Prevalence and Outcomes of Geriatric Traumatic Brain Injury in Developing Countries: A Retrospective Study

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Abstract

Introduction The world populace is aging and it is anticipated that 2 billion people will be older than 60 years by 2050. Traumatic brain injury (TBI) is a major cause of death and disability worldwide. In the United States, 2.8 million people pursue medical attention yearly. TBI exemplifies a leading cause of mortality and morbidity among the geriatric age group worldwide.

Methods A retrospective study of geriatric cases who were admitted to the Neurosurgery Department in Khoula Hospital from January 1, 2016, to December 31, 2019, was conducted. Patients' demographics, risk factors, neuro-vital sign, diagnosis, Glasgow coma scale (GCS) on arrival, treatment types, and length of stay (LOS) were recorded.

Results Two hundred and thirty-four patients were admitted due to TBI in four years period. Seventy-five percent of the study cohort were more than 75 years old. Male to female ratio was 2.4:1. Subdural hematoma (SDH) was the most common TBI diagnosis based on computed tomography (77.4%). Most of the patients were having GCS scores of 14 to 15 (67.9%). Sixteen percent of the patients received antiepileptic medications. The majority of the patients underwent surgical intervention (70.5%). Eighty percent of the patients stayed in the hospital for less than 15 days. There was a significant difference between the LOS and type of surgery. Subarachnoid hemorrhage was found to have the highest mean age (79.7 years). Intracerebral hemorrhage patients had the longest LOS in the hospital with a mean of 44.2 days. There was no significant difference between the age of patients and type of surgery.

Conclusion The number of TBI in the elderly population is increasing annually. The most common type of TBI in our cohort was SDH and most of the patients were treated with burr hole surgery.

Keywords
- traumatic brain injury
- surgery
- geriatric
- hematoma

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Introduction

The world populace is aging and it is anticipated that 2 billion people will be older than 60 years by 2050.[1] Traumatic brain injury (TBI) is a major cause of death and disability worldwide.[2] In the United States, 2.8 million people pursue medical attention yearly.[2] TBI is referred as the silent epidemic, as the problems arise from TBI are often invisible.[3] The elderly population can be defined as those having age greater than or equal to 65 years.[4] TBI exemplifies a leading cause of mortality and morbidity among geriatric age group.[2] There has been a shift in the epidemiology of TBI as it has been prevalent in young people. However, nowadays it is more prevalent toward elderly patients. This can be due to the increase in the life expectancies and significant reduction in traffic accidents.[2] Males in their middle age are predominately affected with TBI due to their higher contribution in outdoor activities and motor vehicle accidents.[4] TBI accounts for up to 10% of health care budget.[5] Falls, from standing heights, are the primary mechanism of TBI in elderly population.[6] Nearly 8% of elderly visit to the emergency departments are due to fall-related injuries.[7] Several physiological changes put the elderly population at high risk. For instance, dura adherence to skull, cerebrovascular atherosclerosis, and bridging vein fragility are all factors that increase the frailty of this age group, as well as the increased usage of anticoagulant medication.[6] Seventeen percent of elderly presenting with TBI had a normal neurological examination and Glasgow coma scale (GCS). The existence of comorbid conditions such as hypertension, bleeding disorder, and diabetes mellitus in the elderly population is associated with much worse outcomes after TBI.[6] TBI can be classified into three categories according to severity: mild, moderate, and severe. Each category is classified according to structural imaging, loss of consciousness, mental state, posttraumatic amnesia, and GCS.[8] The pathophysiology of TBI occurs in two consequent stages. The initial stage is due to direct tissue damage and impaired autoregulation of cerebral blood flow. This stage is similar to ischemic brain injury. The second stage is illustrated by sustained membrane depolarization and excitation and the consequent activation of voltage-depending calcium and sodium channels. Mortality rates for older patients with mild TBI are higher compared with younger population.[7] Also, elderly with TBI required more medical care and consultations, and had more complications compared with younger age group.[7] Multiple studies have showed that older age is an independent predictor of poor outcomes following TBI.[4]

The aim of this study is to retrospectively analyze the prevalence and outcome of TBI in the Department of Neurosurgery in a tertiary hospital in Oman as an example of a developing country in the Middle East. The health care services in Oman are considered as having one of the best health care systems in the world according to World Health Organization reports.[9,10] The Department of Neurosurgery in Khoula Hospital (KH) is the main neurosurgical center in the country with average admission of 1,600 patients annually.[11,12] In this study, we chose a cut of 65 years and older according to the local definition, taking into account the increase in life span throughout the last decades as well as the improvement in the quality of life.

