"A Terrorist Incident"

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Introduction

This paper documents a terrorist incident when two British soldiers were shot by the Provisional IRA. Their first and second line management is described, and the lessons learnt from the incident are discussed.

The Incident

Two off-duty soldiers were ambushed in a street by three men in a car, who fired upon them at point blank range with a sustained burst from an automatic weapon and spaced shots from a handgun, at least 25 rounds being fired (Fig 1). Both soldiers collapsed and the terrorists escaped. The weapons have since been identified as a Yugoslavian 7.62 mm Kalashnikov AK47 and a 0.38 inch revolver.

First aid was administered by troops from an adjacent barracks and an off-duty doctor. Resuscitation was initiated on the arrival of two civilian ambulances and a military ambulance, a civilian trauma surgeon, and the duty surgical registrar from a British Military Hospital, (BMH) who had been despatched to assess the situation.

Soldier A

Soldier A sustained two high velocity gunshot wounds and one low velocity wound to his lower limbs (Fig 2). The entry wounds were proximal to each patella. On the right thigh there was a combination injury with a compound comminuted fracture of the shaft of the femur and a 12 cm defect in the femoral artery and vein, in addition to a very large soft tissue medial exit wound. On the left there was a large soft tissue exit wound in the popliteal fossa, fortunately without neurovascular damage.

A tourniquet was applied to the upper right thigh, and intravenous fluid replacement with dextran 40 was rapidly instituted via several large bore cannulae. Progressive loss of consciousness necessitated intubation and ventilation.

It was decided to transfer him to the British Military Hospital. The Emergency Services relayed this message to the Orderly Medical Officer at BMH, who co-

Fig 1. Wall with bullet holes.

ordinated the call-out of operating theatre staff, consultant surgeon, anaesthetists, pathology and X-ray staff. On arrival at BMH, Soldier A was transferred directly to the operating theatre.

Resuscitation was continued with the insertion of central venous lines, an arterial line, further peripheral lines and an urethral catheter. Three units of group-compatible A-Positive blood were immediately transfused, the blood group having been ascertained from the soldier's identity card.

Despite these measures, resuscitation was ineffective, the soldier's blood pressure being unrecordable. The tourniquet had loosened, and was removed. Direct pressure over the wound and proximal femoral artery was only partially successful in controlling bleeding and immediate surgical exploration was undertaken. The proximal and distal ends of the divided femoral artery and vein were exposed and vascular clamps applied.

By now, one hour had elapsed from the time of the shooting. Once haemorrhage had been controlled, the patient was stabilised by further blood transfusion.

Fig 2. Wounds incurred by Soldier A (left) and Soldier B.

The subsequent operation consisted of the following stages:

- Temporary restoration of circulation to the right leg with an improvised rubber shunt.
- Cooling of the leg with ice packs.
- Full heparinisation.
- Fracture stabilisation with the "field fixator"*.
- Autogenous interposition saphenous vein grafting to the femoral artery and vein.
- Definitive excision of all wounds.
- Adequate fasciotomy.
- Partial closure of the right thigh wound to protect the vein grafts.
- All other wounds were left open and dressed.

During the operation, he received high dose intravenous antibiotic therapy with benzylpenicillin, gentamicin and metronidazole, as well as antitetanus immunoglobulin and tetanus toxoid booster.

He also received 18 units of blood (including 12 units of fresh platelet-rich blood) in addition to 2000 mls of dextran 40 pre-operatively, 2000 mls Haemaccel, and 7 units of fresh frozen plasma.

*"Centrafix" external fixator, military pattern. Central Orthopaedics Ltd.

Serious intra-operative problems were hypovolaemia, hypocalcaemia, hypokalaemia and metabolic acidosis. Of note, the resultant hypotension adversely affected blood flow through the grafts, which on occasion had to be maintained by intermittent manual compression.

He was extubated and awakened at the end of the operation, when he demonstrated that he could feel and move his right foot.

Post-Operative Progress. A large fracture-site haematoma was evacuated under general anaesthetic 4 hours later. This haematoma had caused the femoral vein graft to thrombose. However, further grafting was not indicated at this stage, as limb swelling was controlled by elevation.

