Technical Note

Implantless Supplementary Fixation of Anterior Cruciate Ligament in Tibia with "Make and Use" Anchor

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Abstract: Supplementary fixation after anterior cruciate ligament reconstruction may be necessary in some situations. There are several methods described for supplementary fixation with their advantages and disadvantages. Anchor fixation is preferred by many because it does not require a second surgery for removal. However, anchors are costly. We described the "make and use" all-suture anchor, which can be made instantly whenever required. We modified "make and use" all-suture anchors for supplementary fixation after ACL reconstruction. This technical note aims to describe the method of supplementary fixation using the "make and use" all-suture anchor.

Tibial supplementary fixation after anterior cruciate ligament (ACL) reconstruction is widely debated. However, it is recommended to be used in female patients and in situations like revision ACL reconstruction, osteoporotic bone, and short graft length.[1-3] There are several methods of supplementary fixation; screw posts, washers, anchors, bone bridge, and staples are the most commonly used supplementary fixation devices.[4,5] Some of these supplementary fixation devices are known to cause hardware prominence and pain, requiring a second surgery for removal.[1,5,6] Bone bridge fixation requires additional drilling of the bone, and its fixation strength depends on bone quality.[7] An additional anchor is simple and easy but comes with an additional cost to the surgery.[8] Several modifications of supplementary fixations techniques have been described in the literature, but they are for a few specific situations.[9] In this technical note, we describe a modification of the "make and use" anchor described by Joshi et al.[10] for tibial supplementary fixation after ACL reconstruction with the hamstring graft. This technique is simple and cost-effective and can be accomplished with locally available materials.

Indication

Tibial supplementary fixation using this technique can be used in the following conditions:

1. Primary ACL reconstruction where the graft is inside the tunnel
2. Revision ACL reconstruction using a soft tissue graft
3. ACL reconstruction in osteoporotic bone
4. Meniscal root repair
5. Tibial spine fracture fixation with pull-out sutures
6. Can be used in any surgery where a suture has to be fixed in the bone

This technique elaborates on the surgical steps of supplementary fixation in the tibia after quadrupled hamstring ACL reconstruction (Video 1).

Material Required

This technique requires minimal materials readily available in orthopaedic operation theaters. The following materials are needed (Fig 1):

A. Anchor introducer: Made by grinding off half the eyelet of a 2.4 mm Beath pin and tapered from the side.

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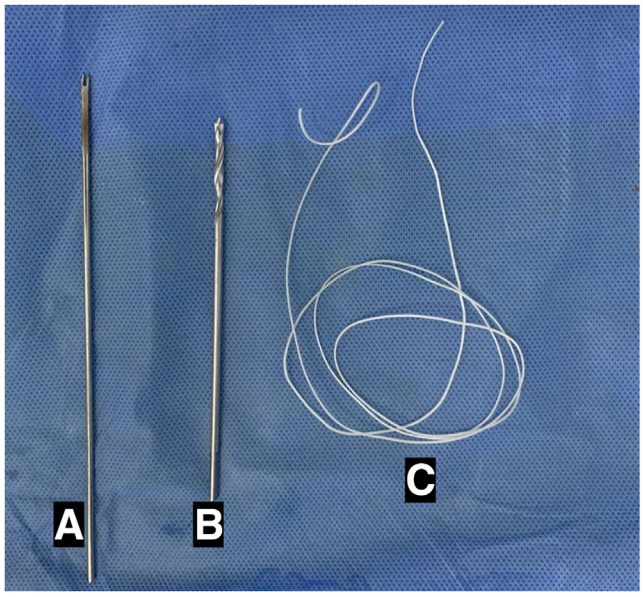

Fig 1. Materials required for supplementary fixation. **(A)** The anchor introducer was made by grinding the eyelet end of a 2.4 mm Beath pin. **(B)** A 3.2 mm drill bit. **(C)** Pulling suture of fixed loop Endobutton, used for femoral fixation of a hamstring graft.

