Missed Injuries in Multiple Trauma Patients: a Tertiary Care Experience in Tanzania

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Background: Missed injuries remain a worldwide problem in all trauma centers and contribute significantly to high morbidity and mortality among trauma patients. There is paucity of information regarding missed injuries in Tanzania. The aim of this study was to establish the incidence, contributing factors, and short-term outcome of missed injuries among polytraumatized patients in our setting.
Methods: This was a one-year duration (from January to December 2009) prospective cohort study involving all multiple trauma patients (ISS > 16) admitted to Bugando Medical Centre. After informed consent to participate in the study, all patients were consecutively enrolled in the study. Data was collected using a pre-tested, coded questionnaire and analyzed using SPSS computer software version 11.5.
Results: Ninety six of 462 patients (incidence, 20.1%) had 112 missed injuries. Head and the neck (46.4%) was the most common body region affected. Clinical error (57.1%) was the most common factor contributed to the occurrence of missed injuries. Of the factors contributing to missed injuries, 57.4% were potentially avoidable and 42.6% were unavoidable. There was statistically significant difference in the mean ISS, mean GCS, orotracheal intubation, patient's arrival time and seniority of the attending doctor between patients with missed injuries and those without missed injuries (*p*-value <0.001). Mortality in patients with missed injuries was 19.8% compared with 8.7% in patients without missed injuries (*p*-value <0.001). Among the deaths in patients with missed injuries, 57.9% were directly attributable to missed injuries (O.R. = 14.8, *p*-value =0.001, 95% CI = 6.1- 32.46). Patients with missed injuries had longer stays in the hospital compared with patients without missed injuries (*p*-value <0.001).
Conclusion: The incidence of missed injuries at BMC is high in patients with high ISS, low GCS, orotracheal intubation and those who reported during night hours. A high index of suspicious is needed when dealing with such a group of patients. The majority of missed injuries are potentially avoidable by repeated assessments both clinically and radiologically and by staff redistribution to address the increase of missed injuries during night hours. Implementation of a tertiary trauma survey should be routine in the Accident & Emergency department to minimize the occurrence of missed injuries.

Introduction

The management of multiple trauma patients presents a worldwide diagnostic and therapeutic challenge to trauma, orthopedic and general surgeons [1]. Significant injuries can be missed during primary and secondary surveys in multiply injured patients, for whom resuscitation, diagnosis and therapy have to proceed simultaneously[2]. Many factors involved in the initial resuscitation of the multiple trauma patients, such as altered level of consciousness, hemodynamic instability, or inexperience and inadequate diagnostic evaluation, may lead to missed injuries. Injuries can be missed at any stage of the management of the trauma patient, including intraoperatively, and may involve all regions of the body[1,3,4].

Missed injuries are a potential source of morbidity and mortality and may also represent varying degrees of clinical inexperience and are common reasons for litigation[5,6]. Missed injuries are often associated with prolonged length of hospital stay resulting in increased costs of care as well as consumption of hospital resources[3-6]. The incidence of missed injuries has been reported in trauma

literature to range between 0.6% and 65%, and less missed injuries have been found in retrospective studies [5-9]. In a prospective study which was done in Uganda, the rate of missed injuries was reported to be 19.4% and the commonest contributing factor for missed injuries was found to be inadequate assessment[10].

At Bugando Medical Centre, missed injuries, though not studied, are a common surgical problem among multiple trauma patients; however, its incidence, contributing factors and the impact of these injuries on the outcome of trauma patients are not known, as no local studies have been done despite large number of trauma admissions. The majority of missed injuries are potentially preventable, therefore understanding the incidence, contributing factors and clinical outcome of these injuries is essential in minimizing their occurrence and in planning preventive measures and management strategies.The aim of this study was to establish in our setting, the incidence and factors contributing to missed injuries in polytrauma patients, and to determine the influence of these concealed injuries on the outcome of our polytraumatized patients.

Patients and Methods

A prospective cohort study was undertaken at the Accident and Emergency Department of Bugando Medical Centre over a one year period from Jan 2009 to December 2009. Bugando Medical Centre is one of the four consultant tertiary referral hospitals in the country and has a bed capacity of 1000. Trauma patients are first seen at the A&E department where primary and secondary surveys are done by the admitting surgical team. Resuscitation is initiated at this point (including operative resuscitation if needed). Resuscitation is carried out according to Advanced Trauma Life Support (ATLS) principles. From the A&E department these patients are admitted in their respective surgical wards or ICU. Tertiary survey is later carried out by consultants during morning clinical meeting or by the firm consultant or specialist surgeon during next ward round.

