Displaced tibial intercondylar eminence fractures

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ABSTRACT

Purpose. To review outcomes of 19 patients with tibial eminence fractures.

Methods. Records of 10 female and 9 male patients with type II (n=3) and type III (n=16) displaced tibial intercondylar eminence fractures were reviewed. Nine of whom were skeletally immature aged 6 to 15 (mean, 12) years; the remaining 10 patients were aged 19 to 55 (mean, 32) years. 14 involved the left knee. All patients presented with a painful haemarthrosis and reduced range of movement.

Results. The most common activity causing this injury was skiing (n=7, primarily in adult females [n=5]), followed by cycling or motocrossing (n=6) and falling or other sporting activities (n=6). The injury mechanisms entailed forced flexion with rotation (n=7), hyperextension with rotation (n=7, primarily in skeletally immature males [n=4]), and direct trauma (n=5, primarily in adult males [n=4]). Eight patients (60% of adults and 22% of children) had associated injuries of the knee, which commonly occurred after direct trauma. Two patients were treated in a cast or brace after closed or open reduction without fixation. Two patients underwent arthroscopic reduction and internal fixation, and 15 underwent open reduction and internal fixation (2 after failed arthroscopic reduction and 11 proceeded directly). Postoperatively, 7 patients had a positive Lachman test, but none complained of subjective instability. Ten patients had knee stiffness; all except one had been immobilised for 4 to 6 weeks. Seven patients had extension impingement; 6 of them had been treated with open reduction and internal fixation. Two patients underwent further surgery for debridement and screw removal at years 1 and 3. One patient developed arthrofibrosis and underwent arthrolysis at month 6, but knee stiffness remained. No patient underwent subsequent anterior cruciate ligament reconstruction.

Conclusion. Tibial eminence fractures are as common in adults as in children. Female skiers are at higher risk. Stiffness is a more common complication than laxity. Early range-of-motion exercise may reduce stiffness and extension impingement.

Key words: anterior cruciate ligament; tibia
INTRODUCTION

Tibial eminence fractures were considered a condition of skeletal immaturity and the paediatric equivalent of an anterior cruciate ligament (ACL) rupture. This injury is increasingly common in adults. The injury mechanisms include motor vehicle accidents and sporting activities secondary to forced hyperextension and rotation. We reviewed outcomes of 19 patients with tibial eminence fractures.

MATERIALS AND METHODS

Records of 10 female and 9 male patients with type II (n=3) and type III (n=16) displaced tibial intercondylar eminence fractures treated between 1989 and 2009 were reviewed (Table). The Lower South A Regional Ethics Committee approved the study. Nine of the patients were skeletally immature aged 6 to 15 (mean, 12) years; the remaining 10 patients were aged 19 to 55 (mean, 32) years. 18 were of European descent and one was Maori. 14 involved the left knee. All patients presented with a painful haemarthrosis and reduced range of movement. All fractures could be seen on radiographs. To delineate associated injuries, 4 patients also underwent magnetic resonance imaging and 6 also underwent arthroscopy.

Patient demographics, injury mechanism, symptoms, range of motion, collateral ligament stability, complications, and follow-up duration were recorded, as were associated injuries to the knee, interposition of meniscal or inter-meniscal ligamentous tissue, and surgical technique. Patients were contacted if records were incomplete to determine any further complications or whether further operative intervention had been undertaken.

RESULTS

The most common activity causing this injury was skiing (5 adults and 2 children), followed by cycling or motocrossing (2 adults and 4 children) and falling or other sporting activities (3 adults and 3 children). All 5 adult skiers were female and aged 19 to 40 (mean, 25) years; the injury mechanism was forced flexion with rotation while landing a jump and falling backward in a crouched position. The other injury mechanisms entailed direct trauma (3 adults and 2 children) and hyperextension with rotation (2 adults and 5 children).

Eight patients (60% of adults and 22% of children) had associated injuries of the knee, which commonly occurred after direct trauma (in 3 of 5 patients). The associated injuries were medial collateral ligament tear (n=4), lateral collateral ligament tear (n=2), lateral meniscal tear (n=2), medial meniscal tear (n=1), popliteus tear (n=1), medial tibial plateau fracture (n=1), and lateral tibial plateau fracture (n=1).

The mean interval from injury to surgery was 6 (range, 1–25) days. Two patients were treated in a cast or brace locked in extension for 6 weeks after closed or open reduction, which was stable under the intermeniscal ligament and thus fixation was not performed. Two patients underwent arthroscopic reduction and internal fixation, and 15 underwent open reduction and internal fixation through an anteromedial parapatellar arthrotomy (2 after failed arthroscopic reduction and 11 proceeded directly). In addition, 3 patients had inter-meniscal ligament interposition and 3 had meniscal entrapment. Fixation was performed using sutures (for 2 adults and 6 children) or a screw (for 7 adults and 2 children).

The mean length of hospital stay was 3 (range, 0–7) days. Postoperatively, the leg was held in extension with a cast or brace for 4 to 6 weeks (n=12) or <2 weeks for early graduated range of movement (n=7).

