Technical Note

Press-Fit-Hybrid Technique for Anterior Cruciate Ligament Reconstruction With Autologous Hamstring Tendons

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Abstract: Arthroscopic-assisted anterior cruciate ligament reconstruction follows standardized protocols. Multiple fixation techniques are known. Discussion has been raised about osseus fixation and integration. To improve a biological osseous fixation of the anterior cruciate ligament transplant, a *Press-Fit-Hybrid* technique has been developed. The basic principle is to recycle bony cylinders obtained from the femoral and tibial tunnel to fix the transplant in the femoral and tibial tunnel. In addition to the biological advantage, there are additional economic benefits, such as no extra fixation material is necessary compared with common fixation techniques, and the overall surgical procedure requires minimal effort.

Anterior cruciate ligament (ACL) reconstruction aims to prevent early onset of degenerative changes of the knee joint.[1] The anatomical restoration of the ligamentous knee stability enables return to sport activities as usual.

As predominantly young and active patients are affected with ligamentous knee injuries, biological methods for reconstructive surgery are sought. The graft for ACL reconstruction can be either gained by using ligamentum patellae as a bone patellar tendon bone graft, quadriceps tendon as a bone—tendon graft, or hamstring tendons, which are most popular due to anatomical and biomechanical advantages.[2] The osseous tunnel fixation at the femoral condyle is most widely performed using a button.[3] At the tibial side, different fixation techniques are known, but the use of an interference screw is most common. Kocabey et al.[4] described a press-fit fixation technique using the patellar tendon bone autograft. Biological observations showed that graft healing and osseous integration are achieved as the graft forms perpendicular collagen bundles at the tendinous—osseous contact surface to either overcome shear stresses and to attach the tendon to the bone.[5] The newly created collagen bundles resemble Sharpey fibers of an indirect insertion site.[6]

To improve the size of the contact area of the ACL graft and the osseous tunnel, the *Press-Fit-Hybrid* fixation technique has been developed. While drilling the bony tunnels using a diamond AlphaLock-Turbo-Cutter (*BIOMEDIX*, Heusenstamm, Germany) an osseous cylinder is gained, prepared, and reused to fix the transplant in the femoral and tibial tunnel.

Surgical Technique (With Video Illustration)

Patient Positioning

Please see Video 1 for the complete surgical technique. The patient is placed in a supine position with the affected leg in a holder. At the operating table, a hook is attached to allow a fixed and reproducible knee flexion (130°) while drilling the femoral tunnel and impacting the cancellous bone cylinder afterwards (Fig 1 A-E). A nonsterile tourniquet is placed at the proximal thigh.

Graft Harvesting

A 25- to 30-mm-long anteromedial longitudinal skin incision is made over the pes anserinus (Fig 2A) followed by sharp dissection through the subcutis down to the sartorius fascia. The semitendinosus and the gracilis

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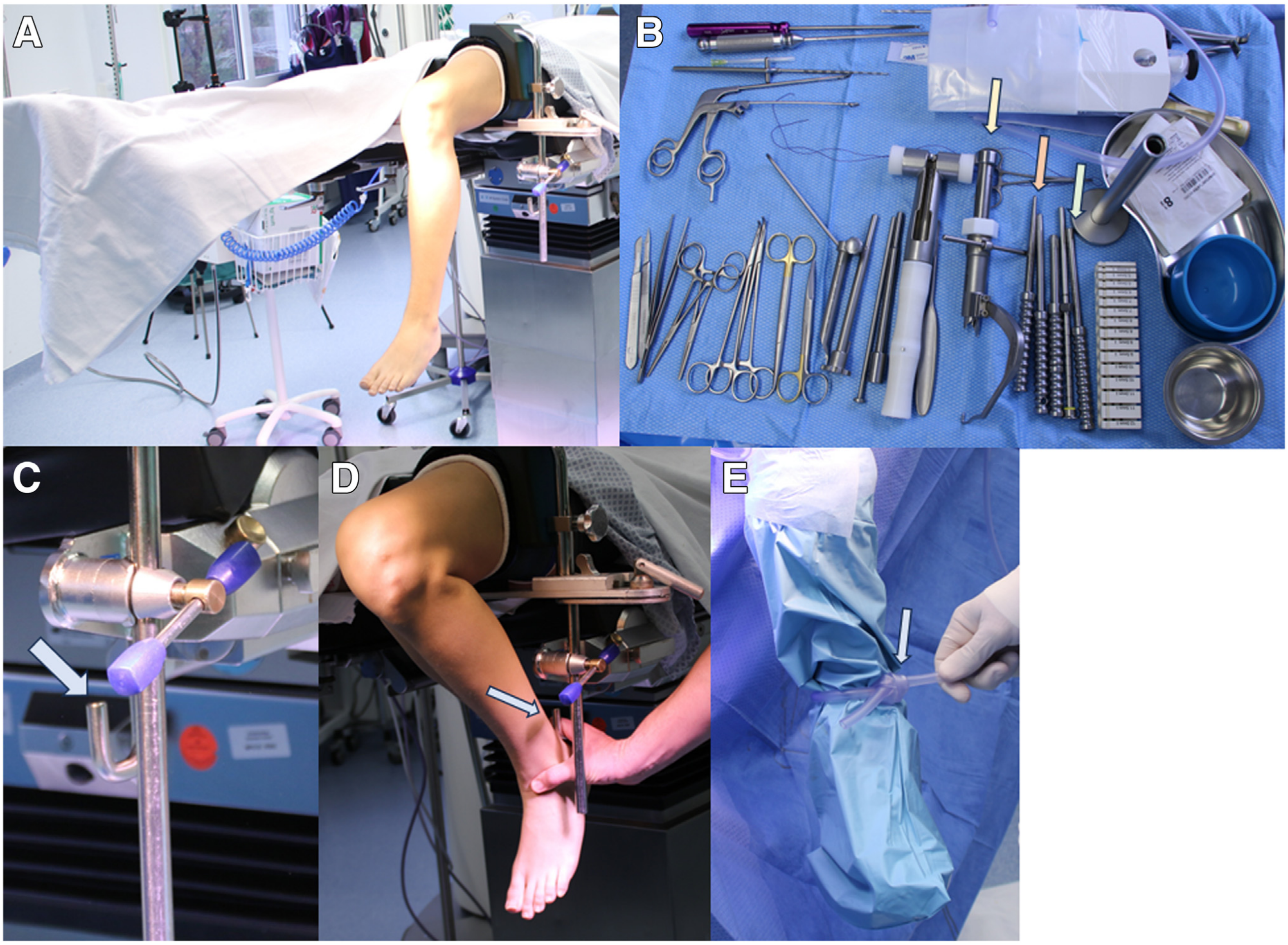

Fig 1. Patient positioning and instrumentation table. (A) The patient is placed in a supine position with the affected leg (in this case the left knee) in a holder. The not-operated leg is stretched out and the operated leg hanging. (B) Instrumentation table. The instrumentation table includes, additional to the usual instruments for ACL reconstruction, the target device (yellow arrow), the dilatators (orange arrow), and the bone cylinder applicator (green arrow), which are specific for the *Press-Fit-Hybrid* technique. (C) and (D) A special hook below the operation table is installed (clear blue arrow) for holding the leg in 130° flexion for placing the femoral tunnel. (E) A band (clear blue arrow) is placed around the ankle of the patient to hold the leg on the hook. (ACL, anterior cruciate ligament.)

