Outcome, following significant delays in initial surgery, of ballistic femoral fractures managed without internal or external fixation

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We reviewed the clinical details and radiographs of 52 patients with ballistic fractures of the femur admitted to the International Committee of the Red Cross Hospital in Kenya (Lopiding), who had sustained injuries in neighbouring Sudan. In all cases there had been a significant delay in the initial surgery (> 24 hours), and all patients were managed without stabilisation of the fracture by internal or external fixation.

Of the 52 patients, three required an amputation for persisting infection of the fracture site despite multiple debridements. A further patient was treated by an excision arthroplasty of the hip, but this was carried out at the initial operation as a part of the required debridement.

All of the remaining 48 fractures healed. Four patients needed permanent shoe adaptation because of limb shortening of functional significance.

Although we do not advocate delaying treatment or using traction instead of internal or external fixation, we have demonstrated that open femoral fractures can heal despite limited resources.

Although the specific techniques may vary, it is currently accepted that open fractures should be managed by early debridement of the wound and stabilisation by internal or external fixation.1 Previously, traction or plaster would have been considered appropriate methods of stabilisation for open fractures,2 but with advances in fracture techniques, such methods were soon considered inadequate,3 and are not even mentioned in modern reviews.1 Operative stabilisation of the fracture site is thought to be required to eliminate movement. This is said to reduce the risk of infection,4 and therefore methods such as plaster are not considered suitable for stabilisation.3

However, the use of adequate debridement, together with traction or splintage of ballistic femoral fractures, was shown to be an effective treatment over 90 years ago, and during the First World War helped to reduce the mortality of such injuries from 80% to 20%.5 Immobilisation in plaster has also been shown to be effective in the management of open fractures during conflict. Trueta,6 in the Spanish Civil War, treated ballistic fractures by wound debridement and total encasement in plaster, without any changes of dressing. He treated 1073 open fractures, with only six deaths, of which two were due to gangrene. He also felt that the two cases of gangrene were because of a failure of adequate initial debridement.

It has been believed that these wounds must be operated on without delay, and preferably within six hours, to minimise the risk of infection.7 However, there is little evidence to support this view, and recently it has been reported that delays of up to 24 hours do not affect the outcome.8

Both of these issues have resource implications for civilian trauma services. They are also of significant concern to military surgeons, who may have to manage such injuries following significant delays in evacuation and with limited resources, and for less developed countries which may lack the resources to perform complex orthopaedic procedures.

This study reviewed the outcome of open femoral fractures managed following a significant enforced delay in initial surgery (> 24 hours), and without stabilisation of the fracture by internal or external fixation, to determine whether satisfactory results can be achieved.

Patients and Methods
We have previously described the management of war wounds involving bone9 to demonstrate that the quality of the initial surgery was the most important factor in determining outcome, and that the method of stabilisation was a secondary concern.

In order to study the effect of significant delays in the initial surgery, we reviewed the...
clinical details and radiographs of patients admitted to the International Committee of the Red Cross (ICRC) Hospital in Kenya (Lopiding), who had sustained injuries in neighbouring Sudan. All patients’ details had been collected within a year of their admission, and had been maintained in a specific database. Patients were usually admitted at least a week after injury. None had been admitted within 24 hours of injury, owing to the long distances involved and the lack of available transport. It was not possible to determine the exact delay in presentation.

Treatment before arrival in hospital was limited to a clean dressing. No antibiotics were administered, and any stabilisation was fashioned using local resources only.

The ICRC hospital at Lopiding is a purpose-built facility in open bush country approximately three miles from a major aid centre in northern Kenya. All resources are either brought in by air or lorry over distances of more than 600 miles. Locally constructed water and sanitation units are supported by locally generated electricity. There is one operating room with three tables, which can be used simultaneously and are employed exclusively for the victims of war. Both the operating room and the wards for pre- and post-operative care are manned by expatriate skilled and trained staff working with locally trained, but formally unqualified, personnel drawn from the local community.

As this was a retrospective review and included a wide range of patients, we chose to study only open ballistic fractures of the femur, as these comprised the majority of the injuries. This allowed a relatively homogeneous group to be studied. All the patients were admitted between 1 January 1996 to 31 December 1996, and their details and radiographs had all been collated as part of a previous study. All the notes and radiographs were reviewed by an experienced military orthopaedic surgeon (JCC), who had not been part of the original investigation.

