



Management of a large post-traumatic skin and bone defect using an Ilizarov frame

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The authors report the case of a 28-year old male who presented with a compound diaphyseal fracture of the tibia, which was treated with intramedullary nailing. Postoperatively he required an extensive fasciotomy for an acute compartment syndrome. The fracture evolved towards post-traumatic osteomyelitis, growing methicillin-resistant *Staphylococcus aureus* (MRSA), combined with a large overlying soft tissue gap.

An Ilizarov frame was used to treat both the bone and the skin defect. The infected fracture was treated by resection and longitudinal bone transport. Meanwhile, the skin was gradually closed using extra rods on the frame, allowing for a transverse 'skin transport'. Both the bone and the soft tissues healed without further complications.

Keywords : Ilizarov ; fasciotomy ; soft tissue defect ; bone transport ; skin transport.

partment syndrome necessitating extended fasciotomy to relieve all compartments of the lower leg may turn a simple fracture into a complex problem with major soft-tissue damage (9). Soft-tissue defects often cannot be closed "per primam". They often require some form of coverage, for which different types of rotation or free microvascular flaps have been described (4, 5, 14). These flaps usually result in good coverage of the defect, but have the disadvantage of donor-site morbidity.

Another possibility, in cases where the size of the skin defect is similar to that of the underlying bone defect, is progressive closure during a bone transport, when this method is chosen to re-establish the continuity of the bone (2). If however the soft-tissue gap is far more extended than the underlying bone defect, this method is insufficient ; we present another possibility for progressive closure of a large soft-tissue defect while treating the

INTRODUCTION

High-energy fractures often present as a combined soft tissue and bony problem, either as a result of the injury or following fasciotomy, or as a result of wound healing problems after surgical treatment.

The lower leg is frequently affected in high-energy trauma. High-energy tibial fractures often present with a soft-tissue defect, owing to the subcutaneous situation of the tibia. Even closed fractures may result in soft-tissue problems. A com-

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underlying bony problem, using an Ilizarov frame and gradual transverse skin traction. Few reports in the English literature have mentioned this method of secondary wound closure (6, 13), usually not in combination with bone transport, and often not as gradual as in the case reported here.

CASE REPORT

A 28-year-old male patient was injured in a soccer accident in October 2004. He was admitted to a local hospital, where a closed mid-diaphyseal fracture of his left tibia was treated with intramedullary nailing after reaming.

On the first postoperative day, he developed an acute compartment syndrome which required extended fasciotomy of all four compartments of the lower leg through an antero-lateral approach. The skin was initially left open. Despite the fasciotomy, he developed a complete deep peroneal nerve palsy, resulting in a drop foot.

During further follow-up, the fracture evolved towards non-union and osteomyelitis, with a large overlying skin defect. Wound cultures grew methicillin-resistant *Staphylococcus aureus* (MRSA), which was treated with Vancomycin intravenously.

Two months later, he was referred to our department, and presented with a mid-diaphyseal tibial fracture and a large overlying skin defect, approximately 100 cm² (17 × 6 cm) at the antero-lateral aspect of the lower leg (figs 1, 2 and 3).

The nail was removed, and the infected bone segment was resected, resulting in a 10-cm long bone defect in the mid-diaphyseal region. An Ilizarov frame was placed to stabilise the leg. Along the two edges of the soft-tissue defect, loops of Ticron N° 5 sutures were attached in a diverging manner, and were tied to an extra rod on the frame, parallel to the long edges of the wound on both sides. The rods were then gradually pulled away from the wound edges, and the skin defect was thus gradually closed, taking advantage of the elasticity and growth of the healthy surrounding skin (fig 4).

Postoperatively, the “skin transport” was started at a rate of 4 times 0.25 mm per day on each side, thus pulling the edges of the wound closer to each other by 2 mm a day. After four weeks of “skin



Fig. 1. — Initial tibial fracture, AO type 42.A3

transport”, the soft tissue defect was completely covered with viable skin, and a secondary closure could be performed (fig 5).

