INVITED ARTICLE

THE ORTHOPAEDIC CONSEQUENCES OF CIVIL DISTURBANCE IN NORTHERN IRELAND

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For several hundred years, rival factions within the religious communities of Ireland have had their differences. The division of Ireland in 1920 into a predominantly Protestant North and Catholic South emphasised the geographic, political and ethnic polarisation of the island. Violence, however, had been sporadic and relatively short-lived until the current civil disturbance in Northern Ireland, euphemistically referred to as 'the troubles', began in 1969.

There have now been 20 years of continuous violence by a number of terrorist groups; almost every conceivable weapon has been used. Over 2600 people have been killed and more than 30000 injured. In a relatively static population of 1.5 million, where there had been only one murder in the 10 years before 1969, this represents an horrific increase in the level of violence, leaving few untouched.

However, this must be seen in perspective – road accidents in Northern Ireland have claimed over 5000 lives and injured 150000 people within the same period. In only one of 19 years has the death toll from civil disturbance exceeded that from road traffic accidents (Fig. 1). The victims of the troubles have included both civilians and members of the security forces (Fig. 2).

MEDICAL ORGANISATION

The worst areas for civil disturbance have been the rural borders of Ulster and the urban areas of North and West Belfast. Injured patients from the rural areas are evacuated to one or more of 14 district general hospitals, where primary treatment is the responsibility of local general surgeons. These have coped admirably with both initial and continuing patient care (Brown and Marshall 1988). Specialist opinion is available by telephone or from a visit by the appropriate consultant but, provided the patient's condition is stable, transfer by road or by helicopter to a major centre is preferred.

In the Belfast area, many of the serious civil

![Deaths from civil disturbance 1969–1987](chart1.png)

**Fig. 1**

Annual death toll from civil disturbance and from road traffic accidents.

![Injuries resulting from civil disturbance](chart2.png)

**Fig. 2**

disturbance casualties are managed at the Royal Victoria Hospital (RVH), a 1 000-bed teaching hospital with full specialist medical and surgical services and a large Intensive Care Unit. The major disaster plan of the RVH was used 46 times in the first three years of the troubles. This compares with 42 disaster situations in the remainder of the United Kingdom over the 20 years from 1951 to 1971 (Rutherford 1973). The RVH is sited on the boundary between the rival factions of the community, and this proximity has resulted in minimal delay between injury and primary care in the Accident and Emergency Department; in most cases this has been less than half-an-hour. This compares well with average delays of 10.5 hours in World War II, 6.3 hours in the Korean War, and 2.8 hours in the Vietnam War (Barros D'Sa 1982). It is estimated that the RVH has dealt (either directly or indirectly) with about half of all the injuries related to civil disturbance (Johnston and Kennedy 1976), but again to provide perspective it should be noted that, even at their height, the troubles provided only 5% of the accident and emergency workload.

**Skeletal trauma.** The management of skeletal trauma and orthopaedics is centralised under the Northern Ireland Orthopaedic Service (NIOS). Eighteen orthopaedic surgeons in the Belfast area share the fracture workload between four hospitals, and all elective orthopaedic operations are performed in a separate hospital, which has a rehabilitation and engineering centre with a comprehensive prosthetic and orthotic service. Three orthopaedic surgeons in Londonderry, in north-west Ulster, share the orthopaedic and fracture workload from their area. Orthopaedic consultants from the cities hold regular clinics in peripheral hospitals where they can discuss and assist with any ongoing problems.

Limb injuries form about 40% of the civil disturbance trauma, and are often associated with the abdominal, thoracic or neurosurgical problems which have been discussed elsewhere (Gordon and Crockard 1974; Stevenson and Wilson 1975). When surgeons from several disciplines are simultaneously involved in the care of a single patient, close co-operation is essential. The anaesthetists who provide instant and effective resuscitation must also be responsible for steering the trauma team through the stages of this multi-disciplinary treatment.

