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AOI OSTEOSYNTHESIS OF FRACTURES OF THE DISTAL THIRD OF THE FEMUR

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Fractures of the distal third of the femur comprise about 10-15 per cent of all fractures of the femoral shaft. They may be classified, according to the site of the lesion, as metaphyseal, supracondylar, and condylar fractures, or as conjoined fractures of both the metaphyseal and condylar regions (Stewart et al. 1966). Common treatment problems comprise restoration of the distal articular joint surface, adequate fracture retention, and avoidance of subsequent stiffness of the knee joint due to fibrosis in the suprapatellar region.

The good osteogenic properties in the cancellous bone and the ample blood supply in the distal third of the femur usually allow rapid consolidation of the bone fragments. In fractures of slight to moderate severity, union is usually achieved in 5 to 8 weeks (Charnley 1963, Neer et al. 1967). Hence, most authors recommend non-operative treatment in these cases (Watson-Jones 1955, Fisk 1962, Charnley 1963, Neer et al. 1967).

There remain, however, the severe fractures of the distal third of the femur. These are usually sustained in traffic accidents by axial impact against unyielding structures, either in car accidents by dashboard injuries (Buttner & Friedhoff 1959, Ritchey & Schonholtz 1958), or in motorcycle accidents by a severe blow against the flexed knee (Vollmar & Benz 1960). These fractures are frequently compound and often extend into the knee joint. Several operative procedures have been advocated: medullary pins (Rush & Gelbke 1957), blade-plate fixation (Altenberg & Shorkey 1949), plates and screws, and combinations of these. The results have been discouraging, owing both to inadequacies of the metallic implants and to inexact indications for surgical intervention. Thus Neer & coworkers (1967), in a review of 110 supracondylar fractures, state that no category of fractures is well suited

for internal fixation and that satisfactory results can only be obtained in 52 per cent of operated cases.

Recent development of straight and angled heavy AOI compression plates by Müller et al. (1965) has provided better facilities for stable internal fixation of these fractures (Anderson 1965). Both Neff (1966) and Olerud (1966), reporting small series treated by this method, claim encouraging primary results. The superiority of the compression method is still unconfirmed, however, (Wade 1970) and further reports therefore seem justified.

MATERIAL AND METHODS

The series comprises 21 fractures of the lower third of the femur in 20 patients treated by the AOI technique at the Department of Orthopaedics and Traumatology, University Central Hospital, Helsinki, during the years 1966–1968.

There were 12 male and 8 female patients, their ages ranging from 17 to 70 years, with a mean of 37 years.

Type of accident. The fracture was sustained in traffic accidents in 13 cases, in high-energy industrial accidents in 4 cases, and in low-energy domestic accidents in 3 cases. Since high-velocity impacts predominated, many of the patients sustained multiple injuries: one out of two patients had severe injuries in other gross body areas.

Types of fractures, as delineated from the radiographs, have been compiled in Figure 1. Nine fractures were comminuted, and 5 of these extended into the knee joint. In this series the conjoined metaphyseal and condylar fractures were all compound, an injury typically encountered in motorcyclists. The commonest fracture was the metaphyseal transverse or short oblique fracture (13 cases).

Indications for operative treatment were as follows: (1) intra-articular bursting fracture of the metaphyseal and condylar region, with poor alignment of the joint surfaces (5 cases), (2) severe comminution or severe displacement of metaphyseal fracture (9 cases), and (3) multiple injuries to other gross body areas complicating nursing in balanced traction (6 cases).

Fractures with slight displacement and no comminution were treated non-operatively in balanced traction (19 cases during the same period). Thus, the operatively treated series included no spiral fractures of the type encountered in elderly women after slipping or stumbling. An attempt to compile a control series failed because of discrepancies in severity between operatively and non-operatively treated fractures.

	METAPHYSEAL FRACTURES		CONJOINED METAPHYSEAL AND CONDYLAR FRACTURES
			
NUMBER OF FRACTURES	13	3	5
COMPOUND FRACTURES	0	0	5
MULTIPLE INJURIES TO OTHER GROSS BODY AREAS	4	2	4

Figure 1. Type of fracture and incidence of multiple injuries in 20 patients with 21 fractures of the distal third of the femur, treated by AOI osteosynthesis. Note the preponderance of severe injuries in the group with intra-articular fractures.

