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# Penetrating Missile Injuries in the Gulf War 1991

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**SUMMARY: During the recent Gulf War 63 patients with penetrating missile injuries (including 29 Iraqi prisoners of war) underwent operation in a British Army Field Hospital. Their injuries and initial operative management are reported. Fifty-one casualties (81%) suffered an average of 9 wounds (range 1-45) due to fragmentation weapons, and 12 casualties sustained bullet wounds. All wounds were explored following the established principles of war surgery. The extremities were involved in 48 patients (76%). Eight compound long bone fractures were managed with external skeletal fixators applied at the time of initial operation. Laparotomy was performed on 7 patients, one of whom died. The average duration of operation was 77 minutes for shrapnel wounds and 85 minutes for bullet wounds.**

## Introduction

The recent Gulf Conflict represented an unparalleled military success in the sphere of conventional warfare. The effectiveness of massive air bombardments and subsequent rapid armoured thrusts resulted in a short, sharp, one-sided offensive with unexpectedly few Allied wounded. It had been predicted that on a future conventional battlefield the effectiveness of modern explosive munitions would produce high mortality from high energy transfer wounds and blast injury, and that most casualties reaching hospital would have multiple low energy wounds caused by modern anti-personnel fragmentation devices (1-3).

The 32 Field Hospital was deployed as the most forward British surgical facility in support of the ground offensive. It handled both British casualties and Iraqi prisoners of war. We report on the initial operative procedures in 63 casualties and discuss specific aspects of their surgical management.

## Patients and Results

### *32 Field Hospital*

The hospital was established in its forward position on 20 January 1991. It comprised a reception/triage area, an 8 bay resuscitation department, a treatments area, an 8 table operating theatre, 8 surgical teams and 200 beds in 4 wards. In addition a pathology laboratory and a radiography facility were available.

Injured casualties received initial resuscitation and treatment at Regimental Aid Posts and Field Dressing Stations. Following helicopter evacuation to 32 Field Hospital, resuscitation was continued and appropriate radiographic studies were performed. Data on patients who underwent surgery were recorded on proformas to include the date and time, cause and nature of injury, duration of operation, operative findings and surgical management. Patients were evacuated on the first postoperative day to military general hospitals in southern Saudi Arabia.

## Presentation and Management of Injuries

Between Jan 20 and Mar 6, 1053 patients were received by the hospital and 100 operations were performed. Sixty-three casualties sustained penetrating trauma because of missile injuries, 31 were British, 29 were Iraqi prisoners of war and 3 were Egyptian. The causes of the missile injuries are outlined in Table 1. Eighty per cent were due to fragments and three of 12 bullet wounds were high energy transfer injuries. Table 2 reflects the predominance of limb wounds in both fragment and bullet injuries (76%), compared with chest wounds (12%) and abdominal wounds (11%).

Fragmentation weapons inflicted multiple low energy transfer wounds affecting more than one body area in 63% of cases (Table 3). One patient had sustained

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**Table 1**
**Causes of Missile Injuries. (n = 63)**

| | | | |
|---|---|---|---|
| Fragment | Not Specified | 40 | |
| | Mine | 5 | |
| | Grenade | 6 | |
| | | — | |
| | | | 51 (80%) |
| Bullet | 9mm | 5 | |
| | 7.62mm | 4 | |
| | 5.56mm | 1 | |
| | unknown | 2 | |
| | | — | |
| | | | 12 (20%) |

**Table 2**
**Penetrating Missile Wounds: Site of Injury**

| Site | Shrapnel (n = 51) | | Bullet (n = 12) | | Combined (n = 63) | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % |
| Head | 4 | 8 | 0 | 0 | 4 | 6 |
| Extremity | 41 | 80 | 7 | 58 | 48 | 76 |
| Upper Limb | 24 | 47 | 4 | 33 | 28 | 44 |
| Lower Limb | 40 | 78 | 7 | 58 | 47 | 75 |
| Chest | 8 | 16 | 0 | 0 | 8 | 12 |
| Abdomen | 6 | 12 | 1 | 8 | 7 | 11 |
| Buttocks | 16 | 31 | 1 | 8 | 17 | 26 |
| Back | 4 | 8 | 0 | 0 | 4 | 6 |

