



Original Research Article

Functional outcome of arthroscopic reconstruction of anterior cruciate ligament using tightrope with endobutton and interference screw

Christina Boda^{1*}, Sanjay Mattam², Maheshwar Lakkireddy¹,
Deepak Kumar Maley¹, Ravi Kumar¹, Tadikonda Adinarayana Kashyap¹,
Sreedhar Sathu¹, Srikanth Eppakayala¹

¹Dept. of Orthopaedics, All India Institute of Medical Sciences, Hyderabad, Telangana, India

²Dept. of Orthopaedics, MNR Medical College, Sangareddy, Telangana, India



ARTICLE INFO

Article history:

Received 01-04-2023

Accepted 08-08-2023

Available online 07-12-2023

Keywords:

Anterior cruciate ligament injuries

ACL reconstruction

Knee instability

Hamstring tendon

ABSTRACT

Anterior Cruciate Ligament (ACL) injuries are one of the most commonly occurring ligament injuries in and around the knee joint. ACL gets torn easily and has a poor capacity for intrinsic repair. Anterior knee instability associated with ACL rupture is a disabling clinical entity. The current study has been designed to analyze the post-operative outcome of arthroscopically reconstructed ACL using a quadrupled autograft of semitendinosus and gracilis tendon which is fixed with an endo button on the femoral side and an interference screw on the tibial side. This was a prospective open label non-randomized interventional study. Subjects of both genders between 15 to 45 years presenting with an isolated ACL tear at M.N.R. Medical College & Hospital, Sangareddy, Telangana between June 2018 to May 2020 were included. Subjects were assessed for functional outcome and complications of arthroscopic ACL reconstruction. All the subjects were evaluated pre and post-operatively using clinical tests, the International knee documentation committee (IKDC) score, Lysholm Gilquist Score (LGS), and single leg hop test. A comparison between IKDC and LGS scoring was done to assess the functional outcome. An excellent outcome has been seen in 56.6%, a good outcome in 36.67% and 6.67% had a fair outcome using the LGS system. All three scoring systems showed a very high correlation as displayed by the Kendal-tau values ranging from 0.647 to 0.923. The pre-injury activity level was achieved in 97% of patients in a period of four to six months following strict rehabilitation protocol. The functional outcome of ACL reconstruction with quadrupled semitendinosus plus gracilis tendon autograft using a tightrope with endo-button and interference screw on femoral and tibial sides respectively is excellent to good (90%) with mild laxity noted objectively at the end of 6 months.

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

Anterior Cruciate Ligament (ACL) injuries are one of the most common knee injuries accounting for more than 50%.¹ The Anterior Cruciate Ligament is the weakest ligament out of the two cruciate ligaments and thus may get wounded easily than the Posterior Cruciate Ligament.²

There are several authors who have identified successful reconstruction of the ACL with the use of autograft such as patellar tendon, hamstring tendon, or quadriceps tendon and allograft like Achilles tendon, Patellar tendon, Hamstring tendon, or Tibialis anterior tendons. Anterior Cruciate Ligament Reconstruction has been previously tried by using Silver wire, Fascia lata and Iliotibial band.^{3–5} Thus far, more than 400 various techniques have been attempted for ACL Reconstruction from open surgical methods to arthroscopic

* Corresponding author.

E-mail address: dr.christinaboda@gmail.com (C. Boda).

techniques.⁶ In 1954, the development of a successful arthroscope has brought wide range of possibilities in the field of knee surgeries.⁷ Following 1982, Anterior Cruciate Ligament Reconstructions were thereon been performed arthroscopically.⁸ Arthroscopic ACL Reconstruction has given the advantage of being minimally invasive, accurate graft placement, minimal soft tissue injury resulting in early recovery and rehabilitation, decreased hospital stay, and a very less infection rate. The cells present within the hamstring tendon graft have the ability to survive successfully after intra articular implantation, as the synovial fluid helps in its nourishment and doesn't require extra vascularity for its viability.⁹ Reconstruction using quadrupled hamstring tendon autograft fixed with an Tightrope with Endo button and interference screw on femoral and tibial sides respectively is analyzed in this study.