tendon are identified and dislocated with an Overholt clamp. The tendons are dissected and stripped with an open tendon stripper (DePuy-Synthes/Mitek, Auckland, New Zealand; Fig 2 B-E)

Graft Preparation

The tendons are freed from muscle tissue (Fig 3 A and B) and placed through the sling of an ultra-button (Smith & Nephew, Andover, MA; Fig 3C) to form a 3×-folded, 6-strand tendon graft. The ends are bound and reinforced with sutures proximally 3 cm with a Vicryl size 1 thread (Ethicon, Norderstedt, Germany; Fig 3E) and distally 4 cm with a HiFi-suture-loop (ConMed Deutschland, Groß-Gerau, Germany) and a 5-Ethibond thread (Ethicon; Fig 3F). The result is a graft that is approximately 9-cm long with a diameter of 7.5 to 11 mm (Fig 3 G and H).

Femoral Tunnel Preparation Under Arthroscopy

The ACL stump is resected to expose the lateral posterior edge of the notch (Fig 4A). The target device is positioned through the anteromedial infrapatellar portal (Fig 4B). The bone tunnel is drilled with a diamond *AlphaLock*-Turbo-Cutter (Fig 4 C, D, and I), that generates both the bone tunnel (Fig 4E) and the bone cylinder (Fig 4H) in a single procedure. With 130° flexion of the knee joint, the offset targeting device is attached to the lateral posterior edge of the notch (Fig 4B and I). In this manner, the tunnel can be drilled in a few seconds, thus avoiding necrosis of the bone (Fig 4D). The extractor (*BIOMEDIX*, Fig 4F and J), is positioned in the annulus (Fig 4E) to harvest the bone cylinder. This results in a femoral bone tunnel with a diameter of 8.24 mm and a cancellous bone cylinder with a diameter of 7.16 mm × 25 mm (Fig 4H).

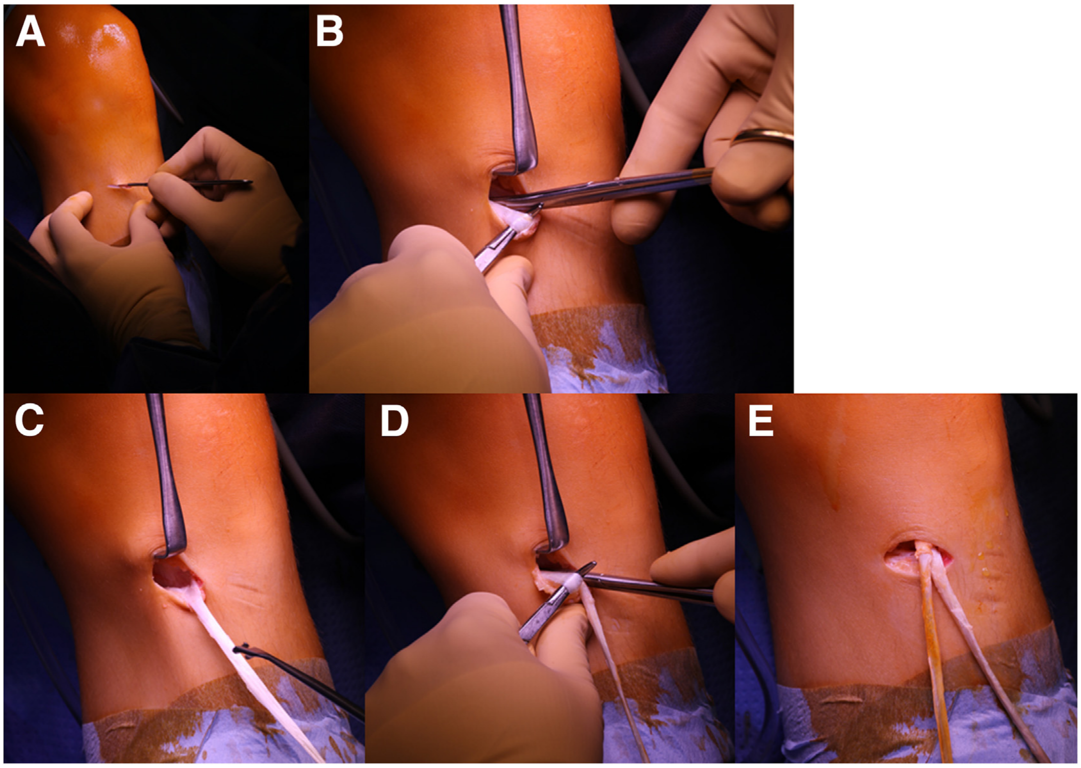

Fig 2. Graft harvest (left knee). (A) A 25- to 30-mm-long anteromedial longitudinal skin incision is made at the pes anserinus followed by sharp dissection through the subcutis down to the sartorius fascia. (B) and (C) The gracilis tendon is identified and prepared. (D) and (E) The semitendinosus tendon is identified and prepared and both are stripped with an open tendon stripper.

K-Wire Placement and Bone Tunnel Dilatation

Using the anteromedial infrapatellar portal, the opposite cortex is drilled with a 2.3-mm drill wire (Smith & Nephew; Fig 5 A-C) and then with the 4.5-mm Endobutton Drill (Fig 5J; Smith & Nephew). A feed line is parked (Fig 5D-E). Dilatation is required if the graft has a diameter of 7.5 mm or larger and follows the standardized protocol of the manufacturer (Table 1; *BIOMEDIX*). Depending on the graft diameter, the femoral tunnel is asymmetrically dilatated by using dilatators and a special mallet, hence achieving the elliptical shape of the tunnel (Fig 5 F-I; *BIOMEDIX*). The graft bed is generated (Fig 5L).

Tibial Tunnel Preparation Under Arthroscopy

The tibial guiding device (Fig 6A-C) is inserted through the medial portal with the knee in 90° flexion. The guiding hook is centered on the anterior horn of the lateral meniscus and with reference to the ACL remnant (Fig 6A). A bone tunnel with a diameter of 8.24 mm (Fig 6N) and a cancellous bone cylinder with a diameter of 7.16 mm × 30 to 40 mm (Fig 6H) is produced again using the diamond *AlphaLock*-Turbo-Cutter (Fig 6 D-G). Extraction of the bone cylinder and dilatation is as described for the femoral tunnel (Fig 6 G-M). The last 1 or 2 dilatations (Fig 6M) for the tibial tunnel are not completed to the end of the tunnel to create a stop for the inserted cylinder later.

Graft Insertion and Femoral Fixation

The transplant is pulled through the previously drilled tibial tunnel into the femoral tunnel (Fig 7 A-C) until the Ultrabutton (Fig 7F) passes the opposite cortex. Then, the Ultrabutton (Smith & Nephew) is flipped, and the graft is vigorously distally withdrawn (Fig 7G). The Ultrabutton threads are tightened, and the transplant is pulled in completely by that procedure (Fig 7H). For conditioning of the transplant, the knee joint is cycled between 0 and 90° thirty times with maximum tension on the distal sutures of the graft (Fig 7 D-E, yellow arrows).

