E-ISSN: 2616-3470
P-ISSN: 2616-3462

www.surgeryscience.com
2019; 3(3): 88-93
Received: 24-05-2019
Accepted: 26-06-2019

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A clinico-epidemiological study of traumatic brain injury

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DOI: https://doi.org/10.33545/surgery.2019.v3.i3b.154

Abstract
Background: The CDC has termed traumatic brain injury (TBI) as the "silent epidemic" of developed nations. WHO states, by 2020 TBIs will be third largest killer in the developing world. In India Road traffic accidents (RTAs) accounts for 45-60% of TBIs. Karnataka is ranked the fourth highest in the total number of RTAs in the country.
Objectives: To study the clinic-epidemiological profile and determinants of outcome of TBI patients.
Methodology: A retrospective case series study was conducted in the setting of Neurosurgery department where data from all TBIs admitted from January 2011 to December 2015 were analyzed based on age, sex, GCS score, mechanism and severity of injury, concurrent injuries, CT scan results, type of management and outcome.
Results: Among 5092 patients studied, the majority were aged 15 - 45years (68%) and males (82.6%). RTAs (74%) were the leading cause and 63% of had mild, 16% had moderate and 21% had severe head injury. 16% of TBIs were associated with other injuries, majority of which include chest and abdomen injuries and lower limb long bone fractures. Skull bone fractures, acute subdural, intarcerebral and extradural hemorrhages were the most common CT findings. 13.2% of the patients were managed surgically. The overall mortality in our series was 15% and the factors associated with increased mortality are elderly age, poor presenting GCS, associated thoraco abdominal injuries, lower limb and pelvic fracture, multiple bleed, diffuse axonal injury, diffuse subarachnoid hemorrhage, bleed involving more than one cranial fosse, occipital bleed and counter-coup injuries.
Conclusions: RTAs are the leading cause of TBIs in Karnataka affecting mainly young adult males. Overall mortality of TBI patients was 15%.

Keywords: Traumatic brain injury, clinico-epidemiological profile, determinants, outcome

Introduction
Cranio-cerebral injury or Head injury is defined by the National Advisory of Neurological Disease and Stroke Council as "A morbid state resulting from gross or subtle changes in scalp, skull and/or contents of the skull produced by mechanical forces restricted to those forces applied externally to head." [1] Traumatic brain injury can be classified into primary and secondary injuries. Primary injury occurs at impact and includes bone fracture, intracranial hemorrhage, and diffuse axonal injury (DAI). Secondary injury occurs as a result of decreased oxygen delivery to the brain, which in turn sets off a cascade of events that causes more damage than the initial injury [2]

Head injury is one of the major health problems and is most common cause of death in young adults [3]. In United States, combined rates of traumatic brain injury (TBI) related hospitalizations, Emergency Department visits, and deaths climbed slowly from 521.0 per 100,000 in 2001 to 615.7 per 100,000 in 2005. The rates then spiked sharply to 823.7 per 100,000 in 2010 [4]. The Centre for Disease Control and Prevention has TBI as the "silent epidemic" of developed nations [5].

According to WHO data, by the year 2020, head trauma will be third largest killer in the developing world. In India studies by traffic police have shown that on an average one person dies every six min and 70% of these attributed to head and spinal trauma [6]. Road traffic accidents account for 45-60 per cent of traumatic brain injuries in different parts of India [7].

In India number of accidents per lakh population increased from 21.2 in 1970 to 22.8 in 1980, followed by a sharp increase to 33.8 in 1990. It again rose to 42.5 in 2010 and is 38.9 in 2013 [8].

Karnataka ranked the fourth highest in the total number of road accidents (44,020) in the country in 2013, with a share of 9 per cent [8]. This study was conducted in a tertiary care hospital in Karnataka a south Indian state, with the intension to describe the disease burden, distribution, management outcome and to provide epidemiological data, so the preventive measures can be undertaken.

Objectives

1. To study the trends and patterns of head injuries among patients at tertiary care hospital.
2. To study the clinical and radiological profile of the patients.
3. To study the determinants of outcome of head injury among the patients.