2. Materials and Methods

This is a prospective open label non-randomized interventional study conducted on 40 patients who have presented to M.N.R. Medical College & Hospital, Sangareddy, Telangana with an isolated ACL tear between June 2018 to May 2020. The subjects were assessed for the functional outcome and complications following arthroscopic ACL reconstruction.

All male and female patients in the age group of 15 to 45 years presenting with a complete ACL tear confirmed by an MRI scan and concomitant meniscal injuries were included in the study. Patients with associated PCL/MCL, LCL or posterolateral corner injuries of the ipsilateral knee and patients undergoing revision ACL reconstruction were excluded from the study.

The patients usually present with a history of giving away or hearing of a pop in the injured knee. The majority of the patients complain of instability of the knee, especially while using stairs and on uneven ground. Clinical diagnosis was made after performing Lachman's test, anterior drawer test, pivot shift test, posterior drawer test, valgus/varus stress test, and McMurray's test (Figure 1). MRI was performed to confirm the diagnosis (Figure 2). Reconstruction of torn ACL in the acute phase may be delayed until the swelling completely subsides and a full range of motion of the joint is attained with physiotherapy in order to prevent stiffness and loss of range of motion of knee.^{10,11}

The arthroscopic ACL reconstruction was performed in all patients under spinal anesthesia. Clinical examination such as pivot-shift test was conducted for every case before surgery under anesthesia. All the cases were prepared pre-operatively with a prophylactic dose of antibiotic administered one hour before starting the surgery. The patient is positioned supine with thigh well-padded and tourniquet applied, the operative area was prepped and draped followed by landmarks for making portals. High



Figure 1: Clinical tests– **A):** Lachman's test. **B):** Anterior drawer test

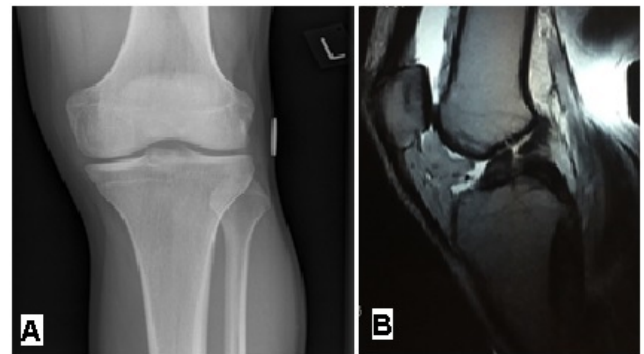


Figure 2: **A):** Radiograph of Left knee Anteroposterior (AP) view of a patient with an ACL injury; **B):** T2 weighted MRI of the left knee joint of the same patient with buckling of ACL fibers showing mid-substance tear of ACL

lateral and medial portals were placed and diagnostic arthroscopy was performed as per the 'W' maneuver. An incision of 3-4 cm is taken over the leg approximately 5cm below the joint line and 3cm medial to tibial tuberosity. It is essential to identify the palpable gracilis and semitendinosus tendons 3 to 4 cm medial to Sartorius tendon insertion and short incision is given in a hockey stick fashion. Semitendinosus tendon and gracilis were released from their insertion by pulling forward with a curved clamp or mixtar. After confirming the absence of any fibrous bands, the tendons are released proximally by controlled tension with an open-end tendon stripper to prevent it from folding over and being cut off short. The harvested graft of approximately 28cm in length is prepared for pre-tensioning and control of the tendon (Figure 3). The tendon is folded into four segments with equal length and the ends are tied with No. 2 ethibond sutures. Prepared grafts were passed and secured using a standard technique where the threads of the endo button are pulled by flipping and finally the femoral fixation is confirmed by toggling of the endo button. The tibial side of the graft is fixed with an interference screw of appropriate size after cycling maneuver. Graft inspection was done by Lachman's test to ensure the stability of the graft. Skin closed with staples under aseptic compression dressing. Post-operative X-rays are done to confirm the placement of endo button and interference screw (Figure 4).

