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TENSION BAND WIRING FOR ACUTE TIBIAL TUBEROSITY AVULSION FRACTURE IN AN ADULT: A RARE CASE REPORT WITH FUNCTIONAL OUTCOME ASSESSMENT

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ABSTRACT Detachment of the tibial tuberosity from the parent bone is reported only sporadically in the orthopaedic literature, contributing to fewer than one in every hundred physeal injuries, and its appearance after closure of the proximal tibial growth plate — an event ordinarily completed in late adolescence — is rarer still. When the lesion does declare itself in an adult, the responsible insult is almost always high-velocity, disrupts the extensor apparatus of the knee, and warrants early operative restoration so as to preserve quadriceps continuity and forestall lasting impairment. The patient described here, a 24-year-old man, sustained an isolated avulsion at the right tibial tuberosity after losing control of his motorcycle on wet tarmac. Clinical assessment revealed anterior knee swelling with focal tenderness, a superiorly displaced patella, and inability to actively extend the leg. Radiography supplemented by computed tomography placed the lesion within the Ogden type III group. The treating team proceeded with open reduction and tension-band stabilisation, employing two parallel 2.0 mm Kirschner wires in conjunction with a 1.0 mm stainless-steel cerclage configured as a figure-of-eight. Rehabilitation thereafter advanced in defined phases. The Lower Extremity Functional Scale (LEFS) tracked his recovery from 38 at the end of the first month, through 61 at week eight, to 74 at the end of week twelve — a trajectory mirrored radiographically by visible trabecular bridging at around ten weeks. The take-home message is that adult-onset tibial tuberosity avulsion, although uncommon, responds favourably to expeditious surgical management; the tension-band assembly, by translating distractive load into compression at the bone interface, supplies a robust yet motion-friendly construct with reliable functional outcomes.

KEYWORDS : Tibial Tuberosity, Avulsion Fracture, Tension Band Wiring, Extensor Mechanism, Ogden Classification, Lower Extremity Functional Scale

INTRODUCTION

For much of orthopaedic history this injury has been viewed as the near-exclusive preserve of the growing knee, with cases clustering in the narrow window just before fusion of the apophysis at the upper end of the tibia — a phase during which the still-cartilaginous ossific centre is most susceptible to failure under traction. Across the spectrum of physeal trauma, published series estimate it accounts for under one per cent of all such lesions, and somewhere in the band of 0.4 to 2.7 per cent of injuries involving the proximal tibial epiphysis. Once apophyseal fusion is complete, however, the mechanical weak link disappears: the tuberosity becomes an uninterrupted continuation of the underlying metaphyseal bone, and its separation in the adult skeleton is therefore distinctly unusual and almost invariably reflects substantial energy transfer, whether through direct impact or indirect loading.

Among adults, the typical inciting event involves an abrupt, forceful eccentric contraction of the quadriceps with the joint either fixed in position or moving rapidly into flexion — a circumstance one encounters after jumps from height, road traffic incidents, or athletic manoeuvres involving explosive take-off or sprint mechanics. Anatomically, the tuberosity acts as the osseous footprint of the patellar ligament and forms one of five linked components of the knee's extensor apparatus, the others being the quadriceps muscle, its tendon, the patella, and the patellar ligament itself. Disruption at any of these levels abolishes voluntary extension and mandates surgical intervention.

Stratification of these injuries today most commonly follows the Ogden scheme, itself a refinement of the earlier Watson-Jones system, and is based on the path the fracture line takes through the tuberosity, the proximal tibial epiphysis, and ultimately the articular surface. Whenever displacement is present, operative reduction becomes the standard recommendation, the dual objectives being to re-establish continuity of the extensor mechanism and, in injuries that breach the joint surface, to reduce the articular cartilage anatomically and permit early movement. Many fixation strategies have appeared in print — cancellous lag screws, K-wires combined with cerclage in tension-band fashion, suture-anchor repairs, and buttress plates among them. The biomechanical rationale for the tension-band construct, credited to the AO school, rests on its conversion of the distractive force generated by the quadriceps into compression at the fracture line as the knee flexes — a dynamic effect that simultaneously stiffens the construct and creates conditions favourable to bony consolidation.

The present report details the clinical course, imaging features, and functional recovery of a skeletally mature individual managed by this technique for an isolated tuberosity avulsion, with serial assessment undertaken using a validated lower-extremity outcome instrument (LEFS).

