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Disability can be avoided after open fractures in Africa—results from Malawi

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Summary In a free-at source hospital in Malawi, East Africa, 55 open fractures were treated within a 3-year period. The majority (33/55) involved fractures of the lower leg. The treatment regimen contained the following: primary external fixation; scheduled sequential debridement; immediate coverage of any bone devoid of periosteum using local muscle or fasciocutaneous flaps, alternatively limb shortening; no skin closure; controlled secondary healing under moist dressings; dynamisation and/or removal of the external fixator followed by functional treatment (Sarmiento and Latta) as soon as the soft tissues permitted.

The first 34 consecutive cases were monitored from the time of treatment; 24 of them attended for clinical review at 36 (±16) weeks after injury. Only 72% (13/22) patients had reached the hospital within 24 h after sustaining the fracture; 80% (18/22) had developed a septic wound infection, which healed in all cases after 20 weeks. At the time of follow-up, recovery of function was found in 20 (80%) of the injured extremities. Only three patients (12%) remained disabled due to the open fracture, one other patient died during treatment from tuberculosis secondary to AIDS and one patient required knee disarticulation. *Conclusion*: If the biological principles guiding the contemporary treatment of open fractures in the first world are respected, results under third world conditions do not differ as much as the differences in setting might suggest. The application of recent advances of global knowledge in trauma surgery into methods of treatment appropriate to the health care systems of highly resource constraint countries remains a rewarding task for modern trauma surgeons and their scientific community.

Introduction

According to the World Health Organisation the burden of certain diseases for a given population can be measured in terms of '*disability-adjusted life years*' (DAILY). In Africa, the burden of morbidity and mortality caused by road traffic accidents (RTA) per year, per million inhabitants is almost double that found in Europe.[14] As a result of the relatively low density of motor vehicles, the majority of RTAs involves pedestrians, bicyclists or passengers on the back of pick-ups and lorries. All of these groups of victims are easily exposed to

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mechanical forces during the RTA, as no surrounding vehicle parts provide them with protection. Open fractures are quite common among these patients.

In a country such as Malawi, defined by the UNDP as a 'least developed country' open fractures usually reach the orthopaedic surgeon at a time when contamination has already grown into infection. Despite all surgical efforts, osteitis occurs in most cases, so, the concept of prevention of infection in open fractures that is practised in developed countries has to be modified into infection control and allowing wound healing to take place despite a significant septic period. Even this appears a rather idealistic concept considering that post-traumatic or postoperative osteitis is one of the most common reasons for permanent disability after fractures all over the world. These clinical challenges are compounded when working within a health care system where vacuum sealing, powerful antibiotics and microsurgical techniques are unavailable. That it is possible to work towards this ideal and what a fascinating and challenging task for both a first world trained surgeon and his local counterparts it can be, is what we wish to demonstrate here.

Patients and methods

Between 15th October 1995 and 15th June 1998 we treated 55 open fractures at the Zomba Central Hospital in Zomba, Malawi, East Africa. This comprised 33 fractures of the lower leg, 10 of the forearm, three of the femur, two of the humerus, one complex hand, one foot injury and three others.

The treatment plan was as follows. (1) Primary external fixation as a rule (53/55 patients). (2) Initial debridement as soon as possible after admission, followed by repeated pre-planned debridements. (3) Immediate coverage of any bone that had been stripped of its periosteum using a local muscle or fasciocutaneous flap; if this was not feasible by shortening of the extremity. (4) No closure of the skin. (5) controlled secondary healing under moist dressings (Chloramine, Vinegar as an alternative) and reoperation (debridement, sequestrectomy or skin grafting when ever necessary). (6) Dynamisation when the fracture configuration and the construction of the external fixator permitted and the soft tissues had not closed by that time. (7) Removal of the external fixators as soon as the soft tissues were closed, followed by functional treatment according to Sarmiento/Latta.[12]

For logistical reasons, only a series of 34 open fractures in 30 patients treated between 15 October 1995 and 15 October 1997 could be followed up systematically; these are the data now presented.

