FRACTURE OF THE TIBIAL SPINE IN ADULTS AND CHILDREN

A REVIEW OF 31 CASES

NAMITA S. KENDALL, STEPHEN Y. C. HSU, KAI-MING CHAN

From the Chinese University of Hong Kong

We reviewed 19 adults and 12 children who had been treated for avulsion fractures of the tibial spine. Adult injuries have not previously been reported at length; most were caused by road-traffic accidents, and 68% were associated with other injuries, of which 58% were around the knee.

The higher incidence of associated injuries in adults as compared with children, indicates that the injury is the result of greater energy and perhaps a different mechanism. The worse outcome in some adults was due to other associated intra-articular fractures and tears of the medial collateral ligament. Arthroscopy is useful in both diagnosis and treatment. Early accurate diagnosis and the correct treatment produce a good outcome.

Fractures of the intercondylar eminence of the tibia were first described by Poncet in 1875 (Burstein, Viola and Fulkerson 1988) and have been considered to be the childhood equivalent of anterior cruciate ligament (ACL) ruptures in adults. Apart from case reports of unusual presentations and complications, little has been published about the fracture in adults (Fyfe and Jackson 1981; Grönkvist, Hirsch and Johansson 1984; Hayes and Masear 1984; Crenshaw 1987) and it is generally accepted that it rarely occurs as an isolated injury, usually being associated with soft-tissue injuries around the knee and having a poor prognosis (Liljedahl, Lindvall and Wetterfors 1965; Keys and Walters 1988).

We have compared and contrasted the childhood and adult fractures, with the aim of describing the characteristic features of the latter and determining their aetiology and the prognostic indicators of poor outcome.

Fig. 1

Diagram showing the modified Meyers and McKeever classification of fractures of the tibial spine. Type I is minimally displaced, type II shows anterior elevation, type III has complete separation of the fragment and in type IV the fragment is also rotated, with comminution.

PATIENTS AND METHODS

We reviewed the records and radiographs of patients treated for avulsion fractures of the tibial spine since 1984 at the Prince of Wales Hospital, Hong Kong, recording the patients' ages, the mechanisms of injury, the clinical presentation and the fracture type (Fig. 1)

N. S. Kendall, FRCS Ed, Registrar
Department of Orthopaedics, Royal Berkshire Hospital, London Road,
Reading, Berkshire RG1 5AN, England.

S. Y. C. Hsu, MCh(Orth), FRCS Ed, FRACS, Consultant Orthopaedic
Surgeon
Department of Orthopaedics and Traumatology, Princess Margaret
Hospital, Kowloon, Hong Kong.

K.-M. Chan, MCh(Orth), FRCS G, FRCS Ed, FRCS Ed(Orth),
Reader
Department of Orthopaedics and Traumatology, Chinese University
of Hong Kong, Prince of Wales Hospital, Shatin, New Territories,
Hong Kong.

Correspondence should be sent to Mrs N. S. Kendall.

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0301-620X/92/6447 \$2.00

J Bone Joint Surg [Br] 1992; 74-B:848-52.

using Meyers and McKee's (1959) classification. We also reviewed the treatment regime and rehabilitation programme.

Subjective outcome was obtained from a standard questionnaire, and all clinical examinations were performed by one of the authors (NSK), to eliminate intra-observer error. The Stryker knee laxity tester (Stryker Ltd, Reading, England) was used to obtain quantitative values for the anterior drawer and Lachman tests, and the Cybex ED1320 electronic goniometer to determine ranges of movement. Quadriceps wasting was measured as the thigh circumference 18 cm above the tibial tubercle. Pivot shift and varus/valgus instability were also tested. Follow-up anteroposterior and lateral radiographs were taken of both knees, with a tunnel view of affected knees.

RESULTS

We treated a total of 31 patients from 1984 to 1991; there were 12 children from eight to 16 years of age (mean 12.5) and 19 adults from 19 to 56 years of age (mean 37). **Children.** There were 11 boys and one girl; in nine the injuries were right-sided and in three, left-sided. Seven of the fractures were sustained during sporting activities (including bicycle accidents), one resulted from a fall and four were caused by road-traffic accidents. In all cases the presentation had been with a painful haemarthrosis associated with decreased range of movement. Eight of the 12 patients had a positive anterior drawer or Lachman test (Table I). Only one had an associated knee injury, a crack fracture of the lateral femoral condyle. Eight of the fractures were diagnosed on initial radiographs; one was type I, five type II and two type III. The remaining four required arthroscopy for diagnosis, and all of these were type I.

Treatment for type I fractures was conservative in all cases, by immobilisation for a minimum of four weeks, initially in a plaster cast at between 0° and 45° of flexion,

and then in a long-leg hinge brace. Two of the type II fractures were treated by closed reduction and immobilisation. In one of these there was a refracture after the early removal of the hinge brace, converting it from a type II to a type III fracture and requiring open reduction and internal fixation.

