Arthroscopic fixation of avulsion fractures of tibial eminence using cannulated screws

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Purpose
Assessment of the short-term results of arthroscopic fixation of types II and III fractures of the tibial eminence using cannulated screws.
Type of study
This was a prospective study.
Patents and methods
A review of 16 patients with Meyers and McKeever type II or III fractures of the tibial eminence were treated with arthroscopic cannulated screw fixation at Zagazig University Hospital between May 2013 and January 2016. The International Knee Documentation Committee form, Lysholm Knee Score, and Tegner Activity scale for assessment were used for preoperative and postoperative assessments. The study group included seven men and nine women. Their average age was 25.4 years (range: 17.5–43 years). Mean follow-up time was 27 months (range: 24–32 months). The study included six type II and 10 type III fractures.
Results
At follow-up clinical examination, all the patients with types II and III lesions had a negative Lachman test result and a full range of motion, except one patient with flexion contractures (extension lag 10°). The mean Tegner score was 7 and mean Lysholm score was 96. All patients except one returned to preinjury activity levels. However, in general, the best outcomes were seen in younger patients who had significantly better scores for the International Knee Documentation Committee. In six cases, the intermeniscal ligament was interposed between the tibia and the avulsed fracture and was retracted to allow reduction of the fracture, and there were no significant differences in the outcomes of these patients.
Conclusions
Arthroscopic fixation with cannulated screws for types II and III of avulsion fractures of the tibial spine provides a satisfactory outcome. Arthroscopic treatment allows for complete inspection of the joint regarding associated injuries, fast rehabilitation, and decreased hospital stay. Moreover, fixation with cannulated screws gives firm fixation of the fragment and an early start of the range of motion.

Keywords:
anterior cruciate ligament, arthroscopy, fixation, outcome, screw, tibia eminence, tibial avulsion fracture

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Introduction

The anterior tibial spine (ATS) fracture is an avulsion fracture of the tibial attachment of the anterior cruciate ligament that may cause knee instability, and the intra-articular fragment may cause mechanical blocking to knee flexion and extension [1].

Intercondylar eminence fractures of the tibia result from extreme ACL tension that causes tibial bone avulsion rather than ACL substance rupture [2].

It is sometimes misunderstood that avulsion fracture of the intercondylar eminence occurs only in the younger population, though less common, tibial intercondylar eminence fractures also occur in adults [3].

Anatomical reduction and a stable internal fixation of avulsion fractures of tibial eminences are required to restore normal knee biomechanics [4].

In 1959, Meyers and McKeever [5] introduced a classification of the ATS fractures into three types. In type I, the fragment is minimally displaced. In type II, the anterior part is elevated but the fragment still has bony contact posteriorly. A completely avulsed fragment is classified as type III. Later, Zaricznyj [6] added a type IV fracture in which the completely avulsed fragment is comminuted.

In 1982, McLennan [7] introduced arthroscopic reduction and fixation with percutaneous pins in the treatment of displaced type III ATS fractures. Since then, many arthroscopic techniques have been described in the literature using reduction only or in combination with pullout sutures, screws, or metallic pins [8].

Many associated soft tissue involvements in and around the knee, including chondral, meniscal, and ligament damage have been reported with avulsion fractures of tibial eminences [9]. Identification and treatment of these injuries, combined with the need for accurate reduction of these fractures to ensure stability of the knee postoperatively, make arthroscopic examination critical in the successful treatment of types II and III fractures [10].

Patients and methods

We conducted a review of 16 patients with Meyers and McKeever type II or III fractures of the tibial eminence treated with arthroscopic cannulated screw fixation at our university hospital between May 2013 and January 2016. We used the International Knee Documentation Committee (IKDC) form, Lysholm Knee Score, and Tegner Activity scale for assessment.

Surgical technique

All cases were done under spinal anesthesia with the use of tourniquet. The leg was flexed at the end of the surgery table. The contralateral leg was supported and well-padded and abducted to the side to allow fluoroscopy of the involved extremity in both anteroposterior and lateral projections.

A standard anterolateral portal was established. A fluid pump in the range of 50–70 mmHg was used to promote hemostasis and adequate visualization. The hematoma was evacuated until visibility improved. After the pathology was visualized, the notch, patellofemoral compartment, and medial and lateral compartments were examined to determine initial injury or underlying conditions.