Methodology

A retrospective record based case series study was undertaken in the Department of Neurosurgery in association with Medical Records Department of Vijayanagara Institute of Medical Sciences, Ballari, Karnataka, a tertiary care centre. All patients who had sustained head injury, admitted in the department of Neurosurgery from the year January 2011 to December 2015 were included in the study. Those patients who were discharged against medical advice were excluded from the study. A total of 5092 case records with head injuries were screened and the following data variables were documented

1. Socio-demographic data variables
2. Place wise distribution of the event of sustaining head injury.
3. Time wise distribution of the event of sustaining head injury which included year and month wise occurrence and time of the day of occurrence.
4. Variables related to clinical profile at the time of admission like etiology, GCS and associated injuries.
5. Variables related to Radiological profile at the time of admission using CT scan like skull bone fractures, areas of brain involved and type of bleed, type of injury.
6. The outcome was measured by the onset of mortality and determinants of the outcome was assessed.

Statistical analysis: All the collected data variables were entered into an excel sheet and after data filtration, the data sheet was transferred and analysed using SPSS software version 20.0. Appropriate descriptive statistics like proportions and percentages were used to describe the data and appropriate tests of significance like Chi-square test was applied to study the association between various data variables and the outcome variable.

Ethical Clearance: Ethical approval for the study was given by the Institutional Ethical Committee of VIMS, Bellary.

Results

A total of 5092 records of the patients were included in the study and among them one third of them were young patients in the age group of 15 – 29 years (37.5%), 30.5% of them were in the age group of 30 – 44 years, followed by 45 – 59 years (16.1%). Children in the age group of 0 – 14 years constituted 9.4% and elderly group constituted about 6.5%. Majority of the patients were males (82.6%) and remaining 17.4% of them were females. Majority of the patients with traumatic head injury (87.7%) were from Hyderabad Karnataka districts (Bellary 67.3%, Raichur 13.3%, Koppal 6.1% and Yadgiri 1%). Remaining patients were from Ananthapur (6.8%), Kurnool (1.5%) districts of Andhra Pradesh and 3.8% of them were from Chitradurga district of Karnataka.

Table 1: Time distribution of the patients with head injuries

Time	N	%	Time	N	%
1:00 AM	45	0.9	1:00 PM	167	3.3
2:00 AM	39	0.8	2:00 PM	273	5.4
3:00 AM	32	0.6	3:00 PM	275	5.4
4:00 AM	52	1.0	4:00 PM	421	8.3
5:00 AM	52	1.0	5:00 PM	377	7.4
6:00 AM	80	1.6	6:00 PM	447	8.8
7:00 AM	96	1.9	7:00 PM	600	11.8
8:00 AM	147	2.9	8:00 PM	420	8.2
9:00 AM	164	3.2	9:00 PM	308	6.0
10:00 AM	181	3.6	10:00 PM	261	5.1
11:00 AM	200	3.9	11:00 PM	167	3.3
12:00 PM	72	1.4	12:00 AM	216	4.2
Total	1160	22.8	Total	3932	77.2

After studying the time distribution of the event of traumatic head injury, it was observed that the events occurred more commonly during 4 pm to 9 pm contributing to half of the cases (50.5%).

Table 2: Year wise trends in the occurrence of head injuries among the patients in our hospital

Month	2011		2012		2013		2014		2015	
	N	%	N	%	N	%	N	%	N	%
January	94	9.8	91	9.4	110	11.0	72	6.8	102	9.2
February	80	8.4	76	7.8	81	8.1	63	5.9	86	7.7
March	91	9.5	87	9.0	100	10.0	86	8.1	74	6.7
April	83	8.7	75	7.7	102	10.2	76	7.2	66	5.9
May	95	9.9	97	10.0	78	7.8	120	11.3	85	7.6
June	61	6.4	63	6.5	69	6.9	86	8.1	78	7.0
July	65	6.8	64	6.6	69	6.9	66	6.2	98	8.8
August	77	8.1	83	8.6	86	8.6	82	7.7	117	10.5
September	67	7.0	70	7.2	80	8.0	83	7.8	121	10.9
October	90	9.4	102	10.5	81	8.1	122	11.5	103	9.3
November	75	7.9	82	8.5	61	6.1	98	9.3	89	8.0
December	77	8.1	80	8.2	79	7.9	105	9.9	93	8.4
Total	955	100.0	970	100.0	996	100.0	1059	100.0	1112	100.0

On observing the annual trends of patients sustaining traumatic head injury, it shows a gradual increase in the number of traumatic head injuries ever year. The mean events of traumatic head injury was observed to be high during the months of January (93.8 ± 14.25), May (95 ± 15.9) and October (99.6 ± 15.5) followed by months of March (87.6 ± 9.4), August (89 ± 15.9) and December (86.8 ± 11.9).