All multiple trauma or major trauma patients (defined as an injury severity score (ISS) of >16) of all age groups and gender seen in the A&E department during the study period were, following informed consent, consecutively recruited into the study. Patients who died before initial assessment and those without next of kin to consent were excluded from the study.

All recruited patients were, after primary and secondary surveys by the admitting team, screened for the presence or absence of missed injuries and were then stratified into two groups. Group I included all patients with missed injuries and group II were patients without missed injuries. For the purpose of this study, missed injury was defined as injury not detected during primary and secondary surveys of the ATLS. Only clinically significant missed injury (defined as an injury with worse outcome as a result of delayed diagnosis) was included. Minor injuries were taken into account when they accompanied the former. The diagnosis of missed injury was established through clinical examination, radiologically and surgically. In case of death, post-mortem examination was performed to establish the missed cause of death. Missed injuries were classified into three types; type I (injuries occurred outside the body area of clinical focus), type II (injuries occurred within the body area of clinical focus) and type III (injuries occurred as a result of the surgeon's decision to abbreviate surgery).

The study variables included: demographic characteristics; times of injury; patient's arrival and receipt of care; mechanism of injury and type of injuries missed; injury scores (Injury Severity Score and Glasgow Coma Score); reasons for missed injuries; type of physician involved in the primary and secondary surveys; radiological findings; operative and post-mortem findings; length of hospital stay and mortality. Delayed presentation of injury was defined as an injury that was not clinically or radiologically evident on admission but became apparent upon repeat examination or imaging study. Factors contributing to missed injuries were classified into 4 types: clinical error (injury missed during physical examination), radiological error (injury missed as a result of error in the choice of investigation, view taken, limitation of the technique chosen and interpretation of radiographs),

communication error (injury missed as a result of poor communication between the radiologist and clinician) and surgical error (injury missed during the surgical survey)

All identified missed injuries were managed accordingly. The study patients were followed up either until discharge or for up to 30 days. During this period any unaddressed complaints were thorough investigated. The approval to carry out this study was sought from relevant authorities. Data was collected using a pre-tested and coded questionnaire and analyzed using SPSS computer software version 11.5. Data were compared and statistically analyzed in two patient groups to identify factors associated with missed injuries. A *p*-value of less than 0.05 was taken as statistically significant.

Results

A total of 462 multiple trauma patients were studied. Ninety six out of 462 patients (20.8%) had 112 missed injuries with an average of 1.2 injuries per patient. There were 62 males (64.6%) and 34 females (35.4%) whose ages ranged from 6 to 72 years (median age 23 years). The mechanism of injury was road traffic accidents (RTAs) in 60 patients (62.5%), fall in 15 patients (15.6%), assault in 11 patients (11.5%), missile injuries in 9 patients (9.4%) and sport-related injuries in 1 patient (1.0%). 52 (54.2%) of RTAs were related to motorcycle injuries affecting passengers, cyclists and pedestrian. The most frequent missed injuries were head and the neck which made up 46.4% of all missed injuries. (*Table1*).

Of all the missed injuries, 56.5% occurred outside the body area of clinical focus (type I), 40.2% occurred within the body area of clinical focus (type II) and 3.3% occurred as a result of the surgeon to abbreviate surgery (type III). We found that 18%, 30% and 52% of missed injuries were discovered during primary, secondary and tertiary surveys respectively. Clinical error due to incomplete clinical assessment was the most common factor contributed to the occurrence of missed injuries and accounted for 57.1% of all missed injuries (Table 2). Of the factors contributing to missed injuries, 57.4% were potentially avoidable and 42.6% were unavoidable in patients with increased ISS, a low level of consciousness due severe head injuries and in intubated polytraumatized patients.

