

REHABILITATION AND RETURN TO PLAY AFTER SINGLE-STAGE BILATERAL ACL RECONSTRUCTION: A REVIEW & CASE SERIES

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Abstract

Background & Aim: Anterior cruciate ligament (ACL) injuries are common among athletes and require surgical intervention to restore knee stability and function. Successful rehabilitation is crucial in facilitating safe and efficient return to sport. Bilateral ACL injuries, though rare, can result in significant career time loss in professional athletes. Single-stage bilateral ACL reconstruction (SBACLR) could be an efficient approach in such cases but poses unique challenges for rehabilitation. Outcomes of SBACLR and rehabilitation factors to be considered in the preoperative & postoperative phases have been inadequately researched and is the focus of the present study. **Methods:** Ten athletes with bilateral ACL injuries underwent SBACLR using hamstring (STG) or bone-patellar tendon-bone (BTB) autografts, depending on individual factors. A criteria-based postoperative rehabilitation protocol emphasising early mobilisation, progressive weight-bearing, muscle strengthening and proprioceptive exercises was administered under supervision until 18 months post-surgery. **Results:** At 18 months post-surgery, improvement in knee stability, range of motion and self-reported functional outcomes were observed in all athletes. The rehabilitation protocol facilitated gradual return to sport in less than 15 months in all athletes. **Conclusions:** SBACLR coupled with a rehabilitation protocol emphasising early mobilisation and criteria-based progression is a successful treatment option for athletes ensuring safe and efficient return to sport, with optimal outcomes in knee function, stability, and athlete satisfaction.

Keywords: Bilateral ACL tear, Bilateral ACL reconstruction, Return to sport, Rehabilitation.

1. INTRODUCTION

The anterior cruciate ligament (ACL) is one of the most important stabilizing structures within the knee joint which aids in restraining anterior tibial translation primarily, in addition to tibial torsion. The ACL is at risk of injury in athletes playing contact sports requiring sudden changes in direction, deceleration, or direct trauma to the knee. Majority of injuries have been found to be due to non-contact mechanism. Bilateral ACL injuries, though relatively uncommon (incidence: 2-4%) ¹ can significantly impair knee stability and function. In an athlete this would lead to major surgical intervention requiring extensive rehabilitation leading to loss of career time. The incidence of Bilateral ACL tears have been found to occur as two individual injuries. However, simultaneous bilateral tears also can occur which are usually traumatic ². The gold

standard management for ACL ruptures in athletes is arthroscopic ACL reconstruction (ACLR) followed by post-operative rehabilitation, progressive strength & conditioning and return to sport. Bilateral ACL injuries are traditionally managed through two staged arthroscopic reconstruction. Few studies have evaluated single stage bilateral ACL reconstruction (SBACLR), which has recently gained attention as a cost effective and time saving approach for athletes. Single stage reconstruction offers advantages such as reducing the overall time away from activities, minimizing anaesthesia and rehabilitation costs, and potentially optimizing bilateral limb symmetry³.

This review & case series aims to provide a further understanding of SBACLR and its rehab implications, by reviewing the existing literature, outlining the surgical technique, discussing outcomes and complications, and highlighting key rehab considerations.

The ACL is among the most commonly torn ligaments. This is attributable to more sports participation in all age groups across both genders. About 70-84% of ACL tears have been due to non-contact mechanism of injury during contact sports, with highest incidence in age group of 15 to 25 years¹. Risk factors for these non-contact ACL tears are multifactorial, with environmental, anatomical, hormonal, neuromuscular and biomechanical factors playing key roles¹.

The incidence of Bilateral ACL tears has been reported as 2% to 4% with injuries occurring as two separate instances¹. The mechanism of injury and risk factors for bilateral ACL injury are not as well defined/evaluated as those of unilateral injury. The risk of opposite ACL injury has been found to be greater than the risk of the primary ACL injury. The advantages and disadvantages of managing bilateral ACL tears with single-staged versus two staged ACL reconstruction are outlined in Table 1.

Table 1: Advantages and disadvantages of single stage versus two staged bilateral ACL reconstruction

Procedure	Advantages	Disadvantages
Single stage bilateral ACL reconstruction	<ul style="list-style-type: none"> • Single rehabilitation • Single exposure and risk of anaesthesia • Lower expenses due to single hospital admission • Lesser days of hospital stay • Lesser time to return to full activity, time away from career/ sport 	<ul style="list-style-type: none"> • Technically more demanding procedure • Longer surgical time • Can be performed only by experienced surgeons
Double-stage bilateral ACL reconstruction	<ul style="list-style-type: none"> • Technically lesser demanding procedure • Shorter surgical time • Easier to carry out for surgeons with lesser experience 	<ul style="list-style-type: none"> • Hospital admission required twice • Athlete has to undergo entire postop rehabilitation program twice • Exposures and risk of anaesthesia twice, for two separate procedures • Total time to return to full activity and time away from career/sport more • Greater total number of days of hospital stay and expense

This table highlights the key advantages and disadvantages of single stage versus double stage bilateral ACL reconstruction

Several studies have shown that SBACLR is a relatively safe and economical treatment option which can offer good functional results with financial benefits of up to \$3,750 per knee²⁻⁵. 15% of this was accounted by rehabilitation costs. Anaesthesia disposables, medications and surgical disposable items as required during hospital admission, are required to be bought only once making this a more economically viable option⁵.

