



F. Lavini • E. Carità • C. Dall'Oca • R. Bortolazzi • G. Gioia • L. Bonometto • A. Sandri • P. Bartolozzi

Internal femoral osteosynthesis after external fixation in multiple-trauma patients

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Abstract In this study the authors evaluate the results of internal synthesis of femoral fractures in polytraumatised patients initially treated by external fixation (EF). From January 2002 to December 2005, 39 femurs in 37 polytraumatised patients (average age 34.2 years, range 18–44) with closed fractures and an ISS>20 were initially treated with EF. There were three groups: Group A, 13 cases when conversion to internal osteosynthesis occurred after 4–7 days (average 5.6 days); Group B, 11 cases with a 4–6-month interval before internal osteosynthesis, and after investigation using MRI and scintigraphy with labelled leucocytes; Group C, the remaining cases treated definitively with EF. Time of healing, lower limb function, time of return to previous activities and short and long-term complications were evaluated at the follow-up. The average time of follow-up was 23 months. In Group A the time of bone healing was 123 days; there were no events of embolism but one case of pseudoarthrosis and one case of instrument failure. In Group B the time of bone healing was 274 days, with one case of pseudoarthrosis and one case of deep infection. In Group C the average healing time was 193 days, with 3 cases of screw

(half-pin) osteolysis. Functional recovery was delayed by the presence of other fractures. EF is a simple, quick and safe procedure to stabilise fractures in polytraumatised patients. According to damage control orthopaedic (DCO) concepts, it is possible to replace EF with internal synthesis after an interval as this reduces the risks of internal osteosynthesis when performed in the emergency period. EF can also be maintained as definitive treatment but should a change to internal synthesis be needed, it is possible to do it safely after excluding bone infection.

Key words Femoral fractures • Damage control orthopaedics • Internal femoral osteosynthesis • External fixation

Introduction

Management of multi-trauma patients requires a multi-disciplinary approach that must initially ensure stabilisation of general conditions and vital functions. In this context, the first stage in orthopaedic treatment involves fracture stabilisation in order to reduce blood loss and facilitate patient management. A useful method for assessing the seriousness of such trauma is the Injury Severity Score (ISS). An ISS >20 indicates the need for immediate stabilisation treatment [1]. In this context, external fixation (EF) is fast and ensures good stabilisation, as well as providing versatility and essential management in the emergency period, especially in cases of multiple fractures.

Nevertheless, internal synthesis of long bone fractures in the lower limbs, especially the femur, also offers numerous advantages such as early weight-bearing, simpler overall management and good stability. In critical patients a combination of the two methods, a first stage where EF is used as an emergency procedure to stabilise long bone fractures followed by a second stage of intramedullary nailing, exploits the advantages of both approaches provided that certain clinical conditions are met.

F. Lavini (✉) • E. Carità • C. Dall'Oca • R. Bortolazzi
G. Gioia • L. Bonometto • A. Sandri • P. Bartolozzi
Clinica Ortopedica e Traumatologica
Ospedale Policlinico GB Rossi
Pzz.le L.A. Scuro 10, I-37134 Verona, Italy
e-mail: lavfra@tiscali.it

Materials and methods

Between January 2002 and December 2005, 37 multi-trauma patients (average age 34.2 years, range 18–44) with ISS>20 had 39 femoral fractures initially treated with the Orthofix Dynamic Axial Fixator. Twenty-four patients subsequently underwent internal osteosynthesis. In Group A (n=13), the EF was replaced by an intramedullary nail (n=9) or a plate and screws (n=4) after an average of 5.6 days (range 4–7). In all conversion was only enacted after vital and blood-chemical parameters had stabilised.

In Group B (n=11) EF was removed after 4–6 months and replaced by an intramedullary nail in order to treat delayed consolidation (n=5) or loose fixator screws (n=6). Removal of the external fixator was followed by an interval of 3 weeks, at the end of which MRI and scintigraphy with isotope-labelled leucocytes were performed; a negative response to these examinations was considered a prerequisite for subsequent conversion to internal osteosynthesis.

The remaining 15 fractures (Group C) were managed definitively by EF as the general medical condition at the time did not facilitate further surgery.

Internal synthesis of the femur was carried out using a reamed antegrade intramedullary nail (AFN Synthes or GK Stryker) or an angle-stable plate such as LISS (Synthes). Fracture healing time, general and local complications in the short and long term were used as evaluation parameters.

Results

Results were assessed with an average follow-up of 23 months (range 6–42 months). In Group A, the average healing time was 123 days; there were no cases of pulmonary embolism, but one case of infection, one case of pseudoarthrosis and one case of hardware failure (failure of the distal locking screws). In Group B, the average healing time was 274 days; there were no cases of pulmonary embolism, 1 case of pseudoarthrosis and 1 case of infection. In Group C, the average healing time was 193 days with 3 cases of screw osteolysis.