**Table 3**
**Shrapnel Wounds: No. of body areas involved (n = 51)**

| No. of areas | Patients No. | % |
|---|---|---|
| 1 | 19 | 37 |
| 2 | 10 | 20 |
| 3 | 10 | 20 |
| 4 | 9 | 17 |
| 5 or more | 3 | 6 |

wounds to all four limbs, buttocks and back. The mean number of fragment wounds per patient was 9 (range 1-45).

The average time for a casualty to reach the hospital was 10.2 hours for Allied casualties and 24.7 hours for Iraqi POW's (Table 4). The mean duration of operation was 78.7 minutes; it was longer for bullet wounds (84.6 minutes) than for fragment injuries (77.3 minutes). These times include both the induction of anaesthesia and extubation, which were performed on the table.

*Soft tissue wounds.* Most fragment wounds affected soft tissue only (Table 5). All soft tissue wounds were explored according to established principles of war surgery (4). Wound edges were excised permitting free

**Table 4**
**Mean Time for Allied and Iraqi patients to reach hospital, operating theatre and duration of operation.**

| | No. | Time to reach hospital (hrs) | Pre-operative period (hrs) | Duration of operation (mins) |
|---|---|---|---|---|
| Allied Troops | 34 | 10.2 | 2.1 | 76.2 |
| Iraqi POW's | 29 | 24.7 | 4.5 | 97.5 |

access to the damaged tissues beneath. Limb incisions were longitudinal, facilitating decompression of underlying muscle and visualisation of damaged structures within the wound cavity. Viability of muscle was determined by colour, texture, contractility and lack of bleeding. All non viable muscle and fat was excised, and foreign bodies that were easily accessible were removed.

Wounds were irrigated with hydrogen peroxide and dressed with dry gauze. Benzylpenicillin had been administed to all casualties prior to arrival in hospital. Flucloxacillin was added to this regimen at operation and both were continued for a maximum of 5 days.

*Bone Injury.* Bone was fractured in 6 patients (50%) with bullet wounds and 17 patients (33%) with fragment wounds. Following wound excision and lavage, loose avascular splinters of bone were removed, together with foreign bodies. External skeletal fixators ("Centrafix", Military Pattern, Howmedica Ultra-X, New Jersey, USA) were applied to 8 limbs at the initial operation as follows: humerus-2, ulna-1, tibia-4 and ankle and foot-1. All these fractures were either comminuted or associated with segmental bone loss. They were characterised by severe soft tissue injury requiring extensive surgical

**Table 5**
**Type of Injury and Type of Treatment for bullet and shrapnel wounds. (n = 63)**

| Injury and Treatment | Bullet (n = 12) | | Fragment (n = 51) | | Total (n = 63) |
|---|---|---|---|---|---|
| Soft Tissue | 6 | | 51 | | 57(85%) |
| Wound excision | | 6 | | 51 | |
| Bone Injury | 6 | | 17 | | 23 (35%) |
| External Fixation | | 3 | | 5 | |
| Amputation | | 0 | | 4 | |
| POP Splintage | | 3 | | 8 | |
| Thoracic Injury | 0 | | 5 | | 5 (7.5%) |
| Chest drain | | 0 | | 5 | |
| Abdominal Injury | 1 | | 6 | | 7 (11%) |
| Laparotomy | | 1 | | 6 | |
| Vascular Injury | 1 | | 1 | | 2 (3%) |
| Vein Patch | | | | 1 | |
| Lateral Suture | | 1 | | | |

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**Table 6**
**Management of Abdominal Injuries.**

| Patient | Laparotomy findings | Operative procedure |
|---|---|---|
| 1 | Penetration of liver and common bile duct | T-tube drainage CBD Drainage Liver |
| 2 | Penetration of liver | No procedure |
| 3* | Penetration of liver, spleen and rectum | Splenectomy, Hartmann's procedure |
| 4 | Penetration of Stomach | Two-layer closure |
| 5 | Negative Laparotomy | — |
| 6 | Penetration of Liver | No procedure |
| 7** | Penetration of Rectum, Ileum and caecum | Right hemicolectomy, ileostomy, mucus fistula and Hartmann's procedure |