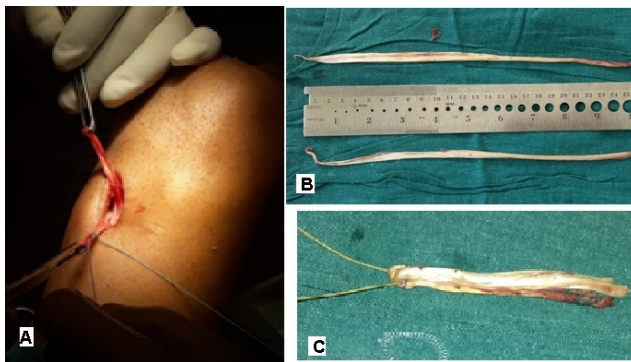


Figure 3: A): Harvesting the graft; B): Measuring the graft after removing muscle from tendon; C): Preparing it into quadrupled graft of required size



Figure 4: Post-operative radiographs of the right knee showing endo button on the femoral side and interference screw on the tibial side; A): AP view; B): Lateral view

The selected cases underwent arthroscopic ACL reconstruction with quadrupled semitendinosus tendon autograft and were given Wilk et al, rehabilitation protocol¹² for a period of six months from postoperative day one. Results were evaluated periodically at 16 weeks, 20 weeks, and 24 weeks. All patients were advised a rehabilitation protocol with three intervals i.e., 0 to 2nd post-operative day (POD), 3rd to 14th POD, two weeks to four weeks POD. Patients were followed up regularly upto six months with three-month intervals. Post operative complications like anterior knee pain (continuous and intermittent), numbness, superficial and deep infections, joint effusion were assessed.

None of the patients were lost to follow up and all of them were evaluated clinically using tests for stability and also by using Lysholm Gilquist score at six weeks, three months and nine months. International knee documentation committee score (IKDC) and single leg hop test was done pre-operatively and post-operatively.

Single Leg Hop test: The subjects after six months were asked to hop from a starting line and each limb hopping distance and maintenance of landing for minimum two seconds were recorded (Figure 5).

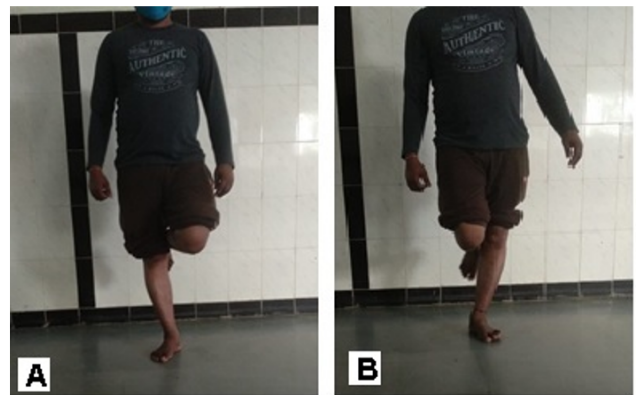


Figure 5: Postoperative images of subjects performing single leg hop test after 6 months of rehabilitation protocol; A): Subject standing on operated knee; B): Standing on normal knee

Lysholm Gilquist Score is a questionnaire containing eight domains namely limp, locking pain, usage of stairs, walking aids, instability, swelling and squatting to give information about knee getting affected in daily life activities.¹³ Score of 0 to 100 is calculated.¹⁴ (Table 1).