Table 3: Clinical profile of the patients with head injuries

Variable		Frequency	Percentage
Etiology			
	RTA	3757	73.8
	Assault	476	9.3
	Falls & Other	859	16.9
	Total	5092	100.0
GCS			
	3 – 8	1076	21.1
	9 – 12	803	15.8
	13 – 15	3213	63.1
	Total	5092	100.0
Associated Injuries			
	Abdomen	111	2.2
	Chest	208	4.1
	Upper Limb	139	2.7
	Clavicle	102	2.0
	Lower Limb	211	4.1
	Pelvis & Urethra	33	0.6
	Hand & Foot	25	0.5
	Total	829	16.3

Etiologicial profile of the cases revealed that 73.8% of the traumatic head injuries were due to Road Traffic accidents (RTA), followed by falls (16.9%) and assault (9.3%).

On admission the patients CNS status was assessed using Glasgow Coma Scale, which revealed that nearly two thirds of the patients (63.1%) had mild head injury with GCS of 13-15, 15.8% of the patients had moderate head injury with GCS of 9-12 and 21.1% of them sustained severe head injury with GCS of 3-8.

Out of the total 5092 cases of traumatic head injury cases, 829 (16.3%) of them had associated injuries wherein Chest injury (4.1%) and Lower limb fractures (4.1%) were common associated injuries followed by abdomen injury (2.2%) and upper limb fractures (2.7%).

Table 4: Radiological profile of the patients with head injuries (N=5092)

Variable		Frequency	Percentage
Skull Bone involved in Fracture			
	Frontal	481	9.4
	Parietal	152	3.0
	Temporal	415	8.2
	Occipital	181	3.6
	Orbit	79	1.6
	Zygomatic - Maxillary Complex	208	4.1
	Le Fort	25	0.5
	Mandible	63	1.2
	Nasal	26	0.5
	Total	1630	32.0
Areas of brain involved in bleed			
	Frontal	604	11.9
	Parietal	311	6.1
	Temporal	537	10.5
	Occipital	225	4.4
	Anterior + Middle Cranial Fossa	671	13.2
	Middle + Posterior Cranial Fossa	319	6.3
	Total	2667	52.4
Type of Injury			
	Acute SDH	368	7.2
	EDH	245	4.8
	ICH	314	6.1
	Contusion	199	3.9
	Chronic SDH	80	1.6
	IVH	29	0.6
	Diffuse SAH	225	4.4
	DAI	191	3.8
	Tent	79	1.6
	Fracture (Alone)	728	14.3
	C Oedema	156	3.1
	Pneumocephalus	212	4.2
	Multiple Bleed	403	7.9

	CT not done	561	11.0
	Normal	1272	25.0
	Total	5092	100.0

Out of the total 5092 cases of traumatic head injury cases, 89% of them under went plain CT scan of brain which revealed that normal findings were noted in 25% of the patients and 1630 (32%) of them had skull bone fractures wherein frontal (9.4%), temporal (8.2%) and Zygomatic - Maxillary Complex(4.1%) were common. Evidence of intracranial bleed was also assessed where in half of the cases showed intracranial haemorrhage (52.4%) among which the common areas involved were frontal (11.9%), temporal (10.5%) and combined anterior end middle cranial fossa bleed (13.2%). The type of bleed was assessed which revealed that Acute subdural Heamorrhage (7.2%), Intracerebral haemorrhage (6.1%), Extradural haemorrhage (4.8%) and multiple bleed (7.9%) were common. Other injuries included Diffuse axonal injury (3.8%), diffuse Subarachnoid haemorrhage (4.4%), cerebral contusions (3.9%), Pneumocephalus (4.2%) and cerebral edema (3.1%).