B. A 3.2 mm drill bit
C. Pulling suture: A fixed loop Endobutton (BioTek; Chetan Meditech Pvt. Ltd., Gujrat, India), used for femoral fixation of the hamstring graft

Surgical Technique

The surgery is completed in 4 steps (Video 1): anchor preparation, drilling a socket, insertion of anchor, and knot tying. The details of these steps are described below.

Step 1. Anchor Preparation

Once the quadrupled hamstring graft is fixed with a fixed loop Endobutton on the femoral side and bio-composite interference screw on the tibial side, the pulling white suture of the Endobutton is pulled out to be used as the anchor. The Ethibond (No 5) suture limbs coming out of the tibial tunnel are separated into two pairs, keeping one each from semitendinosus and Gracilis (Fig 2A). The pulling suture is double-folded, and a loop is created by throwing two simple knots (Fig 2B). The assistant holds the loop and pair of Ethibond (Fig 2C). Now, the surgeon wraps the Ethibond pair with the pulling suture and makes a loose simple knot. The wrapping of the Ethibond and making a loose, simple knot must be continued until six knots are made over the Ethibond. Each knot has to have a gap of about 5 mm (Fig 2D). After the sixth knot, two more knots are thrown without wrapping the Ethibond to create a suture extension. This wrapping and knotting will make a sleeve of suture over the Ethibond, which will act as a suture anchor. The pulling sutures are cut, leaving a 1 to 2 mm length of suture. The loop of the pulling suture is also cut, leaving a 1 to 2 mm length of suture (Fig 2E). The length of the suture sleeve is measured to identify the center of the suture sleeve (Fig 2F). Now confirm that the sleeve of the suture is loose and easily slides over the Ethibond pair (Fig 2G), and, by looping the sleeve with another suture, confirm that bulb formation of the sleeve takes place (Fig 2H).

Step 2. Drilling a Socket

A point 2 cm below the tibial tunnel is marked in the anteromedial surface of the tibia (Fig 3A). Soft tissue around the marked point is cleared with cautery (Fig 3B). A socket is made at this point by drilling only 1 cortex with a 3.2 mm drill bit. The drill bit has to be directed toward the medullary canal and about 45° caudally (Fig 3C). The aperture of the socket is cleared of all debris (Fig 3D).

Step 3. Insertion of Anchor

A locally made anchor introducer is used to insert the anchor inside the socket. A 2.4 mm Beath pin is cut into two halves, and the eyelet side is used to make the introducer. Half of the eyelet is grinded off, and the sides are flattened (Fig 4A). Now, the anchor is loaded into the introducer at the center of the anchor (Fig 4A). The anchor with the introducer is placed into the socket and manually pushed (Fig 4B). A light mallet is then used to insert the anchor into the socket completely (Fig 4C). The anchor and introducer have to go inside the socket easily. If it is too tight, remove the introducer and anchor, clear the aperture, and repeat the process until the whole anchor is inside the socket (Fig 4D). After confirming the adequacy of complete insertion, the introducer is removed. At this point, if the anchor is still visible in the aperture, the same introducer can be used to insert the anchor completely by manually pushing the anchor inside the socket. Finally, pull the Ethibond sutures one by one to deploy the anchor and confirm the strength by forcefully pulling both Ethibond sutures.

Step 4. Knot Tying

Finally, the Ethibond limbs of the semitendinosus and gracilis are identified and tied with each other (Fig 5A). Once the knots are secured, the sutures are cut to complete the surgery (Fig 5B). The surgical wound is closed in standard fashion.

