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Short-term clinical and functional outcomes of all-inside anterior cruciate ligament reconstruction surgery

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ABSTRACT

Background: The clinical efficacy and safety of all-inside anterior cruciate ligament (ACL) reconstruction remain subjects of ongoing discussion. This study aimed to evaluate the outcomes and complications associated with this technique in patients undergoing primary ACL reconstruction.
Methods: This prospective cohort study included fifty patients presenting with a first-time traumatic ACL tear who underwent all-inside ACL reconstruction. In all cases, a Semitendinosus autograft harvested from the ipsilateral limb was prepared and used for reconstruction. Patients were followed for one year after surgery. Clinical outcomes were assessed using the International Knee Documentation Committee (IKDC) score, the Lysholm knee score, and instrumented laxity testing with KT-1000, along with clinical evaluation of the pivot-shift and Lachman tests.
Results: There was a significant improvement in Lachman and pivot-shift test scores post-operatively ($p<0.001$). The IKDC score after surgery was 96.1±7.1 (range 70-100), respectively. Based on Lysholm scoring, there were excellent knee function in 88%, 6% good and 6% fair knees. The mean side-to-side difference in tibial translation was 1.1±1 mm. Physiotherapy sessions revealed a direct positive correlation with IKDC scores ($r= 0.504$, $p<0.001$). In none of the cases was graft failure seen. 2 patients had final follow-up grade I or more tibial-creaking at the pivot.
Conclusions: The inlay allograft ACL reconstruction provides excellent clinical and objective stabilization results and low complications with good subjective scores.

Keywords: Anterior cruciate ligament, Knee surgery, All-inside reconstruction, ACL outcomes, Arthroscopic ACL repair

INTRODUCTION

An important stabilizing factor for the knee joint is the anterior cruciate ligament (ACL), which is particularly important for regulating anterior tibial translation and rotation.[1,2] People who are physically active often have ACL injuries, which usually happen when they suddenly stop, pivot, or land from a jump.[3,4] After an ACL damage, recovery usually takes six to eight months.[5,6] Nevertheless, many patients are unable to regain their prior levels of athletic ability, even with rigorous rehabilitation programs.[7] The quality of life is greatly impacted by this limitation, especially for athletes who want to quickly return to optimum function.[8] Over the past decade, ACL restoration techniques have evolved dramatically in an effort to enhance surgical outcomes and speed recovery.[9] The conventional reconstruction method usually involves creating a tibial tunnel to secure the tendon graft, but this approach can cause considerable postoperative pain due to the violation of the tibial cortex.[10]

In 1995, Morgan introduced the All-inside ACL reconstruction technique as a minimally invasive alternative to traditional methods. This approach utilizes a socket rather than a full tunnel on the tibial side and eliminates the need for a femoral incision.[11] Additionally, by preserving the gracilis tendon, the All-inside technique maintains greater knee flexion strength and medial knee stability, as the gracilis plays a role as a dynamic medial stabilizer.[12,13]

From a graft perspective, using a quadrupled semitendinosus tendon alone often yields a larger diameter compared to a combined semitendinosus–gracilis graft, since the gracilis is typically smaller in size.[14-16] These procedural modifications have been associated with decreased postoperative discomfort, improved cosmetic results, lower complication rates (such as tibial plateau fractures), faster recovery times, and more anatomical graft placement.[17,18]

The goal of the current study was to prospectively evaluate the short-term clinical results of the All-inside ACL reconstruction procedure in a consecutive series of patients who presented with solitary ACL ruptures in light of these possible benefits.

METHODS

Study design

This study was designed as a prospective cohort investigation. Between March 2017 and February 2019, 129 consecutive patients presenting to the Trauma and Orthopaedics Department of Firouzgar Hospital in Tehran, Iran, with suspected ACL injury were evaluated for eligibility.

Patients were considered suitable for inclusion if they were between 18 and 60 years of age, had a confirmed isolated ACL tear based on clinical and imaging findings, provided informed consent, and demonstrated adherence to postoperative physiotherapy and routine follow-up appointments.