Table 1: Lysholm gilquist score

Score >90	Excellent outcome
Score 84 to 90	Good Outcome
Score 65 to 83	Fair Outcome
Score <65	Poor Outcome

IKDC Score (of 100) provides a set of questions upon the symptoms, sporting activities and functions to assess the stability of knee.

$$IKDC\ Score = \left[\frac{\text{Sum of Completed Items}}{\text{Maximum Possible sum of completed items}} \right] \times 100$$

This method of scoring by using the IKDC Subjective Knee Form is considered more accurate than the original scoring method.

2.1. Statistical analysis

The statistical analysis was done using SPSS 17.0 software package (SPSS, Inc., Chicago, Illinois) for the analysis. Descriptive statistics are reported in the study as mean, median, minimum, maximum, and standard deviation. The differences of means were calculated by the analysis of variance (ANOVA). Chi-square test were utilized to assess the association between two variables. Comparison of the group means were done using independent T test. A probability value of less than 5% was accepted statistically significant.

3. Results

The total number of patients in the study was 40. 37 were male patients (92.5%) and three were female (7.5%) and all were aged between 15 and 45 years. 62.5% [n=25] patients had right knee injury while 37.5% [n=15] injured their left knee. The duration of surgery ranged between 95 minutes to 140 minutes with a mean of 109.5 minutes.

Upon evaluating the patients during the follow-up using IKDC, LGS, SQ & single hop test, 90% of the patients were observed to have excellent to good results. 87% of the patients who were operated were able to return to their pre-injury level of activity.

The interval given from the time of injury to surgical reconstruction varied between 1 1/2 months and 2 1/2 years with a mean value of 6.6 months. The length of the surgery lasted about 95 to 140 minutes with a mean of 109.5 minutes. Post operative complication sensus showed only five patients (12.5%) had pain at the graft donor site, one patient (2.5%) had numbness around the graft donor site which gradually resolved completely and 15 patients (37.5%) had laxity up to grade 1 and despite this, the Lachman test had a hard end. Three patients (7.5%) had superficial skin infections with delayed wound healing.

4. Discussion

The injured anterior cruciate ligament (ACL) if not managed effectively can eventually lead to knee instability, which can be severe with possible long-term consequences.¹⁵ Multiple-stranded hamstring tendon graft used in ACL reconstruction as portrayed by several studies said to have better strength, stiffness, and cross-sectional area compared with patellar tendon grafts.^{16,17}

A study of femoral hamstring graft fixation with tightrope and endo button has been shown to have excellent initial mechanical properties, including pullout strength.¹⁸

A calculable results towards better outcome has been noticed with injury to the dominant leg when assessed using three scoring systems, although it was insignificant.

Among the athletes (n=34), 23 were into competitive sports while others were involved in recreational sporting activities. 27.5% of subjects were from the farming community and 15% had sedentary lifestyle. Once the regular daily activities of walking, squatting, and climbing stairs were reinitiated following the rehabilitation protocol for six months, it was observed in the further study that adherence to physiotherapy for most of these patients gradually waned and discontinued.

In 2003, Fareed H et al¹⁹ and in 2005 Button K²⁰ has detailed the results of patients who underwent arthroscopic ACL reconstruction in a retrospective study. These results were compared with the present study as depicted in Table 2.

In the LGS system, 52.5% [21 patients] had an excellent outcome while 37.5% [15 patients] had a good outcome and

Table 2: Comparison of Fareed et al, K Button et al, and present study results

	Fareed H et al¹⁹ (2003)	K Button & Others²⁰ (2005)	Present study
No. of patients	25	48	40
Average follow up	25.4 weeks	20 weeks	24 weeks
IKDC Normal	12 (48%)	26 (54%)	24 (60%)
Near normal	12 (48%)	18 (38%)	11 (27.5%)
Abnormal	01 (4%)	04 (8%)	05 (12.5%)

10% [4 patients] had a fair outcome. In like manner, 62.5% [25 patients] have responded as “very satisfied” and 37.5% [15 patients] “satisfied” to the subjective questionnaire that was used for the study. This could be in probability to the fact that most of the patients were keener to return to their regular daily activities than returning to sports. There is a high correlation between the three scoring systems as proved by Kendal – tau values varying between 0.647 and 0.923. Theoretically, the statistics showed to be highly significant with p value 0.000-0.0001. 87.5% (35 subjects) of the patients were able to return to the pre-injury activity level.

