

ORIGINAL RESEARCH

Comparison of clinical profile between 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

The femoral insertion of the anterior cruciate ligament (ACL) is in the shape of a crescent, with the lateral intercondylar ridge as its straight anterior border and the posterior articular margin of the lateral femoral condyle as its convex posterior border. 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. All the operated knees were divided based on the mode of injury and those treated by suspensory fixation were found to be sports injuries (13.33%), falls from height (10%), falls during dancing (6.66%), self-fall (3.33%), hit by a bull (6.66%), kicked by a bull (0) & road traffic accidents (10%), whereas those treated by aperture fixation it was found to be sports injuries (10%) fall from height (10%), fall during dancing (6.66%), self-fall (6.66%), hit by a bull (0), kicked by a bull (3.33%) & road traffic accidents (13.33%) respectively. All the operated knees were divided based on the duration of injury, those treated by aperture fixation were found to be 0-1 month (6.66%), 1-2 months (30%) & 2-3 months (13.33%), whereas those treated by suspensory fixation were found to be 0-1 month (13.33%), 1-2 month (30%) & 2-3 month (16.66%).

Key words: Anterior cruciate ligament, clinical profile, ligament reconstruction surgery

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INTRODUCTION

The femoral insertion of the anterior cruciate ligament (ACL) is in the shape of a crescent, with the lateral intercondylar ridge as its straight anterior border and the posterior articular margin of the lateral femoral condyle as its convex posterior border.

The configuration of the intraligamentous part of the ACL is a "ribbon-like" ligament. The twisted flat structure creates the "double-bundle effect" when the knee is flexed.

The flat ACL midsubstance forms a narrow C-shaped bony tibial attachment along the medial tibial spine to the anterior aspect of the anterior root of the lateral meniscus in the area intercondylaris anterior. There are only anteromedial and posteromedial inserting

fibres. Freddie H. Fu concluded The femoral insertion of the anterior cruciate ligament (ACL) is in the shape of a crescent, with the resident's ridge (lateral intercondylar ridge) as its straight anterior border and the posterior articular margin of the lateral femoral condyle as its convex posterior border. Most anterior ACL fibres are aligned posteriorly, directly along and on the lateral intercondylar ridge which extends to the posterior femoral cortex

This extension creates an angle to the femoral shaft axis which varies between 0° and 70°. Most posterior fibres of the femoral ACL insertion blend with the posterior cartilage of the lateral femoral condyle and

the periosteum of the posterior femoral shaft.

In 2006, Mochizuki *et al.*¹ described the femoral insertion to be not “oval” “but rather flat” and “very similar to the midsubstance configuration of the ACL after removal of the ligament surface membrane”.

The authors differentiated between the main femoral straight attachment of the midsubstance fibres along the intercondylar ridge and the attachment of the thin fibrous tissue which extended from the mid-substance fibres and broadly spread out like a fan on the posterior condyle (“fan-like extension fibres”).² These two different structures form a fold at the border between the mid-substance fibres and the fan-like extension fibers in knee flexion.

Iwahashi *et al.*³ described these main (anterior) femoral attachments of the midsubstance fibres in the depression between the lateral intercondylar ridge and 7-10 mm anterior to the articular cartilage margin as “direct” femoral ACL insertion in which dense collagen fibres were connected to the bone by a fibrocartilaginous layer.

Sasaki *et al.*⁴ reported a narrow “direct” ACL insertion area posterior and along the lateral intercondylar ridge”. The “indirect” ACL insertion was located just posterior to the direct attachment where ACL fibres from Type I collagen and blend into the posterior cartilage.⁵

Smigielski *et al.*⁶ reconfirmed the above descriptions of the femoral anatomical attachment after dissections in 111 cadaver knees with the removal of the surface membrane and performed macroscopic measurements and histologic investigations.

METHODOLOGY

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

Results

Table 1: Distribution of patients according to age in groups

	A	B	C	D	E
	18-25	26-30	31-35	36-40	41-45
Suspensory	1(3.33%)	4(13.32%)	8(26.64%)	1(3.33%)	1(3.33%)
Aperture	3(9.99%)	4(13.32%)	4(13.32%)	4(13.32%)	0

The mean age of patients in the suspensory fixation group was 32.4 ± 3.089 years whereas the mean age of patients in the aperture group was 31.7333 ± 2.557 years. The majority of patients who were managed using suspensory fixation belonged to the more than 31-35 years of age group (26.64%), followed by 13.32% and 3.33% of patients belonging to the age range of 26-30 and 36-

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.

40 years respectively. Similarly, about 13.3% of patients in the aperture group belonged to each 26-30, 31-35 and 36-40 years categories. However, the observed difference in the age group between the two groups of patients was statistically insignificant; thus, the two groups were comparable in age composition (p. 0.3663).