Patients were excluded if they presented with multiligamentous knee injuries, had a history of previous knee surgery (n=5), were undergoing revision ACL reconstruction (n=4), elected for conservative (nonoperative) management, required additional procedures such as meniscal repair or anterolateral ligament (ALL) reconstruction, or failed to comply with regular follow-up visits. Individuals with a follow-up duration of less than one year were also excluded.

Following application of these criteria, 50 patients met the requirements and were included in the final analysis. The cohort comprised 43 males (86%) and 7 females (14%), with a mean age of 28.9±9.6 years.

Surgical technique and postoperative care

With the patient in a supine position, a lateral support post and a high thigh tourniquet were used. Standard anteromedial and anterolateral arthroscopic portals were established. The semitendinosus tendon was harvested and prepared into a quadrupled graft mounted on two adjustable-loop suspensory fixation devices, based on the technique outlined by Jones et al.[19] Only the semitendinosus autograft was used, without harvesting the gracilis tendon. The average graft diameter and length were 8.5±0.5 mm and 6.5±0.2 cm, respectively.

Anatomic landmarks at the native ACL femoral footprint guided the creation of the femoral socket using an inside-out drilling approach. The tibial socket was similarly prepared with a flip cutter aimed at the center of the ACL footprint between the anteromedial and posterolateral bundles. On average, the femoral socket depth was 20 mm, with the tibial socket length adjusted based on graft length. Socket diameters matched graft diameter.

The graft was passed through the anteromedial portal into the femoral socket using an adjustable loop device. Next, the graft was drawn into the tibial socket. Fixation was secured with suspensory buttons while the knee was positioned at 15–20° flexion with neutral rotation, applying posterior drawer force to the tibia and placing a cushion under the distal femur to encourage anterior translation.

Meticulous attention was paid to prevent soft tissue entrapment and ensure direct cortical fixation. Adequate cortical bone was preserved, and care was taken to avoid unnecessary soft tissue disruption. At the end of the procedure, a hemovac drain was placed, and standard wound closure was performed.

Postoperative protocol

All patients received a standardized rehabilitation plan. A knee brace was applied postoperatively, and partial weight-bearing with crutches was allowed from the first postoperative day for four weeks. The brace was discontinued after four weeks. Patients were permitted to bear full weight without assistive devices after six weeks.

Follow-up assessments were scheduled at 2, 4, and 6 weeks, and at 3, 6, and 12 months postoperatively.

Outcome measures

At every follow-up, clinical results and consequences were assessed. The Lachman and pivot-shift tests, which were graded using accepted grading schemes were among the stability tests.[20,21] The KT-1000 arthrometer was used to measure knee laxity in more detail; a side-to-side difference of more than 5 mm was deemed a failure.[22,23]

A goniometer was used to quantify range of motion (ROM) both prior to and following surgery. The International Knee Documentation Committee (IKDC) score and the Lysholm score, which were both given by a physiotherapist who was not involved in the procedures, were used to evaluate subjective results.[24,25]

Statistical analysis

The statistical analysis was performed using SPSS version 16 (Chicago, Illinois, USA). Data were presented as percentages, numbers, or mean±SD. The normality of the data was assessed using the Shapiro-Wilk test. Depending on the distribution, the Wilcoxon signed-rank test or the paired t-test were used to compare paired data. Between-group comparisons were made using the Mann-Whitney U test or an independent t-test. The chi-square test assessed correlations between categorical variables, whereas the Kruskal-Wallis test analyzed ordinal variables. Pearson or Spearman coefficients were employed to examine correlations. A p-value of less than 0.05 indicates statistical significance.

