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Functional assessment of arthroscopic anatomical single bundle ACL reconstruction

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Abstract
ACL is important for maintenance of knee movement. ACL do not heal itself because of its intrinsically poor healing potential and surgery required. Autografts like quadriceps, hamstrings, patellar tendon and allografts of achilles, tibialis anterior and Hamstrings tendon are used. Anatomic placement of ACL tunnels in its native footprint to better restore knee kinematics conventional transtibial reconstruction or its modifications were compared with the anatomic single bundle ACL reconstruction. Reconstruction with single bundle bone-tendon-bone autograft with interference screw fixation.
Methods: Study includes 100 patients undergoing arthroscopic Single Bundle ACL Reconstruction, Age between 18 to 40 yrs. Demographic, Clinical, radiological data used for functional assessment of arthroscopic anatomical single bundle ACL reconstruction.
Results: Comparable distribution of age between groups based on tear grades which suggests that age is unrelated to tear grades (all p values>0.05). Average preoperative Lysholm knee Score was 75.4± 8.2. Average Lysholm knee Score Before Surgery in grade II tear patient group (78.3 ±8.4) was significantly higher than grade III tear patient group (74.12 ±9.1) (p=0.03) After 3 months of surgery, Lysholm knee score was good (84-90) in majority (62%) of the patients. It was found excellent (91-100) in 24% of the cases. After 3 months of surgery Lysholm knee score was fair (65-83) among 6% patients and was unsatisfactory i.e. (<64) in 8% patients. Average duration of hospital stay was 3.42± 1.02. Average duration of hospital stay in grade II tear patient group was 3.39± 1.was slightly lesser than grade III tear patient group (3.43 ±1.01). However the difference of mean was nonsignificant (p=0.856).
Conclusion: Adequate graft with appropriate thickness is a prerequisite for the success of surgery. Timing of surgery, precision in technique and adequate rehabilitation are the variables which strongly influence the outcome of surgery. Grade of injury does not affect the outcomes.

Keywords: arthroscopic anatomical, ACL reconstruction

Introduction
Anterior cruciate ligament rupture is more common nowadays and it can lead to cartilage degeneration and osteoarthritis [1].
Anterior cruciate ligament is important for maintenance of knee movement [2]. ACL do not heal itself because of its intrinsically poor healing potential and surgical mediation is usually required [3, 4]
Allograft and autograft were used for ACL reconstruction [5, 6]. Many authors have described various procedures and techniques with autografts like quadriceps, tendon, hamstrings, patellar tendon etc. and allografts of achilles tendon, tibialis anterior and Hamstrings [7].
Many techniques of ACL reconstruction and its modifications have been described in the literature [8-12]. These unsatisfactory results were attributed to non-anatomic graft placement [13]. Although, there are few recent studies which suggest no difference in outcome when conventional transtibial reconstruction or its modifications were compared with the anatomic single bundle ACL reconstruction [14-17].
Anterior cruciate ligament injuries account for anywhere between 25 and 50% of ligamentous knee injuries [18]. A potential theory to explain this is that the synovial fluid and intra-articular movement prevents formation of a stable fibrin-platelet scaffold [19].
This poor capacity of the ACL to heal is one of the main reasons why the current gold standard

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surgical treatment for an ACL injury in an athletic patient is ACL reconstruction with autograft from either the hamstrings or patella tendon. ACL rupture can be examined by Lachman test and Pivot shift test [20].

Reconstruction with single-bundle bone-patellar tendon-bone autograft with interference screw fixation has the least measurable laxity and the fastest graft incorporation, lowest failure rate, outside procurement costs, no risk of disease transmission, reliable. Interference screw bony fixation remains the gold standard [21].

This study was initiated with the hypothesis that single bundle ACLR may result in favourable patient outcomes in Indian patient with variable degrees of ACL tear. Lysholm system of scoring was used to evaluate the results and outcome of the series of cases.

Aim and Objectives
Assessing functional outcomes of the anatomical single bundle anterior cruciate ligament reconstruction.

Objective
To study the functional outcomes of the anatomical single bundle anterior cruciate ligament reconstruction surgery.

Materials and Methods
Study Design
This observational study was done in tertiary care hospital.

Ethics Committee Approval and Consent Procedure
The study was approved by institutional Ethics Committee for research work. Informed written consent in the vernacular language spoken and understood by the subjects, was obtained from all the study subjects enrolled in the study.

Inclusion Criteria
1. Patients undergoing Endoscopic Single Bundle ACL Reconstruction
2. 18 to 40 Years
3. Of either gender

Exclusion criteria
1. Associated other ligament injury requiring surgery
2. Abnormal contralateral knee joint
3. Previous menisectomy with excision of >1/3 at time of reconstruction
4. Who did not wish to participate in research study
5. Associated with fracture around knee joint
6. Injury due to repeated fall due to neurolgical cause

Sample Size Estimation
Sample size was calculated by using computerized software winpepi (Version 11.65 copyright J.H. Abramson Aug.23, 2016)

Required Sample
Expected Precision
Approx. 95% CI for difference between proportions.
Sample size of 100.

Statistical Analysis
We used Student's t tests to compare continuous variables and Chi-Square tests to assess differences in proportions and to measure the linear trend as appropriate. We deemed p values less than 0·05 to be significant. We used Microsoft Excel 2016 for data compilation and SAS version 20.0 for all statistical analyses.