Results

We identified 77 patients with femoral fractures who had been admitted and treated by skeletal traction during the study period. We excluded 24 of these, as 22 were closed fractures and two were open but had been caused by a fall and a road traffic accident, respectively. This left 53 ballistic fractures of the femur in 53 patients, who formed the study group. Their mean age was 29 years (9 to 60). Only one patient was under the age of 18. There were 45 males and eight females.

There was only one death (1.9%), which occurred 15 days after admission in a patient who sustained a diaphyseal fracture following a gunshot wound. There was no information on additional injuries or the cause of death. Of the remaining 52 patients, four had incomplete radiographs. Of these, three had healed and one had undergone a transfemoral amputation, leaving 48 available for analysis. There were two proximal femoral fractures, one intracapsular and one intertrochanteric, 41 in the diaphysis and five in the distal femur (Fig. 1).

Of the 53 fractures, 47 had been caused by gunshots, three by blast and other fragments, and in three patients it was impossible to determine the exact mechanism. The majority of injuries were caused by high-velocity weapons. It is the energy transfer rather than the velocity that is the critical factor in producing injury, but it is impossible to determine accurately the energy transferred to the limb as the bullet strikes, although the presence of a bony defect after debridement may give some indication. This was evident in 35 of the 48 available radiographs (Fig. 2). In 14 of these the defect was at least 3 cm and was usually managed by autologous bone graft after any infection had resolved.

Of the 52 survivors, three required an amputation for persisting infection despite multiple debridements with one hip disarticulation and two transfemoral amputations. Another patient was treated by an excision arthroplasty of the hip, which was carried out at the initial operation as part of the debridement.

All of the remaining 48 fractures healed. A total of 15 patients were mobilised early and the fracture site was protected with plaster as a simple form of functional brace. Four eventually needed a permanent shoe adaptation to compensate for shortening of the limb of functional significance.

A mean of 6.3 procedures per patient were required for patients who ultimately required an amputation, compared with 5.9 operations for those who did not.

Patients spent a mean of 58.7 days in traction (18 to 214), which was assembled from local materials, and usually involved a proximal tibial pin (Fig. 3).
Discussion
As with the majority of reports on military injuries, this is a retrospective review. However, it is unlikely that there will ever be a prospective study comparing traction with internal or external fixation of ballistic femoral fractures.

This may be a self-selected group, as it is not possible to say how many casualties with ballistic femoral fractures died before reaching hospital. However, these are common injuries in survivors presenting late, so they may not have a high mortality rate in the first few days after injury.

We had no patients with a significant vascular injury requiring repair or a compartment syndrome. This is similar to the experience of Bhatnagar, Curtis and Smith, who felt that it was due to self-selection and that the patients with significant vascular injuries probably died before reaching the hospital. However, this was not the experience of Gosselin et al, who described the management of arterial repairs in 23 consecutive patients at the ICRC-Peshawar hospital for war wounded. In their series more than half of the patients presented at least 12 hours after injury, with a mean delay of 34 hours. Although there was a high amputation rate, particularly when the delay was more than 12 hours, no patient died after reaching the hospital. A significant vascular injury does not necessarily lead to significant bleeding, and it cannot be assumed that the casualties with vascular injuries to the limb bleed to death. In a description of the use of tourniquets in wounded patients, Beekley et al noted that major vascular injuries were more common in those who did not require a tourniquet, possibly owing to spasm of the artery limiting blood loss.

Saidi, Nyakiamo and Faya in a paper on gunshot injuries seen at the Aga Khan Hospital Nairobi, Kenya, found an incidence of vascular injury of 3.4%. This was a private hospital with middle- and high-income patients who presented with only a short delay. In a further report of victims of conflict, Aderounmu et al described 185 patients with a 3.2% overall rate of vascular injury. The casualties presented relatively early compared with many reports of conflict, with 27.6% seen within six hours and a further 52% between six and 12 hours after injury. There were 100 fractures, 28 of which involved the femur, and again no patient died of injuries to the limb. It is therefore unlikely that our cohort was significantly self-selected.

In our patients the majority of injuries were caused by gunshot, which is usual in Africa, where the use of artillery and other missiles is uncommon. Chaloner, in a paper from the conflict from Angola, noted that gunshot wounds were the most common mechanism of injury (46.4%), followed by landmines (38.9%). Given that mines are associated with traumatic amputation rather than a fracture, it is not surprising that gunshot was by far the most common cause of a fracture in our series.