Table 2: Distribution of patients according to gender

Sex	Aperture		Suspensory	
Male	13 Male	39.96%	12 Male	33.33%

Female	2 Female	9.99%	3 Female	16.65%
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The majority of patients with ACL tears of the knee in both groups were males, i.e. 39.96% and 33.33% in the aperture and suspensory groups, respectively.

However, the test of significance observed no statistically significant difference in gender composition between the two groups (P. 0.409).

Table 3: Distribution of patients according to occupation

	Suspensory fixation	Aperture fixation	Chi square value	P value
Highly active	6 (40%)	4 (27.7%)	0.6857	0.7097
Moderately active	6 (40%)	8 (53.3%)		
Sedentary	3 (20%)	3 (20%)		

About 40% of patients in the suspensory fixation group were highly active, 40% moderately active and 20% sedentary whereas the majority of patients in the aperture group were 53.3% moderately active followed by 27.7% and 20%

highly active and sedentary patients respectively. The level of activity was comparable between the two groups of patients (p>0.05) P value is not significant at P>0.05.

Table 4: Distribution of patients according to the side of the operation

Injured site	Aperture fixation	Suspensory fixation	Chi square test	P value
Right	9 (29.97%)	8 (26.64%)	0,1357	0,71
Left	6 (19.98%)	7 (23.31%)		

The right knee was operated on in 29.97% of patients of the suspensory group as compared to 26.6% of patients with aperture fixation. However, the

observed difference in the side of operation between the two groups was statistically insignificant (p>0.05)

Table 5: Distribution of patients according to the mode of injury

	Suspensory Fixation	Percentage	Aperture Fixation	Percentage
Sports Injury	4	13,33 %	3	10 %
Fall From Height	3	10 %	3	10 %
Fall During Dancing	2	6,66 %	2	6,66 %
Self-Fall	1	3,33 %	2	6,66 %
Hit by A Bull	2	6,66 %	0	0
Kicked by A Bull	0	0	1	3,33 %
RTA	3	10 %	4	13,33 %
Total	15	50 %	15	50 %

All the operated knees were divided based on the mode of injury and those treated by suspensory fixation were found to be sports injuries (13.33%), falls from height (10%), falls during dancing (6.66%), self-fall (3.33%), hit by a bull (6.66%), kicked by a bull (0) & road traffic accidents (10%), whereas

those treated by aperture fixation it was found to be sports injuries (10%) fall from height (10%), fall during dancing (6.66%), self-fall (6.66%), hit by a bull (0), kicked by a bull (3.33%) & road traffic accidents (13.33%) respectively.

Table 6: Distribution of patients according to the duration of injury

Duration of injury	Suspensory fixation	Percentage	Aperture fixation	Percentage
0-1 month	4	13,33%	2	6,66%
1-2 month	6	20%	9	30%
2-3 month	5	16,66%	4	13,33%
Total	15	50%	15	50%

All the operated knees were divided based on the duration of injury, those treated by aperture fixation were found to be 0-1 month (6.66%), 1-2 months (30%) & 2-3 months (13.33%), whereas those treated

by suspensory fixation were found to be 0-1 month (13.33%), 1-2 month (30%) & 2-3 month (16.66%).

DISCUSSION

In our present study, the mean age of patients in the aperture group was 32.4 ± 3.089 years whereas the mean age group of patients in the suspensory group was 31.733 ± 2.557 years. Majority of the patients belonged to the 31 to 35 years of age group and hence the p-value was statistically insignificant ($p < 0.05$).

In a study conducted by Pranjale *et al.* (2022), the age group taken into consideration was between 19 and 58 years. A statistically significant difference was not observed between the suspensory method and screw fixation in the age group distribution. However, the maximum number of patients were distributed in the age Group 21-30 with 36 (51.4%) and 31-40 with 20 (28.6%) in total. The minimum age was 19 years and the maximum was 58 years with a mean of 29.87 years with a standard deviation of 8.27⁷.

However, in a similar study conducted by Balijepalliet *al.* (2021) showed that most of the patients were between 19 and 25 years of age in both groups ($n=8$ in the aperture fixation group and $n=12$ in the suspensory fixation group). The 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. This can largely be attributed to the high prevalence of ACL tears among young individuals by virtue of their participation in strenuous physical activities and sports; also, due to road traffic injuries⁸.

Muhammad Waqaret *al.* (2021), conducted a similar study and the age of patients ranged from 18 to 56 years with a mean age of 25 years⁹.

