MULTIPLE FIREARM INJURY: CASE REPORT AND REVIEW OF LITERATURE ON THE BURDEN OF FIREARM INJURY IN AFRICA

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INTRODUCTION AND LITRETURE REVIEW

Firearms as a global concern[1,2,3].

Everyday around the world, about 16,000 people die from injuries. An estimated 5.8million people died in 1998 from injuries worldwide, which corresponds to a rate of 97.9 per 100,000. Injuries occur in all regions and countries and affect people in all age and income groups. The magnitude, however, varies considerably by age, gender, region and income group. In Africa the leading causes of death include war, interpersonal violence and road traffic injuries. Among the people aged 15 to 44 years interpersonal violence and suicide rank third and fourth respectively as the leading causes of ill-health and premature mortality. While war related injuries rank 6th, a large proportion of these are caused by firearms. The widespread and indiscriminate use of firearms has drawn increasing concern especially in the past decade. The proliferation of firearms also known as small arms and light weapons (SALW) has been described as a "cancer" spreading across the developing world, undermining political, social and economic stability; and leaving injury, death and mayhem in its wake.

Small arms misuse is one of the leading causes of fatal and non-fatal injury in many countries. However, little research has been done on the long-term consequences of the non-fatally injured patients. Victims of gun violence who cannot reach hospital or have emergency treatment will either die of their wounds or suffer permanent disability and reduced productivity.

The United Nations Program of Action to prevent, combat and eradicate the illicit trade in SALW in all it aspects was negotiated by states in 2001 and reviewed in 2003[4]. The next review conference is due in July 2005.Global data on the impact of small arms on the health of individuals is scanty. Available data, however, suggest that thousands of people are killed while millions are left with permanent physical, social and mental disabilities. Often victims require expensive and time consuming surgery followed by weeks or months of hospitalization and rehabilitation. This is a serious drain on the resources of poor people already impoverished by poor economies and other disease burdens such as HIV/AIDS, T.B and Malaria compounded by the increasing incidence of road traffic injuries (RTI)[5,6]. Of the non-fatal firearm injuries that have been studied, spinal cord injuries and amputations are among the leading causes of permanent disability. Firearms are among the leading causes of brain injury in the U.S while in Brazil over 25% of spinal injuries are caused by firearms. In Finland, there is an average of 13 hospitalization days on mild to moderate fire arm injuries. In Los Angeles, U.S.A patients of firearm injuries spend an average of 10 days in hospital[2]. A preliminary survey at the spinal injury hospital in Nairobi revealed that gunshot was the third most common cause of spinal injury after RTI and falls from heights respectively.

The firearm situation in Kenya

In Kenya, a wide range of firearms are used mainly in violent robberies, whence rifles and pistols are the most commonly used. According to the Kenya crime survey of 2002, a total of 791 firearms were used in 286 robbery incidences. At least in every robbery incidence either firearms or crude weapons were used. Pistols were used in 252 incidences while riffles were used in 279. Specific pistols named included the Browning automatic, German/Walther, U.S colt revolver and toy guns[7].

A study commissioned by the reference group on small arms of the United Nations Inter -Agency standing committee (IASC) and whose report is contained in 'Humanitarianism under threat' gives a detailed analysis of the impact of firearms possession in Kenya[8]. It reports the upsurge in gun related crimes especially in urban centers and attributes this to the spill over effects from neighboring countries involved in armed conflicts. According to this report, there were over five hundred firearms related homicides in Nairobi in 1999, 25 per 100,000 and a national rate of 15 per 100,000. Lokichogio and Garissa

towns in Northern Kenya have recorded up to 5 shooting incidences per week and reporting as high as 590/100,000 per year. Many more civilians are permanently disabled or die of related injuries due to lack of access to clinical facilities. In a recent outbreak of violence in North Eastern Kenya more than 30 people were shot dead in a single incident, ten of the dead were children all below the age of 8 years and eight of the adults killed were women[9].

