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BASIC SURGICAL MANAGEMENT OF WARS WOUNDS: The ICRC Experience

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ABSTRACT

According to WHO statistics, war injuries are the first surgical cause of death and the first cause of surgical disease in the Africa Region. The International Committee of the Red Cross is an impartial, neutral and independent organization whose humanitarian mission includes the assistance to war wounded. During the last 30 years ICRC surgeons have gained a wide experience in the management of war wounded patients under difficult conditions, more than 40,000 have been registered in the ICRC surgical database. In additions, hundreds of thousands of operations for the wounded of war have been performed in ICRC supported hospitals. The authors present the basic principles for a correct understanding and treatment of war wounds. Attention is focused on ballistics, triage, pre hospital care, antibiotic prophylaxis, early physiotherapy and rehabilitation, and wound surgery: large debridements, wound left open with no unnecessary dressing changes, delayed primary closure.

INTRODUCTION

War wounds are an important cause of morbidity and mortality around the world. According to WHO (1) in Africa they represent the first surgical cause of death and the first surgical cause of disease.

The ***International Committee of the Red Cross*** (ICRC) is an impartial, neutral and independent institution created in 1863 in Switzerland whose humanitarian mission is to protect the life and dignity of the victims of war and internal violence and to provide them with assistance. During the last 30 years the ICRC surgeons have gained a huge experience in the management of war wounded patients under difficult conditions. Hundreds of thousands of operations have been performed in the ICRC supported hospitals to treat war injured patients and more than 40,000 cases have been registered in the ICRC surgical database.

During the last year (2001) ICRC gave substantial assistance to 134 hospitals in 22 countries where 18,189 war wounded patients have been treated. ICRC surgical teams worked in 8 hospitals (4 in Afghanistan, 1 in Kenya, 1 in Sudan, 1 in Sierra Leone, 1 in East Timor) performing more than 13,500 operations on 10,500 patients and treating also 69,850 outpatients.

THE USUAL SCENARIO

The usual scenario where war surgeons work is quite peculiar. Most of the conventional wars take place, nowadays, in developing countries, where the health system might have already been weak before the conflict started and might be almost non functioning during the conflict. Water and electricity supplies can be unreliable, trained staff often leave the area, drugs and disposable

equipments cannot be replaced, buildings can be destroyed. Security is always a major concern. The influx of patients is not regular and depends on active fights and the possibility of transporting the wounded. As a result war surgeons have to face sudden large influxes of patients.

TRIAGE [2,3]

To be able to cope with large numbers of wounded, arriving within a short space of time at a facility with limited resources, triage is needed. Triage is the process of sorting wounded into categories of priority for the treatment. The underlying principle is "do the best for the most".

Triage categories:

- Category I: serious wounds – resuscitation and immediate surgery (vascular injuries, abdominal and thoracic penetrating wounds).
- Category II: second priority wounds – can wait for surgery (mainly limb wounds).
- Category III: superficial wounds – ambulatory management (do not require hospitalization).
- Category IV: severe wounds – supportive treatment (patients likely to die or survive with very poor quality of life. Es: comatose and moribund patients).

PATTERNS OF INJURY [4]

War wounds are caused by bullets, metallic fragments from bombs, mines, rockets and grenades or as a direct result of blast and/or heat waves into tissues (mines, bombs). Tissue damage is the result of energy transfer from the missile to tissues that interfere with its progress, according to the formula:

$$Et = \frac{M (V1^2 - V2^2)}{2}$$

Where Et is the energy transfer; M is the mass of the missile; V1 is the entry speed; V2 is the exit speed.

Bullets: While handgun bullets have low speed (below 300 m/sec) and cause a damage that corresponds to the simple bullet tract, war rifles shoot high speed (more than 800 m/sec) bullets that can transfer a much higher amount of energy to the tissues resulting in a large volume of dead tissue.

Metallic fragments: Tracts produced by fragments have a consistent pattern. The energy transfer is maximal at entry and reduces progressively as the fragment passes through the tissues. The wounds are conical in shape with the entry usually larger than the exit.

Mine injury: Antipersonnel mines are made either to produce multiple fragment injury or to cause the damage through the blast wave. Pressure-detonated blast mines blow off the foot or the lower leg with considerable damage to the other leg, perineum and upper limbs. The particular danger and difficulty in treating these wounds depends on earth, mud and debris blown into the tissues and into the intermuscular planes. Fragmentation mines spray around small metallic fragments that can be deadly as far as 30 metres away.

PRE HOSPITAL CARE

First aid can be provided in or closed to the battlefield, usually by military nurses or doctors. Essentially their

aim is to prevent death and to avoid further injury. The basic trauma-life-support rules applied in civilian traumatology (Airway, Breathing, Circulation) applies also in the first aid of war wounded. Most deaths are caused by loss of cardio-respiratory function and from haemorrhage. If these 2 problems are controlled, the patient has excellent chances of surviving the evacuation to the hospital.

In some situations a system is set up to stabilize the war wounded before transferring them to the hospital (long routes, unstable patients, immediate transport not possible for security reasons, etc.). Dispensaries and other health facilities are individuuated to be used as "first aid posts". Here wounds are dressed, bleeding is stopped, fractures are stabilized, IV fluids, blood, antibiotics tetanus serum and vaccination are administered, according to the needs.

ANTIBIOTIC PROPHYLAXIS [5]

All war wounds are contaminated with bacteria and will inevitably become infected unless treated quickly and correctly. In case of mine blast, contamination is massive. The role of antibiotics is to prevent spreading of infection from the contaminated wound. Locally, the main role is played by surgery: wound excision should be performed, ideally, within 6 hours from injury. The major bacterial contaminants in war wounds are: Gram-positive pyogenic cocci (staphylococci and streptococci), Gram-negative bacilli (escherichia coli, proteus klebsiella, pseudomonas, bacteriodes), Gram-positive bacilli (clostridia, demonstrated in about 30% of war wounds). The major threats to a patient with a war wound are gas gangrene and tetanus. Here is the ICRC antibiotic protocol for war wounded:

Soft tissue wounds, with/without fracture, less than 3 days old:

- Benzyl penicillin 5 M IV 6 hourly for 48 hours then penicillin V orally 6 hourly for 3 days.

Soft tissue wounds older than 3 days, antipersonnel mine injuries:

- Benzyl penicillin 5 M IV 6 hourly for 48 hours then penicillin V orally 6 hourly for 3 days.
- Metronidazole 500 mg IV 8 hourly for 48 hours followed by 500 mg orally 8 hourly for 3 days.

Penetrating cranio-cerebral and eye injuries:

- Benzyl penicillin 5 M IV for at least 3 days, then orally for 7 more days.
- Chloramphenicol 1 gr IV 8 hourly for at least 3 days, then orally for 7 more days.

In case of brain abscess add metronidazole 500 mg 8 hourly IV for at least 3 days, then orally for 7 more days.

Maxillo-facial and oral cavity wounds:

- Ampicillin 1 gr IV 6 hourly for 2 days then orally for 3 more days.
- Metronidazole 500 mg IV 8 hourly for 2 days then orally for 3 more days.

Penetrating chest wounds:

- Ampicillin 1 gr IV 6 hourly for 2 days then orally till 2 days after removal of chest drain or 5 days.

Penetrating abdominal wounds:

If only liver, spleen, kidney or bladder injured:

- Benzyl penicillin 5 M IV 6 hourly for 48 hours then penicillin V orally 6 hourly for 3 days (depending on possibility of oral intake).

Stomach, small bowel injury:

- Ampicillin 1 gr IV 6 hourly for 3-5 days.
- Metronidazole 500 mg IV 8 hourly for 3-5 days.

Colon, rectum, anus injury or peritonitis:

- Ampicillin 1 gr IV 6 hourly for 3-5 days.
- Metronidazole 500 mg IV 8 hourly for 3-5 days.
- Gentamycin 80 mg IV 8 hourly for 3-5 days.

If metronidazole or gentamycin not available, replace with chloramphenicol.

WOUND SURGERY [6]

The surgery for war victims is different from the type of surgery practiced for civilian injuries. War wounds are always extremely contaminated and missiles may cause massive destruction of soft tissues, bones and other structures. Strangely, the principles of treatment of war wounds have been known for decades but need to be re-learned by each new generation of surgeons facing war situations. War surgeons work following basic priorities: save life, save limbs, avoid infectious complications, minimize residual disability. There is no room for fancy, high technology surgery. Time, human resources, material, hospital beds are never enough and need to be optimized.

War wounds are often multiple and tricky, a chest wound may enter the abdomen, a wound in the perineum or buttocks may be hidden and ignored due to the patient position, a penetrating brain injury may go unrecognized as masked by hair: the entire patient should be thoroughly examined, paying particular attention to the back and buttocks.

Soft tissue wound treatment is a 2 stages procedure: excision of the wound and delayed primary closure.