**TYPES OF INJURY**

Civil violence injuries may be classified in many different ways: by the causative weapon, the victim (civilian, terrorist or security forces), or the part of the body involved. Alternatively, an injury can be categorised in terms of the quantity of energy transmitted to the tissues, whether this was local or general, blunt or penetrating. The essential feature is that it is the transfer of kinetic energy which causes the injury; and kinetic energy is proportional to the mass and the square of the velocity of impact. This energy may arrive as a missile, a blast wave, heat, or a hand-held club. Some specific injuries seen in Northern Ireland are worthy of discussion.

**'Baton rounds' or 'plastic bullets'**. 'Baton rounds' were introduced in 1970 by the army and are also termed 'rubber or plastic bullets'. The rubber missiles were indeed bullet-shaped, but 15 cm long and 3.5 cm in diameter, weighing 135 to 140 g. For riot control, they were fired from a weapon originally designed to propel gas canisters, and were used as a deterrent to give a painful blow, but not a serious injury. Their effects are local and blunt. Millar et al (1975), reporting on 90 patients, found 19 limb injuries with only one minor limb fracture, but skull and facial fractures in 21. Ocular, cerebral, thoracic and abdominal injuries occurred and one death resulted from cerebral oedema. Seventeen victims had permanent disabilities, which included blindness, facial disfigurement and anosmia. Due to its inaccuracy and erratic flight the rubber bullet was phased out and replaced by a plastic bullet which is more stable in flight and therefore more accurate. Limb fractures have been more common with plastic bullets, seven being reported in a series of 99 patients (Rocke 1983). These limb fractures are, however, low velocity injuries easily treated by closed methods.

![Fig. 3](image-url)

A 'knee-capping' injury, unusual in that the patella was involved.

**Punishment injuries.** Punishments administered by terrorist groups for such reasons as petty theft, car stealing or informing the security forces vary from 'tar and feathering' to beating, 'knee-capping', and assassination.

Knee-capping is a particularly vicious injury administered with a low velocity weapon aimed at the popliteal fossa of the victim (Fig. 3). There have been over 1 300 recorded incidents since 1973 and the victims are almost exclusively men in their late teens and early 20s. The injury varies from a simple soft-tissue injury to an intra-articular fracture with neurovascular damage requiring...
weeks in hospital and intensive outpatient physiotherapy. Contrary to popular belief, the patella is rarely involved (Nixon 1975): this has been confirmed in a recent review where only 2 of 80 patients with knee-capping had sustained patellar fractures (Barr and Mollan 1989). Limb punishment shooting would be a more accurate term, especially as several victims have had this punishment extended to include both elbows and both ankles.

Systematic beatings inflict local blunt injuries. Weapons have included hammers, hurley sticks, pickaxe handles and baseball bats, some with nails driven through their ends to increase the injury. Mullan and Templeton (1986) have reviewed 25 such cases; these included a high proportion of limb as against trunk injuries, with 43 limb fractures of which 12 were open. Nerve injury, deep venous thrombosis and fat embolism were among the complications. Direct injury to bone with power drills and hacksaw blades has also been seen.

**High velocity gunshot wounds.** High velocity gunshot wounds are particularly destructive (Fig. 4), since the kinetic energy dissipated to the tissues is proportional to the square of the missile velocity. Modern high velocity weapons, available to security forces and terrorists alike, have a muzzle velocity which exceeds 762 m (2 500 ft) per second. Entering through a small entrance wound, the missile produces a large positive pressure wave which causes displacement of the tissues at right angles to its track. This shock wave damages structures many centimetres from the missile and may cause fractures, even when the bone has not been hit. A temporary cavity with a pressure lower than atmospheric is formed as a result of cavitation and this sucks in debris which contaminates the whole wound. If the missile does hit compact bone, this shatters and forms many more fragments, each with kinetic energy and the potential to cause further damage. There is usually a large exit wound. The severity and lethal potential of such injuries cannot be overemphasised.

