Operative fixation of fractures in children

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Summary

A total of 39 fractures of the diaphyses of long bones in 31 children were subjected to operative fixation. Indications for surgery included concomitant severe head injury, multiple injuries, patients nearing skeletal maturity, inability to obtain a satisfactory reduction by conservative means, severe soft-tissue injury with or without vascular trauma, long-standing neurological disorder with incapacity and contractures, mal-union, and delayed union. Although long-bone diaphyseal fractures in children are generally managed non-operatively, the use of fixation may be indicated in certain cases.

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Operative fixation of fractures in children lacks traditional support, yet many surgeons accept limited indications, generally in relation to fractures around major joints. A series of fractures in long bones of children managed by metal fixation for specific indications is reported in order to determine if this management can be regarded as acceptable in certain cases.

Patients and methods

A total of 31 skeletally-immature patients with long bone diaphyseal fractures were managed by operative fixation at Addington Hospital, Durban, during the years 1986 - 1989. There were 21 boys and 10 girls aged 5 - 17 years (average 10,3 years) at injury. They were followed up for 12 - 40 months (average 19,55 months). The causes of injury are listed in Table I.

TABLE I. CAUSE OF INJURY

Mechanism of injury	No. of patients
Motor vehicle accident	**11**
Pedestrian struck by car	**9**
Fall from height	**9**
Electrical machinery	**1**
Unknown	**1**

Patients were assessed according to: mechanism of injury; orthopaedic injuries; other relevant clinical conditions; associated injuries; reason for fixation; delay before definitive surgery; time to mobilisation; length of hospital stay; complications; time to fracture union; limb function at follow-up; limb length at follow-up; and further surgery required (e.g. removal of metal).

Results

A total of 46 fractures were sustained (radius and ulna, and tibia and fibula counted as 1 fracture each), 39 of which were subjected to rigid fixation. Indications for fixation are summarised in Table II. As might be expected, there was more than one indication in 8 patients, most notably concomitant head injury and multiple fractures. The fractures fixed and the methods used for fixation are summarised in Table III.

TABLE II. INDICATIONS FOR FIXATION

Indication		No. of patients
Multiple orthopaedic injuries		**13**
Head Injury		**7**
Difficulty maintaining reduction in patients nearing skeletal maturity		**6**
Open fractures		
Grade I	**4 fractures**	**6**
Grade II	**2 fractures**	
Grade III (with vascular injury)	**2 fractures**	
Significant abdominal injury		**2**
Severe fractured ribs		**1**
Delayed union		
Tibia		**1**
Radius		**1**
Mal-union of humerus		**1**
Spastic cerebral palsy		**1**

Some patients had more than one indication.

TABLE III. FRACTURES FIXED AND METHODS OF FIXATION

Femur	
Large fragment plates	**9**
Closed AO nails	**10**
Open 'K' nails	**2**
Tibia	
Large fragment plates	**1**
External fixators	**4**
Closed AO nails	**1**
Humerus	
Plate	**1**
Rush rod	**1**
Radius and ulna	
Small fragment plates	**5**
External fixator	**1**

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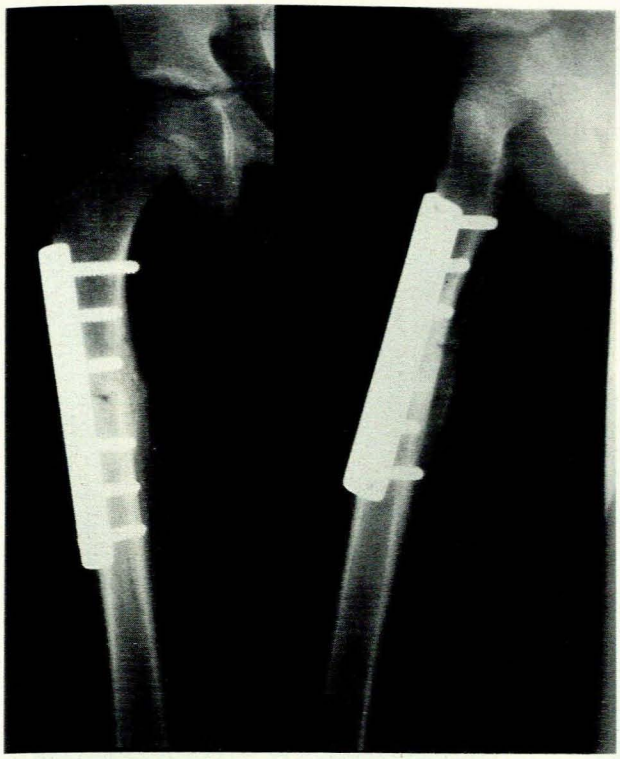

Fig. 1. Radiographs 6 weeks after internal fixation of a fracture of the right upper femur in a 6-year-old girl with a head injury. A good position has been maintained and union is advanced.

