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ORIGINAL ARTICLE

Assessment of Outcomes of Arthroscopic Fixation of Avulsed Tibial Spine Type Two and Three

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ABSTRACT

Background: In most cases, the results of arthroscopic fixation for the treatment of avulsed tibial spine in kids and teens are usually satisfactory. Arthroscopic fixation has greater results in younger patients. This study aimed to evaluate the clinical as well as radiological outcomes of avulsed tibial spine management by arthroscopic fixation.

Methods: This is a prospective study carried out on 18 cases, presented with fractures of the tibial intercondylar eminence, and managed by arthroscopic fixation at Zagazig University Hospitals. The follow-up duration was 6 months. Clinical as well as radiological assessments were applied pre and postoperative.

Results: Regarding classification according to Mayers and Mckeever, 10 cases (55.5%) were type II and 8 cases (44.5%) were type III. According to the Lysholm score, 15 cases (83.3%) had excellent outcomes and 3 cases (16.6%) had good outcomes, all cases were negative Lachman postoperatively, and no symptoms of instability. Postoperative complications include effusion which subsided within one month in two patients, superficial wound infection in another one which subsided after usage of appropriate antibiotic, and one patient had lost the last 5o of terminal extension.

Conclusions: Arthroscopic management of avulsed tibial spine injuries has many advantages, including complete joint evaluation, treatment of related injuries, early mobilization, rapid rehabilitation, and a shorter length of stay in the hospital.

Keywords: Arthroscopic Fixation; Avulsed Tibial Spine; Outcomes

INTRODUCTION

Injury to the insertion of the anterior cruciate ligament (ACL) at the tibia, known as a fracture of the tibial eminence, is a common sports injury. Like ACL tears, these injuries can occur in a variety of circumstances, such as car accidents, falls, and sport events [1,2].

About 3 out of every 100,000 people could have an isolated tibial spine avulsion fracture each year. This fracture occurs in a ratio of 60:40 between young people and adults. Contrary to popular belief, adults are not resistant to these fractures [3].

A categorization of these injuries was initially established in 1959 by Meyers and McKeever. This categorization distinguished between three distinct forms of tibial eminence fractures and provided treatment guidelines for each. Type I eminence fractures were those with no or minimum displacement. The lateral radiograph of a type II avulsion shows a beak-like deformity, caused by the displacement of the anterior one-third to one-half of the avulsed bone in the proximal direction. The bone is totally displaced from its normal position in type III fractures. Comminuted and displaced fractures were classified as category IV injuries [4].

Most experts agree that immobilization is the best treatment for non-displaced fractures, while arthroscopic or open reduction and fixation is the best treatment for a displaced tibial spine. The surgical procedure aims to restore knee stability and complete range of motion [5].

In most cases, the results of arthroscopic fixation for the treatment of avulsed tibial spine in kids and teens are usually satisfactory. Arthroscopic fixation has greater results in younger patients [6].

Motion limitation and instability following arthroscopic fixation have been described at alarming rates by some researchers. Because of the tension placed on the ACL just before the tibial spine is torn away, structural damage and functional lengthening may occur despite ligament continuity, leading to this undesirable outcome [7], which means that the knee may not be stabilized after a displaced tibial spine fracture has been fixed. Knee stiffness is a known risk of arthroscopic fixation [5].

This research was conducted to analyze the clinical and radiological results of arthroscopic fixation of the avulsed tibial spine.

METHODS

This is a prospective study on eighteen patients, who presented with a fracture of the tibial intercondylar eminence and were treated with arthroscopic fixation at Zagazig University Hospitals during the period from November 2022 to June 2023. The follow-up period is 6 months. A written informed consent was obtained from all participants and the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University, Institutional Research Board (IRB) number (#10152/27-11-2022) The Declaration of Helsinki, issued by the World Medical Association to ensure the protection of people participating in medical research, was strictly followed during this study.

Inclusion criteria: Adolescents and adults cases who had Meyers and McKeever type II, and III with recent fractures from both genders.

