Traumatic brain injury: Does gender influence outcomes?

Ashok Munivenkatappa, Amit Agrawal\textsuperscript{1}, Dhaval P. Shukla\textsuperscript{2}, Deepika Kumaraswamy, Bhagavatula Indira Devi\textsuperscript{2}

ABSTRACT

Background: Traumatic brain injury (TBI) is a major public health problem. Both genders are affected, but little is known about female TBI. The present study exclusively explores epidemiological, clinical, imaging, and death aspects of female TBI, and how it differs from males.

Methods: It is a retrospective study. Data were documented from a tertiary institute during January 2010 to March 2010. All variables were documented on standard proforma. The data were analyzed using R statistics software. Age group was categorized into pediatric (<18 years), middle (19–60 years) and elderly (>61 years). Significance was tested using Chi-square test at the significance level of \( P < 0.05 \).

Results: Data of 1627 TBI patients were recorded. Of the total, female TBIs contributed nearly 20\%. Compared to males, female patients reported higher percentages in manifesting symptoms (84.3\% vs. 82.6\%), injuries due to fall (32.1\% vs. 24.4\%), and surgical interventions (11.6\% vs. 10.4\%). Female patients were significantly higher in mild head injury group (76.8\% vs. 69.5\%, \( P = 0.016 \)) and mortality (3.4\% vs. 1.6\%, \( P = 0.048 \)). Number of patients and deaths was more among females than males in pediatric and elderly age group. Severities of injuries were more among female patients than male patients in middle and elder age groups.

Conclusion: The study results observe that female TBI group differ significantly in the severity of injury and mortality.

Key Words: Epidemiology, female gender, traumatic brain injury

INTRODUCTION

Traumatic brain injury (TBI) is a major public health problem as evidenced by both clinicians and epidemiologist in India. Disability due to neurological illness ranks third in India; the major contributor is TBI.\textsuperscript{1} Rapid increase in population, motorization, and industrialization in our country has contributed to the significant increase in TBI. TBI results in deaths, injuries, and disabilities of all age groups, especially young and productive people.\textsuperscript{2,3}

Gender has a significant effect on TBI,\textsuperscript{4} although both men and women experience brain injury there is the difference in them in the epidemiological, clinical, imaging, and outcome.\textsuperscript{5,6,7} Majority of the studies on TBI emphasize more on male population as the incidence of TBI is more in male population. If stated, only few variables related to the female population are highlighted. In the literature, the characteristics or differences unique to female patients with TBI has not been explored in great detail. The present study scrutinizes epidemiological, clinical, imaging, treatment, and mortality variables exclusively among female TBI patients. The study also

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This study was conducted in National Institute of Mental Health and Neurosciences, a tertiary-level referral center for neuroscience that has exclusive trauma care facility for TBI patients. The patients with brain injury are evaluated by neurosurgery residents and patients details are entered on a structured head injury pro forma. These data are verified by a qualified duty neurosurgeon. Data of all patients with TBI who presented to casualty over a period (from January 1, 2010, to March 15, 2010) were retrospectively reviewed. The following variables were analyzed: Demographic details such as age, gender, the cause of the injury; clinical data like time since injury, injury severity, symptoms manifestation; computed tomography (CT) scan findings such as intracranial bleed, skull fractures; treatment like medical or surgical management; and mortality at discharge. The data were categorized into pediatric (<18 years), middle age (19–60 years), and elderly age (>61 years).

Analysis
The statistical analysis was performed in R statistics (R.3.2.0) (Institute for Statistics and Mathematics of WU (Wirtschaftsuniversität Wien)). Data were expressed using descriptive statistics such as mean and standard deviation for continuous variables, and frequency and percentage for categorical variables. Chi-square test was used among categorical data with $P < 0.05$ as significance.

RESULTS

Demographic and clinical symptoms
During the study period, there were 1627 patients with head injuries. Of them, 293/1627 (18%) were female patients. Their mean age for female patients was 35.06 ± 20.95 years. The incidence of TBI was higher in first, fifth, and the sixth decade among the female patients as compared to males [Figure 1]. Mean duration for the female patients to reach hospital was 18 h 27 min which was lesser than male patients (19 h 29 min).