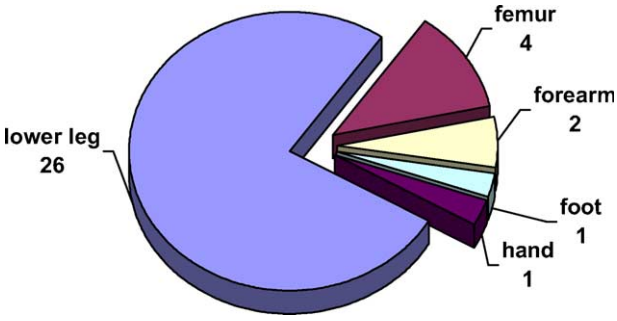


Figure 1 Site distribution of open fractures treated ($n = 34$).

Results

Twenty-six of the 34 open fractures in the 30 patients were in the lower leg, four in the femur, two in the forearm, one patient had a complex injury to the hand and one a crushed foot (Fig. 1). Thirty-two of these 34 open fractures were treated by primary external fixation. The exceptions were a forearm fracture that required nerve repair and was plated and an infected open fracture of the lower leg that had been referred 10 weeks following injury, which required an amputation.

The severity of soft tissue injuries met the criteria for third degree according to the Gustillo and Anderson classification in 14 cases and for second degree in 11 (Fig. 2). Only four fractures could be classified as first degree open, but such fractures are usually treated successfully at district and local hospitals and so are not referred to us. In one case of subtotal amputation of the lower leg, vascular repair was necessary.

Thirteen patients were admitted during the first 24 h after their accidents; all of them underwent surgery on that same day. Six patients arrived during the second day after the accident, one during the first week and one even later.

Fixation was mainly done with either a Hoffmann I or a Miehle-fixator. The Miehle (Fig. 3) was widely used in the then East Germany during the 1970s and

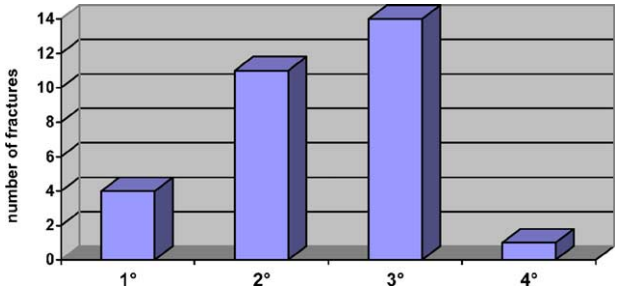
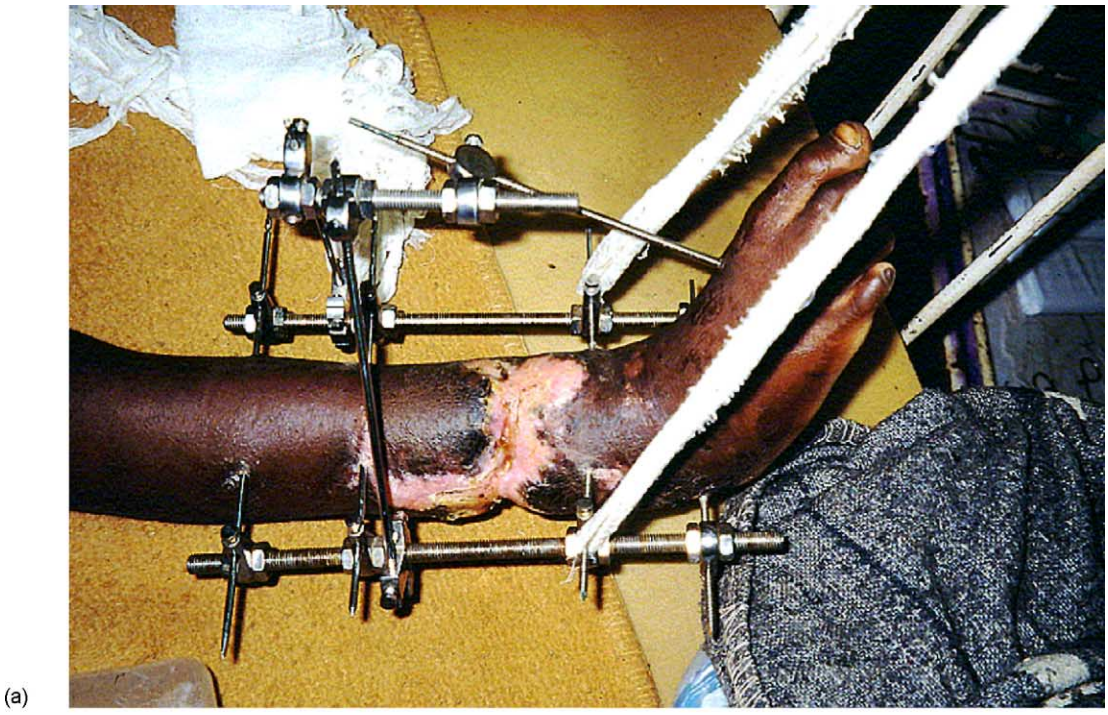