Exclusion criteria: Cases with open fractures, unfit or refuse surgery, cases with Infection or neglected fractures, or comminuted fracture.

All subjects underwent the following: Clinical evaluation which included full history including patient complaint, present, past, and family history in addition to clinical examination which included general and local examination with complete back, hip, and lower limb examination for evaluation of potential and clinically detectable concomitant lesions.

Radiologically, all patients had an anteroposterior & lateral view X-ray, CT, and MRI; a plain X-ray was done in anteroposterior and lateral views. Laboratory investigations included: complete blood count, coagulation profile, Hb A1C, urine analysis, liver and Kidney function tests, and Hepatitis C, and B virus antibodies.

Operative procedure: All procedures were done under a well-padded thigh tourniquet and spinal anesthesia. Supine positioning of the patient. A leg holder was used to suspend the lower leg at around 90 degrees of flexion, where it can hang freely. Under general anesthesia, the patient undergoes a thorough evaluation of the knee to detect any concomitant ligament problems.

Anterolateral and anteromedial arthroscopic portals were employed. There may be a need for more entry points. Diagnosis as routine After arthroscopy confirmed the diagnosis, any meniscal pathology could have been used. Hemarthrosis in the knee was treated with lavage. Once enough of the infrapatellar fat pad has been removed, the ligamentum mucosum can be resected with a shaver. Blood clots and debris were shaved off using a small curette or shaved off with a shaver, and the fracture fragment was raised. Any entombed musculature in the fracture crater was surgically excised. An anteromedial portal probe was used to bring the piece together.

A bird beak was loaded with a number 2 fiber wire and introduced through the anteromedial porter. The ACL was sutured through as close to the bone as possible. Through the anterior cruciate ligament (ACL) portal, a drill guide was inserted. By bringing the drill sleeve up to the patient's skin, you may locate the anteromedial aspect of the tibia epiphysis, where the pins were inserted. The periosteum is lifted through a 2-cm incision made here. Two parallel tunnels 1 cm apart were drilled through the medial and lateral borders of the fracture crater using the ACL drill guide and a 2.4-mm drill tip guide wire. After the lateral guide pin had been extracted, a 2-0 vicryl was threaded into the tunnel and extracted using a grasper at the medial portal. The vicryl was tied to the lateral limb of the fiber wire and then pulled out through the lateral tunnel.

The hook helped shrink and compress the fracture. The anteromedial portal was used to position the point of the C-ring drill guide on the ACL's insertion site. The anteromedial aspect of the tibia was incised so that the matching section of the C-ring guide could be brought into contact with the tibial cortex. The ACL insertion site was marked, and a guide pin was inserted through the guide, across the tibial cortex. The following stage was using a cannulated drill to create a 4-mm hole in line with the pin guide. A drill was used to create a hole in the notch, and the suture was then threaded through and retrieved through the anterior portal. To verify the reduction in fragment size and check the ACL tone, a second look was performed. After the tourniquet was deflated, the remaining fiber wire was snipped just distal to the knot, and the skin was repaired with simple sutures. Injuries are treated with dressings, and the knee is bandaged.

Follow-up: All cases were followed up for at least 6 months using the Lysholm knee score. Also, X-ray (AP) and lateral views of the knee and CT were done to assess callus formation and healing.

Statistical analysis*:* The statistical work was performed in SPSS 28. (IBM Co., Armonk, NY, USA). The Chi-square, t- t-paired, and Paired Wilcoxon tests were used to examine categorical data, which were then displayed as frequencies and percentages.

RESULTS

The mean age of cases was 23.5 years. Regarding sex, 77.8% were male, and the causes of the lesion in 55.6% of the cases were non-contact while in 44.4% were contact, 55.6% of the cases were type I, and 44.4% were type II. Regarding the side, 50% had lesions on the right side and 50% had lesions on the left side (Table 1).

About 77.7% had a fixation with suture mode while 22.3% had tightrope mode. FU ranged from 6 to 12 with a mean of 6.89 (Table 2). There was a statistically significant decrease in Lachman among the studied cases post-operation when compared to pre-operation with a percentage reduction of 100%. (Table 3). About 66.6% of cases had excellent quality reduction, three cases (16.7%) had good quality and three cases (16.7%) had poor quality.

