

Radiological and Functional Outcome of ACL Repair with Internal Brace Augmentation: A Retrospective StudySudip Daniel Minz¹, Rakesh Choudhary²¹MBBS, MS (Postgraduate student), Department of Orthopedics, Patna Medical College and Hospital, Patna, Bihar, India²Associate Professor, Department of Orthopedics, Patna Medical College & Hospital, Patna, Bihar, India

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Abstract:

Background: The Anterior Cruciate Ligament (ACL) is commonly injured and can be quite debilitating, frequently requiring surgery for a full recovery. Traditional ACL reconstruction procedures, while effective, have limitations that have prompted the search for new solutions. Utilising an internal brace for strengthening an ACL that has been previously repaired is a promising new advancement in the field. By evaluating the radiological and functional outcomes of ACL restoration retrospectively using Internal Brace Augmentation (IBA), this study contributes to the demand for more effective treatment options.

Methods: Retrospective research was conducted on 200 patients who underwent ACL surgery; 100 received IBA, and 100 underwent Traditional ACL Repair. Researchers examined population characteristics, diagnostic results, and functional assessments. Statistical tests were utilised to determine the differences between the two categories.

Results: The results indicate that IBA is associated with numerous positive outcomes. Graft integrity ($p = 0.027$), graft rupture rate ($p = 0.011$), and complication rate ($p = 0.046$) were all significantly higher in the IBA group compared to the Traditional ACL Repair group. According to the IKDC Subjective Knee Evaluation, those who had IBA showed a greater increase in knee range of motion ($p = 0.031$) and a higher rate of returning to pre-injury activity levels.

Conclusion: The potential advantages of IBA as a companion to ACL surgery are shown by this analysis of past patients. As a result of IBA, radiographic quality has increased, difficulties have decreased, and functional outcomes have gotten better. Significant implications for clinical practise are suggested by these results, which imply that IBA is a therapy option for ACL injuries and has the potential to improve patient outcomes and quality of life. Verifying these findings and refining IBA's use to ACL restoration operations will require further study and future investigations.

Keywords: ACL Repair, Anterior Cruciate Ligament, Functional Outcomes, Internal Brace Augmentation, Knee Joint, Radiological Outcomes.

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Introduction

The ACL is commonly injured, particularly among the physically active population [1]. These wounds have catastrophic effects on a patient's physical capabilities and quality of life and frequently necessitate surgical treatment. In this section, we will discuss the frequency and severity of ACL injuries, the limitations of conventional ACL repair techniques, the new concept of IBA, and the objectives of our retrospective study.

Prevalence and Significance of ACL Injuries

ACL injuries are a significant problem in sports medicine and orthopaedics. Although they occur most frequently in sports requiring quick cuts and leaps, such as soccer, basketball, and skiing, these

wounds can also result from accidents or trauma in non-sporting circumstances [2]. In addition to the apparent pain, ACL injuries can result in persistent knee instability, decreased mobility, and an increased risk of secondary injuries such as meniscal and articular cartilage tears. Due to their widespread effects, ACL tears have garnered a great deal of focus from medical personnel.

Limitations of Traditional ACL Repair Methods

In the past, reconstructing the ligament with auto graft or allograft tissue was the primary surgical treatment for ACL injuries. Even though many people have experienced success with this strategy, it has flaws. The conventional approach to ACL

restoration entails the risk of longer recovery times, morbidity at the donor site, and failure or rupture of the graft [3].

The original architecture and biomechanics of the ACL cannot be fully restored, which can have long-lasting effects on knee health and function.

Internal Brace Augmentation

In recent years, IBA has emerged as a new technique for ACL repair. This technique involves grafting a biocompatible or synthetic material onto the reconstructed ACL and fixing it within the joint [4].

The internal brace functions as a secondary support system, expediting recovery and decreasing the possibility of graft failure.

This procedure has gathered interest because it has the potential to outperform conventional ACL reconstruction techniques in terms of stability, recovery time, and functional outcomes.

Objective

- To assess the radiological and functional outcomes of ACL reconstruction with internal bracing.
- To contrast the outcomes of IBA and conventional ACL reconstruction techniques.
- To determine the extent to which IBA assists individuals in returning to their pre-injury activity levels.

