Technical Note

Arthroscopic ACL Avulsion Fixation With Adjustable Loop Length Cortical Endobutton

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Abstract: Various surgical management techniques have been introduced to treat anterior cruciate ligament avulsion fractures. There is disagreement among orthopedic surgeons about which fixation device to use during arthroscopy. Recently, there has been an increase in the use of arthroscopic techniques for fixation, and different devices such as sutures, screws, and fiber wires are being considered. The development of fiber wires has made it possible to use them in comminuted avulsions with satisfactory stability, whereas screws cannot be used in such cases. Sutures do not provide adequate stability for early range of motion compared to other methods. The article then goes on to describe a specific arthroscopic fixation technique that uses an adjustable loop cortical button to manage the avulsed fragment and provide stability.

Anterior cruciate ligament (ACL) avulsion, equivalent to anterior tibial spine fracture, is a rare injury, with an incidence of approximately 3 per 100,000 people per year. However, because of an increase in motor vehicle accidents and sports-related injuries such as falls, skiing, soccer, and football, the incidence of ACL avulsion is on the rise.[1] Classification of these fractures is based on the Meyers and McKeever classification system, which categorizes them into Type I (non-displaced fractures), Type II (hinge or partially displaced), Type III (completely displaced with no cortical contact), and Type IV (completely displaced and comminuted).[2] The management of these fractures remains a topic of debate. However, surgical treatment is often recommended for Type II or higher fractures. Surgical methods can be open or arthroscopic, using different fixation methods such as screws, sutures, pins, or wires. Arthroscopic fixation and reduction are preferred because of less soft tissue injury and smaller incisions. The article describes a specific method of fixation for ACL avulsion using an adjustable loop cortical button and evaluates its advantages and disadvantages (Video 1).

Surgical Technique

Patient Positioning

After the patient is given proper spinal or general anesthesia, they are placed in a supine position. A tourniquet is placed on the upper thigh, and the knee is positioned at a 90° flexion, allowing for the full range of motion. The patient is given tranexamic acid (1 g) and prophylactic intravenous antibiotics (Cefazolin, 2 g) to prevent infection. The surgical site is then cleaned and draped, and the anterolateral and anteromedial portals are marked (Fig 1). The tourniquet is inflated to 250 to 300 mm Hg. The leg should be hung beside the bed. An incision is made on the anterolateral portal site, which allows any hemarthrosis of the fracture site to exit. The anteromedial working and anterolateral visual arthroscopic portals are then created to detect any accompanying knee joint lesions. The avulsed portion of the ACL is identified at the tibia plateau.

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Fig 1. The patient is in a supine position with their right knee exposed and accessible. The anterolateral and anteromedial portals have been marked for identification (right knee, supine position; the foot hangs on the edge of the bed).

Surrounding soft tissue that may prevent the avulsed fragment from seating properly on the tibia plateau is then removed using a shaver (Fig 2).

Avulsed Fragment Reduction and Fixation

In the next step of the procedure, the ACL director tibial tunnel guide (Zimmer Biomet, Warsaw, IN) is used to reduce the avulsed fragment in place while passing a guide pin through the tibia over the ACL (Fig 3). After the tibial tunnel is reamed to 4.5 mm, the guide pin is removed while holding the 4.5 mm reamer in place, and a Lasso wire is passed through the reamer over the ACL (Figs 4, 5). The loop of the Lasso wire is placed outside the tibial cortex. When reduction is placed by the ACL director tibial tunnel guide (Zimmer Biomet, Warsaw, IN), the XL adjustable loop cortical Endobutton (Zimmer Biomet, Warsaw, IN) is passed through the tunnel using the Lasso wire and flipped over the avulsed fragment using direct arthroscopic visualization (Figs 6, 7). A 2-hole reconstruction plate is used as an anchor for the button loop to hold it in place against the tibial cortex. After fixing the plate complete reduction and stable fixation checked arthroscopic in case of instability and loosed reduction, the Endobutton can be re-tensioned for better reduction stability. The Endobutton is tensioned properly as the avulsed fragment is seated completely, and the plate is further fixed in place by two cortical screws (Fig 8). The tension and stability of the ACL fragment are checked arthroscopically using a hook, and the range of motion of the knee joint is also checked to ensure there is no locking or impingement. The joint is then irrigated. Endobutton fiber wires are sutured finally to decrease the possibility of Endobutton loosening in the long term. The surgical wounds are closed using monofilament absorbable sutures. Tables 1 and 2 describe the pearls/pitfalls and advantages/disadvantages of the procedure, respectively.

