Combined Anatomic Anterior Cruciate Ligament and Anterolateral Ligament Reconstruction

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\section*{ABSTRACT}

\textbf{Purpose}: The purpose of the current paper was to report the surgical technique of combined anatomic anterior cruciate ligament (ACL) and anterolateral ligament (ALL) reconstruction as well as the short term clinical results after this surgical procedure.

\textbf{Material and Methods}: The current prospective study included 32 patients (5 females and 27 males) with combined ACL and ALL reconstruction performed between December 2015 and July 2016. The patients were included in the study taking into consideration the following criteria: chronic ACL lesion, high grade rotational instability (pivot shift grade II and III) and participation in high grade pivoting sports. Patient evaluation followed an established clinical and imaging protocol both preoperatively and at 6 and 12 weeks postoperatively. This included clinical knee stability testing (Lachman test, Pivot shift test), Rolimeter differential laxity testing, subjective and objective IKDC scores and Lysholm score and Tegner score.

\textbf{Results}: Postoperative stability at 6 weeks and 12 weeks as tested with Lachman test (p=0.02 and 0.01, respectively), pivot shift test (p=0.03 and 0.01, respectively) and the Rolimeter arthrometer (p=0.008 and 0.006, respectively) showed a statistically significant difference as compared to preoperative values. Postoperative scores at 6 weeks and 12 weeks as measured using objective IKDC form (p=0.008 and 0.006, respectively), subjective IKDC form (p=0.04 and 0.03, respectively) and Lysholm form (p=0.02 and 0.01, respectively) were statistically significant improved as compared to preoperative values. All patients had a negative Lachman test at 6 and 12 weeks postoperatively. One patient had a positive grade I pivot shift test at 6 weeks postoperatively and two patients had a positive grade I pivot shift test at 12 weeks postoperatively. Differential anteroposterior laxity as measured with the Rolimeter arthrometer improved from 7.19±1.96 mm preoperatively to 0.28±0.45 mm and 0.13±0.34 mm, at 6 weeks and 12 weeks postoperatively, respectively. According to the objective IKDC form, 29 patients were normal or nearly normal (grade A and B) at 6 weeks postoperatively and 31 patients were normal or nearly normal at 12 weeks postoperatively. Subjective IKDC score improved from 47.72±17.18 preoperatively to 56.52±11.74 and 73.38±14.28 at 6 and 12 weeks postoperatively, respectively. Lysholm score improved from 63.44±23.01 preoperatively to 80.41±11.94 and 90.47±8.22 at 6 and 12 weeks postoperatively, respectively. Improved Tegner activity scores were present at 12 weeks postoperatively as compared with 6 weeks postoperatively, but still lower as compared to pre-traumatic scores. No significant complications were present in the current study group.
INTRODUCTION

Anterior cruciate ligament reconstruction (ACLR) is a commonly performed surgical procedure with very good long term results. Yet, residual rotational instability may persist in some cases and this may predispose to secondary meniscal and cartilage lesions, recurrent ACL tears and difficulties in performing high level pivoting sports (1-3). Thus, a better control of rotational instability, either by double bundle ACL reconstruction (4-6) or by adding a lateral extra-articular surgical procedure (6-8), may contribute to improving the clinical results. Recent publications demonstrated the presence of the anterolateral ligament (ALL) as a distinct ligamentous structure on the anterolateral side of the knee (9-12), extending from the femoral origin, in a region situated posterior and proximal to the lateral femoral epicondyle to the tibial insertion, located halfway between the Gerdy’s tubercle and the tip of the fibular head. Biomechanical studies emphasized the role of the ALL as an important stabilizer of tibial internal rotation. Sectioning the ALL was greatly associated with high grade pivot shift testing (13-15).

The purpose of the current paper was to report the surgical technique of combined anatomic ACL and ALL reconstruction and the short term clinical results after this type of surgical procedure. Our hypothesis was that combined ACL and ALL reconstruction is associated with improved clinical results without any specific short term complications.

