ClinicalPractice

Evaluating patient epidemiology and clinical practice on the outcome of patients admitted with skull fractures secondary to assault

Objectives: Patients whom incur skull fractures secondary to assault are a common referral to the Department of Neurosurgery at Dr. George Mukhari Academic Hospital in Pretoria, South Africa. Our study aimed to statistically evaluate patient epidemiology and our clinical practice in relation to patient outcome.

Methods: A retrospective chart review of 246 consecutively admitted patients with skull fractures secondary to assault from January 2015-December 2016 was performed. Medical records were analyzed for patient demographics and key aspects of our clinical practice which included patient age, gender, employment status, type of referral, days from injury until admission, mechanism of injury, severity of head injury, CT scan findings, days from admission until operative intervention, type of surgery performed, in-patient sepsis rate, length of hospital stay and Glasgow Outcome Score.

Results: On univariate analysis the variables that demonstrated an increased chance of a patient having a favorable outcome were having a mean age of 30 years ($p=0.01$), being referred from a local clinic ($p<0.001$), being assaulted with a brick ($p=0.02$), having a mild head injury ($p<0.001$), having an extradural haematoma ($p<0.001$), having a craniectomy with/without a dural repair performed ($p<0.001$), and having a mean length of hospital stay of 9 days ($p<0.05$). The variables associated with a patient having an unfavorable outcome were being above the age of 40 years ($p=0.003$), being referred from the scene of the assault ($p<0.001$), being assaulted by the community ($p=0.02$), having a severe head injury ($p<0.001$), having an acute subdural haematoma or contusion ($p<0.001$), having a decompressive craniectomy performed ($p<0.001$) and having a mean length of hospital stay of 13-18 days ($p<0.05$).

Conclusion: Our study demonstrated that the majority of the significant prognostic variables were determined in the pre-hospital setting. Our study highlights the importance of primary prevention as the major consideration that should be targeted to prevent the morbidity and mortality associated with this social problem.

Keywords: Skull fracture, assault, prognosis, glasgow outcome score

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Introduction

Patients whom incur skull fractures secondary to assault are a common referral to the Department of Neurosurgery at Dr. George Mukhari Academic Hospital in Pretoria, South Africa. Many of these referrals require not only admission but also emergency neurosurgical intervention. This issue constitutes a preventable social problem that carries with it not only a considerable socio-economic burden within the community and to the families of these patients, but also places a considerable burden on limited hospital resources. Our study aimed to evaluate patient epidemiology and our clinical practice in relation to patient outcome. Our focus was to establish the statistical significance of the specific variables relevant to our local environment that could be used to predict outcome and thereby serve as targets for intervention.

Considering the epidemiology of patients whom present with skull fractures secondary to assault it is noted in several studies to be a phenomenon occurring almost exclusively in young males [1,2]. A South African study considered head injuries secondary to machete injuries and noted that 93% of the patients were male with a mean age of 31 years [1]. An Australian study from Queensland noted that 97% of the study patients in the assault group were male [2]. Considering the socio-economic status of patients presenting with traumatic brain injury secondary to assault a study done in Wales noted that the highest clustering existed for residents of the poorest communities [3]. Considering the mechanism of injury a recent study from North America noted that being assaulted by multiple assailants was the most common mechanism of injury comprising 38% of cases [4].

Skull fractures in traumatic brain injury are important markers of possible serious underlying brain injury which include extradural haematomas, intracerebral contusions, intracerebral haematomas and acute subdural haematomas [5]. In fact even in linear skull fractures the incidence of extradural haematomas has been evaluated to be as high as 35% [6]. While skull X rays may be of screening value to detect a skull fracture, Computed tomographic (CT) scan of the brain becomes invaluable if a skull fracture is present to exclude clinically significant intracranial lesions [7]. In addition to the significance of a skull fracture an accompanying dural tear carries with it a significant risk of sepsis and as such should be treated as a Neurosurgical emergency [5]. The importance of recognizing a dural tear and performing a dural repair is so well recognized that evidence exists to support the consideration that all compound skull fractures should be afforded a formal operative intervention [8,9]. Skull fractures can however be of two types, depressed or linear depending on the amount of displacement of the fracture edges. Depressed skull fractures must by definition have displacement of bone greater than the full thickness of the adjacent calvarial thickness [5].

