

# Anterior Tibial Spine Avulsion Fracture With Concomitant Tibial Side Anterior Cruciate Ligament Tear in an Adolescent Male: A Case Report

Ajit Swamy<sup>1</sup>, Ishan Shevate<sup>1</sup>, Girish Nathani<sup>1</sup>, Yogesh Khandalkar<sup>1</sup>

## Abstract

**Introduction:** Tibial spine avulsion fractures are common in children and adolescents. Tibial spine avulsion fracture along with an Anterior cruciate ligament (ACL) tear are rarely reported in paediatric age group. We present a case of an adolescent child with avulsion of anterior tibial spine with complete tear of antero-medial bundle and near total tear of postero-lateral bundle.

**Case Report:** An adolescent male child presented with twisting injury to right knee while playing football. Local examination revealed positive patellar tap, Lachman test and anterior drawer test were grade 2 positive. Radiographs showed type 3 tibial spine avulsion fracture. Magnetic Resonance Imaging (MRI) and arthroscopy confirmed the diagnosis of avulsion with complete ACL tear. We decided to do transphyseal ACL reconstruction using hamstring autograft and excision of the avulsed fragment. Post operatively physiotherapy and weight bearing were started as per pain tolerance. Patient achieved full range of motion and returned to pre injury activity and sports 1 year post operatively.

**Discussion:** After reviewing the literature we found that anterior tibial spine fractures along with ACL tear are most uncommon reported in paediatric age group. In nearly 30-60% cases of displaced tibial eminence fracture, concomitant injury either to the meniscus, ligaments or the articular cartilage were diagnosed on MRI. Reported literature shows no difference in percentage of growth abnormalities in transphyseal verses physeal sparing techniques.

**Conclusion:** A thorough preoperative evaluation with radiographs and MRI is important to detect these injuries and planning the treatment accordingly. Primary ACL reconstruction gives good results in these cases.

**Keywords:** ACL avulsion fracture with tear; Paediatric sports injury; ACL reconstruction; Concomitant ACL avulsion and tear.

## Introduction

Tibial spine avulsion fractures are common in children and adolescents between the age group 8-14 years [1,2]. Paediatric tibial spine avulsion fracture are the counterparts of the anterior cruciate ligament (ACL) tears in adults, as the immature unossified cancellous bone fails before the ligament [3,4]. Tibial spine avulsion fracture along with an ACL tear are rarely reported in adults and less commonly in paediatric age group [5, 6, 7, 8]. A preoperative MRI is essential in diagnosing these concomitant injuries [9, 10]. We present a case of an adolescent child with avulsion of anterior tibial spine with complete tear of antero-medial bundle and near total tear of posterior-lateral bundle which we treated by doing transphyseal arthroscopic ACL reconstruction along with excision of the fracture fragment.

## Case Report

An adolescent male child suffered twisting injury to right knee while playing football and presented to our out-patient department 10 days post trauma. Patient noticed a popping sound followed by pain and give away sensation in right knee joint. He developed significant swelling over the next 12 hours. On local examination of the right knee at presentation there was severe effusion with positive patellar tap. Range of motion was 0° to 90° of flexion and painfully restricted. Lachman test and anterior drawer test were grade 2 without any bony end point. Pivot Shift test couldn't be performed due to pain.

There was no valgus, varus and posterior drawer instability. Radiological investigation showed open physes of femur and tibia with Meyers and Mckeever's type 3 tibial spine avulsion fracture (Figure 1a and 1b) [11, 12].

Magnetic Resonance Imaging Study (MRI) confirmed the displaced avulsion fracture of anterior aspect of intercondylar region of tibia at the attachment site of anterior cruciate ligament. It also revealed a full thickness tear of anterior cruciate ligament near the tibial attachment (Figure 2a and 2b). Patient was posted for arthroscopic procedure after taking informed consent for ACL reconstruction and fixation of avulsed fragment depending on intra operative findings. On performing diagnostic arthroscopy, it confirmed avulsion of tibial eminence with complete tear of anteromedial bundle of ACL from avulsed tibial eminence and near complete tear of posterior-lateral (PL) bundle from the avulsed fragment (Figure 3a,b,c).