To our knowledge, though there are currently no prospective studies or clinical trials which compare single-stage ACLR to SBACLR, there have been several case reports which compared the two and have purported SBACLR as an efficient treatment option. The reported average time of return to work was 9 weeks and to return to sport was 7 months in people who underwent SBACLR, versus eight weeks to return to work and six months to return for sport, in people who underwent unilateral ACLR. These studies also showed lesser impact to the routines of these patients and their caregivers due to having a single stretch of time away from work and for post-operative rehabilitation in SBACLR.

There is definitive literature consensus on the post-operative rehabilitation and return to play times for SBACLR. Multiple studies were found to deploy various principles of rehabilitation, sometimes with guidelines from two different surgical teams operating on each knee. Most previous studies followed an accelerated approach with range of motion exercises and isometric strengthening initiated on the immediate day after the procedure. During the 1st week non-weight bearing walking was allowed. This was progressed to assisted full weight-bearing at the end of the 1st week and later full weightbearing walking with no assistance within 6 weeks. The chief operating surgeon oversaw the rehabilitation program which was carried out under a physiotherapist. The program was based on the Bristol orthopaedic clinic ACL reconstruction rehabilitation protocol. The program allowed full range of motion (with brace in locked extension only at night) at 2 weeks, along with static cycling and resisted muscle strengthening. Return to sedentary work including driving was allowed at 1 month with weaning off the knee brace, along with progression of the resisted strengthening exercises. Manual/physical work, outdoor cycling and gym-based strengthening, jogging, recreational sports such as golf were allowed at 3 months. Return to training for contact sports such as football were allowed at 6 months.

With SBACLR showing significant advantages over two staged ACLR, the present case series could contribute to the available literature on rehabilitation considerations following this procedure.

2. MATERIALS AND METHODS

In the present study, we present a case series of ten athletes who underwent SBACLR and a list of considerations that need careful reviewing for optimum rehabilitation.

Data was collected prospectively. The study included a total of 10 athletes (9 male & 1 female, aged between 19 to 32 years) who underwent SBACLR at our institution between 2021-2022. The same surgeon assessed the patients independently clinically and radiologically using MRI (Figure 1). All patients were evaluated for eligibility, with only isolated bilateral ACL who were motivated to undergo an aggressive rehabilitation

process taken up for surgery. Patients with concomitant meniscal or collateral ligaments injury diagnosed either clinically or radiologically were excluded.

