

Original Research Article

A Comparative Review on ACL Reconstruction vs Internal Brace Augmentation

Sunil Dhanger¹, Sandeep Bhinde²

¹Senior Resident, Department Of Orthopaedics, VMMC & Safdarjung Hospital, New Delhi

²Assistant Professor Department of Orthopaedics, RD Gardi Medical College, Ujjain, M.P.

ABSTRACT

Increasing knee injuries mainly of Anterior Crucial Ligament have led to the development of different surgical procedures for its treatment. ACL reconstructive surgery is the most frequently used surgery in the orthopaedic field. It is performed by either a bone-patellar tendon-bone (BPTB) or semitendinosus and gracilis tendon (STG) graft. Earlier the ACL injury was treated by reconstructing the ligament but recurrence of 2nd injury after surgery was reported. This led to the development of a suture to tie up the graft in its place which provides more knee stability and good functional outcomes. The functional outcome of the surgeries was evaluated by some outcome measures like IKDC, KOOS, Lysholm score, etc. The patients who underwent surgery were asked to perform some physical tests to evaluate the success rate of surgery. The results of these tests determined the motion, functional activity, and efficacy in sports. This review focuses on understanding the benefits of suture augmentation in combination with ACL reconstruction and also discusses the combination of these two modalities that has led to a revolutionary change in the future of ACL ligament surgery.

Keywords: ACLR, anterior cruciate ligament, grafts, knee injury

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Corresponding author : Sandeep Bhinde, MD. Email: drsandeepbhinde4280@gmail.com

INTRODUCTION

One of the most frequent knee injuries in teen athletes is the fracture of ACL ligament.^{1,2} The most commonly damaged part of the knee is the anterior cruciate ligament (ACL), responsible for around 50 percent of all injuries to the knee ligament.³ The injury is prevalent among athletes, especially females. Reasons attributed for gender-based observation include the difference in genders in neuro-muscular build and physique. The anatomical pattern of the pelvis and legs have a hormonal influence of Oestrogen. During athletic events, the numbers of accidents arise. Soccer is one of the games that have the greatest ACL injury incidence.^{4,5} The individual's response to cope-up with the injury varies when allowed to heal without any interventions. The partial nature of the injury may heal without intervention. However, it takes more than 90 days, and the symptoms may persist in many individuals. Severe injuries are the potential candidates for surgical management. The meniscus, when damaged, often demands more attention than any type of injury.

With the incidence of tearing of the ACL and the constant need for enhanced reconstructive procedures, surgeons are continuously searching for future developments in surgical techniques. While some studies have shown strong results in ACL regeneration^{6,7} utilizing allograft tissue, there is a high risk of surgical failure in younger athletes.^{8,9} Besides, the risk of an additional surgical site often prevails with autograft. The identification and rectification of this complication will be a potential therapeutic approach to enhance the reconstructive procedure for the management of used in ACL injuries.¹⁰

STRUCTURE OF ACL

The ACL is the knee's main static stabilizer against tibia-to-femur anterior translation. The ACL is a circle-shaped ligament that derives from the medial portion of the lateral femoral condyle and extends posteriorly through the intercondylar notch. The attachment's anterior surface is nearly vertical, while the posterior part is convex. In the direction of the tibia, the ligament runs distally, anteriorly, and medially. The ligament's strands move slightly to the exterior throughout the duration of its existence. The ligament averages 38 mm in length and 11 mm in width on average.¹¹

ACL RECONSTRUCTION

The most important surgical procedure performed in the orthopaedic field is the reconstruction of the Anterior Crucial Ligament (ACL). Once torn, the fan-shaped complex ACL lacks the ability to repair or regenerate by itself. With rising life expectancy and quality of life changes in developed nations, athletic standards and demand are increasing among older aged patients.^{12,13} Injured athletes forced to compete the professional game event are typically recommended for reconstructive operation. The ideal choices of the graft may include BPTB & STG.¹⁴ Many competitors suffering from injured ACLs fail to recover back to their degree of pre-injury activities successfully^{15,16} and one of the biggest explanations for this may be that athletes may not recover to their complete potential.¹⁷

SUTURE AUGMENTATION

To speed up postoperative healing, SA has been employed to establish fast stabilization before the graft integration. With aims close to ACLR, this procedure has been utilized for posteromedial corner and medial collateral ligament reconstructions and repairs, Achilles tendon repairs,¹⁸ posterior cruciate ligament avulsion fracture repairs, elbow ulnar collateral ligament repairs, and lateral ankle weakness reconstructions.