Osteosynthesis was performed on the day of admission in 3 cases because of extensive soft tissue lesions in the knee region. In the other cases, primary treatment consisted of balanced traction until the tissue swelling around the fracture had subsided. Osteosynthesis was undertaken on the 9th day, on average, after the accident.

The operative technique was that advocated by Müller et al. (1965), involving a posterolateral incision and fixation of the fragments with the AOI armamentarium. In fractures through the condylar region, the incision was extended down to the tibial tubercle. This ample exposure proved advantageous for reconstruction of the joint surface and for adequate repair of the damaged suprapatellar pouch.

Single or double straight compression plates were used in 15 fractures and an L-compression plate in 6 fractures. No plaster immobilisation was used postoperatively, except in cases with extensive soft tissue injury or concomitant injuries to the same limb.

Postoperative physiotherapy was started early and intensified when wound healing was completed. The patients were allowed out of bed on the 4th to 7th day postoperatively and encouraged to move around on crutches. Training was continued for several months after hospital treatment under the supervision of a physiotherapist. Light weight-bearing (10–15 kg) was included early in the programme, whereas full weight-bearing was postponed for several months.

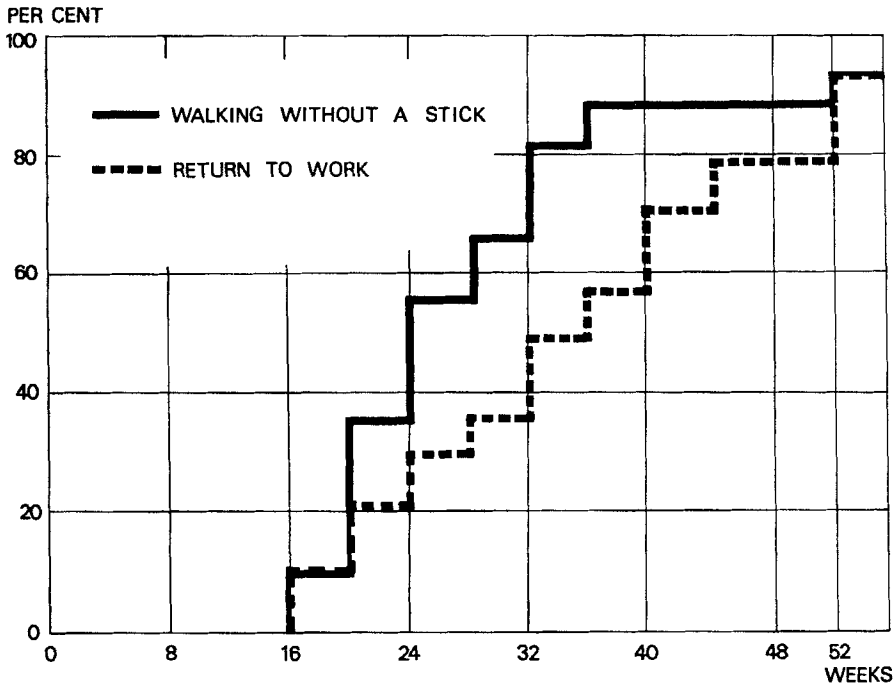


Figure 2. Time interval between operation and ability to walk without a stick, and return to work after AOI osteosynthesis of fractures of the distal third of the femur. Walking ability and return to work are expressed in cumulative percentages.

All cases were followed until the end of treatment. In addition, the patients were summoned to a follow-up examination one year or more after the operation. Of the 20 patients, 1 had died of a concomitant head injury, 2 of other diseases and 1 did not attend the examination. An end-result was thus obtained in 16 out of 17 patients alive.

RESULTS

Internal fixation rendered the fractures stable in all cases. Clinical and radiographic appraisal of fracture union was therefore inconclusive and healing had to be assessed by functional results. The following criteria were chosen for further analysis: (1) the range of movement of the knee joint, (2) the time interval between operation and ability to walk without a stick, and (3) the time interval between operation and return to work.