Discussion

The gold standard in the treatment of diaphyseal fractures of the femur is intramedullary nailing. The management of multi-trauma patients often demands rapid fracture stabilisation given the high risk of potential complications such as blood loss and embolism. In 1989 Bone et al. [2] reported the benefits of early stabilisation of fractures in relation to a decrease in the duration of hospitalisation (early total care – ETC). ETC became the standard in the treatment of multi-trauma patients; it ensured a more rapid return to mobility and consequently reduced complications associated with prolonged recumbency [3–5]. In 1985 Ecke et al. [6] published a study of 1127 femoral fractures describing the appearance of unexpected thoracic complications in patients

treated initially with reamed nails, especially in the 20–30-year-old age group. It was proposed these complications could be averted if multiply injured patients with specific characteristics were not subjected to reamed intramedullary nailing in the first instance. Pape and Tschernke defined these patients to be those with multiple trauma and an ISS>20 associated with thoracic trauma, those with multi-trauma and pelvic or abdominal lesions and blood-loss shock, patients with an ISS>40, patients presenting with bilateral pulmonary contusions, patients with an initial pulmonary arterial pressure of >24 mmHg or an increase in this parameter of >6 mmHg during intramedullary femoral nailing [1]. A concept of damage limitation, first introduced into general surgery in the military sphere by Rotondo, was adopted; now known as damage control [7, 8], it envisages a two-stage approach to serious multiple trauma or critical patients – emergency stabilisation is initially achieved through EF and followed with a second stage, 5–7 days later, of definitive internal osteosynthesis. The concept accords an increased risk of multiple organ dysfunction syndrome (MODS) in the first few days after severe trauma owing to general inflammatory processes and a systemic increase of pro-inflammatory cytokines [9, 10]; definitive internal stabilisation, which itself may provoke additional inflammatory reactions, where possible, should not take place until such systemic processes to trauma has been resolved [11–13]. Moreover, second-stage surgery should not exceed 3–4 h to avoid exposing patients to excessive stress and the subsequent risk of thrombo-embolism [14, 15]. Other authors have recently described the effectiveness of this method in several trials [16, 17].

We have implemented the method of damage control orthopaedics (DCO) for critical patients with ISS>20 or proven pulmonary contusions (Figs. 1–3). The advantages of converting to internal synthesis in these femoral fractures were definitive stabilisation, the possibility of active–passive joint movements, and complete and early weight-bearing and mobility, together with fewer risks of infection from the absence of pin sites. The long healing times involved in such high-energy femoral fractures often lead to difficult tolerance of EF devices, which require careful hygiene, impede complete joint movement, do not always allow immediate weight-bearing and are subject to high loads that may cause failure of the screws [18–21].

It was not possible to convert from an external fixator to internal synthesis after the recommended interval in some patients owing to contraindications of a local (exposure, wound contamination, etc.) or a general (blood problems, high ISS, surgical or neurological) nature. Replacement was therefore performed some months later following intolerance of the DAF, delayed consolidation or pseudoarthrosis. In these cases, as recommended by some reported protocols, internal synthesis was preceded by removal of the DAF, a wait period in a plaster-cast without any other kind of synthesis for 3 weeks, and MR and scintigraphy (scanning) to exclude the presence of infection. The results achieved, in terms of healing times and



Fig. 1 Case 1. **a** Post-operative X-rays of stabilisation in emergency of a 36-year-old polytraumatised man with femoral fracture and head trauma, ISS 27. **b** Secondary conversion after 7 days to internal fixation of femoral fracture. **c** X-ray check at 7 months showing healing



Fig. 2 Case 2. **a** Pre-operative X-rays of a 35-year-old polytraumatised man with bilateral femoral fracture, tibial fracture, bilateral forearm fracture and spleen rupture, ISS 42. **b** Stabilisation in emergency of femoral and tibial fractures with DAF. Secondary conversion after 6 days to internal fixation with bilateral femoral intramedullary nailing. **c** X-ray check at 7 months: bilateral healing of femoral fractures

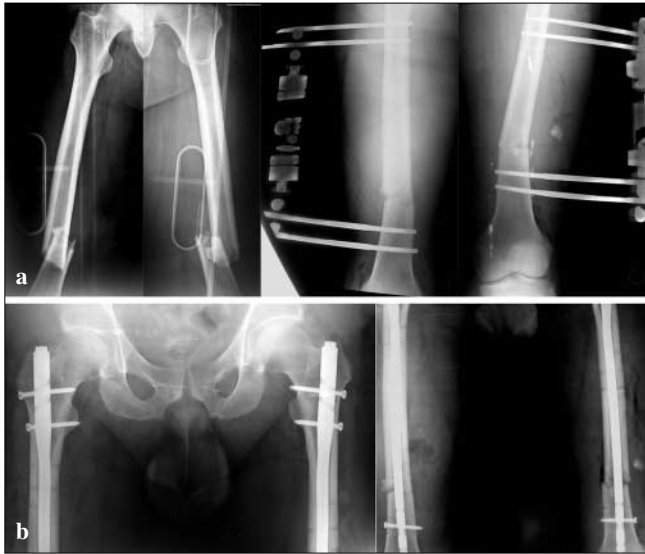


Fig. 3 Case 3. **a** Pre-operative X-rays of 46-year-old polytraumatized man with bilateral femoral fracture, head trauma, ISS 32. **b** Stabilisation in emergency of femoral fractures with DAF. Secondary conversion after 8 days to internal fixation of both femoral fractures

percentages, are in line with those published in the literature for the treatment of high-energy femoral fractures.

The study reported here has limitations; the wide variety of trauma and the presence of multiple fracture sites, at times involving joints and associated tissue loss, do not allow meaningful analysis of functional results. Even so, the absence of short-term complications such as MODS or pulmonary embolism highlights the prudence and effectiveness of this type of approach to multi-trauma patients. Some medium-long-term complications in Group A, namely infection and pseudoarthrosis, are probably not related to surgical technique or timing but the fracture characteristics (high-energy and open types). A study involving higher numbers of patients demonstrates the risk of infection increases with the interval between EF and conversion to internal fixation, and is negligible if carried out within one week of the initial trauma [22]. We conclude that initial emergency stabilisation by EF followed by conversion to internal synthesis, provided the interval is appropriate, is a reliable and effective strategy for treatment of femoral fractures in multi-trauma patients.

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