* = Died ** = GSW

excision and wide fasciotomy. When applying the fixators, simple, unilateral, single plane configurations were constructed. Pin tracks were pre-drilled and pins introduced by hand through generous skin and fascia releasing incisions. When bone mass was lost the fracture was held distracted to preserve limb length and axial alignment. Restoration of continuity was not practised in tendon and nerve injury.

Three patients underwent completion of traumatic amputations (bilateral through knee, Symes, and mid forearm). POP splintage was applied in 11 hand and foot injuries.

*Abdominal Injury.* Six patients with fragment wounds and 1 patient with a bullet wound received injuries to the abdomen necessitating laparotomy (Table 6). Fragment wounds to the liver did not cause significant bleeding, and no further procedure was required. Case 3 was the only fatality having sustained multiple fragment wounds to both lower limbs, buttocks and abdomen, with perforation of the liver, spleen and rectum.

*Thoracic Injury.* Thoracic penetration resulted in haemopneumothorax in 5 patients with multiple fragment injuries. All were managed with local wound excision and chest drainage without the necessity for thoracotomy.

*Vascular Injury.* Vascular injury was rare: one fragment wound to the brachial artery was reconstructed using a vein patch graft and a bullet wound to the profunda femoris artery was repaired using a lateral suture technique.

**Discussion**

Despite the potential magnitude of the Gulf Conflict, Allied casualty figures were low. The pattern of wounding seen in this small series was in keeping with experience from previous conventional battles (1, 4, 5). Fragment wounds accounted for 81% of casualties and were caused by modern anti-personnel weapons. An average of 9 low energy transfer wounds were inflicted per patient. This emphasises the inherent design features of the modern preformed fragment device, designed largely to incapacitate rather than kill.

The average operating time of 77 minutes illustrates the burden that the treatment of non life-threatening fragment injured casualties can impose upon surgical resources during war. When faced with the circumstances of multiple wounds in multiple patients the surgeon may be tempted to adopt less aggressive surgical management (6, 7). Our experience of battlefield injuries included many malnourished casualties, with multiple fragment wounds which were typically heavily contaminated and more than 24 hours old. At operation, the extent of the cavity and degree of tissue necrosis beneath the small puncture fragment wounds illustrated that, even at moderate range, these fragments generate sufficient energy transfer to form a temporary cavity, which results in skin and fibres of clothing being dispersed in radial fashion within the wound. These findings reinforce the military dictum that all penetrating missile wounds should be thoroughly explored and that one should err on the side of a more radical excision (7, 9). Of the 63 casualties 48 patients (76%) sustained limb wounds in this series. Missile fractures were seen in 23 of these 48 patients (48%) but only eight (17%) involved long bones and required external fixation. In the last two decades external skeletal fixation has undergone a renaissance in the management of severe limb wounds associated with fractures in war (10, 11). This fact has been due in large part to improvements in design and the development of basic principles which govern their safe and effective application (12). Experience in recent conflicts has emphasised that an ample supply of fixators is essential in war and that military surgeons should be trained in their use (11). The external fixators used in our 8 cases were simple, versatile and disposable systems specifically designed for use by surgeons in field hospitals.

Coupland has suggested that application of an external fixator has lower priority than wound excision and should be delayed until delayed wound closure (13). We found external fixators applied at the time of initial surgery provided immediate stabilisation of soft tissues, and assured limb length and axial alignment when bone mass was lost. Additional benefits included the reduction of patient discomfort during rearward evacuation to a general hospital.

Allied and Iraqi casualties showed a pattern of penetrating injury in keeping with a perceived conventional battlefield. This series has underlined the effectiveness of present day anti-personnel munitions and highlighted the continued requirement, in the practice of military surgery, for a clear understanding of the mechanism of wounding in war and the appropriate management.

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