In general, intramedullary rods/nails were used only in patients nearing skeletal maturity, and external fixation devices in cases of severe soft-tissue injury, with or without vascular damage. Three late internal fixations were performed, 2 for delayed union and 1 for mal-union.

The delay before definitive surgery in the 28 patients with acute injuries ranged from immediate (i.e. after initial resuscitation) to 14 days (average 2,36 days). Satisfactory mobilisation was achieved in 1 - 56 days (average 8,58 days in the 31 patients), this being the time taken for patients to exercise the limb and get out of bed.

Hospital stay ranged from 2 days to 165 days (average 22,39 days). Delayed mobilisation or prolonged stays were never due to fracture management but rather to the sequelae of head injury. In most cases without complicating cerebral, vascular or other significant injuries, the patient left hospital in about 2 weeks or less.

There were no immediate postoperative complications and only 1 case of superficial sepsis occurring after removal of metal. In 3 cases there was persistent stiffness of nearby joints. One patient had cerebral palsy, 1 had an associated injury of the joint, and 1 had extensive soft-tissue injuries requiring numerous operations for soft-tissue cover. One patient, a girl, had a hypertrophic scar after plating of the femur.

Femoral fractures united in 5 - 12 weeks (average 7,8 weeks), tibial fractures in 5 - 12 weeks (average 6,8 weeks), and fractures of the radius/ulna and humerus in 4 - 6 weeks.

Limb lengths measured clinically were equal at follow-up in 27 patients within the first year of follow-up. However, in 6 children under 12 years of age returning after 1 year for removal of metal after plating of the femur limb overgrowth was consistently seen, and measured 1 - 1,5 cm in every case.