Tibial Fixation

To secure the graft, a hybrid extracortical fixation is performed. A 6.5 × 30-mm bollard screw (Nano Medical GmbH, Riedstadt, Germany; Fig 8A) is inserted after drilling approximately 15 mm distal to the tibial bone tunnel opening. In a 20° flexion—position, the distal pair of Hi-Fi-threads (ConMed) and the Ethibond thread (Ethicon, a Johnson & Johnson Company, New Brunswick, NJ) pair are placed around the screw neck and firmly knotted together (Fig 8 B-C). Then the screw

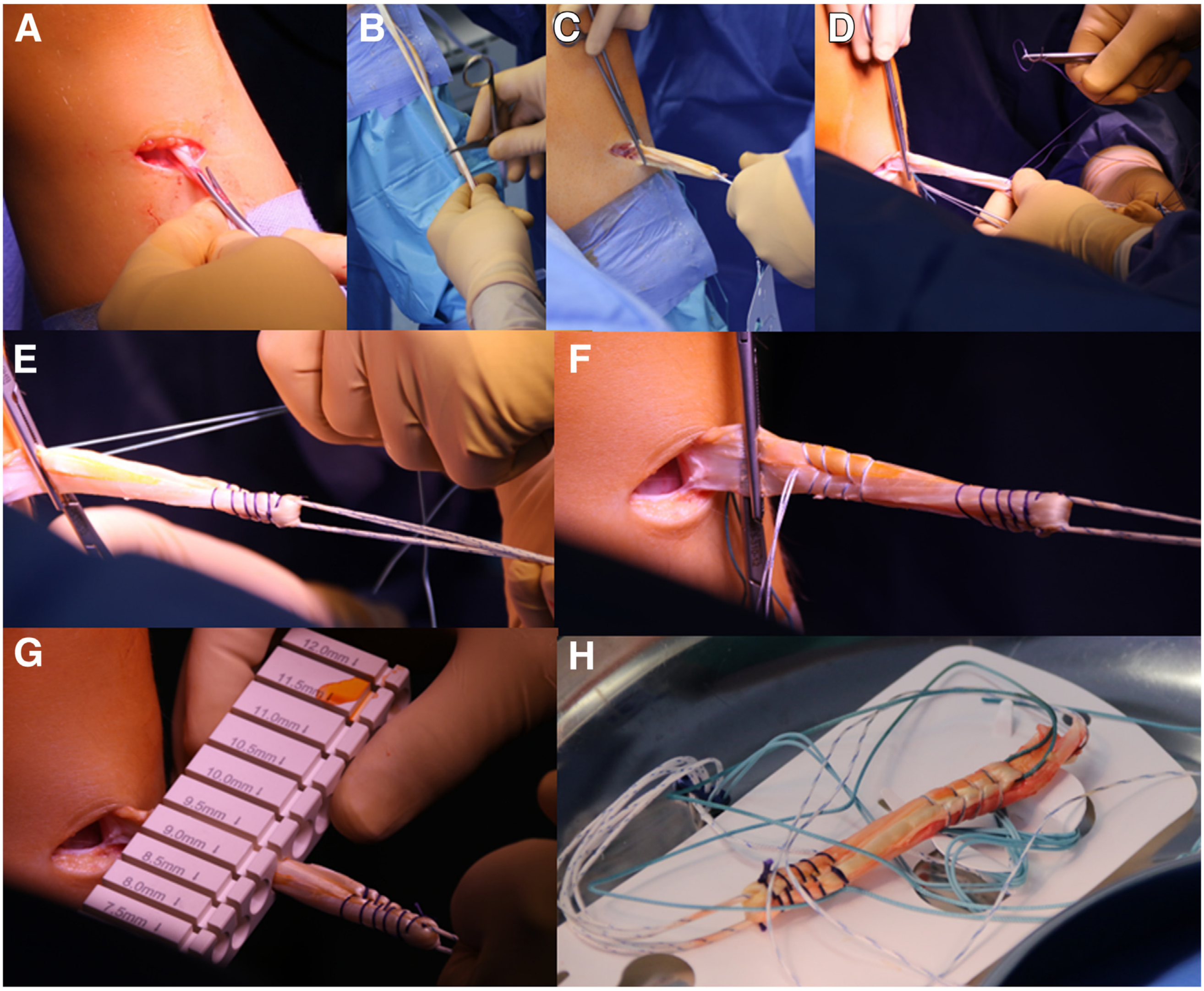

Fig 3. Graft preparation (left knee). (A) and (B) The tendons are freed from muscle tissue. (C) The tendons are folded and placed through the sling of an Ultrabutton to form a 3× folded, 6-strand tendon graft. (D-F) The ends are bound and reinforced with sutures—proximally 3 cm with a Vicryl size 1 thread and distally 4 cm with a HiFi-suture-loop and a 5-Ethibond. (G) and (H) The graft is approximately 9 cm long with a diameter between 7.5 and 11 mm.

is fully tightened (Fig 8 D-E; E view using the anteromedial incision). The transplant is positioned asymmetrically and the bone tunnel for the bone cylinders is prepared using a cone dilatator.

Application of Bone Cylinder for Tibial Fixation

Using the cancellous bone applicator (*BIOMEDIX*), the prepared 2 cancellous bone cylinders, approximately 7.16 × 15 to 20 mm each (Fig 9 A-C), are pressed in the tibial bone tunnel (Fig 9 D-G), which now fills and seals the tunnel nicely (Fig 9H).

Femoral Fixation and Final Arthroscopic Checking

At the femur side, the transplant is positioned using a cone dilatator in the same manner as previously described for the tibial tunnel. The dilatator is placed into the femur using the anterolateral infrapatellar arthroscopy approach. The transplant now aligns anatomically to the dorsocaudal border of the lateral notch. Using the cancellous bone applicator, a 7.16 × 17-mm cancellous bone cylinder (Fig 10A) is now decentered to the transplant and pressed into the femoral tunnel, so that in addition to the extracortical fixation, a press-fit fixation close to the joint is created (Fig 10B). The cancellous bone cylinder is hammered into the tunnel in such way, that the cortical part of the bone cylinder is at the same level as the cortical boundary of the femur/tibia (Fig 10 C-E; E view via the anterolateral infrapatellar arthroscopic approach). Arthroscopy is conducted for correct positioning of the