Three overseas patients were lost to follow-up. The mean follow-up period for the remaining 16 patients was 45 (range, 6–260) weeks. Seven patients had a positive Lachman test, but none complained of subjective instability. Ten patients had knee stiffness, with the range of movement being <10° to 120°; all except one had been immobilised for 4 to 6 weeks, compared to 2 of 6 patients who had no knee stiffness had been immobilised. Seven patients had extension impingement, despite having been held in extension for 4 to 6 weeks; 6 of whom had undergone open reduction and internal fixation (4 with a screw and 2 with a suture) and one adult had been treated conservatively.

Two patients underwent further surgery for debridement and screw removal at years 1 and 3. One patient developed arthrofibrosis and underwent arthrolysis at month 6, but knee stiffness remained (range of motion, 15°–110°). No patients underwent subsequent ACL reconstruction.

DISCUSSION

Tibial eminence fractures can be classified into 4 types depending on fracture displacement. Type I is undisplaced, Type II is partially displaced or hinged, and type III is completely displaced, whereas type IV refers to comminuted fractures. They are more common in children, as the incompletely ossified tibial...
eminența nu este la nivelul ACL, și sunt considerate echivalentul pediatric al rupturilor ACL.13 Cu toate acestea, rupturile ACL la copii și apațuri tibiale în adulți sunt de mai multe ori reconnoscute. 

<table>
<thead>
<tr>
<th>Sex/age (years)</th>
<th>Activity causing injury</th>
<th>Injury mechanism</th>
<th>Injury side</th>
<th>Severity (type)</th>
<th>Associated injury</th>
<th>Treatment*</th>
<th>Immobilisation (weeks)</th>
<th>Range of motion (ROM)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/13</td>
<td>Motocross</td>
<td>Hyperextension + rotation</td>
<td>Left</td>
<td>III</td>
<td>Lateral meniscal tear</td>
<td>ARIF (suture)</td>
<td>2</td>
<td>0°–130°</td>
<td>-</td>
</tr>
<tr>
<td>M/13</td>
<td>Rugby</td>
<td>Direct trauma</td>
<td>Right</td>
<td>III</td>
<td>-</td>
<td>ORIF (suture)</td>
<td>Early graduated ROM exercise</td>
<td>0°–120°</td>
<td>-</td>
</tr>
<tr>
<td>M/13</td>
<td>Fall while running</td>
<td>Direct trauma</td>
<td>Left</td>
<td>II</td>
<td>-</td>
<td>Open reduction &amp; casting</td>
<td>6</td>
<td>0°–90°</td>
<td>-</td>
</tr>
<tr>
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<td>Skiing</td>
<td>Forced flexion + rotation</td>
<td>Left</td>
<td>III</td>
<td>-</td>
<td>ORIF (suture)</td>
<td>6</td>
<td>0°–130°</td>
<td>-</td>
</tr>
<tr>
<td>M/12</td>
<td>Skiing</td>
<td>Forced flexion + rotation</td>
<td>Left</td>
<td>III</td>
<td>-</td>
<td>ORIF (screw)</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>M/14</td>
<td>Bicycling</td>
<td>Hyperextension + rotation</td>
<td>Left</td>
<td>II</td>
<td>-</td>
<td>ORIF (suture)</td>
<td>Early graduated ROM exercise</td>
<td>-</td>
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</tr>
<tr>
<td>M/14</td>
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<td>Hyperextension + rotation</td>
<td>Left</td>
<td>III</td>
<td>-</td>
<td>ARIF (suture)</td>
<td>6</td>
<td>0°–130°</td>
<td>-</td>
</tr>
<tr>
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<td>Forced flexion + rotation</td>
<td>Right</td>
<td>III</td>
<td>Medial collateral ligament tear</td>
<td>ORIF (screw)</td>
<td>4</td>
<td>10°–120°</td>
<td>Screw removal</td>
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<td>Forced flexion + rotation</td>
<td>Left</td>
<td>III</td>
<td>-</td>
<td>ORIF (screw)</td>
<td>6</td>
<td>20°–90°</td>
<td>-</td>
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<td>Forced flexion + rotation</td>
<td>Right</td>
<td>III</td>
<td>Medial collateral ligament tear</td>
<td>ORIF (screw)</td>
<td>Early graduated ROM exercise</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>Forced flexion + rotation</td>
<td>Right</td>
<td>III</td>
<td>-</td>
<td>ORIF (screw)</td>
<td>2</td>
<td>0°–130°</td>
<td>-</td>
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<tr>
<td>F/29</td>
<td>Fall</td>
<td>Hyperextension + rotation</td>
<td>Left</td>
<td>III</td>
<td>Lateral tibial plateau fracture + medial meniscal tear</td>
<td>ORIF (suture)</td>
<td>4</td>
<td>20°–60°</td>
<td>Arthrolysis</td>
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<tr>
<td>M/32</td>
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<td>Direct trauma</td>
<td>Left</td>
<td>III</td>
<td>Medial tibial plateau fracture + Medial collateral ligament tear + lateral collateral ligament tear + popliteus tear</td>
<td>ORIF (suture)</td>
<td>2</td>
<td>0°–100°</td>
<td>-</td>
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<tr>
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<td>Tyre vs. knee</td>
<td>Direct trauma</td>
<td>Left</td>
<td>III</td>
<td>Lateral collateral ligament tear</td>
<td>ORIF (screw)</td>
<td>2</td>
<td>0°–120°</td>
<td>-</td>
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<tr>
<td>F/34</td>
<td>Netball</td>
<td>Hyperextension + rotation</td>
<td>Left</td>
<td>III</td>
<td>Medial collateral ligament tear</td>
<td>ORIF (screw)</td>
<td>4</td>
<td>0°–90°</td>
<td>-</td>
</tr>
<tr>
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<td>Skiing</td>
<td>Forced flexion + rotation</td>
<td>Left</td>
<td>III</td>
<td>-</td>
<td>ORIF (screw)</td>
<td>4</td>
<td>10°–90°</td>
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</tr>
<tr>
<td>F/55</td>
<td>Motocross</td>
<td>Direct trauma</td>
<td>Left</td>
<td>II</td>
<td>Lateral meniscal tear</td>
<td>Closed reduction &amp; casting</td>
<td>6</td>
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<td>-</td>
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</tbody>
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* ORIF denotes open reduction and internal fixation, and ARIF arthroscopic reduction and internal fixation

