EARLY MANAGEMENT OF OPEN TIBIAL FRACTURES

Open tibial fractures are frequently complex, and inadequate or inappropriate primary management will lead to complications that are potentially devastating for the patient.

KEN BOFFARD

BSc (Hons), MB BCh, FRCS, FRCS (Edin), FRCPS (Glasg), FCS (SA), FACS

Chief Specialist and Head

Department of Surgery

Johannesburg Hospital

Professor

Department of Surgery

University of the Witwatersrand

Johannesburg

Ken Boffard is Professor and Clinical Head of the Department of Surgery at Johannesburg Hospital, University of the Witwatersrand. He was previously Head of Trauma at the Johannesburg Hospital Trauma Unit, National Chairman of the ATLS programme, and Head of the Education Subcommittee for the International Association for the Surgery of Trauma and Surgical Intensive Care.

The evaluation of any injury to a limb follows the classic process of history, examination and appropriate special investigations. The A, B, C, D, E approach of ATLS pertains throughout.

HISTORY

As with any case it is essential to try to obtain the maximum amount of information regarding the mechanism of injury, which can give a good idea of the amount of energy transferred. Fractures may be missed in the presence of other more major injuries, altered level of consciousness, etc. Specific factors leading to a high index of suspicion of tibial fractures include:

- motor vehicle crash, especially in the absence of a seat belt
- all pedestrians
- fall from a height (especially over 3 metres)
- crush injury of the lower limb
- missile injuries
- entrapment
- any indication of limb ischaemia.

EXAMINATION

A systematic examination should look for the following features:

- Skin
  - large or multiple wounds
  - extensive contamination
  - imprints or tattooing
  - crush or burst wounds
  - closed degloving (shear injury).
- Signs of compartment syndrome
  - more pain than should normally be expected (especially if the pain is resistant to *adequate* analgesia)
  - pain on passive stretching of motor groups
  - a tense, swollen limb
  - sensory disturbance of the foot.

Pitfall: A strong peripheral pulse, both clinically or on Doppler, can be present even in the presence of an established compartment syndrome.

- Signs of vascular injury
  - absence of peripheral pulses, or reduced capillary refill *after* adequate resuscitation and correction of the gross deformity.
- Signs of nerve injury
  - Abnormal sensation, especially loss of proprioception.

Pitfall: Sensation loss is always more sensitive than motor loss.

Pitfall: Always compare both sides.

A strong peripheral pulse, both clinically or on Doppler, can be present even in the presence of an established compartment syndrome.

Sensation loss is always more sensitive than motor loss.

Underestimation of energy transfer in a fracture will lead to a lack of appreciation of the extent of the tissue damage and thence to inadequate initial care.

It is a fallacy that compound (open) fractures do not cause compartment syndrome.

Betadine should be avoided, as it delays wound healing in what may already be an ischaemic area.

SPECIAL INVESTIGATIONS

- Plain radiology
  The fracture pattern often gives the truest picture of the extent of energy transfer:
  - multiple bone fragments
  - wide displacement of fragments
  - segmental (and 'butterfly') fragments
  - more than one fracture in the same limb
  - air in the tissues.

Pitfall: Underestimation of energy transfer will lead to a lack of appreciation of the extent of the tissue damage and thence to inadequate initial care.

CLASSIFICATION OF FRACTURES

Gustilo classified open fractures as follows:

- Grade I — open fracture with a skin wound less than 1 cm long, and clean.
- Grade II — open fracture with a laceration more than 1 cm long, without extensive soft-tissue damage, flaps or avulsions.
- Grade III — either an open segmental fracture, an open fracture with extensive soft-tissue damage, or a traumatic amputation. The infection rate for grade III fractures is at least 24%, which is so high that these fractures were further classified as follows:
  - Grade IIIA — adequate soft-tissue coverage of a fractured bone, despite extensive soft-tissue laceration or flaps, or high-energy trauma, irrespective of the wound.
  - Grade IIIB — extensive soft-tissue loss with periosteal stripping and bone exposure, usually associated with massive contamination.
  - Grade IIIC — open fracture associated with arterial injury, often requiring repair. (In the lower leg, where there are three arteries, loss of one or two will not generally require repair. Loss of all three generally precludes repair, and especially in the presence of complete neurological loss, mandates amputation.)

INITIAL DECISION MAKING

Once the presence of a high-energy tibial fracture has been recognised, it is extremely important that the patient be managed by medical personnel experienced in treating these covertly complex injuries. If necessary, to achieve this, the patient should be transferred to a more appropriate institution or referred to a more experienced colleague, as may also be the case with severe head or spinal injuries.

Pitfall: Failure to appreciate this has resulted in large numbers of patients developing non-union, or osteomyelitis. A specific time scale for management needs to be established:

- management of other injuries or pathologies
- time to initial surgery (especially wound toilet)
- time to and type of appropriate skeletal fixation
- time to soft-tissue reconstruction.

Pitfall: It has been shown that 19% of open tibial fractures occur in patients with multiple injury. The patient's other injuries need to be treated appropriately ('save life before limb').

