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PŮVODNÍ PRÁCE

Combining ACL Reconstruction and Refixation: the Single Anteromedial Bundle Biological Augmentation and Refixation (SAMBBAR) Technique

Kombinovaná rekonstrukce a refixace PZV: technika jednoduché biologické augmentace a refixace anteromediálního svazku (SAMBBAR)

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ABSTRACT

PURPOSE OF THE STUDY

Anterior cruciate ligament (ACL) preservation surgical techniques have been rising lately. In the acute setting, proximal ACL tears and femoral avulsions of the ACL are good indications for primary repair of the ACL. However, literature shows a wide range of failure rates. An intact synovial membrane seems to be a predicational factor for the outcome of primary ACL repair. Disruption of the synovial membrane is associated with higher failure rates. We describe a surgical technique repairing the ACL in combination with a semitendinosus augmentation for proximal ACL tears with or without disruption of the synovial membrane.

MATERIAL AND METHODS

The procedure preserves as much of the original anatomy as possible by repairing the synovial membrane and ACL remnant to the femoral origin. To accomplish this, we have built on the so-called "Single Anteromedial Bundle Biological Augmentation (SAMBBA) technique" and developed it further to the "Single Anteromedial Bundle Biological Augmentation and Refixation (SAMBBAR) technique", which we firstly describe here.

RESULTS

All three patients treated with the SAMBBAR technique showed very good short-term clinical outcomes comparable with successful standard ACL reconstruction. There were no complications. Twelve months postoperatively, patients had no pain. They had normal range of motion in the affected knee without any signs of instability.

DISCUSSION

The SAMBBAR technique seems to be an adequate procedure to preserve as much proprioceptive native tissue as possible, while at the same time ensuring high tissue strength in order to reduce failure rates. Prospective randomized controlled trials are needed to compare the new SAMBBAR technique with standard ACL reconstruction, with the original SAMBBA technique, and with techniques of ACL refixation.

CONCLUSIONS

With the presented surgical procedure, it is possible to perform a standard ACL reconstruction using an autologous semitendinosus graft and at the same time preserving the tissue remnant of the ACL in all proximal tear patterns. This might contribute to improved proprioception and rehabilitation without sacrificing stability.

Key words: anterior cruciate ligament, Lachman test, Ligamys, knee instability, semitendinosus tendon.

INTRODUCTION

In recent years, anterior cruciate ligament (ACL) preservation surgical techniques have become more and more common. Proximal ACL tears and femoral avulsions of the ACL are good indications for primary repair of the ACL (1, 3, 4, 5). However, studies demonstrated a wide range of failure rates between 1.8% and 20% (1, 2). An intact synovial membrane seems to be a predicational factor for the outcome of primary ACL repair. Three groups of different proximal ACL tears with either intact or ruptured synovial membrane were identified. The groups with disruption of the synovial membrane were associated with higher failure rates after primary ACL repair (3).

We describe a surgical technique repairing the ACL in combination with a semitendinosus augmentation for proximal ACL tears with disruption of the synovial membrane. The goal of the surgery is a primary repair of the ACL with biological augmentation using a hamstring tendon resulting in a stable ligament. The procedure preserves as much of the original anatomy as possible by repairing the synovial membrane and ACL remnant to the femoral origin. To accomplish this, we have built on the so-called "Single Anteromedial Bundle Biological Augmentation (SAMBBA) technique" (7) and developed it further to the "Single Anteromedial Bundle Biological Augmentation and Refixation (SAMBBAR) technique", which we firstly describe here.

