Technical Note

A Simple Instrument for Intraoperative Fluoroscopic Localization of Anatomic Insertions in Medial Patellofemoral Ligament Reconstruction

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Abstract: Medial patellofemoral ligament (MPFL) reconstruction is the most common operation for treating patellofemoral joint instability. Accurately identifying the fluoroscopic location of the MPFL anatomical insertion point is critical in this procedure. However, current radiographic localization has some limitations, such as inaccuracy and radiation exposure. We recommend a simpler and more accurate instrument for intraoperative fluoroscopic positioning.

Medial patellofemoral ligament (MPFL) reconstruction is a well-established operative procedure that can be performed alone or in conjunction with bony procedures in patients with recurrent episodes of lateral patellar instability.[1] Accurate anatomic insertion positioning, especially for the location of the tunnel in the medial condyle of the femur, is critical to the success of this operation. The Kirschner wire fluoroscopic positioning method has been widely used in surgery, but this method has several limitations, such as inaccurate positioning due to the difficulty of fixing the Kirschner wire and the need for repeated fluoroscopy, which increases radiation exposure. We used a simple instrument, the ear stud, which can be easily fixed and more accurately positioned for intraoperative fluoroscopy.

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Materials

The fluoroscopy instrument we used is an ear stud. The ear stud is composed of a spherical head with a diameter of 3 mm and a tail with a length of 11 mm (Fig 1A). The ear stud is made of stainless steel or pure silver and is resistant to damage and deformation even when sterilized at high temperatures and pressures.

Construction Steps

The following construction steps are taken (Video 1):

Step 1: First, a routine knee arthroscopy is performed to determine whether there are any intra-articular structural injuries. The semitendinosus tendon is harvested as a graft. Longitudinal incisions of approximately 3 cm are made at the medial border of the patella and the medial condyle of the distal femur. The subcutaneous tissue and fascia layer are dissected. The bone is exposed in approximately the upper 1/3 of the medial border of the patella, and a longitudinal bone slot (10 mm long, 3-4 mm deep) is developed to accommodate 2 anchor sites. Then, the adductor tubercle is palpated in the medial condyle of the distal femur by a surgeon for tunnel positioning. The femoral insertion point of the MPFL is typically located at the distal and posterior 10 mm of the adductor tubercle.[2]

Step 2: A 1.5-mm Kirschner wire is used to drill holes with depths of approximately 20 mm at two anchor points in the bone slot of the medial border of the patella. Then, the Kirschner wire is withdrawn, and the tails of two ear studs are inserted into the bone holes (Fig 1B). The spherical heads of the ear studs are pressed against the openings of the bone holes and while fluoroscopy is performed. A 2.0-mm Kirschner

