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## Functional outcome in arthroscopic anterior cruciate ligament reconstruction by suspensory fixation in comparison with aperture fixation method

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### Abstract

**Background:** Arthroscopic anterior cruciate ligament (ACL) reconstruction with suspensory and aperture fixation methods has been proposed to recreate the natural anatomy of ACL. Reconstruction of the anatomy of the ACL has been thought to be able to restore the rotational stability of the knee joint. Nevertheless, it remains unclear whether the suspensory fixation method has a better functional outcome than the aperture fixation method.

**Aim:** To assess the clinical outcome of Arthroscopic ACL Reconstruction using suspensory fixation and aperture fixation methods.

**Methods:** We prospectively followed 40 patients with an isolated ACL injury operated for ACL reconstruction after applying the inclusion and exclusion criteria. Patients were evaluated pre-operatively and in the post-operative period at regular intervals with the minimum follow up of 6 months. Functional outcome was evaluated by the Modified Lysholm knee score. Clinical stability was assessed by Lachman, anterior drawer, and pivot shift tests.

**Results:** Functional outcome in terms of Lysholm score was satisfactory at the end of six months with both suspensory and aperture fixation methods. Graded stability results of the Lachman, anterior drawer and pivot shift tests were almost near to that in the normal knee with both the methods.

**Conclusion:** ACL reconstruction by suspensory and aperture fixation methods seem to offer satisfactory results in terms of subjective scores and stability tests in patients with ACL tears, with no particular clinical advantage of one method over the other.

**Keywords:** isolated ACL injury, suspensory fixation, aperture fixation

### Introduction

Anterior cruciate ligament (ACL) is an intra-articular extra synovial structure in the central complex of the knee joint, which maintains a static and dynamic equilibrium of the joint <sup>[1]</sup>. ACL is most commonly injured in road traffic accidents and sports activities <sup>[2]</sup>. Absence or the deficiency of ACL alters joint mechanics resulting in asynchronous movement of the knee in loading, leading to functional instability and unphysiological loading of articular cartilage, secondary meniscal tears, subchondral trabecular fractures, which ultimately lead to accelerated osteoarthritis of the knee joint <sup>[3,4,5]</sup>. Anterior knee instability associated with untreated rupture of ACL is disabling, especially in young and athletic individuals <sup>[3]</sup>. The goal of ACL reconstruction is to prevent symptomatic instability and restore normal knee kinematics to prevent premature degenerative joint disease. The standard treatment as per the International Knee Documentation Committee for the reconstruction of ACL injuries is the arthroscopic single-bundle technique, which demonstrated excellent-good results in 60% of patients <sup>[6]</sup>. Though there is standardization of arthroscopic ACL reconstruction techniques, there is debate regarding graft selection, graft fixation methods, and types of bundles to be used.

Many methods of surgical repair have been proposed for ACL reconstruction <sup>[7]</sup>. The ultimate goals of anterior cruciate ligament repair include a graft with low morbidity; excellent cosmesis, strength, and stiffness; and secure early fixation and incorporation near the joint

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Line [8]. Suspensory fixation (fixation of graft to bone at the lateral cortex of the femur) and aperture fixation (fixation of the graft to the bone through the tunnel at the joint level in the intercondylar notch) are the two widely used methods for graft fixation at the femoral end [9, 10]. However, research continues about which technique is superior.

A study conducted by Hardik S *et al.* evaluated the outcomes of Arthroscopic ACL Reconstruction in patients with ACL deficient knee using suspensory fixation technique demonstrated it to be an effective fixation method [11]. Another study showed significant improvement in KT 1000, Lysholm, and IKDC scores with aperture fixation in ACL reconstruction [12].

A review aimed to compare suspensory and aperture fixation methods in primary anterior cruciate ligament reconstruction found both the techniques to be equally effective with regards to clinical outcomes and complication profiles [13]. A meta-analysis demonstrated improved overall arthrometric stability and fewer graft ruptures using suspensory fixation compared to aperture fixation in ACL reconstruction with no differences in IKDC, Lysholm, Lachman, and pivot-shift outcomes [14]. A study comparing the outcome of aperture and cortical fixation techniques in ACL reconstruction demonstrated an advantage of less enlargement of tunnel diameter due to decreased micromotion of graft in the tunnel with aperture fixation as compared to cortical fixation [15].

