TIBIAL SPINE AVULSIONS IN THE SKELETALLY IMMATURE

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Abstract

In children, displaced avulsions of the tibial spine are equivalent to ruptures of the anterior cruciate ligament. They present to general orthopaedists as well as a wide variety of orthopedic subspecialty surgeons including sports medicine and pediatrics. Restoration of normal knee kinematics is dependent on anatomic reduction and fixation of the avulsed fragment. Given these premises we aimed to evaluate the current treatment of displaced tibial spine fractures in the skeletally immature in our clinic.

We performed a retrospective review of displaced avulsions of the tibial spine in skeletally immature patients treated in our clinic over the last years and identified 4 cases: 3 girls and one boy, with a mean age of 12 (11-14). One case was type II and three were type III. All were treated operatively: 2 with arthroscopic / mini-open reduction and internal fixation using wire, one with screw and one with 2 K wires.

The patients had the final follow-up evaluation at a mean of 20 months after index surgery. All had IKDC scores for excellent and good outcomes. Three out of four cases had increased manual antero-posterior tibial translation without subjective feeling of instability. All patients had regained full range of motion by the time of final examination even though incomplete recovery was noted for the three cases which returned for implant removal before the second operation.

In our patients, surgical treatment has offered good final outcomes. Arthroscopic evaluation has proved extremely useful in articular exploration for associated lesions as well as reduction and internal fixation. However, extended approaches were needed for adequate stabilization, although this was at most at the mini-open level. Wire has offered good fixation but the screw offered less postoperative symptoms and did not require removal. All three methods were comfortably kept within the epiphyses and did not create concern regarding the open growth cartilage.

Key words: tibial spine, avulsion fracture, pediatric ACL

Clinical background

Avulsions of the tibial spine are functionally equivalent to ruptures of the anterior cruciate ligament (ACL) in adolescent athletes. It therefore presents to general orthopaedists as well as a wide variety of orthopedic subspecialty surgeons, including sports medicine and pediatrics. Restoration of normal knee kinematics is dependent on anatomic reduction and fixation of the avulsed fragment. Because this injury is typically sustained by the skeletally immature patient, epiphyseal fixation is ideal to avoid physeal injury, which can lead to angular limb deformity [1].

Lafrance et al [2] consider that although most fractures heal successfully, residual laxity usually persists because of prefracture anterior cruciate ligament midsubstance attenuation. This does not typically manifest in subjective instability, and reconstruction of the anterior cruciate ligament is rarely required.

Prince et al [3] found that ACL injuries in skeletally immature patients are seen more often in boys. In addition, tibial avulsion fractures and partial tears are more common in younger, less rigid skeletons that can absorb the forces of trauma. As children mature, complete ACL tears and associated injuries occur in frequencies approaching those patterns seen in adults.

Sometimes when close reduction of the fragment is attempted this is obtained incompletely due to soft tissue interposition. Kocher et al [4] found that 65% of type III fractures and 26% of type II fractures had entrapment of the anterior horn of the meniscus, most commonly medial. This has been confirmed by other authors as well, particularly in type III fractures. This is why most authors such as Accousti et al [5,6] consider the treatment algorithm for tibial eminence fracture management with regard to displaced and irreducible fractures to require arthroscopic or open treatment, based on surgeon preference. Objective sagittal plane laxity does not translate into long-term clinical or subjective instability. However, every effort should be made to obtain the best possible reduction with stable fixation, when needed, to maximize function.

Given these premises we aimed to evaluate the current treatment of displaced tibial spine fractures in the skeletally immature in our clinic.

Material and Method

The classification system of Meyers and McKeever is the current standard used to classify these fractures and to guide treatment. It is based on the degree of displacement, mainly on the lateral x-ray. Zaricznyj modified this classification to include a fourth type - comminuted fractures of the tibial spine, which applies mostly to adults:

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- type 1: minimal displacement of the tibial spine fragment
- type 2: displacement of the anterior third to half of the avulsed fragment, which is lifted upward but remains hinged on its posterior border
- type 3: complete separation of the avulsed fragment from the proximal tibial epiphysis, usually associated with upward displacement and rotation

We performed a retrospective review of displaced avulsions of the tibial spine in skeletally immature patients treated in our clinic over the last 6 years and identified 4 cases (fig.1 and 2): 3 girls and one boy, with a mean age of 12 (11-14). One case was type II and three were type III. All were treated operatively: 2 with arthroscopic / mini-open reduction and internal fixation using wire (fig.3 – 6), one with screw and one with 2 K wires.

