Technical Note

Proximal Tibiofibular Reconstruction in Adolescent Patients

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Abstract: Instability of the proximal tibiofibular joint (PTFJ) can present as frank dislocations, vague symptoms of lateral knee pain, discomfort during activity, or symptoms related to irritation of the common peroneal nerve. An accurate preoperative diagnosis is imperative and should include a trial of taping of the PTFJ for a 4- to 6-week time frame before surgical reconstruction is indicated. In the adolescent population, surgical planning can be complicated by the presence of open physes; therefore, caution must be taken to avoid drilling through or placing screw fixation across the physes. Potential complications include growth arrest and limb length discrepancy. Therefore, the purpose of this Technical Note is to describe the surgical technique for addressing PTFJ instability in adolescent patients.

Instability of the proximal tibiofibular joint (PTFJ), although rare, can further alter stability of the posterolateral knee if not managed because of its proximity to structures of the posterolateral corner, or even neurologic damage to the peroneal nerve.[1,2] Isolated injuries to the PTFJ are possible and typically result from twisting injuries of the knee and ipsilateral ankle as well as a result of traumatic blows to the lateral aspect of the knee.[3] Subluxation of the PTFJ is most commonly associated with bilateral symptoms and ligamentous laxity.[1,3] Ogden.[1] described the most common patterns of instability being anteromedial dislocation, posteromedial dislocation, superior dislocation, and atraumatic subluxation.

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Nonoperative protocols are sufficient in temporarily reducing the joint and resolving symptoms, but continued pain remains commonly reported after this protocol, thus highlighting the need for surgical management,[4] especially for chronic injuries. Earlier surgical management protocols were dictated by concurrent arthrodesis with fibular head resection,[1,2] but these proved unfavorable from the ensuing postoperative ankle or knee pain. More recent publications have migrated to techniques emphasizing anatomic reconstruction procedures.[4-7] With the majority of PTFJ instability occurring in the anteromedial direction, Warner et al.[7] advocated for the restoration of solely the single, thin-banded posterior ligament,[8] as opposed to techniques that additionally reconstruct the anterior ligaments,[4,6] which could overconstrain the PTFJ.

The surgical treatment of knee injuries in adolescent patients is difficult because of the vulnerability of growth plates in this patient population. Physeal injury can result from damage during reconstructive operations as well as from latent harm that develops from continued PTFJ instability not appropriately treated. Premature fusion can occur from drilling through an open physis, which can result in a limb length or angular discrepancy. Although drilling of the physes can result in bone growth inhibition, nonoperative treatment of continued PTFJ instability can also pose future growth disturbance complications. The purpose of this Technical Note was to describe the surgical protocol for addressing PTFJ instability in adolescent

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Large incision to identify the common peroneal nerve proximally, posteromedial to the biceps femoris tendon	Small incision may make it difficult to identify structures, and may lead to iatrogenic injuries
Neurolysis of the common peroneal nerve	Injury to the common peroneal nerve
Use fluoroscopy for pin placement	Injury to the epiphyses and growth arrest
Place the screw distal to the graft in the tunnel	

patients, specifically by reconstructing the posterior ligaments of the PTFJ while avoiding the proximal tibial and fibular head growth plates.

Fig 1. External view of the opening lateral hockey stick incision over the inferior aspect of the superficial layer of the iliotibial band prior to dissection through the superficial layer down to the long and short head of the biceps femoris (right knee).

Diagnosis

The posterior ligaments of the PTFJ have been reported to be weaker than the anterior ligament complexes, and hence an anterolateral PTFJ dislocation is the most common instability pattern, accounting for more than 85% of all cases.[1,9] The most commonly reported mechanisms of PTFJ injury include falling onto a flexed knee with the foot inverted and plantar flexed, twisting the knee with the foot planted on the ground, or spontaneous/inherent instability.[1] Most patients present with chronic instability, highlighting that injury to the PTFJ is often missed or misdiagnosed, especially in the setting of concurrent multiligament knee injuries. Therefore, it is important to perform a thorough preoperative workup, including a physical examination, magnetic resonance imaging, and a trial of taping of the PTFJ to ensure surgical reconstruction is indicated.

Operative Indications

The indications for surgery are significant anterolateral rotation of the PTFJ consistent with nonfunctional posterior ligamentous restraints of the PTFJ on examination and pain relief with PTFJ taping for a minimum of 4 to 6 weeks. Surgical treatment is also recommended in patients who present with common peroneal nerve irritation symptoms, lateral knee pain, and PTFJ instability.

