

Clinical And Functional Comparison Of Anterior Cruciate Ligament Reconstruction With Two Different Fixation Techniques: Single Bundle Versus All-Inside

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Abstract

Introduction: The All-inside ACL reconstruction procedure features some distinguished components like closed-socket tunnels with less bone expulsion, double suspensory fixation and smaller incisions. We aimed to compare the clinical and functional outcomes of two different graft fixation methods via all-inside and single-bundle anterior cruciate ligament (ACL) reconstruction techniques.

Methods: To compare the outcome of two different groups, the prospectively recorded data of patients diagnosed with isolated ACL rupture between 2022 and 2023 were reviewed retrospectively. Two groups of patients who underwent unilateral isolated ACL reconstruction via two different tibial fixation techniques (19 patients with all-inside [Group 1]; 20 patients with single-bundle [Group 2]) from the same institution were enrolled as the study group. The patients were called for the final follow-up and evaluated for symptoms, knee stability (Lachman test, pivot shift test, and KT-1000 arthrometer analysis), and functional scores (Tegner and Lysholm knee scoring scale, International Knee Documentation Committee (IKDC) subjective knee score and visual analog scale [VAS]).

Results: The follow-up period and mean age were not statistically different between the two groups. In the functional comparison of patients with Tegner and Lysholm knee and IKDC scores, no statistical difference were found at the mid-term follow-up period. In the clinical assessment of the operated knees, based on the Lachman test and KT-1000 arthrometer, the anterior translation results in group 1 were better than those in group 2, which was statistically significant. However, we obtained similar pivot shift test results in both groups.

Conclusion: The present study showed that ACL reconstruction via the all-inside technique had functionally better anterior translation and similar rotational stability results compared with the single-bundle technique with tibia interference screw fixation.

Level of Evidence: Level III case control study.

Keywords: anterior cruciate ligament; anterior translation; functional results; all inside.

1. INTRODUCTION

Anterior cruciate ligament (ACL) rupture is the most common type of knee injury, with an estimated incidence of 30 to 78 per 100,000 person-years. In the literature, many arthroscopic ACL reconstruction techniques and graft fixation materials have been described [1]. Although there are many graft fixation materials, such as cross pin, interference screws, etc., cortical suspensory fixation devices have superior biomechanical properties, especially for soft tissue grafts, and are currently the most common femoral fixation implants used [2]. Currently, there is a consensus that anatomic ACL reconstruction is the main factor for successful ACL reconstruction [3-6]. However, tibial fixation of the ACL graft is still controversial. In standard ACL reconstruction with femoral cortical suspensory devices, soft tissue graft is fixated by an interference screw and a common secondary fixation with a staple, a post-tibial screw, or an anchor [7]. This fixation was criticized because of its potential to push the graft material to the tibial tunnel that may loosen the final ACL graft tension or its insufficient fixation strength that may cause loosening of the graft in the rehabilitation period [8]. Some authors identified this limitation as the cause for mild laxities after ACL reconstruction using this method [9, 10].

The All-inside ACL reconstruction technique features some distinguished components including closed-socket tunnels with less bone expulsion, double suspensory fixation, and smaller incisions. Several studies showed both controversies and potential benefits of the All-inside technique compared to the standard

reconstruction technique. However, ideal tension of the graft is still controversial, and flexibility or elasticity of the graft is another factor considered during ligamentization of the ACL graft. In the literature, there is no evidence that the cortical suspensory tibial fixation method prevents mild laxities and has superior clinical outcomes. To our knowledge, there have not been previous studies which specifically compare the outcomes between the All-inside and Single-bundle ACL reconstruction techniques. The present study aimed to compare the outcomes between the All-inside Single-bundle and the All inside ACL reconstruction techniques.

2. MATERIAL AND METHOD

Study design

We prospectively recorded data of patients diagnosed with isolated ACL rupture, who underwent surgery between January 2022 and December 2023 at a single institution, and 40 patients were enrolled in our study group. One of the patients from the all inside group was excluded due to unfollow, nineteen patients in all inside and twenty patients in Single-bundle groups were included in our study group. The institutional review board approved this study. The procedures were explained in detail to all the patients, and written informed consent was obtained.

Inclusion criteria: Primary ACL reconstructions using ipsilateral hamstring autografts for isolated unilateral ACL rupture in skeletally mature patients.

