ACL Reconstruction

utilizing press-fit fixation on hamstrings
without hardware - by Hans H. Paessler
1 Introduction

Reconstruction of the ACL using the hamstring has recently become of increasing interest. Fixation using endo buttons is the most common method. The disadvantages of this fixation away from the point of insertion are:

- enlargement of the tunnel
- creep at the tendon-tape transition along with giving of the tendon construct and permanent elongation (Höher et al\textsuperscript{*}) (3.8+/-0.8mm). This is also known as the Bungee effect.

Fixation close to the insertion has been suggested and such methods have already been used successfully:

1. Fixation using an interference screw
2. Suspension of loops using transverse rods

Disadvantages of these techniques are:

- hardware costs
- problems with revision surgery
- awkward and time-consuming

Alternative solution
A technique has been developed with the following major features:

- Fixation close to the point of insertion
- Avoidance of hardware
- Simple graft preparation

2 Horizontal skin incision

- less risk of sensory nerve injury
- better cosmesis

Harvest of the hamstring tendons can be performed through a 2-3 cm horizontal incision over the pes anserinus (one finger-breadth below the tibial tubercle). The skin incision is infiltrated with 15 ml 0.25% bupivacain with 1:100,000 epinephrine solution followed by intra-articular application of a further 15 ml. This allows harvesting without the use of a tourniquet.
3 Harvesting of hamstring tendons using open stripper

3-1. With the knee flexed to 90° the pes anserinus is opened at its proximal border.

3-2. The tendons are exposed. The gracilis tendon is located proximal to the semitendinosus tendon.

3-3. Retracting the crural fascia with a Kocher clamp, first the gracilis tendon is grasped using a curved clamp. Maximum manual traction is applied and already most of the "web-like" fascia bands connecting the undersurface of the crural fascia to the MCL and the posterior corner of the tibia tear free. Also the interconnecting fascial bands between the two tendons can be released by traction. The more proximal fascial bands are released by blunt dissection with scissors, taking care to keep the tip of the scissors away from the tendon.

3-4. With the tendon under traction using the curved clamp, the open stripper is positioned on the tendon and its mouth is closed half way (harvesting position). Traction is applied to the gracilis tendon and the stripper is gently advanced proximally parallel to the tendon. The tendon is released from its muscle by pulling the tendon out of the incision. Now the semitendinosus tendon is harvested in the same way. The strong fascial connections between the semitendinosus tendon and the medial head of the gastrocnemius muscle located approximately 7 cm proximal to the tibial insertion of the tendon must be divided sharply. If the tendon stripper cannot be advanced beyond a depth of 12 to 15 cm, thickened semimembranosus fascia may be present forming a loop around the semitendinosus tendon. In this case the stripper should be removed and this sling should be released by finger or scissors dissection.

3-5 / 3-6. Both tendons are pulled out of the incision. The periostal insertion is divided by a horizontal incision up to the anterior border of the tibia and then removed forcefully. The common periostal insertion of both tendons is divided.
Preparation of hamstring grafts

The ends of each tendon (ST and G) are tied in a simple knot, which is secured using 4 Ethibond no. 2 sutures.

4-1. On the workstation remnants of muscle tissue are removed carefully using a raspatory.

4-2. A simple knot is tied at the ends of the tendons. The knots are made as tight as possible by hand and secured by four U-shaped sutures.

4-3. A mark is made 10 mm below the knot of the semitendinosus graft and 20 mm below the knot of the gracilis tendon (due to the thicker knot of the semitendinosus graft, this must be pulled into the femoral tunnel first followed by the thinner and therefore 10 mm longer gracilis tendon). A second mark is made 3 cm below the first mark. This mark should be visible in the tibial tunnel within the joint when both grafts are pulled fully in.

4-4. The size of the knots and the smallest diameter of the loops are measured using a transplant template in 0.5 mm steps.
Tunnel placement

5 Placement of femoral tunnel
- K-wire placed at 10 or 2 o’clock
- 4 mm alignment device, anteromedial portal
- Knee flexed to 120°

The disadvantage of transtibial drilling of the femoral tunnel is that the position of the tunnel is too steep in the notch (11-12 or 12-1 o’clock) missing the anatomical point of insertion. By drilling through the anteromedial portal, on the other hand, the centre of the anatomical point of insertion is always reached.

Using the 4 mm offset drill guide, a K-wire is drilled into the cortical bone through the medial portal under fluoroscopic control, positioned at 10 or 2 o’clock and to a depth of 3-4 mm. The knee is then flexed at 120° to 130° and the K-wire drilled slightly deeper.

Alignment wire 8869.811
(K-wire) Ø 2.4 mm / WL 430 mm

Transtibial drill guide*
- Offset 4 mm 8868.241
- 5 mm 8868.251
- 6 mm 8868.261
- 7 mm 8868.271
*incl. 1 alignment wire (8869.811)
Drilling the cortical bone

Using a cannulated drill over the K-wire, a tunnel with a diameter corresponding to that of the tendon loops is drilled until cancellous bone is reached at a depth of 5-7 mm.