Rehman et al. looked at sepsis rates in compound skull fractures in fifty-six patients. This study identifies dural breach and comminution as risk factors for an increased sepsis rate. A statistically significant difference in the sepsis rate was revealed if the patient presented more than eight hours after trauma. This finding puts further emphasis on the importance of early operative intervention which although traditionally put forward as necessary within twenty four hours to prevent sepsis, should, according to Rehman et al., be even earlier than this. The sepsis rate in this study was five percent [10].

Considering the intracranial findings in patients with skull fractures secondary to assault a recent study considered linear skull fractures and reported a thirty-four percent incidence of extradural haematomas in patients presenting with this fracture type. In parieto-temporal fractures this increased dramatically to seventy-four percent [6]. A recent North American study identified variables in 201 patients diagnosed with mild traumatic brain injury that could be used as predictive outcome markers. This study noted that being younger, having a post resuscitation GCS score of 15/15, and on imaging having at most an isolated subarachnoid haemorrhage were three important variables that found statistical significance in predicting a favourable outcome [11]. Other large studies such as the International Mission for Prognosis and Analysis of Clinical Trials in Traumatic Brain Injury (IMPACT study) identified the severity of head Injury as the major determinant predicting outcome [12].

Methodology

This was a retrospective chart review of patients with skull fractures secondary to assault presenting to the Department of Neurosurgery at Dr. George Mukhari Academic Hospital located in Pretoria, Gauteng, South Africa. The study period was from January 2015-December 2016. The study was granted approval by the Medical Research Ethics Committee of Sefako Makgatho Health Sciences University, reference number SMUREC/M/38/2017:PG.

A total of 246 patients with skull fractures secondary to assault were admitted during the study period. In terms of referral 150 (62%) were referred from four local hospitals, 46 (19%) were referred from the scene of the assault and 43 (18%) were referred from local clinics. Post irrigation with limited debridement and simple suturing in the Emergency department under local anesthetic cover, the indications for formal operative intervention at our institution are brain matter or cerebrospinal fluid oozing from the wound, depressed compound skull fractures, skull fractures with associated intracranial haematomas for example extradural haematomas, intracerebral haematomas, intracerebral contusions and acute subdural haematomas which are managed according to the guidelines of the brain trauma foundation. org [13]. Additional indications for surgery are fractures involving the posterior wall of the frontal sinus, contaminated fractures and fractures which are septic. Closed fractures are rarely managed operatively however will be taken to the operating room if the depression is causing a focal deficit through pressure on the adjacent cortex or if the closed fracture is depressed and causing a cosmetic abnormality, for example fractures over the forehead.

The local policy at our institution is to perform a craniectomy and in all compound depressed skull fractures and we remove loose bone fragments to minimize the sepsis risk. We rarely perform a primary cranioplasty except in the rare instance when the depressed skull fracture was closed but even then it is at the discretion of the attending surgeon. Dural repair is a special consideration and post debridement we rarely find the dura able to be closed primarily. Harvested pericranium is our dural substitute of choice and is sutured in a water-tight manner with 4/0 silk sutures to the debrided dural edges.

We utilize 72 hours of empiric prophylactic intravenous antibiotics in all patients with compound skull fractures irrespective of whether we suspect dural breach has occurred or not. An antibiotic with gram positive cover namely intravenous cloxacillin 500 mg administered 6 hourly and gram negative cover namely intravenous ceftriaxone 1 g administered 12 hourly are used. We add anaerobic cover in the form of intravenous metronidazole 400 mg administered 8 hourly. In patients going to surgery where the scalp is copiously irrigated and meticulously debrided and a craniectomy and dural repair performed, we may continue these antibiotics post operatively for 5 days if there is any intra-operative suspicion of sepsis. In clean wounds these antibiotics are stopped post-operatively and they are replaced by a first generation cephalosporin namely intravenous cephazolin 1 g administered 8 hourly for 72 hours. A pus swab is taken intra-operatively and antibiotics are adjusted to directed therapy based on culture and sensitivity results.