We found interstitial haemorrhage and laxity of the remaining PL bundle on reducing the fragment. The femoral attachment was found

<sup>1</sup>Department of Orthopaedics, Dr. D.Y. Patil Medical College, Hospital and Research Centre, Pune, Maharashtra, India.

## Address of Correspondence:

Dr. Ishan Shevate,  
Assistant Professor, Department of Orthopaedics,  
Dr. D.Y. Patil Medical College, Hospital and Research  
Centre, Pune, Maharashtra, India.  
E-mail: ishanshevate@gmail.com



Dr. Ajit Swamy



Dr. Ishan Shevate



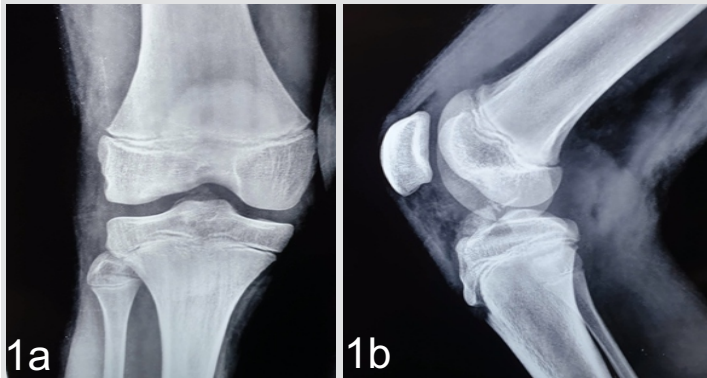
Dr. Girish Nathani



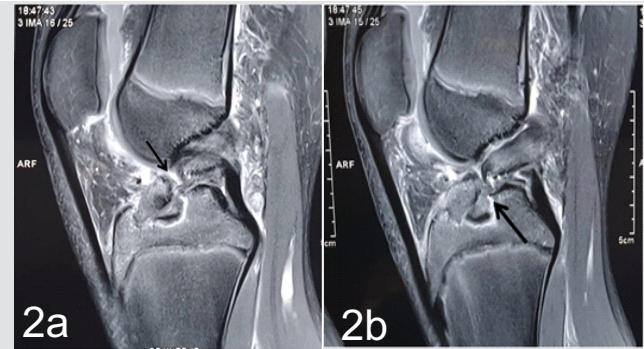
Dr. Yogesh Khandalkar

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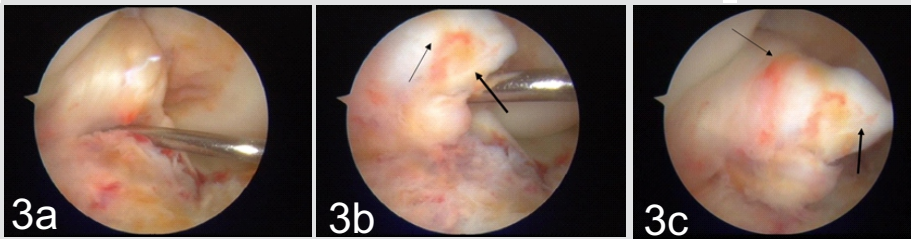
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**Figure 1:** Radiographs showing type 3 displaced anterior tibial spine avulsion fracture with unfused femoral and tibial physes in (a) Antero-posterior and (b) lateral views.



**Figure 2:** T2W sagittal cuts of Magnetic Resonance Imaging confirming tibial spine avulsion. It also shows (a) near total tear of ACL from the tibial side (thin arrow), (b) with few fibres of postero-lateral bundle attached to the avulsed fragment (bold arrow).



**Figure 3:** Intraoperative arthroscopic picture showing (a) Complete tear of the Antero-medial bundle with tip of the probe insinuated between the anterior cruciate ligament fibres and the avulsed fragment, (b-c) few fibres of postero-lateral bundle (thin arrow) attached to the avulsed fragment (bold arrow) with probe being put in the fracture crater.

intact. Considering that the majority of ACL fibres were torn and the remnant intact bundle was significantly injured we decided to do a transphyseal ACL reconstruction using 5 strand gracilis and semitendinosus auto graft and excision of the avulsed fragment. The graft was fixed using a suspensory device at femoral site and bio absorbable interference screw on tibial side. The reconstructed grafts' tension was confirmed and knee stability checked. Post operatively the range of motion exercises and weight bearing were started gradually as per pain tolerance in a straight knee brace along with quadriceps and hamstring rehabilitation. Sequential follow-ups were undertaken after 6 weeks, 3 months, 6 months, 1 and 2 years to see the clinical and functional progress.