The remaining type II and all type III fractures were treated by arthrotomy and fixation by absorbable sutures. After operation the patients had two weeks of immobilisation in a plaster cast followed by bracing. This allowed an initial range of movement of 0° to 30° for two weeks, which was increased weekly by 30° until the brace was removed at the end of the fifth week. At an average follow-up of 2.6 years (4 months to 5.5 years) all the knees were asymptomatic with no instability on testing (anterior drawer and Lachman).

Follow-up radiographs showed union in 11 cases,

Table I. Details of 12 cases of avulsion of the tibial spine in children

Case	Sex/Age	Type	Lachman test	Anterior drawer	Associated injuries
1	M 8	I	—	—	Crack fracture lateral femoral condyle
2	F 10	II	—	+	None
3	M 10	I	—	—	None
4	M 11	III	+	+	Fracture clavicle and pubic rami
5	M 13	III	+	+	None
6	M 13	I	+	+	None
7	M 13	II	—	—	None
8	M 14	II	+	+	None
9	M 14	I	—	+	None
10	M 14	II	—	—	Fracture distal radius
11	M 15	II to III	+	+	None
12	M 16	I	+	+	None

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Pre-operative (a, b) and three-year review (c, d) radiographs of an eight-year-old boy with a conservatively treated type II fracture which failed to unite.

Table II. Details of the 12 adult cases with associated injuries and avulsion of the tibial spine

Case	Sex/Age	Type	Cause	Associated injuries
13	F 19	II	Bicycle	Partial tear lateral meniscus
14	M 25	IV	RTA*	Lateral malleolus and fibular neck, avulsed MCL
16	M 30	III	RTA	Femoral trochanter and humeral condyle
17	F 30	III	RTA	Intracerebral bleed
18	M 31	II	RTA	Partial PCL tear, head injury
19	F 33	III	RTA	Head injury
22	M 35	II	RTA	Femoral condyle and navicular
23	M 35	II	RTA	Fibular neck
24	M 37	III	RTA	Fibula
27	M 43	I	RTA	Medial malleolus, perforated small bowel
28	M 46	II	Fall	Head injury, both medial malleoli 4th and 5th metacarpals and 4th metatarsal
31	F 56	IV	Fall	Lateral tibial plateau

*road-traffic accident

Fig. 3

Number of fractures in children and adults related to their classification.

two showing a slight increase in the height of the tibial eminence. There was nonunion of one type II fracture (Fig. 2) but after three years the patient was asymptomatic with no clinical evidence of instability and had returned to normal sporting activities.

Adults. Of the 19 adults, 12 were male and seven female;

the injury was right-sided in 11 and left-sided in eight. Road-traffic accidents were responsible for 11 of the injuries, falls in six and bicycle injuries in two. All the patients had a haemarthrosis and seven showed anterior instability; of these, four also had medial instability.

Twelve patients had associated injuries, but only seven of these were of the knee (Table II). The fracture classification is shown in Figure 3. The average follow-up was three years (4 months to 5.5 years).

All type I fractures were treated conservatively after arthroscopy to drain the haemarthrosis and exclude meniscal injury. One type II fracture was reduced by extending the knee; one required arthroscopically assisted reduction; the remaining three had an arthrotomy, open reduction, and wire-loop fixation. All type III and IV fractures had open reduction and internal fixation using a variety of methods including Vicryl pins (Ethicon Ltd, Edinburgh, Scotland), sutures and a steel wire-loop (Fig. 4). A Vicryl pin was inserted arthroscopically for a type IV fracture.

Fig. 4

Postoperative radiographs of a 28-year-old man treated by reduction and wire fixation.

Four patients complained of instability. Two had also had tears of the medial collateral ligament, one had a femoral condylar fracture and the fourth had developed reflex sympathetic dystrophy. This patient had only a 15° to 90° range of movement, but in all the others movement was good, with an extension lag averaging 6° (5° to 8°) in four cases, but not affecting function. Only two patients had significant quadriceps wasting of 30 and 35 mm respectively; one of these also had a femoral condylar fracture and one had failed to attend for physiotherapy.

Radiographs indicated union in all cases with an increase in the height of the tibial spine of 3 to 5 mm. One knee showed osteoarthritic change, but this was in the oldest patient, a 56-year-old woman with a tibial plateau fracture.

Both subjectively and on examination, 14 of our 19

patients had a good outcome with no residual symptoms or demonstrable disability (Table III).

DISCUSSION

Our literature review revealed a reported ratio of 60 children to 40 adults for tibial spine fractures (Keys and Walters 1988). We found a reversed ratio, and consider that adult fractures may be more common than previously believed. One report on ACL ruptures stated that 13 of 48 acute injuries were associated with avulsion fractures (Liljedahl et al 1965). In our centre, 219 cases of acute and chronic rupture of the ACL have been treated during the period of our study. Avulsions therefore appear to represent 14% of ACL injuries.