A spinal needle was used for localization of anteromedial portal. An arthroscopic probe was used to manipulate the fragments and to begin debridement of the clotted blood. A 4.5-mm synovial resector was used to further debride the region and to remove clot and loose pieces of cancellous bone from the bed. It is important to determine the amount of displacement, comminution, and soft tissue involvement. The medial meniscus, lateral meniscus, and intermeniscal ligament are examined and probed to determine their relationship to the fracture fragments. The ACL should be examined for ecchymosis and attenuation. The medial compartment in particular is evaluated for articular involvement, as many of these injuries involve a significant portion of the medial tibial plateau. The fragment was assessed regarding comminution and the possibility of fixation by one or two screws without breaking (type II and III fractures), which is the case in all patients included in this study. Patients with comminuted tibial spine fracture (type IV) were excluded from this study, as they need a different type of fixation and are not the target of our study.

The probe inserted through the anteromedial portal was used for reduction. In six cases, interposition of the intermeniscal ligament prevented complete reduction. When this occurred, the probe was used to pull the ligament anteriorly while a probe or ACL guide was used through an accessory medial portal to maintain reduction. In cases in which the ligament blocked reduction and could not be mobilized effectively, it was resected allowing reduction without obstruction.

After achieving anatomical reduction, a 1.8-mm K-wire was placed percutaneously from a medial parapatellar position and was used to fix the fragments in a reduced position. Fixation was achieved with one or two 4.0-mm cannulated screws according to the fragment size. The screws were placed from a superomedial portal positioned at a level of mid to upper patella with a percutaneous technique. One or two guide wires were inserted into the fragment according to its size, taking care not to penetrate the posterior cortex of the tibia. Care was taken when passing the screw over the guide wire to avoid causing damage to the articular cartilage with the threads of the screw. Fluoroscopy was used frequently while the screw was advancing to ensure the wire was not being pushed out the back of the tibia. We usually do not countersink the screws' heads too much to avoid breaking the fragment, as they usually lodge in the intercondylar notch and will not interfere with full extension, keeping in mind that all screws will be removed after complete union.

Although synovial leakage is a rather rare complication after a normal arthroscopic procedure, the leg is protected for 1 week postoperatively with an above-knee plaster cast to prevent synovial leakage. Postoperative rehabilitation of knee included allowing range of motion from 0 to 30° and 0 to 90° in 2 and 4 weeks after surgery, respectively. Weight bearing was allowed as tolerated, and a night locking brace in full extension was applied. The stability of the knee was evaluated manually. A Lachmann test was performed, and the range of motion and quadriceps weakness were checked. All the patients were interviewed according to the Lysholm functional score. All the screws were removed within 4-12 months after surgery. No complications were encountered after removing these screws (Fig. 1).

Figure 1 shows (a) a radiographic lateral view showing avulsed tibial spine. (b, c) MRI coronal views show the avulsed tibial spine. (d, e) MRI sagittal views show the avulsed tibial spine. (f, g, h, i) Arthroscopic views show the fracture site of the avulsed tibial spine after dislodgment of the interposed intermeniscal ligament. (j, k, l) Intraoperative radiography by C-arm shows reduction and length and direction of the screws. (m, n) Arthroscopic images show the tibial spine well reduced and fixed by canulated screws. (o, p) Postoperative radiography shows reduction and length and direction of the screws.

Results

The study group included seven men and nine women. Their average age was 25.4 years (range: 17.5–43 years). Mean follow-up time was 27 months (range: 24–32 months). The study included six type II and 10 type III fractures. There were no associated injuries in type II lesions, and one case has a lateral meniscal tear, and one case has a medial meniscal tear in the type III group treated by partial meniscectomy (Tables 1 and 2).

At follow-up evaluation, the clinical examination showed that all the patients with types II and III lesions had a negative Lachman test, and a full range of motion except one patient (case no. 8) with flexion contractures (extension lag 10°) (Table 2).

In six cases, the intermeniscal ligament was interposed between the tibia and the avulsed fracture and was retracted to allow reduction of the fracture, and there were no significant differences in the outcomes of these patients.

