Anterior Cruciate Ligament Reconstruction using hamstrings in press-fit technique without hardware

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Introduction

Reconstruction of the ACL using hamstring has recently become of increasing interest. The fixation using endobuttons is widest spread. Disadvantages of this fixation away from the point of insertion are:

– enlargement of the tunnel (3),

– creeping near the tendon-tape-transition with a giving in of the tendon construct and a permanent elongation (Höher et al (3) 3,8+-0,8 mm). This is also known as Bungee effect (2).

Fixations close to the insertion are therefore being suggested and being technically applied successfully:

1. Fixation using an interference screw (6, 7)
2. Suspension of loops using transverse rods (Transfix)
3. Sewing in of a bone block into the loop (4).

But the disadvantages of these techniques are:

1. They are expensive (1)
2. There are problems with revisions (2)
3. They are complicated and time-consuming (3)

Alternative solution

A technique has been developed that should have 3 paramount properties (Fig. 1):

1. fixation close to the point of insertion
2. avoidance of implants
3. simple preparation of the graft

Factors that lead to tunnel enlargement after reconstruction of the ACL using hamstrings (3):

Biological factors:

– Toxic effects, metal- e.g. interference screws, bio-screws?

– Unspecific reactions to infection (cytokins, 1)

– Necrosis of the cells due to drill heat

– Necrosis due to graft re-modelling (avascularity)

Mechanical factors:

– Local strain on the wall of the tunnel

– Longitudinal displacement of the graft within the femoral and tibial tunnels

Fig. 1.: Anterior Cruciate Ligament Reconstruction using hamstrings in press-fit technique without hardware

as a result of fixation away from the point of insertion e.g. endobutton (bungee effect)

– Aggressive rehabilitation,

– Increased tension as a result of incorrect positioning of the tunnel.

Surgical technique:

The hamstrings are harvested by standard procedure through a vertical skin incision of 3 cm. Graft preparation on the workstation the tendons are gently dissected free using a raspatorium. The ends of each tendon are tied together by a simple knot. The knots are maximally tightened under cyclic manual load and secured with 4 diverging U-shaped Ethibond 2 sutures

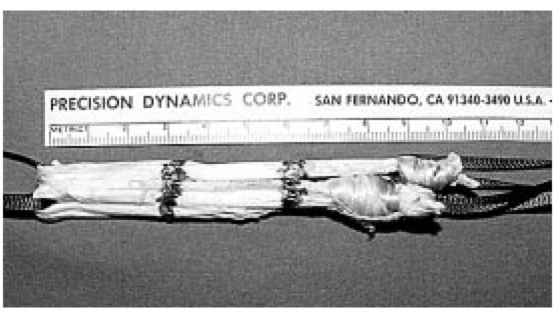


Fig. 2.: The ends of the thus prepared tendons are tied together into an ordinary knot to form a closed loop (the length of the semitendinosus loop being about 7cm without the knot and that of the gracilis loop being 8 – 9 cm)

(Fig 2). A mark is made 10 mm beyond the knot on the sling of the semitendinosus graft and 20 mm beyond the knot of the gracilis tendon, because the semitendinosus graft with ist larger knot will be first pulled into the femoral tunnel followed by the thinner gracilis graft. Therefore the sling of the gracilis tendon is 10 mm longer than the soling of the semitendinosus tendon. A second mark is made 3 cm beyond the first mark. This mark should be seen at the intrarticular entrance into the tibial tunnel, when both grafts are inserted completely into the tunnels. Each loop is held by mersilene tape. The lengths of the loops and the diameters of their knots are measured with a precision of up to 0,5 mm (Fig. 3). A femoral drill guide (graded in 4 and 5 mm steps) is applied via the medial porta (Fig. 4) and a guiding K-wire is drilled into the cortical bone only. This is done with the knee joint flexed at 125 °. Using a canulated drill, a tunnel, as thick as the loops (5 – 7 mm) is drilled until cancellous bone is reached. The drill is then replaced by a bone cutting tube and a trans-femoral tunnel is cut (Fig. 5). The cancellous bone

Fig. 3. The size of the knots and the smallest diameter of the loops (midportion) are measured using a template in 0.5 mm steps.