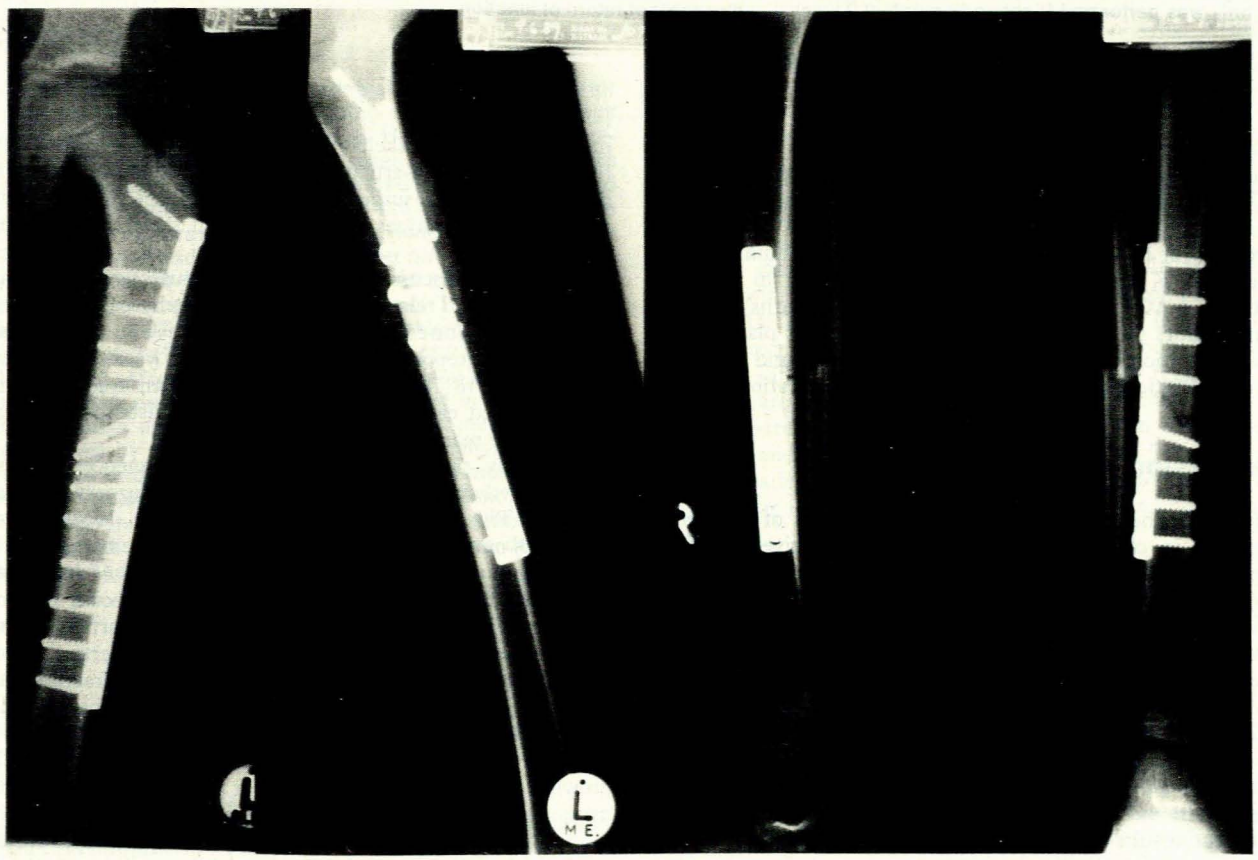

Fig. 2. Radiographs of injuries of contralateral limbs in a polytraumatised boy (age 6 years). Early callus production is visible. Early mobilisation was achieved.

