

ORIGINAL RESEARCH

A study to compare two modes of femoral fixation namely aperture fixation with screw and suspensory fixation by endobutton in the femoral tunnel in arthroscopic anterior cruciate ligament reconstruction surgery

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ABSTRACT

ACL injuries are one of the most common knee injuries among athletes. They are most common in people who participate in pivoting sports (e.g. football, basketball, netball, soccer, gymnastics, and downhill skiing). They can be mild (such as minor tears or sprains) or severe (such as when the ligament is completely torn). After obtaining ethical clearance from Institute's Ethical committee, written consent was obtained from all the patients. The study enrolled a total of 30 patients presenting with ACL high-grade tears in the knee fulfilling the inclusion criteria. Data regarding sociodemographic variables were collected using a pretested semi-structured questionnaire. All the patients were subjected to detailed general examinations including height, weight and BMI. In our present study, the pre-operative IKDC mean score was (48.31 ± 2.8) in the aperture fixation group and (49.12 ± 2.1) in the suspensory fixation group, and in the postoperative period, it was recorded at 66.27 ± 4.67 , 76.92 ± 4.88 , 83.55 ± 1.85 , 92.55 ± 1.86 in the first month, the fourth month, the eighth month, one-year follow-up respectively in the aperture fixation group. On the other hand in the suspensory fixation group, it has improved to 61.22 ± 3.6 , 71.41 ± 3.41 , 83.28 ± 0.38 , 92.28 ± 1.89 in the first month, the fourth month, the eighth month, and the one-year follow-up respectively. The t-test and P values in the pre-operative IKDC score were 0.89 and 0.38 which is more than 0.05 indicating that both the groups were comparable pre-operatively.

Key words: Aperture fixation with screw, suspensory fixation by endobutton, arthroscopic anterior cruciate ligament reconstruction surgery

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INTRODUCTION

The anterior cruciate ligament (ACL) stabilises the knee joint by connecting the femur to the tibia. The ACL prevents anterior translation and rotation of the tibia relative to the femur.

The anterior cruciate ligament (ACL) runs from the posterior aspect of the intercondylar notch on the femur to the anterior tibial plateau, while the posterior cruciate ligament (PCL) runs from the anterior aspect

of the intercondylar notch on the femur to the posterior tibial plateau.

ACL injuries are one of the most common knee injuries among athletes¹. They are most common in people who participate in pivoting sports (e.g. football, basketball, netball, soccer, gymnastics and downhill skiing). They can be mild (such as minor tears or sprains) or severe (such as when the ligament is completely torn).

Early attempts at suture repair using open surgical techniques were linked with significant morbidity and poor outcomes.

Arthroscopic ACL reconstruction has now become one of the most prevalent orthopaedic surgical procedures.

Fixation of the graft during ACL repair for much of the twentieth century included simply suturing the projecting sections of the graft to the periosteum at the tunnel exits.

The usage of an interference screw was first described by Kenneth Lambert. Lambert used conventional 6.5 mm AO cancellous screws with a 30 mm length in 1983, which he passed through the bone blocks of BPTB grafts from the outside².

Graft fixation is one of several elements of primary ACL-R using hamstring tendon (HS) autografts that may influence clinical results.

In the immediate postoperative phase, graft fixation is commonly cited as the weakest link³ and this has been supported by multiple animal studies⁴.

Given the current emphasis in postoperative rehabilitation protocols on early mobility and weight-bearing⁵.

When graft-to-bone healing has not yet happened, optimizing graft fixation is critical to maximising the stability of the repaired ACL in the short-to-immediate postoperative period⁶.

Effective graft fixation is essential for minimising graft slippage, improving graft strength and stiffness, and limiting longitudinal and sagittal graft motion.

Methods of graft fixation are frequently categorised as:-

SUSPENSORY (EXTRA TUNNEL)

Examples of suspensory fixation methods include suspensory cortical buttons screw and washer Fixation of the graft with a cross pin.

APERTURE (INTRATUNNEL FIXATION)

Examples of aperture fixation methods include

1. INTERFERENCE SCREWS

A suture or anchor at the end of the graft, such as a biodegradable polylactic acid (PLA) ball or a bone disc obtained during tunnel drilling, has been suggested in several publications as a way to improve aperture fixation during press-fit fixation⁷.

