

Gunshot and bomb blast injuries: a review of experience in Belfast¹

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Civil violence has been endemic in Northern Ireland since 1968, occasionally spilling over into the Republic of Ireland and the rest of the United Kingdom. Injuries due to gunshot and bomb blasts follow a cyclic pattern in which particular types of injury predominate for a time until another pattern emerges. For the surgeon involved (both consultant and registrar) these injuries represent an addition to road traffic and industrial injury familiar throughout the world.

The greatest problem for the surgeon is the infinite variety of injury inflicted. By international standards the number of cases, 3418 in 10 years, is relatively small (Barros D'Sa 1982). The consequence is that each situation is unique. The only exception to this are the 'knee capping' injuries, of which there have now been about 400 recorded, and neurosurgical injury. It is by regarding each situation as unique that the error of the missed lesion can best be avoided. A patient may look like another one recently treated, but they are seldom the same.

Resuscitation and assessment

Rapid access to resuscitation has been the rule for most of our patients. The Royal Victoria Hospital is situated close to where much of the violence occurs; consequently about 60% of the casualties are being resuscitated within 40 minutes of injury and, by two hours, 80% are being treated. Patients do not, therefore, suffer prolonged periods of hypoxia and most of the severely injured are intubated and anaesthetized on admission. In parallel with resuscitation goes assessment, first to assess the degree of shock and impairment of pulmonary function and later to define the precise injuries either by careful examination or by simple investigation. It is important to know how the injury occurred and what weapon was involved. Volume replacement is commenced with crystalloid solutions and continued with both blood and colloids keeping the haematocrit at about 35%. There is a large Intensive Care Unit in the charge of three anaesthetists and to it, between 1971 and 1979, 368 patients were admitted as a result of civil violence; 224 of them recovered.

Types of wounding

There are three kinds of wounds: gunshot wounds, which can be divided into those due to high velocity missiles and those, less severe, due to low velocity weapons; injuries due to bomb blast, which are less common and tend to be episodic; while blunt injuries, most commonly due to baton rounds ('plastic' bullets), occur at times of rioting.

The high velocity missile releases a large amount of energy as it decelerates in the tissues, causing wide disruption often beyond what seems to the naked eye to be damaged. There is a tendency to underestimate the amount of debridement that should be performed but this does not apply to skin which resists disruption and should be conserved as far as possible.

Bomb blast inflicts contusion, blunt injury, burns and penetrating wounds. A missile propelled from a bomb may be travelling at high velocity and its entry wound may be disguised by other superficial injury inflicted by the blast. Many bomb blast injuries are, however, trivial. Out of 1532 victims seen between 1969 and 1972, only 250 (16%) required admission, only 10 had a visceral injury and only 9 died; there were about 50 deaths before

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admission (Hadden *et al.* 1978). This is different from the Birmingham experience where most of the victims were severely injured in an enclosed space.

Baton rounds do not often cause severe injury. The most serious injuries are those to the head, but they may also cause severe lung contusion or blunt abdominal injury with visceral damage.

General principles

The various studies by my colleagues and my own practice suggest that we tend to be interventionist. If in doubt we open the chest or explore the abdomen. This is probably because we have excellent facilities and are operating in familiar surroundings, usually without any pressure from large numbers of patients presenting at one time (the only exception to this being a few occasions in 1970–72). We feel that once the patient has been stabilized he is in the best state for intervention and that, when this period (probably about 24 hours) has elapsed, the patient is in a much poorer metabolic and respiratory state for major surgery. Delayed intervention is best avoided. The optimal sequence of events is: resuscitation and assessment 0–6 hours; intervention 2–24 hours; control of respiration, metabolism and infection 1–4 days; revisionary or secondary treatment 4–14 days.

Infection

Infection is the major cause of late deaths, particularly in abdominal injury. It is best prevented by early and complete intervention supported by a specific antibiotic policy. Within the abdomen gram-negative anaerobes are the greatest danger; metronidazole is the drug of choice with cotrimoxazole, cephalosporins or gentamycin for other gram-negative organisms. When, despite early measures, sepsis becomes established, every effort must be made to isolate the organism for specific antibiotic therapy and efforts made to eliminate any source of continuing infection often due to a missed lesion.

