Treatment of Casualties in a Forward Hospital of Indian Army : Nine year Experience

Lt Col KM Rai, ^{SM,*}, Lt Col R Kale⁺, Surg Capt SK Mohanty, ^{SM,VSM#}, Lt Col A Chakrabarty^{**},
Brig MR Waghlay⁺⁺, Lt Col Rajesh Kumar^{##}, Brig Dinesh Prasad, ^{AVSM (Retd)***},
Lt Gen AK Lahiri, ^{VSM, PHS+++}

Abstract

Background : To analyze the outcome of the management of casualties in a level II trauma centre of a forward hospital of Armed Forces over a nine year period. Retrospective analysis of all casualties received in a single forward hospital of Indian Army was carried out.

Method: During 9 years (1990-1998), a total of 5737 casualties were received in a single level II zonal hospital of the Army in a forward area. Majority of the injuries were caused by bullets, or by fragments of improvised explosive devices. A policy of aggressive resuscitation and early primary repair of injuries was followed. General surgeons routinely performed craniotomies, thoracotomies, laparotomies, stabilization of fractures by fixators and repair of vascular injuries.

Result : 38% of patients had injuries to several body parts (polytrauma), resulting in a total of 8578 injuries. Region-wise distribution of injuries was as follows : 14.2% head and neck injuries, 13.3% chest wounds, 13.5% abdominal injury and 59% extremity wounds. The overall mortality rate was 3.6%. The complication rate was about 7% with infection as the major complication. The results of primary repair of colonic injuries were similar to those of staged repairs. The results after primary closure of war wounds were better than those treated with delayed primary closure in selected cases.

Conclusion : Prompt evacuation, speedy resuscitation and early definitive repair of war injuries results in low mortality and morbidity. A motivated and dedicated team and adequate availability of blood and ancillary services adds to the excellent outcome. The policy of primary repair of colonic and selected soft tissue injuries appears justified in selected cases.

MJAFI 2004; 60 : 20-24

Key Words : Casualties; Improvised Explosive Devices; Militancy; Trauma

Introduction

Trauma due to insurgency by militants is a peculiar problem faced in several parts of the world. The aim of militancy is to terrorize people. Attacks by militants have the characteristics of surprise (time and place), shoot and run, volume of burst of ammunition rather than accuracy and indiscriminate targets. The epidemiology and patterns of casualties may be different from actual wars or high intensity conflicts. Nevertheless, proper medical organization is necessary for the care of these critically injured patients. The experience of treating over five thousand casualties over a period of nine years is presented. The aim is to profile the injuries sustained in militancy operations, and to present our resuscitation and management protocols.

Material and Methods

This is a retrospective analysis of all casualties treated in a single hospital over a nine year period (January 1990-December 1998). Patient evacuation and reception registers, operation theatre logs, ward admission and discharge lists,

battle casualty reports, complication forms, death certificates, statistical report and returns and annual hospital reports were perused to compile this report.

This 600 bedded hospital serves as a regional trauma centre in an area that has witnessed militancy for over a decade. Casualties were brought directly to the centre by road or by air (helicopter) in most instances. Treatment under field conditions was rendered by medical officer, a paramedic or a buddy prior to evacuation wherever feasible. However, in majority of cases resuscitation at the site of injury could not be rendered due to surprise attack, non-availability of trained medical staff and the panic rush of casualty to a medical centre. Some casualties received treatment (including emergency surgery) at one of the several field medical units.

Resuscitation

The casualties were directly received in the intensive care unit (ICU) or the acute surgical ward where they were assessed by the surgeon himself, and the patients were resuscitated and prepared for surgery. In the event of mass casualties, experienced medical officers and other specialists also helped the surgeons in triage [1] and in allocating priorities for

*Classified Specialist (Surgery & Vascular Surgery), +Classified Specialist (Surgery & Paediatric Surgery), Army Hospital, (R&R), New Delhi, #Senior Advisor (Surgery), INHS Asvini, Mumbai, **Associate Professor, Department of Anaesthesiology, Armed Forces Medical College, Pune - 411 040, ++ADMS, Head Quarter, Eastern Command (Medical), Calcutta, ##Classified Specialist (Surgery), Military Hospital, Jamnagar, ***Ex-Commandant, 92 Base Hospital, C/o 56 APO, +++DGMS (Army,) AG's Branch, 'L' Block, Army Headquarters, New Delhi.