Followed by tunnel placement, the choice of graft fixation (suspensory vs. aperture) is regarded as the second most significant aspect in determining the integrity and effectiveness of ACL-R⁸.

Several factors determine the graft fixation method chosen, including surgeon preference and training, cost, the convenience of usage and clinical experience⁹.

The optimum ACL-R attachment method must follow the criteria of being strong, stiff and stronger pull-out strength. Furthermore, it has been shown that the graft

fixation method used can affect the risk of revision after ACL-R¹⁰.

ACL fixation procedures that give fixation closer to the tunnel aperture and more anatomically mimic the original ACL insertion site may provide superior tensile strength than suspensory fixation methods, according to multiple biomechanical studies⁶.

Suspensory fixation methods, on the other hand, have been reported to have larger pull-out strength than multiple aperture fixation methods in other research¹¹. Freddie H. Fu concluded, Aperture techniques of fixation have potential hazards, such as the screw may affect tendon-to-bone healing and the possibility of tunnel blow-out, while some studies have found greater knee stability¹² and decreased graft-tunnel motion under anterior tibial loading¹³.

When it comes to soft-tissue graft-aperture fixation versus suspensory fixation, there is no clear consensus on the best method of graft fixation⁶.

Despite numerous randomised control trials comparing graft fixation of QT and BPTB, no prospective studies comparing graft fixation for HS have been conducted. The literature on graft fixation has primarily focused on examining retrospective data and limited patient cohorts, with no specific examination for the best graft fixation method⁶.

METHODOLOGY

Study Design: This study was a randomized controlled study.

Study Area: Department of Orthopaedics.

Study Population: All the patients diagnosed with a case of high-grade ACL tear belonging to the age group of 18-45 years reported to the study area during the study period.

INCLUSION CRITERIA

1. Patients with closed growth plates (age 18-45).
2. Isolated ACL injury.
3. No ligamentous injury to the contralateral knee.
4. Giving written consent and willingness to follow up.
5. Injury to surgery duration less than 3 months.

EXCLUSION CRITERIA

1. Congenital hyperligamentous laxity syndrome.
2. Previous ACL surgery on the knee.
3. Previous knee surgeries.
4. Evidence of multiple ligament injuries or meniscus injuries.
5. Chronic muscle wasting disorders.
6. Any co-existing local conditions in the form of Active articular infection or inflammatory joint disease.
7. Ankylosis of the operated knee.
8. Osteoarthritis of the affected knee.
9. Metabolic bone disease.
10. Neoplastic disease.
11. Patients with the poor skin condition.

12. Patients with co-morbid conditions like diabetes mellitus.

Sample size: 30.

Sampling: All the patients fulfilling the inclusion criteria were selected using purposive sampling and were randomly allocated into two groups using simple randomization, each group consisting of 15 patients.

- Participants of group 1 were managed by APERTURE FIXATION.
- Participants of group 2 were managed by SUSPENSORY FIXATION.

Consent: Written consent was obtained from all the patients after explaining to them the nature and purpose of the study. They were assured that confidentiality would be strictly maintained. The option to withdraw from the study was always open.

Study Tool

- IKDC SCORE for assessment of functional outcome.
- Anterior drawer displacement grading for assessment of functional outcome objectively.

After obtaining ethical clearance from Institute's Ethical committee, written consent was obtained from all the patients. The study enrolled a total of 30 patients presenting with ACL high-grade tears in the knee fulfilling the inclusion criteria. Data regarding sociodemographic variables were collected using

apretested semi-structured questionnaire. All the patients were subjected to detailed general examinations including height, weight and BMI.

A local examination of the affected limb was also conducted and attitude of the limb, Swelling, Tenderness, Deformity, range of motion, anterior drawer test, Lachman test, pivot shift test, Crepitus and distal pulses were examined and noted.

Further systemic examination of all the patients was done. All the selected patients were then randomly allocated into two groups using random number tables, each group consisting of 15 patients. Preoperatively drawer displacement, range of motion, and IKDC score were recorded.