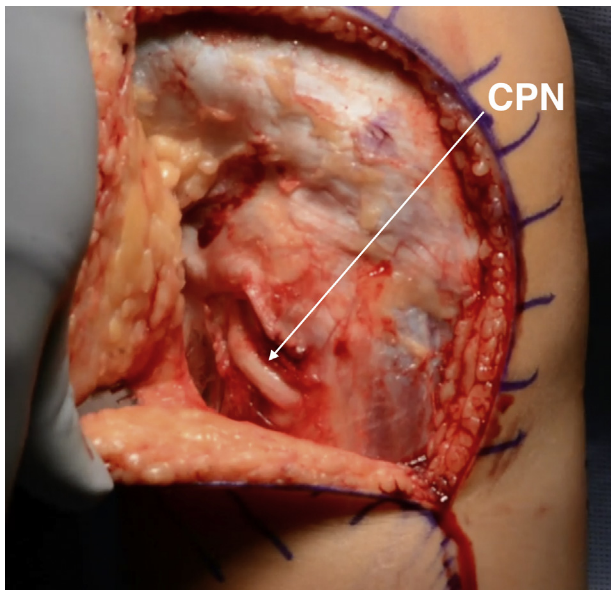

Fig 2. External view of CPN (right knee), after a 6-cm-long CPN neurolysis in which release of all scar tissue surrounding the nerve is performed, in addition to releasing the lateral fascia of the peroneus longus muscle. (CPN, common peroneal nerve.)

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Anatomic reconstruction	Thorough knowledge of the anatomy of the knee is mandatory
Use of autograft enhances healing	Iatrogenic injuries
Use of fluoroscopy minimizes risk of injury to the epiphyses	

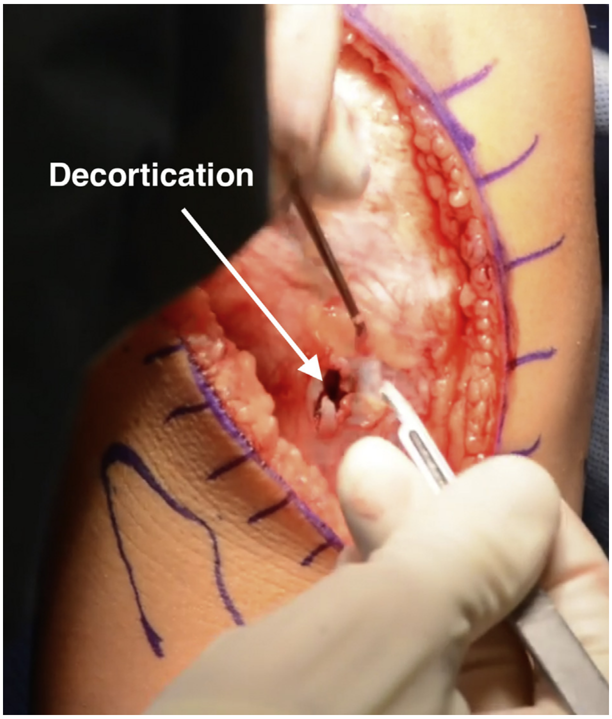

Fig 3. External view of the identification of the anterior aspect of the fibular head (right knee) which is followed by dissection down to bone and subsequent decortication, prior to guide pin placement and fibular tunnel reaming.

Surgical Procedure

A detailed video of the technique is shown in Video 1. Pearls and pitfalls of this technique and a step-by-step approach are described in Tables 1 and 2, respectively.

Patient Positioning and Patient Examination

The patient is brought to the operating room and induced under general anesthesia. A high, well-padded, thigh tourniquet is placed. A bilateral knee examination is performed to assess any concurrent ligamentous instability and to assess knee motion. Specifically, the varus stress test in full extension and 30° and dial testing at 30° and 90° should be conducted to rule out any associated injury to the posterolateral corner structures and to confirm that the injury is isolated to the PTFJ. The PTFJ is then assessed, usually displaying signs of anterolateral instability close to 90° of knee flexion. The patient is then administered prophylactic antibiotics against infection and the operative limb is prepped and draped in the usual sterile manner.