Six weeks after secondary closure of the wound, a proximal osteotomy of the tibia was performed, and the bone transport procedure was initiated to fill the bone defect (2) (fig 6). This procedure was uneventful and, after five months, the docking site was debrided of scar tissue to promote healing. Another four months later, the circular frame was reduced to a unilateral fixator. Both the distraction zone and the docking site healed without further problems (fig 7).

There was no wound problem whatsoever during the entire treatment (fig 8). The peroneal palsy however remained unchanged.



Fig. 2. — Clinical picture on admission, showing a central zone of necrosis covering the infected tibia.



Fig. 3. — Clinical picture of the 'skin transport' construction on the Ilizarov frame.

DISCUSSION

The use of the Ilizarov frame for bone transport in bone defects due to trauma, non-union or osteomyelitis is well documented (2, 10, 11). High-energy trauma to the lower leg is however often associated with large soft-tissue defects. Besides, these fractures are sometimes complicated by an acute compartment syndrome, requiring fasciotomy (9). These fasciotomy procedures generally result in a large skin defect that needs some form of coverage.

A widely accepted procedure for such cases is the use of pedicled or free microvascular flaps (4, 5, 14). However, these are complex procedures, requiring specific surgical training and a good vascular supply to the affected limb. Moreover, in the presence of external fixation material, such as an Ilizarov frame, surgical access to the limb is limited. Also, these procedures result in a significant amount of donor-site morbidity, are characterised by long healing times and sometimes require secondary procedures, such as debulking (7).

Another method for closing such a large skin defect is based on crossed vessel-loops, stapled like a shoelace across the wound (1). This technique, however, gives less predictable results, and traction on the skin is not well controlled.

Natural healthy skin is able to regenerate under tension. This is well known under physiologic

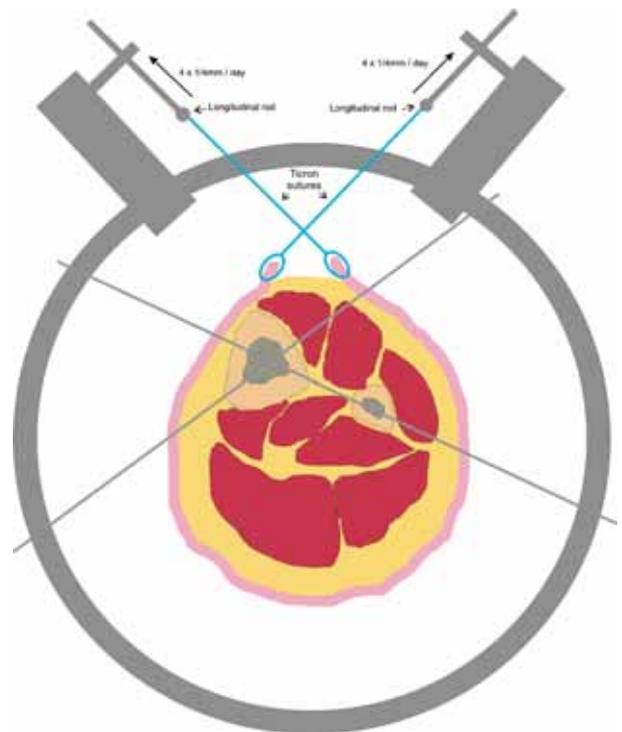


Fig. 4. — Schematic drawing of the 'skin transport'

circumstances such as obesity and pregnancy. In the field of plastic surgery, the use of skin expansion is well known since the use of subcutaneous expansion balloons (8). The use of skin expansion



Fig. 5. — The soft tissue defect completely covered after secondary closure.