Range of movement of the knee joint. At follow-up examination, the range of movement was evaluated as good, with full extension and

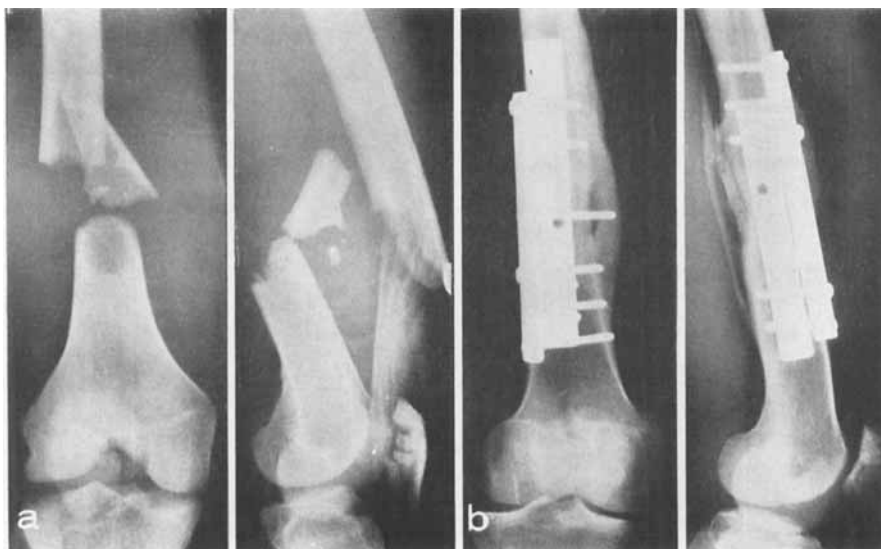


Figure 3. Comminuted, closed metaphyseal fracture of the femur, with additional fracture of the patella (a). AOI osteosynthesis with double plates resulted in functional (and radiological) union within 20 weeks. At follow-up, full extension and flexion of the knee, undisturbed walking, but occasional pain from post-traumatic osteoarthritis of the patellofemoral joint (b).

flexion not limited by more than 10 degrees, in 9 out of 16 patients.¹⁾ Five of these patients considered their knees normal; the rest had occasional pain in the joint region after strenuous effort (cf. Figure 3). One patient was unable to bend his knee to 90 degrees (range 0–80 degrees) owing to osteitis and delayed union of the fracture.

Avoidance of postoperative immobilisation and early joint exercises resulted in rapid improvement in the knee joint movements, although considerable stiffness was invariably observed in the initial postoperative stage. Thus, all patients had poor knee joint mobility for 4 weeks after the operation. After this, the range of movement increased rapidly, reaching fair readings within 20 weeks in all but two patients. In four cases, normal knee movement was recorded within 16 weeks.

Experiences with these cases indicate that the importance of early

¹⁾ The evaluation of residual joint stiffness closely followed the criteria proposed by Nicoll (1964):

Good = Full extension, flexion not limited by more than 10 degrees.

Fair = Any loss of extension or loss of more than 10 degrees of flexion.

Poor = Inability to flex the knee to 90 degrees.

