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ORIGINAL STUDY

Treatment of fractures of the tibial tuberosity in adolescent soccer players

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Fractures of the tibial tuberosity are uncommon injuries that mainly occur in 14 to 16 year- old adolescents involved in sports activities. The mechanism of injury is related to jumping while practicing sports. This retrospective study presents the outcome of fractures of the tibial tuberosity in a series of 18 adolescent soccer players treated with the same surgical technique in one center. The hypothesis was that our surgical technique with two parallel screws, one proximal and one distal to the physis, avoids physis injury and has no repercussions on growth.

The average age was 14.7 years. All patients were male.

The fractures included 4 type IIA, 3 type IIB, 6 type IIIA, and 5 type IIIB (Ogden classification). All patients underwent open reduction and internal fixation consisting of screw placement parallel to the joint surface, sparing the tibial physis. There were no complications in any case, and all patients were able to resume their previous sports activities.

The technique used appeared to be safe. Screws were removed in 8 patients owing to local discomfort. All patients achieved the same competition level as before the injury.

Keywords : tibial tuberosity fractures ; internal fixation ; surgical treatment ; children ; physeal injury.

INTRODUCTION

Fracture of the tibial tuberosity is an uncommon injury that is reportedly seen at a rate of one case every four years in busy emergency centers (*18*). Avulsions of the tibial tuberosity account for 3% of tibial fractures (*8*) and less than 1% of physeal fractures (*2,18*). They represent 0.4% to 2.7% of epiphyseal fractures (*17*). The injury mainly affects young males engaged in sports, with a peak incidence in the 14 to 17 year-old age group. The predominance of males is believed to be due to the larger number that practice sports and the fact that fusion of the physis occurs later as compared to females (*4*).

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The fracture is usually related to jumping in basketball or other sports competitions (*1,2,16,19,21*). The mechanism of injury is explained by a double cause. First, a traction force is produced by strong contraction of the quadriceps with the knee in extension, during a jump. Second, acute passive flexion occurs against the powerful quadriceps contraction when landing from the jump. When both forces come into play, fracture of the tuberosity is produced (*13*). If the fracture is non displaced conservative treatment is elected but surgical treatment is needed when there is a fracture displacement (*21*). In this study we present the 2-year outcome of a series of adolescent boys treated with open reduction and internal fixation for this injury.

PATIENTS AND METHODS

An institution review board approval was obtained for this retrospective study of 18 cases of avulsion-fracture of the tibial tuberosity from one hospital. The study only included soccer players because our team works for the Mutualitat de Futbolistes in Catalonia, which is the medical insurance of the Soccer Spanish Federation, that offers health assistance to more than 100 000 soccer players per year in Catalonia.

The inclusion criteria were all patients admitted during two years (2002-2003) with only physeal fractures sustained while playing soccer. Patients would be excluded if the physes were completely closed or the fracture was due to an activity other than soccer or if they also had another fracture. The diagnosis was based on plain radiography except in cases in which other injuries were suspected. None of the patients were excluded and all completed 2 years of follow-up. The series included 18 adolescent boys with a mean age of 14.7 years (SD 1.6). The age distribution is shown in table I. The fracture was located on the right side in 4 cases and the left side in 14 cases.

The surgery was performed through an anterior midline approach. The bone fragments were exposed and individualized. A medial arthrotomy was performed to provide visualization of the reduction of the articular surface. First, the intra-articular fragment was reduced and fixed with one or two 3.5-mm cannulated cancellous bone screws depending on the size of the fragment. The more superficial fragment was subsequently treated in the same manner. We usually used two screws but if the fragment was small we only used one screw. The surgical technique consisted of parallel placement of screws