Case Presentation

The subject of this report was a 24-year-old man, working as a bank clerk and otherwise medically well, with no contributory background of illness or surgery. He arrived in the emergency department roughly three hours after a road traffic event. At the time of injury he had been riding a two-wheeler at moderate speed when the vehicle skidded on a wet patch of road; he fell onto his right side, the same-side knee being in partial flexion at impact. He recalled a distinct audible “pop” emanating from the front of the knee, followed immediately by sharp localised pain in the same region, inability to weight-bear, and complete loss of voluntary extension. He denied any preceding knee symptoms, episodes of patellar instability, anabolic steroid intake, fluoroquinolone therapy, inflammatory joint disease, prior Osgood–Schlatter disease, or any other condition known to predispose tendinous tissue to attritional change.

On arrival his vital parameters were entirely within normal limits. Inspection of the affected knee revealed marked diffuse swelling with a tense effusion suggesting haemarthrosis, cutaneous bruising over the anterior proximal tibia, and a palpable depression immediately below the inferior pole of the patella. Side-to-side comparison disclosed apparent superior migration of the patella, in keeping with patella alta. The patient could neither lift the limb against gravity nor perform a straight-leg raise; passive range of motion, although painful, was preserved within tolerable limits. Distal neurovascular evaluation was unremarkable — dorsalis pedis and posterior tibial pulses were both well-felt, and dermatomal sensation was preserved throughout. The skin envelope was intact, excluding open injury, and a thorough head-to-toe survey did not reveal any additional osseous trauma. The opposite knee was clinically normal in every respect.

Fig 1: Pre operative x-ray

Investigations

Standard anteroposterior and lateral radiographs of the affected knee showed a bony fragment elevated from its native bed at the tuberosity, accompanied by upward migration of the patella — findings entirely in keeping with mechanical failure of the extensor apparatus. The plain films did not reveal any obvious extension of the fracture line toward the joint surface. Cross-sectional imaging was therefore obtained to better characterise the fragment's geometry and to definitively exclude articular involvement; CT confirmed an extra-articular fragment of roughly 28 × 14 mm, displaced anterosuperiorly by approximately 12 mm, fitting the Ogden type IIIB pattern. Routine preoperative haematological, biochemical, electrocardiographic, and chest radiographic screening returned values within the accepted reference ranges.

MANAGEMENT

Preoperative Preparation

Once formal written consent had been obtained covering the surgical procedure, the anaesthetic plan, and use of the clinical data for academic dissemination, the injured lower limb was placed in a hinged long knee brace locked in full extension; cold packs were applied over the anterior knee, and the leg was kept elevated above heart level. Analgesia was provided by oral non-steroidal anti-inflammatory medication. To prevent further upward migration of the quadriceps complex and to avoid the displaced fragment becoming set in an unfavourable position, the operating theatre was arranged for the patient within the first 24 hours of admission.

Surgical Technique

The procedure was carried out under spinal anaesthesia with the patient supine on a radiolucent operating table. After exsanguination, a pneumatic thigh tourniquet was inflated to 300 mmHg. Exposure was achieved through a vertical anterior midline incision running from approximately 2 cm above the inferior pole of the patella to roughly 6 cm below the tuberosity. Following skin and subcutaneous division, fracture-site haematoma was washed out and the displaced fragment identified — found to remain attached to the insertion of the patellar tendon. The recipient bed was meticulously cleared of fibrinous tissue and small loose fragments so that the principal piece could be reseated anatomically.

Fig 2: Intra Op Pic

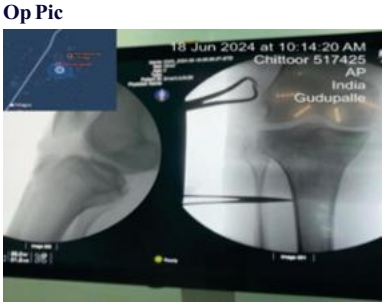

Fig 3: Intra Op C-arm Pic

Provisional reduction of the fragment onto its bed was first secured with a pointed reduction clamp. Two 2.0 mm Kirschner wires were then driven antegrade from the proximal margin of the fragment, crossing the fracture plane and engaging the posterior tibial cortex in a mutually parallel orientation. A transverse tunnel was prepared roughly 4 cm distal to the fracture, drilled across the anterior cortex of the tibia with a 2.5 mm bit. A 1.0 mm stainless-steel cerclage was passed through this tunnel and brought upward in a figure-of-eight configuration, looped over the protruding proximal ends of the two K-wires just superficial to the patellar tendon footprint. Even tension was applied on either limb of the figure-of-eight with paired wire tensioners until palpable interfragmentary compression was achieved. The protruding superior ends of the K-wires were then rotated through 180°, trimmed, and tamped into the bony fragment to minimise soft-tissue irritation.