Observations and Results

Table 1: Gender Distribution

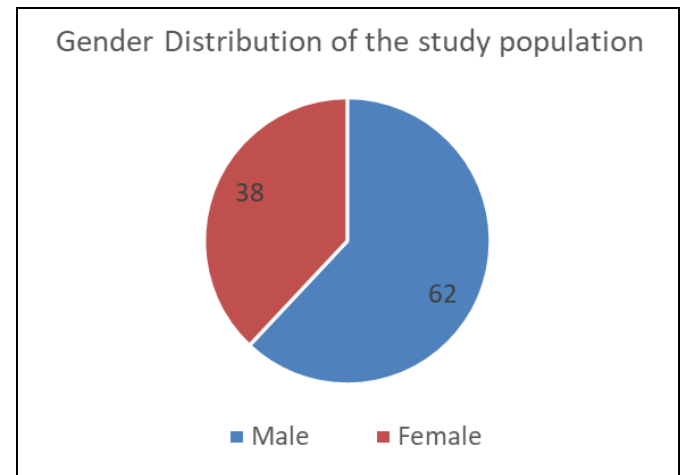| Gender	Number	Percentage
Males	62	62
Females	38	38

Fig 1: Male to female ratio was found to be 1:0.61

Table 2.1: Age Distribution

| Age Group | Total (N=100) | |
	Frequency	%
≤ 20 Years	3	3
21 to 30 years	34	34
31 to 40 years	63	63
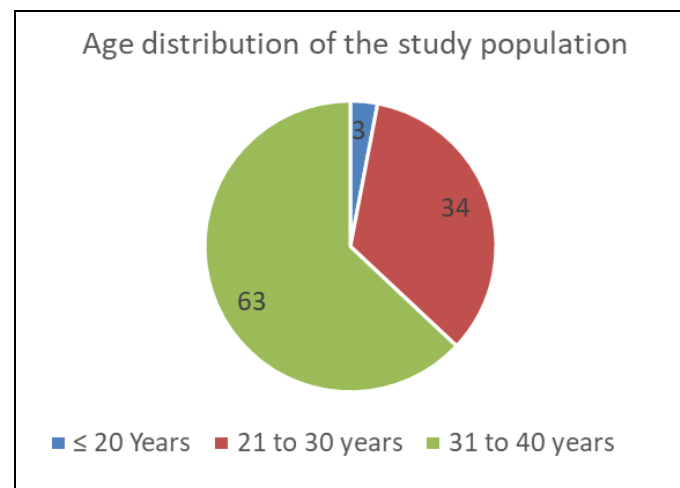
Fig 2: Age distribution of the study population

Table 2: Descriptive Statistics of Age

| Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age	100	18	40	30.73	4.649

Average age of the total population 30.73 ± 4.64 years. Minimum age was 18 years while maximum age was 40 years.

**Table 3:** Age distribution stratified by ACL tear grades

Age Group	Total (N=100)		ACL tear grade 2 (N=30)		ACL tear grade 3 (N=70)		P
	frequency	%	frequency	%	frequency	%	
≤ 20 Years	3	3	2	6.67	1	1.4	0.155
21 to 30 years	34	34	10	33.33	24	34.3	0.923
31 to 40 years	63	63	18	60.00	45	64.3	0.684
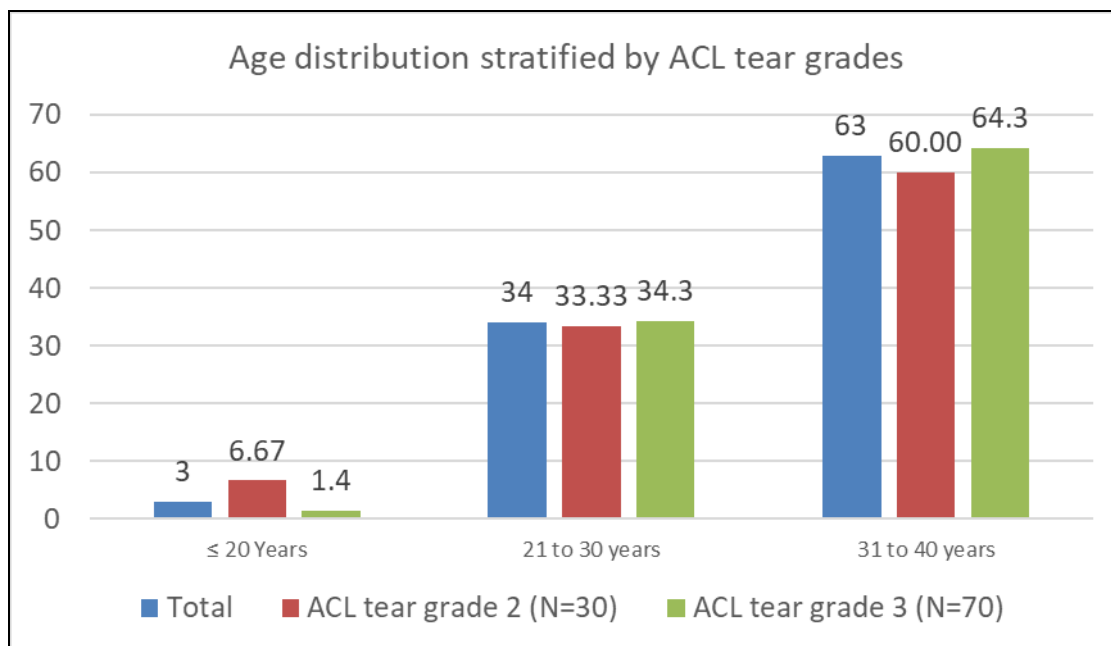
Fig 3: There was comparable distribution of age between groups based on tear grades which suggests that age is unrelated to tear grades (all p values>0.05)

Table 3: Distribution of ACL tear based on MRI diagnosis.