Table I. — Patients' details

Patient	Age (years)	Weight (Kg)	Height (m)	BMI	Years playing soccer	Level soccer	Dominant	Ehrenborg*
1	15	47	1.50	20.89	8	Federation	Non dominant	3
2	15	60	1.64	22.31	9	Federation	Dominant	2
3	15	63	1.67	22.59	3	Federation	Non dominant	4
4	10	26	1.10	21.49	3	Federation	Non dominant	0
5	13	38	1.35	20.85	5	Federation	Dominant	0
6	15	62	1.66	22.50	8	Federation	Non dominant	3
7	16	73	1.70	25.26	7	Federation	Dominant	4
8	16	64	1.68	22.68	4	Federation	Dominant	4
9	14	42	1.45	19.98	2	Federation	Dominant	3
10	14	58	1.62	22.10	6	Federation	Non dominant	0
11	15	62	1.66	22.50	6	Federation	Non dominant	0
12	14	54	1.61	20.83	5	Federation	Dominant	4
13	16	60	1.64	22.31	3	Federation	Non dominant	2
14	14	63	1.70	21.80	1	Federation	Dominant	4
15	14	44	1.55	18.31	2	Federation	Dominant	4
16	16	65	1.69	22.76	7	Federation	Non dominant	4
17	15	64	1.68	22.68	8	Federation	Dominant	4
18	16	70	1.80	21.60	5	Federation	Dominant	3

*Ehrenborg G. The Osgood–Schlatter lesion. A clinical and experimental study. *Acta Chir Scand* 1962, Suppl 288 : 1-36.

Fig. 1. — Screws are placed parallel to the joint surface, above and below the physis.

between the joint surface and the tibial physis and between the physis and the metaphysis, such that the tibial physis was spared. Cannulated screws were chosen because they allow for the use of K wires with fluoroscopic visualization to guide the screw position into the bone. The screws went through the tuberosity physis but not through the proximal tibial physis (Fig. 1).

If the fracture did not affect the articular surface, and the fracture was below the physis, screws were only placed distal to the physis. If the fracture involved the articular surface, we placed screws proximal and distal to the physis. No screw penetrated the tibial physis. If the fracture was comminuted, or had several fragments we tried to fix them with strong suture (Ethibond, Johnson), if this was necessary. Usually the fragments were large and the reduction was stable enough with screws and sutures.

Following surgery, a plaster cast was left in place for 4 weeks with partial weight bearing on crutches. Rehabilitation was then initiated. The rehabilitation program started with cold packs over the knee, continuous ultrasound at 1w/cm^2, assisted active movement of the knee, free active movement of the ankle and hip, hamstring isokinetic exercises, and quadriceps electrostimulation. The patients underwent nearly eight weeks of rehabilitation and resumed competitive sports activities 18 to 20 weeks after the injury. They returned to soccer when the muscular stretch was recovered. The patients had a Tegner activity level scale of 9 pre-injury and all of them returned to the same level. At the end of the rehabilitation program, all had full active range of motion. The follow-up visits, consisting of clinical and radiological examination, were performed at 1 week, 4 weeks, 8 weeks, 12 weeks, 16 to18 weeks, 1 year and 2 years, respectively. The follow-up and the results were documented retrospectively. All patients were recalled to have a last control. No patient was lost to follow-up. Radiographs were taken until consolidation of the fracture (at 1 week, 4, 8 and 12 weeks). A final radiograph was taken at the last follow-up visit.

RESULTS

Fractures were classified according to Ogden (*17*) as follows : 4 type IIA (21.1%), 3 type IIB (15.8%), 6 type IIIA (31.6%) and 5 type IIIB [31.6%]. Among the 18 patients, 6 required proximal and distal screws and 12 only distal screws (Fig. 2). No preventive fasciotomies were carried out. A complete reduction was achieved in all cases. There were no intraoperative or immediate postoperative complications, such as compartment syndrome or infection.