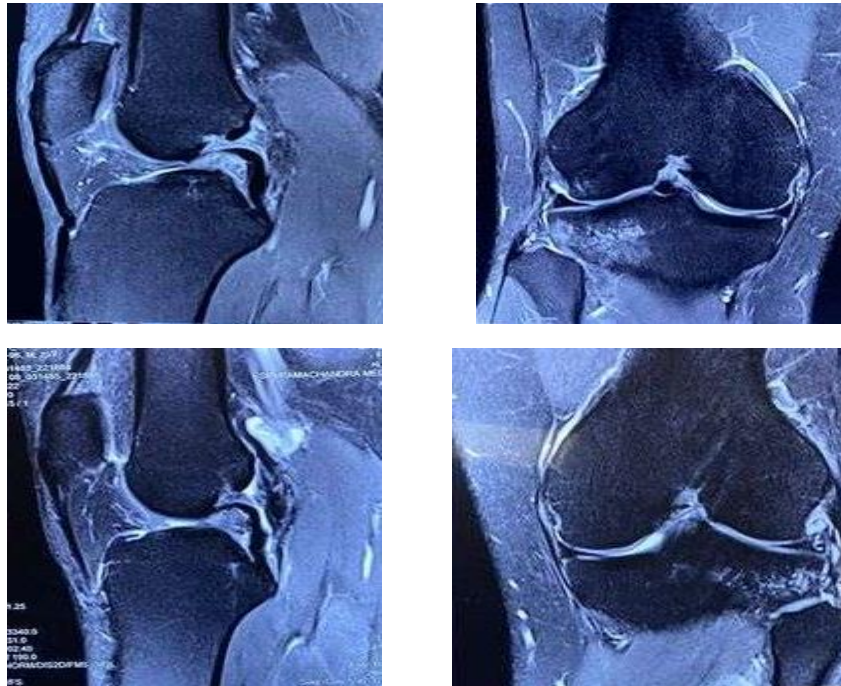


Figure 1: MRI images of isolated bilateral ACL tear

Prior to surgery, thorough assessment and evaluation of the athletes' overall physical condition, strength, and range of motion were done. Prehabilitation exercises, including quadriceps and hamstring strengthening, balance training, and proprioceptive exercises, can help optimize outcomes by enhancing muscle strength and joint stability. All surgeries were carried out by the same team of surgeons with a chief surgeon who has over 20 years experience in arthroscopic ACLR. All athletes sustained injuries to both ACL while playing sport and the injuries occurred as two separate incidents.

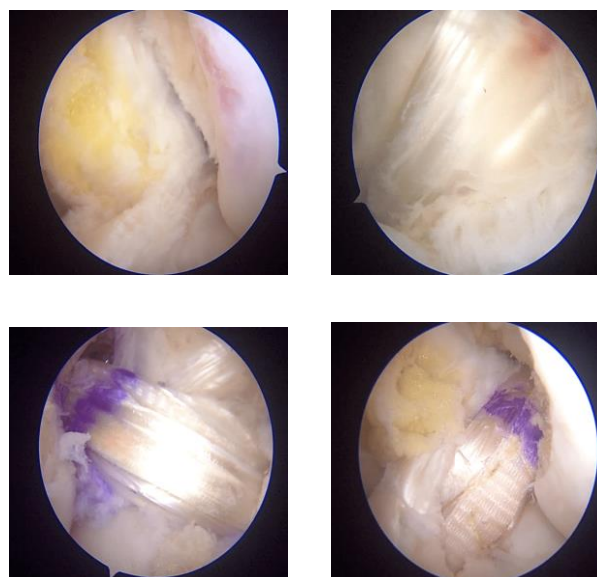


Figure 2: Arthroscopic images of SBACLR with STG grafts

All surgical procedures were performed with patient in supine position with both legs on table. After performing diagnostic arthroscopy and notch preparation, femoral tunnel was drilled at the midpoint of AM and PL bundle. Outside-in drilling was used to drill the tibial tunnel using ACL tibial guide. Semitendinosus-Gracilis (STG) grafts were harvested through a cosmetic oblique incision and fixed using an endobutton on femoral side and bioabsorbable interference screws on tibial side (Figure 2). After a 10-minute interval, the opposite limb tourniquet was inflated and the same surgical procedure was performed.



Figure 3: Rehabilitation exercises

Post operatively, ROM knee brace locked in 0° extension was applied for both knees. Patients were mobilised on full weight bearing with walker support on the next day of surgery. All patients were discharged on the following day with favourable outcomes. The rehabilitation program involved the following phases (Figure 3):

Early Postoperative Phase (Weeks 0-6): In the immediate postoperative phase, emphasis was placed on controlling pain, reducing swelling, and restoring range of motion. Initially, weight-bearing was restricted to partial weight bearing with the use of crutches. Progressive weightbearing was allowed and within 2 weeks all athletes were allowed to walk with full weight bearing, wearing the knee braces. Rehabilitation exercises during this phase involved isometric quadriceps contractions, ankle pumps, and gentle active-assisted range of motion exercises.

Mid-Phase Rehabilitation (Weeks 6-12): During this phase, focus shifted towards improving strength, stability, and neuromuscular control. Gradual progression of weight-bearing exercises, such as partial squats and step-ups, were introduced. More

functional activities including proprioceptive training were gradually integrated to simulate real-life scenarios and prepare athletes for their respective sporting movements.

Late Phase Rehabilitation (Weeks 12 and beyond): At this stage, athletes were advanced to more challenging exercises aimed at enhancing power, endurance, and sport-specific skills. Plyometric exercises, agility drills, and dynamic balance training were the essential components of this stage. A multidisciplinary team approach was used with close collaboration between the sports medicine team, sports physiotherapists, strength & conditioning trainers and sports psychologists to ensure a comprehensive approach which would result in early and safe return to sport.

Psychological Considerations: Rehabilitation following SBACLR can have significant psychological implications for athletes. The fear of re-injury, loss of confidence, and anxiety about returning to sports can impact the recovery process. We thus incorporated sports psychological support and counselling under a senior sports psychologist early into the rehabilitation program. This helped athletes navigate these challenges and facilitate a positive mindset throughout the rehabilitation phases.