Table 1. Location, Type and Number of Missed Injury

Location	Type of Missed Injuries	Number of Missed Injuries (%)
Head/neck		**(52 injuries, 46.4 %)**
	Skull fractures	**32**
	Subdural/epidural haematoma	**11**
	Intracerebral haematoma	**7**
	Cervical spine fracture/dislocation	**2**
Maxillofacial		**(8 injuries, 7.2%)**
	Mandibular fracture	**4**
	La forte I injuries	**1**
	La forte II injuries	**1**
	La forte III injuries	**1**
	Loss of teeth	**1**
Thoracic		**(18 injuries, 16.1%)**
	Rib fractures	**8**
	Hemothorax/pneumothorax	**7**
	Clavicle fracture/dislocation	**3**
Abdominal /pelvis		**(22 injuries, 19.6%)**
	Bowel perforation	**10**
	Gastric perforation	**5**
	Pelvic fractures	**4**
	Liver laceration	**1**
	Renal injury	**1**
	Urethral injury	**1**
Extremities		**(12 injuries, 10.7%)**
	Fractures	**6**
	Dislocations	**4**

	Compartment syndrome	**2**
Total		**112 missed injuries**

Missed injuries were detected by consultants/specialists in 61 cases (54.8%), by investigating team in 25 cases (22.3%), by radiologist in 3 cases (2.7%) and by pathologist (during post-mortem examinations) in 13 cases (11.6%). Missed injuries were diagnosed by detailed clinical assessment in 42.8%, by surgery in 20.1%, by review of radiological error in 16.2% and by post-mortem examination in 11.6%. 9.3% of the missed injuries were detected on the basis of no improvement. Twelve patients ((12.5%) who had missed injuries had been reviewed by consultants and specialist surgeon by the time the missed injuries was diagnosed and definitive treatment instituted. Eighty- six (76.8%) of the injuries were detected within the first 24 hours. The remaining twenty-one (18.8%) injuries were detected during the course of treatment and five (4.5%) injuries were detected on discharge. Mean delay in diagnosis of missed was 4 days (range 1–16 days). Forty two (37.5%) of missed injuries required some form of additional therapeutic interventions. Comparison of patient characteristics between the population of patients with and without missed injuries is shown in *Table 3*. There was statistically significant difference in the median ISS, median GCS, patient's arrival time, patient's orotracheal intubation and seniority of the attending doctor between patients with missed injuries and those without missed injuries (*p*-value <0.001).

The mean patient's waiting time between arrival and assessment was 58 minutes and 24 minutes among night and day arrivals respectively. The overall mortality was 11.0%. Mortality in patients with missed injuries was 19.8% compared with 8.7% in patients without missed injuries (*p*-value <0.001). Among the deaths in patients with missed injuries, 57.9% were directly attributable to missed injuries (O.R. = 14.8, *p*-value =0.001, 95% CI = 6.1- 32.46). Patients with missed injuries had longer stays in the hospital compared with patients without missed injuries (*p*-value <0.001).

Table 2. Contributing Factors to Missed injuries.

Contributing factor	Number of missed injury (N=112)/%
Clinical error	**64 (57.1%)**
Radiological error	**24 (21.4%)**
Communication error	**18 (16.1%)**
Surgical error	**6 (5.4%)**

Table 3. Comparison of Patient Characteristics in the Two Groups

Study variable	No missed injuries (N=366)	Missed injuries (N= 96)	*p*-value
Mean age (in years)	**26**	**32**	**Not significant**
Gender			
Males	**262 (71.6%)**	**62(64.6%)**	**Not significant**
Female	**104 (28.4%)**	**34(35%)**	**Not significant**
Median ISS	**18.4**	**24.8**	**< 0.001**
Median GCS	**11.8**	**9.2**	**< 0.001**
Designation of attending doctor			
Consultant / Specialist surgeon	**220 (60.1%)**	**12 (12.5%)**	**< 0.001**
Resident in surgery	**102 (27.9%)**	**30 (31.3%)**	**< 0.001**
M.O.	**38 (10.4%)**	**52 (54.2%)**	**< 0.001**
Intern doctor	**6 (1.6%)**	**2 (2.0%)**	**< 0.001**
Patient's arrival time			
Day time (%)	**192 (52.5%)**	**32 (33.3%)**	**< 0.001**
Night time (%)	**174 (47.5%)**	**64 (66.7%)**	**< 0.001**
Orotracheal intubation	**78 (21.3%)**	**54 (56.3%)**	**< 0.001**

Mortality (%)	**32 (8.7%)**	**19 (19.8%)**	**< 0.001**
Median LOS (days)	**16.5**	**20.3**	**< 0.001**

Discussion

Advanced Trauma Life Support (ATLS) of the American College of Surgeons[11] has introduced primary and secondary surveys in the management of multiple traumatized patients, to prioritize the most life-threatening injuries and to address all other injuries respectively. Despite such detailed and standardized treatment principles, some injuries still escape detection during these two phases. This study was conducted to establish in our setting, the incidence, contributing factors and the clinical outcome of these concealed injuries on multiple trauma patients; the problem not previously studied at our centre or any other hospital in the country. The management of multiple trauma patients at our centre follows ATLS principles.