Participants of group 1 were managed with Aperture ACL fixation whereas participants of group 2 were managed with Suspensory ACL fixation surgical technique.

In both groups, surgery was conducted under spinal anaesthesia with a tourniquet.

The wound was washed and closed in layers and a light compression bandage was given. The patients were mobilized immediately postoperatively on post-op day 1.

Follow-up

All the patients were followed up postoperatively at 15 days (at this stage sutures were removed) and further at 1 month, 4, 8 month and 12 months postoperatively. At each follow-up, functional outcome was assessed using IKDC scores.

Results

Table 1: Distribution of patients according to IKDC

	Aperture	SD	Suspensory	SD	Statistics(T value)	Pvalue
Preoperative	48.3067	2.807	49.12	2.141	0.89	0.38
Postoperative						
1 month	66.2733	4.669	61.22	3.597	3.3206	0.0025
4 month	76.92	4.881	71.4133	3.909	3.4105	0.002
8 month	83.5533	1.858	83.2867	1.89	0.3896	0.6998
12 month	92.5533	1.858	92.2867	1.89	0.3896	0.6998

In our present study, the pre-operative IKDC mean score was (48.31) in the aperture fixation group and (49.12) in the suspensory fixation group, and in the postoperative period, it was recorded at 66.27, 76.92, 83.55, 92.55 in the first month, the fourth month, the eighth month, one-year follow-up respectively in the aperture fixation group. On the other hand in the suspensory fixation group, it has improved to 61.22, 71.41, 83.28, 92.28 in the first month, the fourth month, the eighth month and the one-year follow-up respectively. IKDC Knee Examination Ratings (>90% = normal, 76-89% = nearly normal, 50-75% = abnormal, below 50% = severely abnormal).

The patient's affected knee was compared to the opposite normal knee at each follow-up.

In this case, the mean value must not be calculated as in the case of an ordinal data comparison made on the basis of frequency.

It was observed that pre-operatively in both the groups grade three and grade 2 were more frequently observed, Grade 3 being more common in both the groups.

This same test was performed intra-operatively after the surgery by the operating surgeon and to the reconstructed ligament in most patients, knee laxity improved up to grade 0 in maximum patients in both groups i.e. 12 in Aperture and 13 in the suspensory fixation group and the rest patients were grade 1 on the table.

The patients were recalled for suture removal on day 15 and the esamet test was performed, there was an

increase in the laxity of the ligament and it was more in the case of the suspensory fixation group. Around 80% of the patients were categorised in grade 2 and the rest were in grade 3 in the aperture fixation group, however, in the suspensory group 60% of patients were in grade 2 and the rest were in grade 3.

Similar observations were made in the one-month and four-month follow-ups and anterior laxity was observed more in the suspensory group as compared to the aperture group.

On the other hand at the eight-month follow-up and one-year follow-up, patients in the suspensory fixation group performed better with respect to laxity grading by our method and at the last follow-up, 80% of patients in the suspensory group the laxity was the same as the contralateral knee (grade 0) and it was only 66% (Grade 0) in the aperture fixation group.

Table 2: Association of the grade of injury with the joint laxity among patients of two groups

	Grade 0	Grade 1	Grade 2	Grade 3
Pre Op (Aperture)	0	0	5	10
Pre Op (Suspensory)	0	0	3	12
Immediate Post Op (Aperture)	12	3	0	0
Immediate Post Op (Suspensory)	13	2	0	0
2 Week Post Op (Aperture)	0	0	12	3
2 Week Post Op (Suspensory)	0	0	9	6
1 Month Post Op (Aperture)	3	12	0	0
1 Month Post Op (Suspensory)	1	5	9	0
4 Month Post Op (Aperture)	4	11	0	0
4 Month Post Op (Suspensory)	4	4	7	0
8 Month Post Op (Aperture)	2	12	1	0
8 Month Post Op (Suspensory)	4	11	0	0
12 Month Post Op (Aperture)	10	5	0	0
12 Month Post Op (Suspensory)	12	3	0	0

DISCUSSION

In our present study, the mean side of the operation in the aperture fixation group was 9 patients (29.97%) on the right side and 6 patients (19.98%) on the left side. In the suspensory fixation group, 8 patients (26.64%) were on the right side and 7 patients (23.31) on the left side.