MRI Tear grade	Frequency	Percentage
Grade II tear	30	30
Grade III tear	70	70
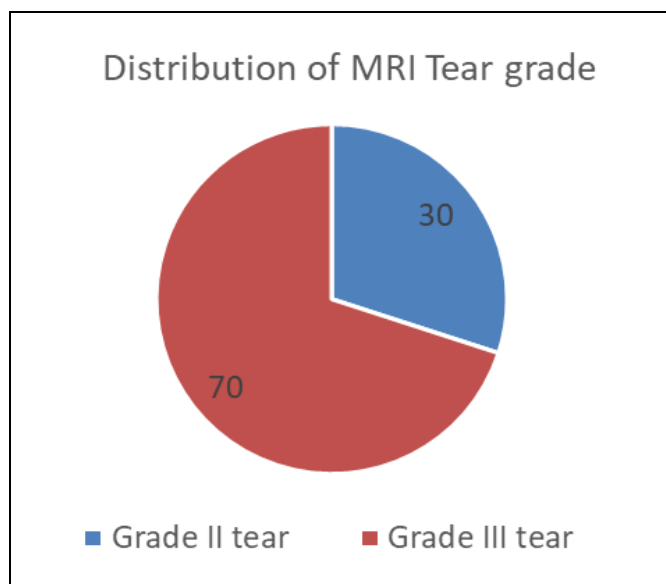
Fig 4: 30% cases were found to have grade II ACL tear and 70% cases were found to have grade III ACL tear.

Table 4: Distribution of Cause of Injury

Cause of Injury	Frequency	Percentage
Fall at house	17	17
Road Traffic Accident	65	65
Sports injury	18	18
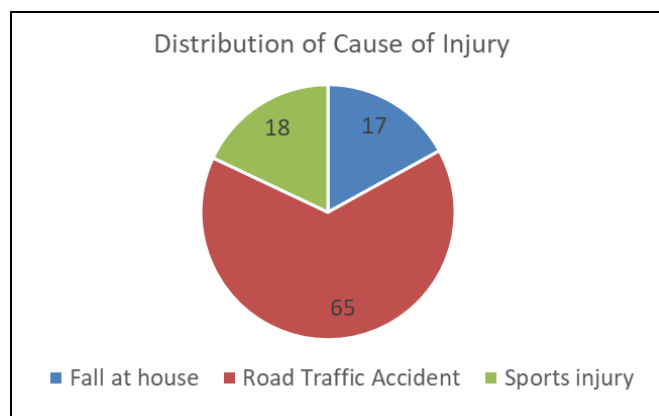
Fig 5: 65% ACL injuries were caused due to road traffic accidents. Sports' injuries responsible for 18% ACL injuries. Fall at house leading to ACL tear was reported by 17% cases

Table 5: Clinical features of ACL injury patients.

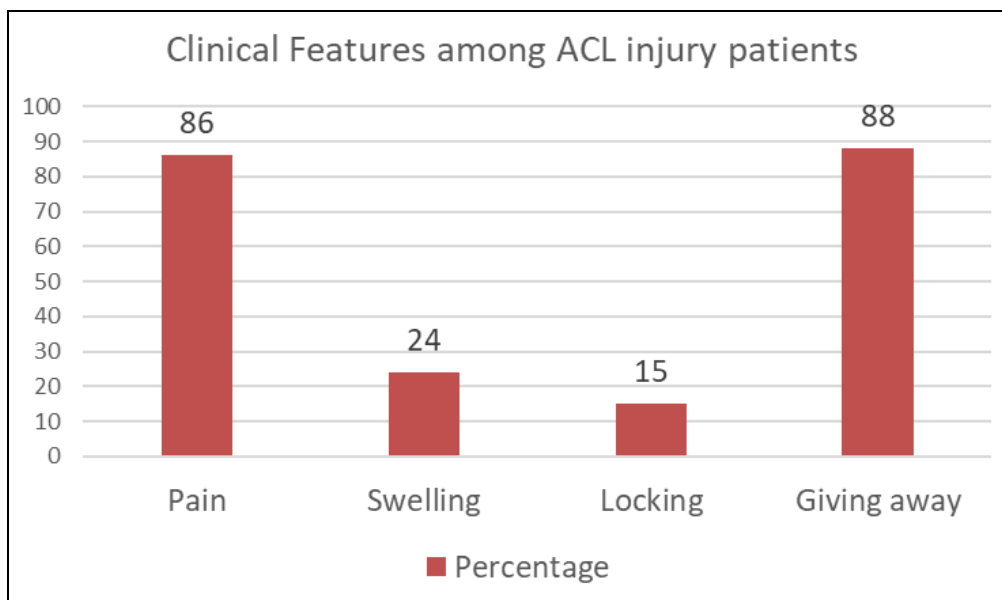| Clinical Symptom	Number	Percentage
Pain	86	86
Swelling	24	24
Locking	15	15
Giving away	88	88

Fig 6: The commonest symptom presented was instability or feeling of giving away (88%) followed by pain (86%). Swelling was observed in 24 cases while locking was reported by 15 cases.