management. These mass casualties were received in a separate reception centre, a large room specifically earmarked for this purpose. The initial evaluation of the extent of injury was based on revised trauma score [2] and on other factors suggestive of severity of trauma [1]. The airway was secured and patient intubated as necessary. Shock was defined as presence of systolic blood pressure below 90 mm Hg. Intravenous fluids were administered with the help of two large-bore cannulae inserted into arm veins or internal jugular or subclavian veins. Blood was administered to shocked patients as soon as it was available. The time interval for initial evaluation and resuscitation, basic radiological investigation and preparation of these critically ill patients for operation theatre (OT) was usually only a few minutes. In some instances profoundly shocked and exsanguinated patients were wheeled into the OT almost immediately on arrival. Pressure bandages if already applied under field conditions were usually opened in operation theatre just prior to surgery to prevent blood loss. The trauma protocol practised in the hospital has been published earlier [3].

Operative treatment

The patients were then taken-up for definitive surgery at the earliest. Priorities were established in polytrauma patients regarding the sequence of interventions [1,4]. At times more than one surgical team operated on the patient e.g. simultaneous craniotomy and laparotomy in a patient of severe head injury with gunshot wound abdomen and shock. Quick, speedy operations were encouraged, as it is now well established that the duration of surgery has a bearing on morbidity and mortality. The management policies are briefly outlined.

Soft tissue wounds

A policy of selective primary closure following debridement of wound was adopted. Primary closure was done unless the wound was grossly contaminated, was more than 12 hours old, was in the perineal region or the skin edges could not be approximated. This approach is in contrast to the guidelines of International Red Cross [5], which advocates wound debridement and delayed primary suturing for all wounds except those of genitalia. However, we have not had any cause for regret by this management policy. The infection rate in 3598 wounds, closed primarily after debridement, was 8.97% in comparison with 6.89% infection rate of war wounds treated by delayed primary suturing. Convalescence and hospital stay is considerably reduced in patients whose wounds are closed primarily. The cosmetic result was better and the hospital stay considerably shorter with primary closure of wounds. Grossly contaminated wounds were either dealt with by debridement followed by delayed primary suturing or left to heal by secondary intention. Repeat wound excision was required in many cases. Split skin grafts were employed when necessary.

Compound fractures

The soft tissue wounds were debrided and closed primarily after leaving suction drains in selected cases (see above). POP casts were used for fracture stabilization; however for

unstable or malaligned fractures external fixation was used. The “pin less” fixator was made available in the last year (1998) and was used in a few cases. Internal fixation was used in a few selected cases with clean wounds, which came early. These fixations were carried out mostly in the absence of image-intensifier facilities (the latter has since become available in 1999). The orthopaedic surgeon treated majority of the fractures.

Chest trauma

Intercostal chest drains were liberally employed in thoracic injuries for management of hemo-or pneumothorax. Standard indications for thoracotomy were followed [6,7]. Cardiac injuries were treated by thoracotomy / sternotomy. The mortality in over 100 thoracotomies was below 3%. Management of these injuries has been presented elsewhere [8].

Abdominal trauma

Routine exploration of all wounds with suspected peritoneal violation was carried out [9,10] via a long midline incision. Control of haemorrhage was the first priority. Thereafter a thorough formal laparotomy was performed. Small bowel perforations were repaired in two layers. Colonic perforations were repaired with a proximal covering colostomy, Hartman's procedure or exteriorization. However, in selected cases primary repair of colonic injuries without a proximal colostomy was done [11,12]. One author repaired all colonic injuries primarily in 42 patients without mortality or peritonitis, fecal fistulae formed in 3 cases, but all healed spontaneously. Splenic injuries were usually dealt with by splenectomy, as splenorraphy was considered unsafe by most surgeons in these war wounds. Liver injuries were sutured; partial hepatectomy was occasionally required. “Damage control” approach [13] was followed in some cases of massive haemorrhage, which was difficult to control. The incidence of a “negative laparotomy” was 5.1% in 394 laparotomies.

Head Injuries

The neurological status of the patient was assessed by the Glasgow Coma Scale (GCS). X-ray skull was done in all cases. Since CT scan facilities were not available at the hospital till 1999, clinical judgement was used to decide the indication for craniotomy. Patients with penetrating cerebral injuries, with focal neurological deficit and those with depressed fracture skull were operated. In addition, several patients with severe head injury (GCS <5-6) were operated and exploratory burr holes were made or a craniotomy done and wide decompression carried out. General surgeons performed these operations, as no neurosurgeon was available. While operating on a head injury patient without a CT scan is considered inappropriate at the turn of the century; our peculiar geographic location and absence of access / evacuation to a neurosurgical centre dictated this policy. We were gratified by the clinical improvement in a surprisingly large number of patients with severe head injuries. Out of 156 patients with head injury, 103 were operated and 29 died. All patients with severe head injury were electively ventilated postoperatively. Steroids were not used routinely; nor was

routine intracranial pressure (ICP) monitoring done. A CT scan has since been installed in 1999, completely altering this management protocol. Patients are currently operated only if indicated on CT scan.