However, there are few studies and limited data regarding arthroscopic ACL reconstruction in patients with isolated ACL deficiency using suspensory fixation and aperture fixation techniques from this part of India. Based on this perspective, this study was conducted on patients with isolated ACL deficiency. Here, we aimed to assess the clinical outcome of Arthroscopic ACL Reconstruction using suspensory fixation and aperture fixation techniques.

This study is undertaken with the primary objective of comparing the functional outcome of arthroscopic ACL reconstruction by suspensory fixation in comparison with aperture fixation technique.

## Materials and Methods

The present study is a prospective study conducted to study the outcome of arthroscopic ACL reconstruction by suspensory fixation and aperture fixation techniques in patients who have presented with isolated ACL deficiency to the Orthopaedic clinic of a tertiary care hospital over two years from 1<sup>st</sup> December 2017 to 30<sup>th</sup> September 2019, after obtaining approval from the Institutional Ethics Committee.

All the consecutive patients between 18 and 45 years of age having symptomatic instability with isolated ACL tear were approached. A total of 53 patients with isolated ACL deficiency were selected based on detailed history, clinical examination, and radiological assessment (radiograph and Magnetic Resonance Imaging). Patients between 18 and 45 years of age, willing to give informed risk consent for arthroscopic ACL reconstruction using a graft from the ipsilateral leg were included in the study. History of any other meniscal and associated ligament injuries and inflammatory arthropathy was taken as exclusion criteria.

Forty patients meeting the fixed criteria were taken as subjects for the study and assigned randomly to two groups; those to undergo single-bundle arthroscopic ACL reconstruction with suspensory fixation ( $n=20$ ) and double-bundle arthroscopic ACL reconstruction with aperture fixation ( $n=20$ ). Informed risk consent was obtained from all participants after they were explained about the surgical

procedure and the risks versus benefits associated with the procedure, nature, and purpose of the present study and verbally assured about the confidentiality of their information. At the baseline, sociodemographic details were obtained, including the age and gender of the patients. The cause of injury was taken note of. Clinical stability was assessed by Lachman, anterior drawer, and pivot shift tests [16]. A study by Dhavalakumar KJ *et al.* concluded Lachman, anterior drawer, and pivot shift tests to be highly specific for diagnosing ACL laxity and that the pivot shift test under anesthesia is the most sensitive and specific among the three tests for diagnosing ACL laxity [17]. In a meta-analysis of diagnostic studies to assess the validity of the anterior drawer, Lachman, and the pivot shift tests for the diagnosis of rupture of the ACL, the Lachman test emerged to be the most sensitive and the pivot shift the most specific test for the diagnosis of ACL rupture [18]. The Modified Tegner Lysholm Knee Score was applied to assess knee function and activity level after a ligament injury [19].

A quadrupled hamstring tendon (ipsilateral semitendinosus and gracilis) was used for the single-bundle arthroscopic ACL reconstruction with suspensory fixation. The tendon was fixed proximally with a flip button and distally with an interferential screw of appropriate diameter.

Ipsilateral semitendinosus and gracilis tendons were used for all the patients in the double-bundle arthroscopic ACL reconstruction group and fixed proximally and distally with interferential screws of appropriate diameter.

Patients in both the groups were assessed during the immediate post-operative period, at one week, at one month, and six months by applying the Modified Tegner Lysholm Knee Score and clinical examination Lachman, anterior drawer, and pivot shift tests.

The Modified Tegner Lysholm Knee Score includes functional and objective criteria. The maximum score is 100 points, and 50% of the total score is based on symptoms of pain and instability [20].

Statistical analysis was done using SPSS 21 software. Change in the scores from baseline was noted and assessed by independent t-test. Intergroup comparison was also made by using the student t-test. A probability value of less than 0.05 was taken as statistically significant.

## Results

### Sample characteristics

Of the 53 patients selected for the study participation, 13 were excluded as they did not meet the fixed criteria. The remaining 40 patients were assigned to two groups, those to undergo single-bundle arthroscopic ACL reconstruction with suspensory fixation, which included 20 patients, and those to undergo double-bundle arthroscopic ACL reconstruction with aperture fixation, which included 20 patients. All the patients were followed up over six months and analyzed at the end of the study.

The sample characteristics are summarized in Table 1.