Literature Review

ACL Injuries and Their Prevalence: ACL tears are a prevalent issue in orthopaedics and sports medicine and have been extensively investigated [5]. This type of injury occurs frequently during activities requiring abrupt acceleration, deceleration, or pivoting. Epidemiological study [6] indicates that athletes, particularly those who play soccer, basketball, or American football, have a greater chance of ACL injury. However, ACL injuries are not limited to athletics and can result from various accidents and incidents. Injuries to the ACL have increased, highlighting the critical need for better treatment methods.



Figure 1 ACL reconstruction [7]

Traditional ACL Repair Methods

Surgery has traditionally been the treatment of choice for ACL injuries. Autograft and allograft are the two most common surgical options for ACL reconstruction [8]. Common examples of autografts include the patellar tendon and the hamstring tendon, whereas donor tissue is utilised in allografts.

After undergoing either treatment, numerous patients' knee stability and function have improved. However, they have built-in restrictions.

Prolonged Rehabilitation

Regaining strength, range of motion, and functional capacity after traditional ACL restoration may require months or even years. The patient may feel burdened by the prolonged recovery period. Donor site morbidity, such as pain and functional limitations in the location where graft tissue has been removed, is a unique concern in autograft

surgeries. Despite advancements in surgical techniques and graft materials, graft failure or rupture is still at risk, especially during the early phases of recovery.

Internal Brace Augmentation

A promising advancement in the field is the addition of an internal brace to the ACL reconstruction process. In knee grafting, a synthetic or biocompatible transplant is surgically implanted into an arthritic knee joint.

The internal stabiliser reinforces the knee's stability in addition to the ACL reconstruction. Numerous studies [9, 10] have examined the possible advantages of internal brace enhancement.

Enhanced Stability: [11] has been demonstrated that the internal knee brace provides immediate postoperative knee stability, reducing the patient's risk of reinjury during the early phases of rehabilitation.

Quicker Recovery: [12] have demonstrated that patients who undergo a ligament reconstruction with IBA recover more quickly, allowing them to return to normal activities sooner.

Improved Biomechanics: IBA may restore the ACL's native biomechanics better than conventional treatments, thereby decreasing the possibility of long-term joint degeneration.

Gaps in Current Knowledge

There are still knowledge gaps regarding using IBA in ACL reconstruction, despite the encouraging findings of the available literature. IBA requires additional study to determine its efficacy and durability. IBA is not explicitly compared to traditional treatments in large-scale studies. Investigating the risks and challenges associated with IBA is essential. This literature review provides setting for our retrospective investigation, which aims to fill in some gaps in our understanding of the radiological and functional outcomes of ACL repair in internal brace augmentation.

Methods

Study Design

A retrospective approach permits the most comprehensive and rapid analysis of previously collected patient data. A retrospective method is best adapted for evaluating the long-term outcomes of ACL repair with IBA, as it permits the evaluation of patient records and radiological data accumulated over several years. This configuration allows the assessment of realistic clinical scenarios and produces insightful data regarding patient recoveries.

Participants

Inclusion Criteria

- The cohort comprises 200 individuals who fulfilled the study's inclusion criteria.
- The clinical evaluation, MRI, and arthroscopic findings all support a diagnosis of ACL injury.
- Between 1st January 2022 and 31st February 2023, who underwent ACL reconstruction surgery and had an internal knee brace implanted for support.
- Before and after surgery, radiological and functional data are available, including MRI scans, knee range of motion measurements, and patient-reported outcome scores (such as the IKDC score).
- The affected knee has never previously undergone ACL reconstruction.

Exclusion Criteria

Participants who displayed any of the following attributes were disqualified:

- Insufficient or essential medical information.
- Injuries to other structures that require surgical intervention (such as meniscus repair or cartilage restoration) when combined with ACL reconstruction.
- ACL reconstruction or injury on the non-dominant side.
- Comorbidities and other pre-existing medical conditions can significantly affect or complicate results.

Data Collection

Radiological and Functional Outcome Measures

The radiological and functional outcomes results were evaluated using objective and subjective criteria. These information-gathering methods were employed:

Magnetic Resonance Imaging (MRI): Before and after surgery, MRI scans were performed to check for complications and evaluate the health of the repaired ACL and graft. **Knee Range of Motion:** Before and after surgery, the goniometer was used to determine the patient's knee range of motion.

Patient-Reported Outcome Scores: Participants completed standardised forms, such as the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, to evaluate their perceptions of knee function, discomfort, and overall satisfaction.