Vascular injuries

Primary repair of all vascular injuries was attempted [14]. The repair was usually by autogenous vein graft, or by polytetrafluoroethylene (Gore-Tex) interposition graft. Occasional ligation of the damaged artery was resorted to in order to save life or rarely if the treating surgeon was not conversant with vascular repairs. Concomitant venous injuries were repaired if possible. Concomitant fractures were stabilized prior to vascular repair. Liberal fasciotomy was routinely employed if the repair had been delayed beyond 8 hours, if there was extensive soft-tissue injury or evidence of compartment syndrome. Completion angiography was not performed routinely. Post-operative heparin was given if the patient was hemodynamically stable.

Results

The total number of casualties received year wise is listed in Table 1. The latter years have shown a decrease in number of casualties. The battle casualties according to causative agent are listed in Table 2. 44% of patients were injured by bullets, whereas 56% were injured by fragments due to improvised explosive devices (IEDs), artillery shells and landmines. The injuries sustained region-wise are listed in Table 3. Approximately 38% of patients had injuries to multiple body regions. A total of 8578 injuries were sustained in 5737 patients. Maxillo-facial and ocular injuries have been included in head and neck injuries. Back, spinal, perineal and groin injuries have been included in abdominal injuries. Extremity injuries include both soft tissue wounds alone as well as fractures (1895 patients).

Table 1
Year wise distribution of casualties

Year	Number of casualties
1990	516
1991	657
1992	729
1993	788
1994	946
1995	781
1996	514
1997	426
1998	380
Total	5737

Table 2
Injuring agent

Wounding agent	Number	Percentage
Bullet	2546	44.37
Fragments	3191	55.63
Total	5737	100

Table 3
Site of injury in 5737 patients

Region	Number	Percentage
Head and neck	1214	14.2
Chest	1136	13.3
Abdomen	1163	13.5
Extremity	5065	59
Total	8578	100

Note : 38% of patients had injuries at multiple regions

A total of 4766 out of 5737 patients were operated (83.07%). They underwent a total of 7191 procedures, including secondary operations and re-operation in some cases. The number of operations performed region-wise in these patients is listed in Table 4. The year-wise post-operative and overall mortality is listed in Table 5. A total of 208 patients died after admission to the hospital giving an overall mortality of 3.62%. The post-operative mortality varied from 1.9-3.9% (overall 3.03%).

Table 4
Total operations performed region-wise (4766 patients)

Region	Number of operations	Percentage
Head and neck	448	6.13
Chest	796	11.07
Abdomen	889	12.36
Extremity	5065	70.44
Total	7191	100

Table 5
Mortality figures

Year	Postoperative mortality (%)	Total mortality (%)
1990	3.9	4.2
1991	3.7	4.2
1992	3.4	4.3
1993	2.7	3.2
1994	2.2	3.2
1995	3.7	4.2
1996	3.2	3.4
1997	2.4	2.8
1998	1.9	2.4
Overall mortality	3.03	3.62

The cause of death is listed in Table 6. 98 patients (47%) came in severe shock and despite all measures ultimately succumbed to their injuries. Septicemia leading to multiple organ failure, severe head injury and pulmonary complications were the other major causes of mortality.

Discussion

The war-like situation, which this region has faced due to militant insurgency, is perhaps unique in the world, since it continues after nine long years. This has brought

Table 6**Cause of death**

Cause of death	Number	Percentage
Irreversible shock	98	47
Septicemia	51	25
Severe head injury	29	14
Renal failure	5	2
Fat embolism	15	7
Pulmonary aspiration	4	2
Unexplained cardiac arrest	4	2
Unknown	2	1
Total	208	100

untold misery to the region and this is also reflected in the number of patients who have died or have been injured. Fortunately, the number of casualties has decreased steadily after peaking in 1994 (Table 1). Still the number remains substantial, and this report of 5737 patients is the largest single institutional experience of this kind from this country.

Since this is a military hospital primarily meant for treatment of service personnel, the largest category of patients treated was military and paramilitary personnel. This is similar to the report from Yugoslavia where this category of patients constituted 88% of the injured [15]. However, treatment was rendered to all patients brought to the hospital; thus civilians as well as some anti-national elements also received definitive treatment.