Surgical Approach

A standard lateral hockey stick–shaped incision is made over the inferior aspect of the superficial layer of the iliotibial band (Fig 1). Next, dissection is carried down to the superficial layer of the iliotibial band and posteriorly over the long and short heads of the biceps femoris. Palpation and identification of the common peroneal nerve follows (Fig 2). A 6-cm-long common peroneal nerve neurolysis is then performed by releasing all scar tissue around the nerve itself and releasing the fascia of the peroneus longus muscle. Once the anterior aspect of the fibular head is identified and soft tissues have been cleared off it (Fig 3), an elevator is used to lift the soleus muscle off the posterior aspect of the fibular head, and a transfibular guide pin is placed using a fibular head tunnel guide. Anterior-posterior (AP) and lateral fluoroscopic imaging should be used to ensure the origin and trajectory of the pin, and subsequently the reamer will not protrude through the proximal fibular head physis and potentially disrupt bone growth (Fig 4). This pin should be positioned approximately 5 to 6 mm distal to the physis. Using a chandler retractor to protect the posterior tissues from the fibular head, a 6-mm-diameter tunnel is then

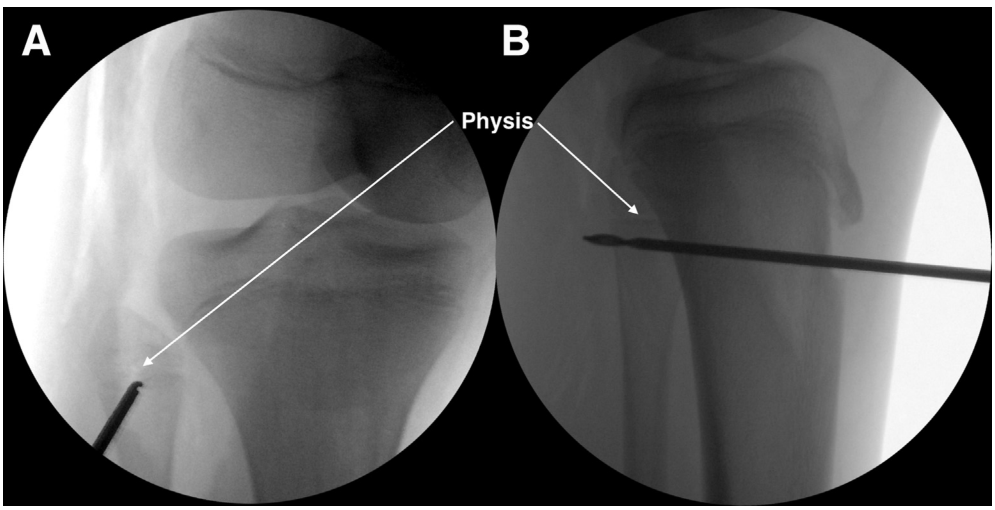

Fig 4. Fluoroscopic imaging of a right knee in (A) anteroposterior (AP) and (B) lateral views, displaying guide pin placement below the open physis of an adolescent knee so as to not damage the growth plate and potentially disturb/alter bone growth of the fibula. Pin placement on an adolescent fibula should be placed 5 to 6 mm distal to the fibular "physis line."

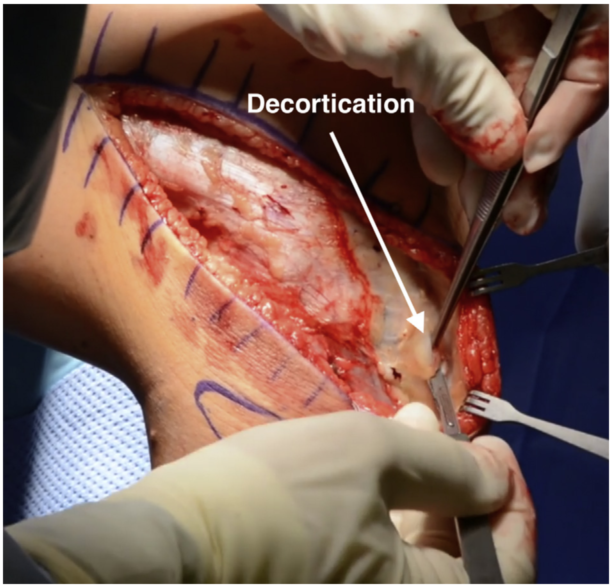

Fig 5. External view of the identification of the flat spot distal and medial to the Gerdy tubercle on a right knee, which is followed by dissection down to bone and subsequent decortication, before guide pin placement and tibial tunnel reaming.

reamed from anterior to posterior, followed by a passing stitch through this fibular head tunnel.