2-years follow-up of patient showed no extension lag and full flexion movements from 0° to 140° with negative anterior drawer test and Lachman test. Patient was able to perform pre trauma outdoor and sports activities.

### Discussion

Anterior tibial spine fractures are most commonly seen in skeletally immature patients aged 8 to 14 years [12,13]. These fractures are relatively uncommon in adults. They are found to occur due to the failure of immature cancellous tibial spine area before the tear of anterior cruciate ligament (ACL)

[3,4]. Noyes et al in their biomechanical study of ACL failure found an incidence rate of 14% for a combined tibial eminence fracture and ligamentous rupture. They demonstrated that a slow deforming rate results in increased frequency of tibial eminence avulsion but faster loading conditions resulted in increased frequency of ligament injuries. The high amount of forces that fractures the tibial spine causes ACL elongation and partial failure due to the attenuation of its biomechanical structure leading to laxity and instability [14]. Though such cases are rarely come across in routine practice, getting a pre-operative magnetic resonance imaging (MRI) done is essential to diagnose such concomitant ACL injuries and plan for ACL reconstruction or meniscus repair accordingly. In nearly 30-60% cases of displaced tibial eminence fracture, concomitant injury either to the meniscus, ligaments or the articular cartilage [15,16]. Most common injury in simultaneous anterior tibial spine fracture and ACL injury was found to be lateral meniscus tear [7]. Johnson et al found 6 meniscus tears and 2 ligaments injuries including medial collateral ligament and postero-lateral corner injury in 20 cases of paediatric tibial eminence fracture. They concluded that associated ligament injuries are less often diagnosed than meniscus tears on preoperative MRIs as compared to

arthroscopy [16]. In an MRI study to detect concomitant injuries with tibial spine fracture, 27% adults had associated ACL mid substance tear but none in paediatric population with tibial eminence fracture [5].

In our case preoperative MRI showed a type 3 displaced tibial spine avulsion fracture along with a near total ACL tear, with few fibres of posterolateral bundle attached to the avulsed fragment. There was also a grade 2 medial meniscus and grade 1 lateral meniscus tear associated, which did not require any further treatment.

Concomitant anterior tibial spine fracture and ACL tear are less commonly reported in the literature so far. Levy et al reported 2 cases of displaced tibial avulsion fracture with associated ACL interstitial tear in adults [6]. In an observational cohort study by Mayo et al, it is reported that around 19.4% of skeletally immature adolescents with tibial spine fractures also had concomitant ACL injury, with older adolescent males being at the highest risk of this combined injury [7]. Wilfinger et al retrospectively evaluated 38 patients clinically, 3 years post non-surgical treatment of anterior tibial spine fractures and found that 5 out of 9 patients had ACL injury on MRI [2]. In a case report by Yamauchi et al, they demonstrated that concomitant tibial avulsion fracture and midsubstance ACL tear can occur in skeletally immature patients. They emphasized the need of preoperative MRI to detect these lesions and help identify the cases which may need a reconstruction [8]. In spite of the efficacy of MRI to diagnose ACL tear, its limited ability to detect ACL injury in acute stage associated with tibial eminence fracture has been reported in the literature. Majority being identified intraoperatively. However, it is effective in diagnosing meniscal and chondral injuries associated with type 2 and 3 tibial spine avulsion fracture [7, 9, 10].

As opposed in our case we were able to detect the ACL tear in the MRI.