Table 7: Pre-operative Assessment of ACL injuries using Lachman test

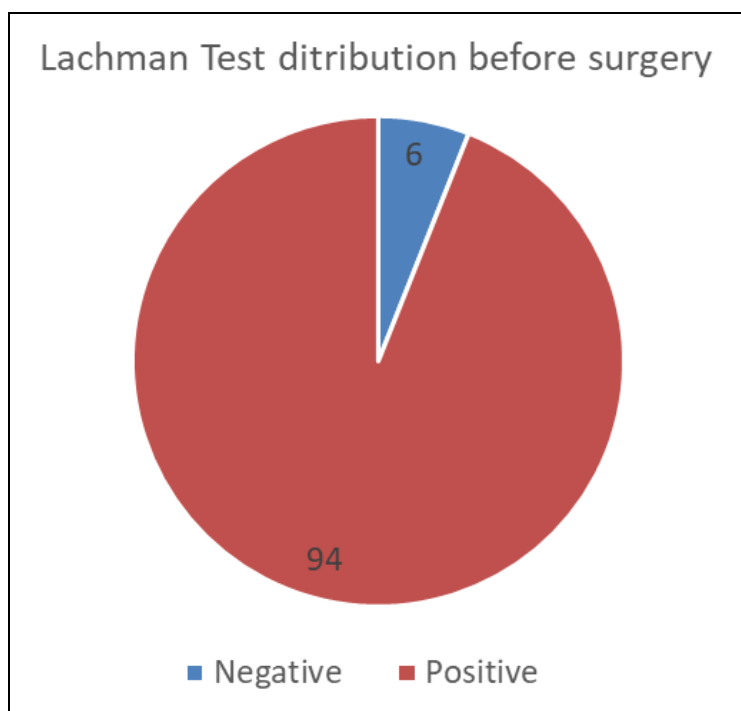| Lachman Test	Frequency	%
Negative	6	6
Positive	94	94

Fig 7: Lachman test was found positive in 94% of the cases and negative in 6% of the cases.

Table 8: Pre-operative Assessment of ACL injuries using Pivot Shift test

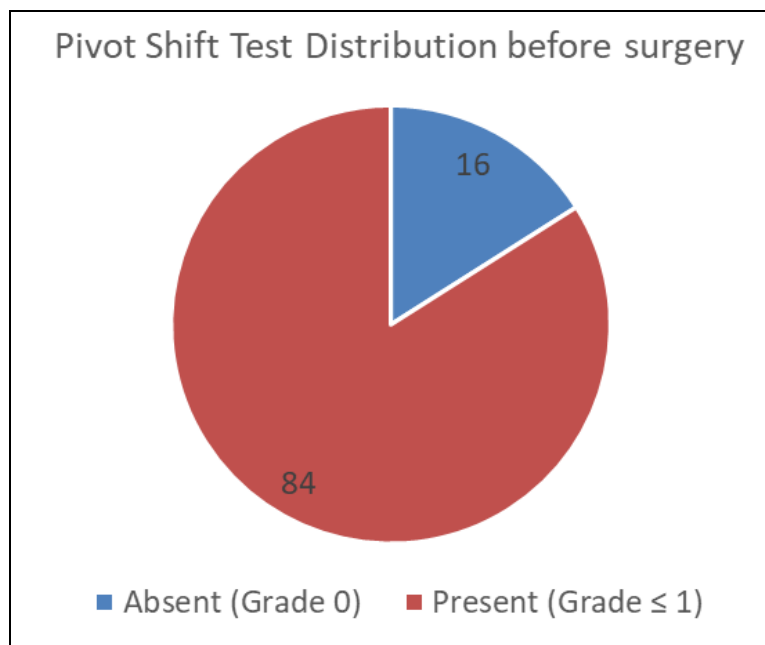| Pivot Shift Test Instability Grade	Frequency	%
Absent (Grade 0)	16	16
Present (Grade ≤ 1)	84	84

Fig 8: There was slight to definite subluxation in 84% of the cases whereas in 16% of the cases Pivot shift was graded as 0 i.e. subluxation was absent.

Table 9: Pre-operative Assessment of ACL injuries using Lysholm knee Score

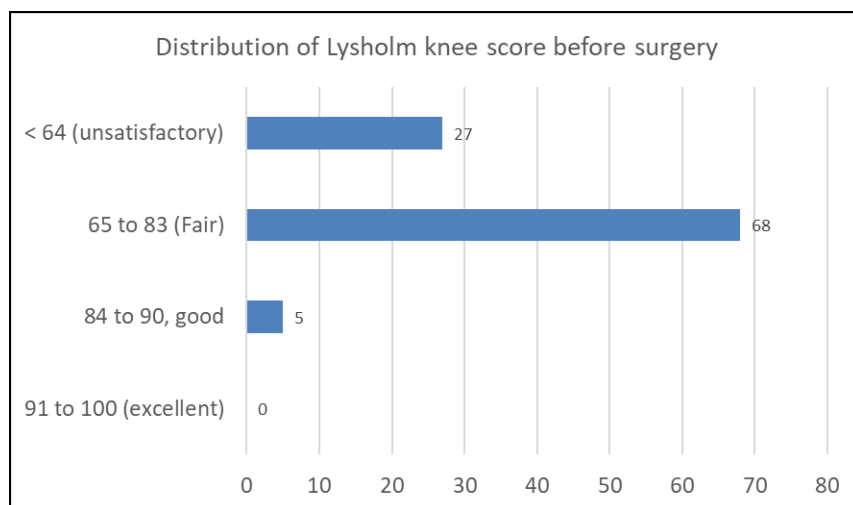| Lysholm knee Score (Before Surgery)	Frequency	%
91 to 100 (excellent)	0	0
84 to 90 (good)	5	5
65 to 83 (Fair)	68	68
< 64 (unsatisfactory)	27	27

Fig 9: Lysholm knee score was unsatisfactory i.e. (<64) in 27% patients. Lysholm knee score was fair (65-83) among 68% patients and it was good (84-90) in 5% patients.