**Explosions.** Explosive devices come in many guises, from the seemingly innocuous letter or parcel through the post, to the car packed with explosives. Sometimes adequate warning is given, the area is cleared and the bomb either explodes or is defused. The only casualties then are buildings with great financial loss (paradoxically glazing firms have prospered in the past 20 years). Other bombs explode without warning and may cause many human casualties. The explosives used have ranged from crude mixtures of agricultural nitrates to the highly destructive Semtex. Bombs may be detonated in many ways, including timers, booby-trap mechanisms and remote control, while the amount of explosive ranges from 1 kg to 250 kg or more. Bombs are the most destructive terrorist weapon: a few kilograms of explosive in a confined space can result in horrific injuries. One example was a bomb exploded inside a restaurant injuring 83 people. Two were dead on arrival at hospital and 25 required admission, including two sisters who had lost a total of five limbs.

Over 700 people have lost their lives in over 8 500 explosions in Northern Ireland, and the British mainland has also suffered. An explosion at the Old Bailey in London resulted in 160 injured and 19 admissions to hospital (Caro and Irving 1973), while 82 patients were treated after two explosions in Birmingham (Waterworth and Carr 1975). The severity of injury from explosions is inversely proportional to the distance of the victim from the detonation. An initial shock wave is followed by a fireball which lasts only a few milliseconds. The simultaneous blast wave, travelling at approximately 1 000 km (600 miles) per hour causes most of the damage. Missiles are generated both from the casing of the bomb, and other nearby objects. Falling masonry from damaged buildings causes further crush injury. Those close to the bomb may be killed instantly, others lose limbs by traumatic amputation. Respiratory and auditory injuries
are also common, and 'blast lung' may develop 24 to 48 hours after the explosion (Gray and Coppel 1975).

PRIMARY MANAGEMENT

Casualties from civil disturbance tend to be sporadic and range from the single victims of a shooting incident, to more than 50 from an explosion. Large numbers are managed by a graded response in accordance with predetermined disaster plans which have been worked out for each hospital. In Belfast it was soon learnt that the victims of a major civil disturbance disaster are best served by a 'scoop and run' policy, with the medical staff remaining within the hospital. Police, fire and ambulance services provide initial first-aid and co-ordinate the smooth and rapid evacuation of casualties to hospital. The presence of doctors at the scene tends to inhibit this well rehearsed procedure (Johnston and Barros D'Sa 1981).

When large numbers of casualties arrive at the hospital, the most experienced surgeon present assumes the responsibility for triage, designating urgent and non-urgent cases. A third category, those brought in dead, or with injuries which are incompatible with survival, is recognised. This directs time and effort to those who will benefit most from immediate resuscitation and early surgery. If there is uncertainty as to the severity of injury, the victim is always given the benefit of the doubt and no effort is spared in attempting resuscitation. Of paramount importance is the establishment of an adequate airway and the placement of peripheral or central lines for vascular access. When respiration and circulation are under control, the patient is examined to assess the extent of the injuries.

Primary investigation of seriously ill patients is kept to a minimum. Each investigation causes delay, and may result in death, particularly if the patient leaves the accident and emergency department for a dimly lit radiology department with minimal supervision. If necessary, radiographs are taken with portable machines in the resuscitation room or operating theatre.

**Drugs.** Broad spectrum antibiotics, usually a penicillin or a cephalosporin, and tetanus toxoid are given on admission to patients with penetrating wounds or compound fractures. Analgesia is important and the dose is titrated by its effect. Antibiotics are continued for a variable period, depending on the degree of contamination of the wound and at the discretion of the consultant in charge of each case.

**Gunshot wounds.** The presence of senior surgeons who had experience of war has ensured that the lessons of gunshot wound management did not have to be relearned. Delayed primary suture and early split skin grafting were employed from the beginning.

Low velocity gunshot wounds which are uncomplicated do not require full exploration of the missile track. The margins of the entrance and exit wounds are excised, the track is thoroughly irrigated with saline or hydrogen peroxide, and if possible it is identified by passing through a length of saline-soaked gauze. This 'pull-through' technique helps with cleansing. The track is then loosely dressed with Vaseline gauze and covered with saline-soaked dressings, dry gauze, wool and crépe bandage. At 5 to 10 days after injury, the wounds are inspected and, if they are clean, sutured.

If a bullet remains embedded in the tissues, a
lighter synthetic casting materials, with or without hinges.