Table 5: Clinical profile versus outcome among the patients with head injuries

Variable		Total No.	Alive		Death	
			n	%	n	%
Age Group (In Years)						
	0 – 14	477	450	94.3	27	5.7
	15 – 29	1911	1672	87.5	239	12.5
	30 – 44	1552	1333	85.9	219	14.1
	45 – 59	820	645	78.7	175	21.3
	≥ 60	332	238	71.7	94	28.3
	Total	5092	4338	85.2	754	14.8
Chi-square value= 116, df=4, P value < 0.001						
Sex						
	Male	4206	3585	85.2	621	14.8
	Female	886	753	85.0	133	15.0
	Total	5092	4338	85.2	754	14.8
Chi-square value= 0.0353, df=1, P value =0.851						
Etiology						
	RTA	3757	3184	84.7	573	15.3
	Assault	476	451	94.7	26	5.5
	Falls & Other	859	703	81.8	155	18.0
	Total	5092	4338	85.2	754	14.8
Chi-square value= 40.91, df=2, P value < 0.001						
GCS						
	3 – 8	1076	476	44.2	600	55.8
	9 – 12	803	703	87.5	100	12.5
	13 – 15	3213	3159	98.3	54	1.7
	Total	5092	4338	85.2	754	14.8
Chi-square value= 1873, df=2, P value < 0.001						
Associated Injuries						
	Abdomen	111	76	68.5	35	31.5
	Chest	208	156	75.0	52	25.0
	Upper Limb	139	101	72.7	38	27.3
	Clavicle	102	80	78.4	22	21.6
	Lower Limb	211	131	62.1	80	37.9
	Pelvis/ Urethra	33	23	69.7	10	30.3
	Hand & Foot	25	21	84.0	4	16.0
	Total	829	588	70.9	241	29.1
Chi-square value= 15.08, df=6, P value < 0.0196						

The overall mortality, out of 5092 patients with traumatic head injury, was 14.8% (754) and remaining 85.2% of them survived. The mortality rate increased as the age of the patients increased where low mortality (5.7%) was observed in 0-14 years and high mortality (28.3%) was seen in patients aged above 60 years. This association of increasing mortality with increasing age of the patients was found to be statistically significant. The mortality rates were similar in both males (14.8%) and in females (15%). The mortality of patients with THI was more among patients with falls and others (18%) and RTA (15.3%) compared to patients who were assaulted (5.5%) and this difference in the outcome with respect to the varied etiology of THI among patients was found to be statistically significant.

As the GCS of the patients at the time of admission decreased the mortality increased where in 55.8% of mortality was observed in patients with GCS 3-8 and this difference in the mortality rates with respect to the GCS status of the patients was found to be statistically significant. Patients who had associated injuries had higher mortality rate (29.1%) when compared to patients who did not had any associated injuries (14.8%) and this difference was found to be statistically significant. Among patients with associated injuries, who had injury to lower limb (37.9%), abdomen (31.5%) and pelvis/urethra (30.3%) had higher mortality rates compared to other associated injuries.

Table 6: Areas of brain involved in head injuries versus outcome among the patients

Areas of brain involved	Total No.	Alive		Death	
		n	%	n	%
Frontal	604	493	81.6	111	18.4
Parietal	311	254	81.7	57	18.3
Temporal	537	424	79.0	113	21.0
Occipital	225	164	72.9	61	27.1
Anterior + Middle Cranial Fossa	671	461	68.7	210	31.3
Middle + Posterior Cranial Fossa	319	232	72.7	87	27.3
Counter coup injury	155	99	63.9	56	36.1
Chi-square value= 52.15, df=6, P value < 0.001					
Type of Injury					
Acute SDH	368	316	85.9	52	14.1
EDH	245	192	78.4	53	21.6
ICH	314	247	78.7	67	21.3
Contusion	199	168	84.4	31	15.6
Chronic SDH	80	70	87.5	10	12.5
IVH	29	23	79.3	6	20.7
Diffuse SAH	225	149	66.2	76	33.8
DAI	191	126	66.0	65	34.0
Tent	79	72	91.1	7	8.9
Fracture (Alone)	728	702	96.4	26	3.6
C Oedema	156	144	92.3	12	7.7
Pneumocephalus	212	196	92.5	16	7.5
Multiple Bleed	403	195	48.4	208	51.6
Not Done	561	446	79.5	115	20.5
Normal	1272	1262	99.2	10	0.8
Total	5092	4338	85.2	754	14.8

Chi-square value= 869.6, df=13, P value < 0.001

The mortality rates were assessed with respect to the areas of the brain involved in the injury and it was found that patients with counter coup injury (36.1%), anterior middle cranial fossa injury (31.3%), Middle and posterior cranial fossa injury (27.3%) and occipital injury (27.1%) had higher mortality rates compared to injuries involving other parts of the brain and this difference was found to be statistically significant.