RESULTS

Patient characteristics

The study included 50 patients who underwent isolated All-inside ACL repair. The group's mean age was 28.9±9.6 years (range: 16–47), with 43 males (86%) and 7 females (14%). The follow-up time ranged from 16 to 30 months, with an average of 20±6.2 months. The BMI ranged from 20 to 34, with the mean being 25.9±3.2 kg/m². 54% of injuries were caused by non-contact causes, particularly during sporting activities (n=27). A thorough summary of the clinical and demographic information is given in Table 1.

Clinical stability outcomes

Lachman test

Preoperatively, 11 patients (22%) were categorized as Lachman grade 2, while 39 patients (78%) were grade 3. At the last follow-up, 18 patients (36%) had grade 1 laxity, 2 patients (4%) were still at grade 2, and 30 patients (60%) had a normal Lachman test. Anterior knee stability has improved statistically significantly ($p<0.001$).

Pivot-shift test

9 patients (18%), seventeen patients (34%), and 24 patients (48%) had pivot-shift test scores of 1+, 2+, and 3+ prior to surgery. Two patients (4%) had a grade of 1+ after surgery, while 48 patients (96%) had unfavorable results. Additionally, there was a statistically significant improvement in rotational stability ($p<0.001$).

Table 1: The clinical, demographic, and surgical characteristics of the patients who underwent all-inside ACL reconstruction surgery.

Variable	Value
Demographics	
Age (years)	28.9±9.6
Gender	Male: 43 (86%), Female: 7 (14%)
BMI (kg/m²)	25.9±3.2
Laterality	
Right	26 (52%)
Left	24 (48%)
Mechanism of injury	
Non-contact sports	27 (54%)
Contact sports	5 (10%)
Motor vehicle accident	8 (16%)
Falling down	10 (20%)
Surgical and rehabilitation data	
Operation time (min)	45.9±5.7
Physiotherapy – yes	44 (88%)
Physiotherapy – no	6 (12%)
Physiotherapy sessions	20.4±13.7

Range of motion and instrumented testing

The mean preoperative knee ROM was 119.8±23.3° (range: 70–140°), which improved significantly postoperatively to 133.6±7° (range: 100–140°) ($p<0.001$) Table 2.

According to KT-1000 arthrometer readings, the operated knee's average anterior tibial translation was 1.4±1.1 mm, while the contralateral knees was 0.3±0.29 mm. The average difference from side to side was 1.1±1 mm. According to instrumented laxity criteria, no patient showed a side-to-side discrepancy more than 5 mm, suggesting that there were no instances of procedural failure.

Subjective and functional results

The postoperative IKDC score varied from 70 to 100, with an average of 96.1±7.1. Based on the Lysholm score, 44 people (88%) had excellent, and 3(6%) good knee function. There were no cases of poor function.

Among the cohort, six patients did not attend postoperative physiotherapy. The mean number of physiotherapy sessions attended was 20.4±13.7 (range: 10–70). A significant positive correlation was found between the number of physiotherapy sessions and the IKDC scores ($r=0.504$, $p<0.001$).

Further research found a statistically significant difference in the IKDC scores. between genders: males had a mean score of 97.3±5.2, while females had a lower mean of 88.3±11.9 ($p=0.004$).

Table 2: Comparison of pre- and postoperative outcome measures in patients who underwent all-inside ACL reconstruction.

Outcome measure	Preoperative	Postoperative	P value
Lachman test			
Normal	0	30 (60%)	<0.001
Grade 1	0	18 (36%)	
Grade 2	11 (22%)	2 (4%)	
Grade 3	39 (78%)	0	
Pivot-shift test			
Negative	0	48 (96%)	<0.001
1+	9 (18%)	2 (4%)	
2+	17 (34%)	0	
3+	24 (48%)	0	
Range of motion (ROM)			
Limited rom – yes	16 (32%)	2 (4%)	0.03
Limited rom – no	34 (68%)	48 (96%)	
Knee rom (°)	119.8±23.3	133.6±7	<0.001

Postoperative complications

No patients experienced graft rupture, cortical disruption, or failure of the fixation device. One case of superficial surgical site infection occurred one month postoperatively and resolved with oral antibiotics and local care. There were no incidences of deep infection or venous thromboembolism.