Our results in children agree with previous reports, including the rarity of associated injuries and the good outcome (Liljedahl et al 1965; Grönkvist et al 1984; McNair, Marshall and Matheson 1990). We report a higher incidence of adult injuries and agree with earlier reports of other knee injuries (Meyers and McKeever 1959; Liljedahl et al 1965), particularly the medial collateral ligament. We did not find an association with meniscal injuries, seeing only one case, but did show a high incidence of local bony injury. These were both fibular neck fractures and intra-articular fractures, the latter having a strong bearing on prognosis.

All cases presented with a painful haemarthrosis and this injury should lead to careful radiographic evaluation in all age groups, not only children. Tunnel and oblique views may be required to make the diagnosis. The distribution of fracture types in Table III suggests that adults sustain a more severe injury, there being no type IV fractures in children. Zaricznyj (1977) reported, however, an incidence of 60% of type IV fractures in children.

Arthroscopy is useful in acute haemarthrosis for several reasons. It is diagnostic, particularly where the cartilaginous areas of the skeleton in children make radiographic diagnosis difficult, and it allows precise classification of type. It also allows an accurate diagnosis of other intra-articular injuries, both soft-tissue and articular. In two of our cases initially diagnosed as type II fractures, arthroscopy revealed comminution with loose cartilage fragments not visible radiographically. Arthroscopy not only allowed drainage of the haemarthrosis, but the removal of loose fragments. In the future, arthroscopic surgery will have a greater role in both adults and children, allowing the insertion of strong absorbable pins and avoiding the need for arthrotomy and the associated longer rehabilitation period.

Conservative treatment for all type I injuries is effective. In adults, type II, III and IV injuries require arthroscopy for lavage and accurate classification, to allow the selection of the best treatment. If satisfactory closed reduction cannot be obtained, open or arthroscopic reduction and fixation should be performed. All type III

Table III. Final results in all patients

Case	Sex/Age	Range of movement (degrees)	Quadriceps wasting (mm)	Lachman sign (mm)
1	M 8	0 to 126	No	0
2	M 10	0 to 142	No	0
3	F 10	0 to 130	No	0
4	M 11	1 to 127	No	1
5	M 13	0 to 145	No	1
6	M 13	0 to 145	No	0.5
7	M 13	0 to 148	No	0
8	M 14	1 to 140	No	0
9	M 14	0 to 142	No	1
10	M 14	0 to 145	No	2
11	M 15	1 to 140	No	1
12	M 16	0 to 140	5	1
13	F 19	2 to 124	5	1
14	M 25	0 to 119	No	2
15	M 28	8 to 132	20	1
16	M 30	1 to 118	No	0
17	F 30	5 to 129	No	0.5
18	M 31	1 to 135	5	0.5
19	F 33	1 to 130	5	2
20	M 34	2 to 142	No	0
21	M 34	2 to 125	5	1
22	M 35	1 to 113	30	1
23	M 35	5 to 145	10	0
24	M 37	0 to 136	No	0
25	F 38	0 to 131	35	0.5
26	F 42	1 to 138	5	0
27	M 43	0 to 135	No	0
28	M 46	15 to 89	5	0.5
29	F 52	2 to 140	5	0
30	M 53	5 to 130	No	0
31	F 56	1 to 129	10	0

and IV fractures require internal fixation, for which a variety of methods are available. A poor outcome, with residual pain and instability, was associated with additional intra-articular fractures or damage to the medial collateral ligament. We recommend immobilisation for four weeks in children under 12 years of age but a minimum of six weeks for older patients. Protected limited motion may be started at four weeks.

We found a low association with meniscal injuries in comparison with that reported for ACL rupture (Meyers and McKeever 1959); this may be due to the different mechanism of injury. Isolated ACL rupture commonly occurs as a result of deceleration, internal rotation, and excessive hyperextension, or deceleration, valgus and internal rotation (Roth 1928; Zaricznyj 1977). The mechanism of avulsion of the tibial spine in children is thought to be either a direct blow on the lowermost part of the femur or forceful hyperextension with rotation (Rockwood and Green 1984). In our series most adults sustained the injury in road-traffic accidents, in a seated position with the leg stretched out. In this situation, the knee tends to be near full extension at the time of injury and may be forced into hyperextension by the impact. Thus it may be that the rotatory element in ACL ruptures, which causes the high association with meniscal injuries, is not present in avulsion fractures; these may be produced only by deceleration and hyperextension. The relative energy causing the hyperextension was also much greater in adults than in children; this, with the lack of rotation, may be responsible for the differences between the two groups in our series.

Our results suggest that tibial spine fractures are more common in adults than was previously thought, but are more usually associated with other injuries than in

children. In 35% of our series, they were isolated injuries and should be considered in the differential diagnosis of acute traumatic haemarthrosis. Early accurate diagnosis and the correct treatment are essential for a good outcome.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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