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Research Article

Anterior Cruciate Ligament Reconstruction Using Hamstring Graft with and without Suture Augmentation: A Randomized Trial

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Abstract

Background: The anterior cruciate ligament (ACL) is a vital knee joint stabilizer with rising injury rates. Anatomic ACL reconstruction (ACLR) aims to restore the ACL to its original dimensions, collagen orientation, and insertion sites, but complete restoration may not be possible. Suture augmentation (SA) involves the use of autologous hamstring tendons with a braided ultra-high molecular weight polyester or polyethylene (UHMWPE) suture or suture tape to act as a secondary stabilizer until complete integration. This study aimed to compare the outcomes of ACLR using hamstring grafts with and without SA.
Methods: This trial was conducted at a tertiary-level health care center, with 50 patients divided randomly into two groups: 25 patients for standard ACLR (group A) and 25 patients for ACLR with SA (group B). Participants provided informed consent. Baseline clinical characteristics including range of motion (ROM), pain [Numeric Pain Rating Scale (NPRS)], and functional outcomes [Lysholm and International Knee Documentation Committee (IKDC) scores] were collected.
Results: The mean age was 25.5 years, with 96% male and 4% female participants. A statistically significant improvement was found in both groups in ROM, NPRS scores, and functional outcomes at 1 and 6 months. There was no significant difference in both groups regarding the IKDC score. Lysholm's score showed a remarkable improvement in both groups.
Conclusion: SA could be an effective technique for ACLR, with comparable outcomes to standard ACLR.

Keywords: Anterior Cruciate Ligament Injuries; Knee Joint; Anterior Cruciate Ligament Reconstruction; Sutures; Clinical Trial

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Background

The knee joint relies on two cruciate ligaments for stability, one of which is the anterior cruciate ligament (ACL) (1). As ACL injuries become more prevalent, advancements in ACL injury management are being developed to help patients return to normal activities. Anatomic ACL reconstruction (ACLR) aims to restore the ACL to its original dimensions, collagen orientation, and insertion sites, but achieving complete restoration is challenging due to the ligament complexity (2). Suture augmentation (SA), also known as internal bracing, has gained popularity as a concept for treating ligament injuries (3). Studies have shown promising results for ACLR with augmentation techniques, such as SA, but research comparing standard ACLR to ACLR with augmentation is limited (4, 5). The goal of decreasing pain, stiffness, instability, and recovery time has driven the development of new techniques, such as SA, to provide early stability and expedite post-operative recovery (6).

The ACL SA technique involves augmenting ACLR with autologous hamstring tendons using a braided ultra-high molecular weight polyester or polyethylene (UHMWPE) suture or suture tape and fixing it to both the femoral and tibial sides as a backup or secondary stabilizer until complete integration and ligamentization of the graft occur (7, 8). To further understand the effectiveness of ACLR with SA, this hospital-based study aims to compare outcomes between standard ACLR using hamstring grafts with and without SA.

Methods

The study was carried out in the Department of Orthopedics at a tertiary-level health care center, Jaipur city, to evaluate outcomes in standard ACLR using hamstring grafts with and without SA. We assessed the clinical outcomes, including range of motion (ROM), pain [Numeric Pain Rating Scale (NPRS)], and functional outcomes [Lysholm and International Knee Documentation Committee (IKDC) scores].

All participants submitted informed consent before enrolment. Twenty-five ACL tear cases were taken each for the SA group and standard ACLR group and were followed subsequently.

Inclusion Criteria: We included patients in the age group of 18 to 50 years, presenting with the clinico-radiological sign of complete ACL tear [positive Lachman test, anterior drawer test, and magnetic resonance imaging (MRI) findings] with the willingness to participate in an investigational technique and follow-up with written consent.

Exclusion Criteria: We excluded patients who had any previous surgery for knee joint or around knee joint fracture/pathology and patients having any peripheral vascular disease of the lower limb. ACL tears associated with other knee joint ligament, menisci or chondral injury, and any knee joint anatomical or pathological abnormality other than ACL tear were also excluded.

The study was approved by the Ethics Committee of SMS Medical College and Hospital. We included 50 consecutive patients and divided them randomly into two groups (computer-based randomization). Twenty-five patients were allotted to group A (standard ACLR) and 25 to group B (ACLR with SA). Baseline clinical characteristics, including patients' demographic and clinical data, were

collected. For each enrolled subject, a detailed history with personal and family medical histories was obtained.

Outcome Measures: Pre- and post-operative evaluation included ROM, average and maximum daily NPRS scores, IKDC scores, and Lysholm score.

Results

We evaluated a total of 50 patients in our study (25 in each group). The mean age in group A was 24 years and 26.5 years in group B, with 96% male and 4% female participants in both groups. The right lower limb was involved in 16 patients in group A and 12 patients in group B, and the left lower limb was involved in 11 patients of group A and 13 patients of group B. The mean duration between injury and surgery was 4.2 months.

Knee assessment was done using IKDC and Lysholm scores. Each of these scores showed a statistically significant improvement at 1 and 6 months with $P < 0.05$. The mean IKDC score in the standard group before the procedure was 46.25 ± 0.76, and after six months of follow-up, it was 53.91 ± 0.68, which was statistically significant with $P < 0.0001$. Meanwhile, the IKDC in the SA group was 45.88 ± 0.55 pre-operatively and at the 6-month follow-up was 57.16 ± 2.94, which was also statistically significant with $P < 0.001$. There was no significant difference noted between both of the groups in terms of IKDC score.