Meyers and McKeever classified fracture of the intercondylar eminence of tibia and reported a follow-up study after 10 years, showing that almost 50% patients had poor outcome after conservative treatment of type 2 and 3 fractures and arthroscopy assisted repair of all injured ligaments may improve the results [17]. Kocher et al in their study of children and adolescents with partial tears of the ACL, found about 31% patients needed ACL reconstruction (ACLR) for the complaints of instability in the future. They also observed increased age as a risk factor for symptomatic instability requiring ACLR. Hence it can be stated that concomitant tibial spine fracture and ACL tear in an older adolescent has increased risk for future instability needing ACLR [18].

In the 2 cases reported by Levy et al with type 3 tibial spine avulsion fracture, with an associated interstitial tear, primary ACLR was done to prevent any anterior knee instability related to ACL injury if only reduction and fixation was done [6]. Yamauchia et al performed ACL avulsion fixation in spite of a posterolateral bundle midsubstance tear as good stability was achieved after the avulsed fragment fixation [8]. In our patient, we went ahead with arthroscopic removal of the

avulsed fragment of the anterior eminence along with the torn and hemorrhagic remnant ACL fibres. Reduction and fixation of its remaining posterolateral bundle fibres attached to the avulsed fragment could have been performed with an augmentation graft for the anteromedial bundle, but due to the evidence of injury to the remaining fibres in the form of hemorrhage and laxity which may lead to subsequent instability, we decided to do a ACLR with 5 strand hamstring autograft.

The reconstruction of ACL in skeletally immature patients still remains a controversial topic. The physeal sparing technique is a good option for reconstruction in younger patients with Tanner stage 0 and 1 growth [1, 19]. Routine anatomic transphyseal tunnels are recommended in adolescents with Tanner stages 4-5 and stages 2-3 as well with some modifications to avoid physeal injuries [20]. In a 10 years follow-up study by Calvo et al the transphyseal ACLR was found to be a safe procedure with good functional and clinical outcomes without significant growth alterations [11]. According to recently published systematic review by Collins et al, the growth disturbances after ACLR in patients with unfused physes are under-reported and the etiology of these abnormalities is not clearly understood [21]. In another systematic review of transphyseal

verses physeal sparing techniques, Pierce et al reported no difference in percentage of growth abnormalities [22]. Our patient had tanner stage 4 growth and taking the published literature into consideration the author decided to do a transphyseal ACLR, with no significant growth disturbances at 2 years follow-up. Patient returned to pre injury sports activity with good clinical and functional outcomes. A pre-operative counseling of the patient and the parents about the risk of angular and length related growth abnormalities is very important. Limitation of our study is that we didn't evaluate for the results with fixation of the remnant ACL bundle with augmentation for the anteromedial bundle.

A further research is required in finding out the outcomes in a larger cohort of patients and also comparing for the results with fixation along with augmentation technique.

### Conclusion

Tibial eminence avulsion fracture with concomitant ACL tear is a relatively rare injury in skeletally immature patients. A thorough preoperative evaluation with radiographs and MRI is important to detect these injuries and planning the treatment accordingly. Primary ACL reconstruction gives good results in these cases.