There was a statistically significant decrease in Pivot among the studied cases postoperative compared to preoperative with a percentage of reduction 96.3% (Table 4), while there was a statistically significant increase in Lysholm among the studied cases postoperative compared to preoperative with a percentage of increase 87.3% (Table 5).

We found that 22.7% of the cases had complications. Stiffness was reported in 5.6% of the cases, effusion in 11.1%, and superficial infection in 5.6% of the cases (Table 6).

A female patient, 11 years old, presented with avulsed tibial spine fracture type III, Fixed by suture technique (Figure 1).

Table 1: Characteristics of the studied patients (n=18)

Variable		**(n=18)**	
Age: (years)	Mean ± Sd Median Range	23.5±11.44 21 9-45	
Variable		**No**	**%**
Sex:	Female Male	4 14	22.2 77.8
Type:	II III	10 8	55.6 44.4
Side:	Right Left	9 9	50 50

Table 2: Fixation data among the studied cases

Variable		**(n=18)**	
		No	**%**
Mode:	Suture Tightrope	14 4	77.7 22.3
FU:	Mean ± Sd Range	6.89±1.6 6-12	

Table 3: Lachman among the studied cases pre & postoperative

Variable		Pre (n=9)	Post (n=9)	t	P	% of change
Lachman:	Mean ± Sd Range	2.11 ± 0.75 1 - 3	0 ± 0 0	**11.81**	**<0.001 ****	100%

SD: Standard deviation t: Paired t-test **: highly significant (P<0.001)

Table 4: Pivot among the studied cases pre & postoperative

Variable		Pre (n=9)	Post (n=9)	W	P	% of change
Pivot:	Mean ± Sd Median Range	2.28 ± 0.46 2 2-3	0.11 ± 0.32 0 0-1	**4**	**<0.001 ****	96.3%

SD: Standard deviation Paired W: Paired Wilcoxon test
**: highly significant (P<0.001)

Table 5: Lysholm among the studied cases pre & postoperative

Variable		Pre (n=9)	Post (n=9)	t	P	% of change
Lysholm:	Mean ± Sd Range	50.56 ± 4.49 41 - 57	94.11 ± 3.48 86-98	**44.55**	**<0.001****	87.3%

SD: Standard deviation t: Paired t-test **: highly significant (P<0.001)

Table 6: Complications among the studied cases

Variable		(n=9)	
		No	%
Complications:	No	12	77.3
	Stiffness	1	5.6
	Effusion	2	11.1
	Superficial infection	1	5.6