After Operation

After surgery, no knee immobilization is needed. Weightbearing as tolerated and range of motion are initiated the day after surgery, followed by an open chain range of motion after 3 weeks. The patient is discharged the following day (Fig 9).

Discussion

The treatment of ACL avulsion fractures has evolved significantly since their initial description in 1875. Arthroscopic fixation has emerged as a viable option because of its potential for causing less soft tissue damage compared to traditional open fixation. However, there is still a debate in the medical community regarding the most appropriate fixation device to use during arthroscopy.

Several studies have evaluated different techniques for treating these fractures.[3,4] Mortazavi and colleagues[1] explain a basic arthroscopic method that

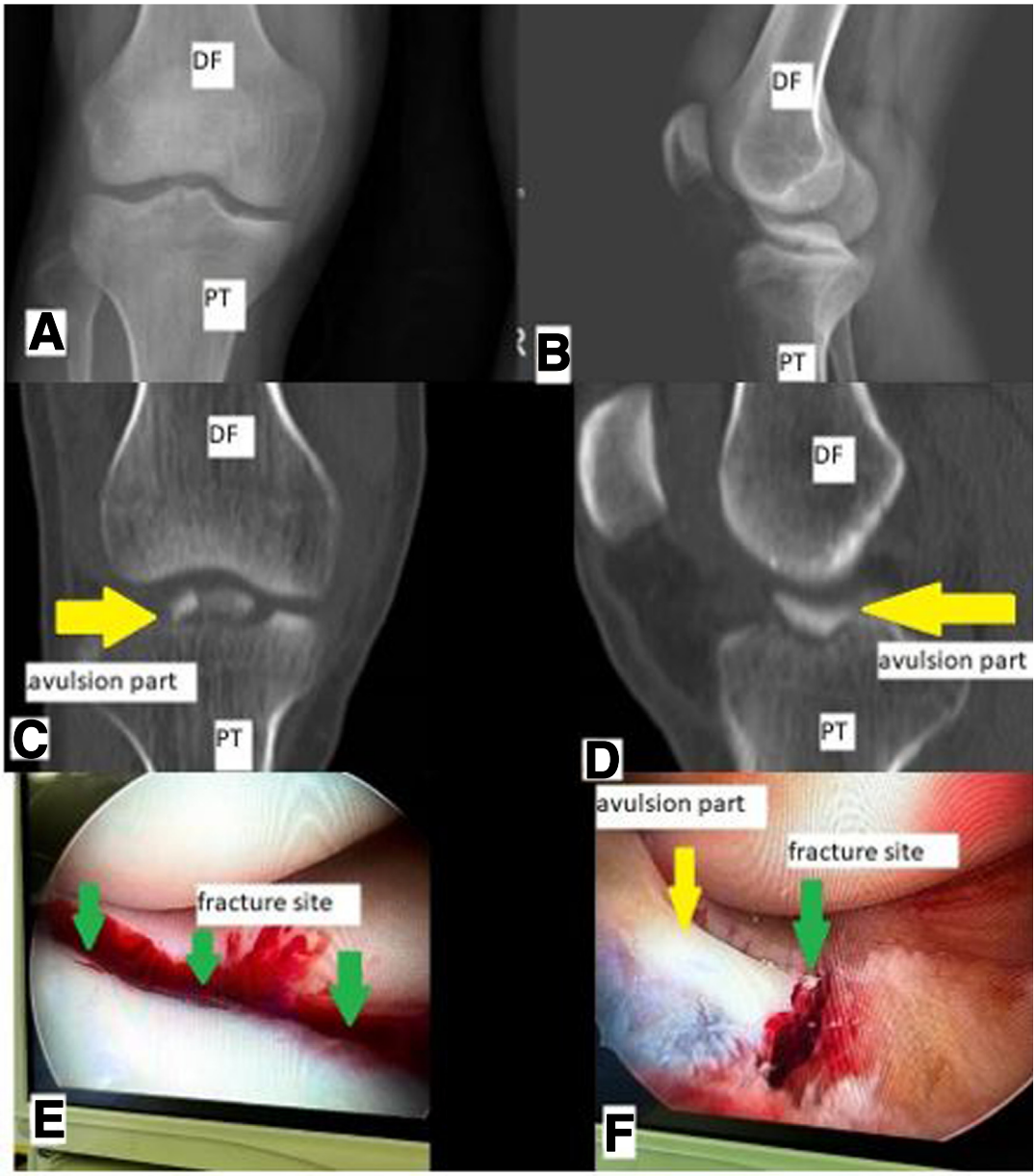

Fig 2. The figure displays radiographic and computed tomography (CT) scan images, as well as an arthroscopic view of the right knee joint. Anteroposterior and lateral radiographs of the knee joint. The distal femur (DF) and proximal tibia (PT) can be seen in both images **(A, B)**. Coronal and sagittal views of the knee joint in a CT scan. The avulsed part is indicated by the *yellow arrows* (*anterolateral visual arthroscopic portals*) **(C, D)**. The arthroscopic view shows the fracture site indicated by the *green arrows* and the avulsed part indicated by the *yellow arrow* **(E, F)**.