Most of the patients were between 19 and 25 years of age in both the groups ( $n=8$  in the aperture fixation group and  $n=12$  in the suspensory fixation group). More males ( $n=34$ ; 85%) were included in both the groups in our study. Half of them ( $n=20$ ) had a history of road traffic accidents, 20% ( $n=8$ ) sustained a sports injury, and 30% suffered injury due to other causes like slip and fall.

Modified Lysholm Knee Scores were calculated at the baseline and over six months following Arthroscopic ACL reconstruction using suspensory fixation and aperture fixation

methods. Thirty-five patients (87.5%) complained no instability while five patients (12.5%) did during athletic activities; 36 (90%) patients had no pain while 4 (10%) suffered intermittent mild pain during physical activity at six months of follow up. Slight difficulty in climbing stairs and while squatting was reported by 2 (5%) patients.

On evaluation, there was a difference in the scores at one month and six months post-operatively with both the techniques. No significant difference was found between the two groups on intergroup comparison, in terms of change in Modified Lysholm Knee Scores.

Lachman test was negative in 14 patients (70%) in the suspensory fixation group and 15 patients (75%) in the aperture fixation group. Anterior drawer test was negative in 55% ( $n=11$ ) of the patients in the suspensory fixation group,

while 45% ( $n=9$ ) had a grade 1 anterior drawer test. Whereas in the aperture fixation group, 14 patients (70%) had a negative anterior drawer test, and six patients (30%) had a grade 1 anterior drawer test. Post-operatively, the pivot shift test was negative in the suspensory fixation group, while it was positive in 10% ( $n=2$ ) of the patients in the aperture fixation group. No statistically significant differences were found between the two groups pertaining to clinical evaluation using Lachman, anterior drawer, and pivot shift tests post-operatively as shown in Table 2.

One patient each in the suspensory and aperture fixation groups had complications regarding wound healing. Nine patients (22.5%) had decreased sensation over the distribution of the infrapatellar branch of the saphenous nerve, which recovered with time.

**Table 1:** Sample characteristics

Variable	Suspensory fixation group ( $n=20$ )	Aperture fixation group ( $n=20$ )
Age (years)		
19-25 years ( $n=20$ )	12	8
26-35 years ( $n=12$ )	4	8
36-45 years ( $n=8$ )	4	4
Gender		
Male ( $n=34$ )	19	15
Female ( $n=6$ )	1	5
Cause of injury		
Road traffic accident ( $n=20$ )	13	7
Sports ( $n=8$ )	6	2
Others ( $n=12$ )	1	11

**Table 2:** Functional outcome and clinical stability across both groups

Variable	Suspensory fixation group (Mean±SD)	Aperture fixation group (Mean±SD)	P value*
Age (years)	27.05±8.64	29.1±8.16	0.445
Lysholm score			
Pre-Op	45.85±7.19	43.85±6.47	0.311
One Month Post-Op	77±5.23	76.55±6.84	0.801
Six Months Post-Op	87.15±3.73	87.7±4.85	0.689
Lachman test			
Pre-Op	2.7±0.47	2.6±0.50	0.518
One Month Post-Op	0.45±0.51	0.45±0.51	1
Six Months Post-Op	0.3±0.47	0.25±0.44	0.730
Anterior Drawer test			
Pre-Op	2.6±0.50	2.8±0.41	0.017
One Month Post-Op	0.55±0.51	0.6±0.50	0.755
Six Months Post-Op	0.45±0.51	0.3±0.47	0.339
Pivot shift test			
Pre-Op	2.5±0.51	2.5±0.51	0.880
Six Months Post-Op	0±0	0.1±0.3	0.1525

\* $P<0.05$  is considered statistically significant, using student t-test

## Discussion

The current study was conducted to compare the functional outcome of arthroscopic ACL reconstruction by suspensory fixation compared to the aperture fixation method.

Mean age of the patients in the suspensory fixation group was 27.05±8.64 years, while it was 29.1±8.16 years in the aperture fixation group. Similar trend in the age group of patients with ACL injuries, as observed in our study, was reported by Frobell *et al.* and Mohtadi *et al.*, in their respective randomized controlled trials [21, 22]. This can largely be attributed to the high prevalence of ACL tear among young individuals by virtue of their participation in strenuous physical activities and sports; also, due to road traffic injuries. In our study, 85% ( $n=34$ ) of the total patients were males, and 15% ( $n=6$ ) were females. In a 21-year population-based study on the incidence of ACL tears and reconstruction, Sanders TL

*et al.* reported that the incidence of ACL tears was significantly higher in male patients than in females, which agrees with our results [23].