MATERIAL AND METHODS

The current prospective study included 32 patients (5 females and 27 males) with combined ACL and ALL reconstruction performed between December 2015 and July 2016. The mean age at surgery was 28.8±7.53 years. The mean surgical time was 93.38±15.06 minutes. The sport practiced was football for 22 patients, cycling for two patients and other sports for the rest of the patients.

Patients were included in the study taking into consideration the following criteria: chronic ACL lesion, high grade rotational instability (pivot shift grade II and III) and participation in high grade pivoting sports. Exclusion criteria were recurrent ACL tears, knee dislocation and associated ipsilateral extra-articular knee surgery (osteotomies, associated ligamentous procedures). Patient evaluation followed an established clinical and imaging protocol both preoperatively and at six and 12 weeks postoperatively. This included clinical knee stability testing (Lachman test, Pivot shift test), Rolimeter anteroposterior differential laxity testing, subjective and objective IKDC scores and Lysholm score and Tegner score.

Written consent was obtained from the patients. This study received institutional review board approval.

Postoperative rehabilitation protocol included progressive weight bearing as tolerated with two crutches without brace, range of motion training without hyperextension and proprioception and muscle training starting from 4th postoperative week. A gradual return to sports program was established – non-pivoting sports started at three months postoperatively, non-contact pivoting sports at six months postoperatively and contact pivoting sports at nine months postoperatively.

The paired t-test was used to compare the preoperative and postoperative numerical data. The Fisher exact test was used to compare the preoperative and postoperative Lachman and pivot shift test results and IKDC objective score. The level of significance was established at p<0.05.

Surgical technique

Combined ACL and ALL surgical procedure is meant to anatomically reconstruct the ACL using a triple stranded semitendinous and gracilis autograft and to replicate the triangular native shape of the ALL by double-bundle reconstruction using the gracilis tendon.
**Patient positioning**

The patient is positioned supine with a padded tourniquet applied in the proximal region of the thigh. Two posts are attached to the surgical table, the first lateral to the proximal thigh and the latter as a foot roll in order to maintain a 90° knee flexion (Figure 1).

**Hamstring graft harvesting**

Graft harvesting is performed using a 3-cm skin incision located in the antero-medial region of the proximal third of the leg. The semitendinous tendon is kept attached in order to obtain a better fixation and vascularization of the graft, while the gracilis tendon is whip-stitched with a traction suture, detached and used both for ACL and ALL graft preparation. Graft diameter measurement is performed during this surgical step (Figure 2).

**Preparing of the ALL reconstruction site**

Two stab incisions are used to prepare a V-shaped tibial tunnel, the first positioned at the level of the Gerdy tubercle and the latter half-way between the Gerdy tubercle and the tip of the peroneal head, in order to replicate the large native tibial insertion of the ALL. A 2-cm incision is centered over the lateral epicondyle and is meant for ACL femoral tunnel drilling (Figure 3).

**ACL tunnel drilling**

Outside-in ACL femoral tunnel drilling is performed with the lateral starting point located posterior and proximal to the lateral epicondyle, corresponding to the femoral insertion point of the ALL (Figure 4). Tibial tunnel is drilled outside-in using graft harvesting incision (Figure 5). Graft length measurement is performed after this surgical step (Figure 6).
ACL and ALL graft preparation

The semitendinous tendon was tripled in order to reproduce the previously performed length measurements and the gracilis tendon was sutured over the tripled semitendinous graft. Thus, the ACL graft was composed of three strands of semitendinous tendon and one strand of gracilis tendon, while the ALL graft consisted of the remaining gracilis graft (Figure 7).

ACL graft passage and fixation

ACL graft is pulled from distal to proximal and fixation is performed with bioabsorbable screws first on the tibial side and then on the femoral side in 30° of flexion and posterior drawer (Figure 8).

ALL graft passage and fixation

ALL graft is pulled deep to the fascia lata from proximal to distal through the V-shaped tibial tunnel and re-routed proximally to its femoral origin, located at the lateral entry point of the femoral tunnel (posterior and proximal to the lateral femoral epicondyle) (Figure 9). Fixation is performed using the ACL traction sutures in full extension and neutral rotation (Figure 10).