At one-year follow-up, four patients reported moderate discomfort during high-demand physical activities, and one patient reported severe activity-related pain. Knee laxity was noted in two patients during final clinical examination. No other complications were reported in this cohort.

DISCUSSION

In this prospective trial, we evaluated the short-term clinical and functional outcomes of the All-inside ACL restoration approach in patients with isolated ACL rupture. A significant percentage of satisfied results was shown by the 94% of patients who had good to outstanding functional outcomes on the Lysholm scale. There were no notable intraoperative or postoperative technical problems, nor were there any instances of graft failure noted.

Among the most commonly observed postoperative complaints were activity-related discomfort in a small number of patients and mild knee laxity in two cases. Notably, only one case of superficial infection was reported, resolving without the need for surgical intervention. These results suggest that All-inside ACL reconstruction is both safe and effective in the short term, providing good stability and function.

Our results are in line with those reported by Yasen et al, who studied 108 patients undergoing All-inside hamstring ACL reconstruction with a minimum two-year follow-up. They observed significant improvements in KOOS, Lysholm, and Tegner scores and reported a side-to-side KT-1000 difference of 1.8 mm and a re-rupture rate of 6.5%.[26] In our study, the mean KT-1000 side-to-side difference was 1.1 mm, and no graft ruptures were reported, which may reflect shorter follow-up or optimized surgical techniques.

Similarly, Schurz et al evaluated 79 patients with All-inside ACL reconstruction and reported significant improvements in IKDC, Lysholm, Tegner, and visual analogue scale scores at a minimum of 24 months.[27] They had a 12.7% re-rupture rate and an average side-to-side KT-2000 difference of 1.7 mm. They proposed that increased graft failure rates could result from aiming for more anatomic graft location, such as the femoral tunnel orientation at 10 o'clock. Possibly as a result of variations in follow-up duration or technique, the current study found a decreased re-rupture rate.

A systematic review by Darren et al examined 13 studies with 526 patients undergoing All-inside ACL reconstruction and reported improved subjective and objective outcomes, especially within the first 6–12 months. The overall complication rate was 5.89%, with a graft failure rate of 2.47%.[28] These findings align with our observations of favorable short-term outcomes and minimal complications.

Volpi et al compared traditional and All-inside ACL reconstruction techniques in a pilot study and found no statistically significant differences between groups in terms of pain, function, or return to sport.[29] Although we did not include a control group for direct comparison, our findings support the view that the All-inside technique achieves results comparable to the conventional method.

Connaughton et al also reviewed differences between All-inside and standard ACL reconstruction approaches, concluding that while both techniques yield similar outcomes, concerns remain regarding a possibly higher

failure rate in the All-inside method.[30] However, in our series, no graft failures occurred, suggesting the technique, when performed meticulously, can produce excellent outcomes.

The need of systematic rehabilitation was further demonstrated by our study's conclusion that the number of physiotherapy sessions was positively correlated with higher IKDC scores. This supports the significance of post-surgical follow-up and therapy and is in line with earlier research.

Additionally, we found that patients with bigger graft diameters had higher IKDC ratings. This result is consistent with studies conducted by Mariscalco et al, who found that larger graft sizes produced better results.[31] Preoperative planning and surgical decision-making may benefit from this observation.

Study limitations

A number of constraints need to be noted. First, there was no direct comparison with preoperative state since subjective outcome measures were only evaluated after surgery. Second, the relatively brief follow-up period limited our understanding of the long-term stability of the graft. Last but not least, we omitted a control group having traditional ACL reconstruction, which would have improved the study's comparison element.

CONCLUSION

In the immediate term, all-inside ACL restoration improves objective stability measurements as well as subjective functional ratings significantly. The operation appears to be safe, with low complications and no known graft failures in this cohort. More comparison trials with longer follow-up periods are needed to establish the stability of these findings and assess whether this procedure has clear advantages over typical ACL repair methods.

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