Thoracic injuries

Ferguson & Stevenson (1978) reviewed the thoracic gunshot wounds over seven years. The most interesting finding was the high rate of thoracotomy (78%). This is much higher than other series and they justify it by the results (a mortality rate of 12.8%). It is possible that, as so many of our patients are victims of assassination attempted at close range, a high proportion of the missiles pass close to the centre line of the thorax and thoracotomy is indicated. The indications for thoracotomy are: significant and continued haemorrhage from a chest drain; a dangerous predicted track; associated intra-abdominal injury.

Thoracic wounds are often just one of several injuries including abdomen, limbs and head, but if there is any possibility of penetration into the thoracic cavity the least that should be done as soon as possible is the insertion of a large (28 FG) chest drain. In cases of diffuse bomb blast injury to the chest, bilateral chest drains are essential particularly if intubation and mechanical ventilation is going to be required. It is difficult to separate blast injury to the lung from 'shock' lung and the consequences of the diffusion of transfused fluid into the alveoli. It is probably wise to restrict the infusion of crystalloid solutions in these cases and increase the volume of colloid solutions.

Abdominal injuries

It is particularly in the abdomen that there can be an infinite variety of injury, and a painstaking examination must be carried out in every case. As far as preoperative diagnosis is concerned, abdominal lavage is seldom necessary except in closed injuries due to bomb blast. Again we are interventionist and believe that if there is any possibility that the abdominal cavity has been penetrated a laparotomy should be performed.

The liver presents the same problems as it does in closed injury. A particular problem, however, is the through-and-through penetrating wound due to a low velocity missile. It should not be widely opened up unless it is bleeding copiously but should be probed with gauze soaked in saline to remove foreign bodies and detached pieces of tissue. If, however, the

wound has been inflicted with a high velocity weapon, it is likely that a major portion of the liver has been shattered and resection of necrotic tissue will be required. All injuries to liver should be drained. We have no experience of endocaval shunts, nor is there a survivor of major injury to hepatic veins or the retrohepatic cava.

Pancreas

Campbell & Kennedy (1980) have reviewed the pancreatic injuries. In 10 years 24 injuries due to terrorist violence were seen: all those injured with high velocity missiles died (5), whereas only 2 out of 17 injured with low velocity missiles did so. Four retroperitoneal haematomas were not explored and 2 of the patients died. Haematomas in the region of the pancreas should probably be explored while those in the region of the kidneys and in the pelvis, unless progressive, are usually better left undisturbed. They suggested a flow chart for management which defined three basic procedures: minor injury – drain; major injury, head and neck – drain into a Roux loop; major injury, body and tail – resect.

Colon and rectum

Parks (1981) has very recently reviewed 10 years' experience in the Royal Victoria Hospital (106 cases). At the beginning of the period there was a trend towards primary closure of colonic injuries and the avoidance of colostomy but, as a result of a high morbidity rate due to sepsis, there was by 1972 a swing to a policy of exteriorization of injured colon, colostomy being performed in nearly every case. The present policy, however, stands between these two extremes. No patient with an isolated colonic or rectal injury died and only one of the 18 deaths was considered to be due to sepsis.

The principles guiding our therapy at present are: (1) Primary closure is only justified in low velocity injuries with limited damage, less than 4 hours' duration, little or no contamination of the peritoneal cavity and no associated injuries. (2) Injuries to the right colon are best treated by resection and ileocolic anastomosis. (3) Transverse colon is readily exteriorized. (4) The left colon is best resected but not anastomosed; rather the proximal end should be brought out as a colostomy and continuity restored at a second stage. This is especially applicable to injuries to sigmoid colon and upper rectum.

Genitourinary

These injuries have recently been reviewed (Archbold *et al.* 1981). There were 76 in 10 years of whom 12 died, but probably in only 3 cases was this the result of the genitourinary injury. Injury to the kidney may have to be explored but a conservative approach seems effective and in 11 cases a static perirenal haematoma was not explored, without adverse results. Although a preoperative intravenous urogram was performed in only 3 cases, it should probably have been done more frequently especially if there is any possibility of a bilateral renal lesion, pre-existing disease or the likelihood that nephrectomy will be required.