uses a Fiber Wire to handle a displaced fracture of the tibial eminence. Jang et al.[5] found that arthroscopic suture fixation using a three-point technique was effective in treating ACL tibial avulsion fractures. Similarly, Ding et al.[6] demonstrated the efficacy of the arthroscopic tension wire fixation technique for these fractures.

On the other hand, Pan and colleagues[3] found that screw fixation may be a better option for anterior tibial plateau fractures due to its shorter operative time and better objective evaluation. However, Bogunovic and colleagues[7] found that although patient-reported instability and the rate of ACL reconstruction were similar between the suture and screw fixation, suture fixation was associated with improvements in clinical measurements of stability and a reduced need for hardware removal. Kelly and coworkers[8] describe an arthroscopy-assisted reduction and internal fixation

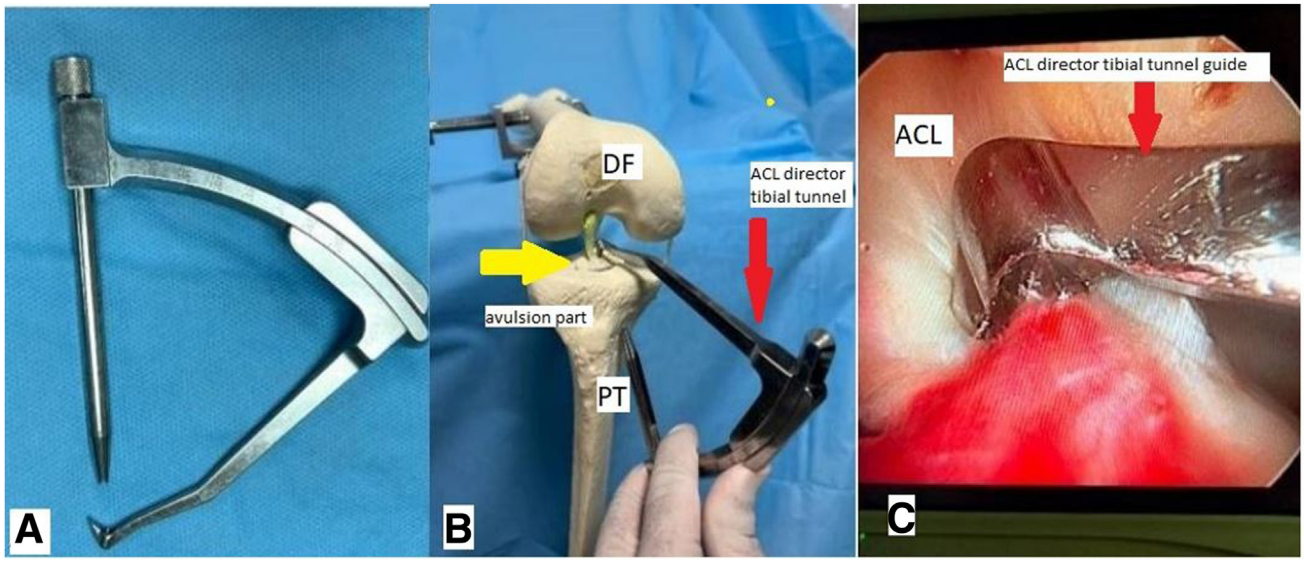

Fig 3. The figure demonstrates how to reduce an avulsed part using an anterior cruciate ligament (ACL) director tibial tunnel guide. ACL director tibial tunnel guide **(A)**. The reduction of the avulsed part was performed on a moulage model using the ACL director tibial tunnel guide **(B)**. An arthroscopic view of the knee joint during the reduction process using the ACL director tibial tunnel guide (right knee; anterolateral visual arthroscopic portals) **(C)**. DF, distal femur; PT, proximal tibia.