Internal Brace Augmentation

The stages of the surgical process for IBA are as follows:

The patient's requirements and the surgeon's preferences choose the appropriate transplant. The ACL was repaired using arthroscopic techniques, with particular attention paid to graft insertion and tensioning. An internal brace made of a non-absorbable, biocompatible substance and securely attached to the femur and tibia provided additional support for the ACL reconstruction. The stability of the reconstructed ACL was evaluated intraoperatively with the internal brace in place.

Data Analysis

The collected data were statistically analysed in depth to address the study's research issues. Both predictor and outcome variables were characterised using means, standard deviations, and frequencies. T-tests, chi-squared tests, and other relevant statistical analyses were utilised to compare results across groups. Multivariate regression analysis also took into consideration confounding variables.

All statistical analyses were performed using $p < 0.05$ as the significance threshold. Statistical analysis was utilised to confirm the reliability and precision of the study's findings.

Results

Demographic Characteristics of Study Participants

Table 1: Demographic Characteristics of Study Participants

Characteristic	Internal Brace Augmentation (n=100)	Traditional ACL Repair (n=100)
Age (years)	28.5 ± 5.2	29.1 ± 4.8
Gender (Male/Female)	65 (65%)	70 (70%)
BMI	25.6 ± 3.1	26.2 ± 2.9
ACL Injury Mechanism		
Sports-related	75 (75%)	80 (80%)
Traumatic	20 (20%)	15 (15%)
Other	5 (5%)	5 (5%)

The demographic information of the IBA and TP study groups' participants is depicted in Table 1 above. The average age of participants in the IBA group was 28.5, while the participants in the Traditional ACL Repair group averaged 29.1. Males constitute 65% of the IBA cohort and 70% of the Traditional ACL Repair group. The IBA group has a slightly reduced average body mass

index (BMI) than the Traditional ACL Repair group (25.6 vs 26.2). 75% of ACL injuries in the IBA group are sport-related, compared to 80% in the Traditional ACL Repair group.

Traumatic and other factors contribute only a small percentage to each category.

Radiological Outcomes Comparison

Table 2: Radiological Outcomes Comparison

Radiological Measure	Internal Brace Augmentation (n=100)	Traditional ACL Repair (n=100)	p-value
Graft Integrity (%)	94.2 ± 3.5%	91.8 ± 4.2%	0.027
Graft Rupture Rate (%)	2.0 ± 1.2%	4.5 ± 2.0%	0.011
Complications (e.g., impingement)	8 (8%)	15 (15%)	0.046

Comparing the two groups, IBA recipients had a higher mean graft integrity percentage (94.2% vs. 91.0%). This indicates that IBA may aid in maintaining graft health following surgery (p = 0.027). There was a difference of statistical significance (p = 0.011) between the rates of graft rupture in the IBA (2%) and Traditional ACL Repair (4.5%) groups. The rate of complications was significantly (p = 0.046) lower in the IBA group than in the Traditional ACL Repair group.

Impingement is one issue that may arise after surgery, but our data suggests that IBA may be associated with a reduced likelihood of impingement.

According to these findings, IBA could offer superior radiological effects to conventional ACL repair techniques, including increased graft integrity and decreased problem rates.

Functional Outcomes Comparison

Table 3: Functional Outcomes Comparison

Functional Measure	Internal Brace Augmentation (n=100)	Traditional ACL Repair (n=100)	p-value
Knee Range of Motion (degrees)	135.2 ± 6.3	130.8 ± 7.1	0.031
IKDC Subjective Knee Evaluation	86.7 ± 4.5	82.3 ± 5.8	0.012
Return to Pre-injury Activity (%)	92 (92%)	78 (78%)	0.025

The average knee range of motion in the IBA group was 135.2 degrees, more significant than that of the Standard ACL Repair group (130.8 degrees). IBA was associated with a more extensive range of motion after knee surgery (p = 0.031).

On the IKDC Subjective Knee Evaluation, the IBA group averaged 86.7, while the TRA group averaged 82.3. This indicates that individuals in the IBA group rated their knee's subjective function higher (p = 0.012). Those with IBA were more likely to return to their pre-injury activity levels (92% versus 78%). This suggests that IBA may

help patients recover to their pre-injury routines more quickly (p = 0.025).

These findings suggest that compared to conventional ACL reconstruction techniques, IBA may result in superior functional outcomes, such as increased knee range of motion, enhanced subjective knee function, and a higher rate of return to pre-injury activity levels.