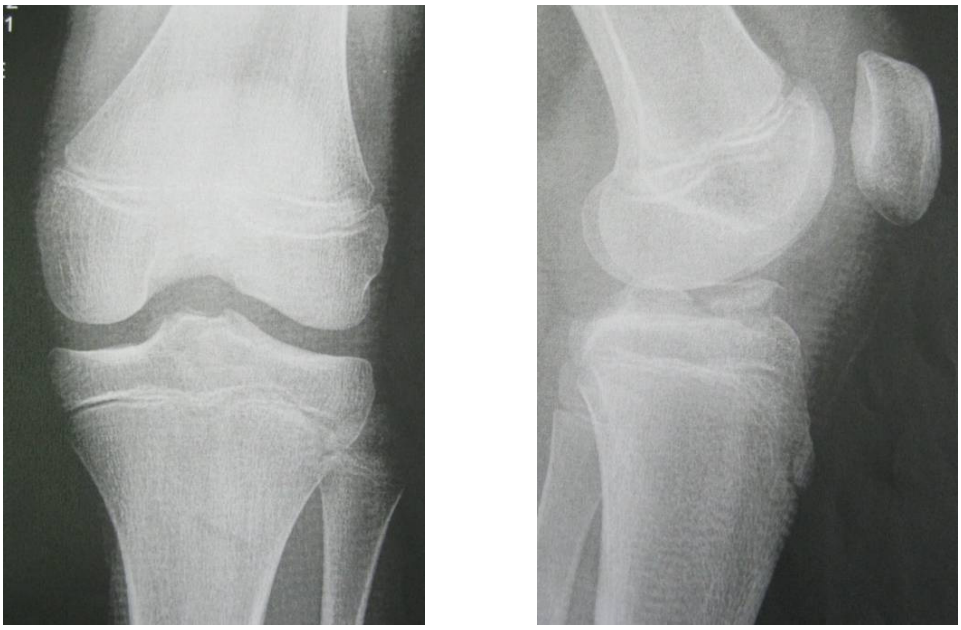

Fig.1 and 2: AP and lateral x-ray views of a 12 years old girl with a type III tibial spine avulsion.

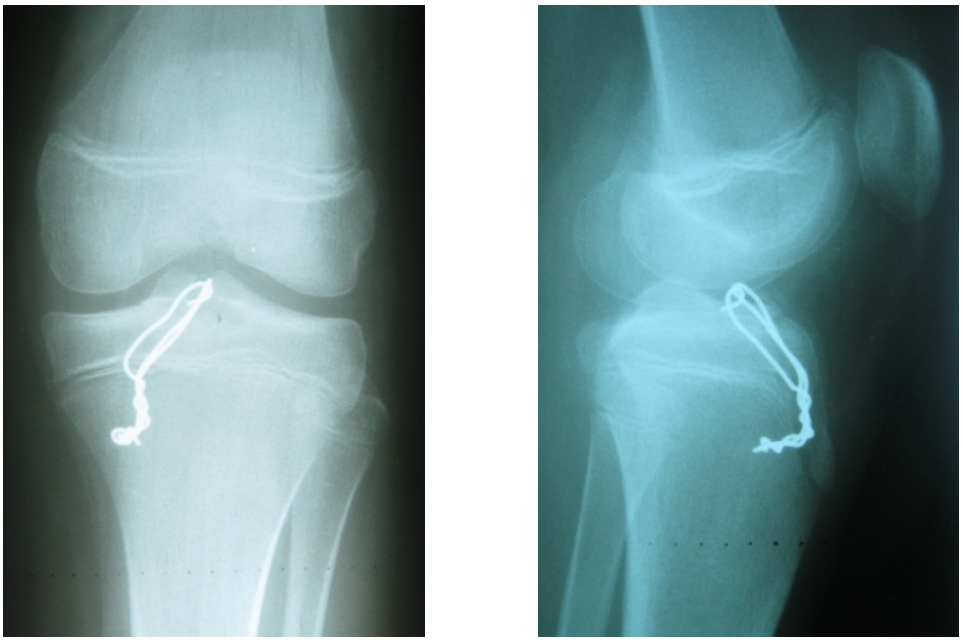

Fig.3 and 4: AP and lateral X-rays after arthroscopic reduction and internal fixation.

Fig. 5 and 6: the same case at 6 months (final) follow-up.

Results

The patients had the final follow-up evaluation at a mean of 20 months after index surgery. All had IKDC (international knee documentation committee) scores for excellent (A) and good (B) outcomes. Three out of four cases had increased manual antero-posterior tibial translation (2mm comparative bilateral as measured by KT-1000) without subjective feeling of instability. All patients had regained full ROM (range of motion) by the time of final examination even though incomplete recovery was noted for the three cases which returned for implant removal before the second operation. Both wires and the 2 K wires have been removed at an average of 6 months postoperatively. All cases have been diagnosed using standard X-rays; one case also had MRI examination. One case had an intraoperative finding of entrapped medial meniscus. Two cases were operated by a slight extension of the anteromedial arthroscopic portal and a third small incision (the cases with wire internal fixation) and two by small medial arthrotomy. All cases were followed by 3 weeks of immobilization in 15 degrees of flexion. None had associated meniscal or chondral lesions identified intraoperatively. One case had a ruptured medial collateral ligament on the MRI.