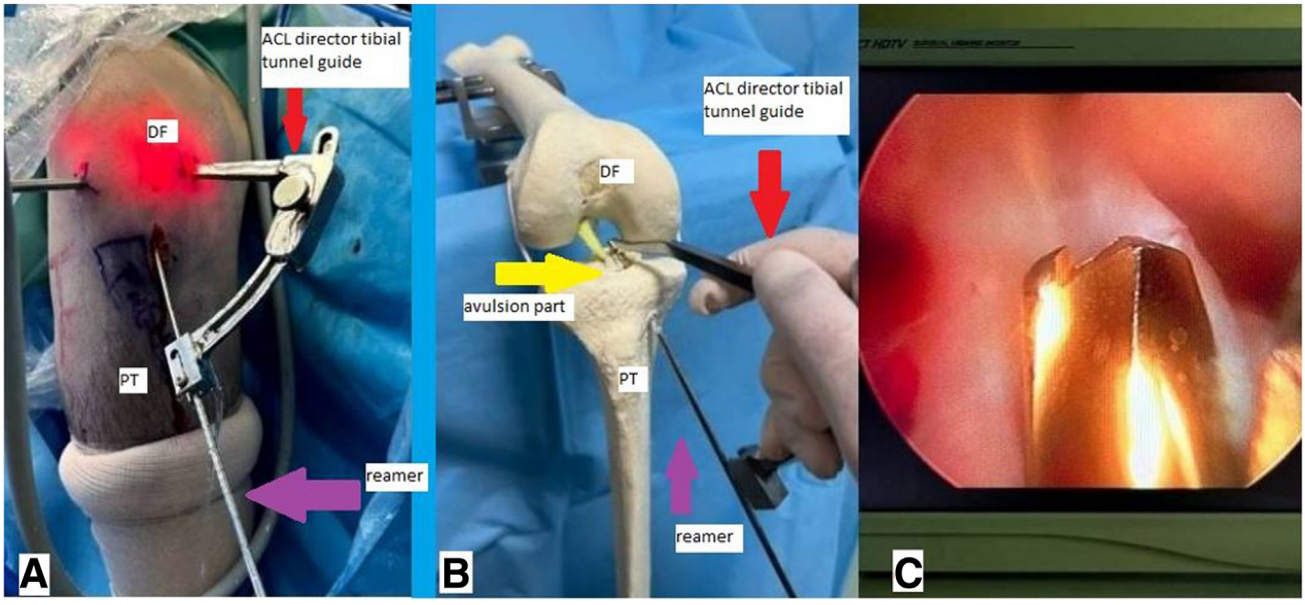

Fig 4. The figure demonstrates the use of an anterior cruciate ligament (ACL) director tibial tunnel guide and a 4.5 reamer to ream the tibial bone. ACL director tibial tunnel guide (*red arrow*) and 4.5 reamers (*purple arrow*) are used to ream tibial bone **(A)**. **(B)** The same process is performed on a moulage model. An arthroscopic view of the knee joint after the avulsed part has been reamed with the 4.5 reamers. The head of the reamer is visible in image (right knee; anterolateral visual arthroscopic portals) **(C)**. DF, distal femur; PT, proximal tibia.

