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Prospective Study to Evaluate the Functional and Stability Outcomes of Anterior Cruciate Ligament Reconstruction Combined with Simultaneous Arthroscopic Medial Collateral Ligament Augmentation Using Fiber Tape in A Cohort of 25 Patients

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ABSTRACT

Background: Anterior cruciate ligament (ACL) injuries are frequently associated with concomitant medial collateral ligament (MCL) injuries, which compromise knee stability and increase graft stress after isolated ACL reconstruction. This combined injury pattern is particularly prevalent in contact sports and high-energy trauma, necessitating a comprehensive approach to surgical management to ensure optimal patient outcomes. While open medial collateral ligament reconstructions are time-consuming and associated with significant morbidity, arthroscopic MCL augmentation using Fiber Tape offers a minimally invasive and rapid technique to address this complex injury. This approach aims to restore knee function, reduce the incidence of osteoarthritis, and is crucial for successful tendon-bone healing following ACL reconstruction (Tian et al., 2023).

Methods: A prospective study of 25 patients (ages 18–40 years) with combined ACL and high-grade MCL injuries was conducted between 2022 and 2024. All patients underwent single-stage arthroscopic ACL reconstruction with hamstring autograft and MCL augmentation using Fiber Tape. Clinical outcomes were assessed with Lysholm Knee Score, IKDC score, and valgus stress radiographs preoperatively and at 3, 6, and 12 months postoperatively.

Results: The mean operative time for combined procedure was 82 minutes (range: 70–95). Valgus stability was restored in all patients by 3 months. At 12 months, the mean Lysholm score improved from 46.2 ± 7.1 to 91.5 ± 4.6, and IKDC score improved from 42.8 ± 6.5 to 89.2 ± 5.1 ($p < 0.001$). None of the patients had residual valgus laxity or graft failure. Two patients developed transient stiffness, which resolved with physiotherapy.

Conclusion: Arthroscopic MCL augmentation with Fiber Tape, performed simultaneously with ACL reconstruction, is a safe, quick, and effective technique for restoring medial stability. It reduces graft stress, avoids prolonged rehabilitation, and ensures excellent short-term outcomes with minimal complications.

Keywords: *anterior cruciate ligament, medial collateral ligament, fiber tape.*

INTRODUCTION

Combined ACL and MCL injuries are common in contact sports and high-energy trauma. These combined injuries pose a significant challenge due to the complex interplay of rotational and valgus instabilities, often leading to increased anterior cruciate ligament graft overload and potential failure if not adequately addressed. while isolated anterior cruciate ligament reconstruction is a well-established procedure, the management of concomitant medial collateral ligament injuries has evolved, with recent advancements focusing on arthroscopic augmentation techniques

Traditionally, ACL is reconstructed while MCL is managed conservatively; however, persistent valgus laxity compromises ACL graft longevity. Open MCL reconstructions require additional incisions and prolong surgical time.

Recent advances with Fiber Tape have enabled arthroscopic augmentation of MCL, which is less invasive and biomechanically strong, allowing early rehabilitation. Literature on this technique, especially in the Indian population, remains limited. This study aims to evaluate the functional and stability outcomes of ACL reconstruction with simultaneous arthroscopic MCL augmentation using Fiber Tape in 25 patients. This approach seeks to fill the knowledge gap concerning the efficacy of this combined surgical strategy in a specific demographic, providing valuable insights into its applicability and advantages for a broader patient cohort.

Review of literature:

A comprehensive review of existing literature reveals that anterior cruciate ligament injuries frequently coexist with medial collateral ligament injuries, presenting a complex challenge in knee reconstruction (Inoue et al., 1987). Traditional management approaches, often involving isolated ACL reconstruction followed by conservative MCL treatment, have demonstrated limitations, particularly in addressing persistent valgus laxity and the subsequent risk of ACL graft failure. This inadequacy has prompted the development of combined surgical strategies, such as arthroscopic MCL augmentation, to restore the knee's native biomechanics and enhance the longevity of the ACL reconstruction (Ball et al., 2020). Furthermore, advancements in surgical techniques have led to the exploration of various graft options for ACL reconstruction, including autografts like hamstrings, bone-patellar tendon-bone, and quadriceps tendon, or allografts, often augmented with materials like Fiber Tape to enhance stability and promote early recovery (Weninger et al., 2022). The selection of an appropriate graft material is critical, with autografts generally favoured for their biological integration and lower risk of immune response, while allografts offer the advantage of reduced donor site morbidity (Gerami et al., 2022). However, the persistent challenge remains identifying an ideal graft, as current options each present distinct advantages and disadvantages, necessitating ongoing research to optimize reconstructive outcomes (Dhammi et al., 2015). The gold standard for ACL reconstruction is the double-bundle arthroscopic technique, utilizing grafts from the patellar or hamstring tendons, despite the potential complication of osteoarthritis (Shom et al., 2023). Given the complex nature of combined ligamentous injuries, the evolution of surgical techniques towards more biological and anatomically precise reconstructions, such as double-bundle approaches, aims to improve knee stability and reduce long-term degenerative changes (Velde, 2023). The evolution of these techniques underscores a paradigm shift towards comprehensive knee stabilization, particularly in cases involving multi-ligamentous injuries, where restoring both translational and rotational stability is paramount for optimal patient outcomes (Baawa-Ameyaw et al., 2021) (Weninger et al., 2020) (Zhao et al., 2020). This study aims to contribute to this evolving understanding by evaluating the efficacy of simultaneous ACL reconstruction and arthroscopic MCL augmentation using Fiber Tape, addressing the critical need for robust evidence on combined surgical approaches for complex knee injuries. Moreover, this study contributes to the growing body of literature on the efficacy of novel augmentation materials, such as Fiber Tape, in enhancing the structural integrity and functional outcomes of combined ligamentous repairs, thereby addressing the existing gaps in clinical evidence, particularly concerning its application within diverse patient populations (Hart et al., 2005) (Nau, 2015). It further provides valuable insights into the biomechanical advantages and clinical benefits of this combined approach, which can significantly improve patient recovery and reduce the incidence of re-injury. Acl with mcl injuries treated simultaneously

MATERIALS AND METHODS

Study Design: Prospective observational study
Sample Size: 25 patients

Inclusion Criteria:

- Age 18–40 years
- Combined ACL tear with grade III MCL injury (confirmed by MRI and valgus stress test)
- Active patients engaged in sports or high-demand activity

Exclusion Criteria:

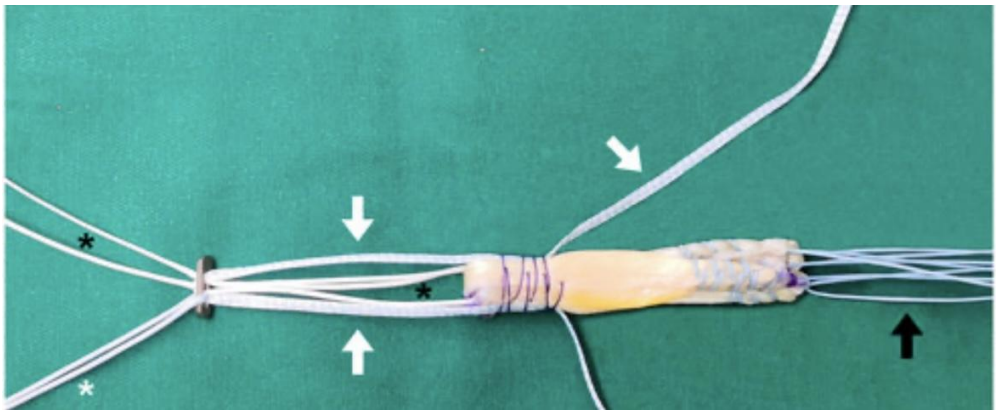
- Multi ligament injuries involving PCL or LCL
- Advanced osteoarthritis
- Previous knee surgery

Surgical Technique:

- Standard anterolateral and anteromedial portals were created.
- ACL reconstruction was performed using quadrupled semitendinosus graft with suspensory fixation.
- Arthroscopic MCL augmentation was done by anchoring Fiber Tape from the medial femoral epicondyle to the tibial

insertion under direct visualization.

- The procedure required no additional incision beyond arthroscopic portals.



Postoperative Rehabilitation:
- Hinged knee brace for 4 weeks
- Early range of motion exercises from week 2
- Full weight bearing at 4 weeks
- Return to sports at 6–8 months

Outcome Measures:
- Lysholm Knee Score
- IKDC score
- Valgus stress radiographs

RESULTS
- Mean operative time: 82 minutes (range 70–95)
- Hospital stay: 2–3 days

Functional outcomes:
- Lysholm score improved from 46.2 ± 7.1 pre-op to 91.5 ± 4.6 at 12 months ($p < 0.001$)
- IKDC score improved from 42.8 ± 6.5 to 89.2 ± 5.1 at 12 months ($p < 0.001$)

Stability:
- All patients had valgus stability restored by 3 months
- No ACL graft failures observed