Injury to the ureter is a lesion which is easily missed. Almost always it is associated with other injuries and, in this series in which there were 8 cases, only 3 were detected at the initial operation. In all cases where there is evidence of injury close to the position of a ureter it should be clearly identified, if necessary, mobilized and inspected for injury. Injury to bladder and urethra did not present unusual problems.

Transverse gunshot wounds of the pelvis are difficult to manage. Venous haemorrhage is often severe and difficult to control, both rectum and bladder may be damaged and ureteric injury is easily missed. Control of arterial inflow at the pelvic brim and packing of the pelvis for a few minutes controls bleeding. The ureters should be clearly identified and the rectum mobilized for inspection.

Vascular injuries

Barros D'Sa (1982) has reported on 192 patients seen over a period of ten years. There were 24 deaths, all except 3 being due to injury to intrathoracic or abdominal vessels and in these 3 the cause of death was not primarily the vascular injury. All 5 cases of injury to the abdominal

aorta died, as did one of two injuries to the thoracic aorta and 4 of the 11 affecting the inferior vena cava. In these injuries only the most expeditious management can hope to save life and it may be that exploration should be performed more often in the emergency room, although it is an extremely difficult judgment to make.

The majority of vascular injuries occurred in the lower limbs as a result of punishment shootings to the knee, which are now such a prominent feature of terrorist 'justice'. There have probably been between four and five hundred of these shootings. Angiography is not routinely used preoperatively; it may be useful if there is doubt and is certainly useful postoperatively to confirm patency or detect late aneurysm formation.

Palpable distal pulses do not exclude vascular injury. Whenever a missile track passes close to a large vessel that vessel should be exposed and inspected. Failure to do this will inevitably result in the late occurrence of aneurysms and fistulae, several of which have had to be repaired. If vascular injuries coexist with limb fractures then those fractures must be immobilized, usually by external fixation.

Arterial injury should be repaired rather than being dealt with by simple ligation, particularly in the popliteal, common femoral/external iliac, axillary and brachial arteries. It is seldom possible to carry out a lateral repair of an artery damaged by a missile. The least that should be done is the insertion of a vein patch, while usually a vein graft taken from the lower saphenous vein of the same or other leg should be used. The graft can be adjusted to the lumen by the compilation technique (Linton 1973). The intima should be carefully scrutinized and steps taken to resect the artery to the level of normal intima or sutures inserted to secure the intima if the other coats are intact.

Injury to veins is also important at certain sites. At femoral and popliteal areas an attempt must always be made to repair at least one large vein and, for this purpose, the compilation graft is of great value. In 67% of the veins repaired flow was re-established, and most of these seem to have had a long-term success.

In vascular injuries to the popliteal region a serious complication is swelling of muscle within the rigid fascial compartments of the lower leg. This may be due to venous obstruction (which is minimized by venous repair) and also to the effects of anoxia on muscle. Whenever, therefore, there has been venous injury or arrest of arterial flow for more than four hours, it is advisable to perform fasciotomies of the three compartments. The amputation rate following popliteal vascular trauma has been 5.1%.

Conclusion

It is essential that experience must be shared. We, from Belfast, sometimes feel like travelling salesmen touring the world with our slides, but the justification lies in the unique variety of injury that can be inflicted by gunshot and bomb blast. My own feelings of inadequacy centre round my difficulty in defining alternative strategies in a particular situation and being able to judge which is best. It is not possible for any of us to acquire from personal experience the knowledge required; it can only be gained from shared experience.

When these injuries occur someone's life hangs in balance, either for survival or for an unblighted future. We fight terrorism by minimizing its effects on its victims. To do that we must be available; must resuscitate and assess; must plan alternative strategies of care; must choose the right one; and then pursue it with discrimination and determination.

My thanks are due to my colleagues for permission to quote from their reviews and for sharing their experience with me.

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