The findings of the present study were in concordance with the findings of BulaRatna Kumar, *et al.* (2021) in which the majority of the patients were in the third decade of life, with the youngest patient being 20 years (in both the groups) and the oldest being 46 years (Endobutton), with a mean age of $27.40 + 5.46$ years in Group 1 (Interference screw) and $30.53 + 7.56$ years in Group 2 (Endobutton). This indicates that young active populations were most often involved¹⁰.

In the present study, 15 patients were suited in both suspensory and aperture out of which 39.96% were recorded as male and 9.99% were female in the suspensory group. There were 33.33% males and 16.15% females in the aperture group, the p-value is more than 0.05 and thus both groups are comparable.

In a study conducted by Pranjale *et al.* (2022), 28 (80%) males were in the suspensory fixation group and 26 (74.3%) were in the screw fixation group. Whereas the suspensory fixation group had 8 (20%) females and 9 (25.7%) in the screw fixation group⁷.

Muhammad Waqaret *al.* (2021), reported that out of 160 patients 156 (97.5%) were male and 4 (2.5%) were female⁹.

According to a study conducted by Balijepalliet *al.* (2021), more males ($n=34$; 85%) were included in both groups in their study⁸.

In the present study, about 40% of the aperture fixation group were highly active patients, 40% were moderately active and 20% were sedentary. Whereas, 27.7% patients of suspensory fixation group were highly active, 53.3% were moderately active and 20% were sedentary.

In a similar study conducted by Evans *et al.* (2022), an ACL tear is the most common knee injury occurring in football, soccer and basketball players¹¹.

Trameret *al.* (2021), reported that ACL tear was more commonly seen in athletes and those playing active games than those playing fewer games¹².

According to a study conducted by Dr. Chidanand KJC *et al.* (2018), ACL tears were common in sports-playing individuals athletes, joggers, jump, physical trainers, kabaddi and cricket players- 11 patients (36.66%) followed by farming (20%)¹³. The findings of the present study are in concordance with the previous studies.

In our present study, all the operated knees were divided based on the mode of injury and those treated by suspensory fixation were found to be sports injuries (13.33%), falls from height (10%), falls during dancing (6.66%), self-fall (3.33%), hit by a bull (6.66%), kicked by a bull (0) & road traffic accidents (10%), whereas those treated by aperture fixation it was found to be sports injuries (10%) fall from height (10%), fall during dancing (6.66%), self-fall (6.66%), hit by a bull (0), kicked by a bull (3.33%) & road traffic accidents (13.33%) respectively.

According to a study conducted by Pranjale *et al.* (2022), the majority of patients got injured from RTA in both 19 (54.3%) suspensory and 16 (45.7%) screw fixation methods and a minimum of 1 (1.4%) patients got injury after fall from height in total, therefore the distribution of mode of injury in suspensory method and screw fixation was not significant statistically⁷.

In a study conducted by Muhammad Waqaret *al.* (2021), 114 (71%) patients had a sports injury, 40 (25%) patients had RTA and 6 (4%) patients had other modes of injuries like fall or slip etc.⁹

Balijepalliet *al.* (2021) documented half of the patients ($n=20$) had a history of RTA, 20% sustained a sports injury, and 30% suffered an injury due to other causes like slip and fall⁸.

In the study by BulaRatna Kumar *et al.* (2021) nature of the injury was mainly sports injury which accounts for 16 patients (53.4%) and the rest were road traffic accidents, injuries at work and slip and falls which account for 7 patients (23.3%), 6 patients (20%) and 1 patient which is (3.3%) respectively¹⁰.

In the present study, for 0 to the 1-month duration of injury, the number of patients in the case of aperture ligament injury is 4 and in the case of suspensory ligament injury, the number of patients is 2. While for 1 to 2 months duration of injury, the number of patients in the case of the aperture is 6 and the number of patients in the case of suspensory is 9. For 2 to 3 months the number of patients

incaseofapertureligament injury are 5 and in the case of suspensory ligament injury, no. of the patient is 4. There is no patient operated on for the duration of injury of more than three months in our study.

In the study conducted by BulaRatna Kumar, *et al.* (2021) 90% of patients presented within 2 years of injury, 19 patients (63.3%) presented between 6-12 months, 8 patients (26.6%), presented between 13-24 months and 3 patients (10%) presented between 2-5 years, these results were found to be in concordance with our present study¹⁰.

Muhammad Waqar, *et al.* (2021), reported that the majority of the patients 108 (67.5%) were operated on after 6 months of injury while 52 (32.5%) were operated on before 6 months of injury⁹.

The study by Beynnon, B D *et al.*, The findings suggests a significant difference in the outcomes between the patients who underwent earlier compared to delayed ACL reconstruction¹⁴.