Lysholm's score also had remarkable results. This score shows the disability in routine activities encountered by the patient for knee function. There was a significant improvement in the average Lysholm score from 48.57 ± 5.18 in standard and 49.53 ± 4.21 in the SA group before the therapy to 57.20 ± 5.20 at the 6-month follow-up in standard and 61.40 ± 2.80 in SA group (Figure 1). After the final follow-up, most of the patients were able to resume their daily activities and encountered no problems in routine day-to-day life.

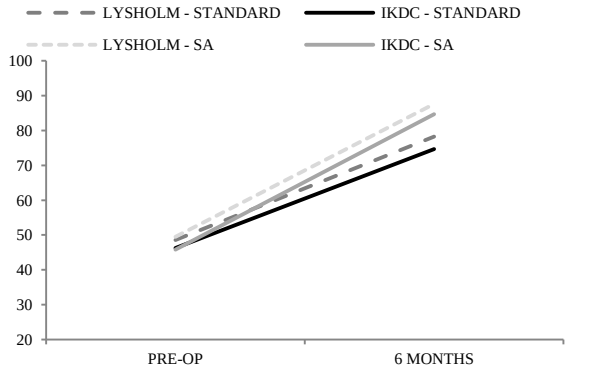

Figure 1. Comparative analysis of pre-op and follow-up functional scores in standard and suture augmentation (SA) groups –both groups statistically significant

For the assessment of pain, we used the NPRS score. For the standard group, the pre-operative NPRS score was 8.22 ± 0.76 at the beginning of therapy; it gradually fell to 7.18 ± 0.68 at the end of 1 month, ultimately reducing to just 3.86 ± 0.68 at the end of 6 months ($P < 0.001$). For the SA group, the pre-operative NPRS score was 8.28 ± 0.55 and 6.47 ± 0.46 at one month, which fell to 2.35 ± 0.42 at six months. Most of the patients had no requirement of non-steroidal anti-inflammatory drugs (NSAIDS)/painkillers in routine lifestyle and were able to put full weight on the affected knee as well. A comparative graph of the same is presented in figure 2.

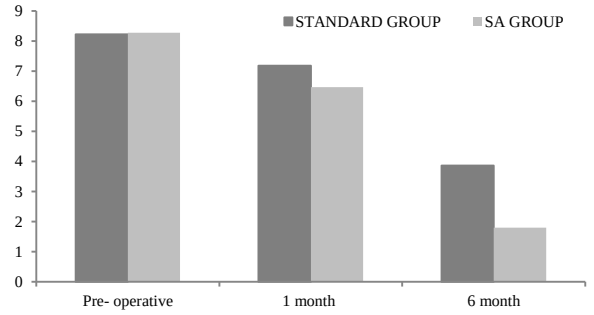

Figure 2. Comparative analysis of Numeric Pain Rating Scale (NPRS) score over time in standard and suture augmentation (SA) groups –both groups statistically significant

There were no major complications observed at the end of the study. Only a 5% extension lag was noted in nearly 80% of the cases in both groups and a 6%-10% lag in 12% of the cases of standard and 8% of the cases of the SA group at the end of the study. None of the patients reported any extension lag of more than 10% in either of the groups. Regarding the loss of flexion, two patients in standard and one patient in the SA group had nearly 25 degrees loss. There was no case of flexion loss for more than 25 degrees in any of the cases. None of the patients reported any infection or discharge from the surgical site.

Discussion

The procedure of anatomic ACLR using autografts or allografts remains a challenging task, and the fixation of the graft during the initial rehabilitation phase is a weak link (9). With hamstring autografts, there is a risk of soft tissue taking up to 12 weeks to heal, which calls for a secure fixation technique to withstand the forces during rehabilitation. The NPRS, IKDC, and Lysholm's scores showed that patients in the SA group had reduced pain and better functional outcomes compared to the standard treatment group. This finding is consistent with Bodendorfer et al.'s study, which also demonstrated improved patient-reported outcome measures, less pain, and an earlier return to pre-injury activity level with SA hamstring ACLR (10). Maximum daily NPRS and IKDC score changes from pre- to post-operation were also significantly superior in the SA group, surpassing the minimal clinically important difference (MCID). Similar to our study, Bula Ratna Kumar and Kumar evaluated the functional outcomes with the mean Tegner Lysholm knee score and observed a value of 96.07 (11). In a recent study by Kaseb et al., it was observed that there were no statistically significant differences between the autograft and allograft groups (12).

A biomechanical study using quadriceps tendon allografts in a canine model demonstrated no significant difference in force and stiffness between the native ACL and SA ACLR at six months postoperatively (13).

Another study using bovine ACLRs augmented by suture tape showed a significant decrease in graft dynamic elongation and increased failure load compared to graft alone, especially with small-diameter grafts (14). These studies suggest that SA may increase reconstruction stability, leading to improved rehabilitation and reduced deconditioning.

Recent studies have also shown that earlier return to play is associated with increased patient satisfaction, emphasizing the importance of expedited recovery time and return to pre-injury activity level (15). However, our

study had limitations, including limited sample size, the need for further follow-up to determine long-term clinical outcomes and complications, and the possibility of selection bias due to the non-blinding of the surgeon who evaluated ROM.

Conclusion

SA augmentation of ACLR increases the strength of the reconstruction and reduces pain during follow-up. While further studies are needed to validate these findings, the biomechanical and clinical evidence suggests that SA may lead to improved rehabilitation and faster return to play.

Conflict of Interest

The authors declare no conflict of interest in this study.

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