Methods and Study Design

Study Group

This is a retrospective study conducted at KH located in Muscat, Sultanate of Oman. The study was approved by the Research Ethical Committee at Khoula Hospital/ Ministry of Health (ID:PRO122020072). Medical records of 234 patients who are above the age of 65 and admitted to the neurosurgical ward and diagnosed with TBI, from the period of January 1, 2016, to December 31, 2019, were included. The study includes both Omani and non-Omani patients. Patients with the following features are excluded: nonelderly patient (below 65 years), non-TBI cases, outside the study period (from January 1, 2016, to December 31, 2019), and patients with missing or incomplete data.

Data Collection

Data were obtained from the health information system, which included: patient demographics (age, gender), preoperative and postoperative GCS, radiological findings, indication for surgery, diagnosis, hospital length of stay (LOS), length of intensive care unit (ICU) admission, and treatment proposed. Data on treatment modality, including surgery or conservative management, were collected.

Data Analysis

Research database is analyzed and processed using the Statistical Package for the Social Sciences software (version 23). The categorized variables were cross-tabulated using frequency tables and pie charts or bar charts. Chi-square test was used to obtain the significance of the association between categorized variables, using a p-value of ≤ 0.05 as the cut-off for significance.

Results

Patients' Demographics

►**Table 1** demonstrates the demographic characteristics of the included cases in the present study. We have total of 669 patients admitted in neurosurgical department at KH in Muscat, the capital city of Sultanate of Oman, in 4-year period (from 2016 to 2019). Out of those 669 patients, 234 patients were admitted due to TBI, which will be the main focus of the present study. Also, 75.6% of the study cohort were more than 75 years old. Male to female ratio was 2.4:1. Subdural hematoma (SDH) was the most common TBI diagnosis based on computed tomography (CT: 77.4%) followed by contusions (7.3%). Most of the patient were having GCS score of 14 to 15 (67.9%). Also, 16.2% of the patients received antiepileptic medications, most commonly phenytoin. Most of the patients underwent surgical intervention (70.5%), and 80.3% of the patients stayed in

Table 1 Demographic characteristics of the geriatric patients

Category	Number of patients (%)
Number of patients admitted each year	
2019	202 (30.0%)
2018	172 (25.7%)
2017	154 (23%)
2016	141 (21.3%)
Total number of admitted neurosurgical cases (2016–2019)	669
Total number of TBI cases	234
Age	
≥75	177 (75.6%)
<75	57 (24.4%)
Gender	
Female	69 (29.5%)
Male	165 (70.5%)
TBI diagnosis based on CT	
SDH	181 (77.4%)
EDH	5 (2.1%)
SAH	3 (1.3%)
ICH	6 (2.6%)
Multicompartmental hemorrhage	7 (3.0)
Contusion	17 (7.3%)
[a]Others	15 (3.7%)
GCS on arrival	
15–14	159 (67.9%)
13–12	22 (9.4%)
11–9	17 (7.3%)
<8	36 (15.4%)
Prophylactic antiepileptic Drugs	
Yes	38(16.2%)
No	196 (83.8%)
Type of interventions	
Surgical	165 (70.5%)
Conservative	69 (29.5%)
Length of stay	
≤15 days	188 (80.3%)
>15 days	46 (19.7%)

Abbreviations: CT, computed tomography; EDH, epidural hemorrhage; GCS, Glasgow coma scale; ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage; SDH, subdural hemorrhage; TBI, traumatic brain injury.
[a]Others: Skull fractures, sublegal hemorrhage, skin wound.

the hospital for less than 15 days. Moreover, 15.8% were on anticoagulants while 20.5% were on antiplatelets. Systolic blood pressure (SBP) of patients was maintained, 92.7% were above 90 mm Hg.

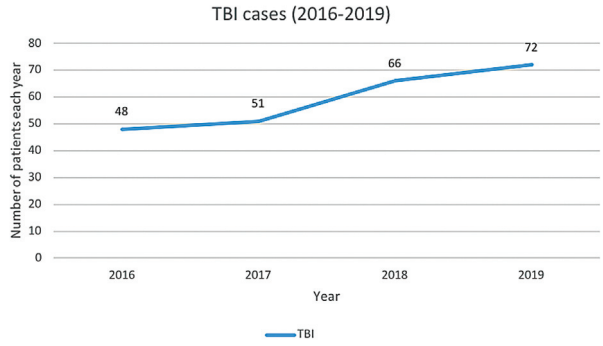

Fig. 1 Total number of admitted patients with traumatic brain injury (TBI) in each year.