On assessing the outcome of the patients based on type of head injury, it was found that patients with multiple intracranial bleed (51.6%), diffuse axonal injury (34%) and diffuse subarachanoid

haemorrhage (33.8%) had higher mortality rates compared to other intracranial findings and this difference in the mortality rates among the patients was found to be statistically significant.

Table 7: Management of Head Injuries

Category	Intervention	Frequency	Percentage
Type of Management (N=5092)			
	Surgical Management	671	13.2
	Medical Management	4421	86.8
Type of Surgical Intervention (N=671)			
	Craniotomy and Evacuation	413	61.5
	Extra ventricular Drainage	14	2.1
	Elevation of a depressed fracture	166	24.7
	Craniotomy and decompression	78	11.6
Type of bleeds undergoing Craniotomy and Evacuation (N=413)			
	Acute SDH	131	31.7
	EDH	70	16.9
	ICH	56	13.6
	Chronic SDH	54	13.1
	Multiple bleed	102	24.7

Among the total cases of head injury, 671(13.2%) were managed surgically and the remaining 4421(86.8%) were managed conservatively. Among the cases who were managed surgically, craniotomy and evacuation of haematoma (61.5%) was the commonest procedure followed by elevation of depressed fracture (24.7%), craniotomy and decompression (11.6%) and extra ventricular drainage (2.1%). Acute SDH (31.7%), Multiple bleeds (24.7%) and EDH (16.9%) were the common type of bleeds requiring craniotomy and evacuation.

Discussion

A total of 5092 cases of head injuries from 2011 to 2015 were studied by systematic review of case sheet from medical record department which included all the head injury cases admitted in our tertiary care hospital from Karnataka.

We have noticed a gradual rise in number of head injury from 2011 (no.955) to 2015 (no.1112) a majority of (73.8%) which was due to road traffic accident, the overall increase in vehicular traffic to the road, lack of legal and safety reforms and use of alcohol were the major factors for RTAs. The studies from other part of India by lalitkumar at al. in Dehradun also showed RTAs as major cause of head injury (65.27%) [9]. Another study by Deepak Agrawal at el.[10] In new dehli also showed RTAs as major cause (64. In RTAs head is the most common cause of mortality fallowed by abdomino-thoracic trauma [11, 12] One third of the head injury occurred in young adult (15 to 29yr) and another 1/3rd were middle aged (30 to 44yr) and 82.6% were males. Similar young age and male predominance was also noted in other studies [9, 10] The reason being the mobility of males are higher than females and they are exposed more to risk factors like RTAs, violence and work place accidents.[13] TBIs in this young & productive age group leading to loss of intellectual & other faculties with a resulting burden on family & the society was also noted in other studies [6]

Two thirds of the cases were from the ballari district, where the tertiary care center was situated and remaining one third of cases was referred from neighbouring districts. We have also observed that half of cases of head injury occurred between 4 to 9pm it was mainly due to increase traffic and use of alcohol. At the time of admission all patients were assessed with glassgow coma scale and 63% had mild, 16% had moderate and 21% had severe head injury. 16% of head injury patients were associated with other injuries which were mainly thoraco abdominal injury (6.3%) and lower limb fracture (4%). Majority of them (89%) underwent a screening plain CT brain one fourth of the patient had normal scan and 14.3% had only skull bone fractures, Acute SDH, EDH, ICH, Contusion, Diffuse SAH and DAI are some of the common abnormalities observed on CT.