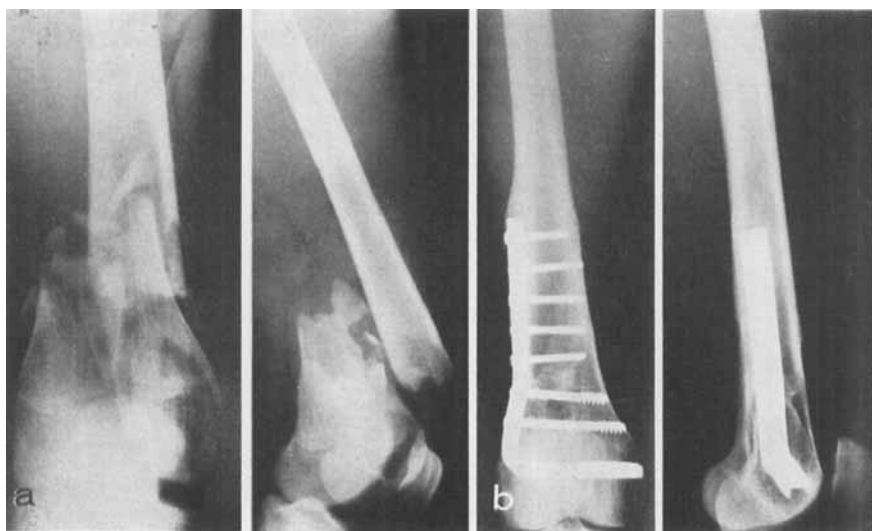


Figure 4. Comminuted, compound, intra-articular fracture of the condylar region (a) treated with an L-shaped compression plate. Twelve weeks after the operation ability to walk without a stick and a further eight weeks later ability to ski. At follow-up, normal function of the knee (b).

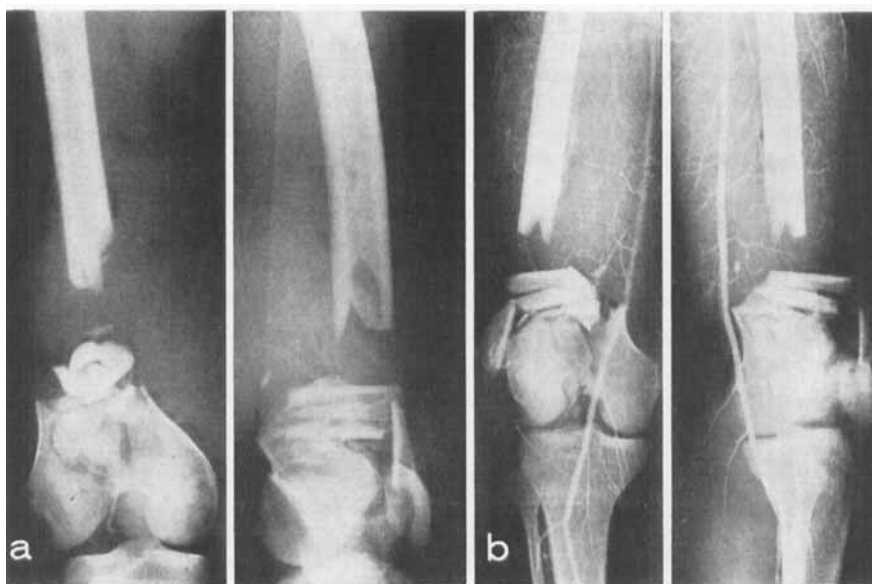


Figure 5. Comminuted, compound conjoined fracture of the metaphyseal and condylar regions of the right femur, sustained in a motor-cycle accident (a). On admission, no peripheral pulses could be traced, but arteriography revealed preserved continuity of the femoral artery (b).



Figure 5 (continued). The fracture was stabilized with an L-shaped plate, the femur deliberately shortened 4 cm, and the bone defect filled with bone chips (c). Ten months after the accident a compensatory subtrochanteric shortening osteotomy of the left femur was performed and a further 22 months later the plate was removed from the right femur. At follow-up, three years after the accident, ability to walk without a stick, without noticeable limping (d). The knee was free from pain, with a fair range of movement (0–90 degrees). Progressive post-traumatic arthritis is to be expected.

muscular exercise should not be overestimated: the final result was far more dependent on accurate realignment of the fragments and accurate reconstruction of the concomitant soft tissue injury.

Walking ability. Three patients were excluded from the results compiled in Figure 2.²) Of the remaining 13 patients, 11 were able to walk without a stick within 12 months after the operation. One patient, unable to walk without a supporting cane, was still under treat-

² The omitted cases were: One patient with comminuted acetabular fracture, 1 patient with congenital luxation of the hip, and 1 patient with bilateral degenerative osteoarthritis of the hip. But the diagram does include the following patients with concomitant injuries to the lower limbs: 2 cases with fracture of the tibia, 1 case with operatively treated total luxation of the contralateral knee joint, 1 patient with non-operatively treated ligamentous rupture of the contralateral knee joint and 1 patient with bimalleolar fracture.

ment (Figure 5) and the other was suffering from delayed union following osteitis.

