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Traumatic Brain Injuries: Experience from a Tertiary Care Center in Pakistan

Travmatik Beyin Yaralanmaları: Pakistan'da Bir Tersiyer Bakım Merkezi'nin Deneyimi

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ABSTRACT

AIM: Traumatic Brain Injury (TBI) is one of the leading causes for morbidity, mortality and economic loss. The impact is much worse in developing countries like Pakistan. The objective of our study was to highlight the etiological pattern and distribution of TBI in Pakistan.

MATERIAL and METHODS: From July 2009 to June 2011, 1378 patients presenting to our Accident and Emergency Department with head injury were included in the study. Patients underwent detailed clinical and radiological evaluation as per trauma protocol.

RESULTS: The most commonly affected age group was 21 to 30 years (34.1%) with male to female ratio of 3.3:1. Injuries were predominantly caused by road traffic accident (62.6%), followed by fall (31.7%) and assault (5.5%). Amongst those with RTA less than 1% of the patients were wearing proper safety equipment. The most common CT scan finding was brain contusion (14.1%); others included traumatic sub-arachnoid hemorrhage (7.1%), subdural hematoma (7.6%), extra-dural hematoma (5.8%) and depressed skull fracture (4.6%).

CONCLUSION: Motorbike accidents are a major cause of severe traumatic brain injury. Although this can be minimized by wearing proper helmets, its use is limited. Moreover, there is an imperative need to implement proper referral system amongst hospitals citywide in order to minimize the consequences of secondary brain injury.

KEYWORDS: Accident, Contusion, CT scan brain, Head trauma, Traumatic brain injury (TBI)

ÖZ

AMAÇ: Travmatik Beyin Yaralanması morbidite, mortalite ve ekonomik kaybın önde gelen nedenlerinden birisidir. Etkisi Pakistan gibi gelişmekte olan ülkelerde çok daha belirgindir. Bu çalışmanın hedefi, Pakistan'da travmatik beyin yaralanması etiyolojik paterni ve dağılımını vurgulamaktı.

YÖNTEM ve GEREÇLER: Temmuz 2009 ile Haziran 2011 arasında, Acil Servisimize gelen kafa travmalı toplam 1378 hasta çalışmaya dahil edildi. Hastalar travma protokolüne göre ayrıntılı klinik ve radyolojik değerlendirmeden geçti.

BULGULAR: En sık etkilenen yaş grubu 21 ila 30 yaştı (%34,1) ve erkek-kadın oranı 3.3:1 idi. Yaralanmalar temel olarak trafik kazaları (%62,6), düşmeler (%31,7) ve saldırı (%5,5) nedeniyleydi. Trafik kazası geçirenlerin %1'inden azı altı uygun güvenlik ekipmanı kullanmaktaydı. En sık görülen BT sonucu beyin kontüzyonuydu (%14,1); ayrıca travmatik subaraknoid kanama (%7,1), subdural hematom (%7,6), ekstra dural hematom (%5,8) ve deprese kafatası kırığı (%4,6) görüldü.

SONUÇ: Motosiklet yaralanmaları şiddetli travmatik beyin yaralanmasının temel bir nedenidir. Bu, uygun koruyucu başlıklar kullanılarak minimuma indirilebilir ama bunların da kullanımı sınırlıdır. Ayrıca şehir çapında sekonder beyin hasarı sonuçlarını minimuma indirmek üzere uygun bir sevk sisteminin uygulamaya konması çok önemlidir.

ANAHTAR SÖZCÜKLER: Kaza, Kontüzyon, BT beyin taraması, Kafa travması, Travmatik beyin yaralanması (TBI)

INTRODUCTION

Traumatic Brain Injury (TBI) is a non-degenerative, acquired insult to the brain resulting from an external mechanical force (27). This may be accompanied by loss or alteration of sensorium. It remains to be one of the leading causes of morbidity, mortality and economic losses worldwide. It is estimated to cause an annual loss of $30 billion in developed countries (15). It is also estimated that more than 1.7 million head injuries are encountered in the US alone (10). The incidence of TBI has been estimated as more than 600 per 100,000 cases by WHO (7), leading to about 90 per 100,000 admissions in the US hospitals (36).

Such an impact is much worse in developing countries where per capita income is low and dependence ratio is high. Moreover, illiteracy, poverty, negligence and frequent delays in acquisition of medical attention exacerbate the course and sequel of ailment.

Unfortunately, the data available on epidemiology of TBI in our region is scarce. The annual incidence of head injury in Pakistan has been estimated as 50/100,000 population based on data from public sector hospitals (34). These victims are frequently males in their most productive years of lives (18), and often the breadwinners for their families. Additionally, the magnitude of problem is readily underestimated because of under reporting and poor record keeping.