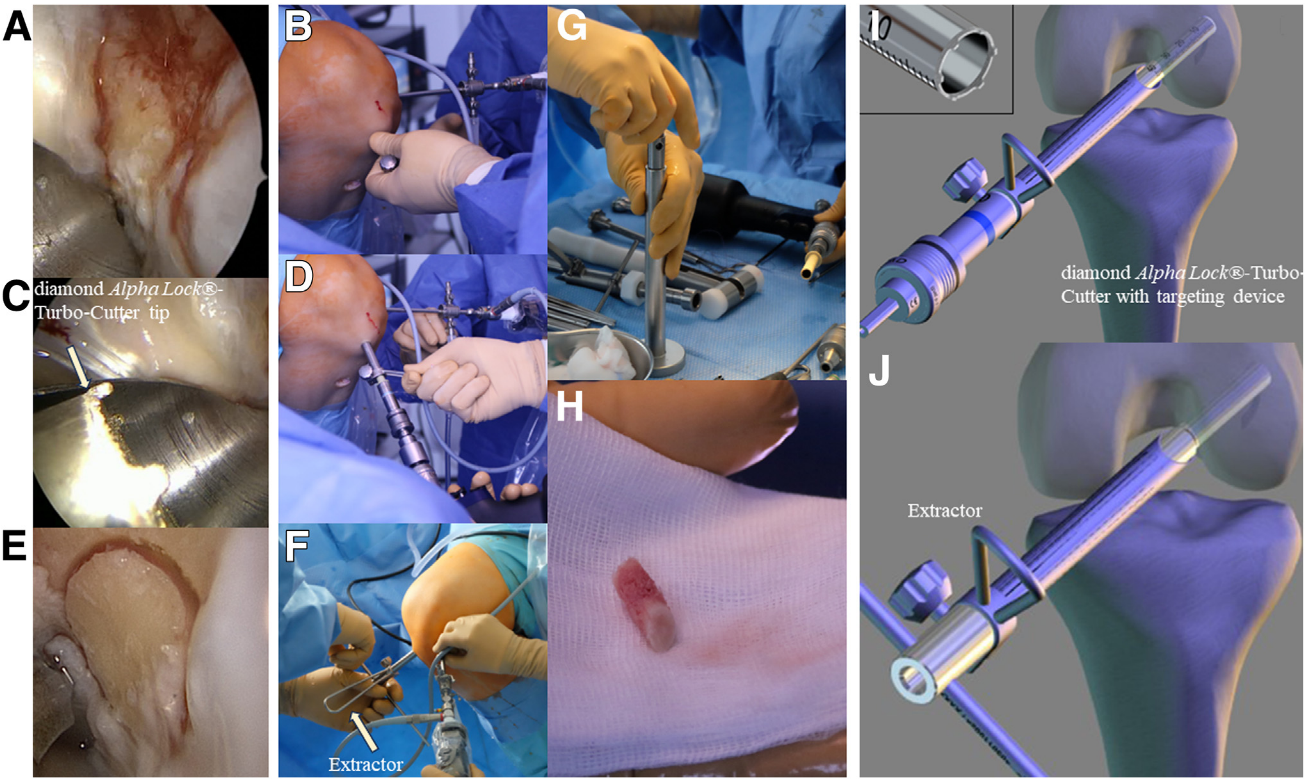

Fig 4. Femoral tunnel preparation under arthroscopy (left knee). (A,C & E) Arthroscopic view via the anterolateral portal. (A) The ACL stump is resected to expose the lateral posterior edge of the notch. (B) With 130° flexion of the knee joint, the offset targeting device is attached to the lateral posterior edge of the notch at 9:30/2:30 o'clock via the anteromedial portal. In this manner, the tunnel can be drilled in a few seconds, thus avoiding necrosis of the bone. (C) The tip of the *AlphaLock*-Turbo-Cutter is well visible (arrow). (D) and (I) The bone tunnel is drilled with a diamond *AlphaLock*-Turbo-Cutter, which generates the bone tunnel and the bone cylinder at the same time. This results in a femoral bone tunnel with a diameter of 8.24 mm and a cancellous bone cylinder with a diameter of 7.16 mm × 25 mm. (E) The bone tunnel is drilled; the bone cylinder is still in the tunnel and has to be extracted. (F) and (J) The extractor (yellow arrow in F) is positioned in the annulus (E) to harvest the bone cylinder. (G) The bone cylinder is removed from the extractor; (H) the harvested bone cylinder. (ACL, anterior cruciate ligament.)

ACL transplant (Fig 10F). The graft should be under adequate tensile stress, and there should be no evidence of notch impingement at full extension. A final check for complete extension is performed first on the non-treated leg followed by the treated leg.

Postoperative Care

Postoperative rehabilitation is described in detail in the publication by Volz and Borchert.[7] In summary, the rehabilitation scheme for patients having additional meniscal re-fixation and for ACL-only patients is different.

Discussion

ACL reconstruction applying the *Press-Fit-Hybrid* technique is a valid alternative to common fixation techniques. Its advantage (see also Table 3) is the use of autologous cancellous bone cylinders for a biological and mechanical stable graft fixation. The generation of the osseous tunnels using an AlphaLock-Turbo-Cutter, which generates both the tunnel and the cylinder atraumatically in one step, is the prerequisite for fast ingrowth and early stabilization of the reconstruction. The bone cylinders are reused to fill the bone tunnel; thus, further revisions often do not need to be 2-step procedures as described by Kocabey et al.,[4] because the bone tunnel is partially filled with bone. The decentered cancellous bone cylinder achieves a press-fit fixation close to the joint in addition to the extracortical fixation, assuring primary and secondary stability. The result is a nearly anatomic alignment of the graft at the dorsocaudal border of the lateral notch.

Early clinical experience with 100 patients managed with the *Press-Fit-Hybrid* technique showed excellent results with lower re-rupture rate, significantly better range of motion, fewer postoperative complications,