Most studies of missed injuries report an incidence of 0.6% to 65%, depending on how a missed injury was defined and the type of injury considered[6-9]. The incidence of missed injuries has been reported to be higher in prospective studies compared with that of retrospective studies [5, 7, 12]. This is because retrospective studies may have a selective memory component or incomplete information, and long-term follow-up may be difficult. The lack of extensive studies on this subject attributable to a general reluctance of clinicians to admit and account for their errors in management may also contribute to low incidence of missed injuries in some areas. Enderson et al[1,7], in a prospective study, reported an incidence of missed injury of 9% which, interestingly, was higher compared with that of their retrospective study, which was 2%. This difference means that the incidence tends to increase with the precise description of diagnostic or surgical errors in multiple injuries.

The incidence of missed injuries of 20.8% in our study was found to be higher than that reported in Uganda[10]. Previous studies have suggested that patients with more severe injuries or associated head injuries tend to have injuries missed during the resuscitation[2,6]. This is reflected in the high rate of missed injuries in our patients, majority of whom had severe injuries and associated head injuries. The increase in the incidence of missed injuries in patients with severe head injuries suggests that diagnosing injuries improves with better patient communication. Our study confirmed this observation. High incidence of missed injuries in our study can also be explained by the prospective nature of the study.

Early detection of injuries

In the management of polytraumatized patients, any delay in the diagnosis and treatment of missed injuries may lead to increased morbidity and mortality, prolonged length of hospital stay, and increased cost [3-5]. Early recognition and treatment of missed injuries appear to reduce mortality and morbidity associated with the disease. In this study, we found that the majority of missed injuries were detected within the first 24 hours. Other authors reported similar observation[5,10].

Road traffic accident

Road traffic accidents (RTAs) remain a leading cause of trauma and admissions to the accidents and emergency units of most hospitals in Tanzania and continue to contribute to an increased incidence of missed injuries [13, 14]. In this study, RTAs were the most common mechanism of injury accounting for 62.5% of patients with missed injuries. The majority of RTAs were due to motorcycle accidents, an emerging popular mode of commercial transportation in Mwanza city, and the victims were passengers, cyclist and pedestrian. Similar observation was also noted in other studies [3, 10]. Factors that contribute to high occurrences of RTAs are largely preventable and are due to a combination of factors, including rapid motorization, poor road and traffic infrastructure as well as the behaviour of road users. Findings from this study calls for urgent interventions targeting at reducing the occurrence of RTAs and subsequently reduce the incidence of missed injuries in this region.

Contributing factors

Analysis of the contributing factors for the missed injuries in our study revealed that 57.4% were attributable to potentially avoidable factors while 42.6% were due to unavoidable factors such as life-threatening injuries and severe head injuries. This finding is agreement with other studies reported previously[4,6,10]. The majority of missed injuries are potentially avoidable with repeat clinical assessments and a high index of suspicion.

The most frequent contributing factor for missed injuries in this study was clinical error due to inadequate clinical assessment in 57.1%. This was followed by radiological error due to misinterpretation or delayed radiological investigations in 21.4%. Similar trend was also reported by other studies[3,10]. The high rate of clinical error in this study could be attributable to the fact that the A&E department being a high risk specialty in which the majority of trauma patients are initially managed by junior doctors with limited clinical experience; significant injuries may be missed during primary and secondary surveys in severely injured patients. The reason for the radiological errors in the present study might be that in most cases interpretation of radiological investigations is performed by non-radiological staff (attending doctors) and not by consultant radiologist; another reason might be the urgency of the situation and therefore lack of time to find less obvious injuries. Whilst interpretation of the trauma films during the resuscitation by a consultant radiologist or reporting within a few hours is the ideal, neither of these currently occur in our institution due to increasing pressure on the radiologist workload. To overcome this problem, all radiology films and CT scans must be seen by a senior radiologist as soon as possible.

In our study, injuries in the head and neck were frequently missed in 46.4%. Abdominal missed injuries ranked second in 19.6%. Similar body region distribution was also noted in Uganda [10]. Patients with head injuries have high risk of suffering missed injuries due to altered levels of consciousness. Abdominal missed injuries pose a diagnostic challenge especially in patients with associated head injuries. Diagnostic peritoneal lavage (DPL) and Focused Adnominal Sonography in Trauma (FAST) have been reported to be useful investigations in the diagnosis of abdominal missed injuries [10, 16]. However, none of these studies were used in our patients despite their usefulness. In our resource-limited setting, clinicians need to develop, retain and rely on clinical acumen.