RESULTS

Postoperative stability at six weeks and 12 weeks as tested with Lachman test (p=0.02 and 0.01, respectively), pivot shift test (p=0.03 and 0.01,
respectively) and the Rolimeter arthrometer (p=0.008 and 0.006, respectively) showed a statistically significant difference as compared to preoperative values. Improved results as measured with the Rolimeter arthrometer were present at 12 weeks postoperatively as compared with six weeks postoperatively without statistical significance. All patients had a negative Lachman test at six and 12 weeks postoperatively. One patient had a positive grade I pivot shift test at six weeks postoperatively and two patients had a positive grade I pivot shift test at 12 weeks postoperatively. Differential anteroposterior laxity as measured with the Rolimeter arthrometer improved from 7.19±1.96 mm preoperatively to 0.28±0.45 mm and 0.13±0.34 mm, at six weeks and 12 weeks postoperatively, respectively (Table 1). Postoperative scores at six weeks and 12 weeks as measured using objective IKDC form (p=0.008 and 0.006, respectively), subjective IKDC form (p=0.04 and 0.03, respectively) and Lysholm form (p=0.02 and 0.01, respectively) showed statistically significant improvement as compared to preoperative values. According to the objective IKDC form, 29 patients were normal or nearly normal (grade A and B) at six weeks postoperatively and 31 patients were normal or nearly normal at 12 weeks postoperatively. Subjective IKDC score improved from 47.72±17.18 preoperatively to 56.52±11.74 and 73.38±14.28 at six and 12 weeks postoperatively, respectively. Lysholm score improved from 63.44±23.01 preoperatively to 80.41±11.94 and 90.47±8.22 at six and 12 weeks postoperatively, respectively. Improved Tegner activity scores were present at 12 weeks postoperatively as compared with six weeks postoperatively but they were still lower as compared to pre-traumatic scores (Table 2).

No significant complications were present in the current study group.

**DISCUSSION**

The main finding of the current study is that combined ACL and ALL reconstruction is an effective surgical procedure, with improved stability (as measured with Rolimeter arthrometer, Lachman test and pivot shift test) and clinical scores (subjective and objective IKDC scores and Lysholm score) early postoperatively as compared to preoperative status. The Tegner activity score followed an ascending trend postoperatively. Yet, at 3-month follow-up it didn’t reach the pre-traumatic values. No significant short term complications were present in our study group.

ACLR is associated with very good clinical results. Yet, residual rotational instability may still be present postoperatively (1-3). Double-bundle ACL reconstruction was introduced aiming to better control rotational instability, but it didn’t manage to provide an obvious clinical benefit. Moreover, it was associated with increased incidence of complications.
cyclops syndrome and more difficult ACL revision surgery (3–6). Lateral extra-articular procedures, as lateral fascia lata tenodesis and more recently ALL reconstruction are expected to better control rotational instability, by providing a better lever arm for controlling internal rotation than intra-articular procedures (6-8).

There is great literature confusion when defining the antero-lateral structures of the knee. The first publication dealing with the topic dates from 1879, when Segond mentioned the presence of a fibrous band on the anterolateral side of the knee. Many inconstant descriptions of the antero-lateral structure are present in the literature. However, only recent publications by Claes et al., Helito et al., Pomajzl et al., Stijak et al., Dodds et al., Kennedy et al., Parsons et al. and Monaco et al. managed to better anatomically describe the anterolateral ligament and emphasize its role in controlling rotational instability of the knee and its role for reducing the pivot shift phenomenon. The role of the anterolateral ligament is minimal in controlling anteroposterior stability, but it may have an important role in controlling internal rotation of the tibia (9-18).

There are some limitations of the current study. Although it is a prospective study, the follow-up is limited to three months. Longer follow-up is necessary to better evaluate the benefits and the potential long term complications of this surgical procedure. A comparative study may be useful in evaluating the results of this surgical procedure with respect to either single or double-bundle isolated anatomic ACL reconstruction.

## CONCLUSION

Combined ACL and ALL reconstruction is an effective surgical procedure with improved clinical results and no significant short term complications. Longer follow-up is necessary in order to better evaluate the results of this procedure.

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### REFERENCES