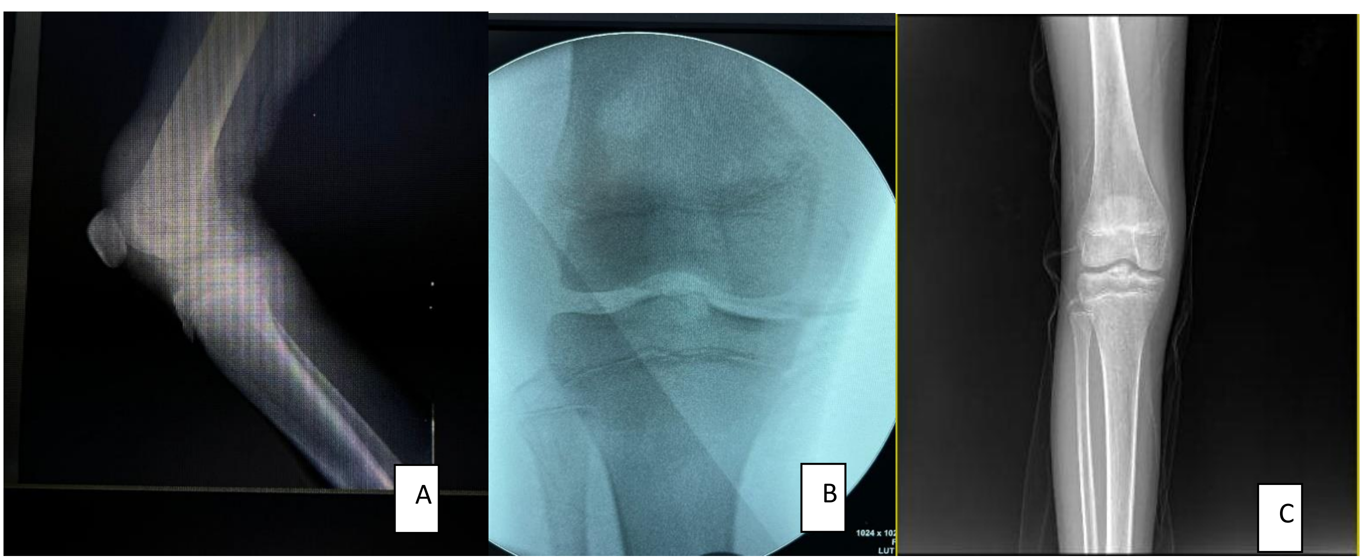

Figure 1: Female patient, 11 years old, presented with avulsed tibial spine fracture type III, fixed by suture technique, (A): Preoperative X-ray, (B): Intraoperative X-ray, (C): Follow-up Postoperative at 6 months A. P view, (D) Follow- up Post operative at 6 months Lateral view

DISCUSSION

The ACL is crucial because it not only helps keep the knee stable and stops the tibia from moving forward, but also because it contains mechanoreceptors that contribute to proprioception [8].

A tibial spine avulsion fracture (TSFA) indicates damage to the anterior cruciate ligament. Knee laxity and impairment in function can result from even a small remaining dislocation. It has been shown that even after anatomical reduction, fractures tend to move. Because of this, it is recommended that all fractures of types II, III, and IV be reduced and fixed. Fixation options for these fractures include excision, K-wire, screw, sutures, and, more recently, suture anchors and meniscal arrows, however, there is no consensus on which is the best [9].

Hunter and Willis [10] found that mostly there were very same effects regardless of fixation type, whereas Seon et al. [11] concluded that screw and suture methods of fixing have yielded satisfactory results in terms of functional outcome and stability.

On the other hand, no.2 fiber wire sutures were shown to have a higher initial ultimate strength than a 4 mm x 40 mm partly threaded cannulated screw with a washer [12], and suture fixation provides more resistance than screw fixation during cyclic loading, as found by Eggers et al. [13].

Since arthroscopic suture fixation may be used on comminuted fractures, it is the method of choice in our department, whereas screw fixation is limited to non-comminuted fractures. In addition, the suture attachment method eliminates the need for subsequent hardware removal.

In this study, 18 patients with tibial spine avulsion underwent arthroscopic fixation in our orthopedic department in Zagazig University hospitals with mean age (23.5±11.44 years) with 14 males and 4 females and 9 patients with Right and 9 left knees.

Those demographic data are similar to Osti et al. [14] (Total sample was ten, seven males and three females women with a mean age of 26.7 years) and Verdano et al. [15] (Total sample of 21 cases, with a mean age of 28 years).

Pretell-Mazzini et al. [16] conducted a systematic study of tibial tubercle fractures dating back to the 1970s, and they found that the great majority (86%) occurred in males. The significant increase in female sports activity since the 1970s may be responsible for this.

In 55.6% of our cases, the mechanism of injury was non-contact 3 patients are athletic 5 moderate to light sports activity and 2 sedentary activity, and