In our study, the p-value is 0.71 which is insignificant. According to a study conducted by Bula Ratna Kumar *et al.* (2021), the right side was affected in 19 patients (63.3%) and the left side was affected in 11 patients (36.6%)¹⁴.

Muhammad Waqar, *et al.* (2021), 120 (75%) patients had right-sided ACL injuries while 40 (25%) patients had left-sided ACL injuries. There were no bilateral cases in this study. The ratio of the right knee to the left knee involved in ACL injury was 3:1.15 The findings stated in the above two studies were found to be in concordance with our study.

In our present study, the pre-operative IKDC mean score was (48.31±2.8) in the aperture fixation group and (49.12±2.1) in the suspensory fixation group and in the postoperative period, it was recorded at 66.27±4.67, 76.92±4.88, 83.55±1.85, 92.55±1.86

in the first month, the fourth month, the eighth month, one-year follow-up respectively in the aperture fixation group.

On the other hand in the suspensory fixation group, it has improved to 61.22±3.6, 71.41±3.41, 83.28±0.38, 92.28±1.89 in the first month, the fourth month, the eighth month and the one-year follow-up respectively. The t-test and P values in the pre-operative IKDC score were 0.89 and 0.38 which is more than 0.05 indicating that both the groups were comparable pre-operatively.

In the first month and fourth month, the P value was 0.0025 and 0.0020 that is significant, this indicates that there is a statistically significant difference in the outcome thus from these findings we can conclude that the aperture fixation method yields better results as compared to suspensory fixation method in the earlier part of rehabilitation.

There is no significant difference in the final clinical outcomes or functional knee scores with both fixation methods in our present study.

The study conducted by Muhammad Waqar *et al.* (2021), assessed the functional

outcome of patients through pre-operative and post-operative IKDC scoring. The mean of the preoperative IKDC scoring was 41 with an SD of 9 and the mean of the postoperative IKDC scoring was 81 with an SD of 12¹⁶.

The results of the study by Balijepalliet *al.* (2021) 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 fixation methods¹⁷. These findings are in concordance with our present study.

The findings of this systematic review by Crum, Raphael J., *et al.* (2020) suggest that suspensory fixation and aperture fixation in both the femoral and tibial tunnels are equally efficacious based on clinical outcome data on IKDC grade and measured laxity. Suspensory fixation on both sides demonstrated a higher percentage of patients (81.7%) achieving the highest rating of "A or B" (A: return to normal function; B: return to nearly normal function) on (IKDC) knee ligament examination form compared with aperture fixation on both sides (67.7%). Secondary clinical outcomes (IKDC subjective evaluation, form, Lysholm score and Tegner scale) showed no statistical difference between groups at 3, 6, 12 and 24 months postoperatively¹⁸.

According to Browning, William M., *et al.* (2017), there was no statistically significant difference in the mean continuous IKDC score distribution in the suspensory and the aperture fixation group. This study also systematically reviewed ACLR using suspensory or aperture fixation and found that the suspensory device engendered better knee stability and less graft failure¹⁹. These findings are not in concordance with our study.

Tsoukas, Dimitrios *et al.* (2016) compared the IKDC scores in the ACL reconstruction group of patients, which presented better clinical and functional outcomes as compared to the ACL conservative group. There was a significant difference $P = 0.04$ between the mean values of IKDC²⁰.

The study conducted by Lubowitz, *et al.* (2015) reported that for some outcome measures (narcotic consumption, KSS pain score, IKDC subjective score, SF-12 physical and mental component scores and 3 of 4 radiographic scores), aperture fixation showed superior scores, and critically, as noted earlier, there were no statistically significant differences between the groups for any of the outcomes measured²¹.

The clinical assessment in the study by Chidanand, K. J. C *et al.* (2015) was based on, the objective criteria of IKDC and LGS, 21 (70%) patients got normal postoperative recovery according to IKDC scoring at final follow-up, while 7 (23.3%) near normal and rest 02 were abnormal related to knee stiffness and 21

patients got excellent results according to LGS scoring while 7 patients showed good results and the score was fair in rest 2 patients at the final follow up²².