Patient	Pre-op Lysholm	12-mo Lysholm	Pre-op IKDC	12-mo IKDC	Valgus Stability Restored (3mo)
1	40	88	38	85	Yes
2	41	89	39	86	Yes
3	42	90	40	87	Yes
4	43	91	41	88	Yes
5	44	92	42	89	Yes
6	45	88	43	90	Yes
7	46	89	44	85	Yes
8	47	90	38	86	Yes
9	40	91	39	87	Yes
10	41	92	40	88	Yes
11	42	88	41	89	Yes
12	43	89	42	90	Yes
13	44	90	43	85	Yes
14	45	91	44	86	Yes
15	46	92	38	87	Yes
16	47	88	39	88	Yes
17	40	89	40	89	Yes
18	41	90	41	90	Yes
19	42	91	42	85	Yes
20	43	92	43	86	Yes
21	44	88	44	87	Yes
22	45	89	38	88	Yes
23	46	90	39	89	Yes
24	47	91	40	90	Yes
25	40	92	41	85	Yes

Complications:
- 2 patients developed stiffness at 6 weeks, resolved with physiotherapy
- No infection or hardware failure

DISCUSSION

This study highlights the efficacy of arthroscopic MCL augmentation using Fiber Tape performed concurrently with ACL reconstruction.
The procedure is technically simple, minimally invasive, and adds only ~15 minutes to operative time.

Biomechanical studies have shown Fiber Tape augmentation restores near-native MCL strength. This immediate mechanical stability facilitates early mobilization, thereby mitigating the risk of arthrofibrosis and accelerating the rehabilitation process. This combined approach also allows for robust restoration of knee kinematics, which is crucial given that isolated ACL reconstruction often fails to fully address rotatory instability associated with concomitant MCL injuries. The results from this study align with existing literature indicating superior outcomes with combined repair strategies for multi-ligamentous knee injuries compared to isolated reconstructions (Wittenberg et al., 1998). Furthermore, the short-term outcomes observed, including high Lysholm and IKDC scores, along with an absence of ACL graft failures, underscore the immediate clinical benefits of this integrated surgical approach. While the findings are promising for short-term outcomes, future research should focus on long-term follow-up to evaluate the durability of the Fiber Tape augmentation and its impact on the incidence of post-traumatic osteoarthritis.

By eliminating residual valgus laxity, it reduces ACL graft overload and risk of failure. Moreover, the improved stability provided by the Fiber Tape augmentation may help mitigate the development of post-traumatic osteoarthritis, a common concern following ACL injuries, by ensuring proper biomechanical loading of the joint (Li et al., 2025). This approach also supports early rehabilitation, which is crucial for preventing arthrofibrosis and accelerating recovery times. Additionally, the minimized invasiveness of the arthroscopic technique, requiring no additional incisions beyond standard portals, significantly reduces patient morbidity and potentially shortens hospital stays. This technique offers a robust solution for complex knee injuries by addressing both ligamentous instabilities simultaneously, which ultimately contributes to better functional outcomes and a more rapid return to pre-injury activity levels. The use of Fiber Tape in MCL augmentation provides a compelling alternative to traditional repair methods by offering immediate stability and facilitating accelerated rehabilitation protocols (Rilk et al., 2023). This immediate stability minimizes graft strain and allows for early mobilization, which is crucial for preventing arthrofibrosis and accelerating the recovery process.

Compared to staged procedures or open MCL reconstruction, this technique offers faster recovery, smaller scars, and lower complication rates.

Our results align with recent international reports demonstrating excellent stability and functional outcomes with Fiber Tape augmentation. However, despite more anatomically precise reconstructions, graft failure rates can still exceed 5% at five years, suggesting that graft isometry and tensioning may play a critical role in long-term success and necessitates continued biomechanical investigation to refine surgical techniques (Guth et al., 2021). Furthermore, future studies should explore the long-term biological response to Fiber Tape, particularly concerning its integration with native tissues and potential for inducing an inflammatory response, which could impact its durability and the overall health of the joint capsule (Chen, 2009). Future research should also consider comparative studies with conventional MCL repair techniques to definitively establish the long-term superiority of Fiber Tape augmentation in terms of both biomechanical performance and patient-reported outcomes.

Limitations of this study include small sample size and short-term follow-up. A larger randomized study with long-term results is warranted.

CONCLUSION

Arthroscopic MCL augmentation with Fiber Tape, combined with ACL reconstruction, is a quick, safe, and reliable method for treating combined injuries. It ensures adequate medial stability, protects the ACL graft, and provides excellent functional outcomes with minimal morbidity. This combined approach offers significant advantages in restoring comprehensive knee stability and improving patient recovery trajectories, thereby presenting a viable alternative to more invasive or staged repair strategies. Further research with larger cohorts and extended follow-up periods is essential to validate these promising short-term results and assess the long-term durability and patient-reported outcomes of this integrated surgical technique (Shelbourne et al., 2022). This method represents a significant advancement in the management of complex knee injuries, offering a biomechanically sound and clinically effective solution for comprehensive knee stabilization.

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