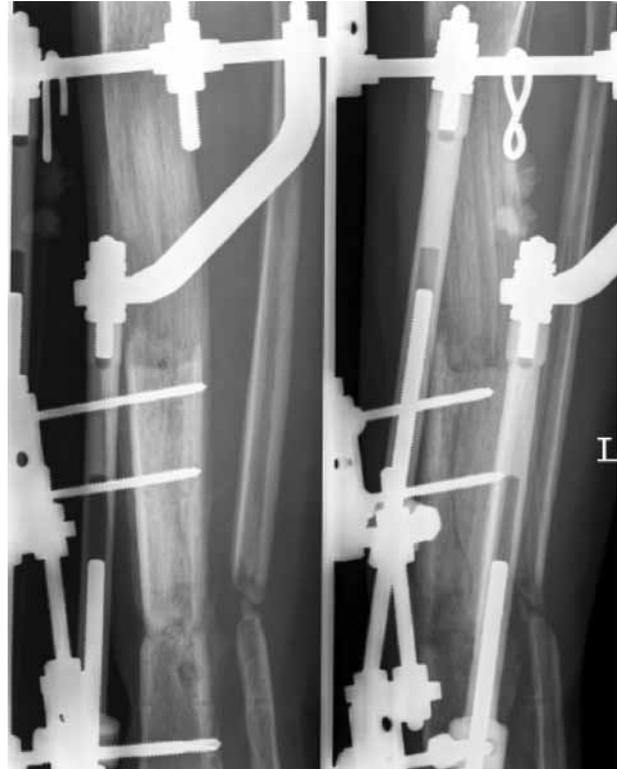


Fig. 7. — Radiological image of the healed docking site after completion of bone transport.

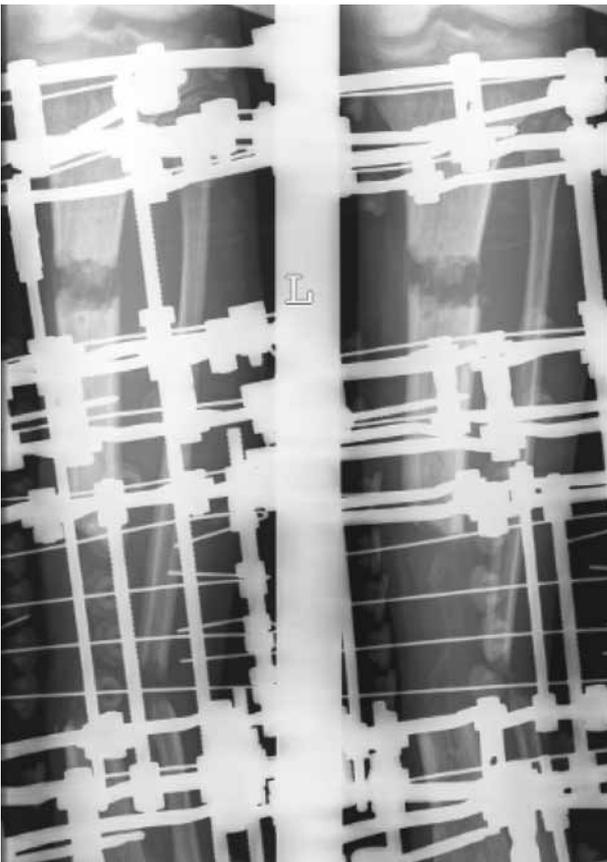


Fig. 6. — Radiological image of the bone transport procedure. The transverse Kirschner wires across the defect are used as a suspension to prevent soft tissue impingement in the bony defect.



Fig. 8. — Final clinical aspect of the closed wound

in the field of orthopaedic surgery is less well studied (6, 13), although longitudinal skin growth is a well know phenomenon in bone lengthening or bone transport (3).

We present the use of the Ilizarov frame as a tool to gradually expand the surrounding skin in a transverse direction. In this patient, the 100 cm² skin defect was successfully covered after four weeks of gradual 'skin transport', thus obviating the need for flap surgery and avoiding the associated donor-site morbidity. It is also a cosmetically acceptable alternative, avoiding disfiguring bulky scars.

This technique of gradual skin closure offers a good treatment option for soft tissue defects, when the Ilizarov method has been chosen to treat the bone and when flap surgery is less indicated because of difficult access to the limb or poor vascular status of the receptor area.

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