Comparison of this study results with Andrea Reid et al²¹ & Gulick TD²² studies who published their results of a series of hop tests on subjects who had undergone ACL reconstruction can be seen in Table 3.

Table 3: Comparison of results of present study with Andrea Reid et al.²¹ & Gulick TD²² studies

	Andrea Reid et al.²¹ study, 2007	Gulick TD²² study, 2002	Present study
Number of patients	42	57	40
Average age	26 years	27 years	29 years
Rehabilitation protocol	4 – 6 months	4 – 6 months	4 – 6 months
Hop test- Mean Limb Symmetry	88.2 +/- 9.5 (63.8 – 103.2) At 22 weeks	-	83.503 +/- 3.65 (66.36–93.33) At 24 weeks
Laxity Up to Grade 1	72%	74.6%	37.5%
Return to the prior level of function	-	84%	87.5%

Gulick TD in 2002 concluded that 84% of their patients returned to the pre-injury level of function while in the present study, 87.5% have returned to their pre-injury level of functions. In conclusion, the timespan between the injury to the ACL reconstruction ranged from 1&1/2 months to 2 & 1/2 years with a mean value of 6.6 months. Five patients (12.5%) had pain at the graft donor site. One patient (2.5%) had numbness around the graft donor site which gradually resolved completely. 15 patients (37.5%) had laxity up to grade 1.

5. Conclusion

The functional outcome of ACL reconstruction using quadrupled semitendinosus with gracilis tendon autograft using tightrope with endo button and interference screw on femoral and tibial sides respectively is excellent to good (90%) with minimal grade 1 laxity at the end of six months.

6. Limitations

Single center, non-randomized, small cohort study with six months follow up.

7. Source of Funding

None.

8. Conflict of Interest

None.

Acknowledgment

No benefits in any form have been received from any commercial party related directly or indirectly to the subject in this manuscript.