Wound excision: it is the process whereby dead and damaged tissue, which is grossly contaminated with bacteria and debris, is completely cut away. The commonest mistakes are too short skin incisions (inadequate exposure) and insufficient excision. Fascial compartments may need decompression by fasciotomy to avoid muscle ischemia. All muscle that is not healthy and red, does not contract when pinched or bleed when cut must be excised. Foreign bodies: explore the wound with the fingers to identify foreign bodies or unexpected extensions of the wound. Do not open fresh planes in healthy tissue. If metallic foreign bodies are not found in the wound while performing the debridement, don't extend the exploration unnecessarily, they can be left in situ. Look for metallic foreign bodies under the sole of the foot and inside joints: if left here they cause important disability. Do not attempt primary repair of tendons, nerves or bones, as success is unlikely in these grossly contaminated wounds. Injuries to major arteries of the limbs should be either repaired or replaced by saphenous graft immediately if the limb is to survive. Delay of more than 6-12 hours from injury usually prevent successful repair.

Delayed primary closure: once performed the excision the wound should be irrigated thoroughly, left open without any suture of skin or deep structures and covered by a bulky absorbent dressing made of dry fluffed-up gauze and held in place with loose crepe bandage. The aim is to avoid any tension/pressure in the tissues and to draw inflammatory fluid out of the wound, into the dressing. Some exceptions to delayed primary closure: wounds of face, neck, scalp, genitals and open chest wall injuries (muscular layer has to be airtight closed). Vaseline gauze should not be used and wounds should not be packed in a way to form a plug and prevent free outflow of fluid. This dressing should not be changed until formal closure. Limb wounds should be elevated to reduce edema. Delayed primary closure is usually performed after 5 days.

PHYSIOTHERAPY AND REHABILITATION

Physiotherapy is of paramount importance. Perfect war surgery not followed by appropriate physiotherapy often results in a disaster. Physiotherapy often starts the first post-operative day with patient mobilization and few days after wound closure, with passive joints mobilization in the affected limb. As soon as the wound situation allows, active limb mobilization also starts. In case of limb amputation, rehabilitation means prosthetic replacement. This is usually done about 2 months after the amputation to give enough time for the wound to heal and for the stump to acquire the definitive shape.

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WAR WOUNDS WITH FRACTURES: THE ICRC EXPERIENCE

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ABSTRACT

Historically, on a conventional battlefield, about 70% of the wounded present injuries to the limbs, the remaining 30% have central wounds involving head, chest or abdomen. The longer the delay in transport to hospital facilities, especially with inadequate first aid, the higher the death rate in the central injury group and the higher the percentage of those presenting with limb injuries. Most of these latter involve bones and/or joints. In a war situation, and especially in developing countries, high-technology facilities and skilled orthopaedic surgeons may not be available to deal with these wounds with particularly heavy tissue contamination. The experience of ICRC surgeons has led to an appropriate technology approach and the avoidance of sophisticated operations and equipment: "the simpler the better" has become our motto! Very important is the initial, extensive excision of all dead and devitalised tissues. The fractured bone is held by POP slabs, bridge POP, skeletal tractions and, in selected cases, external fixation. Internal fixation devices are never used due to the high risk of infection. Early and aggressive physiotherapy is of paramount importance. Good surgery without physiotherapy often results in a human catastrophe!

INTRODUCTION

A good deal of war surgery is orthopaedic surgery. In a conventional battlefield, some 50-75% of war injuries involve the limbs [1]. While a high rate of patients with central (head, chest and abdomen) injuries dies in case of inadequate first aid and long delay before transport to hospital facilities, patients with limb wounds may survive longer and present to the hospital even days or weeks after injury with badly infected wounds. Most of these wounds involve bones and/or joints. As a result, in war affected areas, surgeons will have to deal mainly with limb wounds with fractures. Many principles governing bone healing in civilian blunt trauma do not apply to war injuries. The excisional aspect of the surgery of war wounds with fractures is particularly important. Loose bone fragments, haematoma and surrounding dead tissues must be all excised. The method of fracture fixation is of secondary importance to the wound management. Multiaxial movement of the fractured fragments is a potent stimulator of secondary bone formation. Rigid fracture fixation reduces or eliminates callus formation. This happens commonly where external fixation is widely used by unsupervised surgeons who are unfamiliar with the technique and war wounds. Equipment for internal fixation should not be made available for early management of war wounds: it is readily abused, with disastrous results [2].

For any wound with a fracture, the advantages and disadvantages of each method of immobilization should be considered. Any method, if badly applied or unsupervised, can lead to poor results.

PREOPERATIVE CARE

War wounds with fractures should be covered by a sterile or clean dressing before application of splints. Splints are intended to immobilize the limb so as to reduce pain and prevent further damage to soft tissues by the fractured bone. Particular attention should be paid to vascular and nerve supply of the limb.

A vascular and neurological assessment of the affected limb should be done. Tetanus serum and toxoid and antibiotics should be administered. X-rays should not be requested routinely.

SURGICAL MANAGEMENT

Tourniquet is very helpful in reducing blood loss and allowing a bloodless surgical field. It should not be left in situ for more than 90 minutes. Adequate exposure is mandatory. Surgical access should be through generous skin incisions. Adequate decompression of compartments enclosed by fascia should be obtained through **fasciotomy**. Haematomas, devitalised muscle, debris and foreign materials should be excised (**debridement**). Loose bone fragments without any periosteal attachment should be removed. Major blood vessels should be immediately repaired. Severed nerves should be marked and fixed to prevent retraction. They should be repaired only once the wound is clean and healing. Same procedure for damaged tendons. All wounds should be left open for **delayed primary closure**. A dressing made of dry, bulky, fluffed-up gauze should be applied and fixed with loose bandages. This dressing should not be changed until delayed primary closure. If signs of infection (increased oozing with offensive smelling, high fever) develop in the meantime, the wound should be checked earlier. Major fracture fragments should be aligned and temporarily stabilized

with back slabs or skeletal traction. The patient should be reviewed in the operation theatre, under anaesthesia, after about 5 days (3 to 7 days): if wound clean, the wound should be closed either by delayed primary closure or skin graft. Injured limb elevation is important in the postoperative phase to reduce oedema [1-3].

METHODS FOR FRACTURE IMMOBILIZATION [2,3]

War wounds with fractures are, basically, immobilized using plaster of Paris (POP), traction and, to a less extent, external fixators.

Plaster splinting: in the forms of slabs, cylinder casts and bridge-POPs can provide adequate immobilization. Due to the post-traumatic oedema of the limb, cylinders should be avoided till oedema subsides. *Slabs* are the usual initial means of fracture stabilization. *Cylinder casts* can be applied once skin closure has been obtained or even on clean granulating wounds (Trueta method). They allow early patient mobilization. One disadvantage is the immobilization of proximal and distal joints. Patients with hip or femur fracture can be managed with *hip spica* as alternative to traction. Spica, which can easily be fenestrated, is a good way of clearing beds in rush periods. In case of relatively small wounds, *POP windows* allow dressing to be carried out. Larger wounds can be satisfactorily managed by *bridge POPs*. This particularly applies to wounds of the calf and heel. Two or three Kramer wires are secured to the plaster by circumferential turns at the end of the bridge, allowing the cast to be cut well away from the wound.

Traction: a simple and safe method for fracture holding, especially for the lower limb. It can be used for initial and definitive stabilization and allows easy wound access

and joint mobilization. It gives a rapid callus formation. The disadvantages are long bed rest, difficult access to the buttock and posterior aspect of thigh and leg, and sometimes difficulties in getting a perfect alignment of the fracture. Traction can be applied in different forms: *gallows traction* for femur fractures in babies up to 3 years or 15 kg of body weight, *skin traction* for older children, *pin traction* for femur or tibia fracture. For femur fractures a Steinmann pin is inserted 2,5 cm below the tibial tubercle. Local anesthesia is sufficient unless other surgical procedures have been planned. The leg is then rested on a Brown-Bohler frame. The standard 1 kg traction per 10 kg of body weight has to be adapted to each specific case (degree of muscular injury, bone gap). Pin care is essential. Infected pins must be removed. Physiotherapy should be started as soon as possible, usually few days after delayed primary closure. After the first x-ray assessment, x-ray controls can be done on a monthly basis. Clinical evaluation gives a good picture of the fracture healing and avoids waste of x-rays.

External fixators: External fixation is not the best way to treat all fractures in war surgery [4,5]. It can give very good results when correctly applied for the correct indications. The main advantage of external fixators is the good access to the soft tissue wound. They also allow early mobilization of the patient (quite important if we need beds or the patient has to be evacuated) and the joints adjacent to the fracture. They are very useful if we're planning a limb shortening to reduce a bone gap or to fix the fragments in case of bone graft. The disadvantages are: need of experience with the method, cost of devices, delay in callus formation, complications related to incorrect placing of the pins: stiff joints, muscle tethering, nerves or vascular injuries, pin site infection.