DRAWBACKS OF ACLR

While ACL reconstructions have a high progress rate, they also have a high failure rate which may contribute to chronic damage following the procedure. ACL replacement patients are unlikely to do as well as they did previous to the operation. Following treatment, the early results of ACLR showed gradual degradation. These effects were linked to comprehensive soft tissue deconstruction and cast immobilization, which resulted in a high rate of discomfort, rigidity, and dysfunction. Although ACL reconstruction improves anterior-posterior knee flexibility, there is a reduction in knee strength and work done by the muscles around the damaged knee post-operatively, indicating that donor site morbidity contributes to the changed knee kinematics found after an ACL injury, according to Kowalk et al. The number of research focused on examining gait and knee kinematics after ACL reconstruction indicates an increase in gait pattern relative to pre-surgery, but compensatory muscle usage

mechanisms continue in the number of people, suggesting sub-optimal graft results.¹⁹

MEASURES USED FOR OUTCOMES OF ACL RECONSTRUCTION

Knee-specific success tests are widely used as an assessment during knee surgery, especially during anterior cruciate ligament reconstruction surgery.

A. Anterior Posterior Knee Laxity

On both knees, anterior-posterior laxity values were calculated by a certified physical therapist with the KT-1000 Knee Arthrometer.²⁰ Three manual limit measurements were carried out and averaged the displacement readings. The gap between the legs was measured and used for the study (surgical knee-contralateral intact knee).

B. Knee Injury and Osteoarthritis Outcome Score

For the analysis of patient-reported performance, the KOOS²¹ is applied. The KOOS assesses 5 domains: quality of life linked to the knee (QOL), the role of sports and exercise, everyday living tasks, symptoms, and discomfort. On a scale varying from 0 to 100, the sub-scores were presented, with 100 showing a perfect knee.

C. ACL Return to Sport After Injury (ACL-RSI) Scale

This scale is used for the evaluation of the patient's ability to return to normal functional activities. it is an effective questionnaire that is comprised of 12 questions that include unique features, like management of risk and trust of the patient, and is related to the preparation of an athlete to get back to functional activity.²² The rating of this scale varies from 0 to 100, reflecting the status of patients who can return to their sports after assessing their score. A score of 56 or less on the ACL RSI scale has accurately defined the status of older patients who, because of psychological reasons, can struggle to get back to their sport after their surgical procedure.

D. International Knee Documentation Committee (IKDC)

An IKDC questionnaire is a quantitative scale that assesses the overall functional activity of the patient by providing scores according to the question category. The questionnaire is meant to include three categories: complaints, involvement in activities, and knee activity. Problems such as pain, fatigue, swelling, and knee giving-away appear to be assessed by the subscale of symptoms.

E. Lysholm score

It is a scale that provides 100 points rating for the evaluation of a patient's knee-specific problems, including mechanical locking, pain, discomfort, inflammation, stair climbing, knee instability, and squatting, which is the Lysholm score. Currently, the Lysholm Scale includes eight elements that are scored as given below:

ELEMENTS	SCORE
Pain	25
Instability	25
Locking	15
Swelling	10
Limping	5
Ascending stairs	10
Squatting	5
Need for support	5

On an increasing scale, any query answer has been given an arbitrary ranking. The number of each answer to the eight questions is the overall score, which can vary from 0-100. Higher scores reflect a stronger performance and fewer signs or disorders.

ACLR SURGICAL TECHNIQUE USING SUTURE TAPE²³

Graft Preparation

An anterior dissection is used to extract a normal bone patellar tendon-bone autograft using 20- to 25-mm bone plugs for autografts. Achilles' allograft with the bone block is another choice for allograft. After that, a 2-mm hole is drilled into the superior plug to scale and ready the graft (and inferior bone plugs for an autograft). Suture tape is then wrapped across the distal end of the femoral bone block and threaded through the graft with a loose needle to the intended anterior side.

Graft Passage

A normal femoral tunnel is created across the anterior medial portal, and the tibia is drilled anterogradely. The graft is then threaded into the tibial tube and fixed in the femur with an intrusion pin. The anterior medial portal's suture tape augmentation tails (initially labeled) are then recovered. After that, the graft is cycled, and the isometric point is verified. For the posterior drawer, the leg is almost completely extended.