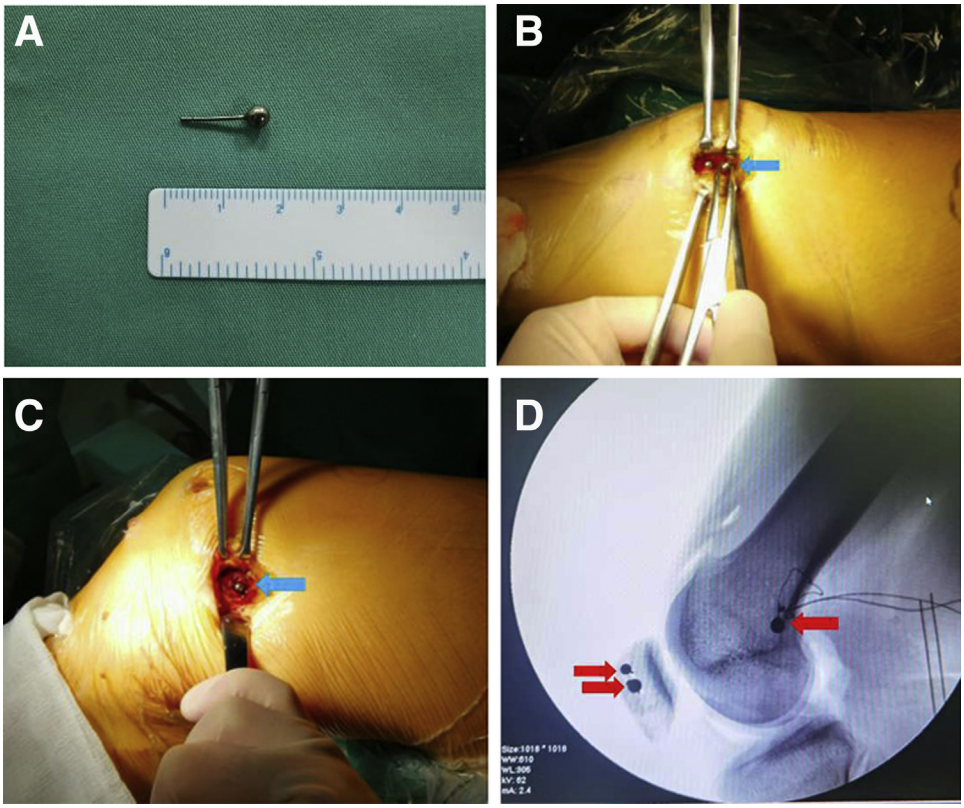

Fig 1. Construction steps. (A) View of the ear stud. (B) Medial side of right knee joint: the tails of two ear studs (blue arrow) are inserted into the bone holes of medial border of patella. (C) Medial side of right knee joint: the tail of the ear stud is inserted into the bone hole and the spherical head (blue arrow) is pressed against the opening of the bone hole of the distal femoral. (D) A true-lateral fluoroscopy of the knee joint is performed to confirm that the spherical heads of the 3 ear studs are located at the insertion point (red arrows).

wire is used to drill a 20-30-mm hole at the insertion point of the MPFL at the medial condyle of the distal femur. The tail of the ear stud is inserted into the bone hole after the Kirschner wire is removed, and the spherical head of the ear stud is pressed against the opening of the bone hole (Fig 1C).

Step 3: A true-lateral fluoroscopy of the knee joint is performed to confirm that the spherical heads of the 3 ear studs are located at the insertion point (Fig 1D). Many authors have described the radiographic localization of the insertion point for MPFL reconstruction.[3,4] The spherical heads of the ear studs are repositioned if they are not in the desired position. If the desired position is achieved, the ear studs could be carefully removed. The anchors are then inserted into the bone holes in the medial border of the patella, and a tunnel with a suitable diameter is drilled in the original bone hole in the medial condyle of the distal femur. Finally, graft fixation is performed on both the patellar and femoral sides.

Discussion

MPFL reconstruction is one of the most common operations for treating patellofemoral joint instability. Accurate localization of the MPFL anatomical insertion site is critical for the success of this operation.[5] Most surgeons agree that obtaining accurate femoral insertion points with intraoperative anatomical landmark palpation is difficult because of the high incidence of variation in bony anatomical landmarks in patients with patellofemoral joint instability. Furthermore, the soft tissue scar formed after MPFL injury complicates the identification of the insertion point.[6] Many authors recommend intraoperative fluoroscopic guidance for anatomical insertion positioning during MPFL reconstruction; however, the femoral tunnel is still placed nonanatomically in 31% to 64% of reported MPFL reconstructions.[7-9] This suggests that femoral tunnel placement is prone to misalignment, even with intraoperative fluoroscopic guidance. Fluoroscopic guidance is generally performed by placing the tip of a Kirschner wire at the proposed insertion point of the MPFL. However, Kirschner wire fixation is difficult to achieve and often results in malpositioning due to movement of the affected limb during fluoroscopy. The procedure is relatively stable when the surgeon holds the tip of the Kirschner wire. However, this kind of pattern must be balanced against the risk of radiation exposure. Some surgeons prefer to drill the Kirschner wire into the proposed insertion point and then clamp forceps on the Kirschner wire as close to the bone cortex as possible.

Table 1. Pearls and Pitfalls of the Ear Studs for Intraoperative Fluoroscopic Guidance

Pearls
Instruments can be sterilized at high temperatures and pressures (or other types of sterilization that meet the requirements of the operating room) without causing deformation or damage.
The shape of the ear stud can meet the requirements and be purchased in stores or online.
Pitfalls
A sufficient drilling depth must be achieved to ensure that the spherical head is pressed against the opening of the bone hole. A true lateral radiograph of the knee joint is critical for accurate medial patellofemoral ligament insertion point localization. The surgeon should be careful when inserting the ear stud to ensure that it does not fall into the incision.