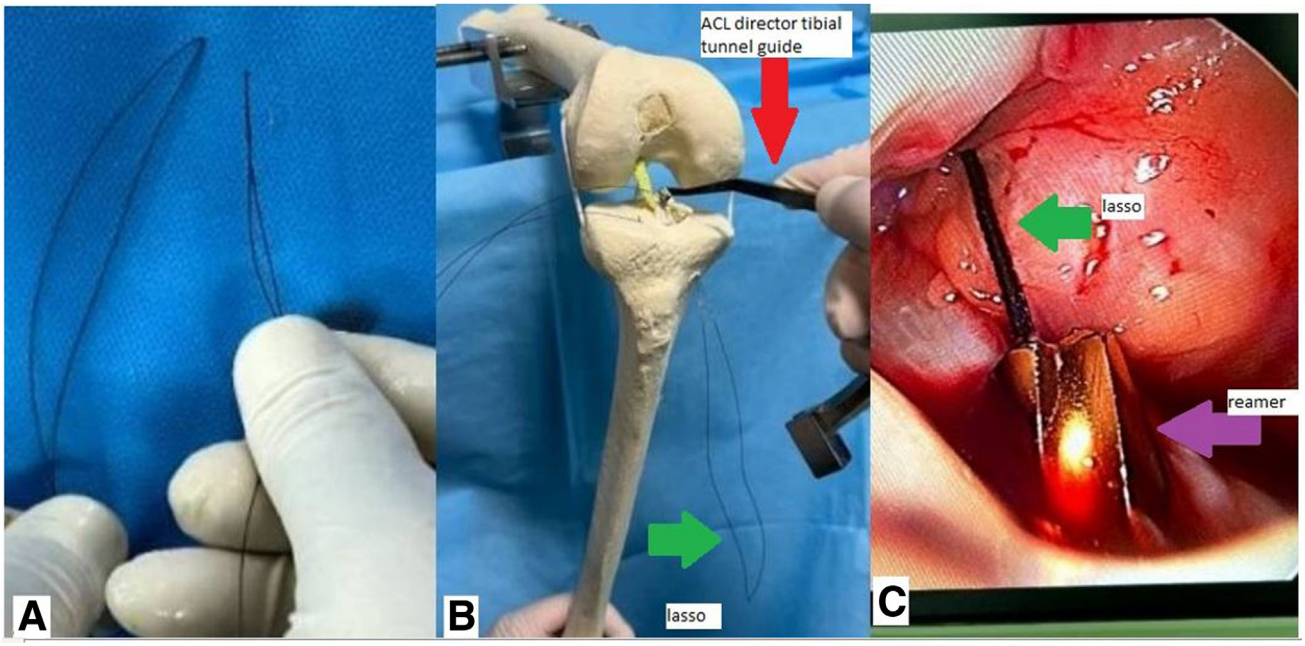

Fig 5. The figure depicts a technique for passing a lasso wire through the reamer over the AC. Lasso wire **(A)**. The lasso wire (*green arrow*) is passed through the reamer over the ACL the loop of the Lasso wire is placed outside the tibial cortex in the moulage model **(B)**. The reamer, which is shown in purple in the figure, is used to create a channel for the lasso wire to pass through and the lasso wire is passed through the reamer over the ACL in an arthroscopic view (right knee; anterolateral visual arthroscopic portals) **(C)**.