Discussion

Tibial fixation in ACL reconstruction is generally a point of less resistance than femoral fixation because of the lower density of the tibial bone and the parallel

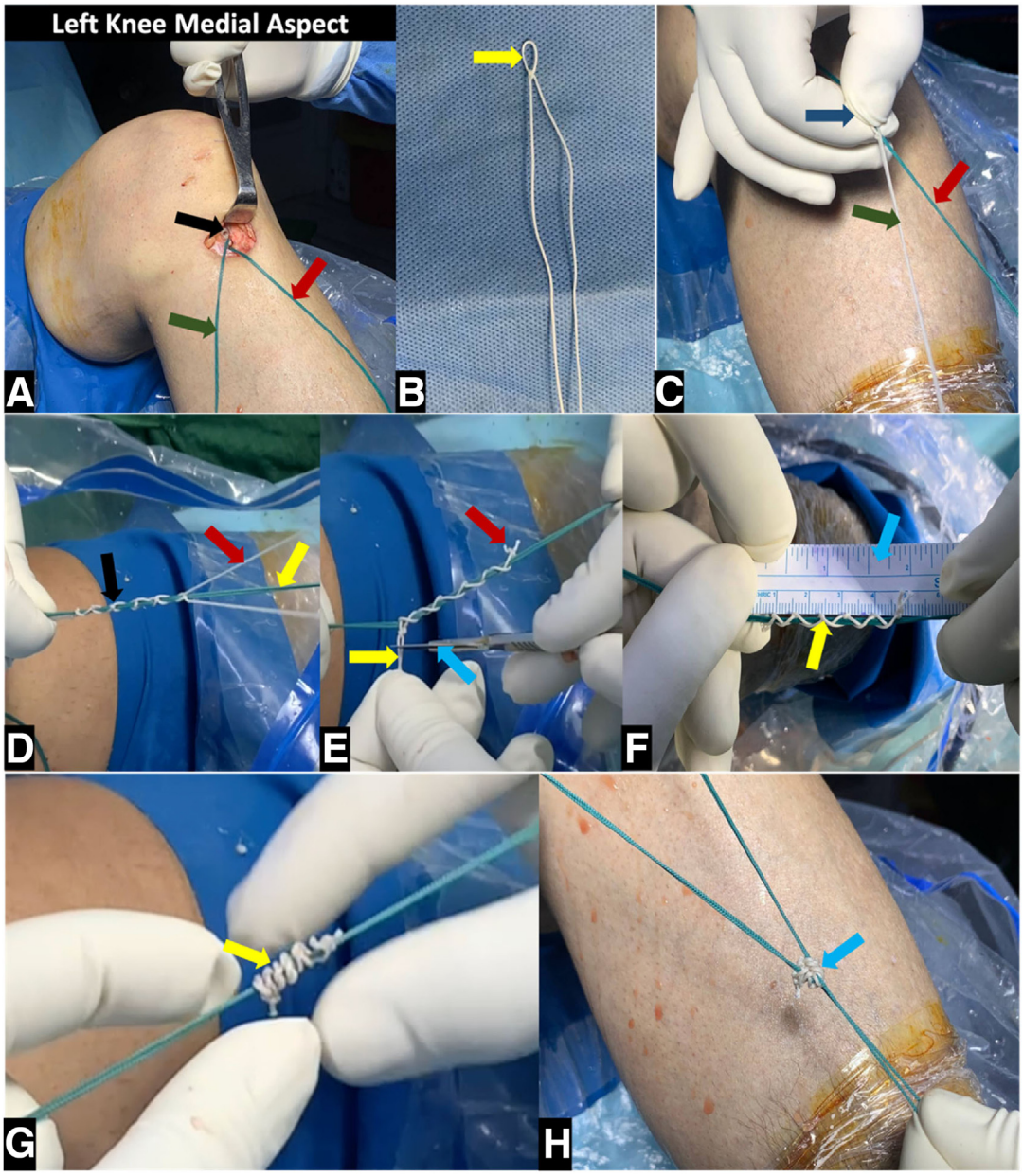

Fig 2. Steps of anchor preparation. **(A)** Anteromedial aspect of the left knee with incision of hamstring harvest. The graft was fixed with a bio-composite screw on the tibial tunnel (*black arrow*). The no. 5 Ethibond suture limbs are separated into 2 pairs, one each from the semitendinosus and gracilis whip stitches. **(B)** A loop is made from pulling the suture of the Endobutton. **(C)** The assistant holds (*blue arrow*) the loop of pulling suture (*green arrow*) and the pair of Ethibond (*red arrow*). **(D)** Creation of anchor sleeve (*black arrow*) by wrapping a pair of Ethibond (*yellow arrow*) with a pulling suture (*red arrow*). **(E)** The ends of the pulling sutures are cut (*red* and *yellow arrow*), leaving 2 mm of length. **(F)** The length of the anchor is measured using a paper scale. **(G)** Sliding the suture sleeve is confirmed by pulling and pushing (*arrow* showing loose sleeve). **(H)** The *arrow* shows the bulb formation of the suture sleeve, and the bulb formation will occur during the anchor's deployment.

graft fixation associated with the tunnel.[10,11] In certain circumstances, supplementary fixation is advocated on the tibial side.[12,13] Staples and washers are the most commonly used supplementary fixation devices, but they were found to have hardware issues.[5,6,13] Eisen et al.[9] described a transosseous backup suture fixation technique for ACL grafts of all varieties.[9] Although this technique has some advantages, the fixation strength depends on bone quality. There is a possible chance of suture cutout in osteoporotic bones.