The factors favouring their use are:

- Multiple limb injuries (amputation on one leg and tibial fracture on the other).
- Fracture plus vascular injury.
- Very large wound and unstable fracture.
- Need of transporting/evacuating the patient.

The factors against their use are:

- Fractures in children.
- Closed fractures.
- Single bone fracture in the forearm or leg.
- Absence of radiography.
- Lack of surgical follow up.

External fixators should be removed and replaced by a plaster cast as soon as soft tissues are healed.

PHYSIOTHERAPY

The rehabilitation programme for patients with limb fractures involves 3 phases:

Phase I, usually the first few days, when priority is given to soft tissue healing and the patient faces important pain. During this period we suggest limb elevation and gentle and passive movement of the joints close to the wound.

Phase II, mobilization of the patient, may start immediately in case of upper limb fracture or be delayed and reduced to bed exercises in case of patients in traction.

Phase III, which consists of active exercises of the fractured limb. It may be limited by the method of fracture immobilization.

The speed with which the patient can go through these phases depends on the site and size of injury, age of the patient, limb pain, rate of callus formation, method of fracture immobilization and multiplicity of wounds: this is why is not possible to give a physiotherapy schedule appropriate for all fractures [2].

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AUTOTRANSFUSION FROM HAEMOTHORAX AFTER PENETRATING CHEST TRAUMA: A Simple Life Saving Procedure

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The International Committee of the Red Cross (ICRC) is an impartial, neutral and independent organization, established in 1863, whose humanitarian mission includes the assistance to war wounded. ICRC surgeons often deal with war-wounded patients presenting with haemorrhagic shock, in need of blood transfusions.

Lack of blood for transfusions is a major issue in developing countries under normal circumstances, not to mention the increased need in war situations. Many systems are available to recover blood from body cavities and surgical fields in the "Western World" (suction machines aspirating blood, mixing it with anticoagulant, washing and filtering and re-infusing it into the patient), which are far too expensive and sophisticated for a developing country's rural hospital.

Simple methods to collect blood from peritoneal cavity when operating a ruptured ectopic pregnancy or closed injuries of the liver or spleen are well described [1] and utilized in many hospitals in developing countries. Yet only few scattered reports have been published on salvage and re-infusion of blood after penetrating chest wounds causing haemothorax, without "Western World" devices [2-6].

We present a simple technique applied in life-threatening situations on more than 200 patients presenting with massive haemothorax due to penetrating chest war injury. The method consists in inserting, through a sterile technique, a large bore chest drain, usually in the fifth

intercostal space, mid-axillary line, on the affected side. The blood is collected in a sterile glass container through a funnel covered by several layers of gauze (fig. 1) and re-infused as soon as the bottle is full, through a standard blood giving set, which has a 200 microns filter.

To properly employ this technique, the necessary materials should be prepared beforehand. Glass jars, to which CPDA-1 (citrate-phosphate-dextrose-adenine solution) is added to ensure anticoagulation [7], are sterilised and correctly stored. These glass jars are still widely used in district hospitals, which prepare their own intravenous fluids and are perfect for this purpose.

We have applied the method in case of massive haemothorax with haemorrhagic shock not responding to crystalloids/colloids infusion and no available blood for allotransfusion. The ethical justification was the fact that this was a life-saving procedure in patients otherwise probably condemned to die.

The main potential complications related to this emergency autotransfusion are infection, coagulopathy and renal failure.

Infection because all war wounds are contaminated and the longer the delay before antibiotic therapy, the higher the bacterial concentration expected. Infection is prevented by high doses of broad-spectrum antibiotics (we use Penicillin G or Ampicillin) and early re-transfusion.

Coagulopathy is related to the presence of coagulation promoting factors and micro particulate matter in the shed blood. We could reduce this risk only by filtering the collected blood through a standard transfusion set

(200 microns filter). Note that the risk of coagulopathy is much higher in case of autotransfusion of haemoperitoneum from rupture of ectopic pregnancy due to trophoblast products, and this is a well-known and established practice [1].

Renal failure depends on transfusion of haemolysed blood as it could happen with re-transfusion of haemothorax dating days. It was not the case in our patients as we applied this method only in “fresh” cases with max 2-3 hours delay after injury. The “old” cases usually are haemodynamically stable, hence not in need of emergency transfusion.

No complication autotransfusion-related has been detected in the group of patients we treated with this method.

Blood collected from pleural cavity is defibrinated by a combination of mechanical factors (contact with functioning heart and lungs) and biochemical interactions with serosal surfaces. Having the fibrinogen being removed, some authors do not advocate the addition of anticoagulant [8].

We have had occasion to use heparin as an anticoagulant in autotransfusion. This technique has also been used by doctors in the former-Soviet Armed Forces in Afghanistan and recently in Chechnya [personal communication during ICRC War Surgery Seminars, Moscow and Naltchik, October 2003]. We have also performed autotransfusion without any anticoagulant as recently as June 2003 during the fighting in Monrovia, Liberia, without any apparent complication. Not all experts agree, and it is difficult to perform a properly conducted prospective clinical trial. As a conservative measure of safety, and until proof to the contrary, we

propose the half-dose CPDA-1 technique (32 ml in 500 ml blood).

As a rural hospital should have the equipment ready for autotransfusion from haemoperitoneum with anticoagulant, we suggest utilizing the same set for autotransfusion from haemothorax.

Equipment for blood autotransfusion:

- 500 ml glass bottles (those for IV fluids are most suitable), re-sterilizable.
- Aluminium screw cap top.
- Rubber stopper – membrane.
- Funnel, re-sterilizable.
- CPDA-1 anticoagulant, 32 ml per 500 ml blood.
- Blood transfusion giving set with standard filter.

Autotransfusion From Haemothorax After Penetrating Chest Trauma: A Simple Life Saving Procedure

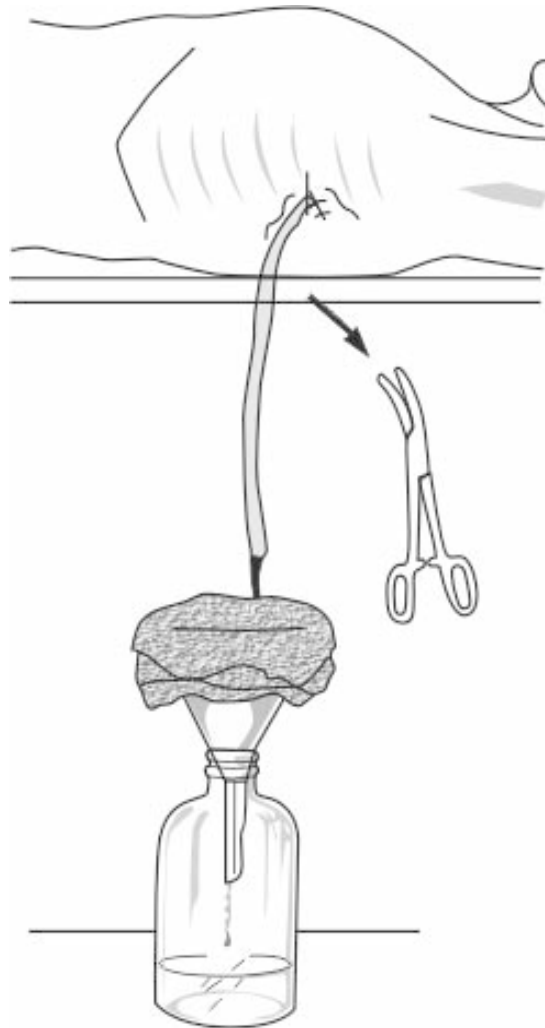


Fig.1 Collection and filtration of blood from pleural cavity into a bottle containing anticoagulant, for immediate autotransfusion (With kind permission of WHO [9], modified).

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Autotransfusion From Haemothorax After Penetrating Chest Trauma: A Simple Life Saving Procedure

METALLIC FOREIGN BODIES AFTER WAR INJURIES: SHOULD WE REMOVE THEM? The ICRC Experience

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ABSTRACT

The presence of metallic foreign bodies is a relatively common finding on the x-rays of war wounded patients. They usually represent entire bullets or part of them, or fragments from bombs or mines. They often catch the attention of the patient and his/her relatives who impute to them the cause of pain and disabilities and insist with the doctor for their removal, even when the soft tissues wound has completely healed. The experience of the ICRC (International Committee of the Red Cross), based on a surgical database of more than 36,000 war wounded patients registered and 200,000 operated in ICRC supported hospitals around the world, shows that these operations are often risky, useless, consume time and material. They result in new surgical trauma with its possible complications, often without identifying and removing the foreign body. The relatively few indications for removal of these foreign bodies are listed together with a simple stereo tactic method to locate them. A special mention of the effective risk of lead poisoning is made as this is sometimes pleaded as a reason for removal of retained bullets.

