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Original Research Article

Prospective Study of Anterior Cruciate Ligament Avulsion Fixation with New Surgical Technique (A Study of 50 Cases)

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Abstract

Background and Aim: Anterior cruciate ligament (ACL) avulsion fractures require prompt surgical intervention for restoring knee stability and function. This study evaluates a new fixation technique's clinical efficacy.

Material and Methods: A prospective observational study involving 50 patients was conducted at a tertiary care hospital in Rajkot. Patients underwent fixation using a novel surgical technique and were followed for one year. Clinical evaluations included IKDC scores, range of motion, and clinical tests.

Results: The study found excellent postoperative extension in all patients, with 94% achieving excellent or good IKDC scores. The majority of injuries resulted from road traffic accidents, and Type I fractures were most common. The new technique demonstrated strong performance across functional parameters.

Conclusion: The new ACL avulsion fixation method offers excellent recovery outcomes in diverse patient profiles, suggesting its suitability for routine orthopedic application.

Keywords: ACL Avulsion, Fixation Technique, IKDC Score, Functional Outcome.

Introduction

Anterior cruciate ligament (ACL) avulsion fractures represent a distinctive subtype of knee injuries in which the ligament remains intact but the bony insertion—typically the tibial eminence—is avulsed. These injuries, while more prevalent in children, are increasingly recognized in the adult population, particularly due to high-impact sports and road traffic incidents. Timely and effective surgical fixation is pivotal to restore joint integrity, prevent nonunion, and maintain knee stability and function [1,2].

Innovations in arthroscopic techniques have revolutionized ACL avulsion fixation. Suture-based methods, including the suture pull-out technique, have demonstrated favorable functional outcomes, such as marked improvements in Lysholm and IKDC scores, by enabling minimally invasive anatomic reduction with early mobilization [3,4]. Comparative studies have revealed that suture fixation may yield superior outcomes to screw fixation, with lower rates of reoperation for implant removal [5]. More recently, refined arthroscopic approaches have broadened the therapeutic arsenal. A novel suture-hook double-stranded suture technique facilitates precise anchorage through the ACL substance, enhancing fixation and recovery [6]. Complementing this, a double-row suture anchor method targeting distal soft-tissue avulsions has shown promise in effectively managing complex injury patterns [7].

Beyond arthroscopy, cost-sensitive and biologically favorable open techniques are gaining attention. A fiber-tape knotless, transosseous repair with dual tibial tunnels offers a balanced and biologic alternative, preserving ligament integrity and minimizing strangulation while being accessible in resource-limited settings [8]. Furthermore, prospective comparative research in adults confirms that both open and arthroscopic fixation methods, selected on the basis of fracture complexity and surgeon expertise, result in favorable functional outcomes, reinforcing the importance of individualized surgical planning [9]. In anticipation of the evolving surgical landscape,

early outcomes of a novel minimally invasive anchor-stitching technique—recently described in 2025—underscore the potential for rapid recovery and enhanced fixation in femoral avulsion injuries, suggesting fertile ground for innovation in tibial-side ACL avulsions as well [10].

This study, "Prospective Study of Anterior Cruciate Ligament Avulsion Fixation with New Surgical Technique (A Study of 50 Cases)", is thus designed to evaluate the effectiveness of our new surgical technique and implant, aiming to deepen understanding of ACL avulsion injuries, improve patient outcomes, and expand the surgical armamentarium.

Material and Methods

This was a prospective, observational study conducted to evaluate the real-world effectiveness and safety of a new surgical technique for anterior cruciate ligament (ACL) avulsion fixation. The prospective design allowed for the collection of real-time data, following patients from the initiation of treatment through postoperative recovery, without any alteration in standard treatment protocols. The observational nature of the study ensured that outcomes were documented as they occurred in a natural clinical setting.

The study was conducted at the Department of Orthopaedics, a tertiary care teaching hospital in Rajkot, Gujarat, India. This institution was chosen due to its advanced surgical infrastructure and robust follow-up systems, which are essential for the accurate evaluation of new surgical methodologies.

The study was carried out over a one-year period beginning in April 2023, allowing for both short-term and long-term outcome assessments.