Annual TBI Cases

►**Fig. 1** represents the total number of admitted patients with TBI in each year. As seen in the graph, trauma cases were continuously rising among the study years with the highest number of cases in 2019 ($n = 72$, 30.7%).

Association between Age and Surgery Type, Use of Antiepileptic Medications, and Glasgow Coma Scale in TBI

The association between the age of the patients and other variables (surgery type, use of antiepileptic medications, and GCS) is shown in ►**Table 2**. It represents that there is no significant difference between age of patients above and below 75 years and type of surgery (burr hole versus craniotomy). The burr hole and evacuation of hematoma surgery was found to be at a higher rate in the older age group (more than 75 years; $p = 0.690$). Also, it is showing that there is no association between age above and below 75 years and the usage of antiepileptic medications as a prophylactic measure postoperatively ($p = 0.257$). There was no significant association between age above and below 75 years and the GCS scale (above and below 8; $p = 0.922$).

Association between Length of Stay and Surgery Type, Use of Antiepileptic Medication, and Glasgow Coma Scale in TBI

►**Table 3** represents the association between the LOS of the patients and other variables (surgery type, use of antiepileptic medications, and GCS). It is showing that there is no significant relationship between the type of intervention (surgical or conservative) and LOS (15 days as a cut-off value). The group that underwent surgical intervention was found to have similar LOS compared with the other group ($p = 0.875$). Also, it is showing that there is a significant difference between LOS and type of surgery (burr hole versus craniotomy), in which the burr hole surgery (BHS) was found to be at a higher rate in the older age group (more than 75 years; $p < 0.005$).

Association between Age and Length of Stay in TBI

The association between the age and the LOS in different types of TBI is represented in ►**Fig. 2**. It shows the average age of the patients among the different types of TBI based on

Table 2 The association between the age of the patients and other variables (surgery type, use of antiepileptic medications, and GCS)

		Surgery type		Antiepileptics		GCS	
		Burr hole and evacuation	Craniotomy/ craniectomy and evacuation	Yes	No	GCS less than 8	GCS more than 8
Age	Less than 75 years	33	6	12	45	9	48
	More than 75 years	106	20	26	151	27	150
p-Value		0.690		0.257		0.922	

Abbreviation: GCS, Glasgow coma scale.

Table 3 The association between the length of stay of the patients and other variables (surgery type, use of antiepileptic medications, and GCS)

LOS	Age		Type of surgery	
	<75 years	≥ 75 years	Craniotomy	Burr hole
Less than 15 days	41	147	15	118
More than 15 days	16	30	11	21
p-Value	0.066		0.001	

Abbreviations: GCS, Glasgow coma scale; LOS, length of stay.

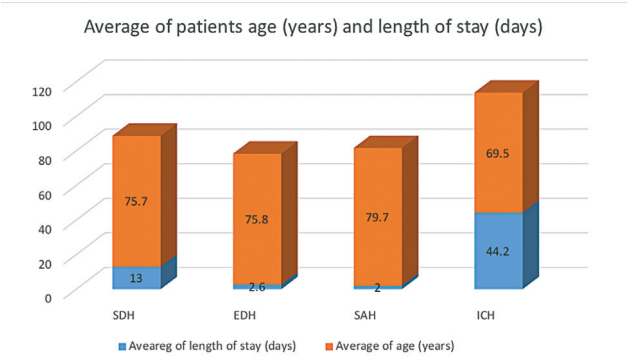

Fig. 2 Average of patients' age (years) and length of stay (days) in different types of traumatic brain injury based on computed tomography findings. EDH, epidural hemorrhage; ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage.

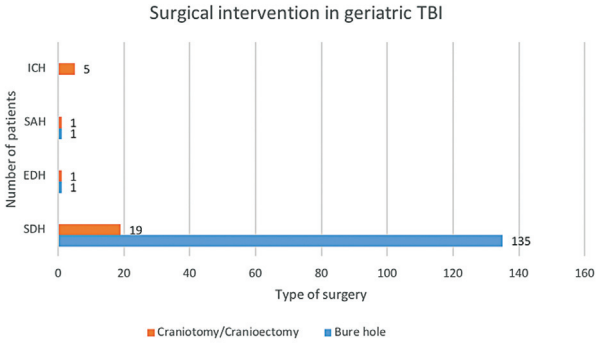

Fig. 3 Type of surgical intervention among different TBI diagnostic subcategories based on computed tomography findings. EDH, epidural hemorrhage; ICH, intracerebral hemorrhage; SAH, subarachnoid hemorrhage; TBI, traumatic brain injury.