Seizure prophylaxis is administered to all high risk patients and stopped at 7 days if the patient does not have a seizure. High risk patients include patients whom have a seizure history or have already had a seizure by the time they are admitted. Radiologically depressed skull fractures with cortical injury, or patients with extradural haematomas, intracerebral haematomas, intracerebral contusions or acute subdural haematomas are all considered high risk and receive seizure prophylaxis. We administer an intravenous phenytoin loading dose of 15 mg/kg over 30 minutes (50 mg/min) and the maintenance dose is 100 mg administered 8 hourly intravenously.

The data captured and analyzed in this study related to patient demographics and clinical practice and included patient age, patient gender, employment status, mechanism of injury, days from injury until admission, severity of head injury, CT scan findings, days from admission until operative intervention, type of surgery performed, in-patient sepsis rate and number of days spent in hospital. Univariate analysis was performed whereby each variable was evaluated in terms of its significance relating to the Glasgow Outcome Score at discharge.

Results and Discussion

Our study finding was that 234 (95%) of patients were male and 13 (5%) were female. This finding is in keeping with another studies looking at traumatic brain injury secondary to assault such as a South African study where 93% of patients were male as well as an Australian study where 97% of patients were male [1,2].

Our study result was that the mean age of patients was 31.7 +/- 12 years. Furthermore 167 (68.2%) of patients were between 20 and 40 years of age. Only 7 (2.9%) of patients were below 12 years of age and 6 (2.5%) were above 60 years of age. The mean age of the patients in another study was also 31 years [1]. In looking for a relationship between the mean age of patients within each Glasgow Outcome Score outcome group our study revealed a statistically significant relationship between the mean age of the patients in Glasgow Outcome Score group one (deceased) when compared to each of the other Glasgow Outcome Score groups (p=0.01). Our study furthermore found no statistically significant difference between the mean ages in each of the other Glasgow outcome groups when compared with one another. This finding is in keeping with another study where it was identified that being of a younger age was a statistically significant positive predictive outcome marker when suffering from mild traumatic brain injury [11]. In our study 114 (46%) of patients suffered by definition a mild traumatic brain injury and our finding that being approximately 30 years of age incurred a protective benefit supports the finding of this study. Further support for the importance of age as an independent prognostic variable can be seen in the findings of the International Mission for Prognosis and Analysis of Clinical Trials in Traumatic Brain Injury (IMPACT study) which looked to identify the significant prognostic variables in over 10 000 patients whom suffered a traumatic brain injury [12]. Age was found to be an important variable determining outcome [12].

In our study 96 (40%) of patients resided in local townships. Our study finding that a significant number of patients were from poorer communities is supported by a study done in Wales where socioeconomic geographic clustering in relation to the risk of suffering a traumatic brain injury secondary to assault was evaluated. In this study it was noted that the highest clustering existed for residents of the poorest communities [3]. This is supported by a further finding of our study in that 173 (72%) of the patients in our study were unemployed and 43 (18%) of the patients in our study were employed.

In our study 112 (46%) of patients were referred from local hospitals and 46 (19%) were referred from the scene of the assault. Thirty nine (16%) of patients were referred to our hospital from local clinics. Univariate analysis revealed a statistically significant relationship being demonstrated where being referred from the scene of the assault gave a patient an increased chance of demising ($p<0.001$) while being referred from a local clinic gave a patient an increased chance of having a favourable outcome ($p<0.001$).

With regards the patients with a known mechanism of injury our study finding was that the most common mechanism of injury involved having been assaulted with a brick which occurred in 55 (25%) of cases. Forty one (19%) of subjects reported being assaulted by their community and 16 (7%) of subjects reported being assaulted with a bottle. A North American study noted that multiple assailants were the most common mechanism of injury comprising 38% of cases [4]. In our study a statistically significant relationship was demonstrated between the mechanism of injury and the Glasgow Outcome Score where the highest percentage of patients whom had a favorable outcome had been assaulted with a brick ($p=0.02$) and the highest percentage of patients whom ultimately died had been victims of community assault ($p=0.02$).