Exclusion criteria: Patients with associated meniscal injury for repair requirement, collateral ligamentous injury, posterior cruciate ligament injury, posteromedial or lateral corner injury, associated fractures involving lower limb injuries, significant arthritis, and other articular diseases were excluded from the study.

All surgeries were performed by two surgeons specialized in sports medicine. The surgical technique was selected based on the medical insurance of patients with the same diagnostic instability criteria, such as positive instability tests (Lachman, anterior drawer, and pivot shift tests) and magnetic resonance imaging findings. In the all inside reconstruction group (Group 1), only the semitendinosus (ST) tendon was harvested and prepared as four strands with both femoral and tibial sides fixated with adjustable cortical suspensory fixation button (TightRope™, Arthrex, Naples, FL, USA). In the Single-bundle group (Group 2), both ST and gracilis tendons were harvested, and the tendons were prepared as five strands to thicken the autograft. In this group, the femoral side was fixated with an adjustable cortical suspensory device (Ultra-Button, Smith&Nephew, USA), and the tibial side was fixated with an absorbable interference screw and an additional staple or post-screw. In both groups, the femoral and tibial tunnels were prepared according to the anatomic single-bundle ACL reconstruction, with anatomical footprints of the native ACL as reference [11]. The patients were followed up with the same postoperative physiotherapy protocol. With full load-bearing, quadriceps strengthening and range of motion exercises were immediately started on the first day with closed chain exercises for 3 months. The patients were allowed to participate in sports at the 6th postoperative month.

Outcome measures: Patient demographics, preoperative Tegner and Lysholm knee scoring scale [12], International Knee Documentation Committee (IKDC) subjective knee score, and visual analog scale (VAS) scores were noted with patient folder, surgery record, and arthroscopy file with retrospective analysis.

All the patients were called for study and underwent functional tests using 77 KT-1000 arthrometer and functional scores. At the last follow-up, all the patients were asked for any symptom regarding knee stability and evaluated for stability of the reconstructed ACL via Lachman and pivot shift tests performed by the same surgeon. To evaluate anterior translation laxity, KT-1000 arthrometer was used (MEDmetric, San Diego, California, USA). This instrument quantifies anterior and posterior tibial dislocation in relation to the femur in the lateral plane by applying a tension system (67 N, 89 N, and 134 N) with quantification of anterior tibial translation [13]. The measurements registered (in mm) were seen through a viewer. The number corresponding to the difference between the operated and unaffected limbs was considered as the degree of knee ligament laxity, and normal values reach up to 3 mm.

At the last follow-up, all patients were examined, and the same author documented the results of the instability Lachman and pivot shift tests according to the KT-1000 arthrometer analysis and modified IKDC criteria (Grade 0 = negative; Grade 1 = subtle glide, but not negative; Grade 2 = glide, Grade 3 = between grades 2 and 4; Grade 4 = clunk; Grade 5 = between grades 4 and 6; Grade 6 = gross) [14]. In KT-1000 arthrometer analysis, the operated and contralateral limbs were compared in pairs of repeated

tests, thus acquiring three values for each tension in each knee. The difference in tension for each knee was acquired by subtracting the values for the operated knee from the contralateral knee.

Statistically Analyses

All statistical analyses were performed using the SPSS version 24.0 statistics software program (IBM Corp, 2011, Armonk, New York, USA). Student t-test and Mann-Whitney U test were used to compare the two groups of quantitative data with normal and non-normal distribution, respectively. Pearson chi-squared test, Fisher Freeman Halton exact test, and Fisher exact test were used to compare qualitative data, with significance level set a priori at $p < 0.05$, which was considered to be statistically significant. Preoperative demographic data of the groups, including age, graft diameter, preoperative VAS, and functional scores, were compared using Student t-test. Pre- and postoperative functional results were compared using paired T-test, whereas the results between the two groups were compared using Student t-test. Sample size was not calculated because of the retrospective nature of this study. However, a post hoc power analysis showed $>80\%$ power for the subgroup comparisons.

3. RESULT

The mean age of the patients in the all-inside group (Group 1) was 25.5 ± 7.2 (16–104 39) years with a mean follow-up of 44.5 ± 5.2 (36–50) months. The mean age of the patients in the single-bundle (Group 2) was 24.6 ± 6.8 (15– 38) years with a mean follow-up of 46.3 ± 5.8 (36–60) months. No statistical difference was found in the mean age and follow-up between the two groups.

