

TRAUMATIC FEMORAL BONE LOSS

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Bone is lost from fractures when swiftly moving objects plough through tissues to lacerate skin, comminute bone and carry osseous fragments with them. In war time high velocity missiles commonly produce such loss; in civil life projections from road vehicles in motion are more likely causes. Any bone may be involved, but the tibia is especially vulnerable. Extruded fragments vary from minute flakes to large pieces, including the full width of a long bone. However, it is exceptional for several inches of bone to be lost and for the exit wound to be smaller than the extruded bone. It is also unusual for the loss to be extensive enough to need operative replacement. For these reasons the following case is reported.

CASE REPORT

A man of twenty riding a motor-cycle collided with a car in April 1962, cutting his face and injuring his left thigh and right wrist. Radiographic examination at Yeovil General Hospital demonstrated displaced fractures of the lower right radius and ulna and an unusual comminuted fracture of the lower part of the left femur. A four-inch transverse wound over the patella was the only skin injury of the left leg. This wound and the cuts were sutured, the forearm fractures were manipulated and plaster-of-Paris applied, and the femur was splinted. The following day he was transferred to the Royal United Hospital, Bath, for management of his "completely disintegrated lower left femoral shaft."

After transfer he was in good general condition, the left thigh was moderately swollen and the circulation and nerve supply of the limb were intact. The accompanying radiographs showed bone loss of uncertain extent. Under general anaesthesia skeletal traction was applied through the upper tibia while new radiographs were taken. These showed absence of approximately nine inches of the shaft above intact femoral condyles and a transverse fracture of the patella (Fig. 1). The patient was returned to the ward with the limb in a Thomas's splint and ten pounds traction was applied. Enquiries were made to trace the lost bone.

The lost bone—The initial suggestion was that the bone had been pulverised and the pieces lost through the patellar wound. However, no one had seen bone fragments in or near the wound, and further reflection suggested extrusion of the bone on impact and its possible impalement in the car. The police were asked to inspect the vehicle and to search the accident area for a broken bone about nine inches long and one inch in diameter. A police dog quickly discovered the bone in a hedge some twenty-four hours after the accident. It was ten inches long and extremely dirty (Fig. 2). The line of section through the cancellous condylar region was remarkably straight; at the upper end the cortical defect corresponded with the comminuted shaft fragment seen in the earlier radiographs. No muscular or ligamentous attachments were seen, but periosteal tags, particularly on the supracondylar lines, and some articular cartilage remained in place. The rest of the periosteum had been stripped off. After cleaning and boiling, the bone was cultured for bacteria. No organisms were found and it was decided to replace the specimen in the thigh once the knee wound had healed. Immediately before the operation the bone was sterilised in an autoclave.

Operation—Through an antero-lateral incision twelve days after injury a comminuted transverse fracture of the patella and an intact bridge of femoral condylar bone attached to the tibia by normal cruciate and collateral ligaments were found. Above this, the missing bone was



FIG. 1



FIG. 2

FIGS. 1 AND 2

Figure 1—Antero-posterior and lateral radiographs taken after traction was applied, confirming massive bone loss.
 Figure 2—The lost bone after cleaning.

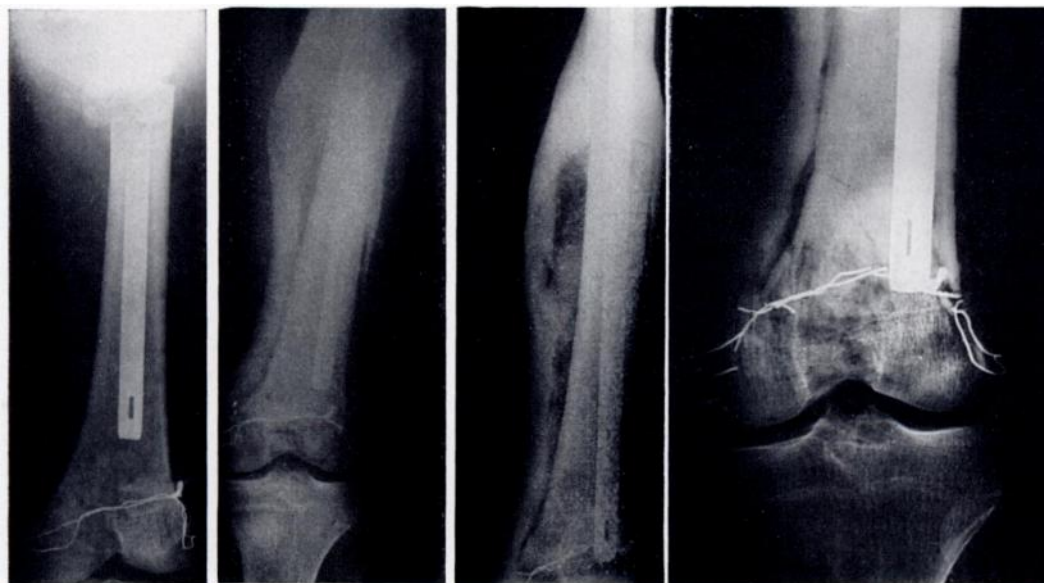


FIG. 3

FIG. 4

FIG. 5

Figure 3—Radiograph after operation. Figure 4—Antero-posterior radiograph six months after injury.
 Figure 5—Two years after injury.

replaced by organising haematoma. Thickened periosteum, deficient anteriorly, maintained continuity between the condylar bone and the proximal femoral shaft.