The objective of the study is to highlight the pattern and distribution of traumatic brain injuries in order to enhance trauma research, improve treatment strategies and prevention.

MATERIAL and METHODS

The prospective study was conducted over a period of 24 months from July 2009 to June 2011. A total of 1378 patients presenting with head injury to our major trauma referral center were included in the study. All patients were subjected to detailed primary head-to-toe clinical survey to rule out involvement of other organ systems, following initial stabilization. During the post-resuscitative period an accurate history was taken from the family and/or eyewitnesses along with meticulous neurological and systemic examination including Glasgow Coma Score (GCS). This was followed by neuroimaging along with imaging of other relevant systems.

Head injury was classified as mild when GCS at presentation was 13 - 15. Patients with GCS 9 – 12, LOC $\geq$ 5 mins, post traumatic amnesia > 30 mins or focal neurology were categorized as moderate while severe head injury was labeled when GCS was $\leq$ 8 at presentation. Canadian CT Head Rule was used for performing CT scan brain in patients with GCS 13 – 15 at presentation. (45) However, all patients with GCS $\leq$ 12, age younger than 16 years, on anticoagulation therapy or bleeding disorder were the candidates for CT brain.

Patients with mild head injury and normal CT brain were discharged after initial emergency management; however, all patients with moderate to severe head injury were offered admission in neurosurgical unit. Patients with more severe injuries of other organ systems were admitted under respective services with routine neurosurgical follow-up.

RESULTS

Over the two- year study period, 1378 patients were included in the study. Out of which 1057 (76.7%) were males and 321 (23.3%) were females. The mean age at presentation was 29.2 years (3 months – 72 years). The most common age group was 21-30 years with 470 (34.1%) patients, followed by 331 (24.02%) patients between 31-40 years (Table I).

Majority (58.3% n=803) of patients arrived at the A & E department between 2-6 hours following trauma. Only 17.2% (n=237) patients were brought at the A & E within 2 hours while 338 (24.5%) patients reached A & E more than 6 hours after injury.

Road Traffic Accident (RTA) was the predominant cause of TBI with 862 (62.6%) patients. A great majority (61.3%; n=528) of RTA victims were two-wheel riders, 114 (13.2%) were car occupants, 196 (22.7%) were pedestrians and 24 (2.8%) were others (Table II). Only 5 (0.94%) bike riders were wearing proper helmets and 1 (0.87%) car occupant was wearing seat belt at the time of accident. Twenty-six (1.88%) of our patients were found to be intoxicated with alcohol.

Fall from height was the second commonest cause of TBI with 437 (31.7%) patients presenting with this history. Two hundred and fifty eight (59%) patients fell from stairs, 58 (13.3%) from roof top, 72 (16.5%) from balcony, while 49 (11.2%) patients fell from electric pole. Seventy-six (5.5%) patients in the study were the victims of assault with 61 (80.2%) blunt weapon assault, 4 (5.3%) sharp weapons assault and 11 (14.5%) sustaining firearm injuries.

Table I: Distribution of Age and Gender

Age (Years)	Patients	Male	Female
$\leq$ 10	62 (4.49%)	41 (66.12%)	21 (33.87%)
11-20	209 (15.16%)	151 (72.24%)	58 (27.75%)
21-30	470 (34.10%)	414 (88.08%)	56 (11.91%)
31-40	331 (24.02%)	271 (82.17%)	60 (18.12%)
41-50	104 (7.54%)	81 (77.88%)	23 (22.11%)
51-60	111 (8.05%)	96 (86.48%)	15 (13.51%)
60+	91 (6.60%)	79 (86.81%)	12 (13.18%)
	1378	**1057 (76.7%)**	**321 (23.3%)**

The table depicts age-specific distribution of patients with respect to gender.

Table II: Mode of Injury

MODE		FREQUENCY
RTA		**862 (62.6%)**
	2-wheeler	528 (61.3%)
	4 wheeler	114 (13.2%)
	Pedestrian	196 (22.7%)
	Train	24 (2.8%)
Fall		**437 (31.7%)**
	Roof top	58 (13.27%)
	Stairs	258 (59.03%)
	Balcony	72 (16.47%)
	Pole	49 (11.21%)
Assault		**76 (5.5%)**
	Blunt	61 (80.2%)
	Sharp	4 (5.3%)
	Firearm	11 (14.5%)
Other		**3 (0.21%)**

The table depicts the distribution of the various modes of injury.

GCS at presentation was 13-15 in 893 (64.8%) patients, 9-12 in 382 (27.7%) and ≤ 8 in 103 (7.5%) patients.