Firearm injuries in general

The most obvious and least controversial indicator of the human cost of small arms is firearm related mortality and injury. These cases are found to be disproportionately high among young men. A study of 107 patients with gunshot injuries seen at the Aga Khan hospital in Nairobi[10], found that males were by far more likely to be victims of firearms(97) than females(10). In 74.7% of the cases the offender was categorized as a thug, thief or robber. Law enforcement officers were responsible for 9.4 % of the injuries. Another study conducted at Kenyatta national hospital found that of the 225 gunshot casualties seen at the hospital between 1994 and 1999, 54.7% were associated with robbery while police were implicated in 12.9%. Admissions due to the gunshot wounds accounted for 0.5% of the total hospital admissions during the period[11].

In the Aga Khan hospital study, the age group most affected was 40-49 years while the Kenyatta hospital study reported 21-30 years as the age group most affected (50.7%). Among the non-fatal injuries extremities are the areas most affected. These wounds caused by missiles lead to unique and complex injury patterns[12,13]. Limb injuries predominate, mostly the lower limbs among survivors. This is attributed to high lethality of shots to the trunk and the craniofacial region[12,13,14]. In the U.S firearms are the implement of choice for commission of both homicide and suicide with the craniofacial region as the favoured target[14].

Classification of firearm injuries

Various methods of classification have been described[12,13,14]. They include those based on the velocity of the missile at the time of hitting the target which has now been modified to the level of energy transferred. In which case the wound can be classified as either low energy transfer (LET) or high energy transfer (HET) wounds (some authorities add middle transfer wounds). There is also classification based on the kind of wound caused and in this category wounds can

be described as penetrating, perforating or avulsive, which tends to be linked to the level of energy transfer caused by the missile. In the maxillofacial region, wounds may also be categorized based on the site as upper face, mid face or lower face and sometimes the neck is included. Wounds may further be classified simply as either soft tissue wounds or those that involve the hard tissue.

Penetrating low energy transfer wounds

LET wounds refer to wounds caused by fragments striking a target at a velocity below that of sound in air ($340ms^{-1}$). Examples include bullets from hand guns which release energy of 100-500 joules. They have a small point of entry and tend to have the missile embedded in the tissue. Some cause cuts and lacerations. The proximity of the bullet to a vital structure such as major blood vessels is significant.

Perforating high energy transfer wounds

HET wounds are caused by bullets fired from riffles with a velocity exceeding $700ms^{-1}$ and can release up to 3000 joules energy[12,13]. *Stress Waves* and *Cavitations* are associated with these high energy missiles. The extent of cavitations is dependent on the density and elasticity of target organs, cavitations in solid organs such as the liver, kidney and spleen lead to higher morbidity and mortality. They pass into the tissues with entry and exit wounds, exit wounds are usually larger than the entrance, and they usually cause extensive damage and cavitations.

Avulsive wounds

These are characterized by loss of tissue and attributed to large irregular fragments from bombs, grenades, mines traveling at medium velocity with some degree of spin. Avulsion may also be due to small ultra-high velocity bullets that cause explosion of temporary cavitations.

Mechanism of firearm injury

A penetrating missile (usually bullets) transfers destructive energy to surrounding tissues. The impact imparts a temporary pressure wave perpendicular to the path of the bullet, accelerating the tissue forwards and sideways. Because of inertia, the tissue particles continue in their forward movement after the missiles have passed and a cavity up to 30 times the original cross-sectional area of the missile is formed followed by a quick collapse. The stress waves which are directly related to the velocity of the missiles destroy or push aside structures on the bullet track. Cavity collapse is influenced by tissue elasticity,

haemorrhage and oedema leaving behind a smaller permanent pathway filled with vapor bubbles, bullet fragments and bone chips.

The velocity of the missile as it strikes, the target is the main determinant of the wounding capacity[12,13]. Injury caused by a bullet or other missiles is directly proportional to the amount of energy transferred and to the actual energy expended. Firearm injuries are also characterized by heavy wound contamination which predisposes to high infection rates that include the risk of tetanus.

The relationship between the velocity of the missile and the amount of energy expended is given by the formula;

E=MV2 or
½ M (V1/2 – V2/2)
V1- Strike Velocity
V2- residual velocity

E=Energy transferred
M=Mass of the missile
V=Velocity of the missile

Bullets

Other than *velocity*, the shape and consistency of a bullet is another determinant of the nature of gunshot wounds. Bullets are head projectiles covered by copper or brass jackets, fully jacketed bullets travel further and are more accurate while hollow soft type bullets deform on impact leading to the release of more energy to the tissues causing severe tissue damage with higher tendencies of failure to exit from the target.