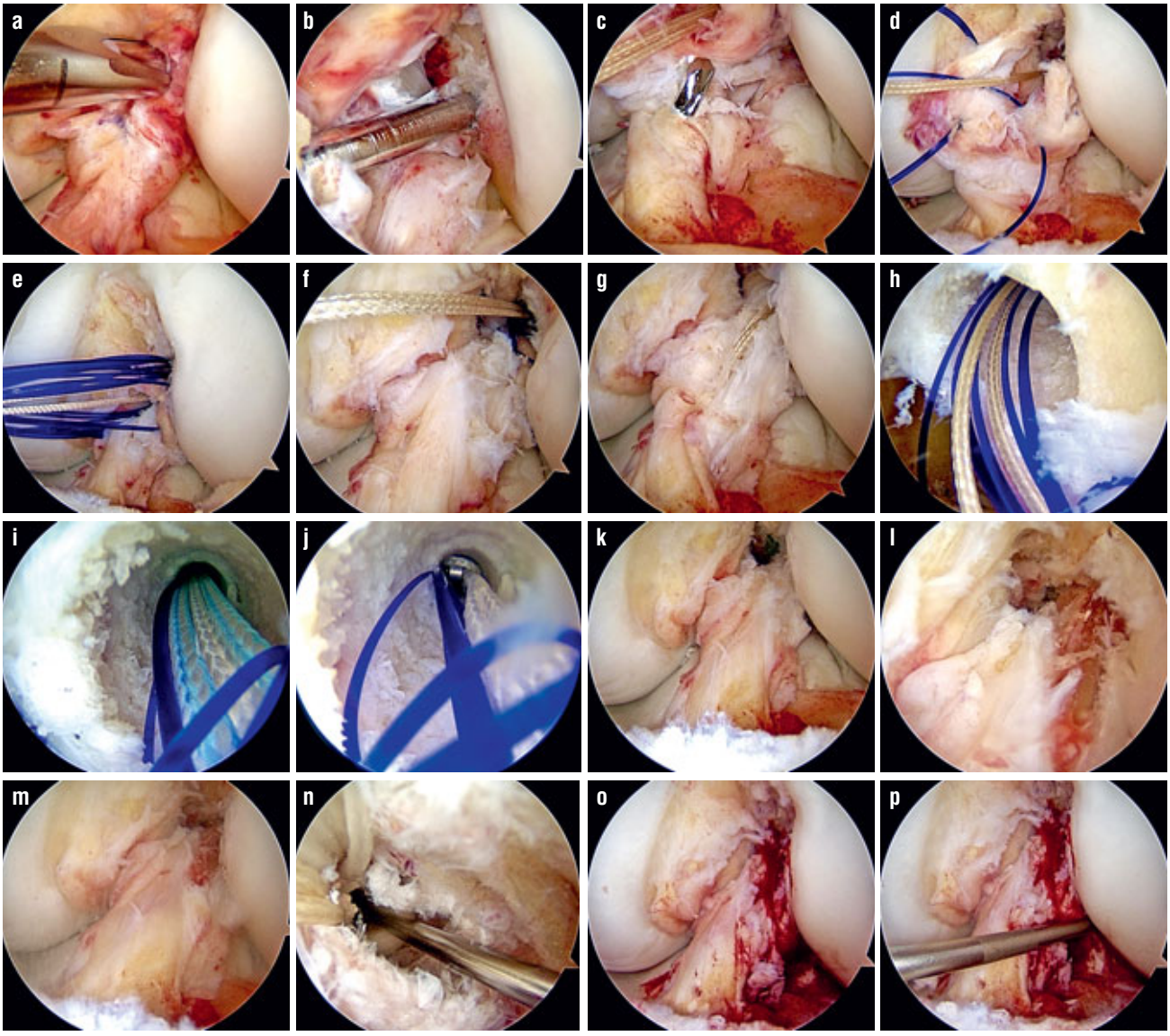

Fig. 1. Arthroscopic surgery for combined ACL reconstruction and refixation of a proximal ACL tear five weeks after trauma to the left knee. The remnant is reinserted at the femoral origin and it is augmented using a semitendinosus autograft.
a – evaluation of the proximal ACL tear pattern including disruption of the synovial membrane;
b – after preparation of the femoral ACL origin, a eyelet drill-wire for femoral tunnel development is placed, overdrilled, and a suture loop shuttled;
c – a tibial drill-wire is placed entering the joint in the middle of the tibial ACL remnant;
d–f – the ligament stump is armed using PDS sutures and these sutures are shuttled through the femoral tunnel together with another suture loop;
g – this loop is now shuttled retrograde through the tibial tunnel using a suture retriever;
h–j – using this suture loop, the semitendinosus graft is shuttled from distal to proximal through the tibial tunnel, the ACL remnant, and the femoral tunnel while the PDS sutures are under slight pulling force to tension the ACL remnant until the femoral button is flipped;
k–m – the tissue is tensioned by pulling distally;
n – view into the tibial tunnel after tibial graft fixation with an interference screw;
o, p – final arthroscopic evaluation of the result showing a stable ACL.

MATERIAL AND METHODS

We treated three patients using the SAMBBAR technique in males and females aged from 20 to 37 years. Patients had proximal ACL tear patterns.

The procedure is illustrated in Figure 1. Standard arthroscopy of the knee is performed. Potential accompanying injuries of the menisci or cartilage are evaluated, documented, and addressed appropriately. The ACL tear is analyzed in regards of tear location and tear type. Also, the integrity of the synovial membrane at the surface of the ACL is evaluated.