References


- Petersen W, Zantop T. Anatomy of the anterior cruciate ligament with regard to its two bundles. *Clin Orthop Relat Res*. 2007;454:35–47.
- Petersen W, Tillmann B. Anatomy and function of the anterior cruciate ligament. *Orthopade*. 2002;31(8):710–8.
- Clancy WG, Ray JM, Jackson DW, Drez D. Anterior cruciate ligament autografts. The anterior cruciate deficient knee. St. Louis: CV Mosby; 1987. p. 193–210.
- Petersen W, Unterhauser F, Pufe T, Zantop T, Südkamp NP, Weiler A. The angiogenic peptide vascular endothelial growth factor (VEGF) is expressed during the remodeling of free tendon grafts in sheep. *Arch Orthop Trauma Surg*. 2003;123(4):168–74.
- Tena-Arregui J, Barrio-Asensio C, Viejo-Tirado F, Puerta-Fonollá J, Murillo-González J. Arthroscopic study of the knee joint in fetuses. *Arthroscopy*. 2003;19(8):862–8.
- Odensten M, Gillquist J. Functional anatomy of the anterior cruciate ligament and a rationale for reconstruction. *JBJS*. 1985;67(2):257–62.
- Anderson AF, Dome DC, Gautam S, Awh MH, Rennirt GW. Correlation of anthropometric measurements, strength, anterior cruciate ligament size, and intercondylar notch characteristics to sex differences in anterior cruciate ligament tear rates. *Am J Sports Med*. 2001;29(1):58–66.
- Duthon VB, Barea C, Abrassart S, Fasel JH, Fritschy D, Ménétrey J. Anatomy of the anterior cruciate ligament. *Knee Surg Sports Traumatol Arthrosc*. 2006;14(3):204–13.
- Amiel D, Kleiner JB, Akeson WH. The natural history of the anterior cruciate ligament autograft of patellar tendon origin. *Am J Sports Med*. 1986;14(6):449–62.
- Harner CD, Irrgang JJ, Paul J, Dearwater S, Fu FH. Loss of motion after anterior cruciate ligament reconstruction. *Am J Sports Med*. 1992;20(5):499–506.
- Almekinders LC, Moore T, Freedman D, Taft TN. Post-operative problems following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 1995;3(2):78–82.
- Wilk KE, Arrigo CA. Rehabilitation principles of the anterior cruciate ligament reconstructed knee: twelve steps for successful progression and return to play. *Clin Sports Med*. 2017;36(1):189–232.
- Tegner YE, Lysholm JA. Rating systems in the evaluation of knee ligament injuries. *Clin Orthop Relat Res*. 1976;198:43–9.
- Mitsou A, Vallianatos P, Piskopakis N, Maheras S. Anterior cruciate ligament reconstruction by over-the-top repair combined with popliteus tendon plasty. *J Bone Joint Surg Br*. 1990;72(3):398–404.
- Ageberg E. Consequences of a ligament injury on neuromuscular function and relevance to rehabilitation - using the anterior cruciate ligament-injured knee as model. *J Electromyogr Kinesiol*. 2002;12(3):205–12.
- Chouliaras V, Ristanis S, Moraiti C, Stergiou N, Georgoulis AD. Effectiveness of reconstruction of the anterior cruciate ligament with quadrupled hamstrings and bone-patellar tendon-bone autografts: an in vivo study comparing tibial internal-external rotation. *Am J Sports Med*. 2007;35(2):189–96.
- Chen L, Cooley V, Rosenberg T. ACL reconstruction with hamstring tendon. *Orthop Clin North Am*. 2003;34(1):9–18.
- Barrett GR, Papendick L, Miller C. Endobutton button endoscopic fixation technique in anterior cruciate ligament reconstruction. *Arthroscopy*. 1995;11(3):340–3.
- Fareed H, Dionellis P, Paterson FW. Arthroscopic ACL Reconstruction using 4 strand hamstring tendon graft. *J Bone Joint Surg*. 2003;85:231–6.
- Button K, Deursen RV, Price P, Rosenbaum D. Measurement of functional recovery in individuals with acute anterior cruciate ligament rupture. *Br J Sports Med*. 2005;39(11):866–71.
- Reid A, Birmingham TB, Stratford PW, Alcock GK, Giffin JR. Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Phys Ther*. 2007;87(3):337–49.
- Gulick DT, Yoder HN. Anterior cruciate ligament reconstruction: clinical outcomes of patella tendon and hamstring tendon grafts. *J Sports Sci Med*. 2002;1(3):63–71.

Author biography

Christina Boda, Senior Resident  <https://orcid.org/0009-0007-3274-5866>

Sanjay Mattam, Professor  <https://orcid.org/0009-0005-0387-4605>


Maheshwar Lakkireddy, Professor & HOD  <https://orcid.org/0000-0002-3700-1125>

Deepak Kumar Maley, Assistant Professor  <https://orcid.org/0000-0003-3436-1704>

Ravi Kumar, Assistant Professor  <https://orcid.org/0000-0001-7637-2482>

Tadikonda Adinarayana Kashyap, Senior Resident  <https://orcid.org/0009-0002-8551-3763>

Sreedhar Sathu, Senior Resident  <https://orcid.org/0000-0001-7736-7992>

Srikanth Eppakayala, Senior Resident  <https://orcid.org/0000-0002-6159-0732>

Cite this article: Boda C, Mattam S, Lakkireddy M, Maley DK, Kumar R, Kashyap TA, Sathu S, Eppakayala S. Functional outcome of arthroscopic reconstruction of anterior cruciate ligament using tightrope with endobutton and interference screw. *Indian J Orthop Surg* 2023;9(4):217-222.