INTRODUCTION

According to WHO, war injuries are a big burden for Africa: they represent the first surgical cause of death and the first cause of surgical disease [1]. Metallic fragments are a relatively common finding on the x-rays of war wounded patients. They are usually bullets, fragments or shrapnel. Quite often they attract the attention of the patient and/or bystanders who attribute to them the cause of their pain and discomfort and, quite often, un-experienced doctors concentrate on their removal instead of on proper wound debridement and damage control.

The International Committee of the Red Cross is an impartial, neutral and independent organization whose humanitarian mission includes the assistance to war wounded. During the last 30 years ICRC surgeons have gained a wide experience in the management of war wounded patients under difficult conditions: more than 200,000 operations have been performed in ICRC supported hospitals and more than 36,000 cases have been registered in the ICRC surgical database. The experience of ICRC surgeons shows that operations expressly performed for the removal of a metallic fragment can very often cause more damage to the tissues than the original injury!

The aim of this article is to provide an answer to the usual questions arising when facing a patient with retained metallic foreign bodies, indications for their removal and a simple method for their localization.

THE NATURAL HISTORY OF RETAINED METALLIC FRAGMENTS

As a result of the human body's reaction, metallic foreign bodies are usually incorporated in strong, fibrous, avascular scar tissue that prevents further mechanical trauma and lead leak. This is true for metallic fragments retained in soft tissues, muscle or bone. Here the risk of subsequent infection is very low (2-3%) [2].

Encapsulation by a scar does not usually happen in case of fragments retained inside joints where destructive arthritis with pain and limitation of movements or, very rarely, systemic lead toxicity may develop.

The question of "migrating bullets" is more a topic for the reporting of strange clinical cases in specialized journals than it is a real clinical problem if we consider the millions of patients throughout the wars of the twentieth century presenting retained foreign bodies.

Nonetheless, in an experimental study on monkey's brain, it has been demonstrated that copper-coated pellets do cause a local necrotic reaction that can be so severe as to allow significant migration of the pellets through the brain [3]. A bullet can also, occasionally, migrate along the spinal canal [4,5], or along a major blood vessel after eroding through the vessel wall. These are incidental reports compared to the number of cases with retained metallic fragments, without consequences, around the World.

THE PROBLEM OF LEAD POISONING AND OTHER METALS TOXICITY

Bullets are usually composed of a lead core and a copper or brass jacket. Pellets from shotguns are composed

exclusively of lead. A systemic toxicity may be caused by lead leaking out of the bullet as reported in case of bullets bathed in synovial joint fluid [6,7] or intervertebral disc space [8]. Again this is an extremely rare possibility if we compare the very few positive reports with the thousands of persons with retained bullets or pellets around the World.

Lead toxicity may affect virtually any organ: from the central and peripheral nervous system (convulsions, delirium, ataxia, slurred speech, neuritis) to the kidneys (renal failure), the gastrointestinal system (nausea, vomiting, colic pain) or the haematological one (microcytic anemia). Death may occur as result of generalized brain edema or kidney failure.

A suspicion of lead toxicity can be proved directly by a serum lead measurement (levels above 10 micrograms/dl in children and 40 micrograms/dl in adults are considered toxic) or the EDTA challenge test, or, indirectly, by a bone marrow aspiration to assess the effect on the haematopoietic system. Once recognized, lead poisoning should be treated with chelating agents (EDTA, dimercaprol, d-penicillamine, succimer). The surgical removal of the source of lead poisoning shouldn't be performed before blood lead levels have been reduced, to avoid acute lead poisoning.

In experimental studies on monkey brain, copper causes a severe local necrotic reaction [9].

THE PROBLEM OF BULLETS OR FRAGMENTS LOCATED IN DANGEROUS OR DELICATE AREAS

In case of metallic foreign bodies close to a major vessel or in the mediastinum, close to the heart, we have to

consider the risks and benefits of a major surgical procedure to remove the foreign body. The morbidity of such a procedure can be significant, whereas the overall incidence of complications is extremely low. Our experience suggests that it is probably better to leave them alone unless they are causing specific, proven complications. Should the surgeon suspect a pseudoneurysm or an artero-venous fistula then an operation to treat the complication would probably involve the removal of the foreign body.

Another delicate area is the central nervous system. It is not yet clear if metallic foreign bodies in the brain increase the risk of brain abscess and epilepsy: there are reports for [9,10] and against [11,12]. Again, as a matter of common sense, our experience tells us that the surgical damage related to the foreign body's removal is much bigger than its benefit. Retained bone fragments in the brain, however, are well known to be more significant a cause of abscess formation than metallic fragments [13].

Brain metallic foreign bodies are removed only if detected in the surgical field during the "debridement". If the patient develops an abscess we treat the abscess; if it was related to such a foreign body, the fragment should come out with evacuation and drainage of the abscess.

If the metallic foreign body is located in the spinal cord, we consider laminectomy and removal only if the surgeon is experienced in this field and there is a clear progressive neurological deficit and radiological evidence of spinal cord compression by the foreign body [14]. For metallic foreign bodies penetrating the eye, we consider the removal in case it is located in the anterior chamber, the surgeon is experienced, magnification, instruments and proper suture material are available [15].

SO WHAT ARE THE INDICATIONS FOR REMOVAL OF METALLIC FOREIGN BODIES?

The problem of retained metallic fragments subsequent to war injury is usually more psychological than organic in origin. Should the surgeon come upon it during primary wound excision, then it should be removed. The surgeon should not, anyway, explore unnecessarily and open fresh planes in healthy tissue to look for metallic fragments: they may be left in situ [16]! Very few metallic bodies cause sufficient problems, however, to warrant their surgical excision.

Here are the usual situations where we suggest removing the foreign body:

- A metallic foreign body causing a localized infection: the abscess or fistula draining pus will not heal until the foreign body is removed or expelled.
- A metallic foreign body that disturbs function: a fragment retained inside a joint is a physical impediment to proper joint movement and damages the articular cartilage, further reducing joint function. (In this case it should be removed as part of the initial surgical excision and wound toilet). Pain can also compromise function: again as in the case of a fragment retained in a joint, or in body areas particularly subject to constant or repeated pressure (sole of the foot; palm of the hand; subcutaneous over elbow, back or sacrum).
- A metallic foreign body causing pain exclusively and convincingly, and within easy access. Pain receptors are located in known parts of the body, particularly in the subcutaneous tissues. There are no pain receptors deep in the muscle, for example: ischaemia will cause muscular pain, not a foreign body that does not cause infection.

And here are some much rarer indications for retained metallic fragment removal:

- A confirmed case of lead poisoning, only after lowering blood lead levels.
- A metallic foreign body in the spinal cord, but only in the presence of an experienced surgeon, a clear progressive neurological deficit and radiological evidence of cord compression by the foreign body.
- A metallic foreign body in the anterior eye chamber in the presence of experienced surgeon, magnification, proper instruments and suture material.

HOW TO LOCALIZE AND REMOVE THE METALLIC FOREIGN BODY

For those patients with pain due to a superficial fragment just under the skin, excision under local anaesthesia is, usually, a straightforward procedure.

For those patients requiring removal of a deeply seated metallic fragment, proper localization prior to surgery is of the utmost importance. Most district hospitals do not have fluoroscopy or an image-intensifier in the operating theatre so that the surgeon can operate under direct vision.

A simple stereo tactic technique to assist localization involves taping a series of radio-opaque objects (paper clips, injection needles, steel wires) to the body part, usually a limb (both anterior surface and lateral surface), and then taking ordinary X-rays with postero-anterior and lateral views. The position of the radio-opaque object is marked on the skin with a felt pen when the object is removed.

By looking at the two X-ray views, the surgeon can estimate the relative distance of the bullet from the radio-opaque objects in the axis across the limb (ex. half-way between the second and third paper clips) and in depth (ex. one-third of the way between the first and second paper clips). The idea is to use a two-dimensional X-ray to extrapolate into three dimensions.

During operation, the surgeon should always remember that, with time, the body will form a fibrous tissue pseudo-capsule around the metallic fragment. This includes other foreign matter and dirt, and should be excised together with the foreign body.

CONCLUSIONS

- The metallic missile is dangerous when it is moving, not when it has come to a stop in the body. The damage has already been done!
- Retained metallic foreign bodies in soft tissue or bone usually do not cause any harm.
- Lead poisoning is an extremely rare event, as it is fragment migration.
- Standard indications for removal of retained metallic foreign bodies are: infection; location inside major joints; superficial localization in the subcutaneous tissues, in areas subject to pressure; in the sole of the foot or palm of the hand.