In our study 107 (44%) of patients were admitted to our neurosurgical unit within 24 hours of injury. One hundred and ninety nine (81.4%) of patients were admitted to our Neurosurgical Unit within 48 hours of injury. No statistical significance was demonstrated between the number of days between injury and admission to our unit and the Glasgow Outcome Score ($p=0.48$).

In our study 130 (55%) of patients were graded as having suffered a mild head injury, 87 (37%) of patients had suffered a moderate head injury and 20 (8%) of patients had suffered a severe head injury. Upon analysis a statistically significant relationship was demonstrated between the severity of the presenting head injury and the Glasgow Outcome Score where in the most favorable Glasgow Outcome Score group 114 (78%) of patients had mild severity head injuries ($p<0.001$) while in the deceased group 12 (57%) of patients had suffered a severe head injury ($p<0.001$). This finding finds extensive support in the literature where the severity of the head injury post resuscitation is a major prognostic variable determining outcome [11,12].

In considering the CT scan findings 56 (30%) of the patients in our study had an intracerebral contusion, 49 (27%) of patients had an extradural haematoma and 33 (18%) of patients had an acute subdural haematoma. Ten (5.4%) of patients had an intracerebral haematoma and 2 (1%) of patients presented with compound skull fractures complicated by an underlying brain abscess. Upon analysis a statistically significant relationship was demonstrated between the CT scan finding and the Glasgow Outcome Score where in the most favourable outcome group the highest percentage of patients had an associated extradural haematoma ($p<0.001$) while in the most unfavourable outcome group the highest percentage of subjects had either an acute subdural haematoma or an intracerebral contusion ($p<0.001$). The literature supports these findings as the IMPACT study found an acute subdural haematoma to carry with it an independent poor prognostic predictive value [12]. An acute extradural haematoma on the other hand carries with it a much more favourable predictive outcome [12]. A landmark study by Marshall looked specifically at the odds ratio in terms of predicting outcome based of the presence of each of these lesions and found that while the presence of an acute subdural haematoma carries with it a mortality rate of 50%, the presence of an extradural haematoma carries with it a mortality rate of 18% [13,14].

Considering days from admission to operative intervention our study finding was that 78 (59%) of patients were taken to theatre within 24 hours of being admitted to our unit. Following this 24 (18%) of patients were taken to theatre on day two, and 13 (10%) of patients were taken to theatre on day three post admission. Hence 213 (86.6%) of patients were taken to theatre within 72 hours of admission. Upon analysis no statistical significance was demonstrated between days from admission to operative intervention and the Glasgow Outcome Score (p=0.72).

In terms of the most common type of operative intervention performed our study finding was that 167 (68%) of subjects had a craniectomy with or without a dural repair performed. Four (2.7%) of patients had a decompressive craniectomy performed. A statistically significant relationship was demonstrated between the type of surgery performed and the Glasgow Outcome Score where in the most favourable outcome group 155 (89%) of patients had a craniectomy with or without a dural repair (p<0.001) and in the deceased group 4 (10%) had a decompressive craniectomy performed (p<0.001). In terms of decompressive craniectomy to outcome 100% of patients ultimately demised. The literature supports a craniectomy and if a dural breach is present unequivocally a dural repair as the primary operative intervention for a compound skull fracture [5]. Due to the fact that 199 (81%) of patients in our study having a compound skull fracture this would logically be the most commonly performed operative intervention and this was our study finding. On the contrary a decompressive craniectomy is performed for uncontrollable intracranial pressure where medical therapy has failed, or as prophylaxis for anticipated brain swelling post injury [15]. This procedure indicates a more severely injured patient where a decompressive craniectomy is performed as an attempted life-saving procedure when all else has failed with the surgeon and patients family knowing the poor outcomes that often accompany this operation [5].

Looking at our sepsis rate over the two year study period our study finding was that 6 (2.4%) of patients, whom were admitted with no wound sepsis, developed wound sepsis while under our care. Referring to the earlier study findings note must be made of the fact that 199 (81%) of our patients were admitted to our unit within 48 hours of the assault and 213 (86.6%) of these were taken for operative intervention within 72 hours of admission. This timeous referral and operative intervention is essential to ensure minimal in-patient sepsis. A further important variable is the use of prophylactic antibiotics at our institution which are commenced in casualty and continued for 3 to 5 days post operatively.