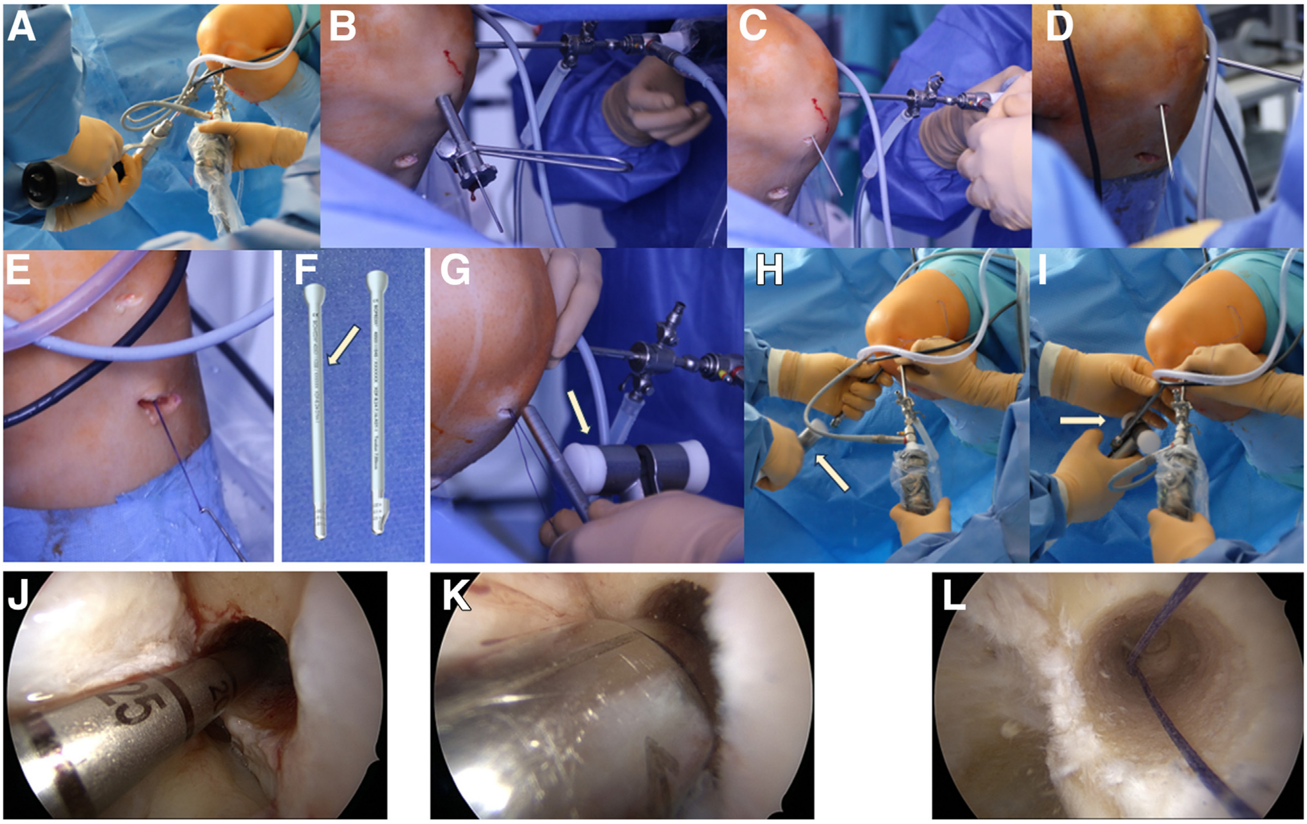

Fig 5. K-wire placement and bone tunnel dilatation (left knee). (A-C) The opposite cortex is drilled via the anteromedial portal with a 2.3-mm drill wire. The K-wire is placed dorsocaudal into the femoral tunnel and is drilled through the lateral femoral cortex, and (J) guided by the K-wire the lateral femoral cortex is drilled with a 4.5-mm drill bit. (D) and (E) A feed line is parked. (F) Dilatation is required if the graft has a diameter of 7.5 mm or bigger and follows the standardized protocol of the manufacturer (Table 1). Dilatation devices, symmetric (yellow arrow) and asymmetric. (G-I and K) Depending on the graft diameter, the femoral tunnel is finally asymmetrically dilatated by using dilatators and a special mallet (G: yellow arrow), hence achieving the elliptical shape of the tunnel. (L) The graft bed is generated. The bone tunnel after dilatation with the feed line. (J-L) Arthroscopic view via the anteromedial portal.

and lower secondary meniscal injury compared with those patients treated with the interference screw-fixation technique.[7] Pearls and pitfalls are described in Table 2.

Graft Choice

Even though greater revision rates are reported with hamstring autografts in comparison with bone—patellar tendon bone,[8] we choose hamstring tendons for the ACL reconstruction, also because of lower donor-site morbidity.[9] The use of B-T-B (ligamentum patellae) or B-T (quadriceps tendon with bone block) grafts are not suitable for this technique, as these grafts have an osseous end. The reported low revision rate of 4%[7] proves that the graft choice may be not the main reason for high revision rates.

Biological Benefits of the Press-Fit-Hybrid Technique

An extra intraosseous fixation implant is not necessary. The use of the harvested bony cylinders maximizes the contact area between graft and vital bone and improves the osseous integration of the implant. The cancellous bone cylinder is impacted into the tibial/femoral tunnel to achieve a press-fit fixation close to the joint. The transplant aligns anatomically to the dorsocaudal border (Fig 7H) of the lateral notch and resembles the natural shape of the native ACL. The *Press-Fit-Hybrid* technique increases the biologic active contact area between the tunnel, the graft, and the cancellous bone cylinders compared with common interference screw fixation techniques, hence improving the osseous integration and stability of the

Table 1. Standardized Procedure for Dilatation

Press-Fit-Hybrid® **-** Femoral Dilatation — BIOMEDIX® Advanced Biomedical Solutions

Folded Diameter											
7,5 mm	**ASY_1**										
8,0 mm	ASY_1	**ASY_2**									
8,5 mm	ASY_1	ASY_2	**ASY_3**								
9,0 mm				SYM_A	SYM_B	SYM_C	**ASY_4**				
9,5 mm				SYM_A	SYM_B	SYM_C	ASY_4	**ASY_5**			
10,0 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	**ASY_6**		
10,5 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	ASY_6	**ASY_7**	
11,0 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	ASY_6	ASY_7	**ASY_8**

Press-Fit-Hybrid® - Tibial Dilatation — MEDI

Folded Diameter											
7,5 mm											
8,0 mm											
8,5 mm	**ASY_1**										
9,0 mm				SYM_A	SYM_B	SYM_C	**ASY_4**				
9,5 mm				SYM_A	SYM_B	SYM_C	ASY_4	**ASY_5**			
10,0 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	**ASY_6**		
10,5 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	ASY_6	**ASY_7**	
11,0 mm				SYM_A	SYM_B	SYM_C	ASY_4	ASY_5	ASY_6	ASY_7	**ASY_8**

ASY: asymmetric dilatation; 1-8 instrument size, SYM: symmetric dilatation

implant. With the *Press-Fit-Hybrid* technique, a fast bone-to-bone and bone-to-graft healing is possible without laceration of the graft, without any bio-incompatibility but with minimizing bone tunnel widening. The Press-Fit-Hybrid fixation close to the joint avoids the bungee and windscreen effects, thus minimizing bone tunnel widening, as described by Kurihara et al.[10] The *Press-Fit-Hybrid* technique can be performed in adolescent and patients with small joints.

Risks and Limitations

Limitations and risks are shown in Table 3. In summary, limitations are that ligamentum patella and quadriceps—bone tendon are not suitable for this technique. The method cannot be performed in very osteoporotic bones as each other surgical technique as well. The method cannot be performed in children with open growth plates and very small joints.

Risks include the following: when dilation is not performed according to the dilatation scheme, there could be problems with fitting the bone cylinder into the bone tunnel. When the bone is very hard, one more dilatation step has to be performed. To know whether additional dilatation is necessary is part of the learning curve. When dilatating the tibial tunnel, care should be taken, as there is a potential risk for cortical fissures. Then, there is no stop for the bone cylinder, and it may enter the joint while impacting it from distal. In this case, the bone cylinder can be pushed distally by an elevatorium until it fits correctly. Handling the loop of the femoral fixation button and the button itself must be done with care. Lower postoperative hamstring weakness shortly after surgery could be recorded using hamstring tendons.[11]