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**AUTOTRANSFUSION IN CASE OF
PENETRATING CHEST WAR
WOUNDS WITH HAEMOTHORAX:
The Keysaney Hospital's
Experience**

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ABSTRACT

In 1991 civil war broke out in Somalia and Mogadishu was divided in two areas, submitted to different clans. No hospital facility was available in Mogadishu North to take care of the war wounded. The International Committee of the Red Cross (ICRC), together with the Somalia Red Crescent Society found a new building, 7 km North of the town, intended to be a prison: Keysaney Hospital was thus inaugurated in February 1992. It was soon established as THE war surgery hospital in Somalia. From 1992 to 2001, 45,900 war wounded patients have been admitted and treated, among whom 13770 chest injuries. Due to lack of a blood bank, insufficient number of donors, continuous need in emergency, life threatening situations and following previous positive experiences, a system was set up for immediate autotransfusion in patients with massive haemothorax from penetrating chest war wounds. The authors describe Keysaney Hospital experience in treating 137 patients with this kind of autotransfusion. To reduce the risk of the 2 major complications (sepsis and coagulopathy), each patient received antibiotic prophylaxis and only cases with a delay of max one hour have been submitted to this treatment. No known complication was detected in the transfused patients.

INTRODUCTION

Chest wounds represent 15-20% of all combat injuries. Many patients die from cardiac or major vascular injuries before reaching medical assistance. As a result, in a forward hospital 7-10% of all the war wounds may be expected to be chest injuries [1]. Penetrating chest injuries do cause, in most instances, haemothorax or haemo-pneumothorax, with or without fracture of thoracic cage bones. Less frequently the result is: pneumothorax alone, pulmonary and mediastinal haematoma, pulmonary contusion, heart, oesophageal, tracheal or major vessels injury. More than 90% of all penetrating chest injuries can be managed initially by chest drain [1]. One major problem, related to haemothorax, is the massive blood loss requiring urgent blood transfusions to stabilize the patient. Apart from the need of a special lab set up and technical knowledge for safe blood transfusion, under war conditions, several other constraints play a role against the possibility of routine blood transfusions: lack of a blood bank, lack of sufficient donors, sudden large influx of casualties in need of blood transfusion, and, in some areas of the world, discharge of a good rate of donated blood as infected by hepatitis or human immunodeficiency viruses.

In case of blood transfusion the donor can be a different person, the most frequent case (allogotransfusion), or the patient himself (autotransfusion).

Allotransfusion bears several risks for the recipient patient [2,3]:

- HIV type 1 and 2: due to the window period, even tested blood is not 100% safe.
- Hepatitis B and C.

- Human T Lymphocyte Virus 1 and 2 and other viruses.
- Malaria.
- Syphilis.
- Other bacterial/parasitic infections.
- Haemolytic reactions, fatal ones occurring in the range of 1 in 250,000 to 1 in 1 million transfusions in USA. Half of them caused by ABO incompatibility, as a result of administrative errors [2].
- "Minor" haemolytic reactions: approximately 1 in 1000 patients has clinical manifestations of a delayed reaction to transfusion and 1 in 260,000 patients has an haemolytic reaction related to antibodies to minor red-cell antigens that were not detected by a routine antibody assay before transfusion [2].
- Contamination of red cells: in the USA a contamination rate lower than 1 per 1 million red cells units has been reported. The organism most often implicated in bacterial contamination of red cells is yersinia enterocolitica [2].
- Transfusion-related acute lung injury: it's an acute respiratory distress syndrome that occur within 4 hours after transfusion and is characterized by dyspnoea and hypoxia due to non cardiogenic pulmonary oedema. The estimated frequency is about 1 in 5000 transfusions. The pathogenesis seems related to potent leukoagglutinating antibodies in the donor's plasma [3].
- Transfusion mediated immunomodulation: immunosuppressive effect of allogenic blood related to exposure to leukocytes and subsequent sensitisation [2].

Autologous transfusion can take different forms [4]:

- Predonation of red blood cells units for planned elective surgical procedures.
- The use of acute normovolemic dilution. This technique involves the removal of whole blood from the patients, immediately replaced by crystalloids or colloid solution, just before the operation.
- The salvage of shed blood, either intraoperatively or postoperatively by collecting the blood with special suction units or drains, to be then reinfused into the patient.

In emergency situations and under war constraints, the first 2 forms of autotransfusion cannot be applied, the patients presenting already anaemia and shock. Vice versa the last technique permits to recuperate important amounts of shed blood from operative fields or body cavities thus reducing significantly the need of allotransfusions. The authors describe Keysaney Hospital experience in treating with this kind of autotransfusion patients with penetrating war chest injuries resulting in massive haemothorax.

PATIENTS AND METHODS

A retrospective study on penetrating chest war injuries submitted to blood autotransfusion in Keysaney Hospital was performed. From 1992 to 2001, 45,900 war wounded patients have been admitted to keysaney Hospital, among them 13,770 with chest injuries, penetrating in 5322 cases. Due to lack of eterologous blood and urgent need of blood transfusions as life saving procedures, and following previous positive experiences, a system was set up for immediate autotransfusion in 137 cases presenting with massive haemothorax.

Only patients with a delay of max 1 hour since injury have been admitted to this procedure. Upon arrival at the hospital all the patients were clinically evaluated, a large bore IV line was inserted and cristalloids and colloids infusion was immediately started to stabilize blood pressure. Haemoglobin, haematocrit and blood grouping tests were done. Anti-tetanus serum, tetanus toxoid and antibiotics were administered (benzyl-penicillin 5 M 6 hourly IV for 5 days). There was, usually, no time for x-rays. If no compatible allogenic blood was available, a system was set up for collecting and reinfusing the blood from pleural cavity.

Under local anesthesia and with a sterile method, a large bore Argyle thoracic drain (N° 36) was inserted and fixed in the 5th intercostal space, mid axillary line, on the affected side. The drain was connected with a water valve system (a 1 litre sterile glass bottle) and with a standard blood collection bag, already containing anticoagulant (CPDA=citrate phosphate dextrose adenine) (figure 1). Once the container was full of blood, it was replaced by a similar one, while the filled one was connected with a blood transfusion set (with a 200 micron filter) and the blood immediately reinfused (figure 2).

Once fully stabilized, and if needed, the patient received general anesthesia and the entry and exit wounds were debrided. Pleural cavity communicating wounds were closed either by a direct suture of the muscular layer or through a muscular flap. The skin was left open, to be closed 5 days later, if wound clean.

The patient was then nursed in a semi sitting position and encouraged to start chest physiotherapy as from the first post-operative day. Due to chronic shortage of

x-ray films, chest x-rays were not routinely taken, relying much more on the clinical examination. Once fluid drained was less than 100 ml in 24 hours and water sealed drain not bubbling when patient asked to cough, the drain was clamped. After 24 hours a control x-ray was taken: if no problem the drain was then removed and the patient observed for further 24 hours and then discharged if clinically ok.

RESULTS

During the period 1992-2001, 5322 patients with penetrating chest wounds out of a total of 45,900 war wounds, have been admitted to Keysaney Hospital. Due to blood shortage, in 137 cases presenting with massive haemothorax and life threatening conditions, the blood was collected from the pleural cavity and immediately reinfused. In the considered group there were 107 males and 30 females. The mean age was 26 years, ranging from 18 to 50 years.

The complications in the 5322 patients with penetrating chest injury have been as follows:

• Important bleeding requiring thoracotomy	90 (1.7%)
• Pneumonia	102 (1.9%)
• Empyema	164 (3%)
• Septicaemia	60 (1.1%)
• Death	267 (5%)

No case with clotted haemothorax or bronchopleural fistula was detected.

The 137 patients who received the autotransfusion had the following complications:

• Pneumonia	2 (1.4%)
• Important bleeding requiring thoracotomy	2 (1.4%)
• Death	5 (3.6%)

No complication, autotransfusion-related (septicaemia, intravascular disseminated coagulopathy, kidney failure), was detected in the studied group.

DISCUSSION

Autotransfusion can be a life saving procedure. Three methods have been described to avoid allotransfusion [4]:

- Predonation of red blood cells before planned elective surgery.
- The use of acute normovolemic dilution, immediately before elective surgery.
- The collection of shed blood either intraoperatively or postoperatively.

In emergency situations and in anaemic, shocked patients the first 2 methods are not applicable, leaving to the third method the possibility of reducing/avoiding blood transfusions.

Intraoperative blood salvage involves the collection and reinfusion of autologous blood shed at the operative site. In developed countries it's used during vascular, cardiac, orthopaedic surgery. The blood is aspirated from

the surgical wound using a double lumen suction line. Anticoagulant flows through one lumen and mix with the blood suctioned into a collection reservoir. Collected, filtered blood can be reinfused directly or after centrifugation and washing with saline [5]. The equipments required are very expensive and sophisticated and need specialized staff for their use.

Postoperative blood salvage involves collection of blood from drains, usually after cardiac, vascular or orthopaedic surgery.

The practice of transfusing autologous blood collected from a chest drain is a very safe and quick way to give transfusions when life is jeopardized by blood loss. Delays for typing and cross matching are eliminated. Blood compatibility is guaranteed. There's no risk of exposure to pathogens like HIV or hepatitis virus. Being fresh blood, its oxigen-carring capacity is superior to that of banked blood. It's cheaper than collecting, processing and storing donors' blood. Contraindications for the procedure are: coagulopathy (disseminated intravascular coagulation), lungs or pleural cavity infection, massive contamination of shed blood, renal failure, pleural cavity malignancy [6].