Table 10: Comparison of mean Pre-operative Lysholm knee score between MRI diagnosed ACL injuries grades.

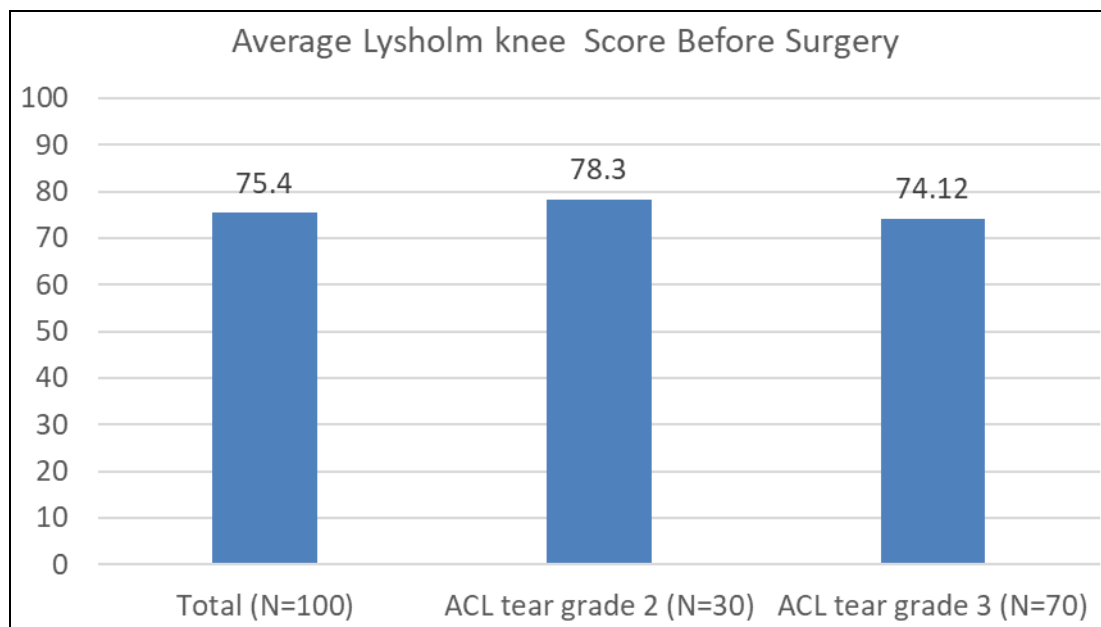|	Total (N=100)		ACL tear grade 2 (N=30)		ACL tear grade 3 (N=70)		P
Lysholm knee Score Before Surgery	Mean	SD	Mean	SD	Mean	SD	
	75.4	8.2	78.3	8.4	74.12	9.1	0.031

Fig 10: Average preoperative Lysholm knee Score was 75.4± 8.2. Average Lysholm knee Score Before Surgery in grade II tear patient group (78.3 ±8.4) was significantly higher than grade III tear patient group (74.12 ±9.1) (p=0.03)

Table 11: Post-operative Assessment of ACL injuries using Lysholm knee Score

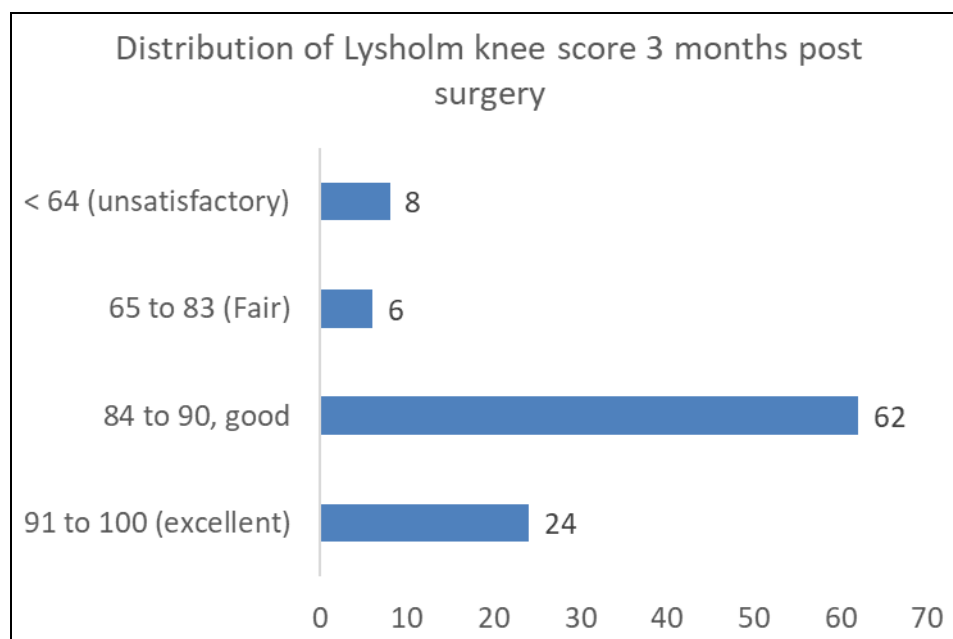| Lysholm knee Score (After 3 months)	Frequency	%
91 to 100 (excellent)	24	24
84 to 90, good	62	62
65 to 83 (Fair)	6	6
< 64 (unsatisfactory)	8	8

Fig 11: After 3 months of surgery, Lysholm knee score was good (84-90) in majority (62%) of the patients, excellent (91-100) in 24% of the cases, fair (65-83) among 6% patients and was unsatisfactory i.e. (<64) in 8% patients.