A total of 50 patients who underwent ACL avulsion fixation using the newly developed surgical technique were enrolled in the study. This sample size was considered adequate for preliminary statistical evaluation while taking into account the feasibility of recruitment and follow-up.

Inclusion Criteria

- Age ≥18 years
- Patients diagnosed with closed ACL avulsion injuries

Exclusion Criteria

- Patients unwilling to provide informed consent
- Presence of significant comorbid conditions in the same limb (e.g., chronic arthritis, infections)
- Open ACL fractures due to differing management protocols

Patient Selection and Follow-Up: Patients fulfilling the inclusion criteria and willing to participate were enrolled consecutively. Each patient was followed prospectively for a duration of one year postoperatively. Follow-up evaluations were performed periodically to assess healing, functional recovery, and any complications.

Data Collection Procedures

- **Source of Data**: Clinical data were collected from the operating theatre records and inpatient files related to trauma surgeries.
- **Radiological Evaluation**: Sequential radiographs were taken to assess bony union, alignment, and potential complications such as non-union or hardware failure.
- **Clinical Assessment**: Functional outcomes were evaluated using the Oxford Knee Score, a validated tool assessing knee function, stability, and pain.
- **Physiotherapy Monitoring**: Progress in rehabilitation was documented through regular physiotherapy assessments to evaluate improvement in range of motion, muscle strength, and mobility.

Outcome Measures: The primary outcomes of interest included radiological evidence of fracture healing, Oxford Knee Score improvement over time, absence of complications such as hardware failure or infection, and the extent of functional recovery as observed through physiotherapy documentation.

Data Management and Statistical Analysis: Data were systematically recorded in Microsoft Excel to ensure clarity and ease of access. Descriptive statistical methods including percentages, arithmetic mean, and standard deviation were employed for data analysis. These analyses provided insights into trends in healing, complication rates, and functional outcomes following the application of the new surgical technique.

Results

Table 1 presents the age distribution of patients included in the study. The largest proportion of cases was observed in the 26–30 years age group, accounting for 40% (20 patients) of the total cohort. This was followed by the 31–35 years group (20%) and 36–40 years group (16%), indicating that ACL avulsion injuries predominantly affect younger adults in their prime working and physically active years.

The smallest group was the 46–50 years bracket, comprising only 4% of the patients, highlighting the lower incidence of such injuries in relatively older individuals. The mean age group centered between 26–35 years, reflecting a young adult

demographic as the primary target of this injury profile. Table 2 describes the classification of fracture types encountered among the patients at the time of initial injury assessment. Type I fractures were the most frequently reported, comprising 48% (24 patients), indicating a significant proportion with minimal displacement. Type II and Type III fractures were equally represented with 26% each (13 patients). This suggests that the new surgical technique was tested across a balanced spectrum of injury severities, offering comprehensive insight into its applicability for different types of ACL avulsion patterns.

Table 3 outlines the mode of injury among the patients. Road traffic accidents (RTAs) were by far the leading cause, accounting for 76% (38 patients), followed by worksite accidents (10%) and daily activity-related injuries (4%). The predominance of RTA-related injuries highlights the high-energy nature of trauma leading to ACL avulsion. It also reflects the common lifestyle and occupational risk factors relevant to the studied population, particularly in regions with higher vehicular density and occupational hazards.

Table 4 consolidates the post-operative assessment findings, including range of motion outcomes, clinical testing, and IKDC scoring. In terms of flexion range, 75% of patients showed excellent recovery, with 20% rated as good and only 4% as fair or poor. Extension range was fully restored in all patients (100%), underscoring the technique's effectiveness in maintaining complete extension post-fixation. Clinical evaluation via Lachman's test revealed excellent stability in 84% of patients, while Pivot Shift test confirmed 80% excellent outcomes. IKDC scoring also demonstrated high functional success, with 44% of patients classified as excellent and 50% as good. Only 6% fell under fair or poor categories. These findings reflect the high clinical and functional efficacy of the new surgical fixation method in restoring knee stability and mobility.