Blood collected from pleural cavity is defibrinated by a combination of mechanical factors (contact with functioning heart and lungs) and biochemical interactions with serosal surfaces. Having the fibrinogen being removed, the blood does not require anticoagulation before reinfusion. Clinical coagulation appear to be unaffected by reinfusion of unwashed blood drained from mediastinal cavity [5]. In our case, we used standard units for blood collection, already provided with anticoagulant (CPDA).

The effects of reinfusion of unwashed blood appear to be minimal, most often febrile reactions [5].

In developing countries simple methods to collect blood from peritoneal cavity when operating a rupture of ectopic pregnancy or closed injuries of liver or spleen are well known and described [7].

Very few reports have been published on salvage and reinfusion of blood after penetrating chest wounds causing haemothorax [6,8,9], probably for the fact that this blood is considered contaminated.

Our decision to treat with autotransfusion 137 patients presenting with penetrating chest war injury depended on 2 factors: the absence of any alternative (absolute need of blood and lack of eterologous blood) and a previous positive experience with this technique of an ICRC surgeon during the Lebanon war in the '80s.

During the Afghanistan war the Russian military surgeons treated 1314 penetrating chest injuries and in some cases, being often short of blood or blood preparations, practiced blood reinfusion. In case of haemothorax not older than 24 hours, the blood collected from the pleural cavity was examined for the criteria of haemolysis and contamination and, if acceptable, reinfused. In some instances they performed blood reinfusion as late as 72 hours after injury, without problems [8].

CONCLUSIONS

- These preliminary reports suggest that collection and reinfusion of blood from pleural cavity in case of haemothorax related to penetrating chest injury can be a relatively safe procedure.
- Due to the fact that the blood in the pleural cavity is defibrinated, some authors suggest that there's no need to add anticoagulant to the blood container.
- Large spectrum antibiotic prophylaxis is strongly advisable as this kind of haemothorax is considered contaminated.

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ABDOMINAL WAR WOUNDS WITH LARGE BOWEL INVOLVEMENT: The Medina Hospital Experience

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ABSTRACT

Medina Hospital was a Police Hospital in Mogadishu South, Somalia. Due to overwhelming difficulties it was closed after the civil war broke out in 1991. In 2000 it was reopened as community based hospital, with the support of the International Committee of the Red Cross (ICRC). From June 2000 to June 2002, 3496 war wounded patients have been treated. Among them 950 cases presenting penetrating abdominal war wounds, with large bowel involvement in 430 cases. The authors present the hospital experience in the treatment of penetrating abdominal war wounds involving the colon. After a first phase, related to the learning curve when all the cases were treated with colostomy, an increased rate of patients have been treated with primary colon closure, without significant increase in the complication rate.

INTRODUCTION

Abdominal war wounds constitute a significant proportion of war casualties. In conventional warfare they account for about 10% of the injured [1]. Due to the great improvements in medical science during the past century, mortality related to abdominal war injuries has declined from more than 75% during World War I to 12% in the Iran-Iraq War [2], but the treatment of penetrating abdominal war wounds involving the colon is still under discussion between primary repair and deviation of the fecal stream. In World War II and Vietnam, one form of colostomy or the other was considered mandatory. Civilian experience with gunshot wounds, a better understanding of physiology and pathology, a wider availability of powerful antibiotics have all tended to a more conservative approach, increasing the rate of cases treated with primary repair. If this is true in a peaceful situation, it is not always the case in contemporary war practice where many constraints work against this approach: lack of water and electricity, shortage of drugs and dressing material, sudden large influx of war wounded and patients with several wounds (chest, abdomen, limbs) resulting in lack of time for a definitive treatment, delay from injury to treatment, but, most important of all, lack of surgical skills in the medical staff involved in surgical treatment.

Medina Hospital was a Police Hospital in South Mogadishu, Somalia. It had been closed in 1991 after the civil war broke out in the country. In 2000 it was reopened as a community based hospital with the support of the International Committee of the Red Cross (ICRC). Admission criteria were any surgical emergency with priority to war wounded patients. Due to the fact that most of the fights happened around or inside Mogadishu town, the delay from injury to admission and treatment

was often shorter than 2 hours. As a consequence the hospital received and treated a high rate of serious cases with "central" injuries, affecting brain, chest and abdomen. The ICRC surgical plan in this specific context has been to rehabilitate the hospital buildings, provide medical and surgical material as well as human resources, train the local staff in hospital management, laboratory technology, patient triage and nursing, and war and general surgery.

PATIENTS AND METHODS:

A retrospective medical records review of civilian and military casualties, with penetrating abdominal war injuries involving the colon, treated in Medina Hospital, was performed. From June 2000 to June 2002, out of 3496 war wounded patients admitted, 950 cases presented penetrating abdominal wounds, with large bowel involvements in 430. Patients with rectal injury below peritoneal reflection or anal injury have been excluded from the present study as there is no doubt that in these cases the treatment requires colostomy.

Almost 90% of these patients could reach the hospital within two hours after the injury. Upon arrival at the hospital, all patients were resuscitated and stabilized with intravenous fluids and/or blood transfusions. Haemoglobin, haematocrit tests and blood group were done. Anti-tetanus serum, tetanus toxoid and antibiotics were administered. Following the ICRC protocol on antibiotic therapy, the patients received benzyl penicillin 5 M IV 6 hourly plus metronidazole 500 mg IV 8 hourly plus gentamycine 80 mg IV 8 hourly, for 5 days. Nasogastric tube and bladder catheter were inserted. General anesthesia (ketamine) with endotracheal intubation and muscle relaxation (suxamethonium) was used. A midline incision approach, extended from the xiphoid to the pubic symphysis, was always used as this provides the best exposure for intraperitoneal organs exploration. After

controlling the bleeding, a systematic exploration of the abdominal cavity was performed to estimate extent and type of damage. Organ injuries were assessed and appropriately managed. Colonic wounds were either: primarily repaired, exteriorized as loop colostomy, repaired and protected by loop colostomy, treated with resection, end colostomy and mucous fistula or Hartmann procedure. Colon repair/anastomosis was performed with a double layer of vycril 2/0 (first layer interrupted stitches, second running). The peritoneal cavity was then irrigated with warm saline in large quantities. Abdominal drains were not routinely used. For the closure of abdominal wall, parietal peritoneum layer was not considered and fascia was closed with a N° 1 vycril running suture. In case of generalized peritonitis the fascia was closed with interrupted sutures. Skin was either closed with interrupted polypropilene stitches or left open, depending on the degree of contamination (ICRC suggestion) and closed after 5 days if clean. The entry and exit wounds were debrided and left open, to be closed after 5 days if clean (ICRC protocol). At the end of the operation, anal stretching was performed in all the cases submitted to primary repair to reduce colon intraluminal pressure.

During a first phase, related to the learning curve of the local surgeons, all colon injuries were treated with colostomy, irrespective of the situation. Once their experience and technical skills improved, primary colon repair has also been considered, depending on the specific situation. As a result 193 cases (45%) have been treated with primary closure while 237 (55%) received a colostomy.

Patients treated with colostomy remained admitted in the hospital till colostomy closure, due to lack of sufficient care in case of discharge. The colostomy was routinely closed after 3 weeks unless there were complications.

RESULTS

From June 2000 to June 2002 Medina Hospital received 430 patients with penetrating abdominal war wounds involving the colon. Only small bowel injuries appeared to be more frequent in our series of 950 penetrating abdominal war wounds.

In the group considered there were 341 males and 85 females and 4 were children below 12 years. The mean age was 25 years with a range from 9 to 60 years. The mean delay from injury to treatment was 2 hours, ranging from less than 1 to 72 hours.

In some cases the patients presented combined injuries: 26 cases had also penetrating chest injuries, 5 cases had head injuries, 29 cases had limb wounds.

The mean hospital stay in patients with primary repair was 17 days (range from 8 to 52 days). For those submitted to colostomy the mean hospital stay was 37 days (range from 28 to 61 days).

Distribution of wounds, according to the site, was as follows: transverse and left colon 57%; cecum and right colon 41%; mixed 2%.

Out of 430 cases, 237 have been treated with colostomy and 193 with primary repair.

Complications

	Colostomy (237 cases)	Primary closure (193 cases)
<i>Fistula*</i>	18	14
<i>Bowel obstruction</i>	5	7
<i>Peritonitis</i>	4	10
<i>Burst abdomen</i>	7	2
<i>Other complications"</i>	7	8
<i>Death°</i>	61	37

*The cases of fistulization in the colostomy group were all related to a colostomy closure complication.

"Other complications include post-operative biliary leak, bleeding, unrecognized urether injury, etc, all requiring relaparotomy.

° Most of the patients died within 48 hours after admission due to multiple injuries and prolonged shock.