Table 12: Comparison of mean Post-operative Lysholm knee score between MRI diagnosed ACL injuries grades.

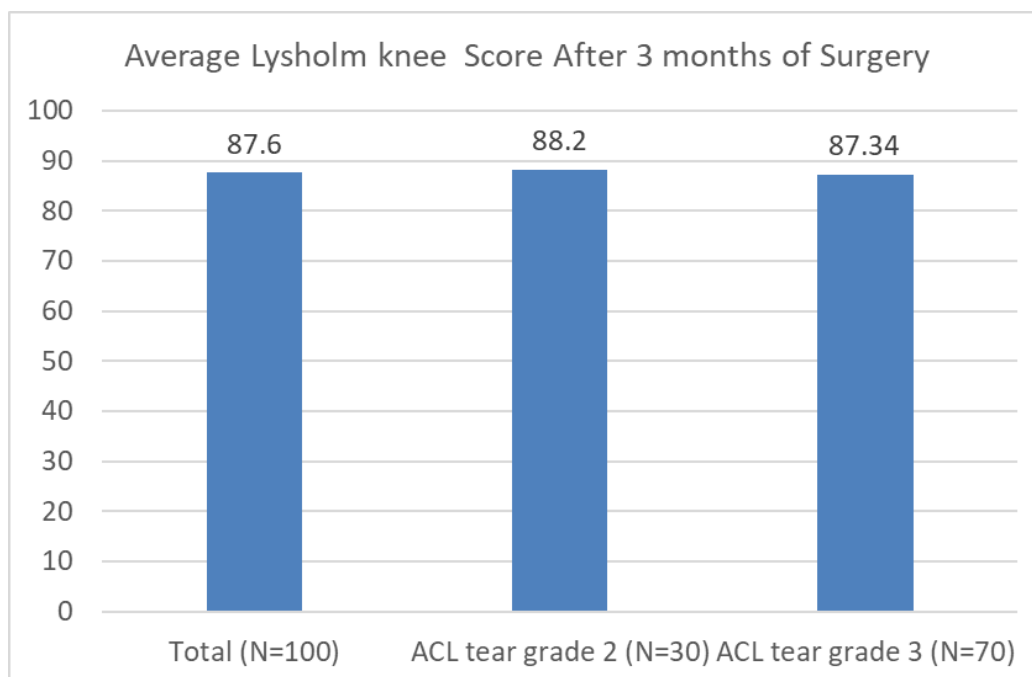| Lysholm knee Score	Total (N=100)		ACL tear grade 2 (N=30)		ACL tear grade 3 (N=70)		P
	Mean	SD	Mean	SD	Mean	SD	
After 3 months	87.6	12.8	88.2	16.5	87.34	15.8	0.806

Fig 12: Average Lysholm knee Score after 3 months of surgery was 87.6± 12.8. Average Lysholm knee Score after 3 months of surgery in grade II tear patient group was 88.2 16.5 was slightly higher than grade III tear patient group (87.34 ±15.8). However the difference of mean was non-significant (p=0.806)

Table 13: Comparison of average Duration of hospital stay (in days)

Duration of hospital stay (in days)	Total (N=100)		ACL tear grade 2 (N=30)		ACL tear grade 3 (N=70)		P
	Mean	SD	Mean	SD	Mean	SD	
	3.42	1.02	3.39	1	3.43	1.01	0.856
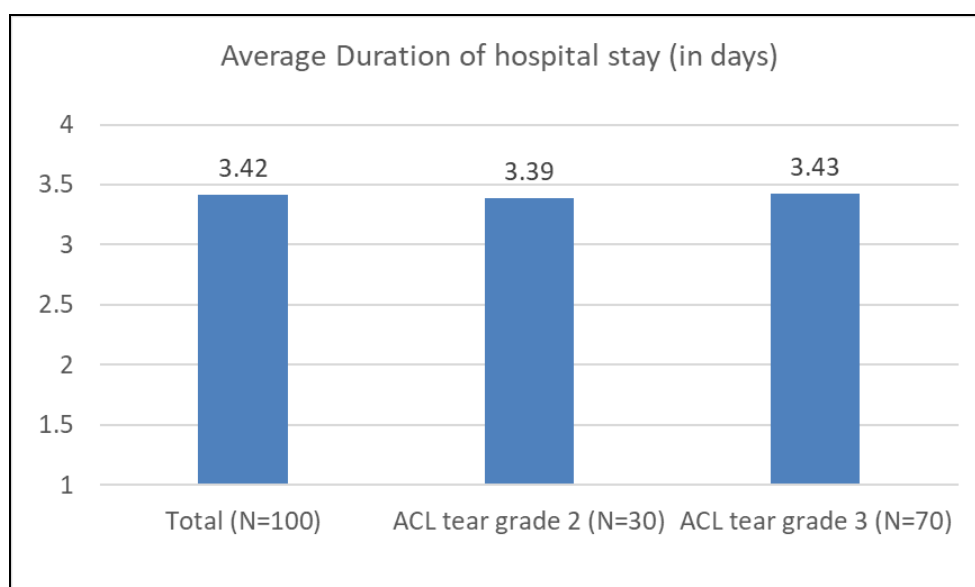
Fig 13: Average duration of hospital stay was 3.42± 1.02. Average duration of hospital stay in grade II tear patient group was 3.39± 1.was slightly lesser than grade III tear patient group (3.43 ±1.01). However the difference of mean was non-significant (p=0.856)