COMPARTMENT SYNDROME

It is a fallacy that compound (open) fractures do not cause compartment syndrome. The four compartments surrounding the tibia are particularly susceptible and even though a compartment may be partially open, the muscle underlying intact fascia may still develop very high intracompartment pressure. Clinical suspicion must remain high. The incidence of the complication is significantly higher than is generally realised, and if the syndrome is suspected, an immediate four compartment open fasciotomy decompression must be performed.

Pitfall: Reperfusion also plays a significant role in the complications of compartment syndrome. As such, the classic clinical findings may be absent before vascular repair. Once the diagnosis has been made, urgent fasciotomy is required.

Pitfall: It must again be emphasised that a pulse, either clinically or on Doppler, may still be recordable, even though a compartment syndrome exists. The measurement of intracompartment pressure is invaluable when doubt exists about the diagnosis.

PREVENTION OF WOUND INFECTION

Routine guidelines for prophylaxis against tetanus should be adhered to. Contaminants and inoculants must be

removed from the injury at initial wound surgery. The greatest threat, however, will come from organisms in the hospital environment, often exhibiting complex antibiotic resistance. After initial management, which primarily consists of copious irrigation to wash away all surface contamination, the wound should be covered with saline-soaked gauze, and cling film. Betadine should be avoided, as it delays wound healing in what may already be an ischaemic area. The dressing should be left until surgery is performed.

The recommended guideline is pre-operative dosing with prophylactic antibiotics (as soon as possible after injury for coverage of Gram-positive organisms). Conventionally a suitable cephalosporin is recommended. For grade III fractures, additional coverage for Gram-negative organisms should be given, such as an aminoglycoside. High-dose penicillin should be added to the regimen where there is a concern for faecal clostridial contamination (especially in farm-related injuries). Antibiotics should be discontinued 24 hours after wound closure for grade I and grade II fractures. For grade III fractures, antibiotics should be continued for a *maximum* of 72 hours after the time of injury, and not more than 24 hours after soft-tissue coverage of the wound is achieved.

TIMING

All high-energy tibial fractures must be considered as surgical emergencies and initial wound surgery should be undertaken within 6 hours of injury. Outcome is improved if skeletal fixation is achieved early. Therefore fracture fixation should form part of the initial surgery. Wound coverage does not need to be achieved immediately, and waiting to confirm adequacy of wound toilet, reduction in swelling, reduced chance of compartment syndrome, and completion of definitive bony fixation increase the success of the soft-tissue reconstruction. The complication rate after microvascular reconstruction is higher if performed after 5 days; all wound cover should be achieved before this.

A proposed plan of action is the following:

- Initial wound surgery and fracture fixation must be done within 6 hours. Operative wound care should be carried out under general or regional anaesthesia as soon as the patient has been fully resuscitated. Wound care should involve thorough debridement of devascularised muscle and fascia, subcutaneous tissue, bone and all foreign material.

Pitfall: Antibiotics are an adjunct to the above, not a replacement for inadequately performed wound toilet!

The margins of the wound are extended as required, and determination of the fracture grade is made. The wound is left open under a sterile moisture-retaining dressing.

- A second-look procedure at 48 hours, with soft-tissue reconstruction if possible.
- A third look is only necessary if there is doubt as to the viability of tissue.

It needs to be remembered that with modern methods of both bony and soft-tissue reconstruction, very large wounds can be covered and bone length restored. Fear of creating a non-reconstructable defect must not deter the surgeon from removing all non-viable tissue. Inadequate debridement will lead to unnecessary complications.

DECISION TO AMPUTATE

Simply preserving length in a severely injured limb is not the aim of reconstruction. The limb must also function and be pain free. In the presence of prolonged ischaemia, crush or nerve damage, functional outcome may be poor, despite multiple procedures carried out over many months. This can be devastating to a patient. It is unkind to make a too hasty decision, and unless retention of the limb is seen as being life-threatening, salvage surgery should be performed at initial wound surgery. Discussion of the issue with the patient can then start early. Definitive amputation can take place at the second look when viability will be much clearer. Patients requiring delayed ablation have longer periods of hospital care, more surgical procedures, at greater cost, and an increased risk of mortality and morbidity from sepsis. Although this can be a very difficult decision for both surgeon and patient, an early correct decision regarding amputation is therefore very important. Various scoring systems can help but dependence on them is unwise. It is therefore important that both orthopaedic surgeons and plastic surgeons experienced in dealing with such injuries are involved early.

CONCLUSION

Open tibial fractures are frequently complex injuries and the early involvement of both orthopaedic and plastic surgeons experienced in such trauma is essential in order to avoid mismanagement. A joint plan needs to be established. Appropriate timing for management is essential, with soft-tissue reconstruction taking place at a second- or third-look procedure.

References available on request.

IN A NUTSHELL

Extremity fractures are caused by either low- or high-energy forces and may be isolated or combined with other injuries. When the underlying fracture is associated with a cutaneous wound, prevention of wound sepsis remains the primary objective in wound management.

These wounds require emergency treatment as soon as possible (within 6 hours).

Expectation of compartment syndrome, and its avoidance or treatment are critical.

Appropriate antibiotic prophylaxis is not a substitute for appropriate wound management.

With grade III fractures, multidisciplinary management is essential.