DISCUSSION

The management of penetrating colon injuries has been, and still is, a controversial subject. The first guidelines regarding the management of colon trauma were published in 1943 by the U.S. Surgeon General and mandated exteriorization or proximal diversion for all colon injuries [3]. Shortly thereafter Ogilvie [4] reported dramatically reduced mortality with exteriorization or diversion of colon injuries sustained during the North African campaign, as compared with the results after suture repair performed during World War I. This policy of mandatory colostomy remained in fashion till the late

70s. The first who tried to go against this "dogma" were Stone and Fabian [5] who, in 1979, presented their landmark, prospective, randomized study comparing primary repair with diverting colostomy. By treating with primary repair 52% of penetrating colon injuries in their patients group, they showed that in selected cases primary repair was associated with fewer complications than colostomy. After them, several studies have been published examining in more detail the role of several risk factors like delay from injury, degree of peritoneal contamination, blood loss and number of transfusions, hypotension, extent of the colon injury, injury on left colon versus right colon, combined injuries etc. [6,7,8]. Demetriades and coll. [6], in their prospective multicenter study concluded that "the method of colon management does not influence the incidence of colon-related abdominal complications, irrespective of the presence or absence of any risk factors." Furthermore Nance and Nance [9] stated that " a surgeon using colostomy in the management of penetrating colon injury should be required to justify the continuation of this obsolete and discredited practice".

If this is the trend in the civilian practice, the situation is not the same under war conditions due to the many constraints the war surgeon has to face: sudden large influx of wounded, shortage of antibiotics and dressing material etc, lack of water and electricity. But probably the most important aspect affecting the decision for primary repair or colostomy is the experience of the surgeon.

Moreover most of the reports on the management of penetrating colon wounds, gunshot related, coming from the civilian practice, are the result of low speed and low energy bullets (handguns) causing small wounds. The situation is different when dealing with war rifles shooting high energy bullets. These can cause high energy transfer resulting in cavitations and huge disruption of the tissues.

In our opinion, in contemporary war practice, primary colon repair and colostomy should both be considered, depending on the particular situation.

Our retrospective study is not complete as we are missing the statistical analysis on the data due to lack of experience in this field. The higher rate of complications in the colostomy group in our series is most probably related to the learning curve of local surgeons. Primary repair, as an alternative for colon repair, was only introduced when the level of experience and technical skills was judged satisfactory by ICRC surgeons. This also explains, in our opinion, the 18 cases of fistulization and the higher rate of deaths in the colostomy group. Besides, colostomy repair was often preferred in case of patients with multiple injuries and bad general conditions as reducing the operation time.

CONCLUSIONS

While in civilian practice there seem to be a trend towards avoiding colostomy in most cases dealing with penetrating colon gunshot wound, in contemporary war situations both colostomy and primary repair still play an important role.

In our opinion, the factors influencing the decision for the operative procedure are as follows:

- Experience of the surgeon (probably the most important).
- Delay from injury.
- Degree of fecal contamination.
- Size and type of injury, related to terminal ballistics.

- Age and general conditions of the patient (nutritional status).
- Number of abdominal organs injured.

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EXPERIENCE OF THORACIC SURGERY PERFORMED UNDER DIFFICULT CONDITIONS IN SOMALIA

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ABSTRACT

Objective: To review our experience in thoracic surgery performed at Medina Hospital over last two years under constraint situations and to assess its feasibility in such conditions.

Design: Case series study.

Settings: Medina Hospital, Mogadishu – Somalia.

Subject & Methods: Thoracotomies were performed in thirty-two (32) patients in traumatic and non-traumatic cases. No proper pre-operative investigation was available such as spirometry, haemogasanalysis, bronchoscopy and CT scan. We could only rely on clinical evaluation and plain x-rays.

Operations were performed under general anaesthesia with no inhalation substance; no anaesthetic machine has been used. We simply used ketamine, Suxamethonium, Diazepam and Atropine.

We did not use post-operative suction drainage but simple "under water seal" bottle drainage.

Results: Thoracic surgery has been performed in 32 patients in Medina Hospital. Most of these cases underwent pleural decortications for chronic empyema (18 patients), 7 patients had removal of bronchial foreign bodies, 4 patients had resection of oesophageal cancer, 2 patients had pericardiectomy for constrictive pericarditis and 1 had lobectomy for lobar consolidation. We had two post-operative complications and 2 patients died after having surgery for carcinoma of the oesophagus.

Conclusion: Thoracic surgery can be performed under constrains with good results in skilled and experienced hands.

INTRODUCTION

Thoracic surgery is usually performed in tertiary hospitals where equipment and well-trained personnel are available.

Medina Hospital was a police hospital in South Mogadishu, Somalia. It had been closed in 1991 after the civil war broke out in the country. In 2000 it was reopened as a community based hospital with the support of the International Committee of the Red Cross (ICRC). Admission criteria were any surgical emergency with priority to war wounded patients. Frequent lack of water and electricity, shortage of drugs and dressing materials, lack of diagnostic equipments and proper post-operative environment, have been usual constraints. This was particularly true for the thoracic surgery due to the lack of proper preoperative investigations (spirometry, bronchoscopy, haemogasanalysis, oesophago-gastroscopy, CT scan), suitable tracheal tubes (Carlens, Robertshaw), ventilators, negative pressure drains [1,2].

SUBJECT & METHODS

This is a case series study based on a review of the patients' medical files during the period June 2000 (hospital opening) - September 2003.

Thoracotomy was performed in 32 patients in traumatic and non-traumatic cases. Pre-operative investigations, usually considered essential, like spirometry, haemogasanalysis, bronchoscopy, esophago-gastroscopy and CT SCAN were not available in our settings. We could only rely on medical history, clinical evaluation and AP-LL x-rays, to diagnose the thoracic problem, decide the proper therapeutic approach and extrapolate the residual respiratory function in case of lung resection. In case of doubt of oesophageal involvement, patients were also submitted to barium swallow and meal (to confirm the diagnostic doubt) and barium enema (to be ready for

colon replacement in case we had to resect the oesophagus).

Prior to surgery patients were also submitted to basic laboratory investigations (haemogram, blood grouping and cross-matching, glycaemia, liver and kidney function) and ECG. After resection, diagnosis could be confirmed by histopathology where needed.

The 18 cases presenting with empyema were first treated conservatively with chest tube drainage for 4 weeks prior to consider major chest surgery.

Operations were performed with the patient lying in a lateral position (postero-lateral approach thoracotomy) in 30 cases, and supine position (median sternotomy approach) in 2 cases. General anaesthesia with Ketamine and Diazepam and a pre-medication with Atropine was always used. Myorelaxation was obtained with Suxamethonium and followed by simple oro-tracheal intubation with single lumen tube. No double lumen tube such as Robertshaw or Carlens was available. Due to lack of mechanical ventilators, patients were manually ventilated with an Ambu bag connected with an oxygen concentrator. To avoid microatelectasia, during the operation, the interested lung was expanded from time-to-time. A pulse-oxymeter was connected to each patient to monitor blood oxygen saturation.

On the surgical instruments point of view we could rely on a standard thoracic set with Finocchietto retractor, lung retractor, rib cutter and Lubsche sternotome.

After completing the operation, proper haemostasis was obtained and the pleural cavity was irrigated with warm physiologic solution. Two chest tubes (size 36F and 28F) were applied and connected with "under water sealed"

bottle drainage. No suction drainage was available in our hospital.

Blood was made available before operation. For safe blood transfusion, donors were tested for Hepatitis B and C, syphilis, malaria and HIV.

From the 1st post-operative day onward all patients had respiratory physiotherapy, mobilization and liquid and semi-liquid diet (with the exception of the oesophageal cases).

Benzyl Penicillin 5mega 6 hourly, Gentamycine 80mg 8 hourly and Metronidazole 500mg 8 hourly IV were administered starting from anaesthesia induction, for 5 days. IV fluids were carefully administered to keep the patient "dry".

18 patients presenting with chronic empyema underwent pleural decortication. Eleven of them had post-tuberculosis empyema and 7 cases were post-traumatic ones. None of them had lung resection as we could obtain complete lung expansion.

Among the seven patients with foreign bodies, 2 have been submitted to left thoracotomy and 5 to right thoracotomy.

One patient underwent a lobectomy of the right upper lobe, for an aspergilloma developed inside a TB cavity (histopathology confirmation), which was causing repeated episodes of haemoptysis.

Two patients underwent pericardiectomy for constrictive pericarditis through a median sternotomy access.

Four patients with carcinoma of the lower oesophagus underwent a resection and tubularized stomach reconstruction through a left postero-lateral approach.

RESULTS

Thoracic surgery has been performed in 32 patients in Medina Hospital, Mogadishu, Somalia.

Thirty patients have been submitted to thoracotomy though a postero-lateral approach followed by pleural decortication in 18 cases, removal of bronchial foreign body in 7 cases, lobectomy in 1 case, oesophageal resection in 4 cases. Two cases underwent a midline sternotomy for pericardiectomy.