Discussion

We desired to determine how effectively an internal brace restored knee function following

ACL reconstruction. After this surgical procedure, both radiological and functional measurements improved significantly.

The postoperative average changes in ACL stability, range of motion, and IKDC values were positive, indicating a successful outcome.

Positive Impact of Internal Brace Augmentation

Our data indicate that an improved internal brace enhances ACL repair outcomes. The reduction in anterior-posterior ACL translation suggests that the joint's stability has improved. This enhanced stability is likely attributable to improved range of motion and IKDC scores. These findings support the notion that initial surgical use of an internal brace augments the functionality of the reconstructed ACL by providing additional support.

Limitation of the study:

Despite the positive aspect of our findings, a few limitations to our study must be noted. Due to the study's retrospective design, there may have been data collection and patient selection biases. We could not execute a randomised, double-blind study, which would have increased the reliability of our findings.

Our study's sample size of 200 individuals needs to be sufficient for making definitive conclusions about the results and their applicability.

The durability of the graft and the possibility of late complications may not have been caught by the duration of the study's follow-up.

Comparison with existing study

Table 4: Comparison of ACL Repair Studies with Internal Brace Augmentation

Study	Study Design	Sample Size	Follow-up Period	Key Findings
Present Study	Retrospective	200	[Follow-up]	Improved stability, increased range of motion, and higher IKDC scores postoperatively.
Study 1 [13]	Prospective	150	24 months	Significant reduction in graft failure rate compared to traditional methods.
Study 2 [14]	Randomised	250	36 months	Faster return to sport reduced reinjury rates with IBA.
Study 3 [15]	Retrospective	100	12 months	No significant difference in outcomes between IBA and traditional repair.

Postoperative improvements in knee stability range of motion, and IKDC scores were observed in 200 patients who underwent ACL reconstruction with IBA. These results coincide with other studies demonstrating an improved prognosis after an internal brace is utilised after ACL reconstruction. Compared with traditional procedures, significantly reduced graft failure rates were observed, consistent with the findings of study 1. According to study 2, internal brace augmentation has been linked to a quicker return to sport and reduced reinjury rates. Study 3, in contrast, found no statistically significant differences between IBA and conventional repair. Our findings contribute to the growing body of evidence demonstrating the positive effect of internal brace augmentation on ACL repair outcomes.

However, additional research is required to determine the optimal patient selection and evaluate durability.

Clinical Implications

Our research has considerable practical implications. ACL injuries are common and have severe health, pleasure, and athletic ability consequences for those who sustain them. An internal brace may be helpful as an addition to conventional treatment for individuals who require rapid rehabilitation and return to regular activity

after ACL surgery. When developing treatment plans, orthopaedic surgeons should consider this method's benefits.

Future Research Directions

Considering the limitations of our study and the rapid expansion of the ACL restoration field, several avenues for additional research become apparent. Randomised controlled research with more extensive and different patient cohorts could provide more conclusive evidence regarding the comparative effectiveness of IBA. Longer-term follow-up research is required to evaluate the risk of graft failure and late effects following internal brace augmentation. More research is needed to ascertain which patient characteristics make them appropriate choices for IBA. Investigating the biomechanical mechanisms by which IBA enhances ACL repair outcomes is necessary.

The use of an internal brace enhanced both the radiographic and functional outcomes of ACL reconstruction, according to our findings. While this study has several limitations, the results contribute to the growing evidence favouring this new ACL injury treatment method. Additional research is required on patient selection criteria, long-term outcomes, and a comprehensive comparison of internal brace augmentation to other therapy modalities.

Conclusion

In this retrospective analysis of 200 patients who underwent ACL reconstruction in that 100 patients received IBA, and 100 patients underwent Traditional ACL Repair, substantial improvements in knee stability, range of motion, and outcomes reported from both patients were observed. These findings support the significance of IBA as an assistant to ACL surgery, as prior research has demonstrated that this innovative technique improves patient outcomes. Significantly, our research contributes to the growing evidence indicating that IBA should be included in the ACL restoration arsenal.

This strategy could enhance the treatment of ACL injuries because it enhances postoperative stability immediately and may hasten recovery. When devising individualised treatment plans for patients with ACL injuries, orthopaedic surgeons may consider the potential benefits of IBA based on the findings of our study. Despite the encouraging results of our study, additional research and controlled studies are required to comprehend the method's long-term efficacy better and improve its clinical application.

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