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

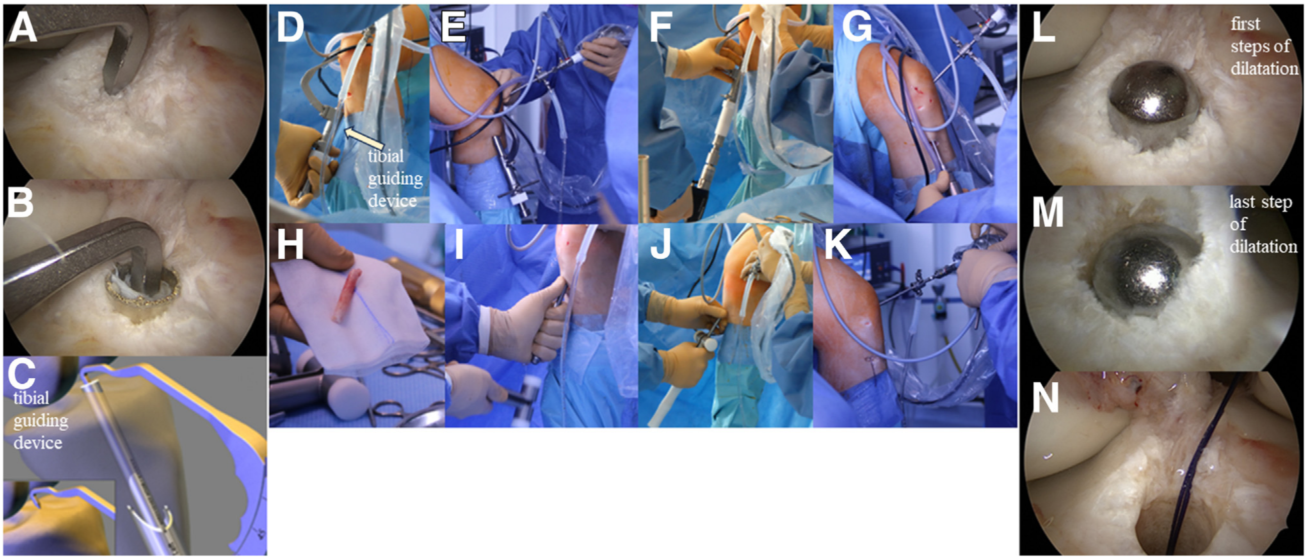

Fig 6. Tibial tunnel preparation under arthroscopy (left knee). (A-C) Arthroscopic view via the anterolateral portal. (A, C, and D) The tibial guiding device (yellow arrow) is inserted through the anteromedial portal with the knee in 90° flexion. The guiding hook is centered around the anterior horn of the lateral meniscus and with reference to the ACL remnant. (B and E-G) A bone tunnel with a diameter of 8.24 mm is drilled using the diamond AlphaLock-Turbo-Cutter. (H) Cancellous bone cylinder with a diameter of 7.16 mm × 30-40 mm is produced. (I-J and L) Dilatation is required if the graft has a diameter of 7.5 mm or bigger and follows the standardized protocol of the manufacturer (Table 1). (L-N) Arthroscopic view via the anterolateral portal. (M) The last dilatation for the tibial tunnel is not done up to the end of the tunnel to create a stop for the inserted cylinder later on. (K) Arthroscopic check of the tunnel through the anterolateral portal. (N) The bone tunnel ready for inserting the graft and the bone cylinder. (ACL, anterior cruciate ligament.)

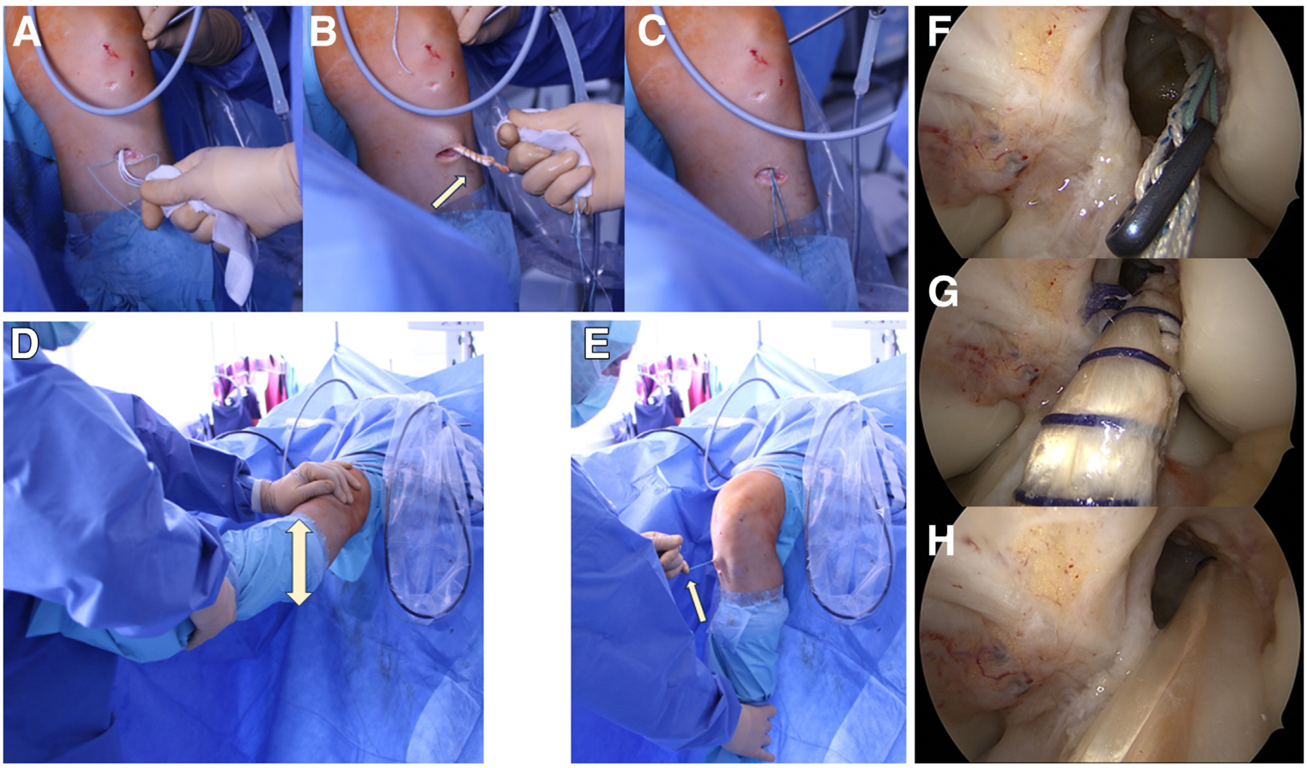

Fig 7. Graft insertion and femoral fixation (left knee). (A-C) External view and (F-G) arthroscopic view via the anterolateral portal. (A-C) The graft (yellow arrow) is pulled through the tibial tunnel into the femoral tunnel till the Ultrabutton (F) passes the opposite cortex. Then the Ultrabutton is flipped, and the graft is vigorously distally withdrawn. (D and E) The knee joint is flexed 30 times between 0 and 90° (yellow arrow, D) with maximum distal tension on the graft (yellow arrow, E). (H) Arthroscopic check via the anterolateral portal if the graft is well in place.