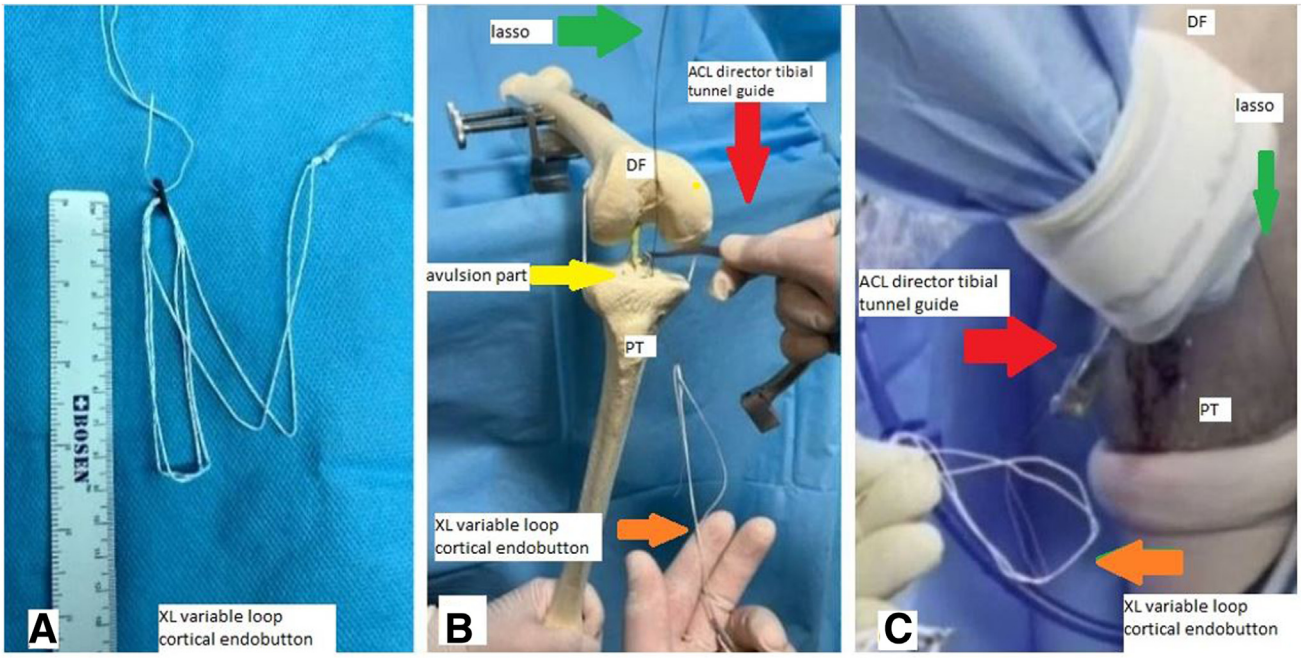

Fig 6. The process of passing the XL adjustable loop cortical Endobutton through a tunnel using a Lasso wire while the avulsed part is reduced by the ACL director tibial tunnel guide. The XL adjustable loop cortical Endobutton **(A)**. moulage model is used to demonstrate the passing of the Endobutton through the tunnel using a Lasso wire, represented by the *green arrow* **(B)**. The XL adjustable loop cortical Endobutton(orange arrow)is passed by using a lasso wire (*green arrow; right knee; supine position; the foot hangs on the edge of the bed*) **(C)**. DF, distal femur; PT, proximal tibia.

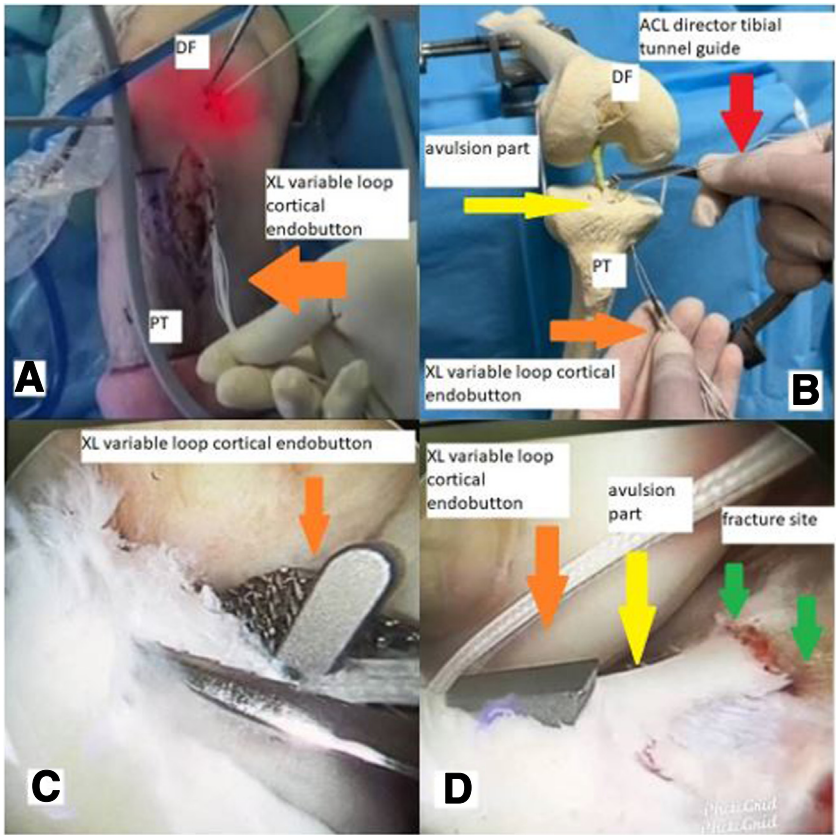

Fig 7. The process of using direct arthroscopic to flip over the avulsed fragment and pass the XL adjustable loop cortical Endobutton (*orange arrow*) through the tibial tunnel. The Endobutton is shown being passed through the tibial tunnel **(A)**. Endobutton is passed through the tibial tunnel in the moulage model **(B)**. Endobutton passing avulsed fragment in arthroscopic view **(C)**. Endobutton being tensioned properly as the avulsed fragment (*yellow arrow*) is fully seated (right knee; supine position; the foot hangs on the edge of the bed; anterolateral visual arthroscopic portals) **(D)**. DF, distal femur; PT, proximal tibia.