We used Lysholm knee scoring system to assess subjective symptoms. The mean preoperative Lysholm score in the 16 knees was 42 (range: 32–58), and the mean postoperative Lysholm score at the final follow-up was 96 (range: 81–100). One patient achieved fair outcome. No patient had a poor outcome. Lysholm scores significantly differed between preoperative evaluation and the final follow-up ($P<0.001$) (Table 3).

All patients (except one) had resumed their full activity by 12 months. Preinjury activity levels for all patients ranged from strenuous to moderate. At the time of surgery, only three of 16 patients (18.75%) had light activity levels, and 30 (81.25%) had sedentary activity levels. Of the 16 patients, 15 (93.75%) achieved strenuous to moderate activity levels at the final follow-up, whereas one (6.25%) could perform light activity. Thus, activity levels significantly improved after surgery ($P<0.001$) (Table 4).

The mean Tegner score for the 16 patients was 3 (range: 2–5) preoperatively, whereas the mean postoperative Tegner score was 7 (range: 6–9). This shows significant ($P<0.001$) improvement (Table 5).

Discussion

The tibial spine or intercondylar eminence is the nonarticular bony prominence between the articular surfaces of the medial and lateral plateau and serves as an attachment for the cruciate ligaments [11].

Meyer and McKeever [5] originally classified this fracture into three subgroups according to the severity. A type I fracture exhibits minimal displacement with good bone apposition, whereas a type II fractures represents displacement of anterior one-third to one half of the avulsed fragment, which is hinged at the posterior border. A type III fracture has complete displacement and usually rotation from proximal tibial epiphysis. Zaricznyj [6] added a fourth type with comminuted fragments.

The treatment of avulsion anterior spine fractures depends on the type of fracture. Types I and II can be treated conservatively using a long-leg cast for 6–8 weeks. Type II fracture is better fixed with a cannulated screw because it is possible to have persistent instability or a conversion to type III. Because of unsatisfactory results from nonoperative treatment and to prevent nonunion or malunion, which can cause knee pain, disability, instability, or loss of full extension, types III and IV fractures are treated by surgical reduction and internal fixation to restore the articular surface, provide rigid internal fixation, and to locate the ACL to its anatomic insertion at its proper length [7,12].

Various methods of reduction and fixation have been proposed for these fractures, each having its own advantages and disadvantages. These included arthrotomy with wires, screws, pins, or suture fixation or arthroscopically assisted internal fixation with cannulated screws, percutaneous pins, and suture fixation with and without hardware [4,7,9,10,12,13].

Figure 1

Shows (a) a radiographic lateral view showing avulsed tibial spine. (b, c) MRI coronal views show the avulsed tibial spine. (d, e) MRI sagittal views show the avulsed tibial spine. (f, g, h, i) Arthroscopic views show the fracture site of the avulsed tibial spine after dislodgment of the interposed intermeniscal ligament. (j, k, l) Intraoperative radiography by C-arm shows reduction and length and direction of the screws. (m, n) Arthroscopic images show the tibial spine well reduced and fixed by canulated screws. (o, p) Postoperative radiography shows reduction and length and direction of the screws.

An arthroscopic pullout suture is a difficult technique and is indicated for smaller comminuted fragments [14].

Arthroscopic internal fixation using a cannulated screw is a simple and rigid bone fixation allowing early motion. Screw insertion is indicated for cases where there is large (¼15 mm square) and noncomminuted fragments; this can be done either antegrade or retrograde [12].

In a biomechanical study, Tsukada *et al.* [12] found that antegrade screw fixation for type III fractures showed less anterior translation under cyclic loading than Ethibond suture fixation.

In our study, all cases were types II and III, so the fragment is large enough and noncomminuted allowing arthroscopic bone fixation with minimal invasion using one or two cannulated screws according to the fragment size inserted in antegrade direction.

Our results at the final clinical examination and assessment by Lysholm, IKDC, and Tegner scores are comparable to the results of Huang *et al.* [14] and May *et al.* [15].

Our results at the final follow-up are comparable to the results of Hunter and Willis [16]. In their retrospective study of 17 cases of intercondylar eminence fractures (eight type II and nine type III) treated with either suture or screw fixation with a mean follow-up of 32.6 months, the mean Tegner score was 6.35 and mean Lysholm score was 94.2 at final examination. They showed no significant differences in outcomes regarding type of fixation.