An X-ray had demonstrated the presence of the low velocity round embedded near the right ischial tuberosity, but an attempt to retrieve it under this same anaesthetic was unsuccessful (Fig 3).

Further transfusions resulted in soldier A receiving a total of 27 units of blood and 9 units of fresh frozen plasma.

He was evacuated to another military hospital, six days after the shooting for further management.

Soldier B

Soldier B received 5 high and low velocity gunshot wounds to the limbs (Fig 2), fortunately without incurring major vascular damage. He sustained a large soft tissue right upper thigh wound, as well as compound fractures of the right elbow (with disruption of the ulnar nerve), right medial femoral condyle, right tibia, and the neck of the left fibula (with division of the common peroneal nerve), with their associated soft tissue entry and exit wounds.

After initiation of intravenous fluid replacement with dextran 40, he was transferred to the local civilian hospital for further resuscitation and surgery.

Initial surgical treatment involved:

- a. High dose intravenous antibiotic therapy with a cephalosporin.
- b. Fracture stabilisation of the right elbow and right leg with external fixators*.
- c. Excision of all wounds, with insertion of gentamicin beads.
- d. Apposition of divided ulnar nerve.
- e. Primary closure of the right elbow and knee, the other wounds being left open and dressed.

Post-Operative Progress. Soldier B subsequently developed compartment syndrome in both legs, necessitating extensive bilateral fasciotomy approximately 30 hours later. Despite this, the muscles of the left anterior tibial compartment underwent extensive necrosis, and were excised in two further operations at the civilian hospital, under the direct guidance and active involvement of the consultant surgeon from BMH, on the invitation of the civilian surgeons (Fig 4). He was ventilated for three days post injury, and transfused a total of 16 units of blood. Eight days after the shooting he was transferred to the BMH where he underwent partial delayed primary closure of most wounds prior to evacuation to another military hospital.

Fig 3. Low velocity round in 'Soldier A'.

*AO-Synthes

Discussion

The facilities available for the resuscitation of the injured have improved dramatically since Dominique-Jean Larrey established the rudiments of casualty care during the Napoleonic Wars¹. Tremendous advances have been made in the First World War² and the Second World War³, with further refinements in more recent conflicts⁴.

A minor criticism of the initial resuscitation of Soldier A is in the choice of dextran 40 as intravenous fluid replacement. Dextran interferes with subsequent cross-matching and a specimen of blood should be obtained for cross-matching prior to dextran infusion. Dextran also causes blood to congeal in the infusion tubing should blood be transfused subsequently. The use of polygeline ("Haemaccel"), 4% gelatin in saline ("Gelofusin"), or human albumin solution would prevent these complications. When it becomes available blood is the fluid of choice for the replacement of blood losses.

Fig 4. AO-Synthes external fixator and excision of left anterior tibial compartment.

The use of a tourniquet is a controversial but life saving measure. We endorse the statement in the "Field Surgery Pocket Book"⁵: "Tourniquets are rarely required for the control of bleeding and should only be used when all other methods fail, the severity of the haemorrhage is considered to be a danger to life and the risk of loss of the limb concerned is accepted. Correctly applied, a tourniquet will save life". However, once applied a tourniquet should be constantly supervised to maintain its effectiveness. Unfortunately during the transfer of Soldier A the tourniquet slackened and became ineffective. In fact by causing venous congestion such a tourniquet may even increase blood loss.

In some cases haemorrhage will not be controlled by "First Aid" measures of direct pressure to the bleeding point, pressure over proximal pulses or a tourniquet, as demonstrated in the case of Soldier A. Surgical exploration and control of bleeding points is a necessary part of resuscitation and should not be postponed while attempts to "stabilise" the patient are failing⁶.

The axiom that correct surgical management is dependent on a knowledge of the cause and mechanism of disease is equally valid when considering traumatic injuries. The successful management of missile wounds, be they sustained through conventional or terrorist activities, requires knowledge of their pathophysiology and the ballistics of modern weaponry. This is especially true when considering the destructive effects of high velocity missile wounds⁷.