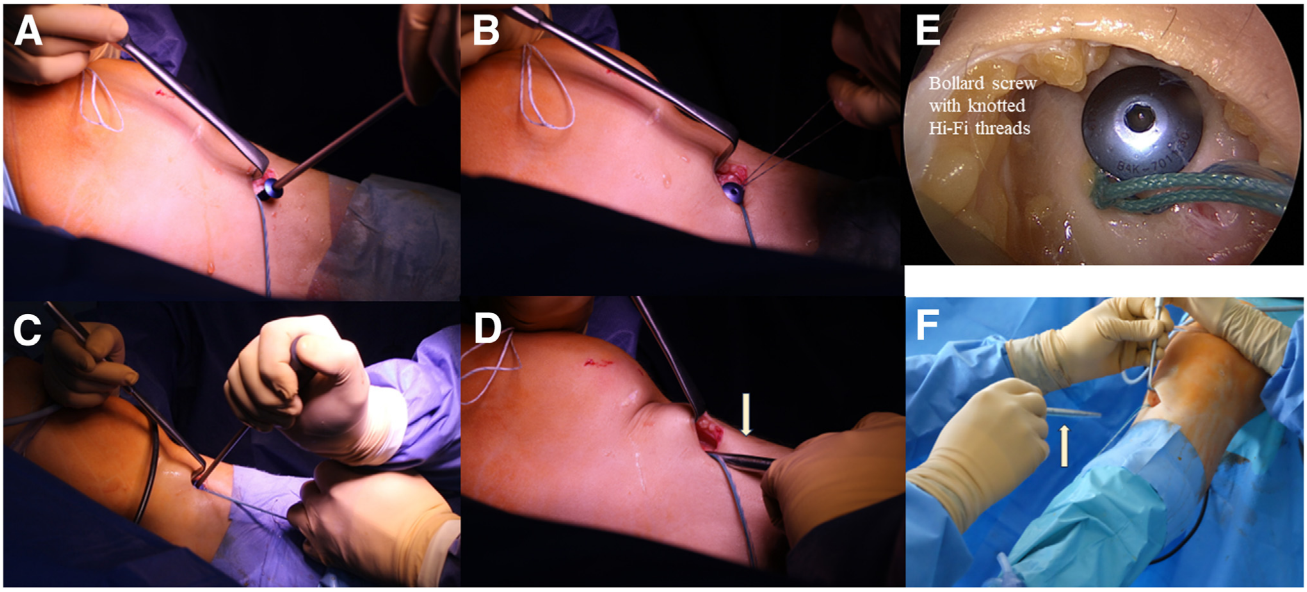

Fig 8. Tibial fixation (left knee). (A) To secure the graft, a hybrid extracortical fixation is performed. A 6.5- × 30-mm bollard screw is inserted after drilling approximately 15 mm distal to the tibial bone tunnel opening. (B) In a 20° flexion-position, the distal pair of Hi-Fi threads and the Ethibond threads are placed around the screw neck and firmly knotted together. (C) and (E) The screw is fully tightened. (D) and (F) The transplant is positioned asymmetrically and the notch for the bone cylinders is prepared using a cone dilatator (yellow arrow).

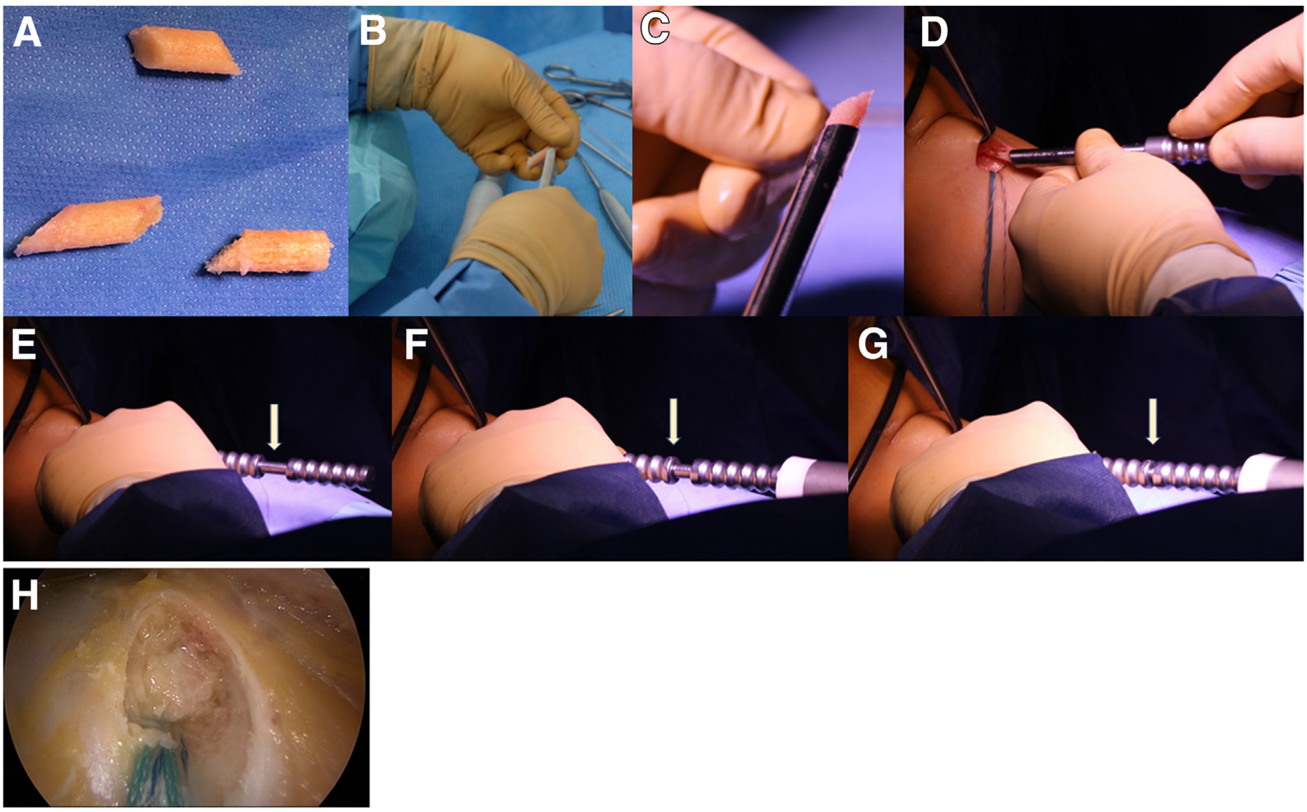

Fig 9. Application of the bone cylinder for tibial fixation. (A) Prepared bone cylinder. (B-D) Using the cancellous bone applicator, the prepared 2 cancellous bone cylinders, approximately 7.16 × 15-20 mm each, are impacted in the tibial bone tunnel in such way that the cortical part of the bone cylinder is at the same level as the cortical boundary of the tibia. (D-G) The bone cylinder applicator is specially designed for the application of this bone cylinder (with a stop, yellow arrows). (H) External view: the bone cylinder fills and seals the tunnel nicely.