In modern warfare, 20-47% of injuries are caused by bullets [15-22], though occasionally in a highly specialized operation like "Desert Storm" the proportion was only 5% [23]. In the present series 44% of these injuries were due to bullets (Table 2). The approximate percentage of injuries caused by wounding agents in different wars is listed in Table 7.

Table 7**Percentage of injuries caused by bullets and fragments**

War	Bullet wounds	Fragments	Others
World War I	40	60	-
World War II	10	85	5
Korea	31	69	-
Vietnam	46	54	4
Arab-Israeli	18	66	16
N Ireland	58	24	18
Yugoslavia	41	64	5
Croatia	24	76	-
Desert storm	5	95	-
Present series	44	56	-

The severity of gunshot wounds depends on many factors, most important of which are the tumbling behaviour of the bullet, temporary cavitation, missile velocity, bullet fragmentation, target density and shooting

distance [24,25]. High velocity bullets cause extensive damage. This is related to their ability for greater kinetic energy dissipation, higher possibility of fragmentation and formation of secondary missiles and larger temporary cavitation than low velocity bullets [26]. The latest weaponry for firing bullets was available with the militants and some devastating injuries were encountered. Similarly, the militants used several varieties of IEDs though use of landmines was rare, 38% of patients had injuries to multiple body regions resulting in a total of 8578 injuries (Table 3).

The injuries sustained to various regions in different armed conflicts are listed in Table 8. Our series seems to have a relatively high number of abdominal injuries. This may be due to the fact that these "abdominal" injuries in the series include injuries to back, spine, flanks, perineum, groin and abdominal wall. The overall mortality in the present series was 3.62%. Comparable mortality figures of some of the wars is listed in Table 9. Our mortality figures have steadily decreased from 4.2% to 2.4% currently (Table 5). In fact some severely injured and shocked patients who were barely alive on arrival (98 patients, Table 6) succumbed to their injury despite all attempts at resuscitation. If these patients are excluded, our mortality figure (post operative) was overall 3.03%; it has decreased from 3.9% to 1.9% presently (Table 5).

Table 8**Injuries sustained to different body regions**

War (ref)	Sample size	Head & neck	Thorax	Abdomen	Extremities
WW II (27)	116,649	25	13	9	53
Korea (28)	90,841	19	8	7	53
Vietnam (4)	23,396	15	8	5	55
Desert Storm (23)	153	13	6	9	90
Croatian (29)	4805	16	12	4	76
Yugoslavia (15)	3700	21	9	8	62
Present series	8478	14	13	14	59

Table 9**Mortality rates in armed conflicts**

Armed Conflict (ref)	Mortality
Vietnam (30)	1.6-3.5%
Israeli (31)	0.5-2.3%
Gulf War (16)	1.3%
Yugoslavia (15)	4.3%
(Vukovan 1991)	
Yugoslavia (15)	2.25%
(Bosnia 1992)	
Present series	3.62% (2.4-4.2%)

Several lessons have been learnt in the management of over 5,700 casualties over a period of nine years.

Evacuation to a well organized trauma centre by fastest available means, aggressive resuscitation and prompt surgery has saved a number of patients who were critically injured, yet had not received any first aid prior to arrival to hospital. War wounds can be closed primarily after debridement in selected patients. Craniotomy in severe head injury is justifiable; CT scan is mandatory for management of these patients. A policy of laparotomy in all cases of penetrating injury of abdomen gives good results even though a certain percentage of "negative laparotomy" will result. Colonic injuries can be closed primarily in most instances. Optimal utilization of human resources in a developing country does not mandate the presence of super-specialists in a forward hospital. Finally, a well trained, experienced, dedicated and motivated team can deliver good results even under trying circumstances.

Acknowledgement

The authors acknowledge with deep gratitude the help of all forward hospitals, evacuating units and Field Ambulances, all Hospital Commanders, Chiefs of Surgery and all surgeons of the hospital over nine years, hospital administrative personnel without whose concern and personal interest this report couldn't have been compiled.