The severity of brain injuries assessed by Glasgow coma scale (GCS) among female patients revealed 225 (76.8%) mild injuries, 37 (12.6%) moderate and 31 (10.6%) severe injuries. The manifesting symptoms among female TBIs are; loss of consciousness 152 (51.9%), vomiting in 154 (52.6%), ear or nose bleeding 71 (24.2%), seizures in 20 (6.8%), headache in 4 (1.4%), and limb weakness in 2 (0.7%). Road traffic accidents was a major cause of injury 168 (57.3%), followed by falls 94 (32.1%), assaults 26 (8.9%), and others 5 (1.66%).

Imaging findings
Among female patients head, CT was abnormal in 177 (60.4%). The abnormal CT findings included parenchymal contusion 70 (23.9%), extradural hematoma 23 (7.8%), subdural hematoma subdural hemorrhage (14%), subarachnoid hemorrhage (4.4%), cerebral edema 72 (24.6%), petechial hemorrhage 5 (1.7%), ventricular hemorrhage 4 (1.4%), infarct 4 (1.4%), skull fracture 61 (20.8%), and pneumocephalus 10 (3.4%).

Treatment and discharge outcome
Majority of patients were managed medically, but however, 34 (11.6%) patients required surgery for emergency hematoma evacuation. Nearly, 33% of patients with severe TBI underwent surgery. Ten (3.4%) patients expired. Tables 1a and b depict details of GCS, cause, symptoms, image findings, treatment, and outcome in both genders and different age groups.

DISCUSSION
Our study summarizes that female population contributes to nearly one-fifth (18%) of the total brain injuries. Highest percentage of brain injuries are appreciated in the third decade (19.8%) followed by fifth (17.5%) and first decade (17%) [Figure 1]. Severity of injury as measured by GCS was significant between female and male. There was a significant difference in mortality between female (3.4%) and male (1.6%).

We found that there was larger proportion of females in age group of <18 years. Mild head injuries were more in females especially in pediatric and elderly age group. Patients in middle age manifest with higher percent whereas pediatric and elderly age report the lesser percent of symptoms as compared with males. In pediatric and elderly age group, the road traffic injuries were lesser and falls were more in females as compared with males. Among females only in elderly age group showed the higher percent of abnormal image findings.
The present study reports high male to female ratio that is 4.5:1 as males are common road users, and are predominantly affected in road traffic injuries and also most commonly involved in disputes. The high ratio of male to female injury is difficult to explain based on place of data acquisition as gender ratio is nearly same (male:female, 1:1:1). High male:female (>4:1) ratio was reported from a South African study. Our study revealed a higher proportion of females in third decade followed by fifth and first decade. We found that nearly two-third of female patients were in a third to sixth decade. The reason might be that these age groups are more vulnerable to road injuries and disputes. Studies from the USA, France, and Eritrean have shown a higher incidence of brain injuries in female in first, second and third decade. Age group <18 years contributes to one-fourth percent of total injuries which is more than male pediatric group. This age group is frequently affected by falls. High percent of mild head injuries are noted in pediatric TBI importantly in both genders, but in the current study proportion of females with TBI was higher (77%) than male in mild injury category. Significance in the severity of injury between female and male is documented with respect to specific risk factors. A meta-analysis observed that female patients with TBI report a higher number of trauma symptoms as compared to males. Our study reports that female in third to sixth decade reports higher percentages of posttraumatic symptoms than males. The females in reproductive age group as an effect of hormonal influences have reported inconsistent posttraumatic symptoms. Studies have reported that among pediatric and elderly age groups falls is the common mode of TBIs. We could appreciate same in our results, but the percentage of female patients is more than male group.