Contamination of missile wounds

All gunshot wounds are contaminated. Clothing and dirt is driven into the wound and a temporary vacuum created by cavitations which suck shredded pieces of clothing and debris. Large missile fragments and bullets if left lodged in the tissues may lead to abscess formation or pseudo-aneurysms. It is important that these fragments detected in the head and neck area be removed. Bullets that remain lodged in tissues have been associated with the risk of plumbism due to the rise in blood lead levels[16]. It is important that these patients are given prophylaxis against bacterial infections including tetanus toxoid injection.

CASE SUMMARY

We report the case of a 31 year old male medical doctor who suffered multiple gunshot injuries from an attack by thugs on 31st March 2005 at about 830- 8.45 pm.
Married with a 7 month old boy and employed at the Aga Khan University Hospital in Nairobi

Circumstances surrounding injury

Waiting for the gate to his compound to be opened, when unknown number of men approached his car and without warning started shooting at him from the right side of the car. He could not tell how many men they were, how many shot at him and how many bullets were fired. He decided to play dead and taking him for dead the men walked away.
His wife who was in the house heard the shots and immediately tried making a phone call to warn him not to come home as she had heard gunshots at their gate, she had no idea it was her husband being shot at. Once there was calm outside, his wife and neighbors came out to see what had happened. He recognized them and stopped faking death. He was able to drive his car into the compound, and reveal that he had been shot before being rushed to the hospital. Arriving at the **Accident and emergency centre of Nairobi Hospital at 9 p.m.** and taken straight in to the resuscitation room.

PRIMARY SURVEY

A: talking
B: breathing spontaneously
C: Pulse present

Head: GCS 15/15 Oriented in TPP

Face: Bleeding from the right cheek and floor of the mouth
Entry wound left maxillary region, exit wound right mandible and upper neck

Chest: Bleeding from the right chest.
Entry wound right lateral chest wall Mid-axillary line.
Reduced breath sounds in the right and mid lower chest wall.
Chest tube with UWSD (under water seal drainage) inserted.
Drained 500ml of blood.

Limbs: Bleeding from the right upper arm.
Two entry and two exit bullet wounds in the right upper arm.

Abdomen: No bullet wounds. No features of blunt trauma. Not distended. Soft non-tender.

SECONDARY SURVEY

A: patient talking
B: Breathing spontaneously but in mild distress
C: BP 115/70 mmHg HR -All pulses present

Head: Wounds cleaned and packed under LA

Chest: Reduced breath sounds in the right and mild lower chest wall

Limbs Wooden splint applied to the right upper arm

Orthopedic review

- Comminuted compound Fracture distal third of right humerus – bag of bones, Radial nerve, median nerve and ulna nerve palsies.

10p.m. Maxillofacial review

- Complex soft tissue injuries: including severe laceration of the upper lip, tongue and floor of the mouth. Wounds on the right cheek and upper neck.
- Compound Maxillary Fracture dentoalveolar fracture with loss of teeth -23, 24, 25
- Comminuted compound Mandibular fracture. fracture of teeth 45, 46, 47, 48
- Acute Hemorrhage – bleeding profusely from the floor of the mouth.

Investigations

Bed side: TBC, U/E/Cr
Hb 13.5g/dl dropped to 8.6g/dl by 3am.
Transfused 2 units of whole blood.
WBC 7500 increase to 12100 by 3am

10.00 p.m. To radiology department for
CT Scan:
Cervical spine: Normal
Head: Normal

Facial bones with 3D reconstruction: Fracture right mandible at the angle of the jaw. No dislocation

Chest: Right chest wall laceration with right pulmonary contusion and haemothorax
Bullet lodged behind the heart
Left basal consolidation

CXR – Bullet lodged above the diaphragm

X-ray right upper arm- comminuted humerus fracture.