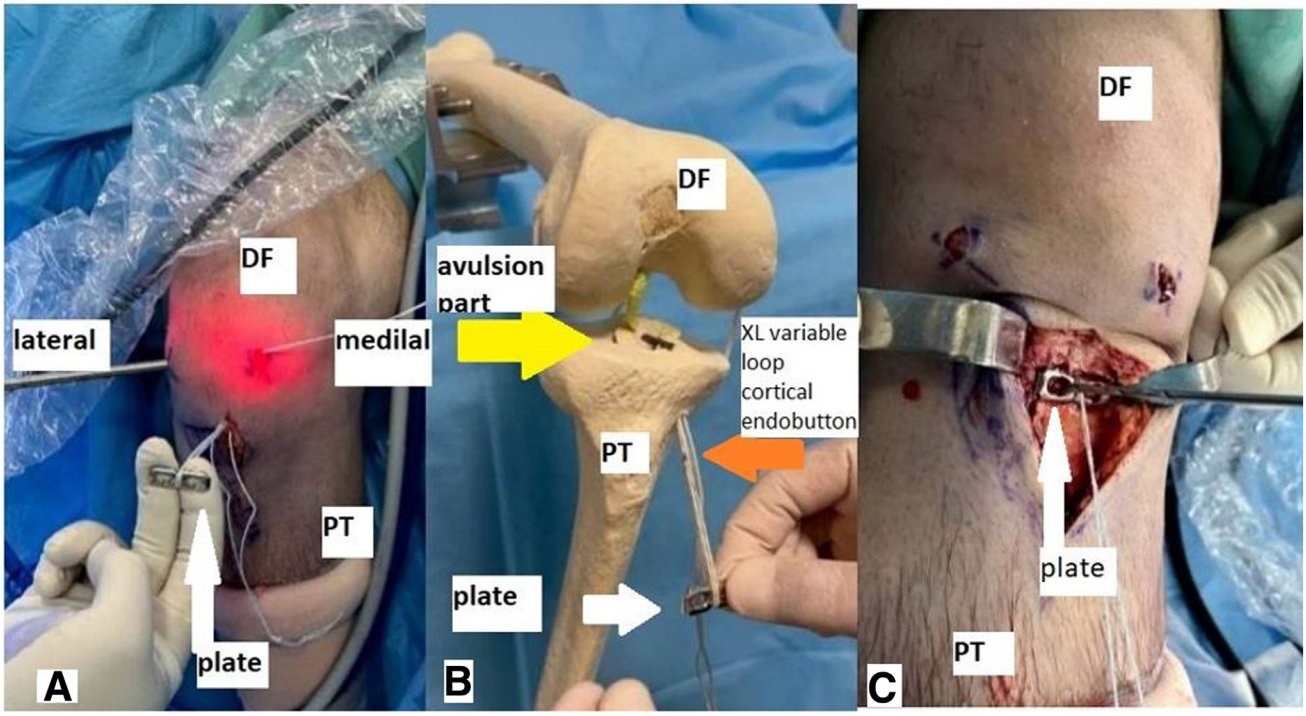

Fig 8. A two-hole reconstruction plate is used as an anchor for the XL adjustable loop cortical Endobutton to hold it in place against the tibial cortex **(A)** and a moulage model **(B)**. Plate is completely fixed by 2 cortical screws in knee extension (right knee; supine position; fixation in knee extension) **(C)**. DF, distal femur; PT, proximal tibia.

Table 1. Pearls and Pitfalls

Pearls
The foot hangs on the edge of the bed during fragment reduction, and it is not necessary to take off the distal part of the bed.
Clear vision and access to the region around the fracture leads to improved reduction outcomes
The removal of loose bodies is essential in reducing the likelihood of restricted knee motion
ACL director tibial tunnel guide is used for reduction and tunnel placement purposes
Using a single tunnel decreases the likelihood of an iatrogenic fracture occurring in the bone fragment.
Arthroscopic evaluation of the reduction status of the avulsed ACL
If there is loosed reduction, the Endobutton can be re-tensioned for better reduction stability.
Early initiation of assisted range of motion is feasible starting from the day of surgery, leading to a gradual attainment of the full range of motion within 1 week.
Early postoperative mobilization of the patient is initiated as soon as can be tolerated.
Pitfalls
Ensuring proper reduction of the avulsed fragment and achieving optimal ACL tension before final suture tying effectively prevents anterior knee laxity.
To avoid impingement within the notch, proper orientation of the Endobutton is crucial. Neglecting this can potentially lead to flexion contracture and cartilage damage.
In cases where the bone fragment has a thin, shell-like structure, it may be feasible to perform endoscopic cutting of the fragment.

ACL, anterior cruciate ligament.