A study from Eritrean has reported that an abnormal CT finding is about 54.5% in all the severities of brain injuries in both the gender. Our study reports higher percent of abnormal CT findings (71.6%) in all severities and both gender, but the elderly female category had higher percentage of abnormal CT findings than elderly male group. In our study, we found that female patients with severe TBI had higher requirement neurosurgical intervention than their male counterparts, which is similar to the findings from Sweden study. The

### Table 1a: Female and male pediatric, middle and elderly patients; mode of injury, clinical symptoms, emergency evaluation and image findings with outcome

| Variables     | Female (293) n (%) | Male (1334) n (%) | \( P < 0.05 \) |
|---------------|--------------------|-------------------|---------------|
| Age (years)   |                    |                   |               |
| GCS Mild      | 225 (76.8)         | 923 (69.5)        | 0.016         |
| Severe        | 37 (12.6)          | 259 (19.1)        |               |
| Symptoms      |                    |                   |               |
| Present       | 10 (3.4)           | 22 (1.6)          | 0.048         |
| Cause RTA     | 168 (57.3)         | 860 (64.5)        | 0.201         |
| Falls         | 26 (8.9)           | 112 (1.8)         |               |
| Assault       | 1 (0.33)           | 23 (1.7)          |               |
| Others        | 5 (1.66)           | 35 (2.7)          |               |
| CT Abnormal   | 177 (60.4)         | 845 (63.3)        | 0.576         |
| Surgery Done  | 34 (11.6)          | 139 (10.4)        | 0.551         |
| Mortality     |                    |                   |               |

### Table 1b: Female and male number and percentages of mode of injury, clinical symptoms, emergency evaluation, and image findings with outcome

| Variables     | Females (293) n (%) | Males (1334) n (%) | \( P < 0.05 \) |
|---------------|---------------------|--------------------|---------------|
| Age (years)   | 35.06               | 33.67              | 0.212         |
| GCS Mild      | 225 (76.8)         | 923 (69.5)         | 0.016         |
| Severe        | 37 (12.6)          | 259 (19.1)         |               |
| Symptoms      |                    |                   |               |
| Present       | 10 (3.4)           | 22 (1.6)          | 0.048         |
| Cause RTA     | 168 (57.3)         | 860 (64.5)        | 0.201         |
| Falls         | 26 (8.9)           | 112 (1.8)         |               |
| Assault       | 1 (0.33)           | 23 (1.7)          |               |
| Others        | 5 (1.66)           | 35 (2.7)          |               |
| CT Abnormal   | 177 (60.4)         | 845 (63.3)        | 0.576         |
| Surgery Done  | 34 (11.6)          | 139 (10.4)        | 0.551         |
mortality report of the study demonstrates that the percentage of female group is significantly more than male group. TBI-induced death at 1 year follow-up study from Scotland reports the percentage of deaths in female (13.5%, 21/156) is more than male (8.5%, 52/611).[17] The mortality after TBI is higher in females as compared to males.

Main limitations of this study are that it is a retrospective study. The data were recorded from head injury proforma, where variables were limited. Proper plan for a prospective study with detailed variables will provide more insight. However, the present study provides basic details of TBI. The study is limited to discharge outcome. A follow-up study documenting serial posttraumatic symptoms and quality of life would have been more effective. The sample size for the study was not calculated. The present study comprises of 293 female TBI patients for a period of 2½ months. An institute study from Asmara, Eritrea reports about 28 female injury patients for 5 months duration.[9] A female domestic violence based study from three metropolitan cities report 169 patients for a period of 7–9 months.[9] Even though the sample size was not planned for the present study, the number of patients reported from a single institute for female TBI seems to be good for the mentioned duration as compared with existing literature. The study lacks statistical evidence for the same.

CONCLUSION

The present study highlights that even though the incidence of TBI is lesser in female population; they have a higher percentage of abnormal image findings in elderly group, needs higher neurological intervention and reports high number of deaths. The researchers in brain injury should strongly consider gender difference and explore in detail. Importance should be given while considering female patients with TBI.

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Conflicts of interest
There are no conflicts of interest.