References

1. Champion HR, Sacco WI. Trauma Scoring. In : Mattox KL, Moore EE, Feliciano DV, editors, Trauma. Norwalk, Appleton and Lange 1988;63-77.
2. Trunkey DD, Siegel J, Baker SP, Gennaralli TA. Current status of trauma severity indices. J Trauma 1983;23:185-201.
3. Suri YV, Venugopalan VM, Tripathy PC, Mahajan TR, Rao AVTK. Militancy Trauma : Anaesthesia and Critical Care Management, MJAFI 1994;50(2):117-22.
4. Whelan TJ, Burkhalter WE, Gomez A. Management of war wounds. In: Welch CE, editor. Advances in Surgery. Vol 3, Chicago, Year Book Medical Publishers, 1968;249-61.
5. Gray R. Surgery of war disaster. Trop Doct 21 (Suppl 1) 1991;56-62.
6. Oprah SS, Mandal AK. Penetrating gunshot wounds of the chest in civilian practice : Experience with 250 consecutive cases. Br J Surg 1978;65:45-8.
7. Adkins RB Jr, Whiteneck JM, Woltering EA. Penetrating chest wall and thoracic injuries. Am Surg 1985;51-140-4.
8. Suri YV, Garg A, Venugopalan VM et al. Militancy trauma : Penetrating and non-penetrating cardiac injuries. MJAFI 1997;53(1):30-4.
9. Moore EE, Moore JB, van Duzer-Moore S et al. Mandatory laparotomy for gunshot wounds penetrating the abdomen. Am J Surg 1980;140:847-50.
10. Feliciano V, Burch JM, Spjut-Patrinley V et al. Abdominal gunshot wounds. An urban trauma center's experience with 300 consecutive patients. Ann Surg 1988; 208:362-4.
11. George SM, Fabian TC, Villier CR. Primary repair of colonic wounds. Ann Surg 1989;209:278-81.
12. Schultz SC, Magnant CM, Richman MF et al. Identifying the low risk patient with penetrating colonic injury for selective use of primary repair. Surg Gynaecol Obstet 1993;177:237-40.
13. Rotondo MF, Schwab CW, McGonigal MD et al. "Damage Control". An approach for improved survival in exsanguinating penetrating abdominal injury. J Trauma 1993;35:375-80.
14. Rai KM. Vascular Injuries. In : Kochar SK, editor. Principles and Practice of Trauma Care. New Delhi, Jaypee 1998;324-50.
15. Vojvodic V. Management of war casualties in the Military Medical Academy (Belgrade) during combat operations in 1991/1992 : An Overview. J Trauma 1996;40:S180-3.
16. Hardaway RM III. Vietnam wound analysis. J Trauma 1978;18:635-42.
17. Jackson DS, Batty CG, Ryan JM et al. The Falklands war : Army field experience. Ann R Coll Surg Engl 1983;65:281-4.
18. Rautio J, Paavolainen P. Afghan war wounded : experience with 200 cases. J Trauma 1988;28:523-5.
19. Bhatnagar MK, Smith GS. Trauma in the Afghan guerilla war: effect of lack of access to care. Surgery 1989;105:699-701.
20. Nassoura Z, Hajj H, Dajani O et al. Trauma management in a war zone : the Lebanese experience. J Trauma 1991;31:1596-1600.
21. Spalding TJW, Stewart MPM, Tulloch DN et al. Penetrating missile injuries in the Gulf War 1991. Br J Surg 1991;78:1102-4.
22. Jevtic M, Petrovic M, Ignatovic D et al. Treatment of wounded in the combat zone. J Trauma 1996;40:S173-5.
23. Carey ME. Analysis of wounds incurred by the US Army Seventh Corps personnel treated in Corps Hospitals during Operation Desert Storm, February 20 to March 10, 1991. J Trauma 1996;40:S165-7.
24. Barach E, Tomlanovich M, Norwak R. Ballistics: A pathophysiological examination of wounding mechanism of firearms. J Trauma 1986;3:225-30.
25. Tikka S. Missile injury. Observation on the mechanism of trauma and revision surgery of soft tissue gunshot wounds. Ann Med Mil Fenn 1989;3:65-8.
26. Swan KG, Swan RC. Principles of ballistics applicable to treatment of gunshot wounds. Surg Clin North Am 1991;71:221-8.
27. Beebe GW, DeBakey ME. Battle Casualties. Springfield III, Charles C Thomas, 1952;165-205.
28. Reister FA. Battle casualties and medical statistics : US Army experience in Korean War. Washington DC, US Govt Printing Office 1973;35.
29. Rukovanski M. Spinal cord injuries caused by missile weapons in the Croatian war. J Trauma 1996;40:S189-92.
30. Bzik KD, Bellamy RF. A note on combat casualty statistics. Mil Med 1984;149:229-30.
31. Rozin R, Klausner JM. New concepts of forward combat surgery. Injury 1988;19:193-6.