Table 2. Advantages and Disadvantages

Advantages
The surgical procedure takes less time, making reduction easier and more effective.
Flexibility for potential re-tensioning, if required
It only uses a single tunnel.
If communication established is with Endobutton incorporation within the ACL, this method can be effectively used.
The postoperative recovery period is shorter.
The surgeon can assess and manage additional potential intra-articular injuries that may be present.
It's a simple technique.
This technique does not disrupt the vascular supply to the ACL.
Disadvantages
If the bone fragment is less than 5 mm, there is an increased likelihood of fracture.
There is a possibility of artifact formation if magnetic resonance imaging must be performed.
Technically demanding
Endobutton fiber wire cutting

ACL, anterior cruciate ligament.

with suture tape through 2 transtibial tunnels with a cortical suture button fixation technique. The choice of a fixation device for treating ACL avulsion fractures remains a subject of debate, and the decision should be based on the patient's situation and the surgeon's expertise. Further research and studies are needed to determine the most effective and safe treatment approach for these fractures.

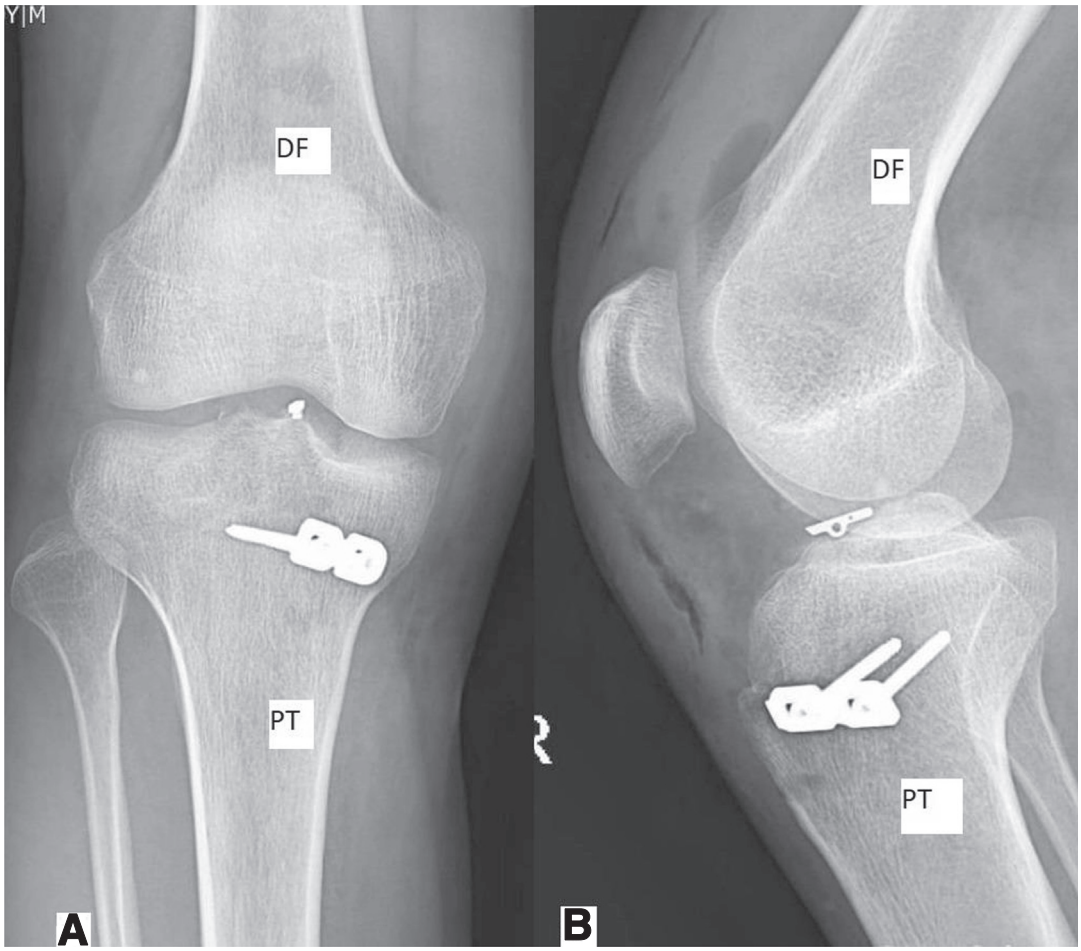

Fig 9. Postoperative anteroposterior and lateral radiographic X-ray films (right knee). DF, distal femur; PT, proximal tibia.

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