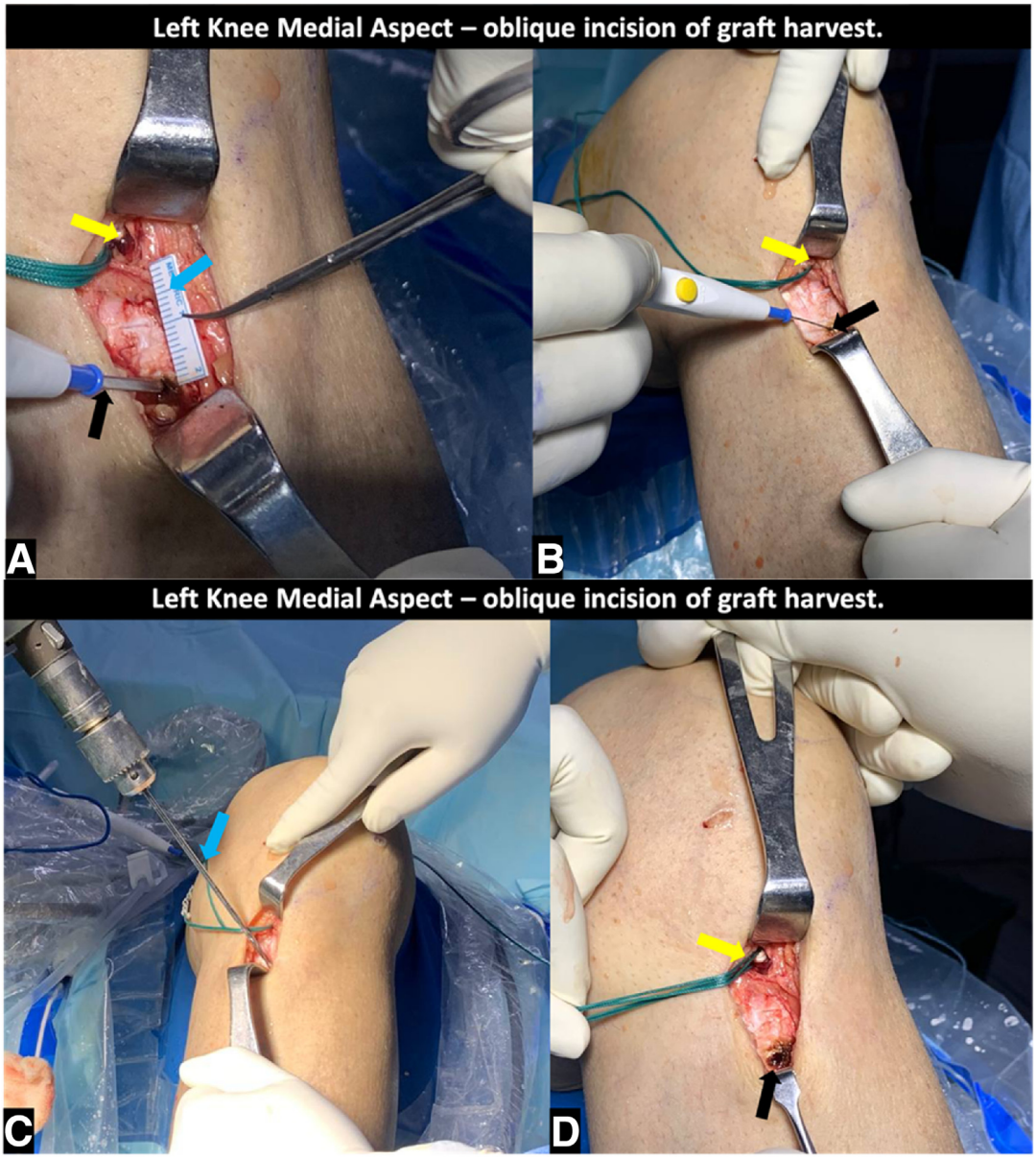

Fig 3. The process of drilling the socket is shown in the anteromedial aspect of the left knee through the hamstring harvest incision. **(A)** A point 2 cm below the tibial tunnel (*yellow arrow*) is identified using a paper scale (*blue arrow*) and marked by electrocautery (*black arrow*). **(B)** Four strands of Ethibond are coming out of the tibial tunnel (*yellow arrow*), and soft tissue is cleared using cautery (*black arrow*). **(C)** A 3.2 mm drill bit (*blue arrow*) is used to drill the socket. The drill bit is directed 45° caudally and toward the medullary canal. **(D)** The tibial tunnel (*yellow arrow*) and 3.2 mm socket (*black arrow*) are created 2 cm below the tibial tunnel.

In an animal study, Lee et al.[3] described a push-lock anchor type for supplementary fixation. The anchor avoided complications associated with the washer and staples.[3] Although this is useful and easy, it is associated with cost and may not always be available. Hence, "make and use" anchors are very useful in these situations.[10] We modified the "make and use" anchor technique to create a suture anchor on the whipstitch Ethibond and anchored it into the bone to achieve supplementary fixation.

The pearls and pitfalls of this technique are described in Table 1. Our method of tibial supplementary fixation during ACL reconstruction can be made with locally available materials and does not need any additional