In one of the largest series from Africa, Yinusa and Ogirima described 212 gunshot fractures, half of which were due to high-velocity weapons, treated at the biggest orthopaedic hospital in Nigeria. Only 37.5% presented within six hours, 27% presented after 24 hours. The femur was the commonest bone affected, and these were
also treated with what would be considered in the western world, minimal resources. Despite this, there were only two nonunions and six malunions. Amputation was required in 5.6%, and 3% died. There was no difference between high- and low-velocity weapons.17 These results are similar to ours, despite the longer delay in presentation in our patients.

Although significant delays are unusual in the western world, some comparisons can be made with papers where the wounds were managed totally conservatively. Brettler, Sedlin and Mendes18 did not debride or explore the wounds, and treated them in plaster, splints or traction. They describe the outcome of 83 fractures, of which only two became infected, with no cases of osteomyelitis. Ryan et al19 also experienced good results with 43 femoral shaft fractures caused by gunshots treated in traction. They found that the open fractures healed faster than closed fractures, with average angular deformities of 5° or less and no rotational malalignment. There were no deep infections or nonunions.

Internal fixation of gunshot fractures of the femur is a relatively recent development. In 1990, Hollmann and Horowitz20 published one of the first reports, a retrospective review of 19 patients with femoral fractures secondary to low-velocity weapons treated with delayed intramedullary fixation. The patients were treated by debridement and skeletal traction with an intramedullary nail at a mean of nine days (5 to 16). Of the 19, 17 healed. There was one delayed and one nonunion with no deep infections or osteomyelitis. Bergman et al21 questioned whether fractures from gunshot wounds are truly Gustilo type III injuries, as they were associated with a lower infection rate than open fractures from other mechanisms. In a report of 65 fractures, they advocated immediate as opposed to delayed nailing, but they still described a mean delay of two weeks with the fractures managed initially in traction.

Immediate internal fixation of femoral fractures caused by low-velocity gunshot was first described by Wright et al22 in 1993 and performed within 15 hours with no deep infections. All the fractures healed, but two required bone grafting and one an exchange nailing. By 1995, Nicholas and McCoy23 felt that “immediate locked nailing was the treatment of choice in gunshot fractures of the femur” based on their experience in Belfast. They advocated early operation with adequate debridement, and this included injuries due to high-velocity weapons. By the end of the 1990s the matter seemed to have been resolved, with Tejan and Lindsey,24 advocating a locked reamed intramedullary nail for low-velocity fractures and a non-reamed nail for high-velocity injuries. They advised that plate fixation or external fixation was indicated for vascular injuries, but given the low incidence of such injuries, routine angiography was not required.

A recent review has also concluded that intramedullary nailing is the treatment of choice, but the authors admit that there are few prospective studies of open femoral fractures.25 Intramedullary nails are associated with a deep infection rate of 3.3%, compared with 13.3% with external fixation, which was also found to give a malunion rate of 23.3% and a re-operation rate 17%; worse than many of the reports of traction. Although external fixation may be used temporarily, an intramedullary nail was the treatment of choice. Given the lack of intramedullary nails in Africa, traction remains an acceptable method of definitive stabilisation. Internal fixation of fractures has been described in Africa, from hospitals with limited resources. Steiner and Kotisso,26 commenting on internal fixation after a delay in presentation, felt that it was controversial whether or not internal fixation should have a place in Africa, because of the “lack of adequate training in internal fixation and adequate infrastructure in the operating theatre”.

Early debridement of the wound is recommended by most authors. Traditionally, the view has been that these wounds must be operated on without delay, preferably within six hours,7 but there is little, if any, evidence to support this view.27 We are not advocating delaying treatment or using traction instead of internal or external fixation, but we have demonstrated that open femoral fractures can heal despite limited resources. Although the ICRC have always believed this, concerns are raised by surgeons who have little experience of managing these injuries with very limited resources, and assume that there will be a universally poor outcome.

Although the long-term outcome and functional results of these patients are not available, the short-term objective of wound and fracture healing were satisfactory and permitted patients to leave the hospital able to walk.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Supplementary material
A further opinion by Dr R. Buckley is available with the electronic version of this article on our website at www.jbjs.org.uk

References