The mean size of ACL graft was 8.19 ± 0.48 (7.5–9) mm and 7.96 ± 0.39 mm (7.5–8.5) mm for the all-inside and single-bundle groups, respectively. No significant difference was found for graft size between the two groups. When each group was compared within itself regarding the preoperative status of patients, both groups of patients showed a statistically significant improvement in function. However, functional scores were not significantly different between the two groups.

The patients had no complaints or symptoms at the last follow-up. In the clinical assessment of patients in the all-inside group based on the modified IKDC criteria, 9 patients had grade 0 (negative) pivot shift, and 10 patients had grade 1 laxity (subtle glide). By contrast, 5 patients had grade 0 (negative) pivot shift, and 15 patients had grade 1 laxity (subtle glide) in the single-bundle portal group. The pivot shift test results were not statistically different between the two groups ($p > 0.05$). In the clinical assessment of patients in the all-inside group based on the Lachman test, 15 patients had grade 0 laxity (<3 -mm translation), and 4 patients had grade 1 laxity (3–5-mm translation).

However, grade 1 laxity was noted in comparison to the non-operated extremity in all patients in the Single-bundle group. The results of the all-inside group were better than those in the single-bundle group, which were statistically significant ($p = 0.027$).

The difference in anterior translation for each knee was obtained by subtracting the values for the operated knee from the contralateral knee by using the KT 1000 arthrometer. In the 67-N evaluation, a difference of 0.775 and 1.133 mm was found from the contralateral knee in the all-inside and single-bundle groups, respectively ($p = 0.038$). In the 89-N evaluation, a difference of 0.8583 and 1.3333 mm from the contralateral knee in the all-inside and SINGLE-BUNDLE groups, respectively ($p = 0.035$). In the 134-N evaluation, a difference of 1.4217 and 1.5667 mm was found from the contralateral knee in the all-inside and SINGLE-BUNDLE groups, respectively ($p = 0.0453$). The all-inside group has better anterior translation results compared with the single-bundle group, which was statistically significant in all strength tests (67 N, 89 N, and 134 N).

4. DISCUSSION

The most important finding of the present study was that tibial fixation with adjustable cortical suspensor device via all-inside ACL reconstruction technique had better clinical results regarding anterior translation compared with the interference screw fixation via single-bundle portal technique. Currently, there is a consensus that an anatomic ACL reconstruction is the main factor for successful ACL reconstruction, and anatomic single-bundle ACL reconstruction with hamstring autografts has achieved very satisfactory results in clinical and functional aspects and has become the most commonly used surgical technique in most countries [10]. Cortical suspensory devices are the most commonly used implants for femoral fixation in these reconstructions due to superior biomechanical properties, especially for soft tissue grafts [7].

In standard ACL reconstruction with femoral cortical suspensory devices, soft tissue graft is fixated to the tibial tunnel via an interference screw and a common secondary fixation with a staple, a post-tibial screw, or an anchor [8, 9]. This fixation was criticized because of its potential to push the graft material to the tibial tunnel that may loosen the final ACL graft tension or its insufficient fixation strength that may cause loosening of graft in the rehabilitation period [10]. Some authors identified this limitation as cause for mild or residual laxities after ACL reconstruction using this method [15, 16]. The all-inside ACL reconstruction technique provides an alternative tibial fixation for solving this problem in addition to lower donor site morbidity due to enabling reconstruction with single ST tendon. The all-inside reconstruction technique has better biomechanical results in cadaveric studies, and these advantages have made this technique more popular [17-19]. There is no evidence that cortical suspensory tibial fixation method prevents mild laxities and has superior clinical outcomes compared with interference screw fixation. Discussions regarding residual laxity following an ideal anatomic ACL reconstruction were focused on the state of secondary stabilizers, such as the anterolateral ligament, meniscal deficiencies, and focused on the graft and ligamentization process during rehabilitation [16]. In the current literature, hamstring autograft is the most common graft used due to its low rate of donor site morbidity and good functional results. In the technical aspect of using soft tissue grafts, such as hamstrings, graft preconditioning has been recommended to remove graft elongation [20]. Although preconditioning is recommended, discussions regarding the amount of applied force and preconditioning time are ongoing [21].