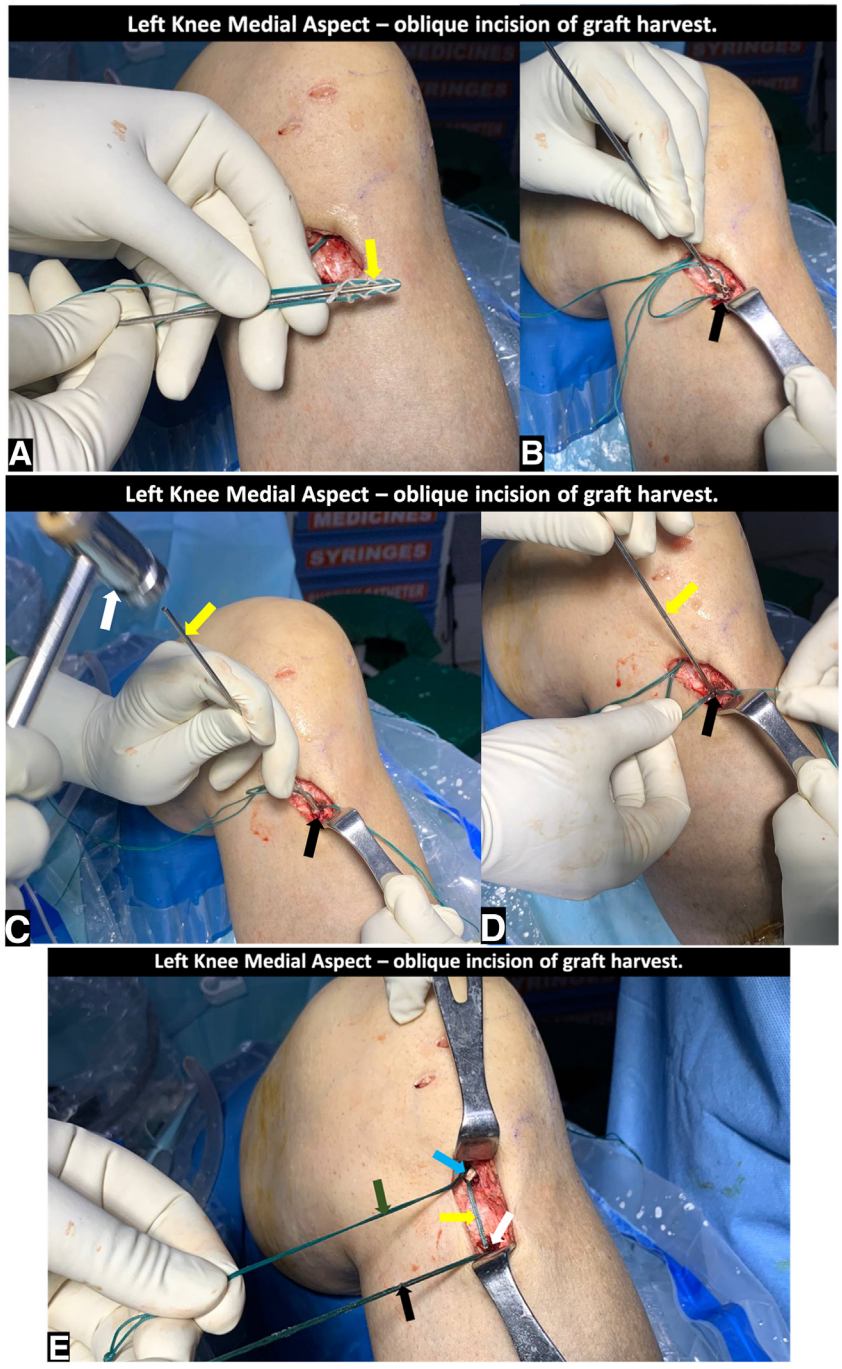

Fig 4. The process of anchor insertion into the medial aspect of the left knee through the graft harvest incision. **(A)** The anchor is loaded into the introducer (*yellow arrow*). **(B)** The anchor is manually introduced into the socket (*black arrow*). **(C)** The introducer (*yellow arrow*) is gently tapped with a light hammer (*white arrow*) to completely insert the anchor inside the socket (*black arrow*). **(D)** If some part of the anchor is still out of the aperture, the introducer (*yellow arrow*) is removed, and again the anchor is pushed inside the socket (*black arrow*) using the same introducer. **(E)** In the final stage of anchor insertion, the *blue arrow* shows the tibial tunnel, and the *yellow arrow* shows the part of the Ethibond pair going inside the socket. The *yellow arrow* marks the socket where the anchor is deployed and the Ethibond pair suture is pulled out (*black arrow*). The *green arrow* depicts the other pair of Ethibond sutures.

hardware, often leading to symptoms associated with hardware. Additionally, adopting this technique can save costs because it doesn't require any additional material to purchase. The technique is simple, efficient, and affordable, using existing materials to strengthen the tibial fixation of the graft. However, this technique requires meticulous anchor preparation and a gentle approach to anchor introduction and deployment. The advantages and disadvantages of our technique are described in Table 2.