Squatting was normal in 7 patients and moderately restricted in 4.

Walking ability was achieved to a similar extent in both metaphyseal and condylar fractures. The majority of cases were able to walk without a stick within 6 months. Stability of the fracture area, absence of pain, and rapid improvement in the range of knee movement undoubtedly contributed to the early recovery seen in many cases.

Return to work (Figure 2). All but two patients had resumed work within one year after the operation. The mean time of sick leave was 37 weeks, and in cases without concomitant injuries 27 weeks.

Complications. There was one case with osteitis following osteosynthesis of a closed fracture in the metaphysis.

A 51 year-old male pedestrian was hit by a car and sustained fractures of the left femur and left lower leg in addition to brain concussion. The femoral fracture was treated with double straight plates and the patient made an uneventful recovery. Six months later signs of infection appeared and a fresh discharging sinus opened in the lower third of the thigh. Irrigation and subsequent removal of the metallic implant were followed by closure of the sinus. The fracture eventually united.

No failure of the metallic implants or loosening of the material used in the osteosynthesis occurred. In one case, a new traffic accident caused bending of double straight plates implanted three months previously. New plates were installed and the fracture united uneventfully.

All fractures united.

DISCUSSION

Conservative treatment is commonly accepted for distal femoral fractures. In the series of Stewart et al. (1966), comprising 422 fractures, the result in 144 patients treated by closed methods and followed for one year or longer was excellent or good in 67 per cent and poor in 33 per cent. The results of operative treatment have been impaired by a high rate of complications: Neer et al. (1967) reported postoperative osteitis in 40 per cent and Stewart et al. (1966) delayed union or non-union in one patient out of three.

Perusal of current reports reveals that in the conservatively treated series the poor results are predominantly due to the fractures with gross comminution and derangement of the articular joint surfaces.

Here, prolonged immobilisation gives rise to residual joint stiffness, and poor alignment of the fragments causes post-traumatic arthritis. In severe fractures, therefore, operative treatment is indicated.

It emerges from the present series that operative treatment affords good results in the majority of cases, provided that stable osteosynthesis is achieved. The internal fixation obtained with the AOI armamentarium was in all cases remarkably stable and proved reliable, even in cases with gross comminution of the fracture. The most gratifying results were, in fact, obtained in the severe fractures, where treatment with closed methods would have been protracted, and few, if any, alternative methods of internal fixation were available.

Notwithstanding, the dangers inherent in the AOI technique of internal fixation should not be forgotten. The technique is difficult and requires a surgical team well trained in this type of surgery. The extensive exposure and the sometimes several-hour procedure increase the risk of postoperative infections. Evidently, fractures of slight to moderate severity are still best treated by non-operative methods. Until further reports have emerged, AOI osteosynthesis of fractures of the distal third of the femur should be confined to severe fractures, complicated by gross comminution, derangement of the condylar area and extensive soft tissue injury, and for patients with multiple injuries, where the plan of treatment as a whole demands internal fixation in order to facilitate appropriate nursing of the patient.

SUMMARY

The results after internal fixation with straight or angled AOI compression plates have been analysed in 20 patients with 21 fractures of the distal third of the femur. The fracture was compound in 5 cases and comminuted in 8. The most frequent causes were traffic accidents and similar high-energy impacts; severe injuries to other gross body areas were encountered in one out of two patients.

Sixteen of the seventeen patients still alive attended a follow-up examination one year or more after the operation. The range of knee movement was good in 9 patients, fair in 5 patients, and poor in 1. When biassing injuries were excluded, all but 2 patients were able to walk without a stick within 12 months postoperatively, most of these within 6 months. All but 2 patients had resumed work within one year after the operation.

There was one failure due to postoperative osteitis.

No failures resulted from the metallic implants or loosening of the material used in the osteosynthesis.

All fractures united.

It is concluded that AOI osteosynthesis affords reliable internal fixation of fractures of the distal third of the femur. Its use should be restricted to fractures of considerable severity and to selected cases among patients with multiple injuries.

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