The principles of such "military surgery" are summarised as follows:

Through a generous incision all damaged skin, deep fascia, fat and muscle are excised, foreign material removed and haemostasis achieved. Compartmental decompression through adequate fasciotomies is necessary to prevent post-operative oedema prejudicing blood supply. Wounds should be left open and dressed, followed by subsequent wound reinspection and delayed primary closure^{4,5}.

The high mortality associated with major vascular damage is demonstrated in the report of the Hungerford shooting incident⁸ when three of the four patients sustaining such injuries died. The surgery of combination limb wounds requires the immediate control of haemorrhage, the restoration of circulation and the stabilisation of associated fractures.

After major vascular damage from high velocity missiles it will rarely be possible to restore circulation by end to end anastomosis. Autogenous interposition vein grafting will usually be necessary⁹.

This is time consuming and the temporary restoration of circulation via a shunt is a well established procedure^{9,10,11}. This allows immediate reperfusion of the limb distal to the injury and reduces ischaemic damage. In Soldier A a temporary shunt was inserted within ten minutes of controlling the haemorrhage with vascular clamps, i.e. within seventy minutes of the shooting. In this case shunting was achieved by the improvised use of a rubber tube but purpose-designed vascular shunts, such as the "Brenner" or "Javid" shunts⁹, are recommended.

Clearly such shunts need to be used with due consideration to the period of limb ischaemia, since the reperfusion of an ischaemic limb with release of toxic metabolites may lead to further circulatory collapse in a patient who is already hypovolaemic. Four to six hours ischaemic time would appear to be the limit⁹.

When considering the management of injuries sustained in a terrorist incident in an urban "peacetime" environment one must be cautious in extrapolating results to a war-time scenario⁹. We believe however, that temporary vascular shunting may have a role in the advanced surgical management of casualties in any future major conventional conflict. Many problems can be envisaged and much research would be needed to establish whether temporary shunting is a viable option in war. However, a preliminary investigation could be

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commenced on the basis of potential financial saving alone if one considers the cost of a shunt against the cost to the state of a permanently disabled serviceman. They may ultimately lead to vascular shunts forming part of the armamentarium of a field surgical team.

Associated fractures should subsequently be stabilised by external fixation, and the Centrafix "fixator" is ideally suited to this task by being both quick and simple to apply and it provides stable fixation (Table 5).

The presence of an experienced surgeon from the British Military Hospital at the incident scene initiated the necessary liaison between the military and civilian medical services. Where logistically possible we would recommend the deployment of such a surgeon to major incidents such as this. His knowledge of the capabilities and limitations of the military hospital will assist the coordination of casualty evacuation. He should be able to direct radio communication with the military hospital to notify them of the number of casualties, their injuries and disposal. This recommendation is backed up by the report of the Royal College of Surgeons of England on "The Management of Patients with Major Injuries" which emphasises that "radio communication between those dealing with the patient at the site of the accident and those preparing to receive the patient in hospital should be of the highest quality"¹². This highlights a deficiency in the present military ambulance equipment scales, as was evident in the case of Soldier A, for whom the military ambulance had no radio, and messages to the BMH had to be relayed by the Emergency Services.

When firearms are used in an urban setting it is likely that civilian hospitals will receive patients with the severe and specialised injuries and some civilian surgeons will not have had experience in the management of these wounds. Perhaps it behoves us as military surgeons to offer our expertise and become actively involved early under these circumstances rather than await a call for assistance as happened in the case of Soldier B, in whom the development of the tibial compartment syndrome might have been anticipated.

Fig 5. 'Soldier A': Centrafix external fixator.

Conclusion

This paper stresses the need to remember the tried and proven principles of military surgery. That our civilian counterparts are not always so conversant in these principles highlights the need for the integration of "military" surgeons into a "civilian" trauma system.

The converse is also true and military surgeons need to be responsive to the developments, such as vascular shunting, occurring in civilian trauma centres. Such cross-fertilisation of ideas will improve the care of the wounded.

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