Table 1 Demographic data of the patients

Type of fracture (II/III)	6/10
Mean age in years (range)	17.5–43 (25.4)
Sex (male/female)	7/9
Mean time from injury to surgery in days (range)	4.93 (2–14)
Mean follow-up duration in months (range)	27 (24–32)

Table 3 Comparison of Lysholm Knee Scores preoperatively and at the final follow-up

Lysholm Knee Score	Preoperatively [*n* (%)]	At the final follow-up [*n* (%)]
Excellent (95–100)	0	13 (81.25)
Good (84–94)	0	2 (13)
Fair (65–83)	0	1 (6.25)
Poor (_65)	16 (100)	0
Mean	42	96
Range	32–58	81–100

Table 4 IKDC rating preoperatively and at final follow-up

Rating	Preoperatively [*n* (%)]	At final follow-up [*n* (%)]
A (normal)	0	14 (87.5)
B (nearly normal)	0	1 (6.25)
C (abnormal)	3 (18.75)	1 (6.25)
D (severely abnormal)	13 (81.25)	0

Table 5 Comparison of Tegner activity level preoperatively and at the final follow-up

Tegner activity level	Preoperatively [*n* (%)]	At the final follow-up [*n* (%)]
0–3	12 (75)	0
4–6	4 (25)	1 (6.25)
7–10	0	15 (93.75)
Mean	3	7
Range	2–5	6–9

Table 2 Demographic data of the patients

Case	Sex	Age (years)	Type of fracture (II/III)	Side	Interval to operation (days)	Mechanism of injury	Associated injury*	Mobility postoperative
1	M	19	II	R	3	RTA	–	Complete
2	F	30	III	L	12	RTA	–	Complete
3	F	21	II	R	5	RTA	–	Complete
4	M	17.5	III	L	8	Fall	M M T	Complete
5	F	24	III	L	2	Fall	–	Complete
6	M	23	III	L	4	Fall	–	Complete
7	F	27	II	L	2	RTA	–	Complete
8	M	34	III	R	6	Sport	–	Ext. lag 10°
9	M	18	III	R	9	Fall	–	Complete
10	F	18.5	II	L	2	Fall	–	Complete
11	F	22.5	III	R	3	Sport	–	Complete
12	F	26	III	L	4	RTA	–	Complete
13	M	43	II	L	11	RTA	–	Complete
14	F	21	III	R	5	Sport	L M T	Complete
15	F	29	III	R	3	Fall	–	Complete
16	M	33	II	L	2	Fall	–	Complete

F, female; L M T, lateral meniscus tear; L, left; M M T, medial meniscus tear; M, male; R, right; RTA, road traffic accident. *Mean nothing here.

Our results at the final follow-up are also comparable to the results of Senekovic and Veselko [8]. In their retrospectively of 32 cases of intercondylar eminence fractures (eight type II fractures, 18 type III, and six type IV) where one or two cannulated screws were used to fix the fracture arthroscopically, soft tissue interposition was noted in all cases. Hardware was removed in 27 of 28 patients. At the 5-year follow-up, the mean Lysholm score was 98.9. Subjective outcomes were normal in 27 patients and nearly normal in one patient.

Our results at the final follow-up are also comparable to the results of Kim *et al.* [17], who in their study of 10 cases of displaced intercondylar eminence fractures fixed by canulated screws at the final clinical examination revealed all patients with type II and III lesions to have a negative Lachman test and no quadriceps weakness except one patient in the type III group. The functional assessment using the Lysholm score was an average of 96.3 (minimum 92.6–maximum 99.0) for all the type II (98.1) and type III (94.9) fractures.

Most of our patients returned to the same level of sports after injury, and no complaints of the knee giving way or episodes of instability were reported. Baxter and Wiley [11] followed up 32 displaced fractures of the tibial spine and had no subjective complaints of instability in their patients. Kim *et al.* [17] reported that all their patients had resumed their full activity by 12 months.

We had no cases of nonunion. Kim *et al.* [17] also had no cases of nonunion in their study.

