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Review

Contemporary management of maxillofacial ballistic trauma

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Abstract

Ballistic maxillofacial trauma in the UK is fortunately relatively rare, and generally involves low velocity handguns and shotguns. Civilian terrorist events have, however, shown that all maxillofacial surgeons need to understand how to treat injuries from improvised explosive devices. Maxillofacial surgeons in the UK have also been responsible for the management of soldiers evacuated from Iraq and Afghanistan, and in this review we describe the newer types of treatment that have evolved from these conflicts, particularly that of damage-control maxillofacial surgery.

Keywords: Maxillofacial; Surgery; Ballistic; Face; Management

Introduction

Ballistic maxillofacial trauma encompasses all injuries that are sustained either directly by, or secondary to, firearms and explosive devices. Such injuries are possible in both military and civilian environments, and generally the causes and patterns differ considerably. Maxillofacial ballistic trauma among civilians is usually from low velocity weapons such as handguns and shotguns. In contrast, most injuries (79%) sustained by UK soldiers during the recent Iraq and Afghanistan conflicts resulted from energised fragments from improvised explosive devices (IED), the rest from high velocity rifles (Fig. 1).[1]

The incidence of facial wounds relative to other parts of the body has varied widely, which reflects both the weapons used, the type of conflict, and the increasing availability of personal armour to both the police and military forces. Mortality that is directly attributable to maxillofacial ballistic injuries is surprisingly low (2%-3%), and primarily results from compromise of the airway.[2]

Pathophysiology

Bullet wounds from high velocity rifles result in the transfer of considerable energy and cavitation of tissue, but it is a misconception that low velocity projectiles cause less maxillofacial injury. Those that pass through the face and jaws often strike hard tissues (the bony skeleton and teeth), which results in deposition of energy and secondary formation of missiles from the hard fragments of tissue.

The most common cause of injuries from energised fragments to the face and neck both in military and urban environments are IED. They are a heterogenous group of homemade devices that are capable of propelling any kind of debris explosively. Most are buried, and when they are detonated they propel soil and other contaminants, including the associated microbiological flora, into any resulting

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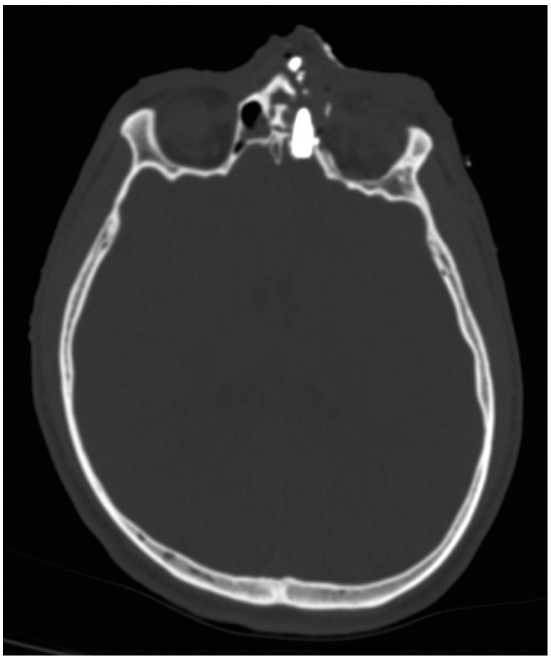

Fig. 1. Computed tomographic scan of the face showing a retained 7.62 mm high velocity rifle bullet within the left ethmoid sinus.

wounds. In addition, human body parts can be incorporated in wounds in suicide bombings. IED produce injury in four ways: primary, secondary, tertiary, and quaternary.[3] Primary blast injuries are caused by the sudden increase in air pressure after an explosion and in the maxillofacial region affect predominantly bones that contain air such as the sinuses and orbits.[4] Evidence of isolated orbital blowout fractures without surrounding rim fractures or penetration of the overlying skin has been reported.[5]

Secondary blast injuries are caused by energised fragments, or soil overlying a buried IED. A small proportion of battle injuries (4%) are thought to be from tertiary blast, which occurs when the casualty is thrown by the explosion and collides with nearby objects; such blunt injuries produce patterns of injury similar to those seen in civilian blunt injury. Quartenary blast injury is related to the thermal effects of the explosion, and is responsible for facial burns.

The effectiveness of modern personal armour worn by the military and, increasingly, the police force, has changed the distribution of injuries caused by ballistic weaponry. The face and neck have historically been left uncovered, which favours greater mobility, spatial awareness, and dissipation of heat, over protection. However, there has been an increasing trend towards the wearing of ballistic eyewear and visors and, more recently, mandibular guards.[6,7] The wearing of low impact ballistic spectacles has, in particular, halved the incidence of ocular and periocular injury in combat operations from 10% to 5% .[8] As IEDs are generally placed at ground level or buried within the soil, the fragments and debris are directed upwards. This places anterior projections of the face, such as the mandible and tip of the nose, at increased risk.[9]

Timing of treatment

Differences in the mechanisms of injury and the environment within which they are sustained, necessitate different timings for the treatment of military and civilian maxillofacial injuries. In both settings, damage-control maxillofacial surgery should commence within an hour, as temporary adjuncts to life-threatening injuries (such as exsanguination and compromise of the airway) are likely to reach the limit of their effectiveness by then. However, the severity of military maxillofacial wounds, and the need to treat more life-threatening injuries to other parts of the body first, means that definitive treatment of maxillofacial wounds is often delayed, unlike in the civilian setting. Well-accepted treatment protocols developed for civilian ballistic trauma are rarely appropriate for managing military injuries, as these are generally based on injuries from low velocity bullets.[10] Newer military protocols based on the experience of maxillofacial surgeons who were deployed to Iraq and Afghanistan have been developed (Table 1).

Immediate management

Immediate management of maxillofacial injuries is based on the principles of Advanced Trauma Life Support. Military personnel are taught a modification of these, in that control of catastrophic haemorrhage precedes the airway, because in combat exsanguination is more likely to threaten life.[11] Haemostatic agents are now available to first- responders, but unfortunately most sources of bleeding in facial injuries are inaccessible.[9] We know of no published evidence about the efficacy and safety of haemostatic dressings applied to the face before admission to hospital, and there is risk of damage to the eyes if the powdered types are used. Fracture of the cervical spine must always be suspected in those exposed to blast injury who may have been thrown against objects by the blast wave. However, compulsory immobilisation of the cervical spine is highly controversial, particularly if there is still the risk of harm towards first- responders.[12] Cricothyroidotomy is the immediate treatment of choice should intubation not be possible, with specialist kits available for first-responders that provide tubes with a larger lumen than the cannula of a wide-bore needle alone.

Damage-control maxillofacial surgery

Damage-control surgery is when surgical operations are shortened to the minimum to prioritise short-term physiological recovery over anatomical reconstruction in seriously injured and compromised patients.[13] Although originally developed to reduce the length of general surgical emergency laparotomies in physiologically unstable patients, the principles of the approach are applicable to ballistic maxillofacial wounds.

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