Discussions

Song et al [7] reviewed their cohort of patients with displaced tibial spine avulsions and identified eight cases of type II and ten of type III in children and two cases of type II, fifteen of type III, and five of type IV in adults. A higher incidence of type IV fractures was encountered in the adult group. Adults had higher incidences of accompanied meniscal injuries and type IV fractures than children. Significant differences were found in mean Lysholm scores, 99.3 points in children and 89.5 in adults. However, no significant differences were found between adults and children in terms of range of motion, the Lachman test and the Pivot-shift test, and instrumented anterior laxity. Lysholm scores of ACL avulsion fractures were better in children than in adults. Possible causes of these results are higher incidences of accompanying meniscal injury and type IV fracture in adults. However, no intergroup differences were found in terms of stabilities.

Arthroscopic treatment is advocated by the majority of authors as the best current option [8,9]. This allows for a complete evaluation and treatment of associated lesions, optimal reduction with removal of any possible soft tissue entrapment, accurate estimate of the size of the fragment (the chondral part is not visualized on x-rays and thus the fragment is usually undersized) and adequate internal fixation using suture, wire or screws. Reynders et al [10] presented a series of 26 cases of displaced fractures of the intercondylar eminence of the tibia treated with an arthroscopically placed, intrafocal screw with washer. Sixteen patients had a type II tibial eminence fracture according to Meyers and McKeever (mean age, 15 years; male/female ratio, 11:5). And ten patients had a type III tibia eminence fracture (mean age, 17 years; male/female ratio, 1:1). They encountered neither stiffness nor iatrogenic chondral abrasion. All but three patients with type II had some degree of residual laxity, without apparent impact on the clinical result. In four patients with a type III lesion, a residual laxity without functional deficit was noticed. In two cases with a type III lesion, a reconstruction of the anterior

cruciate ligament was necessary 3 years after trauma. In four patients with a type III fracture, the fragment remained elevated, with minor impairment of the mobility (extension lag). No mechanical failure or infection was seen in this series. The authors found the intrafocal screw fixation for displaced fracture of the intercondylar eminence to be a reliable and safe technique, although complete restoration of the anteroposterior knee stability was seldom seen. Lubowitz et al [11] recommend arthroscopic reduction and internal fixation for all displaced (type III) fractures and believe this should also be considered for all cases of displaced type II fractures. Fractures without displacement after closed reduction require careful evaluation to rule out meniscal entrapment. Subjective results are found to be uniformly excellent, despite reports of objective anteroposterior laxity.

Early range-of-motion exercises are essential to prevent loss of extension. Repair using nonabsorbable suture fixation, when of adequate strength to allow early range-of-motion, has the advantages of eliminating the risks of comminution of the fracture fragment, posterior neurovascular injury, and need for hardware removal, compared with screws.

Kocher et al [12] reviewed their results in six patients at minimal 2-year follow-up. They found mean postoperative Lysholm and Tegner scores of 99.5 and 8.7, respectively. One patient had a grade A Lachman (normal) test, three had grade B (nearly normal), and two had grade C (abnormal). Instrumented knee laxity showed side-to-side differences of greater than 3 mm in four of six patients.

In contrast, Wilfinger et al [13] performed a retrospective clinical analysis in a single department and identified forty-three patients. Twenty-three were female and twenty male. The mean age at trauma was 11.5 years (6-16 years). Only 1 patient required a change of therapy and needed open reduction. Thirty-eight patients were available for follow-up at an interval of 1-7.5 years after trauma (mean 3.5 years). None of the patients reported pain, swelling, disability or giving-way, or was handicapped in their daily life. Of 26 magnetic resonance imaging examinations, we found a missing anterior cruciate ligament in 1 and a partial rupture in another patient. Based on these results, the authors recommend nonoperative management as the primary treatment for tibial spine fractures in children.

Rademakers et al [14] included 44 displaced tibial spine fractures in a study. The mean age at time of accident was 24 years (range 9-57 years). Out of these, sixteen patients had an open physis at the time of trauma. After a mean follow-up of 16 years (range 5-27 years), the median knee ROM was 130 degrees (range 115-140 degrees). As measured with an objective testing device, no statistically significant difference of anteroposterior stability between the injured and uninjured legs was found, with a mean difference of 1 mm (range -3.9 to 6.9 mm). The Lysholm score showed good to excellent results in 86% of the patients. The patients with open physis at the time of index surgery did not develop axial malalignment in the long term.

Conclusions

In our patients, surgical treatment has offered good final outcomes. Arthroscopic evaluation has proved extremely useful in articular exploration for associated lesions as well as reduction and internal fixation. However, extended approaches were needed for adequate stabilization, although this was at most at the mini-open level. Wire has offered good fixation but the screw provided less postoperative symptoms and did not require removal. All three methods were comfortably kept within the epiphyses and did not create concern regarding the open growth cartilage.

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