

Case Report

# Fixation failure in an isolated tibial eminence ACL traction avulsion fracture in a paratrooper: is there an association with vitamin D deficiency?

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Tibial eminence avulsion fracture at the ACL footprint may be caused by high-energy forces such as a fall, in which the ACL ligament proves stronger than the forces that hold the bone together. For reasons of bone maturity however, tibial spine avulsion fractures where the ACL remains intact, typically occur in children but are rare in adults. This case demonstrates a rare type of adult tibial avulsion fracture with intact ACL and subsequent fragment fixation failure in which vitamin D deficiency may have been contributory. Because there is a high rate of inadequate vitamin D levels in patients undergoing orthopaedic surgery and a known impact on bone healing complications, post-operative bone fixation failure may also occur. This case report may therefore prompt further awareness for considering pre-surgical vitamin D deficiency screening in adults presenting with rare avulsion fractures, and may further demonstrate its impact on surgical outcomes.

## INTRODUCTION

Tibial eminence avulsion fracture at the ACL footprint may be caused by high-energy forces such as a fall, in which the ACL ligament proves stronger than the forces that hold the bone together. For reasons of bone maturity however, tibial spine avulsion fractures where the ACL remains intact, typically occur in children but are rare in adults. This case demonstrates a rare type of adult tibial avulsion fracture with intact ACL and subsequent fragment fixation failure in which vitamin D deficiency may predispose.

## CASE REPORT

A 32-year-old veteran paratrooper with 13 years of military service sustained a left tibial spine avulsion fracture with an intact ACL and concomitant ipsilateral Weber B ankle fracture during a hard parachute landing. The ankle was managed conservatively, but attempted tibial eminence avulsion screw fixation failed. The screw was removed and cortisone injected,

but continued pain prevented his return to sport. He perceived persistent left knee instability and giving way, and failed to progress with 1 year of physiotherapy. He recollected serial lifetime bony injuries from the age of 14 years, which included a right fibular, right tibial stress fracture, left ankle fracture and left ankle re-fracture concomitant to the left tibial eminence avulsion fracture. On post-operative examination left quadriceps bulk was reduced and he offloaded on partial squat, with positive weight-bearing meniscal and ligament integrity tests. Both lower limbs were neurovascular intact. Laxity of the left ACL and LCL was present. There was no reported knee joint line tenderness and lower limb dural tension signs were absent. He was hypermobile, with a Beighton score of 6/9.

A post-operative MRI demonstrated a large, unstable, ununited avulsion fracture of the tibial eminence with the ACL attached. Prominent bone marrow oedema was associated with the avulsed bony fragment, with underlying bone marrow oedema in the tibial plateau. In consideration of his age, significant, advanced tri-compartmental degenerative

changes were also present. In adults, tibial eminence avulsion fracture at the ACL footprint may be caused by high-energy forces such as a fall, in which the ACL proves stronger than the forces holding the bone together. However, for reasons of bone maturity and variance of ligament-bone strength ratios, avulsion injuries with ligament preservation typically occurring in children are rare in adults [1].

The history of multiple prior fractures coupled with adult avulsion fracture, and subsequent failure of bony screw fixation, as well as known occupational and environmental risk factors, raised the index of suspicion for bone weakness. This clinical picture prompted metabolic testing. In accordance with Ministry of Defence guidelines a metabolic screen consisting of full blood count, calcium levels (bone profile), liver and renal function tests and vitamin D assay was performed. The full blood count serves as a screen for anaemia which may be present in malabsorption, while the bone profile tests for endocrine problems such as hyperparathyroidism. Serum vitamin D was found to be deficient at 21.4 nmol/l (sufficient levels 70–150 nmol/l). High dose vitamin D supplementation—12-week loading dose of colecalciferol 20 000 IU—was commenced. Approximately 3 months after colecalciferol supplementation was commenced, serum vitamin D assay had normalized.

Once vitamin D levels were normalized (96.8 nmol/l) he underwent fragment debridement, ACL reconstruction and tibial eminence microfracture. The patient was followed up via telephone consultation 1 year after ACL reconstruction. He reportedly progressed well through rehabilitation and had returned to full contact sport and paratrooper military duties. As per the Ministry of Defence guidelines he was advised to continue lifetime colecalciferol supplementation.

## DISCUSSION

Overall, military parachuting injuries occur at a rate of 0.89% with ankle fractures and head trauma most common [2]. Tibial eminence avulsion fracture at the ACL footprint may be caused by high-energy forces such as a fall, in which the ACL ligament proves stronger than the forces that hold the bone together. For reasons of bone maturity however, tibial spine avulsion fractures where the ACL remains intact typically occur in children but are rare in adults. Screw fixation failure did occur in this case. Vitamin D levels were normalized and the patient then underwent hamstring ACL reconstruction, trochlear microfracture, notchplasty osteophyte removal, as well as ununited proximal tibial. It is possible that screw fixation [3] technique may have played a role in fixation failure in this case. However, it is also notable that vitamin D levels were reduced.

Because there is a high rate of inadequate vitamin D levels in patients undergoing orthopaedic surgery [4] and known associated risks of fracture and bone healing complications, one may conclude that post-operative bone fixation failure may also occur in deficiency states. Vitamin D deficiency or insufficiency is not exclusive to aged populations. A retrospective medical record review of orthopaedic trauma

patients demonstrated a high prevalence of vitamin D deficiency or insufficiency in patient populations, of 77.4%, particularly in those over the age of 26 [5].

Post-fracture treatment with 1,25di-hydroxyvitamin D3 has been reported to promote earlier histomorphometric parameters, such as mechanical strength, load and energy absorption, and increased the transformation of woven bone into lamellar bone in overiectomized rat models [5]. During winter months, dietary intake of vitamin D may become essential to maintain sufficiency levels, particularly in northern latitudes. Yet, normal serum levels of vitamin D may not be achieved by diet alone and attempts to fortify foods such as breakfast cereals and dairy products may be ineffective in correcting deficiencies [6]. Supplementation and subsequent normalization of serum vitamin D levels may have helped to prevent fixation failure.

Research has demonstrated a high rate of inadequate vitamin D levels in adult patients undergoing orthopaedic surgery [7] and given the known increased risk of fracture and complications of bone healing in inadequacy states, one may conclude that post-operative bone fixation failure may also occur. It may therefore be possible that vitamin D deficiency may have contributed to this case of a rare, adult tibial eminence avulsion fracture with an intact ACL and the subsequent fragment fixation failure.

However, some biomechanical data suggest that under cyclic loading conditions, suture fixation of tibial eminence fractures provides more fixation strength than screw fixation [8]. Therefore, screw fixation rather than vitamin D deficiency or both may have played a role in fixation failure in this case. References in the literature about tibial avulsion fracture and vitamin D are lacking. Further research is needed to determine whether normalization of serum vitamin D levels in young adult candidates for tibial eminence avulsion fracture fixation improves surgical outcomes.

One cannot consider cause–effect relationship from a single case. Further research is needed to consider this issue. Nevertheless, this case report may prompt pre-surgical vitamin D deficiency screening of adults presenting with rare avulsion fractures and its potential effect on optimum operative outcomes.

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