Patients with more severe quadriceps atrophy took longer to resume physical activity and needed a longer rehabilitation time. The average duration of rehabilitation was 6 weeks (SD 3.6), and the time to resuming normal physical activity (running, working) was 13.7 weeks (SD 6.2). Maximum sports activity, that is, participation in soccer games, began at 18 weeks. Screws in the anterior position were removed if they caused discomfort. Eight patients required screw removal, which was performed at 6 or 8 months. We considered screw removal as a minor inconvenience.

At the two-year follow-up visit, none of the patients complained of pain or showed complications related to bone growth or to the surgery. There were no angular deviations of the leg on radiographic study. All the patients were reviewed at 2 years of follow-up, and the younger patients were followed up to 5 years. All the patients had their tuberosity and proximal tibial physes fused. No patients had axial deviation in the coronal or sagittal plane. They all resumed their former sports activity.

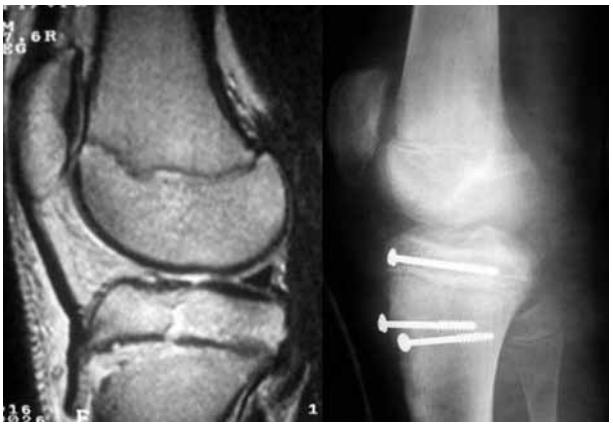

Fig. 2. — MRI : The left image shows a IIIB fracture requiring treatment. The right image shows positioning of the proximal and distal screws.

DISCUSSION

The outcomes noted in these patients show that open reduction and internal fixation with screws not crossing the tibial physis is a safe technique for fixation of fractures of the tibial tuberosity. The screws are placed parallel to the joint surface above and below the physis, providing a stable fixation which allows resumption of sports activities at the same level as before the injury.

The final objective of the open reduction is anatomic reconstruction of the joint surface and stable fixation, so that once the cast is removed, the osteosynthesis will not fail. In contrast, other authors prefer to use a tension band (*2,4,9,10,17*). Lubojacky has proposed arthroscopic and other minimally invasive techniques for the treatment of these fractures (*10*). In our experience, there has been no failure or insufficient stability of the internal fixation. Our results with open reduction and internal fixation are good and comparable to those of other authors (*7,14*). Other studies have reported an internal fixation system with screws similar to ours in smaller and less homogeneous series (*5,11*). Other groups combine internal fixation and tension band wiring for more security (*15*). We did not use tension band wiring because the fixation was stable enough, and a cast was applied postoperatively.

If the patient is at an advanced stage of skeletal maturity with a physiological epiphysiodesis, the proximal tibial physis can be crossed by internal fixation material. However, if the patient is still skeletally immature (Tanner stage 1 or 2) the physis should not be crossed, since this can affect the growth cartilage and cause early physeal closure, which can lead to genu recurvatum or deformities in the coronal plane.

The possibility of associated injuries such as collateral ligament, anterior cruciate ligament and meniscal injury (*3*), and avulsion of the patellar ligament (*12,20*), should be kept in mind. The injury is usually unilateral, but there are bilateral cases (*6*). All fractures in our series were surgically treated on an emergency basis within 24 hours. Hence, additional imaging studies such as magnetic resonance imaging or computed tomography scanning could not be done in all cases. Nevertheless, none of the patients have shown signs of meniscal injury or joint instability.

Our study is limited by its retrospective nature, but it has the advantage of a homogeneous patient sample with a high level of physical activity. The fact that all patients were able to resume their former sports activity indicates the robustness of the technique. At final follow-up, there was no recurvatum deformity, and there was physiological closure of both the tuberosity and proximal tibia physes.

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