Fig 4: K-wires

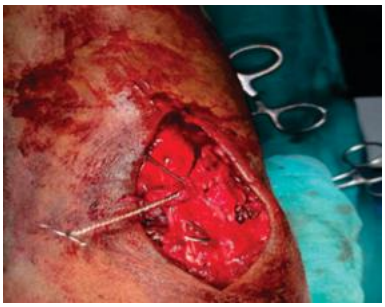

Fig 5: Tension Band Wiring

Fluoroscopic confirmation in two orthogonal planes verified satisfactory reduction, appropriate hardware placement, restoration of normal patellar height, and absence of any articular breach. Construct stability was then tested intraoperatively by carefully flexing the knee to 90°, during which the reduction was maintained without slippage. The surgical field was irrigated copiously with sterile saline, the deeper paratenon and subcutaneous layers were closed sequentially with absorbable suture, and the skin was approximated using interrupted non-absorbable monofilament. A sterile dressing was applied and the limb was secured in a hinged long brace, locked at 0° of flexion.

Fig 6: Post Op X-ray

Postoperative Rehabilitation Protocol

Recovery proceeded according to a phased rehabilitation programme supervised by a senior physiotherapist. During the first fortnight (days 0–14), efforts centred on wound monitoring, isometric quadriceps and hamstring activation, ankle-pump exercises, and brace-protected straight-leg raises; the limb was kept locked in extension within the long hinged brace, and ambulation was restricted to toe-touch loading using bilateral axillary crutches. Beginning in week three, the brace hinge was gradually released, permitting an initial flexion arc of 0–30°, advancing to 0–60° by the fourth week and 0–90° by the sixth. Transition from partial to full weight-bearing was sanctioned once early callus was visible on radiographs, generally by the end of week six. From that point, closed-kinetic-chain strengthening, stationary cycling, and proprioceptive drills were progressively introduced. Light non-impact recreational activity was withheld until the twelfth post-operative week and was made conditional on full and pain-free range of motion, with quadriceps strength of at least 80 per cent of the unaffected side.

Outcome and Follow-up

Review appointments were scheduled at 2 weeks and then at 1, 2, 3, and 6 months. Each visit included pain quantification on a visual analogue scale, an objective measurement of the available knee motion arc, recording of thigh circumference 10 cm above the upper pole of

the patella, assessment for residual extensor lag, palpation over the surgical site for implant prominence, and completion of the LEFS questionnaire. Serial radiographs were obtained to follow fracture healing and to verify ongoing hardware position.

The operative wound healed by primary intention and cutaneous sutures were removed on the fourteenth day. Radiographic union — defined in our protocol as bridging trabecular bone visible across three of the four cortices — was demonstrable by the tenth week. Throughout the entire follow-up there were no instances of implant migration or loosening, secondary loss of reduction, surgical-site infection (deep or superficial), or compartment-related complications. The patient's functional progression was characterised by steady and substantial gains: the LEFS score advanced from a baseline value of 38 at one month — reflecting marked early limitation — through 61 at two months — corresponding to the intermediate recovery phase — to 74 at three months, a figure consistent with near-complete return of lower-extremity function and equivalent to 92.5 per cent of the instrument ceiling of 80. By the end of the third month the patient demonstrated an active knee range of 0–135°, the discrepancy in mid-thigh girth compared with the uninjured side had narrowed to under 1 cm, and no detectable extensor lag remained.

Fig 7: Follow up Clinical Pics

Table 1: Serial LEFS Scores at Follow-up

Follow-up	LEFS Score (/80)
1 month	38
2 months	61
3 months	74

DISCUSSION

Tibial tuberosity avulsion is, broadly speaking, a disorder of the immature skeleton, with the majority of cases reported in the literature occurring in adolescent males between roughly 13 and 16 years of age. Its rarity in adults is a straightforward consequence of physeal closure at the proximal tibial apophysis: once this growth interface has fused, the tuberosity behaves as a seamless bony continuation of the metaphysis, and the osteotendinous junction becomes mechanically stronger than the substance of the patellar tendon itself. The natural consequence is that adult eccentric overload of the extensor mechanism more often results in rupture of the patellar tendon, tearing of the quadriceps tendon, or a transverse patellar fracture, rather than detachment of the tuberosity. The case reported here therefore represents a relatively uncommon clinical entity, and a careful review of the published literature identifies only a sparse scattering of adult cases, most attributable to high-energy mechanisms, sports involving jumping, or heavy lifting incidents.