The overall mortality in our series was 15% and there was no significant difference (p=0.851) between male and female but increase mortality 28% was observed in elderly age it was due to associated co morbid conditions and the hypothesis that the adult brain has a decreased capacity for repair as it ages [6] The in hospital mortality rate was less in our study when we compare to the other study from india like Deepak Agrawal at el (22%)[10] Chandra shekar at el (20%) [13]. Falls as etiological factor was associated with more mortality (18%) as opposed to assault which attributed to 5.5%.

The Glasgow Coma Score (GCS) provides a clinical functional measure of the degree of mass effect and advanced raised ICP. It consists of three components, intensity of stimulus required to cause eye opening, verbal response, and motor response [2]. Severe head injury was associated with 56% mortality where as mild head injury had only 1.7% mortality which clearly showed that presenting GCS was the most important determinant of outcome. Similar relation of mortality to the presenting GCS was also observed from other study. Severe head injury was associated with 36% and 73.5% in studies by Deepak Agrawal[10]and Chandra shekar [13] respectively. Some studies even concluded that post resuscitation GCS is the single most important determinant of outcome in TBIs [6]

When head injury was associated with other injury the rate of mortality raised to 29%, among which thoraco abdominal injuries, lower limb and pelvic fracture were associated with more mortality. Half of the cases with multiple bleed and 1/3rd of cases of diffuse axonal injury, subarachnoid hemorrhage was associated with mortality. Bleed involving more than one cranial fosse (30%), occipital bleed (27%) and counter-coup injuries were associated with increased mortality.

These findings could be simply explained by mass effect of the bleed and more bleed means more raise in intracranial pressure and more adverse effect on brain parenchyma and poor outcome. Whereas DAI is a rotational acceleration-deceleration injury to the white matter pathways of the brain resulting in a functional or anatomic disruption leads to loss of consciousness without mass lesions [2].

Majority of patients of head injuries require only monitoring and supportive care and only a small proportion of them (13.2%) require surgery to reduce intracranial pressure mainly in the form of Craniotomy and evacuation of hematoma or simple craniotomy for decompression.

This study has some limitations as well. Since it is a retrospective study only those variables were studied, which were collected and documented during standard history and clinical examination. We could not get information about important indicators such as velocity of impact, type of road where accident occurred, and use of safety measures like helmets. Another important truth is that only a proportion of all traumatic brain injuries will reach the hospital, and many of those with severe injuries may have died in the pre hospital setting, and many with mild injuries may not have sought clinical care. As this was the only neurosurgery equipped hospital in our and the surrounding districts at the time of the study, referral bias was also possible. Similar limitations were noted in the studies conducted in other parts of india [14].

Some of the causes of RTAs were, use of heavy motor vehicles travelling at high speed in the highways passing through rural

areas, no universal application of safety laws, lack of knowledge about using safety measures like seatbelts, helmets, airbags, and antilock brakes, poor road lighting, lack of traffic signals, were other problems noted. Similar problems were found other Indian studies [14]

Conclusions

The study highlights the TBIs in Karnataka is mostly among the young male population and is increasing every year and RTAs are the leading cause of TBIs. 2/3rd of TBIs are mild and 1/3rd are usually moderate to severe.1/4th of the patient had normal scan and skull bone fractures, Acute SDH, EDH, ICH, Contusion, Diffuse SAH and DAI were common.

The overall mortality in our series was 15% and the factors associated with increased mortality are elderly age, poor presenting GCS, associated thoraco abdominal injuries, lower limb and pelvic fracture, multiple bleed, diffuse axonal injury, diffuse subarachnoid hemorrhage, bleed involving more than one cranial fosse, occipital bleed and counter-coup injuries on CT.

Majority of patients require only monitoring and supportive care and only a small proportion (13.2%) require surgery to reduce intracranial pressure mainly in the form of craniotomy.

The raising trend of TBIs and young male productive population being the common victims is very alarming and the morbidity and mortality in this group will affect the economy and growth of the family. This highlights the need for more political attention, establishing good pre-hospital care, provision of trauma services at site, better infrastructure in the hospital and strict implementation of rules are required to reduce RTA related TBIs in India.

Acknowledgments

We the sincerely thank all the patients and their relatives for their co-operation and support for the smooth conduct of the study. The authors thank all the staff members of department of Medical records, General Surgery and Neurosurgery of VIMS Bellary for their support. The authors are also grateful to authors/editors/ publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

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