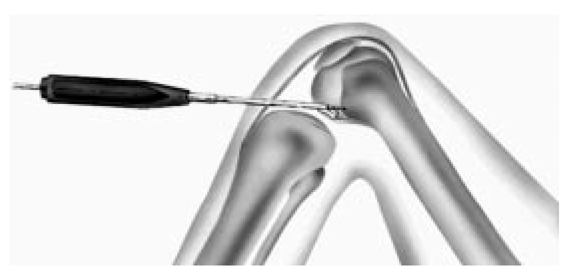


Fig. 4. A 4 mm offset femoral drill guide is applied via the medial porta

Fig. 5. Insertion of a bone harvesting tube with the same diameter as the used drill bit

is laid aside for later. The length of the tunnel is measured and a K-wire passed through it inside out. A skin incision of 15 mm is made at the point where the K-wire perforates it (Fig. 6) and the underlying fascia is split longitudinally. Using a canulated drill, a tunnel is drilled along the K-wire, its width corresponding to the diameter of the knot of the semitendinosus loop and its length about 20 mm (Fig. 7).

The part of the tunnel in close proximity to the femoral notch is dilated and impacted using a canulated bone expander until the inner cortical bone is reached (Fig. 8 a+b). This results in the tunnel having a step (bottleneck principle). The tibial tunnel is pre-drilled with a K-wire using a guide drill halfway between medial tibial tubercle and anterior inner border of

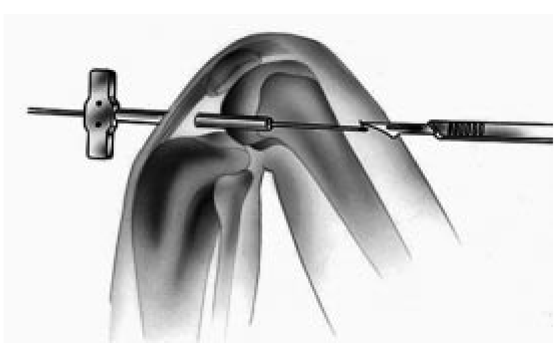


Fig. 6. An impactor with a diameter corresponding the one of the drill is inserted 12 mm deep into the femoral tunnel. A K-wire is inserted through the impactor, perforating the skin at the lateral thigh. A skin incision of 12 – 15 mm is made at the point where the K-wire perforates it

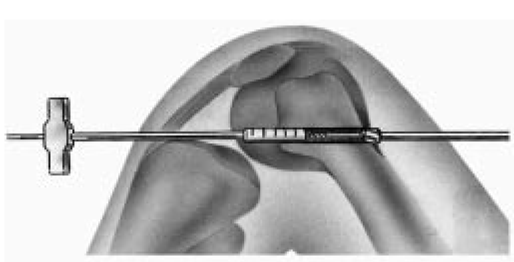


Fig. 7. Using a cannulated drill, a tunnel is drilled along the K-wire

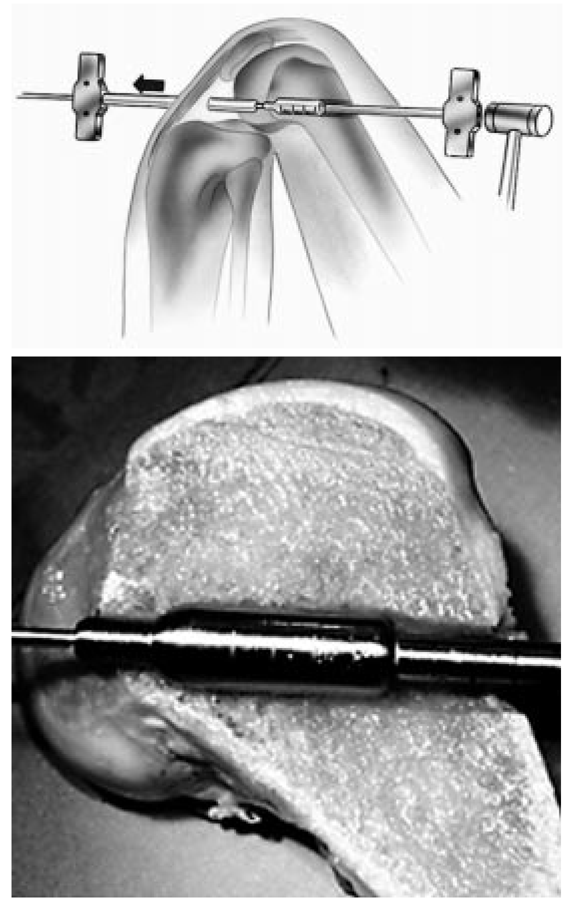


Fig. 8a+b. The part of the tunnel in close proximity to the femoral notch is dilated and impacted using a cannulated bone expander until the inner cortical bone is reached

the lateral meniscus. Than use of an impingement probe placed on K-wire with fluoroscopy in hyperextension (Fig. 9).