Table 14: Postoperative complications

Postoperative complications	Number	Percentage
Consistant Pain	5	5
Re -rupture	0	0
Graft infection	0	0
Reduced range of motion	6	6

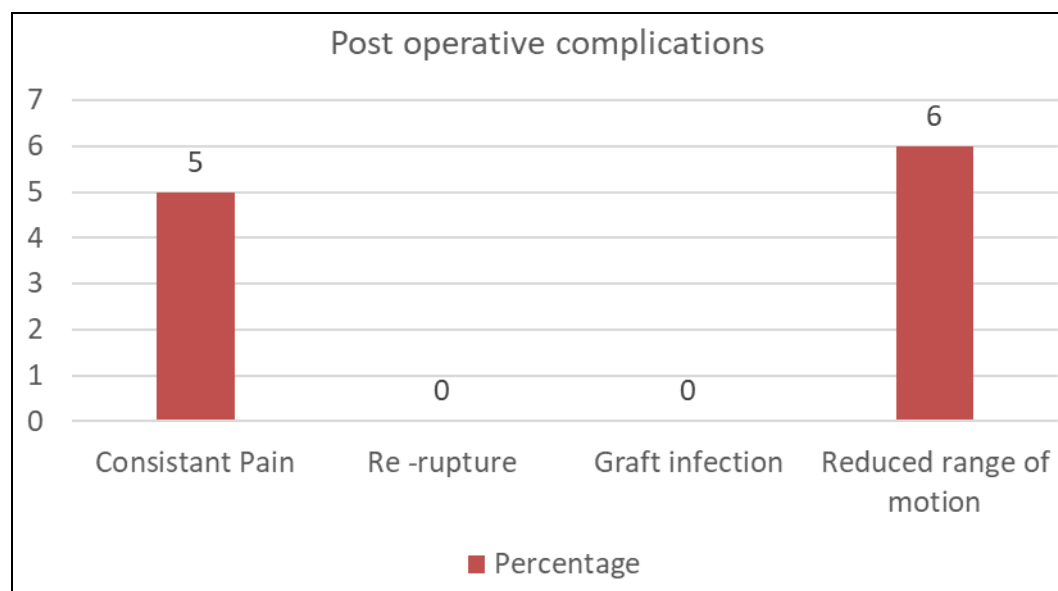**Fig 14:** Post-operative complications

Consistent pain was reported by 5 cases during 3 month follow up.

Re-rupture was not reported.

Reduced range of motion was observed in 6 cases.

Discussion

In this prospective observational study conducted at tertiary academic institute we studied, 100 patients with documented isolated ACL tear (by physical examination and MRI) that had single bundle anatomic arthroscopic ACL reconstruction with autograft. All patients met our inclusion criteria and were followed up for 3 months. 30% cases were found to have grade II ACL tear and 70% cases were found to have grade III ACL tear.

Average age of the total population 30.73 ± 4.64 years. Minimum age was 18 years while maximum age was 40 years.

Chodavarapu LM et al. [22] reported that the mean age of the patients involved was 26.9 years, with a male preponderance. Also a study of 100 cases reported that mean age of patients was 28.3 ± 13.4 years. [23].

A nationwide study in Iceland [24] indicated that in case of ACL rupture for males the peak incidence was in their early twenties. Females showed two peaks, one in their teens and another in their forties resulting in an older average age at rupture compared to males (35 ± 16 vs 33 ± 13, p = 0.06).

There were 62 males and 38 females in the study population and the male to female ratio was found to be 1:0.61. The male preponderance was similar to many Indian studies [22-24].

Our finding was similar to Chodavarapu LM et al. [22] who reported that 60% had a left sided injury but different than other Indian study by Jagtap et al. [24] who reported that 18 out of 30 patients (60%) got right knee involvement and 12 left knee ACL tear (40%).

In majority of the cases, Road traffic accidents was reported as cause in 64% ACL tears in Indian study [22].

A Serbian study [25] reported Sports injuries, as the most frequent cause of anterior cruciate ligament injuries, were recorded in 88% of patients, injuries occurring in everyday activities in 11% and in traffic in 1%.

"Giving out" while cutting and pivoting is the most specific for diagnosis of ACL tear [27] and it was the commonest symptom shown by (88%) of the patients in our study, followed by pain (86%) then Swelling. All these parameters were assessed to derive Lysholm Knee Scoring Scale.

The Lysholm scale is reliable for use in research on ligament and meniscal injuries, chondral injuries, and patellar dislocation. It is important that researchers consistently utilize the same scale version [28] Average preoperative Lysholm knee Score in our study was 75.4± 8.2. Average Lysholm knee Score Before Surgery in grade II tear patient group (78.3 ±8.4) was significantly higher than grade III tear patient group (74.12 ±9.1) (p=0.03)

Lysholm scale was used by various studies for assessing functional outcomes of single bundle ACL repair surgery.