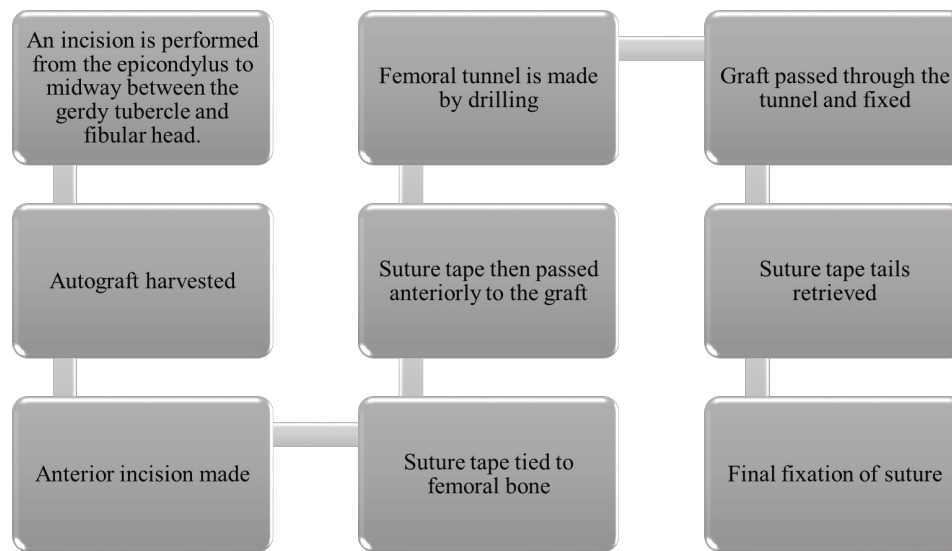


Figure 1. Depicting the surgical procedure of ACLR with SA

Suture Tape Augmentation Fixation

Crucially, during the graft, the FiberTape internal brace is clamped individually. After the allograft ACL has been placed on the tibia and fibula, the focus is shifted to the internal brace's final fixing. At this point, the knee can be tested to confirm that it has a complete scope of movement.

After the patient has shown a possibly optimally functioning quadriceps muscle and strong leg coordination, the range of movement is established using a CPM simulator, and weight-bearing is advanced as acceptable. Closed-chain strengthening is stressed, and patients are normally permitted to return to sports 6 to 9 months following surgery.

BENEFIT OF ACLR OVER SA

Due to the additional mechanical intensity, it may offer in the initial recovery and healing period, SA is presently being employed to assist ACLR. The internal brace has the added benefit of strengthening the overall build, which protects the graft during the remodeling and revascularization phase.

Strong associations among SA and better periods of recovering from preinjury activity level and percentage of preinjury activity level were found by Bodendorf et al. with a tendency toward an enhanced frequency of returning to preinjury activity level.²⁴ In table 1, the comparative results pre- and post-surgery are addressed.

The findings revealed that there were no substantial difference in –pre-operative scores among the SA and normal ACLR categories. SA had slightly higher IKDC and KOOS ratings after surgery. SA had higher comparative KOOS, ADL, and pain sub ratings, but this disparity still trended toward relevance. This showed that participants in the SA community returned to pre-injury activity levels much faster than those in the traditional ACLR group.

Biomechanical experiments utilizing SA to test ACLR have shown positive results. Cook et al. used a canine model to evaluate their theory.²⁵ Six months after treatment, the findings of a quadriceps tendon allograft with SA showed no major variations in force at fixed displacement sites or rigidity relative to the original

Functional measures	ACLR with SA	Standard ACLR	P value
Preoperative			
KOOS	48.44±13.85	49.78±12.04	.712
Pain	47.08±17.95	50.56±15.82	.429
IKDC	30.68±13.78	34.37±13.82	.385
ADL	62.74±17.30	67.58±12.15	.253
Post-operative			
KOOS	92.19±8.89	87.13±10.54	.068
Pain	94.74±9.54	89.63±8.25	.053
IKDC	87.55±14.05	73.24±20.09	.006
ADL	98.07±4.76	94.66±8.05	.073

Table 1. Comparative pre- and post-patient related outcomes

ACL. In this study, the SA showed consistent healing and no signs of osteophyte, cartilage, or meniscal abnormalities.

As opposed to graft alone, a biomechanical analysis conducted by Bachmaier et al. of bovine ACLRs supplemented by suture tape showed dramatically reduced graft dynamic elongation during load applied and enhanced failure load.²⁶ This impact was observed to be particularly powerful with grafts of limited diameter. This research also discovered that the suture tape's load-sharing role would not take control until the graft had significantly elongated, implying that the suture augment will not protect the graft from loads of low tension. These findings indicate that the SA would offer improved dynamic stabilization, particularly soon in the healing phase of the fragile graft, that may be beneficial to the recovered ACLR before the graft is secure.

On three pediatric patients, Smith et al. effectively implemented temporary usage of SA for ACL repair.²⁷ Short-term clinical progress has been shown by DiFelice et al. utilizing a SA construct to offer support for primary ACL repairs.²⁸ Interestingly, Peterson et al. observed no long-term substantial variations in return to operation or KOOS ratings between the augmented and nonaugmented ACL groups utilizing a common conceptual approach.

LIMITATIONS OF ACLR WITH SA

The primary disadvantage regarding the use of an internal brace would be the risk of over-constraining the joint and leading to loss of motion if the internal brace is too tight. For this reason, the internal brace is fixated separately from the graft and always at full hyperextension. Another concern would be potential stress shielding of the graft itself, but this also can be avoided by placing a hemostat tip underneath the FiberTape at the time of tibial fixation to build in a bit of slack with the internal brace. This ensures that the graft sees load, which is important in the tissue revascularization and remodeling process.

CONCLUSION

ACL tears can be distressing. However, the right surgical procedure can get patients walking again. In most cases, ACL reconstruction has long-term benefits.

However, there may be some cases where ACL reconstruction along with suture augmentation will be successful, with shorter recovery. Both techniques have their advantages and disadvantages. Both have equal success and failure rates. The failure rate of ACL reconstruction earlier has led to the development of SA combined with ACLR which provides more patient compliance and better player performance.

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