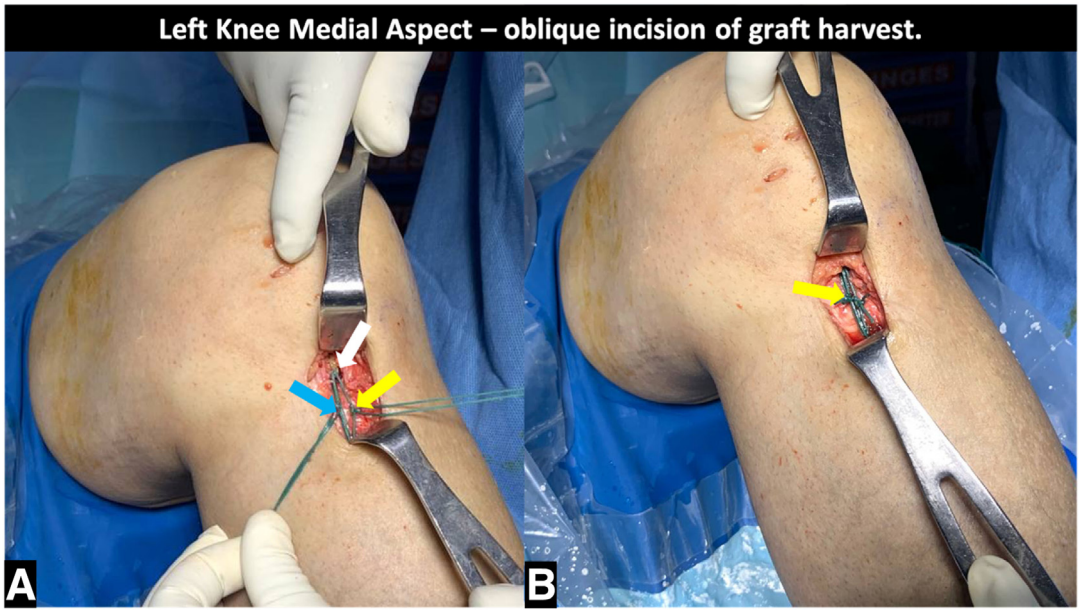

Fig 5. Process of knot tying. **(A)** The respective limbs of the gracilis (*yellow arrow*) and semitendinosus (*blue arrow*) are identified and tied with each other. **(B)** *Arrow* depicts the knots after the sutures are cut.

Table 1. Pearls and Pitfalls

Pearls
It can be used in ACL reconstruction with a soft tissue graft.
Knot-making should not be very tight.
The suture sleeve should be loose to glide over the suture.
A knot has to be applied in the gap of 5 mm so that bulb formation takes place.
The suture sleeve has to be buried inside the tunnel for the anchor to deploy.
The pull-out strength of the anchor has to be checked manually.
Pitfalls
There may be a mismatch in socket size and anchor sleeve size. The socket size has to be bigger than the sleeve size for the complete deployment of the anchor.
If anchor insertion is tight, a larger tunnel has to be made.
Sometimes, there may be an abrasion of the suture limb during forceful deployment. We recommend applying an anchor on the tail end of the suture so that the abraded portion is not involved while making knots.

ACL, anterior cruciate ligament.

Table 2. Advantages and Disadvantages

Advantages
Cost-effective
It can be made with locally available suture materials.
It can be made with both absorbable and non-absorbable suture material.
Disadvantages
Suture material has to be sterile and available.
Cost varies based on the type of suture used.
Pull-out strength is not studied.

Conclusions

This modification of the "make and use" all-suture anchor is a simple, reproducible, and cost-effective method of supplementary fixation after ACL reconstruction on the tibial side.

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