In our study average Lysholm knee Score after 3 months of surgery was 87.6± 12.8. Average Lysholm knee Score after 3 months of surgery in grade II tear patient group was 88.2 16.5 was slightly higher than grade III tear patient group (87.34 ±15.8). However the difference of mean was non-significant (p=0.806).

The outcome in our study was comparable to many studies. The Average post-operative Lysholm score reported by Jarvela et al. [29] was 89, by Siebold et al. [30] was 90 and by Muneta et al. [31] was 95.

When distribution of outcomes was observed after 3 months of surgery, Lysholm knee score was good (84-90) in majority (62%) of the patients, excellent (91-100) in 24% of the cases, fair (65-83) among 6% patients and was unsatisfactory i.e. (<64) in only 8% patients.

Lysholm scoring in our study significantly improved from mean preoperative scoring 75.4± 8.2. to a mean postoperative score of 87.6± 12.8. with a p value <0.001 which is comparable to Williams et al. [32] in which the mean score improved from 55 points to 91 points post operatively at a 2 year follow up (p<0.01)

Maneuvers- the Lachman test and the pivot shift test-- are useful in assessment for ACL tear. In a recent meta-analysis of 28 studies, the pooled sensitivity and specificity of the Lachman test for ACL tear was 85% and 94%, respectively. [33] For the pivot shift, specificity was high (98%) but sensitivity was low (24%).

When we did pre-operative assessment, it was found that there was slight to definite subluxation in 84% of the cases whereas in 16% of the cases Pivot shift was graded as 0 i.e subluxation was absent. Lachman test was found positive in 94% of the cases and negative in 6% of the cases. Magnetic resonance imaging (MRI) is generally used to confirm the

diagnosis. MRI had a sensitivity of 86%, specificity of 95%, and accuracy of 93% for ACL tear [34].

Based on MRI findings 30% cases have grade II ACL tear and 70% cases have grade III ACL tear.

Postoperative infection is a rare but potentially devastating complication after anterior cruciate ligament reconstruction surgery (ACLRS). The incidence of postoperative infection after ACLRS has been reported to be between 0.1% and 2.4% [35, 36]. The incidence of infection reported by Gupta *et al.* [37] was 1.2% (17/1468).

We found one case of post-operative infection (1% incidence) which was similar to the other studies [35, 37].

Summary

This prospective observational study conducted at tertiary academic institute. We studied, 100 patients with documented isolated ACL tear (by physical examination and MRI) that had single bundle anatomic arthroscopic ACL reconstruction with autograft. All patients met our inclusion criteria and were followed up for 3 months.

1. There were 62 males and 38 females in the study population. Male to female ratio was found to be 1:0.61
2. Average age of the total population 30.73 ± 4.64 years. Minimum age was 18 years while maximum age was 40 years.
3. There was comparable distribution of age between groups based on tear grades which suggests that age is unrelated to tear grades (all p values>0.05)
4. 30% cases were found to have grade II ACL tear and 70% cases were found to have grade III ACL tear.
5. In majority of the cases I.e. 65% ACL injuries were caused due to road traffic accidents. Second most common cause was sports' injuries responsible for 18% ACL injuries fall at house leading to ACL tear was reported by 17% cases.
6. Left side injury was more common 58% than right side injury 42%.
7. The commonest symptom presented was instability or feeling of giving away
8. (88%) followed by pain (86%). Swelling was observed in 24 cases while locking was reported by 15 cases.
9. Lachman test was found positive in 94% of the cases and negative in 6% of the cases.
10. There was slight to definite subluxation in 84% of the cases whereas in 16% of the cases Pivot shift was graded as 0 i.e. subluxation was absent.
11. Lysholm knee score was unsatisfactory i.e. (<64) in 27% patients.
12. Lysholm knee score was fair (65-83) among 68% patients and it was good (84-90) in 5% patients.
13. Average preoperative Lysholm knee Score was 75.4 ± 8.2. Average Lysholm knee Score Before Surgery in grade II tear patient group (78.3 ± 8.4) was significantly higher than grade III tear patient group (74.12 ± 9.1) (p=0.03)
14. After 3 months of surgery, Lysholm knee score was good (84-90) in majority (62%) of the patients. It was found excellent (91-100) in 24% of the cases.
15. After 3 months of surgery Lysholm knee score was fair (65-83) among 6% patients and was unsatisfactory i.e. (<64) in 8% patients.
16. Average Lysholm knee Score after 3 months of surgery was 87.6 ± 12.8. Average Lysholm knee Score after 3 months of surgery in grade II tear patient group was 88.2 16.5 was slightly higher than grade III tear patient group (87.34 ± 15.8). However the difference of mean was non-significant (p=0.806)
17. Average duration of hospital stay was 3.42 ± 1.02. Average duration of hospital stay in grade II tear patient group was 3.39 ± 1.was slightly lesser than grade III tear patient group (3.43 ± 1.01). However the difference of mean was non-significant (p=0.856)

Conclusion

Single bundle anatomical ACL reconstruction is time tested technique. Adequate graft with appropriate thickness is a prerequisite for the success of surgery. Timing of surgery, precision in technique and adequate rehabilitation are the variables which influence strongly the outcome of surgery. Grade of injury does not affect the outcomes. Lysholm scores are useful parameters to access the outcome of surgery.

Subjective assessment of each individual after the reconstruction, during follow up sometimes is equally important than relying on objective scoring system.

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