Seniority of attending physician

The majority of missed injuries in our study were detected by consultants and specialist surgeons (in 54.8% of cases) through detailed clinical assessment, review of radiological investigations, surgery and postmortem examinations in case of death. In this study, only 12.5% of patients who had missed injuries had been reviewed by consultants and specialist surgeon by the time the missed injuries was diagnosed and definitive treatment instituted. This finding is in agreement with a Ugandan study in which only 23.1% of patients who had missed injuries had been reviewed by consultants during primary and secondary surveys[10]. The seniority of the attending physicians plays a pivotal in diagnosis of missed injuries due to their good clinical experience. In our study, the occurrence of missed injuries was found to be significantly influenced by the seniority of the attending physician.

We noted that the majority of our trauma patients arrive during the night probably due to increased crime rates at night hours. We also noted high rates of missed injuries (66.7%) in patients arriving during the night compared with 33.3% of day arrivals. Okello *et al* [10] in Uganda also reported similar observation. High rates of missed injuries among night arrivals can be explained by the fact that during night hours, the senior surgical and axillary staffs, which we found to be vital in the diagnosis of missed injuries, were unlikely to be present unless called for difficult cases. In our resource-limited setting, where staff shortage is a challenging problem, re-distribution of the few staff available needs to be designed to address the problem.

Tertiary survey

The primary and secondary surveys of the ATLS are designed to identify all of a patient's injuries and prioritize their management[11]. Implementation of a routine standardized tertiary trauma survey is

vitally important in the detection of clinically significant missed injuries and should be included in trauma care[3,5,7,10,15]. This is reflected in our study in which high detection rate of missed injuries was observed during tertiary survey phase (52%) compared to primary and secondary survey phases (18% and 30% respectively). Enderson et al[7], in their prospective study of missed injuries found a reduction of 35% in missed injuries by applying the tertiary survey protocol; by using this protocol, early detection and treatment can be achieved leading to an improvement in these patients' morbidity and mortality. Previous studies have demonstrated an association between the appearance of missed injuries and an increased ISS, a low level of consciousness (due to brain injury), orotracheal intubation, hemodynamic instability, and closed trauma[1-10,15]. Our study observed a statistically significant association between missed injuries and high ISS, low GCS, patient's arrival time, patient's orotracheal intubation and seniority of the attending physician.

Hospital stay

In our study it was found that patients with missed injuries stayed longer in hospital (mean hospital stay of 20.3 days versus 16.5 days for those without missed injuries). Similar finding was also reported in other studies[3-6,10]. This was because the injuries were not only presented late, but also because more time was required to adequately treat them and their resultant complications, such as shock, peritonitis and vascular injury. The prolonged stay could also have been due to the severity of the injuries in this group as evidenced by the higher mean ISS.

The mortality rate in patients with or without missed injuries (19.8 %versus 8.7% respectively) in the present study is comparable with other studies [4, 6, 10]. The high mortality rate in patients with missed injuries can be explained by the fact that the majority of patients with missed injuries had high ISS with initial neurologic compromise.

Conclusion

The incidence of clinically significant missed injuries among multiple trauma patients in our institution is unacceptably high and they are significantly associated with prolonged in-hospital stay and mortality. This observations call for urgent interventions. In order to minimize the occurrence of missed injuries and their effect on the outcome of polytraumatized patients, we recommend the following:-

- A high index of suspicion is required when dealing with unconscious and intubated patients with severe trauma (ISS↑) and brain injuries (GCS↓) during primary and secondary surveys.
- A tertiary survey to detect missed injuries should be performed as part of routine evaluation of all severely injured patients within 24 hours of admission.
- An experienced consultant/specialist surgeon should be involved in the tertiary survey and should be made available on 24-hour basis.
- Improvement in the radiological investigations such CT scan should also be made available on 24-hour basis.
- Redistribution of the few staff available to cover the night hours.
- A24-hour Focused Abdominal Sonography in Trauma (FAST) should be introduced at the A & E department and this should go simultaneously with training of staff.
- Urgent interventions targeting at reducing the occurrence of RTAs is necessary to reduce the incidence of missed injuries in this region.
- Further study should be done to proper assess the effect of missed injuries on the cost of care.

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