Dissection down to the flat spot distal and medial to the Gerdy tubercle is then performed, to identify the planned tibial tunnel placement (Fig 5). The guide pin is positioned, and fluoroscopy is once again used for AP and lateral intraoperative visualization, this time for the relationship to the tibial growth plate (Fig 6). Once the tibial tunnel pin positioning is confirmed as >5 to 6 mm distal to the tibial physis, the pin is drilled from anterior to posterior, with the exit point location confirmed at the same level posteriorly as the fibular head tunnel.

Next, the semitendinosus tendon is harvested, beginning with an incision over the pes tendons on the anteromedial tibia. On semitendinosus tendon identification, an open hamstring harvester is used to harvest the tendon. This reconstruction graft is prepared on the back table, and whipstitched on each end with No. 2 FiberWire (Arthrex, Naples, FL). The graft is first passed, anterior to posterior, through the fibular head tunnel (Fig 7). An interference guide pin is placed distal to the graft (to avoid the physis) and a 7×23-mm bioabsorbable screw (Arthrex) is used to fix the graft in the fibular head tunnel; quality purchase should be ensured. The passing stitch in the tibial tunnel is then employed to pull the graft from posterior to anterior. With the knee flexed to 70° and the foot in neutral rotation, the graft is then fixed in the tibial tunnel with a 7×23-mm bioabsorbable screw. While applying traction on the PTFJ reconstruction graft, the PTFJ should be held reduced to ensure proper reduction occurs. On tibial screw fixation, the PTFJ is tested to confirm restoration of PTFJ stability, and the surgical incisions are closed in standard fashion using No. 0 Vicryl for deep layers, followed by No. 2-0 Vicryl and No. 3-0 Monocryl for superficial layers.

Postoperative Rehabilitation

After surgery, the patient is nonweightbearing on the operated limb for 6 weeks and placed into a knee immobilizer. Knee flexion should be limited to 90° for the first 2 weeks, after which the patient may increase range of motion as tolerated. Walking and stationary cycling are initiated at 6 weeks and patients may discontinue crutches once able to walk without a limp. Joint mobilizations at both the proximal and distal tibiofibular joints should be avoided until 4 months postoperatively. In addition, deep knee flexion exercises, resistance hamstring exercises, and squatting

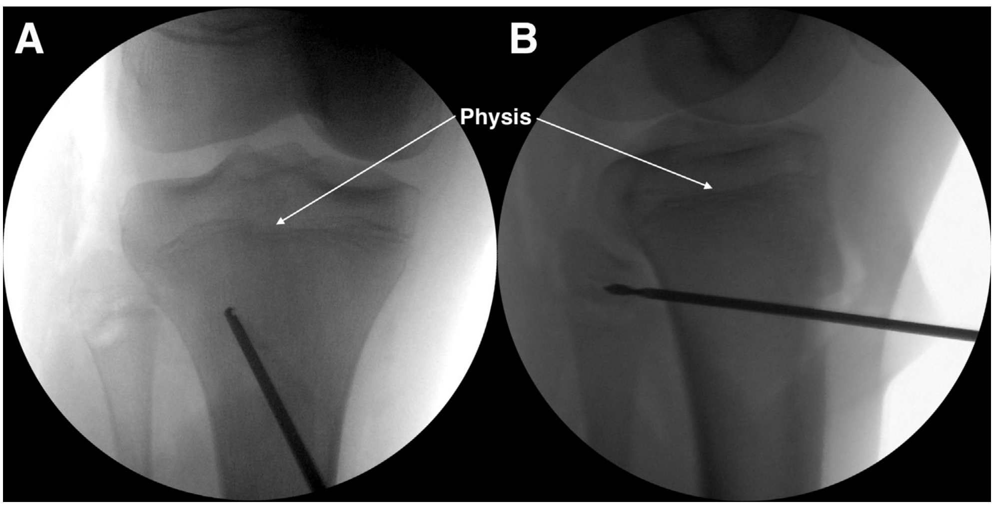

Fig 6. Fluoroscopic imaging of a right knee in (A) anteroposterior (AP) and (B) lateral views, displaying guide pin placement below the open physis of the tibia on an adolescent knee to avoid damage to the physis and potential disturbance/alteration of tibia bone growth. Pin placement on an adolescent tibia should be placed >5 to 6 mm distal to the tibial "physis line."