The Modified Tegner Lysholm Knee Scores calculated during the study were raised by arthroscopic ACL reconstruction using both suspensory fixation and aperture fixation techniques. Modified Lysholm Knee Score in the suspensory fixation group ( $n = 20$ ) was 45.85±7.19 pre-operatively, and at the end of six months, post-operatively was 87.15±3.73. While in the aperture fixation group ( $n = 20$ ), it was 43.85±6.47 pre-operatively and 87.7±4.85 at the end of six months post-operatively. On intergroup comparison using independent t-test, aperture fixation was found to increase the Modified Tegner Lysholm Knee Score than suspensory fixation, which is in agreement with a study conducted by Kashid MR *et al.* [18]. However, the difference was not

statistically significant.

Modified Tegner Lysholm Knee Score has a significant role in assessing the improvement or deterioration of knee function and activity level. In the current study, both suspensory and aperture fixation improved the Modified Tegner Lysholm Knee Score similarly. When suspensory fixation and aperture fixation techniques were compared, as summarized in Table 2, the Modified Tegner Lysholm Knee Score was more effectively reduced with aperture fixation than with suspensory fixation at one month and six months post-operatively, but the difference was not statistically significant. Studies have demonstrated similar kinds of results with suspensory and aperture fixation techniques in the context of the improvement of Lysholm Knee Scores [8, 13, 24]. Ping *et al.* conducted a prospective study using Lysholm, International Knee Documentation Committee (IKDC), and Larson scoring with an average follow up of 29.5 months and found no statistically significant scoring differences between groups at the end of follow up period, which is in accordance with our results [25]. Lubowitz JH *et al.*, in a prospective, randomized controlled trial comparing the outcome of cortical suspensory button and aperture interference screw fixation for knee ACL soft-tissue allograft, found no significant differences in knee AP stability or other outcomes, which is consistent with our results [26].

Clinical stability of the knee joint in the current study was assessed by Lachman, anterior drawer, and pivot shift tests, which showed significant improvement in the stability of the knee with both suspensory and aperture fixation techniques. This finding is in accordance with a prospective study conducted by Hardik S *et al.* in sixty-two patients with ACL deficient knees treated with arthroscopic ACL reconstruction [11].

We observed wound healing complication after surgery in two patients and decreased sensation over the distribution of the infrapatellar branch of the saphenous nerve in nine patients. However, there was no functional restriction in these patients. They recovered with time and successfully returned to their pre-injury activities.

The results of the current study showed both suspensory and aperture fixation methods to be equally effective and comparable clinically for arthroscopic ACL reconstruction in patients with ACL deficient knee. There is no significant difference in the final clinical outcomes or functional knee scores with both the fixation methods.

### Strengths of the study

The prospective nature of the study and randomization strengthened the study. Patients with a history of any other meniscal and associated ligament injuries, and inflammatory arthropathy, were excluded; hence, most other possible causes of knee pain and functional instability are avoided. The scale used to assess knee function and activity level after ligament injury is well-validated. Clinical evaluation tests (Lachman, Anterior Drawer, and Pivot Shift tests) to assess the knee function are reliable and diagnostically accurate. Sparse literature exists on the functional outcome of Arthroscopic ACL reconstruction by suspensory and aperture fixation techniques, especially in our area. Our study may help the readers to enhance their knowledge about both these techniques.

### Limitations of the study

This study was preliminary, done in a single-center with less number of patients. Being an open-label study, no blinding

was done for the evaluation of both the techniques. Relatively shorter duration of follow up, different operating surgeons are also limiting factors. Hence, further research with a greater number of patients and applying more scales to evaluate the functional outcome of Arthroscopic ACL reconstruction by suspensory and aperture fixation techniques in patients with ACL deficient knee is required to confirm the clinical advantage of one technique over the other.

### Conclusion

All-inclusive, our study showed that suspensory and aperture fixation methods for ACL reconstruction are comparable clinically with no significant differences in translational or rotational stability and functional outcomes in both types of fixation methods. No particular clinical advantage of one method over the other was found. However, aperture fixation shows a little edge over suspensory fixation as it is cost-effective.

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