A total of 1241 (90.05%) patients were the candidates for CT scan brain. An overwhelming number of patients (55.7%) had a normal CT scan. However, brain contusion was seen in 175 (14.1%) patients, sub-arachnoid hemorrhage (SAH) in 88 (7.1%), acute sub-dural hematoma (SDH) in 94 (7.6%), extra-dural hematoma (EDH) in 72 (5.8%), depressed skull fracture in 57 (4.6%) while pneumocephlous was the predominant finding on 63 (5.1%) CT scans (Table III).

All patients with moderate to severe TBI were offered admission in addition to 97 (10.86%) patients with mild TBI.

Table III: CT Scan Findings

CT Finding	Mild	Moderate	Severe
Contusion	21	118	36
SAH	17	60	11
EDH	12	54	6
SDH	3	61	30
Depressed fracture	11	43	3
Pneumocephalus	11	46	6
TOTAL	**75**	**382**	**92**

The table depicts the positive CT scan findings with respect to severity of injury.

Neurosurgical intervention was performed in 82 (79.6%) patients with severe TBI and 196 (51.3%) with moderate TBI (Table IV).

The mean hospital stay in patients with mild head injury was 1.17 (1-3) days, with moderate head injury 6.69 (3-21) days and with severe head injury 22.09 (8 – 120) days. The overall mean hospital stay was 8.49 (1 – 120) days.

Majority (77.9%) of our patients had a complete recovery after TBI. Prolonged rehabilitation was required in 17.8% of the patients having moderate to severe disability. A total of 103 (7.4%) of patients expired in our study (Table V).

DISCUSSION

Head injury is considered as a "Silent epidemic of the post-industrialization era" by some authors, with concussion being the hallmark of TBI (40). Although loss of consciousness and post-traumatic amnesia (PTA) are markers for severity of illness, it has conventionally been classified on the basis of GCS at presentation as mild (13-15), moderate (9-12) and severe (≤ 8). However, this has recently been debated if GCS 13 should be classified as moderate TBI, since studies have shown that they have higher risk of an abnormal CT scan finding (23,38).

In our study, males of third and fourth decade were the predominant victims of TBI. Although male gender is an independent risk factor for TBI (26,43); it is unclear whether it has any impact on the outcome. Bazarian JJ et al. found poorer outcome after mild TBI in females (4). The age specific incidence of TBI has been estimated as bimodal with one

Table IV: Surgical Procedures

Surgery	Mild	Moderate	Severe
Contusionectomy	0	47	29
Decompressive Craniotomy	0	0	5 2 (After 24 hours)
SDH	1 (After 4 weeks)	42	30
EDH	5	41	6
Elevation of depressed Fracture	7	32	3
Base repair	1	7	2
Wound debridement	3	27	5
	17	**196**	**82**

The table depicts various surgical procedures with respect to the severity of injury.

Table V: Glasgow Outcome Score (at 6 months)

GOS	Mild	Moderate	Severe	Total
5	893 (100%)	180 (47.1%)	-	1073 (77.9%)
4	-	102 (26.7%)	-	102 (7.4%)
3	-	88 (23%)	21 (20.4%)	110 (7.9%)
2	-	12 (3.1%)	23 (22.3%)	35 (2.5%)
1	-	-	59 (57.3%)	59 (4.3%)
	893	**382**	**103**	**1378**

Table depicts the GOS with respect to the severity of injury.

peak at 15-24 years and another after 65 years (49). In our study most of the patients were in the third decade of life. Similarly, Raja at al. (34) and Jooma et al. (18) in two separate studies estimated second and fourth decade respectively as the most vulnerable age group from the same region. Most of our patients took at least 2 hours to reach the hospital. This crucial delay depicts the sub-optimal first aid services at the site of scene along with gloomy traffic condition in the city. Some of the casualties are even brought in private transport (17). Furthermore, there is no concept of air ambulance to transfer the most critically ill patients. Recently, there has been an upsurge in availability of ambulance services with trained paramedics in our part of the world. Generalization of this facility will have promising results in reducing preventable morbidity and mortality.

Etiologically, RTA was the commonest cause of TBI in our study. This may be attributed towards the high traffic density, lack of traffic rule awareness and most importantly neglect of safety measures. Hyder et al. (16) demonstrated proportional increment in RTA associated deaths with increasing level of motorization in Pakistan. Although helmets have proven efficacy in preventing TBI for two-wheel riders (30,33,35); less than 1% of our patients were wearing proper helmets with appropriate straps. A local publication has estimated the prevalence of helmet usage as 3% which is far from satisfactory (17). Additionally, habit of wearing helmet is almost non-existent amongst pillion riders and specially children and females. Moreover, wearing helmets and seat belts are not compulsory and certain cars are even made without seatbelts (34).