The tibial drill guide is inserted with the knee in 90° degree of flexion. Its position is controlled with c-arm imaging. A 2.5 mm guide-wire is then inserted. Its position is again confirmed by c-arm imaging. An impingement probe is mounted over the guide-wire. The knee is placed in full extension. On the x-ray image on the c-arm monitor the impingement probe should have two mm of clearence to the notch roof. The loops are introduced into the femoral and tibial tunnels from the lateral side, the semitendinosus loop in first position (Fig. 10). A sudden jolt indicates that the

Fig. 9. Lateral fluoroscopy view of the impingement probe. The knee is in hyperextension

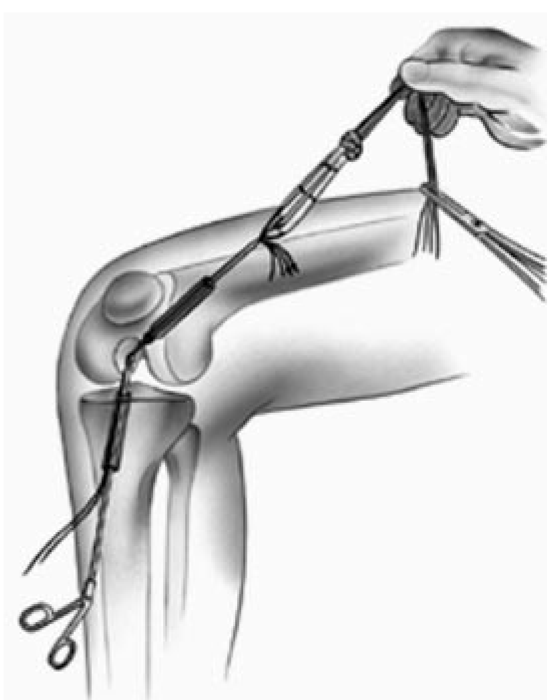


Fig. 10. The loops are now introduced into the femoral and tibial tunnels from the lateral side, the semitendinosus loop in first position.

loops have settled firmly within the bottleneck. The two loops are conditioned under maximal manual load (200N per loop) by movement of the knee joint 20 times along its full range (Fig. 11). After conical dila-

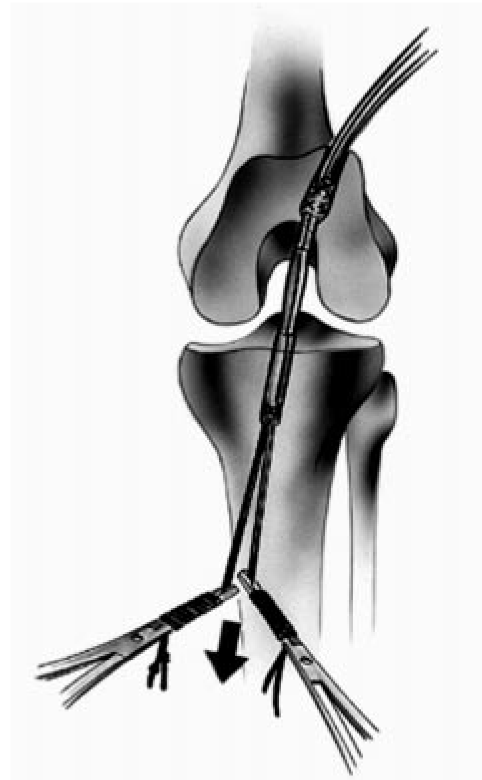


Fig. 11. The two loops are conditioned under maximal manual load (about 200N per loop) by movement of the knee joint along its full range. This is done 20 times

tion of the tibial entrance of the tunnel with a needle holder, press fit of the cancellous bone anterior to the loops. 1 cm distally to the tibial end of the tunnel a drill hole of 4,5 mm is made (Fig. 12 a) and a bone bridge is created by under-tunneling it with a curved clip. The first strips of the mersilene tapes are pulled through the help of a Dechamp and tied to the second strips after repeated maximal loading (Fig. 12 b). This is done with the knee flexed at 10 – 20°. The cancelous bone cylinder from the femoral tunnel is impacted pressfit into the tibial tunnel anterior the loops.