The patella was excised and an intramedullary nail was driven the length of the proximal femur to project below. The extruded bone was then threaded over the nail: half an inch (1.2 centimetres) was removed to permit reduction at the lower end. The condylar fragment was too shallow to afford sound fixation to the replaced bone and it was hoped that wiring would maintain reduction long enough for callus to form (Fig. 3). As the periosteal tube was deficient anteriorly, bone chips from the patellar fragments were put alongside the inert specimen which was also drilled to encourage reossification. After closure of the wound the leg was placed on a Thomas's splint with seven pounds skin traction. Antibiotics were given before and after the operation for a total of ten days.

Progress—A moderate pyrexia settled within a few days and the wound healed by first intention. Twenty-three days after injury radiographic evidence of callus was present. After six weeks, active knee flexion in an articulated Thomas's splint was begun. New bone enveloping the insert continued to increase in amount and partial weight bearing in a caliper was begun two months after operation. Less than eleven weeks from injury he returned home and continued knee mobilisation as an out-patient. Three months later active knee movement was only 20 degrees. There was a strong bridge of bone disposed as an involucrum around the insert (Fig. 4) and the caliper was discarded. Nine months after injury the range of flexion was 55 degrees with 20 degrees of extensor lag. At a year the range was 70 degrees and the extensor lag persisted. He then returned to his former work.

Two years after this strange accident he suffered intermittent discomfort near the knee but he could walk and run with a barely detectable limp. He was employed as a full-time electrician. Active knee movement was 105 degrees and the extensor lag had decreased to 5 degrees. The thigh was thickened and there was half an inch of shortening. Radiographs showed a massive bony involucrum surrounding the insert which remained distinct from it except at the lower end (Fig. 5). Stress cracks were present in the lower part of the insert. The intramedullary nail had migrated downwards a short distance, but it was decided to leave it until reossification of the replaced bone was more advanced.

DISCUSSION

Initially the bone loss was not diagnosed, for clinical examination failed to reveal it and the first radiographs were equivocal. Until the police dog recovered the missing femoral shaft and it was demonstrated that it was a single piece ten inches in length, the diagnosis and the mechanism of loss remained obscure.

The mechanism of injury—Witnesses of the accident were uncertain of the details. The car was almost stationary and the motor-cycle moving moderately fast on impact. Damage to the car was widespread and included a crushed off-side wing and headlight, a buckled radiator grille and bumper bar, a broken windscreen and a dented roof and rear body-work. Damage to the motor-cycle confirmed a frontal collision. This and the final disposition of vehicles suggested that the motor-cycle struck the car head-on near the off-side headlight and then veered obliquely, presenting the victim's left knee to the car before his momentum threw him up and forward on to the roof, from which he bounced off and fell in the roadway behind the car. The dimensions of the average car and motor-cycle are such that the car bumper bar is level with the motor-cyclist's shin and the headlights or upper grille with the motor-cyclist's knee. Close questioning of victims in head-on collisions indicates that the bumper bar causes many tibial fractures and the headlight or grille many knee lacerations and patellar fractures. Knee impact is often transferred to the femur, causing shaft fracture, hip dislocation and occasionally femoral neck or femoral condylar fracture. In any single accident one or more of these injuries may result.

This unusual injury is thought to have followed a glancing impact between the knee and the car, resulting in transverse division of the skin and the patella against an edge which also sheared through the femoral condyles in the same plane (Figs. 6 and 7). The edge was probably the headlight bezel or the grille surround which, on the car in question, were acutely angled. Skidding up the linea aspera the edge stripped off periosteum and muscle while the tibia, patella and femoral condyles were pushed back by the headlight or grille, forcing the bared femoral shaft out of the wound between the patellar fragments and telescoping the thigh (Fig. 8). Eventually further deformity was impossible and the femur snapped as the victim's