Table 1: Age Distribution of Patients

Age Group (years)	Number of Patients	Percentage (%)
18–25	5	10%
26–30	20	40%
31–35	10	20%
36–40	8	16%
41–45	5	10%
46–50	2	4%
Total	**50**	**100%**

Table 2: Fracture Type and Initial Injury Details

Fracture Type	Number of Patients	Percentage (%)
Type I	24	48%
Type II	13	26%
Type III	13	26%
Total	**50**	**100%**

Table 3: Mode of Injury

Mode of Injury	Number of Patients (%)
Road Traffic Accident	38 (76%)
Worksite Accident	5 (10%)
Daily Activity Accident	2 (4%)
Total	**50 (100%)**

Table 4: Range of Motion and IKDC Score Distribution

Examination Outcome	Excellent	Good	Fair	Poor
Range of Motion				
Flexion	38 (75%)	10 (20%)	1 (2%)	1 (2%)
Extension	50 (100%)	–	–	–
Clinical Testing				
Lachman Test	42 (84%)	5 (10%)	2 (4%)	1 (2%)
Pivot Shift Test	40 (80%)	7 (14%)	2 (4%)	1 (2%)
IKDC Score	22 (44%)	25 (50%)	2 (4%)	1 (2%)

Discussion

The findings of this study underscore the significance of selecting an appropriate surgical technique for anterior cruciate ligament (ACL) avulsion fixation to ensure optimal functional outcomes. The high proportion of patients regaining excellent range of motion, particularly full extension in 100% of the cases and excellent flexion in 75%, points to the effectiveness of the new surgical technique employed.

In addition, the IKDC scores and clinical tests such as Lachman and Pivot Shift reinforce the restoration of knee stability in a substantial majority of patients. These results are consistent with recent literature emphasizing the biomechanical superiority of rigid fixation and anatomical reduction in managing tibial spine avulsion fractures. According to Kamath et al., advanced surgical techniques using high-strength sutures or novel implants can provide improved resistance to cyclic loading and restore near-normal knee kinematics, leading to higher functional scores postoperatively [11].

Further, the demographic distribution observed in the present study, with the majority of patients being young adults aged 26–35 years, aligns with trends reported in similar studies. ACL injuries and avulsion fractures are prevalent among active individuals engaged in high-demand activities or exposed to high-velocity trauma, such as road traffic accidents, which accounted for 76% of injuries in this cohort. Almahdi et al. reported a similar demographic concentration and proposed that surgical timing, patient age, and injury mechanism are pivotal predictors of postoperative outcomes [12].

The range of fracture types also influenced surgical planning and outcomes. In our study, nearly half of the cases were classified as Type I fractures, which generally favor surgical fixation due to minimal displacement. Recent advancements in imaging and intraoperative visualization have enabled more precise classification and tailored fixation methods. Zhao et al. demonstrated that early and accurate identification of fracture type significantly enhances the efficacy of fixation techniques and reduces the incidence of complications such as non-union or arthrofibrosis [13]. Postoperative rehabilitation and physiotherapy play a critical role in maximizing the benefits of surgical fixation. The favorable results from clinical and functional assessments in this study—particularly with 94% of patients rated as excellent or good on IKDC—echo the findings of Ghafurian et al., who concluded that structured, protocol-based physiotherapy enhances ligament healing and neuromuscular recovery following ACL surgeries [14]. Incorporating early mobilization and strength training not only minimizes joint stiffness but also accelerates return to function. Finally, the observational nature of this study lends practical value by reflecting real-world outcomes outside controlled trial environments. While randomized controlled trials offer methodological rigor, prospective observational designs, as utilized here, provide insight into effectiveness under routine clinical conditions.

A recent review by Liu and colleagues emphasized the necessity of such pragmatic studies to bridge the gap between clinical trials and everyday practice, ensuring that surgical innovations translate into meaningful patient improvements [15].

Conclusion

The new surgical technique for ACL avulsion fixation demonstrated excellent clinical and functional outcomes in a majority of patients, especially in restoring full extension and achieving high IKDC scores. The technique proved effective across a spectrum of fracture types and injury mechanisms, particularly in young adults with RTA-induced injuries. These results validate the technique's application in routine orthopedic settings and highlight the importance of individualized surgical planning and structured rehabilitation in optimizing patient recovery.

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