Figure 2 Severity of the open fracture according to the Gustillo–Anderson classification.



(a)

(b)

Figure 3 (a and b) The Miehle external fixator in a 12-year old boy with a subtotal amputation of the lower leg 6 weeks after injury.

1980s. When it was replaced there it became available for donation to developing countries. It resembles the AO-tube fixator but instead of the tubes it has threaded rods with nuts riding on them to fix the pin-holding clamps. As there is no bar-to-bar clamp, modular constructions are not possible. In three cases where joint bridging was undesirable, but the epimetaphyseal fragments were too small to take a Steinmann pin, the Ilizarov ring fixator was used; we were proud to have an original from Kurgan. In two of these cases the Ilizarov was used alone; in one other it was combined with a Heidelberg tube fixator, resulting in a home-made hybrid fixator.

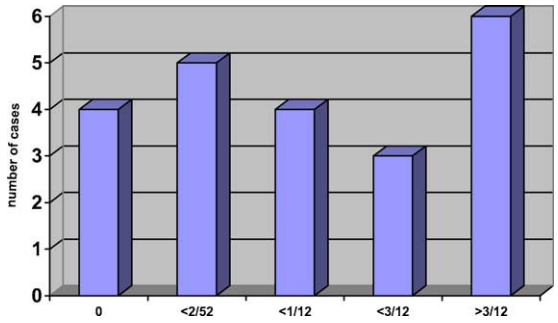


Figure 4 Duration of the period of local septic infection during the course after open fracture.

Over 80% (18/22) of the patients had a septic wound infection for various periods of time (Fig. 4). Only in four cases had the wounds undergone primary healing; all those patients had been admitted during the first 8 h from the time of injury. This had allowed a tensionless soft tissue closure over drains in these cases, sometimes using cutaneous or fasciocutaneous flaps.

In five patients infections were controlled after 2 weeks, in five others before the end of first month, while in three others the infections lasted for 3 months. Six patients had ongoing infection for longer than 3 months. During this period, treatment focused on the removal of all non-viable tissue but always safeguarding sufficient coverage of bone. Only two fortunate cases had the bone exposed with the periosteum intact. These patients were treated with moist dressings until coverage by granulation tissue had been achieved. In all other cases, bony debridement was then followed immediately by advancement of local muscle flaps, gastrocnemius, soleus or anterior tibial muscles were used. This was impossible in four patients due to these muscles being damaged or the injury being in the distal third of the lower leg. These patients had soft tissue coverage achieved by limb shortening at the fracture site. After complete soft tissue and bony healing, these four patients had a leg length discrepancy of 2—4 cm but all refused the offered limb lengthening procedure and preferred compensation for the discrepancy with orthopaedic shoes. All soft tissue wounds were healed after 20 weeks. Partial weight bearing was started with the fixator in place. The choice of time when partial weight bearing was permitted represented a learning curve for the clinicians in charge. In the first half of the patients treated, partial weight bearing was allowed after 15 weeks on average, while in the others it was permitted between 6 and 10 weeks. Nonetheless this decision has always to be made individually, based on the state of the soft tissues (infection, swelling, pain) and on the current radiographic appearance.