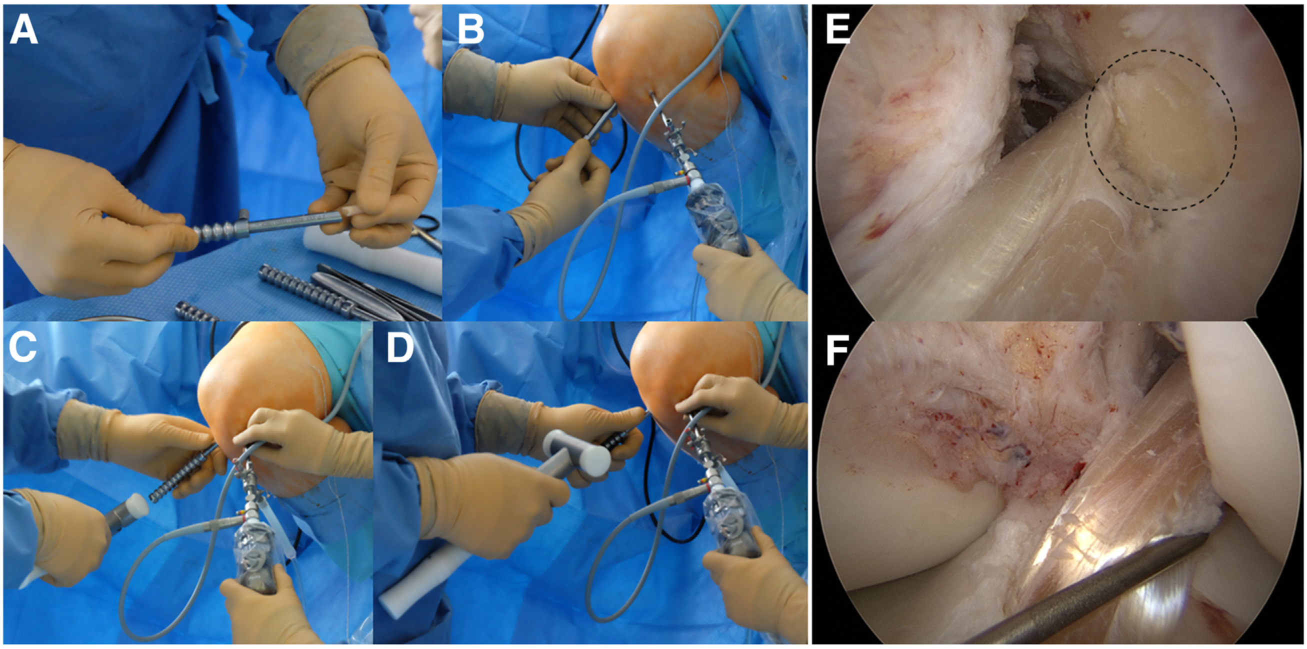

Fig 10. Femoral fixation and final arthroscopic checking (left knee). (A and B) Using the cancellous bone applicator, a 7.16 × 17-mm cancellous bone cylinder is now decentered to the transplant and pressed into the femoral tunnel, so that in addition to the extracortical fixation, a press-fit fixation close to the joint is created. (C and D) The cancellous bone cylinder is hammered into the tunnel in such a way that the cortical part of the bone cylinder is at the same level as the cortical boundary of the femur. (E) View through anterolateral portal: The cortical part of the bone cylinder is at the same level as the cortical boundary of the femur. (F) An arthroscopic assisted check via the anterolateral portal for correct positioning of the ACL transplant is conducted. The graft should be under adequate tensile stress, and there should be no evidence of notch impingement at full extension. A final check for complete extension is performed first on the nontreated leg followed by the treated leg. (ACL, anterior cruciate ligament.)

Table 2. Pearls and Pitfalls

Surgical Steps	Pearls and Pitfalls
Graft preparation	A hamstring graft is obtained, which should attain a folded diameter of at least 7.5 mm. The 3-fold, 6-strand reinforcement of the proximal and distal end is gained over 3 cm with a Vicryl suture, the proximal end is attached to an Ultrabutton sling, and the distal end is attached to a HiFi suture and Ethibond thread.
Femoral/tibial tunnel	The osseous tunnels are drilled using an AlphaLock-Turbo-Cutter, which generates both the tunnel and the cylinder in one step. The position of the target device has to be checked carefully to avoid a "cutting-out" at the dorsolateral femoral cortex. The following dilatation of the tunnels are described in the attached dilatation scheme and should be followed carefully. If the bone is very hard or a previous ACL revision is performed, one additional dilatation step must be performed to avoid fitting problems of the cylinder.
Tibial tunnel	The tibial tunnel is dilatated incomplete for optimal insertion of the cylinder.
Graft insertion	Before insertion of the graft, the tibial entrance should be cleaned carefully from soft tissue to avoid interaction with the graft. Likewise, it should be checked that the loop of the Ultrabutton can freely move. Make sure that all threads run clearly, and none is looped around the titanium plate, otherwise the tightening of the Ultrabutton is not possible. When retracting and flipping the Ultrabutton, care must be taken to ensure that the Ultrabutton is pulled completely through the femoral tunnel but also not significantly beyond it, e.g., beyond the tractus iliotibialis, and then flipped, as otherwise correct extracortical fixation is not guaranteed.
Femoral fixation	The cancellous bone cylinder is decentered to the graft and impacted into the femoral tunnel, achieving a press-fit fixation close to the joint in addition to the extracortical fixation with an Ultrabutton. The result is an anatomical alignment of the graft at the dorso-caudal border of the lateral notch.
Tibial fixation	The tibial fixation is achieved in a hybrid technique: the HiFi suture and Ethibond threats are knotted around an extracortical cancellous Bollard screw. The cancellous bone cylinder, which fills and seals the tibial tunnel, is impacted with the aid of a cancellous bone applicator.

ACL, anterior cruciate ligament.

Table 3. Advantages, Risks, and Limitations

Advantages	Risks and Limitations
AlphaLock-Turbo-Cutter generates both the tunnel and the cylinder atraumatic, in one step	None
Adaptation of the implant bearing to the folded diameter of the graft to achieve the optimum press-fit conditions through dilatation	If the dilatation is not performed according to the dilatation scheme there could be fitting problems when placing the bone cylinder back in the bone tunnel
Compressive stress stimulated contact healing	None
Very low revision rate	Extremely osteoporotic bone may not be suitable for the reconstruction
The fixation technique can be performed in adolescent and patients with small joints	The method cannot be performed in children with open growth plates and very small joints.
Low secondary meniscal injury	None
The biologic active contact area between the tunnel, the graft, and the cancellous bone cylinders is increased compared with common interference screw fixation techniques, hence speeding up the osseous integration and improving the stability of the implant	None
The press-fit fixation close to the joint avoids the bungee and windscreen effects, thus minimizing bone tunnel widening.	If the tibial tunnel is completely dilated, there will be no stop for the bone cylinder.
Femoral fixation button loop and button insertion allow easy graft preparation and secure and stable femoral fixation. Cycling through 30 times reduces the risk of primary "slack" or "slippage" of the button.	Handling the loop of the Ultrabutton and the Ultrabutton itself must be done with care
No alloplastic material, which has to be metabolized and removed	None
No graft laceration, no bioincompatibility	None
Sustainable osseous integration and nearly original cancellous structures after osseous integration. The bone density remains approximately the same at the reconstruction site	Ligamentum patella and quadriceps—bone tendon are not suitable for this technique

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