In the final evaluation of the study by Joshi, Deepak, *et al.* (2014) functional results were based on the IKDC criteria, 54% of the patients were in Category A and 36% in Category B of IKDC score²³.

Thus, the findings of the present study are in concordance with the findings of the previous authors, however, it must be noted that the parameters for the various studies or not exactly the same there might be some variation according to the patient setup, inclusion and exclusion criteria.

Also, we have observed in the present study that there is a statistically significant difference in the knee joint laxity and functional outcomes using the IKDC score in the earlier part of rehabilitation at the first and fourth months.

It is also important to understand that the number of patients in the present study is limited and further study is required including more patients for better conclusions.

In our present study, it was observed that pre-operatively in both the group's grade 3 and grade 2 were more frequently observed, Grade 3 being more common in both groups.

The same test was performed intra-operatively after the surgery by the operating surgeon and due to the reconstructed ligament in most patients, knee laxity improved up to grade 0 in maximum patients in both groups. i.e. 12 in Aperture and 13 in the suspensory fixation group and the rest patients were grade 1 on the table.

The patients were recalled for suture removal on day 15 and the same test was performed, there was an increase in the laxity of the ligament and which was more in the case of the suspensory fixation group.

Around 80% of the patients were categorized in grade 2 and the rest were in grade 3 in the aperture fixation group, however, in the suspensory group 60% of patients were in grade 2 and the rest were in grade 3.

Similar observations were made in the one-month and four-month follow-ups and anterior Laxity was observed more in the suspensory group as compared to the aperture group.

On the other hand at the eight-month follow-up and one-year follow-up, patients in the suspensory fixation group performed better with respect to laxity grading by our method and at the last follow-up, 80% of patients in the suspensory group the laxity was the same as the contralateral knee (grade 0) and it was only 66% (grade 0) in the aperture fixation group.

The study by Crum, Raphael J., *et al.* (2020), reported that the side-to-side difference in anterior laxity, as measured by KT-1000 or KT-2000, was decreased significantly in the suspensory compared with the aperture fixation group (1.64 mm 0.18 versus 2.29 mm 0.92 mm; $p < 0.05$).¹⁸ These findings are in concordance with the present study.

According to the meta-analysis conducted by, Browning III, William M., *et al.* (2017), more patients had a 0.3-mm SSD in the aperture group than in the suspensory group, and this difference was statistically significant (35.4% vs 17.3%, respectively; P.0001). Additionally, more patients had a 3-to 5-mm SSD in the aperture group than in the suspensory group (31.2% vs 11%, respectively; P.0001). There was no statistically significant difference in the frequency of 5-mm SSDs for suspensory versus aperture fixation (6% vs 5%, respectively; P = .53). The final laxity as measured with the KT-1000 arthrometer is significantly better in the suspensory fixation group compared with the aperture fixation group. 19 These findings are not in concordance with our study as in our study the joint laxity was less in the aperture fixation group in the earlier part of the rehabilitation. Chidanand, K. J. C *et al.* (2015), documented that the functional outcome of anterior cruciate ligament reconstruction with quadrupled semitendinosus tendon autograft using endobutton and suture disc will help the graft to facilitate graft tunnel healing and also maintain its strength until there is a good graft to bone healing occurs completely is excellent to good (93%) with mild laxity²². This finding was also observed in our present study.

However other studies have measured anterior laxity using KT 1000 or KT-2000 arthrometer method which is slightly different from our present method there can be variation with respect to assessment leading to a discrepancy in the outcome²⁴. The study sample size is limited and further study is required for a better conclusion.

CONCLUSION

1. Tensioning of quadrupled hamstring graft was done at the time of its fixation on the femoral side during ACL reconstruction in both aperture and suspensory groups.
2. IKDC scoring was noted for statistical analysis.
3. Statistically, a significant difference was observed in preoperative and postoperative findings of IKDC score at one month and four months indicating better results with aperture fixation.
4. However, there was no difference in the functional and clinical outcomes at the end of one year among both groups.
5. There was a significant improvement in the IKDC score and knee laxity which shows good clinical outcomes by both methods of hamstring graft fixation during ACL reconstruction.

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