CT, in which the subarachnoid hemorrhage was found to have the highest mean age (79.7 years) followed by epidural hemorrhage and SDH respectively (75.8 years, 75.7 years). The figure shows that the intracerebral hemorrhage (ICH) patients had the longest LOS in the hospital (mean of 44.2 days) followed by SDH (mean of 13 days).

Type of Surgical Intervention in TBI

►**Fig. 3** is showing the type of surgical intervention in the patients among the different types of TBI based on the CT findings. SDH was found to have the highest rate of BHS ($n=135$) compared with other TBI subcategories. The use of craniotomy/craniectomy was also highest among SDH patients ($n=19$), followed by ICH ($n=5$).

Pyramid for Omani Population

The population pyramid for Omani population for both genders is shown in ►**Fig. 4**. According to the pyramid of population, it is obvious that the Omani population is a young population, majority lying between 25 and 34 years of age. Not just that, clearly the number of males in Omani population is more than females.[13]

Discussion

It is estimated that almost 10 million people are affected yearly by TBI, including the geriatric population.[14] The elderly population has been increasing in the past decade due to advancements in the health care sector and the

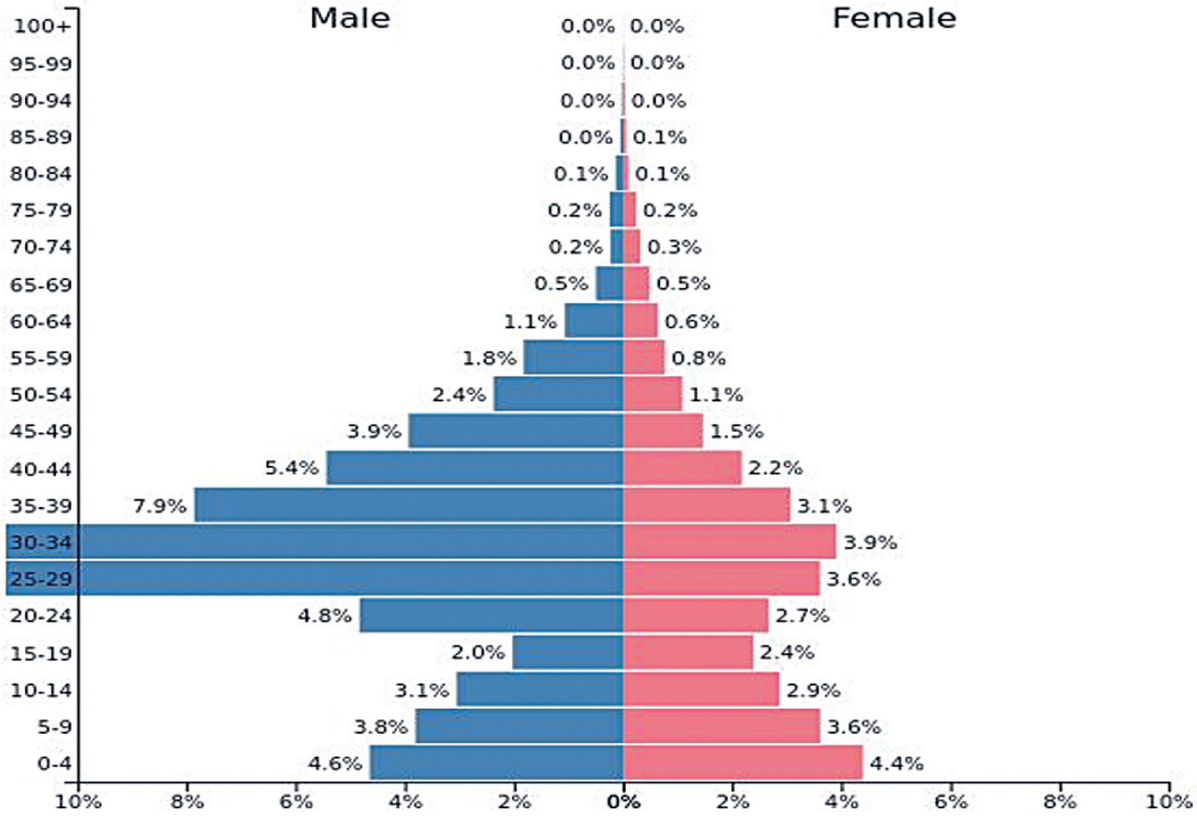

Fig. 4 The Omani population pyramid.