44.4% of the causes were due to road traffic accidents.
Also, Anderson et al. [17] found that non-contact injuries contributed most to the prevalence of avulsion fractures like the mechanism of ACL tears but, unlike intrasubstance ACL tears, eminence fractures tend to happen at lower loading rates.
On the other hand, Pan et al. [18] found that in their analysis, 75% of anterior tibial eminence fractures were caused by traffic accidents.
This study was held to evaluate the outcomes of arthroscopic fixation of avulsed tibial spine type two and three. The method of fixation is determined according to the size and comminution of the fragment. In large fragments (4 cases) we've used tightrope, and in small fragments (14 cases) we've used a suturing technique using fiber wire with no significant difference in the outcome
Our findings showed that the Lysholm score increased significantly at 3 months and 6 months postoperatively. The preoperative Lysholm score was 50.56 ± 4.49 and increased to (94.11 ± 3.48) at 6 months postoperative.
Concerning the results of the Lachman test, highly significant improvement was achieved in the Lachman test postoperatively (P<0.001), all cases had grades 2 & 3 preoperatively, while all of them were negative postoperatively. There were no reports of patients experiencing instability or episodes of giving way.
These values are comparable to Jain et al. [19] who reported that the mean postoperative Lysholm score of the suture cases raised to (91.96 ± 4.40) and (86.00 ± 8.30) for the screw cases. The researchers concluded that the functional outcomes following arthroscopic suture fixation were superior to those following open techniques.
Also, Koukoulias et al. [20] reported an increase in postoperative Lysholm to (94.72±4.97), no signs of instability, and a complete lack of pathological abnormalities on physical exam.
However, our results were inferior to Ballal et al. [21] as they revealed the mean Lysholm score after operation in the thirty knees at 6 months to (97.87 ± 2.047), and at 12 months to (98.17 ± 1.599). Six and twelve months after surgery, the postoperative Lysholm scores were higher significantly, One possible explanation for these remarkable outcomes is the careful selection of highly motivated patients to participate in rehabilitation programs.
Pandey et al. [22] reported that the post-operative Lysholm mean score in 26 patients rose at 6 months to (97.7 ± 3.62). The open physis group had a higher Lysholm score than the closed physis group (99.6 vs. 96.5, p 0.03), and there was no statistically significant difference between the type III and type IV McKeever groups. This better result might be due to the inclusion of younger age groups and longer duration of follow-up.
On the other hand, our results were superior to Russu et al. [9] who used a suture technique in 12 patients with type III tibial spine avulsion. Compared to preoperative values of 53.7 (range: 33–64), postoperative values of 87.7 (range: 72–97) were significantly better (p = 0.0066) for most patients. This may be due to their inclusion of type III only in their study.
Postoperative complications include effusion which subsided within one month in two patients, superficial wound infection in another one which subsided after usage of appropriate antibiotic, and one patient had lost the last 5o of terminal extension.
While Russu et al. [9] reported that no recorded complications in their study, Çağlar et al. [23] revealed that 6,7% had reoperation due to arthrofibrosis and severely limited ROM, Pandey et al. [22] reported that two cases (7%) had flexion contractures of 10° and 40°, Koukoulias et al. [20] reported limited range of motion in one patient (8%) who didn't follow rehabilitation regime.
With considerable improvements in Lysholm scores and radiographs taken after 6 months, the results of this study show that arthroscopic repair in TSAF has good to exceptional results in patients.
There have been reports of very good to exceptional results with this method. The ability to arthroscopically assess and manage the accompanying lesions has made this method the gold standard for tibial eminence avulsion fractures [24]
However, it is important to evaluate tunnel drilling carefully because it may affect the fracture line and subsequently affect the outcomes [24]
Our study had several limitationsThis study's limitations including a lack of long-term follow-up, a small sample size, and stringent inclusion criteria. Another limitation is the study design, which lacked a control group to compare the new procedure to the standard one.

CONCLUSIONS

With an arthroscopic approach, the affected joint may be thoroughly examined, secondary injuries can be treated, early mobilization can occur, recovery time is shortened, and the patient can spend less time in the hospital. Suture fixation has the potential to cure not only isolated big but also minor and comminated fractures and to include the ACL into the fixation system, making it more versatile and biomechanically superior to screw fixation.

There is no need to remove hardware and the danger of harm to a child's developing epiphyseal plate is low. In addition, sutures permit firm fixing and speedy early recovery. Excellent results can be expected whenever arthroscopic suture fixation is used.

Conflict of Interest: None.

Financial Disclosure: None.

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