Return to Sports and Normal Activities: Return to sports and regular activities should be a gradual and carefully monitored process. The final phase of rehabilitation focused on sport-specific skill training and gradually reintroducing the individual to the demands of their chosen activities. Athletes were under a monitored comprehensive strength and conditioning program under the guidance of a senior Biokineticist at our High Performance Centre. This ensured monitoring for quality of movement. All athletes were subject to a periodic Return to Sports (RTS) assessment which included sports medicine clinical evaluation, symptoms, fitness tests for mobility, stability, strength, strength-endurance, speed, balance & proprioception and Isokinetic testing. The strength & conditioning program was periodically modified based on the results of the RTS tests of individual athletes. Athletes were cleared to return to sport after achieving satisfactory results on the RTS test battery.

3. RESULTS

Activity levels using TEGNER scale, knee function by clinical assessment and IKDC scoring were used to evaluate outcomes for all athletes at 6 & 12 months post-surgery. All athletes were followed up to 18 months post-surgery. At 1 year post surgery, all 10 athletes had >90% TEGNER score and >80% IKDC score. All athletes returned to sport within 15 months post-surgery.

4. DISCUSSION

This is among the first studies from India to discuss SBACLR as a treatment option for athletes with bilateral ACL injuries. The case series and the rehabilitation protocol administered provide an insight into the factors to be considered from the pre-surgical to the return to sport phase while planning for SBACLR. The favourable outcomes of all cases who underwent SBACLR in this case series form a strong rationale for advocating SBACLR coupled with a criteria-based program as a safe and efficient method of managing bilateral ACL tears in athletes.

The incidence for Bilateral ACL tears in previous literature was estimated at 2-4%¹. Jari and Shelbourne⁶ were the first to highlight the advantages of SBACLR and reported similar functional outcomes to staged ACLR. However, this and many similar

studies reported outcomes over a short term follow up. In our case series, all functional scales showed positive outcomes following SBACLR and were followed up to 18 months post-surgery. Tegner score in our study of >90% in all our cases was comparable to another similar study evaluating SBACLR⁵, however this study did not include athletes.

This study highlights several careful considerations for the pre-operative phase. Apart from routine pre anaesthetic evaluation to plan for prolonged surgery, it is important to screen for contra-indications to performing arthroscopic procedures such as local dermatological conditions, previous arthroscopic knee surgeries, inflammatory or neoplastic diseases and concomitant knee injuries (menisci, collateral ligaments). Athletes with any of these conditions are unideal for SBACLR and have also been excluded in previous studies⁵. Prehabilitation including quadriceps and hamstring strengthening, balance training, and proprioceptive exercises which were given to all our athletes greatly optimize outcomes by enhancing muscle strength and joint stability. Similar prehabilitation exercises were given in other studies which contributed to faster RTS and better functional outcomes post operatively⁷.

Operative considerations included choice of graft, pain management in the immediate post-operative phase and intraoperative/postoperative complications. Graft choice was STG in our study based on surgeon's preference. Although previous studies have conducted SBACLR with both STG and BTB grafts, some of these studies did not use the same graft for both knees and hence comparative outcomes could not be measured⁸. These studies also used two teams of surgeons operating simultaneously, which could have led to differences in outcomes whereas our study used a single surgical team. A single team operating under a single senior chief surgeon would standardise skill sets and approaches. This may have contributed to the favourable and comparable outcomes observed in all our cases. No serious complications like thromboembolism or major anaesthetic complications due to prolonged surgery were observed in our study. There was no additional requirement of pain management dosages indicating that immediate postoperative pain is not a cause of concern following SBACLR.

In comparison to other studies^{1,4,5,7}, our study utilised a monitored rehabilitation program with focus on early mobilisation and a criteria based approach rather than a time based progression. An individualised approach contributed to better functional outcomes. The return to sports (RTS) time in our study was much larger than previous studies¹. There is presently no data available on the rate of re-tears following SBACLR if an accelerated rehab approach is adopted. Hence we adopted a criteria based rehab program and several careful considerations for RTS based on recent literature advocating delaying return to sport to prevent re-tears following even unilateral ACLR⁹.

The present case series augments previous literature and strongly suggests that SBACLR when coupled with a criteria based & monitored rehab program focusing on early mobilisation, is a suitable cost-saving and low-morbidity option for young, athletic and healthy active population with bilateral ACL injuries. This is further supported by studies which show lower RTS rates in athletes who undergo staged bilateral ACLR¹⁰.

We recognise the lower sample size of our case series and hence are unable to present statistical outcomes currently. The low sample size is attributable to the low incidence of bilateral ACL tears and the vast list of pre-operative considerations in choosing "ideal" cases for SBACLR.

5. CONCLUSIONS

SBACLR coupled with a structured rehabilitation protocol emphasising early mobilisation and criteria-based progression is a successful treatment option for athletes, ensuring economical, safe and efficient return to sport, with optimal outcomes in knee function, stability, and athlete satisfaction.

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