The semitendinosus tendon (ST) is harvested in a standard fashion using a tendon stripper. The ST is prepared as a four- or three-strand graft in standard fashion depending on tendon length and diameter. The final graft

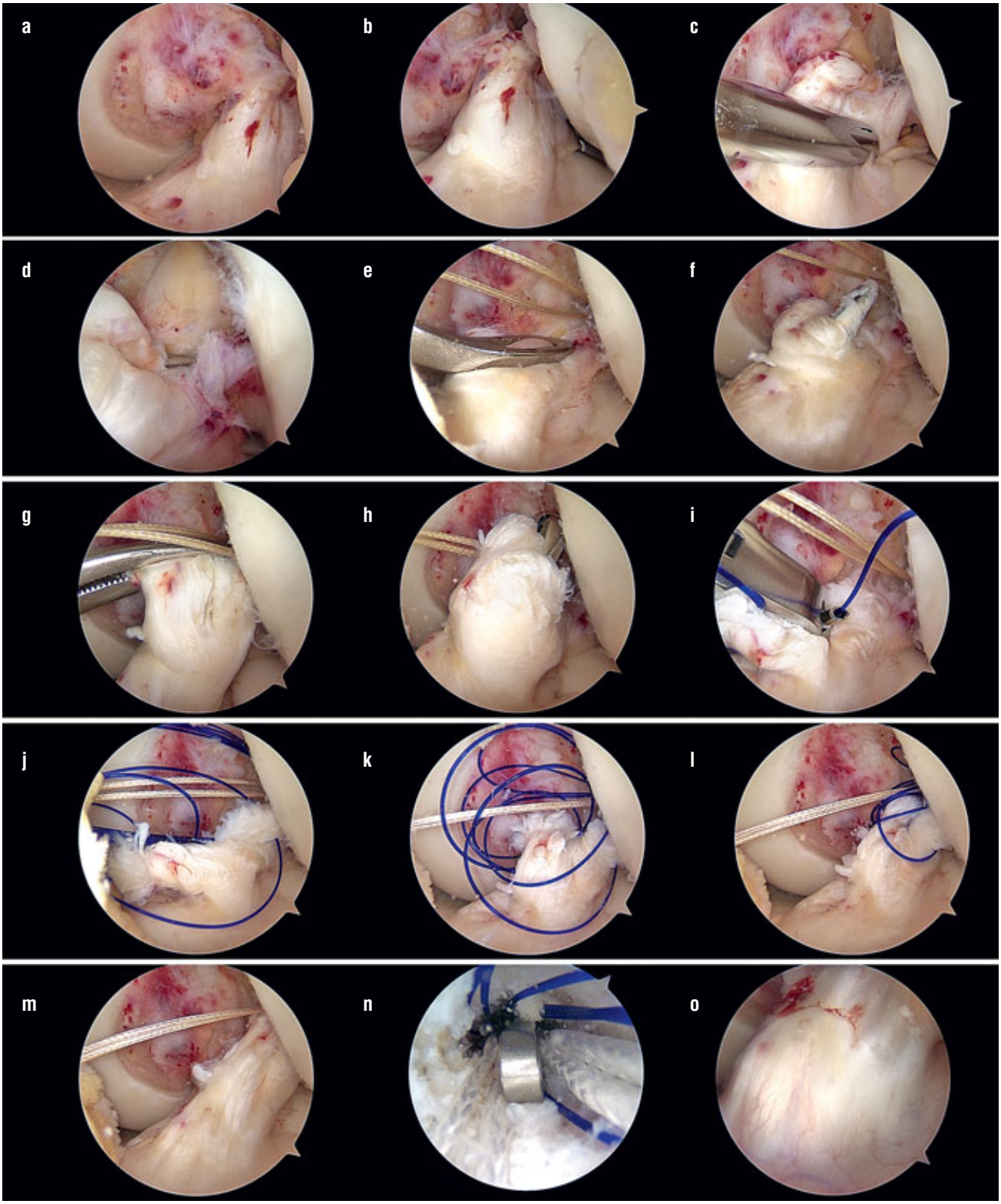

Fig. 2. Steps of arthroscopic surgery for combined ACL reconstruction and refixation of a proximal ACL tear four weeks after trauma to the left knee in a 20-year-old female soccer player.
a, b – proximal ACL tear;
c, d – femoral footprint preparation using a shaver;
e, f – preparation of femoral and tibial tunnel;
g, h – the ACL stump is reduced to the femoral insertion site at the lateral condyle;
i–k – the ligament stump is armed with PDS sutures;
l–n – PDS sutures are tensioned, and the semitendinosus graft is shuttled through the tibial tunnel, the ACL remnant, and the femoral tunnel using a suture loop;
o – final evaluation of the result showing native ACL tissue with a stable graft inside.

dimensions should be 8 to 9 mm in diameter and 70 to 80 mm in length. For optional downsizing the graft, it can be compressed using graft tubes.