The mean length of hospital stay recorded in our study was 11.8 +/- 11.2 days and the shortest stay was one day and the longest stay was ninety days. The most common length of hospital stay was five days. Statistical significance was demonstrated between the mean length of hospital stay and the Glasgow Outcome Score where the patient group with the most favorable outcome score stayed a mean of nine days which was statistically shorter than the mean length of hospital stay of the other Glasgow outcome groups (p<0.05 in all comparisons). Furthermore with regards the other Glasgow Outcome Groups their mean length of hospital stay does not exhibit statistical significance when compared to each other.

In our study 154 (63%) of patients resumed normal life post discharge with/without some minor symptoms (GOS 5). Thirty (12%) of our patients were discharged being able to take care of themselves and work in a sheltered environment however needed some assistance with advanced activities of daily living for example driving (GOS 4). Forty one (17%) of our patients were discharged needed daily support due to a physical disability (GOS 3). In terms of comparing our results to the literature a recent study considered low velocity penetrating head injury secondary to assault and like our study utilized the Glasgow Outcome Score as their measurement tool. In this study sixty-two percent of patients resumed normal life post discharge with/without some minor symptoms (GOS 5).

In our study no patients were in a persistent vegetative state (GOS 2) at discharge due to the simple fact that in our unit these patients are not discharged. This specific patient group needs continuous specialized nursing care as they cannot provide for any of their own needs. Our institution does not have a step-down facility and the patient's family is unable to care for the individual in the home environment. These patients hence remain in our ward where they either improve to a point that they can be discharged needing daily support due to a physical disability (GOS 3) or they deteriorate and ultimately demise (GOS 1).

In our study twenty one (8.5%) of patients ultimately demised (GOS 1). Looking at the cause of death of these 21 (8.5%) of patients, 8 (38%) demised from drug resistant lower respiratory tract infections/pneumonia, 5 (24%) demised due to systemic sepsis, 3 (14%) demised secondary to aspiration pneumonia, 1 (5%) demised due to malignant cerebral edema and 1 (5%) demised secondary to superior sagittal sinus thrombosis. In 3 (14%) of these patients the cause of death was unknown.

Conclusion

Considering the factors that demonstrated significance in predicting a favourable outcome namely having a mean age of 30 years, being referred from a local clinic, being assaulted with brick, having a mild head injury upon arrival at our unit and on CT brain having an extradural haematoma, are all factors determined in the pre-hospital setting and as such are out of our control. In fact in this favourable outcome group the only statistically significant factor demonstrated which we have direct influence over is the performing of a craniectomy with/without a dural repair.

Considering the factors that demonstrated significance in predicting an unfavourable outcome namely being over the age of 40 years, being referred from the scene of the assault, being assaulted by the community, having a severe head injury upon arrival at our hospital and on CT imaging having an acute subdural hematoma or contusion, are again all factors determined before arrival at our hospital and as such are factors on which we have no influence. Performing a decompressive craniectomy is one factor we do have influence over however in terms of decompressive craniectomy to outcome analysis the mortality rate associated with this operation in our study was 100%.

It is hence clear from our study that in our setting the outcome of patients with skull fractures secondary to assault is largely determined by pre-hospital factors that are out of our control. What would be considerably more effective in managing these patients are primary prevention interventions aimed at preventing these injuries from happening in the first place. These interventions could include community education programs aimed to teach individuals how to manage disputes without resorting to violence, community upliftment campaigns advocating peace and respect for one another, more effective community policing and stricter laws and punishment for individuals convicted for assault. These primary interventions must however be framed within a program to address the bigger social challenges currently being experienced in South Africa such as poverty, the high unemployment rate, crime and growing inequality between the rich and poor.

Conflict of Interests

None of the authors listed have any financial or personal relationships with other people, or organisations, that could inappropriately influence (bias) their work, all within 3 years of the beginning the work submitted.

Declaration

We the authors listed below declare that this article has not been published previously, nor is it under consideration for publication elsewhere, and that, if accepted, will not be published elsewhere in the same form, in English or in any other language, without the written consent of the publisher

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