Wang and colleagues performed a prospective review of 10 consecutive patients (six men and four women) who had sustained tibial spine fractures between 1999 and 2007. All their 10 patients showed radiological bone union at a mean 15.1 weeks postoperatively, with no cases of nonunion. All their patients showed less 3-mm side-to-side difference in KT-2000 arthrometer. The mean difference in KT-2000 arthrometer with contralateral control knee was 2 mm (range: 1.3–2.7 mm). The Lysholm knee score was on average 91.1 (range: 83–96), and the IKDC score was on average 88.6 (range: 81–94) at the final follow-up. They stated that all patients showed full knee ROM, especially without any extension limitation at the final follow-up. None of their patients showed the flexion contracture owing to impingement of notch on the screw head, screw breakage or loosening, infection, or patellar fracture.

Conclusion

Arthroscopic fixation with cannulated screws for types II and III avulsion fractures of the tibial spine is a simple, effective, and safe technique that provides satisfactory outcomes. Screws give stable fracture fixation that allows immediate mobilization with no or minimal loss of extension in type II and III tibial eminence fractures in adults. Arthroscopic treatment also allows for complete inspection of the joint regarding associated injuries, fast rehabilitation, and decreased hospital stay.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Medler RG, Jansson KA. Arthroscopic treatment of fractures of the tibial spine. Arthroscopy 1994; 10:292–295.

2 Ahmad CS, Stein BE, Jeshuran W, Nercessian OA, Henry JH. Anterior cruciate ligament function after tibial eminence fracture in skeletally mature patients. Am J Sports Med 2001; 29:339–345.

3 Willis RB, Blokker C, Stoll TM, *et al.* Long-term follow-up of anterior tibial eminence fractures. J Pediatr Orthop 1993; 13:361–364.

4 van Loon T, Marti RK. A fracture of the intercondylar eminence of thetibia treated by arthroscopic fixation. Arthroscopy 1991; 7:385–388.

5 Meyers MH, McKeever FM. Fracture of the intercondylar eminence of the tibia. J Bone Joint Surg Am 1959; 41:209–222.

6 Zaricznyj B. Avulsion fracture of the tibial eminence: treatment by open reduction and pinning. J Bone Joint Surg Am 1977; 59:1111–1114.

7 McLennan JG. The role of arthroscopic surgery in the treatment of fractures of the intercondylar eminence of the tibia. J Bone Joint Surg Br 1982; 64:477–480.

8 Senekovic V, Veselko M. Anterograde arthroscopic fixation of avulsion fractures of the tibial eminence with a cannulated screw: five-year results. Arthroscopy 2003; 19:54–61.

9 Kendall NS, Hsu SYC, Chan K. Fracture of the tibial spine in adults and children. J Bone Joint Surg Br 1992; 74:848–852.

10 Osti L, Merlo F, Liu SH, Bocchi L. A simple modified arthroscopic procedure for fixation of displaced tibial eminence fractures. Arthroscopy 2000; 16:379–382.

11 Baxter MP, Wiley JJ. Fractures of the tibial spine in children. J Bone Joint Surg Br 1988; 70-B:228–230.

12 Tsukada H, Ishibashi Y, Tsuda E, Hiraga Y, Toh S. A biomechanical comparison of repair techniques for anterior cruciate ligament tibial avulsion fracture under cyclic loading. Arthroscopy 2005; 21:1197–1201.

13 Ando T, Nishihara K. Arthroscopic internal fixation of fractures of the intercondylar eminence of the tibia. Arthroscopy 1996; 12:616–622.

14 Huang T, Hsu K, Cheng C, Chen L. Arthroscopic suture fixation of tibial eminence avulsion fractures. Arthroscopy 2008; 24:1232–1238.

15 May JH, Levy BA, Guse D, Shah J, Stuart MJ, Dahm DL. Tibial spine avulsion: mid-term outcomes and rehabilitation. Orthopedics 2011; 34:89.

16 Hunter RE, Willis JA. Arthroscopic fixation of avulsion fractures of the tibial eminence: technique and outcome. Arthroscopy 2004; 20:113–121.

17 Kim KT, Shon SK, Kim SS, Song CG, Ha IS. Arthroscopic internal fixation of displaced tibial eminence fracture using cannulated screw. J Korean Orthop Assoc 2007; 42:659–664.