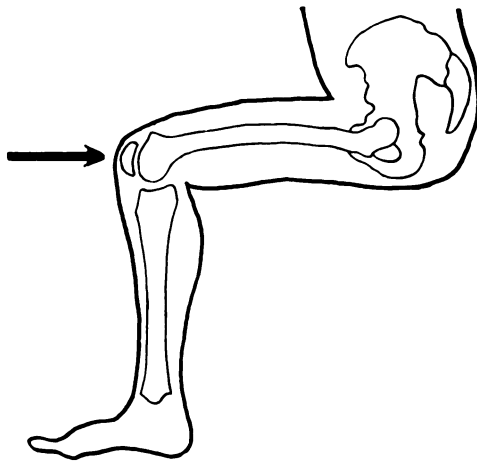


FIG. 6

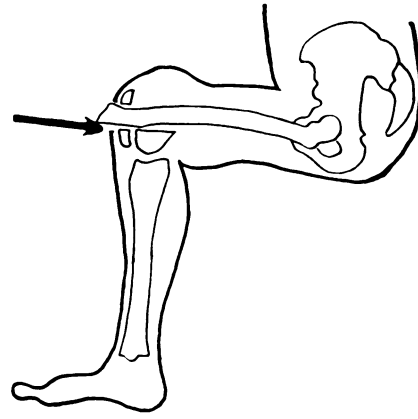


FIG. 7

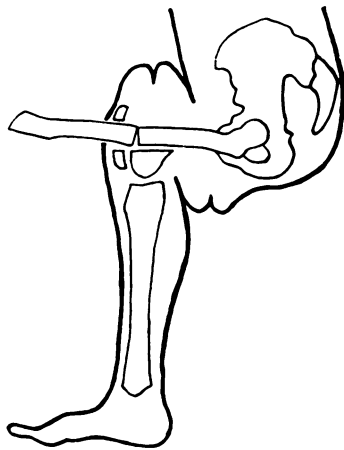


FIG. 8

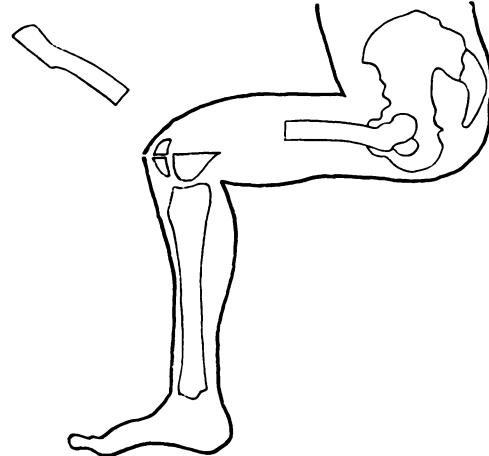


FIG. 9

Diagrams illustrating the probable sequence of events leading to extrusion of the lower femoral shaft.

body came upwards over the bonnet. The windscreen was shattered by a flailing foot, although it is possible that the knee and femoral injuries resulted from collision with the windscreen glass. The victim fell on the roof and then the roadway, injuring his face and wrist, while the extruded bone was projected elsewhere (Fig. 9).

Management of bone loss—Recovery of the missing bone posed the question of replacing or discarding it. In the circumstances of this accident it was difficult to imagine bone extrusion unless the periosteum and musculature had been peeled off. Examination of the fragment

showed almost complete absence of periosteum, indicating its retention in the thigh. Strange (1963) reported recovery after traction when a full-diameter, three-inch length of femoral shaft was missing, and he believed that "given a periosteal tube, loss of bone does not necessarily infer non-union." He also stated (1964) that "healthy periosteum will replace bone throughout its length in the same way that a scar heals, irrespective of its length." Therefore simple traction for long enough might have been sufficient to replace the ten-inch gap but this was not certain. Even if eventual osseous bridging followed, it was felt that union sound enough to allow early mobilisation of the damaged knee was unlikely. Consideration was thus given to methods leading to early stability and, if possible, early movement.

The small size of the condylar fragment made fixation difficult and at one stage primary arthrodesis of the knee, using a long intramedullary nail from the upper femur to mid-tibia, was considered. This would have meant excising the condylar fragment as well as the tibial table, leaving the question of fusion in doubt. Massive fresh autogenous grafting and traction would probably have produced sound union but would have delayed early movement. Prosthetic replacement was a possibility, but the problem of distal fixation meant the insertion of a knee hinge as well or fixation in the tibia and no movement.

The best replacement was the ejected bone. When the cruciate ligaments, menisci and articular cartilage of the retained condyles were seen undamaged at operation, then preservation of knee movement became obligatory. The only technical difficulty was reducing and stabilising the lower end. This required some shortening and wiring the condyles as a short-term measure. Fortunately, no displacement occurred and the nail and insert were soon buttressed by periosteal bone formation, allowing knee mobilisation six weeks after injury. Two years later the replaced bone appeared radiologically inert, except at the cancellous lower end, and its ultimate fate remains a matter for speculation.

SUMMARY

1. A motor-cyclist's temporary loss of ten inches (25 centimetres) of femoral shaft and its replacement are recorded.
2. The mechanism of injury is considered.
3. The management of extensive bone loss is discussed.
4. Attention is drawn to the importance of retained periosteum and its contribution to healing in such injuries.

The late Mr John Bastow kindly permitted and encouraged the publication of this case.

REFERENCES

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