Follow-up was on average 36 ± 16 weeks after accident. Range of motion (ROM), gait and pain were classified on a scale between 0 and 1. ROM '1' equated to a full range of movement, '0.75' ROM represented a decrease of one quarter of the normal range, '0.5' half of the normal ROM and '0.25' a reduction to one quarter of the normal range. For gait, '1' signified unimpaired gait over an unlimited distance and no limping, for '0.75' one of the following was applicable: limping, needing to use a stick or limited walking distance, for '0.5' was walking at full weight with a cast or one stick, '0.25' walking with only partial weight-bearing and '0' unable to walk. For pain the scale was: '0' no pain at all, '0.25' pain with physical demands on the injured extremity, '0.5' occasional pain at rest also, '1' permanent pain. The results are shown in (Fig. 5). In summary the results at follow-up showed that in 20 (80%) of the patients the injured extremity had recovered significant function. Three

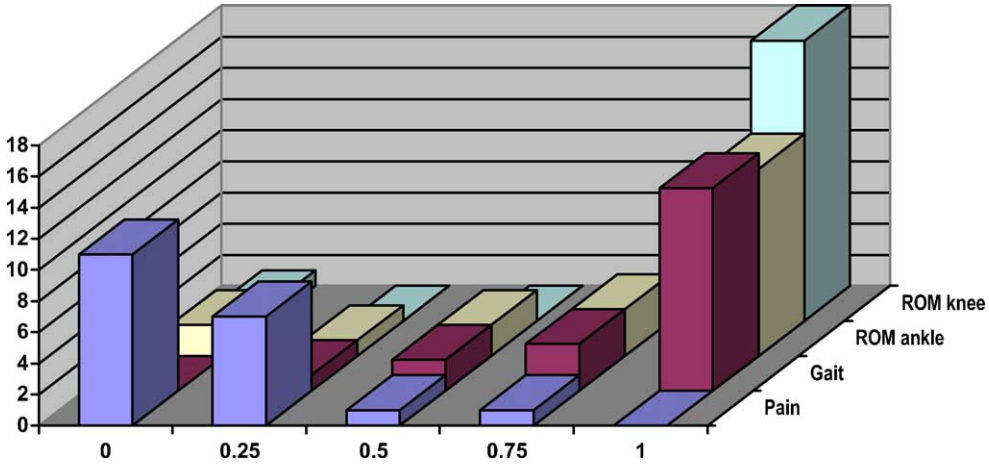


Figure 5 Functional result at follow-up 4—10 months after sustaining an open fracture of the lower leg (20 out of 25 patients followed up). ROM: range of motion.

patients (12%) remained disabled as a result of the open fracture. One of them had an aseptic delayed union that was still under treatment at the end of the study, another developed chronic osteitis after open forearm fracture and refused any further treatment. The third case was an open fracture dislocation of the carpus that was complicated by contractures of the hand. Finally, one patient with a gun shot fracture of proximal femur died from AIDS before the fracture had united and one other was amputated as mentioned above.

Discussion

The four patients who recovered from an open fracture without infection had all arrived within 8 h after the accident and had been immediately operated on. In the developed world this would be the standard; in countries such as Malawi it is the exception. The majority of patients (13/20) arrived at the hospital within the first day after the accident. People are usually so impressed by the rather large wound and obviously broken bones that we believe they try their very best to reach help as soon as possible. That distances are long and ambulances are rarely available will be hard to change in the foreseeable future. For the time being it appears more feasible to exploit any reserves available for shortening the period between sustaining an open fracture and its operative treatment by optimising the management of these injuries inside the hospital. This approach requires formally paving the way for open fractures from casualty to operating theatre raising the awareness of all medical personnel about the degree of emergency in these cases and by providing rules for their management that enables paramedics and nurses to do the right intervention without unnecessary waiting for academic decision-makers. One must here overcome the widespread opinion that orthopaedic emergencies are not as urgent as those in general surgery, which is so common because general surgery has been undertaken for much longer at these hospitals than has operative fracture treatment. In particular the staff of casualty, surgical and anaesthetic departments have generally not seen the outcome of well handled open fractures. In most developing countries only the few hospitals at tertiary care level might have orthopaedic or trauma surgeons. Hospitals in remote regions, however, must rely on general surgeons, other doctors, and in some instances orthopaedic clinical officers to provide damage-controlling, primary operative treatment for open fractures including external fixation. So, in our department in a referral hospital in Malawi, we have successfully trained orthopaedic clinical officers to carry out initial debridement of open fracture wounds and to apply an external fixator as an emergency procedure available at day or night.