This bias was avoided in our studies as all our patients were operated on within the first three months of the injury.

CONCLUSION

1. Thirty patients with ACL tears were included in our study between the age group of 18 years to 45 years.
2. The mean age was found to be 31.73 years with a standard deviation of ± 2.55 years in the suspensory group on the other hand it was 32.4 years with a standard deviation of ± 3.08 years in the aperture group.
3. The female-to-male ratio was founded at 5:1.
4. There were not any major complications during the postoperative period of ACL reconstruction.

REFERENCES

1. Mochizuki T, Muneta T, Nagase T, Shirasawa S, Akita KI, Sekiya I. Cadaveric knee observation study for describing anatomic femoral tunnel placement for two-bundle anterior cruciate ligament reconstruction. *Arthroscopy*. 2006;22(4):356–61.
2. Mochizuki T, Fujishiro H, Nimura A, Mahakkanukrauh P, Yasuda K, Muneta T, Akita K. Anatomic and histologic analysis of the mid-substance and fan-like extension fibres of the anterior cruciate ligament during knee motion, with special reference to the femoral attachment. *Knee Surg Sports Traumatol Arthrosc*. 2014;22(2):336–44.
3. Iwahashi T, Shino K, Nakata K, Otsubo H, Suzuki T, Amano H, Nakamura N. Direct anterior cruciate ligament insertion to the femur assessed by histology and 3-dimensional volume-rendered computed tomography. *Arthroscopy*. 2010;26(9 Suppl):S13–20.
4. Sasaki N, Ishibashi Y, Tsuda E, Yamamoto Y, Maeda S, Mizukami H, Toh S, Yagihashi S, Tonosaki Y. The femoral insertion of the anterior cruciate ligament: discrepancy between macroscopic and histological observations. *Arthroscopy*. 2012;28(8):1135–46.
5. Shino K, Suzuki T, Iwahashi T, Mae T, Nakamura N, Nakata K, Nakagawa S. The resident's ridge as an arthroscopic landmark for anatomical femoral tunnel drilling in ACL reconstruction. *Knee Surg Sports Traumatol Arthrosc Off J ESSKA*. 2010;18(9):1164–8.J.
6. Smigielski R, Zdanowicz U, Drwiega M, Ciszek B, Ciszewska-Lyson B, Siebold R. Ribbon like appearance of the midsubstance fibres of the anterior cruciate ligament close to its femoral insertion site: a cadaveric study including 111 knees. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(11):3143–50.
7. Pranjal A, Shekhar S, Sinha AK. Comparison between suspensory and aperture (Tunnel Screws) fixation of femoral component during anterior cruciate ligament reconstruction using hamstring tendons. *J Orthop Dis Traumatol* 2022;5:66-73.
8. Balijepalli, SaiPhani, ZeeshanMuzahidThakkallapalli, and ZahidHussainThakkallapalli. "Functional outcome in arthroscopic anterior cruciate ligament reconstruction by suspensory fixation in comparison with aperture fixation method." *International Journal of Orthopaedics* 7.3 (2021): 743-747.
9. Muhammad Waqar, Sana Ullah, Muhammad Saeed, Israr Ahmad, Zeeshan Khan, Muhammad Arif Khan. Outcomes of Arthroscopic ACL Reconstruction Using Adjustable Loop Endobutton and Bioabsorbable Screw for Hamstring Autograft. *Ortho Res Online J*. 8(4). OPROJ. 000695. 2021.
10. BulaRatna Kumar, Dr. J. D. Aravind, and S. Hiranya Kumar. "A comparative study of clinical and functional outcome of arthroscopic anterior cruciate ligament reconstruction using hamstring graft with aperture fixation versus suspensory device fixation." *International Journal of Orthopaedics* 7.3 (2021): 116-124.
11. Evans, Jennifer. and Jeffery I. Nielson. "Anterior Cruciate Ligament Knee Injuries." StatPearls, StatPearls Publishing, 5 May 2022
12. Tramer, Joseph S., *et al.* "Association of Prior Anterior Cruciate Ligament Tear With Decreased Career Longevity in Women's National Basketball Association." *Orthopaedic Journal of Sports Medicine*, June 2021, doi:10.1177/23259671211009248.
13. DrChidanand KJC, DrMadanBallal, DrSiddharth Gupta(2018); Suspensory Fixation of Grafts in Anterior Cruciate Ligament Fixation using Endobutton and Suture Disc – A Prospective Study of 30 Cases; *Int J Sci Res Publ* 5(9)
14. Beynnon, B D *et al.* "The effect of functional knee-braces on strain on the anterior cruciate ligament *in vivo*." *The Journal of bone and joint surgery*. American volume vol. 74,9 (1992): 1298-312.