For femoral tunnel preparation, the anatomical origins of the anteromedial (AM) and posterolateral (PL) bundles at the lateral femoral condyle are identified. In 120° to 130° of knee flexion, an eyelet wire is drilled through the femur using a femoral guide for tunnel development. A 20 mm femoral socket is drilled with increasing drill-bit diameters according to the diameter of the graft. The tunnel is dilated to the same diameter as the graft.

For tibial tunnel preparation, the tibial ACL remnant is inspected. If scarred to the posterior cruciate ligament (PCL) or to a non-anatomic site of the femoral condyle, it is carefully mobilized preserving its entire synovial cover and tibial attachment. The tibial guide is introduced through the anteromedial portal and positioned so that the guidewire either splits or stays within the center of the tibial ACL stump. When the location of the guidewire is satisfactory, the tunnel is drilled with increasing drill-bit diameters, stopping as soon as the bone of the tibial plateau is breached, not to compromise the ACL remnant. The drill remains strictly within the ACL remnant to preserve residual tissue. A shaver is passed through the tibial tunnel and into the remnant to emerge at its upper end so that the remnant is hollowed out for passage of the graft. The interior of the synovial sleeve is debrided to avoid overpacking of the intercondylar notch, which may cause anterior tissue impingement and deficit in knee extension.

The proximally avulsed ACL stump is armed with two to five PDS 2-0 sutures at the proximal end. Depending on the condition of the tibial stump, it may be necessary to suture individual bundles using several retaining sutures.

Graft insertion and fixation of the ACL remnant: Using a shuttle suture loop, first the holding sutures are passed through the femoral tunnel and second the graft is transported through the tibial tunnel, the ACL remnant, and the femoral tunnel. Together with the graft, the PDS sutures of the proximal ACL stump-end are fixated. They are hold tense and the femoral button of the graft is flipped.

Then the graft is fixed distally using an interference screw with optional addition of a suture button for hybrid fixation. Sutures are cut, the result is evaluated arthroscopically, and the procedure is finished.

The postoperative rehabilitation protocol is not different from standard protocols and recommendations after ACL reconstruction. Figure 2 illustrates another case of successful usage of the SAMBBAR technique.

RESULTS

All three patients treated with the SAMBBAR technique showed very good short-term clinical outcomes comparable with successful standard ACL reconstruction. There were no complications. Twelve months postoperatively, patients had no pain. They had normal range of motion in the affected knee without any signs of instability.

DISCUSSION

We demonstrated ACL reconstruction not only preserving the ACL remnant, but suturing it back to its origin at the lateral femoral condyle. The perfect indication seems to be a proximal ACL tear with or without disruption of the synovial membrane.

Advantages of the procedure over standard ACL reconstruction: preservation of the ACL remnant including the synovial membrane with its blood supply and proprioception, preservation of the anatomic tibial ACL insertion (6). Advantages of the procedure over ACL refixation: clinical outcome not dependent on healing of native ACL, procedure possible even after 21 days post-trauma.

Disadvantages of the procedure in comparison with standard ACL reconstruction: slightly more complex and time-consuming surgery, limited visual control when drilling the tibial tunnel. Comparing the procedure to ACL refixation, the disadvantage of the described procedure is the necessity to harvest the semitendinosus tendon, if no allograft is to be used.

ACL refixation is indicated in patients with a proximal (femoral) tear of the ACL and an intact synovial membrane. This surgery can be performed successfully within the first three weeks after trauma (1-3). The SAMBBAR technique can be used also in cases with a disrupted synovial membrane. As the SAMBBAR technique utilizes a standard semitendinosus tendon graft like in standard ACL reconstruction surgery, the outcome is probably not dependent from the timing of the operation. It is suitable for all ages. During the procedure, suture management is important. We tensioned the native tissue and the tendon graft in slight knee flexion of 20° to 30° and neutral rotation when fixing the reconstructed ACL with a flip button on the femoral site and we used a hybrid fixation (resorbable interference screw and metal suture button on the tibial site).

Prospective randomized controlled trials are needed to compare the new SAMBBAR technique with standard ACL reconstruction, with the original SAMBBA technique, and with techniques of ACL refixation.

CONCLUSIONS

With the described surgical technique, it is possible to perform a standard ACL reconstruction using an autologous semitendinosus graft and at the same time preserving the tissue remnant of the ACL in all proximal tear patterns. This might contribute to improved proprioception and rehabilitation without sacrificing stability.

All procedures performed on human participants in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent was obtained from all individual participants included in the study.

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