Both ACL ruptures in children and tibial spine avulsions in adults are increasingly recognised. Tibial
spine fractures are similarly common in children and adults,5 with a ratio of 60 to 40% or 40 to 60% (with avulsions comprising 14% of all ACL injuries). The male:female and the child:adult ratios have been reported to be about equal,1,2,5,12,15 which is consistent with our study.

The activities causing this fracture include motor vehicle accidents, sports injuries, and falls that cause hyperextension, hyperflexion, and/or rotation.1,2,5,12,15 The frequency of ski-related injuries is higher near ski fields and among females.7,10,16,17 In 13 children/adolescents and 9 adults alpine skiers with grade-II or -III intercondylar eminence fractures,7 all were females, and the female predilection may be due to relative osteopenia.

Hyperflexion and rotation is the common injury mechanism, as the skier falls back on landing a jump. Direct anterior translation of the tibia on the femur by the boot top combined with a strong quadriceps contraction is the injury mechanism for ACL rupture in more experienced skiers.18 Females have a higher predilection for ACL rupture in sports like soccer and basketball19 but not skiing.20 Hyperextension and rotation is more commonly related to immature patients and bicycle or motobike injuries when the leg is extended to the floor for balance while the body rotates around the leg during skiding or turning a tight corner. Direct trauma occurs more commonly in adult males during motobike accidents. In skeletally immature persons, the impact is less harmful and usually without associated injuries. Associated injuries are more common in adults (with a frequency ranging 19 to 44%2,10,12 and include chondral, meniscal, capsular, bony, and ligamentous injuries.2 In our study, 60% of adults and 22% of children had associated injuries, usually secondary to direct high-energy trauma, collateral ligament injuries being the most common.

Conservative treatment with casting is recommended for type-I fractures and reducible type-II fractures. For displaced or irreducible fractures, open reduction and internal fixation achieves more favourable outcomes, as this enables direct removal and manipulation of soft-tissue interposition such as meniscal or inter-meniscal ligament entrapment.8 A screw is usually used for fixation in skeletally mature patients. For younger patients, a physeal-sparing approach with a suture or short screw is recommended. There are various techniques for arthroscopic fixation using sutures,3,5,14,21,22 Kirschner wires or eyed Steinman pins,10,23 and screws.7,17,21 Suture fixation has the advantage of not entailing metalware removal, but the fixation must be secure enough for early mobilisation.3 Early results of arthroscopic fixation are excellent.14 Treatment outcomes in younger patients are generally better.7 This may be due to the lower liability to associated injuries.

Despite anatomic reduction, anterior instability, stiffness (especially loss of knee extension), and pain on knee extension are common complications.24 In children, the ACL stretches prior to avulsion of the tibial spine and results in laxity.23 Subjective instability is rare. Adults with tibial spine fractures have significantly less laxity and better proprioception than those with an ACL-deficient knee after treatment.16 In our study, no patients complained of subjective instability, although 7 had a positive Lachman test. Most of them had returned to the same level of activity and none underwent further surgery for instability. Stiffness (with or without extension impingement) was the more common complication (rather than instability), especially in adults. This may have been related to our practice of using a cast or brace postoperatively. Early range-of-motion exercises are recommended to reduce stiffness.

60% of children with tibial eminence fractures had a loss of extension of >10°,12 which may be attributed to a bony block, screw impingement, or a Cyclops lesion.24 The bony block may represent incomplete reduction, but loss of extension still occurs despite anatomic reduction. In children, overgrowth of the spine may be the cause.4 A few patients may develop arthrofibrosis or more severe stiffness even after arthroscopic treatment and early movement; the reoperation rate can be up to 29%.5,7,21 Anatomic reduction, secure fixation, and early range of movement are recommended to prevent stiffness and restore full extension. If stiffness or arthrofibrosis occurs, arthroscopic debridement, screw removal, and/or manipulation under anaesthetic should be performed.

REFERENCES