The taxonomy originally introduced by Watson-Jones grouped these avulsions into three categories defined by the position of the fracture line in relation to the proximal tibial epiphysis. Ogden subsequently refined the scheme by appending an A or B suffix to indicate whether the fragment was minimally displaced (A) or appreciably displaced (B) within each parent category. Type I in the Ogden system refers to a fracture confined to the inferior aspect of the tuberosity; type II describes proximal propagation of the fracture toward the meeting point of the tuberosity ossification centre with the proximal tibial epiphysis; type III is defined by extension of the fracture through the epiphysis and into the joint, rendering it intra-articular. Two further patterns have since been described: type IV, where the fracture continues into the metaphyseal bone, and type V, a hybrid Y-shaped configuration combining features of types III and IV. Precise classification is far from a purely academic exercise — it directly informs surgical strategy and prognosis. In our case, the injury was a type IIIB pattern but lacked any true intra-articular extension, allowing extra-articular stabilisation to suffice.

The principal aims of surgical management are threefold: precise reduction of the bony fragment, restoration of normal patellar height, and assembly of a fixation construct of sufficient rigidity to permit early knee motion. Several fixation alternatives appear in the literature. Solid cancellous screws used in lag mode are a frequently chosen option when the displaced fragment is sizeable; however, in the setting of a small, comminuted, or osteoporotic fragment, screw fixation carries a measurable risk of inducing further fragmentation. The tension-band technique, founded on AO biomechanical principles, has particular appeal in this context because the figure-of-eight wire loop opposes the upward distractive force exerted by the quadriceps and, with knee flexion, redirects that force into compression across the fracture line. The resulting dynamic compressive effect reinforces the construct mechanically while simultaneously providing a milieu favourable to osseous healing. An equally relevant consideration in our setting is that the construct is inherently low profile, technically straightforward, economical, and well-suited to the realities of orthopaedic practice in resource-limited environments.

The drawbacks classically linked with tension-band wiring relate largely to the metalwork itself: hardware that becomes palpable beneath the skin and may eventually call for secondary removal, fatigue failure of the wire in patients who do not adhere to rehabilitation precautions, and minor wound-margin complications. A number of newer fixation alternatives have entered the literature over the past decade — these include hardware-free techniques using all-suture or FibreWire anchors that obviate any later implant retrieval, as well as hybrid screw-plus-tension-band constructs designed for larger fragments. Despite the availability of these contemporary methods, conventional K-wire and stainless-steel tension banding continues to enjoy widespread use as a reliable technique with reproducible outcomes.

The LEFS, originally developed and psychometrically validated by Binkley and colleagues in 1999, is a patient-completed instrument containing 20 items that quantifies the individual's own perception of difficulty in performing common everyday activities; the cumulative score ranges from 0 to 80, with higher numbers indicating better functional capacity. Its responsiveness to clinical change, the brevity of its bedside administration, and a published minimum clinically important difference of 9 points make it a particularly useful tool for charting serial outcomes after lower-limb trauma. In our patient, the score advanced from 38 one month after surgery to 74 at three months — a net gain of 36 points, well above the clinically meaningful threshold and reflecting a real and statistically meaningful restoration of function. The recovery pattern documented here mirrors that reported in case-series of operatively managed extensor-mechanism injuries, supporting both the appropriateness of the fixation chosen and the efficacy of the rehabilitation programme employed.

Several limitations deserve mention. First, the present report describes the experience of a single patient, and the breadth to which these observations may be generalised is consequently restricted. Second, although the three-month follow-up period is adequate to confirm bony union and to chart the early phase of recovery, it is not long enough to evaluate longer-term sequelae such as patella alta or baja, persistent quadriceps deficit, or post-traumatic osteoarthritis — though growth-plate–related complications are not a relevant consideration in this skeletally mature patient. Follow-up extending to a minimum of twelve months is therefore recommended.

CONCLUSION

Avulsion of the tibial tuberosity in the skeletally mature individual is an uncommon injury that, when it occurs, produces functional disruption of the extensor mechanism of the knee and consequently demands prompt diagnosis followed by operative reconstitution. Tension-band wiring meets the requirements of such management on several counts: it is biomechanically rational, technically reproducible, and economical, working by capturing the tensile load applied by the quadriceps and redeploying it as compression at the fracture interface — in doing so permitting early mobilisation and

delivering a satisfactory functional result. Periodic application of validated patient-reported instruments such as the LEFS adds an objective dimension to the recovery record that complements clinical and radiological surveillance. The present case underscores the value of early, anatomy-respecting surgical management coupled with a structured, phase-graded rehabilitation programme in the treatment of this rare adult injury.

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