## References

- Anderson AF. Transepiphyseal replacement of the anterior cruciate ligament in skeletally immature patients. A preliminary report. *J Bone Joint Surg Am.* 2003;85(7):1255-1263. PMID: 12851350.
- Wilfinger C, Castellani C, Raith J, et al. Nonoperative treatment of tibial spine fractures in children-38 patients with a minimum follow-up of 1 year. *J Orthop Trauma.* 2009; 23:519-524. PMID: 19633462.
- Reynders P, Reynders K, Broos P. Pediatric and adolescent tibial eminence fractures: Arthroscopic cannulated screw fixation. *J Trauma* 2002;53(1):49-54. PMID:12131389.
- Wiley JJ, Baxter MP. Tibial spine fractures in children. *Clin Orthop Relat Res* 1990; 255:54-60. PMID: 24585047.
- Ishibashi Y, Tsuda E, Sasaki T, Toh S. Magnetic resonance imaging AIDS in detecting concomitant injuries in patients with tibial spine fractures. *Clin Orthop Relat Res.* 2005;(434):207-212. PMID: 15864054.
- H.J. Levy, V.A. Fowble, Type III tibial avulsion fracture with associated anteriorcruciate ligament injury: Report of two cases in adults, *Arthroscopy* 17 (May (5)) (2001) E20. PMID: 11337707.
- Mayo, Meredith & Mitchell, Justin & Axibal, Derek & Chahla, Jorge & Palmer, Claire & Vidal, Armando & Rhodes, Jason. (2017). Anterior Cruciate Ligament Injury at the Time of Anterior Tibial Spine Fracture in Young Patients: An Observational Cohort Study. *Journal of pediatric orthopedics.* 10.1097/BPO.0000000000001011. PMID: 31503222.
- Shohei Yamauchia, Shizuka Sasakia, Yuka Kimuraa, Yuji Yamamotoa, Eiichi Tsudab, Yasuyuki Ishibashiaa. Tibial eminence fracture with midsubstance anterior cruciateligament tear in a 10-year-old boy: A case report. *International Journal of surgery case reports.* 67 (2020) 13-17. PMID: 31991376.
- Lawrance JAL, Ostlere SJ, Dodd CAF. MRI diagnosis of partial tears of the anterior cruciate ligament. *Injury.* 1996; 27:153-155. PMID: 8736285.
- Phelan N, Rowland P, Galvin R, et al. A systematic review and meta-analysis of the diagnostic accuracy of MRI for suspected ACL and meniscal tears of the knee. *Knee Surg Sports Traumatol Arthrosc.* 2016; 24:1525-1539. PMID: 26614425.
- Calvo R, Figueroa D, Gili F, et al. Transphyseal anterior cruciate ligament reconstruction in patients with open physes: 10-year follow-up study. *Am J Sports Med.* 2015;43(2):289-294. PMID: 25404615.
- Chandler JT, Miller TK: Tibial eminence fracture with meniscal entrapment. *Arthroscopy* 1995;11(4):499-502. PMID: 7575887.
- Lubowitz JH, Elson WS, Guttman D: Part II: Arthroscopic treatment of tibial plateau fractures. Intercondylar eminence avulsion fractures. *Arthroscopy* 2005;21(1):86-92. PMID: 15650672.
- Noyes FR, DeLucas JL, Torvik PJ. Biomechanics of anterior cruciate ligament failure: An analysis of strain-rate sensitivity and mechanisms of failure in primates. *J Bone Joint Surg Am* 1974; 56:236-253. PMID: 4452684.
- Mitchell JJ, Sjostrom R, Mansour AA, et al. Incidence of meniscal injury and chondral pathology in anterior tibial spine fractures of children. *J Pediatr Orthop.* 2015;35(2):130-135. PMID: 24992346.
- Johnson AC, Wyatt JD, Treme G, Veitch AJ. Incidence of associated knee injury in pediatric tibial eminence fractures. *J Knee Surg.* 2014;27(3):215-219. PMID: 24283367.
- Meyers MH, McKeever FM. Fracture of the intercondylar eminence of the tibia. *J Bone Joint Surg Am* 1970; 52:1677-1684. PMID: 5483091.
- Kocher MS, Micheli LJ, Zurakowski D, et al. Partial tears of the anterior cruciate ligament in children and adolescents. *Am J Sports Med.* 2002; 30:697-703. PMID: 12239005.

19. Brief LP. Anterior cruciate ligament reconstruction without drill holes. *Arthroscopy*. 1991;7(4):350-357. PMID: 1755882.
20. Frank JS, Gambacorta PL. Anterior cruciate ligament injuries in the skeletally immature athlete: diagnosis and management. *J Am Acad Orthop Surg*. 2013;21(2):78-87. PMID: 23378371.
21. Collins MJ, Arns TA, Leroux T, et al. Growth Abnormalities Following Anterior Cruciate Ligament Reconstruction in the Skeletally Immature Patient: A Systematic Review. *Arthroscopy*. 2016;32(8):1714-1723. PMID: 27161510.
22. Pierce TP, Issa K, Festa A, Scillia AJ, McInerney VK. Pediatric Anterior Cruciate Ligament Reconstruction: A Systematic Review of Transphyseal Versus Physeal-Sparing Techniques. *Am J Sports Med*. 2017;45(2):488-494. PMID: 27045088.

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