Alcohol intoxication is a major culprit in severe TBI after RTA in western world (14). The proposed mechanism for more severe injury is a combination of altered sensorium, impaired decision making, brain atrophy, along with potentiation of effects of TBI on neurons in presence of ethanol (24). However, in our region its prevalence is low and therefore only 26 (1.88%) patients in our study were intoxicated at the time of accident. This figure may have been underestimated since the information was only extracted from history and other confounding evidences.

Fall from height is a common cause of TBI especially in children and females (18,34). This is principally attributed to flaw in designing of fenceless roofs with working, sleeping, playing and flying kites on it as causal factors. Children are especially prone to fall from stairs and balcony as a result of parental negligence. They may also fall while climbing trees and fences. Additionally fall from pole is an occupational hazard in the absence of adequate safety precautions. This is aggravated by unsafe handling of high tension wires and is frequently associated with electro-cautery.

TBI following assault is common in our country because of relatively easy access to weapons in addition to illiteracy and poverty. The weapons may be blunt/sharp objects (e.g. iron rod, axe) or firearm (e.g. gun shot, blasts). Blunt assault is usually associated with communicated depressed fractures while sharp assaults are associated with linear depressed fractures. Skull fracture itself is considered as an independent risk factor of mortality in severe blunt TBI (51).

During the first 24 hours following TBI CT scan is the imaging modality of choice (12). Recent evidence suggests that MRI is at least as accurate as CT in detecting acute hemorrhage (21). It is yet to be established as the first choice investigation in acute phase. Nonetheless, CT scan is superior in assessing bony pathologies, more readily available, swift (41); and correlates with the outcome (48). Although CT scan finding may lag behind actual intracranial damage especially if performed within first 3 hours of injury (37), it is still debatable if it should be repeated in absence of neurological deterioration (9,11,42). Stippler M et al. (46) in a review of literature concluded that routine follow-up scan did not predict the need for neurosurgical intervention however, deterioration of neurological status did. Moreover, hemorrhagic progression was estimated at 19.9% (n = 324). Another study from our institution estimated the yield of repeat CT scan at only 6% (28).

As the composition of blood changes over time, the ability of MRI to detect hematoma increases. Conversely, 48 to 72 hours after trauma MRI becomes a superior imaging modality (24). It is also considered superior for visualizing deeper brain structures and in detecting abnormalities missed by CT scan, especially diffuse axonal injury, minor contusions and restrained neuronal damage. Additionally small acute or subacute subarachnoid hemorrhage can be picked up with FLAIR sequences of MRI (3). Nonetheless, it is yet to be established if detecting additional lesions using MRI would have any significant impact on acute management.

We have used Canadian CT head rules (CCHR) for imaging patients with mild TBI. The criteria rest upon certain high and medium risk factors for neurosurgical intervention (45). Stiell et al. (44) compared sensitivity and specificity of CCHR with New Orleans Criteria (NOC) and found that both rules were 100% sensitive for neurosurgical intervention while conversely CCHR was far more specific (76.3%) than NOC (12.1%). Similar results were observed by Papa L et al. (31) Headache, vomiting, LOC or amnesia, and alcohol intoxication have been estimated as major predictor of positive CT scan (1,39). Leong LB et al. (25) in a study on 2038 cases concluded vomiting, LOC and amnesia as predictors of abnormal CT scan. However, in our study CT scan was performed in 756 (84.65%) patients, out of which only 75 (9.92%) had positive CT findings.

Amongst patients with extra dural hematoma, those with clot thickness $\geq$ 1 cm or midline shift, with deteriorating neurology are the candidates for emergent surgical evacuation (20). Patients who have evolving contusions on initial scan are followed neurologically and radiologically. Those who show increase in size of contusion on repeat CT scan undergo contusionectomy or lobectomy.

Incidence of SDH has been estimated up to 5% (29) with mortality as high as 1 out of 5 cases (50). However, mortality

is directly correlated with pre-operative GCS and interval between trauma and surgery (6,22,50).

Penetrating brain injuries (PBI) are commonly caused by firearms and carry a worse prognosis (13,32). They have a higher mortality if it is suicidal, or the pattern of brain injury is bihemispheric, multilobar or with intraventricular extension (2). Since these injuries are more localized in civilian population, they carry a better prognosis than warfare PBI (32). These are managed with early surgical debridement in combination with prophylactic antibiotics. While removal of foreign body from eloquent brain area reduces the risk of post-traumatic epilepsy, it should be weighed against increased morbidity (8,47). Recent recommendations suggest more extensive antibiotic coverage and less aggressive surgical debridement of deeper fragments (19). However, some authors recommend more extensive surgical debridement in cases of military PBI (5).

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