Table 2. Advantages and Disadvantages of Intraoperative Fluoroscopic Guidance

Advantages
This instrument is inexpensive and relatively easy to obtain.
It is very simple to use and requires no training.
Ear studs allow for more accurate fluoroscopic positioning.
Disadvantages
Ear studs are small and difficult to find if they fall into incisions.
Ear studs are not standard orthopedic instruments.

The location of the insertion point can be determined after fluoroscopy by observing the intersection of the Kirschner wire and the forceps. However, it is difficult to accurately determine the anatomical insertion point with this procedure since the intersection points of the forceps and the Kirschner wire are unlikely to be sufficiently close to the bone cortex. Even small distances between the intersection point and the bone cortex can cause position deviations with intraoperative fluoroscopy.

We recommend ear studs as intraoperative fluoroscopic guidance instruments for improving the accuracy of the MPFL insertion position (Table 1). The spherical head of the ear stud is delicate and small, allowing it to press almost completely against the opening of the bone hole. Hence, the ear stud can be used to more precisely represent the opening of the bone tunnel. In addition, inserting the tail of the ear stud into the bone hole ensures that the spherical head is stable without requiring a surgeon to hold it, and the ear stud does not move even if the limb moves during fluoroscopy, thus allowing surgeons to avoid unnecessary radiation exposure.

Ear studs are relatively easy to obtain and can be purchased in stores or online. These instruments should have a simple shape and consist of a spherical head and a tail. Ear studs are also relatively inexpensive and typically made of stainless steel, which can be sterilized at high temperatures and pressures without deformation or damage. Surgeons should ensure that ear studs do not fall into incisions during surgery; in this case, they may be hidden by soft tissue and difficult to locate (Table 2). Furthermore, because ear studs are not standard orthopedic instruments, we hope to develop a standard, disposable instrument for fluoroscopic positioning in future studies.

References

1. Migliorini F, Oliva F, Maffulli GD, et al. Isolated medial patellofemoral ligament reconstruction for recurrent patellofemoral instability: Analysis of outcomes and risk factors. *J Orthop Surg Res* 2021;16:239.
2. Viste A, Chatelet F, Desmarchelier R, Fessy MH. Anatomical study of the medial patello-femoral ligament: landmarks for its surgical reconstruction. *Surg Radiol Anat* 2014;36:733-739.
3. Barnett AJ, Howells NR, Burston BJ, Ansari A, Clark D, Eldridge JD. Radiographic landmarks for tunnel placement in reconstruction of the medial patellofemoral ligament. *Knee Surg Sports Traumatol Arthrosc* 2012;20:2380-2384.
4. Stephen JM, Lumpaopong P, Deehan DJ, Kader D, Amis AA. The medial patellofemoral ligament: location of femoral attachment and length change patterns resulting from anatomic and nonanatomic attachments. *Am J Sports Med* 2012;40:1871-1879.
5. Sanchis-Alfonso V. Guidelines for medial patellofemoral ligament reconstruction in chronic lateral patellar instability. *J Am Acad Orthop Surg* 2014;22:175-182.
6. Redfern J, Kamath G, Burks R. Anatomical confirmation of the use of radiographic landmarks in medial patellofemoral ligament reconstruction. *Am J Sports Med* 2010;38:293-297.
7. Hopper GP, Leach WJ, Rooney BP, Walker CR, Blyth MJ. Does degree of trochlear dysplasia and position of femoral tunnel influence outcome after medial patellofemoral ligament reconstruction? *Am J Sports Med* 2014;42:716-722.
8. McCarthy M, Ridley TJ, Bollier M, Wolf B, Albright J, Amendola A. Femoral tunnel placement in medial patellofemoral ligament reconstruction. *Iowa Orthop J* 2013;33:58-63.
9. Walker M, Maini L, Kay J, Siddiqui A, Almasri M, de Sa D. Femoral tunnel malposition is the most common indication for revision medial patellofemoral ligament reconstruction with promising early outcomes following revision reconstruction: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2022;30:1352-1361. 2021;8(5).