68% which

is comparatively more higher than the present study and also in rural parts of India, [4] 39% falls are from trees, 12% fall from ladder/staircase and 15% due to fall from building.

The study by A. Khambalia et al [15] showed that young age (0–6 years), male sex and low socioeconomic status were consistent risk factors for fall injuries, males being affected twice than females. In the present study, considering the male female proportion in fall related injuries, males accounted for (61.5%) and females accounted for (38.5%) of total fall injuries, the male / female ratio being 1.6:1. Therefore, males were more prone for falls than females. Also more number of falls occurred in 0-5 years age group (38.5%) as compared to 11-15 years age (23.1%). This finding was within ranges reported by Noel Tulipan et al. [6] These injuries are all preventable if health protection guidelines are adopted.

In the current research, amongst the road traffic accidents, there were (56.5%) females and (48%) males which is contradictory to the WHO reports which state that males are twice more likely to sustain road traffic injuries. [9] This could be possible because the present study is hospital based and has limited data sources, restricted to only one hospital. Among the hit males accounted for (28.5%) and females (71.4%) of head injuries. Intentional injury was present in 2 of 8 (25%) female patients in 0-2 years age-group, who were hit. According to Noel Tulipan et al, [6] child abuse can account for approximately 50% of head injuries in 0-2 years children. This diagnosis is generally underreported since parents want to hide the cause of injury or when the history is not appropriately taken. Thus, any injury not explained by history should arouse suspicion of child abuse.

Kraus et al [2] reported concussion (70%) to be the most common injury in children. Concussions were responsible for 37.9% of head and neck injuries according to MacGregor et al. [7] Suresh et al [11] from Bangalore said that, diffuse head injury (29.4%) was most common followed by extradural hematoma (27.9%), skull fracture (16.4%), contusion (16.17%) and subdural hematoma (10%). The most common type of injury in that order was skull fracture (48%), intraparenchymal haemorrhage (31%), subdural hematoma (24%), subarachnoid haemorrhage (21%) and diffuse cerebral edema (17%) -William H. et al. [16]

In the present study, diffuse cerebral edema was the most common type of injury; found in 41.6% patients followed by concussion in 30.2%, skull fracture in 22.9%, extradural hematoma in 11.4%, hemorrhagic contusion in 10.4%, subdural hematoma in 9.4% and subarachnoid haemorrhage in 4.2% patients. Subarachnoid haemorrhage was least likely probably since children lack sufficient subarachnoid space.

Also as reported by Neuropathologists in Glasgow, [17] diffuse cerebral edema is 3 to 4 times more common in children than adults and accounts for approximately 40% cases. In the present diffuse cerebral edema was present in 41.6% patients.

Considering infants and young children, young children suffer greater damage from diffuse cerebral edema than their older counterparts and show significant impairment in cognitive and performance skills due to injury to developing brain. [11] In the present study, in 0-5 years age group, one child out of 12 (8.3%) with diffuse cerebral edema had poor outcome (death).

According to Malik NK et al, [18] Posterior fossa Extradural Hematoma was an uncommon entity, accounting for only 4% to 12.9% of all EDHs. It has a characteristic clinical presentation, which if detected can be life-saving. The current study had 1of 11 (9.09%) patients of

posterior fossa extradural hematoma. This finding lies in the above mentioned range; however, this finding cannot be accountable due to the small sample size. Also considering the relation of skull fracture and intracranial hematomas, skull fracture is significantly associated with a risk for subdural / extradural hematomas as mentioned by Jennett et al. [13] In the present study, there were 55% cases of subdural and 54.5% cases of extra dural hematoma accompanying with fracture of skull. Subdural hematoma is significantly associated with poor outcome in children and one child out of 9 (11.11%) cases of subdural hematoma had moderate recovery. The outcome of subdural hematoma as reported by Suresh et al [11] was significantly worse than extradural hematoma in children.

According to the on admission GCS patients were divided into mild, moderate and severe injury. [2,4,6,11,12] Gururaj et al [4] found (70%) mild, (14%) moderate and (16%) severe head injuries in children. Suresh et al [11] found (44.8%) mild, (28%) moderate and (27%) severe head injuries. Hence most of childhood head injuries are mild. Jennett et al [13] reported 80% cases of mild head injury alone in UK. A similar finding was noted in the present study where there were (80.2%) of mild, (13.5%) of moderate and (6.25%) of severe head injuries.

Glasgow coma score was a good indicator of the clinical outcome of patients- Kraus et al, [2] Suresh et al. [11] Patients of mild head injuries [GCS 13-15] had good outcome. Suresh et al [11] observed 1.3% patients with mild head injury (GCS 13-15) had poor outcome whereas 45.6% patients with severe head injury had poor outcome. In the present study, all 77 (80.2%) patients with mild head injury and all 13 (13.54%) patients with moderate head injury showed good recovery. Among severe head injury, 2 of 6 patients of severe head injury had good recovery, 1 of 6 patients had moderate disability (able to perform daily activities with parents' support) and 3 of 6 patients with severe head injury had poor outcome in the form of death. The mortality rate was 100% for patients having a Glasgow coma score of 3 or 4 on admission- Kraus et al, [2] which is almost similar to the present study. In the present study, there were 2 patients with GCS 3 on admission and 1 patient with GCS 4, all eventually having 100% mortality. The major cause of mortality was severe head injury and associated diffuse cerebral edema (1 of 3; 33.3%) and contusion (1 of 3; 33.3%); in addition one child had associated abdominal injury with hemoperitoneum. According to Suresh et al, [11] diffuse cerebral edema and contusions were associated with poor outcome in 25% and 18.5% cases respectively.

The in hospital mortality as reported by Kraus et al [2] was 3/100 and as reported by Gururaj [4] was 9%. In the present study, overall mortality was 3/96 cases of paediatric head injury.

CONCLUSION

Pediatric head injury is an important "preventable" health calamity. The mortality rates differ from region to region and represent only the tip of the iceberg. For every fatal injury, there are various non fatal injuries which add up the disability adjusted life years in the population. Hospital based studies are just an indicator of the epidemiological factors causing the head injuries but do not tell us about the overall pattern. Most of the head injuries (36.1%) were present in 0-5 years age group and fall is an important mode of injury in this age group. Male sex was more prone to fall related injuries (M:F ratio=1.08:1). Also, female sex has to bear the burden of inflicted trauma. Road traffic accidents were responsible for majority of the cases (52.1%) and caused severe head injuries.

Road traffic accidents related to 2 wheelers (40%) and pedestrians (36%) are a major cause of paediatric head injury. As head injury is multifactorial in causation; a multifactorial approach is most appropriate for the prevention of head injuries by giving more emphasis on behavioural modification. There is a need for population based researches in both urban / rural areas to know the epidemiological pattern of head injuries which will help in planning for prevention of such injuries. Essentially, foot paths for pedestrians, separate tracts for slow and fast moving vehicles, safe road-crossing provisions, helmet use and taking adequate care of young children would prevent most of the head injuries. Most commonly, children suffer from diffuse head injury and concussion. Presence of skull fracture is a risk factor for intracranial hematomas; hence a Computed Tomography should be done in patients of skull fracture to rule out intracranial pathology. Even though, head injuries are treatable, it is also best to adopt preventive measures because the residual chances of head injury are higher.

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