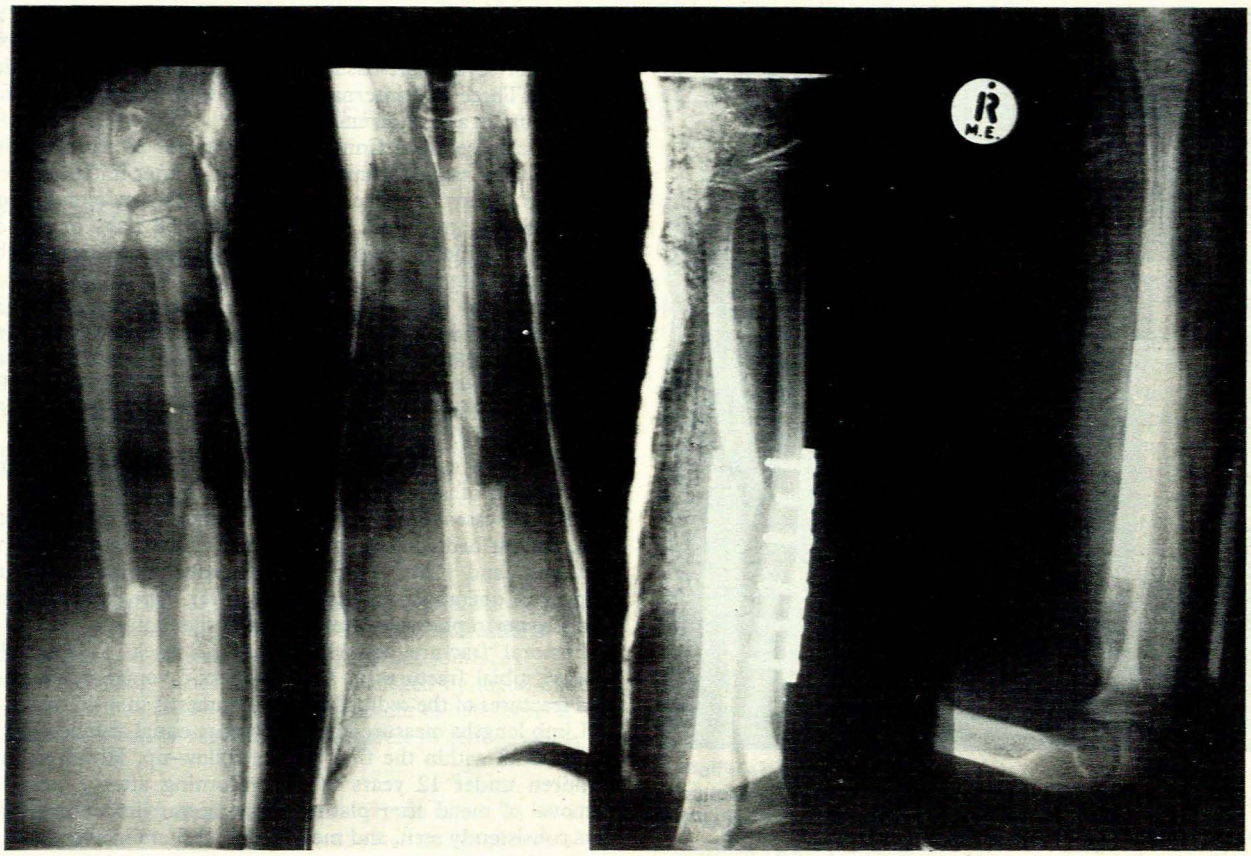

Fig. 3. Difficulty was experienced with closed reduction of this forearm injury in a 12-year-old girl (left). **Fixation of the radius only was performed** (right: radiograph at 2 weeks), **with excellent return of function.**

In 2 cases (fixed for mal-union of humerus and delayed union of tibia) there was slight residual shortening.

To date, second operations have been performed to remove 5 external fixators (between 4 - 6 weeks), 3 plates from forearms (at 12 - 18 months), 1 Rush rod from a humerus (at 6 weeks), 2 'K' nails from femurs (at 18 months, in the same patient), 4 AO nails from femurs (at 12 - 21 months), 8 plates from femurs (between 9 and 21 months), and 1 plate from a tibia (at 9 months). Apart from a superficial wound infection, no complications resulted from these second operations.

Discussion

There have been few reports of metal fixation of long-bone fractures in children, the results of conservative treatment generally being regarded as satisfactory. Moreover, the risks of surgery, the possibility of complications, such as sepsis or growth plate injury, and the need for a second operation for removal of metal are often cited as disadvantages of operative management. There are other issues, such as bone overgrowth, which invite surgeons to be cautious, although the average increase in growth in different series of femoral fractures managed conservatively[1] and operatively[2] is very similar. In Viganto *et al.*'s series 35 patients, the majority aged under 15 years, were subjected to internal fixation for specific indications, the results of which were generally satisfactory. Ziv and Rang[3] reported similar results after internal fixation of 21 femoral fractures in children with head injuries. Thompson *et al.*[4] reported fixation of fractures in 170 young patients, but many of these were skeletally mature, and in many others the fractures were juxta-articular and the indications would not be disputed by many surgeons. Only 5 fractures in their series involved the diaphyses of long bones in skeletally immature patients.

Aside from discussion of femoral fractures, very little has been reported in relation to fixation of diaphyseal fractures of other long bones in children. However, Fuller and McCullough[5] reported that children over 8 years of age have little ability to remodel mal-united forearm fractures, and recommended early surgical treatment in instances of failed conservative management.

Obviously, the possible catastrophic consequences of sepsis weigh heavily in assessing the indications for surgery in young patients. The reported incidence is very low. Nevertheless, such risks must be measured against the possible benefits.

We have reported the use of metal fixation of long-bone diaphyseal fractures in children for certain specific reasons. Unlike the absolute guidelines relating to juxta-articular fractures sometimes involving the growth plate in certain bones, the indications we have used for diaphyseal fractures are relative. Such surgery certainly cannot be performed with inadequate facilities or by inexperienced surgeons. Every effort must be made to protect the vulnerable growth plate of the growing child. We would suggest that the following indications may, in certain cases, be used for fixation of traumatic fractures in previously healthy bone, if matched by an appropriate implant: (*i*) concomitant severe head injury; (*ii*) multiple injuries; (*iii*) patients nearing skeletal maturity; (*iv*) inability to obtain a satisfactory reduction by conservative means;

(*v*) severe soft-tissue injury with or without vascular trauma; (*vi*) long-standing neurological disorder with incapacity and contractures (e.g. cerebral palsy); (*vii*) mal-union; and (*viii*) delayed or non-union.

The principal problem we have encountered has been femoral overgrowth after plating in patients under 12 years of age. This becomes clearly apparent only 12 months or more after surgery, but is a significant disadvantage of the method.

However, the application of the above indications has facilitated nursing care, limited radiation exposure, assured anatomical reduction, aided joint mobilisation and allowed early discharge from hospital (and return to school) in many instances when fracture management might otherwise have been problematic.

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