Our treatment plan did not include the routine resection of bones sticking out of wounds as recommended by others.[9] Certainly this resection will sometimes be necessary, and was done when these parts of bone were deprived of their periosteum, dried out and/or apparently contaminated. On the other hand, bone defects are as difficult to treat as osteitis under these circumstances. So, in our opinion, the routine resection of any emerging bone could be too high a price paid, in some cases unnecessarily, and too late in others where infection is already established before the patient reaches treatment.

However, in our regimen a second line of defence against infection perpetuated by contaminated bone is a scheduled second-look debridement. Alternatively, a thorough first debridement with a radical approach learnt from oncological surgery has been proposed.[8] We would prefer the radical debridement only when it is possible early after the accident, done by highly experienced surgeons, there is sufficient equipment for the reconstruction of soft tissue defects, and where there is no concern about the patients immune competence. One example is the above mentioned case of a grade III open fracture of the forearm requiring nerve repair being internally fixed after radical debridement. However, in most cases at least some of these conditions were not granted in our setting. So, for instance the overall HIV prevalence in Sub-Saharan Africa is considered to be between 8 and 20%.[15] Similar to the principle of scheduled lavage for the treatment of severe peritonitis, the date for the next debridement should be set by the surgeon who did the present one, and definitively in advance. Thus, only the conditions of the wound and its optimal development should influence this decision. Waiting, for instance, for general signs of infection as an indication for re-debridement would often mean responding to worsening wound conditions with an avoidable delay. Just as the treatment of peritonitis was improved by the introduction of methods for temporarily closing the abdomen, which allowed repeated surgical interventions, so part of the success of the vacuum sealing of fracture wounds might be due to the repeated exposure of the wound to the surgeon. Vacuum sealing has other advantages, whose application in developing countries is most desirable and feasible. However, in our setting we lack the most basic equipment and knowledge for vacuum sealing. Instead we use 0.5% Chloramine, known as Edinburgh University Solution of Lime

(EUSOL).[3,11] This not only keeps the tissue moist, but also its basic pH helps to neutralise the unwanted acid milieu in the wound and hinders the growth of most bacteria and fungi. One known exception is *Pseudomonas aeruginosa*; we therefore change to vinegar dressing as soon as a wound discharge turns bluish green.

The main disadvantages of long-term external fixation are pin-track infections, limits on physiotherapy and stress shielding of the fracture site. The rigidity of an external fixator might turn from being an advantage when controlling infection and pain into for a hindrance to bone healing later on. Therefore, we dynamised the external fixator whenever its design and the fracture allowed it. In all shaft fractures we tried to remove the external fixator as soon as the state of the soft tissue permitted the application of a functional brace according to Sarmiento and Latta[12] accompanied by increasing weight bearing. While initially hesitating to take this step until obvious callus formation had become visible on radiographs we later became encouraged to start as early as the fracture appeared clinically stable and the patients did not feel pain when exercising partial weight bearing.

The overall outcome that 80% of our patients retain an extremity of significant functional value does not differ as much from the results achieved in first world countries [2,5–7,10,13] as the differences in setting would suggest. We conclude that the main reason for this parity is the application of the biological principles discovered and introduced into clinical practice of contemporary trauma surgery during the last decades:[13] external fixation, sequential debridement, soft tissue recovery as the first step to bone healing. The lack of equipment can be compensated for to some extend by transferring some essential elements of first world technology, as we were fortunate to be able to do or by local improvisation.[4] However, it remains a rewarding task for modern trauma surgeons to develop solutions appropriate to developing countries for therapeutic problems that have been widely solved in the first world. The fracture with soft tissue defects and post-traumatic infection is an excellent example. The long and winding road to the low cost external fixator ''Dispofix'' eventually produced encouraging results.[1]

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