The trend over the past decade is towards the treatment of compound, unstable fractures with an external fixation device, and we have experience with the Hoffman, AO, Wagner, Orthofix and 'Belfast' fixators. We use single-side fixation where appropriate, and this is invaluable for combined bone and soft-tissue injuries in both lower and upper limb trauma. A fixator is sometimes applied across a joint (see Figs 6 and 8) (Elliott and Templeton 1986). Discussion with vascular and plastic surgeons at the time of application of the fixator ensures its optimal placement to allow access for soft tissue repairs, dressings and procedures such as skin grafting. On some occasions all our stock of external fixation devices has been in use, and we have resorted to makeshift equipment with pins held externally by a length of tubing filled with standard orthopaedic cement. This is especially useful for injuries to the bones of the hand.

Even with meticulous care, fractures resulting from gunshot wounds and explosions lead to complications. Nonunion and delayed union are seen, with, in 1972, a 2% incidence of osteomyelitis in compound gunshot wounds and 8.5% in those due to bomb blasts (Calderwood 1975). In the few cases of chronic osteomyelitis, a two-stage technique of debridement and secondary bone grafting has been useful. All dead tissue is removed from the site of infection, the wound is loosely packed with polymethylmethacrylate beads loaded with Gentamicin and the skin is closed. After three to four weeks the beads are removed, and the defect packed with autogenous bone graft.

Vascular injuries. Most vascular injuries have involved the lower limbs, and some have been associated with unstable fractures (Barros D'Sa 1982-83). In this situation we give preference to stabilisation of the fracture, using internal fixation for a closed injury or an external fixation device for an open injury (Fig. 6). If necessary, distal circulation is quickly restored by using a temporary intraluminal vascular shunt of the type regularly employed to maintain cerebral circulation during carotid surgery (Fig. 7). This has led to a diminished requirement for fasciotomy, particularly when the damaged vessel is a vein. When the intraluminal shunt is in place the orthopaedic surgeon may take his time for careful wound debridement and external or internal fixation, ensuring accurate reduction and stabilisation. Once this has been done, a vascular repair is carried out in the knowledge that there will be no movement at the fracture and no stress on the comparatively delicate vascular work. Elliott, Templeton and Barros D'Sa (1984) report 10 such cases in which postoperative complications were initially vascular, although eventually all repaired vessels functioned, and there were no deaths or amputations.

Plastic surgery. Split skin grafts are used regularly and early for patients with multiple soft-tissue wounds, and
this leads to early and dramatic contraction of the wound edges. The technique of meshing has allowed more economical use of grafts. However, split skin grafts are not used for large defects with bone exposure. In these circumstances, a pedicled muscle flap has been used, especially to cover large defects over the proximal two-thirds of the tibia (Templeton 1988). Occasionally a local flap is not sufficient and a free vascularised flap from latissimus dorsi or rectus abdominis is used to fill and cover the deficit (Fig. 8).

Bone defects are usually bridged with cancellous bone grafts, but where they are associated with soft tissue deficit, a free osseomyocutaneous flap based on the deep internal iliac artery is used. Pecided fibular grafts have also been used.

This current technology allows limbs which would have required amputation to be saved, but careful assessment of eventual function is necessary. Rarely, multiple attempts at limb salvage have resulted in an inordinate number of operations (in one case 32 procedures). The surgical dilemma is between primary amputation and possibly vain attempts to save the limb (Heatley 1988). Our experience is that a decision on definitive treatment should be made at an early stage. If amputation is necessary, psychological management and subsequent rehabilitation calls for considerable effort, with close co-operation between orthopaedic surgeons, psychologists and prosthetists.

Psychology. The personal tragedy of those who have been maimed or injured cannot be overemphasised (McCreary 1976), and those who have lost family members and close friends have severe psychological scars. The effect on entire communities has been assessed for areas of high and low violence; the conclusion was that “the majority of people in Northern Ireland manage to deal effectively with the stress generated by the troubles” (Cairns and Wilson 1984). In spite of the continuing violence daily life continues normally in most areas throughout the province. Even victims of violence have shown the ability to overcome their disability. We know of one double amputee who has taken a primary degree since his injury and is now studying for a PhD. This resilience is typical of the people of Northern Ireland.

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