Completion of the femoral tunnel

The femoral tunnel is completed using a bone harvesting tube. Insertion of a bone harvesting tube with the same diameter as the used drill bit. The tube is driven forward using a hammer until the lateral cortex is reached. In order to avoid damage to the tube, its is replaced by the drill bit for perforation of the cortex.
Femoral tunnel

Cancellous bone preserved
- Cancellous bone is preserved for filling the femoral tunnel

Placement of a cannulated impactor
An impactor with a diameter corresponding to that of the drill is inserted 12 mm deep into the femoral tunnel. A K-wire is inserted through the impactor, perforating the skin at the lateral thigh. A skin incision of 10-12 mm is made at the point where the K-wire perforates it, and the underlying fascia is split longitudinally.

Standard Impactors* (pack of 10)
6 mm / 7 mm / 7.5 mm / 8 mm / 8.5 mm /
9 mm / 9.5 mm / 10 mm / 10.5 mm / 11 mm
*parts of ACL Impactor Set (8866.101)
also:
ACL Mallet 8866.956

Overdrilling the K-wire
A tunnel is drilled over the K-wire using a cannulated drill with a diameter matching that of the knot.

Cannulated drill capacity 2.5 mm / WL 140 mm
9.0 mm 8866.808
10.0 mm 8866.811
11.0 mm 8866.813
also: Handle 8869.821
Impaction of bottleneck

Hammering in of the impactor and finishing the bottleneck.

Impacting the spongy bone as far as the cortical bone prevents subsequent sintering of the knot in the bottleneck.

Stepped Impactors* (pack of 3) for the bottleneck
10-6 mm / 11-6 mm / 12-6 mm
*parts of ACL Impactor Set (8866.101)

ACL Mallet:
The plastic face protects instruments such as impactors and bone punches

also: ACL Mallet 8866.956
Positioning the tibial alignment device

- A 2.5 mm K-wire is inserted
- The K-wire is overdrilled

Impingement

The impingement probe is placed on the drilling wire. The knee is then fully extended under arthroscopic vision with the impingement probe in position. A clearance of 1-2 mm between the impingement probe and the roof of the notch is desirable. Fluoroscopic visualisation and documentation in hyperextension.

Alignment device 8869.011 comprising:
- Basic section with alignment hook (8869.111)
- Drill guide Ø 2.5 mm (8869.151)
- Drill guide Ø 9.5 mm (8869.152)

Alignment wire (K-wire)
- Ø 2.4 mm / WL 300 mm 8869.801

Impingement probe
- Ø 9 mm 8866.931
- Ø 11 mm 8866.932
14 Overdrilling the cortical bone

The K-wire is now overdrilled using a drill bit corresponding to the diameter of the tendon loops.

Cannulated drill capacity 2.5 mm / WL 140 mm
- 6.5 mm 8866.803
- 7.0 mm 8866.804
- 7.5 mm 8866.805
- 8.0 mm 8866.806

15 Impaction of the tibial tunnel
Perforation of the tibial plateau

The tunnel is now enlarged using impactors starting at 6 mm until the desired size is reached. Finally, the tibial plateau cortex is perforated with a drill bit of the same size.

Standard Impactors* (pack of 10)
- 6 mm / 7 mm / 7.5 mm / 8 mm / 8.5 mm / 9 mm / 9.5 mm / 10 mm / 10.5 mm / 11 mm
*parts of ACL Impactor Set (8866.101)
also:
- ACL Mallet 8866.956
- Spoon 8436.601
- Cannulated drill 6.5 mm 8866.803
- 7.0 mm 8866.804
- 7.5 mm 8866.805
- 8.0 mm 8866.806
**16 Pulling in the tendon loops**

- Pulling in the tendon loops from lateral
- The gracilis tendon follows the semitendinosus tendon.

Using the pulling thread, the Mersilene tapes of the two transplants are pulled in from lateral. The gracilis loop with the thinner knot follows the semitendinosus loop. The sudden halt indicates that the semitendinosus knot has reached the graduated part of the tunnel, in other words, the bottleneck.

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**Grasping forceps**  
forceps handle with locking mechanism, tip with additional fine teeth  
WL 130 mm  
Ø 3.4 mm 8488.096  
Ø 4.5 mm 8489.096

**Alternatively:**  
Thread puller  
Ø 5 mm  
WL 350 mm 8869.921

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**17 Conditioning the graft**

The tendons are conditioned by flexing and extending the knee 20 times with forceful traction on both loops.
Creating a bony bridge / Passing a holding suture

18 Creating a bony bridge

A hole is drilled 1 cm distal to the tibial exit of the tunnel with the 4.5 mm drill. A bony bridge is created with a curved clamp.

19 Passing a holding suture

A holding suture is introduced with a Dechamps hook. One half of the Mersilene tapes is pulled through and the ends are then knotted over the bony bridge with the knee in full extension (5-10°).

- Passing a holding suture using a Dechamps hook. (19-1 / 19-2)
- Pulling the Mersilene tapes underneath the bony bridge. (19-3)
- Tying the Mersilene tapes over the bridge with the knee in extension (19-4)

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