Duration of the operations ranged from 1.5 to 4 hours, with a mean time of 2 hours 45 minutes.

An average of 4 units of blood per patient was transfused during the surgical procedure.

Complications

Two patients out of the 18 who underwent pleural decortication for empyema, had a post-operative empyema that subsided after 10 and 14 days respectively.

Two patients, who had oesophageal resection for cancer, died after developing a mediastinal fistula.

DISCUSSION

After an initial scepticism in performing thoracic surgery, well aware of the difficulties and complications accompanying such procedures, we decided to cautiously start to do this kind of surgery. On one side we were facing inadequate preoperative investigations, anaesthesia and post-operative care level and, on the other side, a skilled thoracic surgeon was available and there was no possibility to send these patients abroad for treatment.

The suffering of our patients encouraged us to take the challenge and put together our experiences and skills with an outcome not far away from the results of a traditional well-equipped tertiary hospital around the world. We think that, in our case, an accurate clinical evaluation of the patient combined with a careful assessment of the risks and benefits of such an operation in skilled hands, played a major role in the outcome obtained.

As mentioned above, the patients with chronic empyema had been first treated with a standard conservative method for 4 weeks [3]. The 18 submitted to pleural decortication have been chosen from a larger group as not accepting the less aggressive alternatives (long standing chest drains, pleural fenestration) and being in good fitness.

The patient with pulmonary aspergilloma developed inside a TB cavity, had already had several episodes of haemoptysis and had no therapeutical alternative to lobectomy [4].

The four patients with oesophageal cancer have been selected for standard resection and reconstruction [5,6] after counselling with the specialist and refusal of a simple feeding gastrostomy.

CONCLUSIONS

Due to the small number of cases presented in our study and the many variables included, the results obtained cannot be generalized. The outcome of thoracic surgery performed at Medina Hospital with the poor means available could, anyway, encourage other experienced surgeons to treat locally these cases when there's no possibility of transferring the patient to proper medical facilities.

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THE USE OF EXTERNAL FIXATOR IN THE MANAGEMENT OF GUNSHOT RELATED OPEN LIMB FRACTURES

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ABSTRACT

Objective: To review our experience on the use of external fixators in the management of open limbs' fractures caused by gunshot at Panzi Hospital over the last 4 years.

Design: Retrospective study.

Settings: Panzi Hospital is a missionary hospital located in Bukavu, Democratic Republic of Congo.

Subject and Methods: External fixators have been applied in 62 patients affected by limb war injuries with fracture. Upon admission patients were evaluated, stabilized and submitted to basic preoperative investigations. Under general, spinal or regional anaesthesia a wound exploration and debridement was performed, followed by fracture stabilization with external fixators. These devices were removed and replaced by POP casts once soft tissue injuries had healed. Physiotherapy was started as early as 2 post-operative days.

Results: Out of 17 complications detected (2 pseudoarthrosis, 10 osteitis, 4 limb gangrene, 1 tetanus), only 2 (pseudoarthrosis) could, possibly, relate to the use of external fixators and healed after bone graft. One patient died (the one who developed tetanus).

Conclusions: External fixators can be quite helpful in experienced hands in selected cases of war wounds of the limbs with fracture.

INTRODUCTION

Panzi Hospital is a missionary hospital, one of the 3 referral hospitals of Bukavu, Democratic Republic of Congo. It was recently built and opened its door few weeks after the rebellion started.

During the last two years the hospital has been supported by the International Committee of the Red Cross (ICRC). ICRC has been providing surgical material, drugs and specific surgical training to improve the management of the war-wounded patients (civilians and soldiers). An "in ward" and "in OT" training is delivered, twice a year, by the ICRC Regional Surgeon from Nairobi.

We, thus, started to apply ICRC advice and guidelines for the management of war wounded patients [1-4] and adapt our orthopaedic skills and knowledge to this special category of patients.

SUBJECT AND METHODS

This is a retrospective study covering a four-year period, from September 1999 to August 2003, based on review of the patients' medical files. During this period 2012 patients have been admitted in the surgical ward, 611 of whom were trauma cases. 220 of these had been wounded by gunshot and 62 presented open fractures, which benefited of an external fixator.

Upon admission and after a comprehensive clinical evaluation, these 62 patients have been stabilized haemodynamically (usually with IV crystalloids and colloids and, in rare cases, with blood transfusion). All of them received antitetanus serum and a boost of vaccine and antibiotic prophylaxis (Penicillin G 5 mega 6 hourly for 48 hours followed by oral Penicillin V for 3 days). Before operation they underwent the following preoperative investigations: x-rays of the affected limb, haemoglobin and blood grouping.

The anaesthesia used has been either spinal, in case of lower limb injury, or regional (cervical or axillary block), in case of upper limb injury or general (Ketamine and Diazepam), in case of uncooperative or shocked patients.

The surgical procedure consisted of a systematic exploration of the wound, a tissue debridment, a fasciotomy in case of compartment syndrome risk, followed by a "de visu" fracture reduction and contention by external fixator. Due to the important oedema caused by the high-energy bullet injury combined with the surgical trauma, the wound was left open and dressed with a loose bulky dressing and the limb elevated. The patient was then taken back to the operation theatre and reviewed, usually after 5 days. Once the wound was clean, a delayed primary closure or, in case of tension, a skin graft was performed.

After healing of the soft tissues, the external fixators were removed and fracture stabilization obtained with plaster of Paris (POP) cast.

All patients have been encouraged to early physiotherapy to promote a stronger callus, reduce the risk of joint stiffness, osteoporosis and bedsores.

RESULTS

External fixators have been used in 62 cases of gunshot wounds with open limb fractures between September 1999 and August 2003:

- 53 external fixators have been applied on lower limbs
 - 42 for leg injuries
 - 11 for thigh injuries
- 9 external fixators have been applied on upper limbs
 - 8 for arm injuries
 - 1 for forearm injury

The Use Of External Fixator In The Management Of Gunshot Related Open Limb Fractures

The following table shows the fracture locations

Upper limb				Lower limb			
Arm		Forearm		Thigh		Leg	
Right	Left	Right	Left	Right	Left	Right	Left
2	6	1	0	6	5	18	24

42 patients were males and 20 females. The mean age was 40 year-old with a range between 9 and 72.

Complications:

Type	Number	Management
Pseudarthrosis	2	Osteosynthesis + bone grafting + POP
Osteitis	10	Antibiotic therapy according to antibiogram / sequestrectomy
Tetanus	1	Specific care
Gangrene	4	Amputation
Death	1	

Admission time:

Due to insecurity and social reasons, the average admission time is undeterminable. Patients were forced to stay in the hospital even after treatment. The type of fracture and the damage of soft tissue were also responsible for large variation of admission time.

The shortest admission time was 45 days.

DISCUSSION

War wounds of the limbs with fractures do represent challenging situations even for experienced orthopaedic surgeons. The high-energy transfer related to war rifle's bullets causes extensive soft tissue damage and comminuted fractures with important loss of substance. These wounds are heavily contaminated [1,5]. The longer the delay of treatment, the higher the degree of infection. For these reasons internal fixation devices cannot be applied.

Basic, simple, cheap methods of fracture stabilization such as POPs, window POPs, bridge-POPs, skeletal traction, skin traction do offer acceptable results for the treatment of most of the limb fractures [3,4].

In special situations (ankle injuries, long bone injuries with important bone gap, bone graft) and in experienced hands, external fixator devices do offer a valid solution for the fracture stabilization [2,4].

Panzi Hospital has been provided, since its opening, with skilled orthopaedic surgeons, a good amount of external and internal fixation devices and a proper supply from Europe, a good level of sterility in the theatre and portable x-ray and fluoroscopy units.

When facing war wounded patients with limb fractures we tried to rely as much as possible on simple methods (POPs, skin and skeletal traction), reserving external fixators for special situations where they could clearly make a difference in terms of treatment outcome: ankle joint fractures, large soft tissue injuries, large bone gaps, bone graft.

As far as the complications detected in our series are concerned, only the 2 cases of pseudoarthrosis could, possibly, relate to the use of external fixation. They, anyway, healed after bone grafting; same for the 10 cases

of osteitis probably related to heavy wound contamination and insufficient debridement: they healed after antibiotic treatment and sequestrectomy. The patient who developed tetanus died after a short while. The 4 cases that ended with amputation, arrived to the hospital already with a compromised blood supply to the affected limb. In these cases the external fixator was applied to combine good fracture stabilization with better possibility of limb situation monitoring.

CONCLUSIONS

External fixators proved very useful in our setting on this category of patients presenting comminuted and heavily contaminated or infected fractures where, clearly, internal fixation devices cannot be applied.

The main advantages of external fixators in the management of war wounded open fractures have been:

- Easy wound access.
- Early active limb and joints mobilisation.
- Absence of bedsores and their expensive management.

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