techniques of treatment delivery. A value of 18% is made worldwide for the elderly population to be by 2060.[15] In our cohort, the cut-off age of patients was 75 years and this represented two-thirds of our study group. This was explained by the fact that the average life expectancy of Omani population in both genders was 77.95 years. Reflecting in our study, the number of males is more than double the number of females; this was contrary to other studies in which female population was higher compared with male population. Yet, this is consistent with the population pyramid of Oman. In Oman, the statistics show that the male to female ratio is 180.8 males per 100 females according to latest counts.[13]

TBI remains common in the elderly population as falls account for the majority of injuries in this population. According to Yokobori et al, nontraffic-related accidents including falls have significantly increased over the past years.[16] It is known that the mechanism of TBI in elderly differs from the mechanism of TBI in younger population. Multiple factors increase the risk of TBI, such as atrophy of the brain, which is associated with increase in age, which increases the gap between brain and the skull causing the dura vessel to be more prone to shear damage. Other risk factors include mild cognitive impairments or dementia, comorbid conditions, and polypharmacy.[2]

Several studies showed an incongruity of observed GCS between elderly and young patients with analogous anatomic severity of TBI, with elderly TBI having better GCS than younger. This generates a false idea that elderly could tolerate TBI better. The mechanism of this phenomenon is unknown. This suggest that GCS and neurology examination cannot alone rule out significant intracranial pathology in the elderly.[2] Almost 70% of our cohort had a GCS of 14 to 15 on arrival.

SDH is expected to increase significantly from 2020 to 2040, with the majority of this increase being concentrated in elderly patients.[17] SDH continues to be the most common kind of hematoma and hemorrhage in our population. This was consistent with a study done by Uno et al.[18] As the population ages, brain weight decreases, which can lead to an increase in extracerebral volume. Thus, an arachnoid tear might easily appear after mild trauma in elderly patients, and subsequently subdural hygromas develop into SDH.[18]

BHS is the most common surgical procedure, even in elderly patients.[19] Compared with open craniotomy, which has higher morbidity rate, BHC is the preferred technique.[18] Reflecting in our cohort, patients who underwent BHS were higher in number compared with craniotomy. The use of CT scans in diagnosing TBI is of crucial need, as it determines the extent of injury and guides surgical planning. However, there are indications for the use of CT scans. For instance, in some studies, CT is indicated if GCS is below 15, whereas in other studies it is indicated if the GCS is less than 13, or if the age is more than 65 years according to the Canadian CT head rules.[5] Management of blood pressure is an urgent requirement as it helps to maintain the cerebral perfusion pressure. According to the fourth edition of Brain Trauma Foundation guidelines, it is recommended to maintain an SBP at $\geq$ 100 mm Hg for

patients 50 to 69 years old and $\geq$ 110 mm Hg for patients 15 to 49 or 70 years and older.[19] In our cohort, majority of the patients had their SBP maintained above 90. TBI results in increased intracranial pressure and distorted oxygen supply to brain injured site. This could cause secondary brain injury, and other manifestations of TBI might appear including seizure.

However, to prevent this, Dash and Chavali showed that treatment with antiepileptics decreases the rate of posttraumatic seizures in the first 7 days of injury.[20] Almost, one-sixth of our patients had antiepileptics as prophylaxis after TBI in the present study. According to a study done by Tardif et al, the five determinants of LOS are: discharge destination, severity of concomitant injuries, extracranial complications, GCS, and TBI severity. They found that the geometric mean LOS in the index hospital for TBI was 11.7 days. This was in line with our study, as majority of the patients had less than 15 days of stay at the hospital.[21] Finally, the long-term use of anticoagulants and antiplatelets can increase the risk of immediate and delayed intracranial hemorrhage. In our cohort, a minority of patients were on anticoagulants and antiplatelets, which put them on risk of cerebral hemorrhage.[22]

Limitations

There were several limitations of this study. It was a retrospective, single-centered, cross-sectional study over a 4-year period. Therefore, several confounding factors exist, such as availability of diagnostic imaging facilities, advancement in modern medical technology, and improvement in ICU. Follow-ups were not involved in this study.

Conclusion

The number of TBI cases keeps increasing annually. The most common type of TBI in our cohort was SDH and most of the patients were treated with BHS. The use of CT scans was of a crucial need for diagnosing and surgical guidelines. Elderly population is not exempt from neurosurgical procedures. So, special care is needed when dealing with geriatric population and a more holistic approach may be required.

Conflict of Interest
None declared.

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