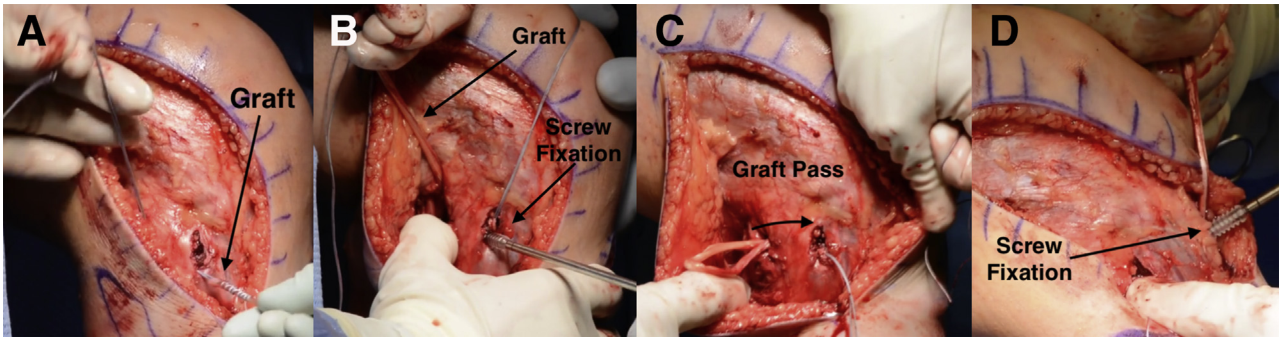

Fig 7. External view of graft passage in a right knee. The graft is first passed anterior to posterior through the fibular head tunnel (A) and is fixed with a 7×23-mm bioabsorbable screw (B). While reducing the PTFJ to the knee joint with the knee flexed to 70° and the foot in neutral rotation, the graft is passed from posterior to anterior through the tibial tunnel (C), and the graft is fixed in the tibial tunnel with a 7×23-mm bioabsorbable screw (D).

should be avoided until 4 months postoperatively to protect the reconstruction graft. In our practice, gradual return to play progression is initiated 6 months after the successful completion of a functional sports test. Return to sports or activity is allowed when normal strength, stability, and knee range of motion is comparable to the contralateral side; this typically occurs at 7 to 9 months postoperatively.

Discussion

The posterior PTFJ ligament complex has been reported to withstand a mean ultimate tensile load of 322 ± 160 N, requiring any reconstruction graft to at least match this value to achieve anatomic restoration of PTFJ biomechanics and stability.[10] The semitendinosus tendon, therefore, provides a sufficient graft strength for reconstruction of this joint.[11] In addition, the posterior complex ultimate tensile strength was reported as significantly lower than the anterior complex,[10] which would provide evidence as to why anterior dislocations are the most common injury pattern of reported PTFJ instability.[1] A similar protocol was followed in a case report in an adolescent patient with a concomitant fibular collateral ligament injury to PTFJ instability; no pain or instability was reported at 6 months postoperation.[12]

For PTFJ instability in an adolescent patient, the importance of intraoperative fluoroscopy is 2-part. First and foremost, anatomic reconstructions have become the most weighted priority for restoring stability, and intraoperative fluoroscopy can be used for ensuring correct tunnel placement for subsequent orientation of the posterior PTFJ structures. Anavian et al.[13] performed an anatomic study and reported that an approximation for the center points of the posterior ligaments should be placed on the posteromedial aspect of the fibular styloid. Relative to these locations, a fluoroscopic study by Marchetti et al.[14] reported the posterior complex on the fibula to span a proximodistal distance of 11.8 ± 7.9 mm and 10.9 ± 7.5 mm, on AP and lateral radiographs, respectively, while spanning 12.8 ± 3.9 mm and 13.7 ± 3.2 mm (AP and lateral, respectively) on the tibia. Second, identification of the growth plate to ensure avoiding disturbance is of analogous importance and the placement of these reconstruction tunnels should be as close to these anatomic positions as possible.

Conclusions

Although operating on an adolescent patient with open physes can be a challenging task due to the vulnerability of the growth plates present in both the tibia and fibula, failure to address any instability may increase susceptibility of adjacent structures of the knee to injury, especially for the common peroneal nerve. This presents a far greater risk when proceeding with nonoperative treatment protocols. By following the technique detailed above, restoration of the PTFJ can be achieved while avoiding the potential consequences of damaging open physes and any ensuing growth defects.

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