Biomechanical testing

In cooperation with Weiler and Kandziora, Unfallchirurgische Klinik, Charité Berlin, (Direktor: Prof. Dr Haas) biomechanical pull out tests on pig knees have

Fig. 12. 1 cm distally to the tibial end of the tunnel a drill hole of 4,5 mm is made and a bone bridge is created by under-tunneling it with a curved clip. The first strips of the mersilene tapes are pulled through the help of a Dechamp and tied to the second strips after repeated maximal loading. This is done with the knee close to full extension (5 – 10°)

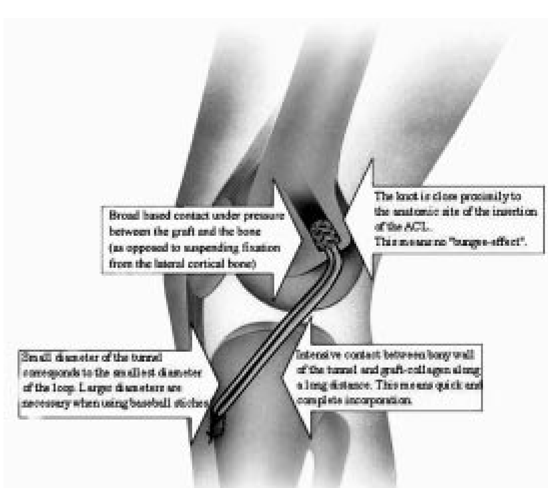
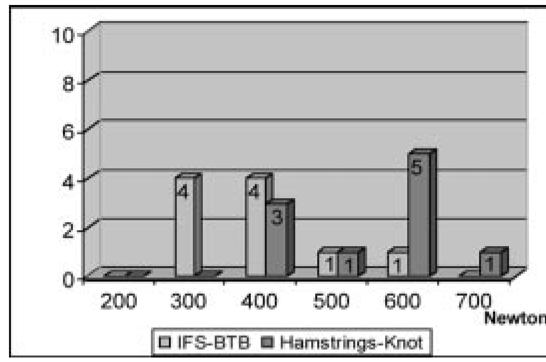


Fig. 13. Conclusion

shown that under cyclic loading (100x300 N, 100x400 N, 100x500 N, 100x600 N, and 100x700 N) this technique demonstrated to be two folds stronger than the „Gold Standard" BTB fixed with Interference Screws (Tab. 1).



Tab. 1. Failure rate to cyclic loading of bone-tendon-bone graft (BTB) fixed with Interference screws (IFS) vs. Hamstring graft fixed with knot technique

Clinical experience

This technique, which has been used on 915 patients in the past 3.5 year shows a particularly low rate of postoperative morbidity. The reason is probably to be found in the „waterproof" of the bone tunnels, which lead to less postoperative bleeding and swelling. No drains were used. Rehabilitation was done following the same schemes as were used for the reconstruction using patellar tendon grafts (accelerated – functional). As expected, there was no widening of the femoral tunnels and little widening of the tibial tunnels.

The measured internal torque of the hamstrings as well as their flexion force returned to normal already 12 months postoperatively.

Conclusion

The advantages of this technique are (Fig. 13):

1. The knot is close to the anatomic site of the proximal insertion of the ACL. This means no „bungee-effect".

2. Broad based contact under pressure between the graft and the bone (as opposed to suspending fixation from the lateral cortical bone).

3. Small diameter of the tunnel corresponds to the smallest diameter of the loop. Larger diameters are necessary when using baseball stitches. This pressfit tunnel placement prevents synovial fluid entering into bone tunnel, decreases bleeding out of tunnels (less postoperative swelling) and reduces windshieldwiper effect. The intensive contact between bony wall of the tunnel and graft-collagen along a long distance may accelerate graft incorporation. Finally, the fact that we do not utilize implants for fixation prevents hardware discomfort and eventually surgical removal, facilitates revision surgery, avoids metal artefacts in MRI and lowers overall costs.

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