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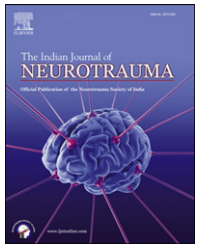

Review article

Bullet injury to brain. A short review of history

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The injury to brain during wartime by firearms started thousands of years ago when lead bullets were used with slings. Approximately 2400 years ago, Hippocrates[1] the father of medicine (460–377) wrote various texts on head injuries and surgeries, the most remarkable of which was "On injuries of the Head".[2] In it, he described six types of trauma to the cranium i.e., (i) Linear fractures (ii) contusions without fractures (iii) depressed fractures, (iv) contrecoup fractures, (v) dinted fractures and (vi) wounds above cranium. Hippocrates gave much importance to clinical examination, patient's history, inspection and palpation of the wound. Hippocrates noted that head injury can occur by 2 types of weapon viz (1) Rounded, blunt and smooth surfaced or (2) sharp, elongated and slender weapon. The first wound causes contuse, linear or depressed fractures and the second type will not cause contusion or fractures. On the management part, he emphasized for wound location on head and to see if the skull bone was broken or not.

Due to changing nature of warfare in combats, there is considerable risk of TBI because of vulnerability of the head. In the present era, soldiers are at great risk from blast injuries from IEDs, land mines and grenades, although they are better equipped from injuries caused by bullets. In present conflicts like Iraq war, the rate of injury to brain is in the range of 60%,[3,4] compared to previous conflicts in which it was about 20%.,[5,6]The history of firearm injury to brain dates back to 1200 AD,[7] when modern bullets were used and gunpowder was used to propel firearms. The large cannons were used at that time.

In mid-fourteenth century, personal firearms came into existence. Stone and metal objects were used initially and later lead alloys by 1550. The bullets became more uniform in size and shape due to better manufacturing techniques. After industrial revolution, there was further improvement and rifled barrel firearms came into existence. In late nineteenth century gunpowder was being replaced by smokeless powders, which were more powerful.

Between 1943 and 1945, in European and Mediterranean combats the artillery shell fragments caused severe cranial penetrating injuries.[8–12] Other weapons caused few or less severe penetrating cranial injuries. One third cranial injuries occurred in parietal area of skull. The cranial injuries were dealt with early debridement and antibiotics were used. Sulpha drugs were applied locally and penicillins were given by parenteral route to tackle infection. During early stages of World War II, less aggressive surgical approaches were used. It resulted in high infection and mortality rates especially when in-driven bone fragments remained after initial debridement. Due to this reason, aggressive initial debridement and early removal of retained bony fragments was advocated.[13,14]

During Tunisian, Sicilian And Italian wars in 1944, the skill of neurosurgeons greatly increased. More thorough debridement of the head injuries was done and penicillin was used routinely to combat the infection. Various types of incisions were used. Simple vertical or curvilinear incisions were in used most wounds. If there was tissue loss, tripod incision or

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S-shaped incision was used after wound debridement. Redebridement or delayed debridement was done in case early surgery was inadequate.[15]

After the World War II, during the Korean War between 1950 and 51, the surgical management of cranial trauma was based on X-ray evidence of depressed skull fracture, focal and progressive neurological signs and symptoms, seizures and evidence of raised intracranial pressure. Craniectomy was frequently performed and dura opened in most cases. The blood and necrosed brain was removed by suction and irrigation with saline. Electrocautery and silver clips were used for doing hemostasis. The dura was closed back by interrupted silk sutures. But no drain was kept in scalp wound. Penicillins and streptomycin was used to counter infection. It was observed that in most severe infections in penetrating skull wounds, gram positive cocci or/and gram negative bacilli usually were involved. Prophylactic systemic therapy began to cause high incidence of drug-resistant cocci and sensitivity to particular antibiotic was tested by medicated disc-blood agar plate culturing. The chloramphenicol was most effective antibiotic at that period of time and penicillin least effective on the basis of sensitivities.

In 1960's, when the cerebral angiography came into existence, the depressed fractures without transdural penetration without any subdural or intracranial clot, the dura was not opened. When angiography revealed any lesion below the dura, the lesion was removed by opening the dura. During the period the aim of doing neurosurgical procedure of head was to remove all retained fragment of missile, in addition to the debridement of the dead tissue. The routine use of angiographies in comparison to exploratory craniotomy or burr holes provided excellent information of the location, nature, arterial damage or damage to dural sinus and epidural hematomas.[16–19] The main aim of the operation was to search and remove all retained fragments and not solely the debridement of dead tissue. It was assumed that the retained fragments ill effects were function of both widespread tissue disruption and foreign body fragments. Delayed intra cerebral hematoma can be a presentation of bullet injuries in vicinity of major vessels.[20]

Between 1982 and 85 during Lebanon conflict, the management of head injuries was revolutionized by the use of computed tomography (CT). With the introduction of CT scanning, it became possible to assertain the brain injury extent and to know the exact location of bone and mental fragment in brain. It also resulted in exact and early detection of intracranial hematomas and their evacuation. During this conflict, effort was made to preserve maximum brain tissue by doing minimal intra cerebral debridement compared to that during the Korean and Vietnam conflicts.[21,22] No bone or metal fragments in brain were removed until they were visualized in operative field during surgery. With the increasing availability of weapons to civilians either legally in some countries like united states and illegally in areas of conflict a new trend of injuries started coming up, i.e., stay bullet induced injury like in celebrity firing, riot controls and even sports.[23,24]

In present Afghan conflict which started from 2001, where no neurosurgeon was available till 2007, the majority of casualities are from IED blasts. Intracranial haemorrhages and penetrating head injuries are the most frequent lesions in head injured patients. Damage to the unprotected face in the form of large soft tissue facial and scalp injuries are common. Spinal injuries caused by direct impact of projectiles or indirectly by blast forces are seen infrequently. Various studies revealed that the outcome of bullet injury was less favorable as compared to that of splinter injury with grenade blasts possibly due to low velocity of the latter.[25]

The Iraq conflict from 2003 saw significant improvement in survival rates due to the rapid field resuscitation in patients with head injuries. The patients were subjected to early decompressive craniectomies within 2–4 h from injury when brain edema and raised ICP was diagnosed after head injuries. There was also better outcome in cranial vascular injuries due to early decompression surgeries and better diagnosis by DSA with 3D reconstruction.[26] Most TBI cases were caused by IEDs. Intracranial injuries without penetrating wounds were seen in significant number of cases.

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