10.30 p.m. Patient for emergency Theatre
11.40 p.m. Anesthesia induced

SURGICAL PROCEDURES

- Control of acute hemorrhage
- Surgical toileting of compound Fracture right humerus. Fracture stabilized with external clamps.
- Surgical toileting of facial wounds
- Repair of left upper lip, right floor of mouth and complex tongue injuries,
- Alveolectomy and alveoloplasty of the maxilla

Admitted to ICU: Ventilated SIMV + PS: TV 400 RR10 FiO2 0.7 PS 10 No PEEP

Subsequent care and recovery

CNS: normal throughout the admission period

CVS: first degree heart block which evolved into complete heart block

Cardiology review:

03-04-05: pansystolic murmur ?Rub ?VSD ?MR
ECG : complete heart block with LBBB
Chest CT reviewed with chief radiologist: ? bullet in wall of LV
Echo: hyperechoic shadow in posterior wall near the posterior mitral valve leaflet and possibly protruded into the LV lumen. MR, trace TR
Troponin 1.71 ng/ml

Recommendation: removal of bullet with cardiopulmonary bypass on stand by

04-04-05: Repeat Echo: ***perimembranous VSD***

11-04-05: ***thoracotomy*** and ***open heart surgery*** for retrieval of bullet with VSD and right atrium repair. Bullet found behind PML in the LV. VSD and RA repaired and pacing wires placed in right ventricle and paced at 80bpm. Pacemaker set on demand at 45 bpm on 8^{th} post-op day

05-05-05 Permanent pacemaker inserted.
Did well post insertion

RS: Weaned off the ventilator rapidly and extubated approximately 30 hours post intubation. He developed ARDS 12 hours later and had to be reintubated and ventilated. CMV: TV 500 RR 20 FiO_2 1.0 PEEP 12. The ARDS resolved markedly over the following 7 days.

Persistent bronchial breath sounds left lower lung with purulent secretions and collapse/consolidation. A chest physician was asked to review. Bronchoscopy done
22-04-05 revealed scanty brownish secretions. These secretions were aspirated and bronchial toilet done bilaterally. No mucous plugs found.

CT Scan Chest: Left atelectasis with small pleural effusion

Pulmonary edema after open heart surgery which resolved after 3 days of diuresis with lasix and vigorous chest physiotherapy extubated on 2^{nd} post-op day

Renal: normal renal function throughout his admission. Required occasional potassium supplementation

MSS: Fracture mandible. Wounds cleaned with NS daily and dressed with betadine gauze.

07-04-05: pus discharge oral toilet with quarter strength hydrogen peroxide 12 hourly.

16-04-05: To theatre for repair of facial bone fractures and right humeral fracture.

Facial bones

- Local debridement and toilet of the intraoral injuries – right retromolar and cheek
- reduction and *rigid fixation with mandibular plate* and screws of the mandibular fracture
- surgical toilet and debridement of cheek wound and closure.

Humerus grafted with *Tricalcium phosphate(* Chron Os) a synthetic osteoconductive and resorbable bone replacement material.

Transfusions: Total during his hospital stay 6 units whole blood and 4 units FFP

ICU stay: 20 days

Discharged to HDU on 20-04-05

Discharged to surgical ward on 24-04-05

Discharged home on 10-05-05

TEAM OF SPECIALISTS WHO MANAGED THE PATIENTS INJURIES

Maxillofacial Surgeons
Orthopaedic Surgeons
Cardiothoracic Surgeons
Cardiologists
Chest Physician
Anaesthesiologist

CONCLUSION

A total of 6 units whole blood and 4 units fresh frozen plasma was transfused, he spent 20 days in the intensive care unit and a total of 41 days in hospital. At least 6 highly skilled surgeons and physicians working as a team was required to save this doctors life.

This case presentation illustrates the burden of firearm injury on a health facility and resources, including the need for qualified personnel to perform the delicate surgical procedures. While there is immediate need to gather data and establish the magnitude of the problem, there is no doubt that the campaign to limit abuse and access to firearms is justifiable.

The quantitative data from the field should be complimented with relevant qualitative presentations aimed at transforming data into advocacy apparatus for positive policy metamorphosis at community, national and global levels

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