Ligamentization of the ACL graft is mostly affected by isometry of the reconstruction. To achieve a functional ACL reconstruction and prevent recurrent instability, the final graft tension should not be loose after fixation to maintain stability during the ligamentization period [22]. However, the ideal graft tension is still unknown [23]. Possible risks of graft loosening in the rehabilitation period may have pushed surgeons to use a more tensioned final graft. However, this may cause premature graft rupture or possible secondary ligamentization problems [24]. Although some studies showed that all-inside ACL reconstruction had well to excellent clinical and functional results, few studies compared these results with interference screw fixation [25]. In this study, the authors compared the functional results of the two groups of patients with a follow-up of 6 months. With this short-term follow-up, they reported better IKDC subjective knee score, Lysholm knee score, Knee Society scores, and better Lachman test results in the all-inside group compared with the single-bundle portal group. In our study, both groups had similar functional results with a mean follow-up for the all-inside and single-bundle portal groups, respectively. Similarly, the all-inside group had better anterior translation results, not only with the Lachman test, but also with KT-1000 arthrometer analysis. The complication rate of all-inside ACL reconstruction was reported at 5.89% in the literature, which were comparable to the other arthroscopic ACL reconstruction techniques [24]. In our study, no major complications required additional surgery or further hospitalization in both groups. Similar minor complications were observed in the early follow-up period in both groups ($p > 0.05$). Two patients in the all-inside group had synovitis, whereas one patient in the single-bundle group had donor site hematoma not requiring further intervention. Therefore, a single hamstring tendon harvest provides sufficient length to serve as the autograft when quadrupled [8]. However, expensive implant cost and insufficient tendon length (because of the creation of four-fold grafts) are the disadvantages of this technique. The main purpose of ACL reconstruction studies was to investigate function recovery and residual laxity. Kouloumentas et al. reported a large series comparing the all-inside technique for ACL reconstruction by using a short, quadrupled ST tendon (ST4) autograft and suspensory cortical fixation on both femoral and tibial sides compared with a semitendinosus/gracilis (ST/G) autograft fixed with a suspensory device on the femoral side and with an interference screw on the tibial side [25]. In that study, they found no significant differences in the anterior tibial translation between the operative and non-operative knees between the two groups. However, Bressy et al. reported significant residual laxity in 35 patients with 19 months of follow-up, which was attributed to the use of adjustable loop cortical button [26]. In this study, the all-inside group had less translation in the single-bundle group, but no significant differences were found. The most important finding of the present study was that ACL reconstruction with the all-inside technique showed similar improvements in subjective scores and knee stability evaluated at 45 months compared with the single-bundle ACL technique. The other main subject which was widely used for reporting functional result of the clinical study. Buchner et al. reported that the Lysholm score showed very good and good results in 85% with a mean of 83.6%, and normal or near normal results on the IKDC score were reported in 85% of the patients [27]. Benea

et al. reported the results of 46 and 23 patients treated with the all-inside and other classical techniques, respectively. In that study, they found that the pain level in the all-inside group seemed lower than that in the classical group [5]. In the most recent study, Kouloumentas et al. reported the results of 90 patients randomized into two groups composed of 45 and 45 patients treated using the all-inside and conventional ACL techniques, respectively, and who were prospectively followed [25]. At 24 months, the Lysholm, IKDC, KOOS, and KSS scores between the two groups were similar. In this study, the functional scores, Tegner, VAS, and IKDC scores, were compared. Both groups showed a significant improvement in all subjective scores postoperatively. However, functional scores were not significantly different between the two groups.

The study had some limitations. First, this is a case-control study with a small number of patients. However, all patients were operated by same surgeons and followed up in the same institution. Second, information in the literature is limited, and the mean follow-up of the present study was one of the longest follow-up periods at 44 months.

5. CONCLUSION

Surgeons are still searching for advances in ACL reconstruction for better functional results. Many surgeons think that tibial fixation is the drawback of ACL reconstruction, and the all-inside ACL reconstruction technique has closed this gap. The present study found that ACL reconstruction via the all-inside technique had functionally better anterior translation results compared with the single-bundle technique with tibial interference screw fixation. However, based on the pivot shift tests, the rotational stability of the patients was similar in both groups. Although we observed better anterior translation results with the all-inside technique, prospective randomized prospective clinical trials on larger series of patients should be performed to conclude that these results have a clinical importance.

Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they have no conflict of interest.

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Informed consent: For this type of study formal consent is not required.

Ethical approval: Approval was given by the institutional review board (IRB).

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