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Prospective study of surgical management of anterior cruciate ligament injury using bone patellar tendon bone graft

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Abstract
Background: Anterior knee instability associated with rupture of anterior cruciate ligament (ACL) is a disabling clinical problem in general and especially in athletic individuals. ACL has a poor capacity of healing. The need for surgical correction of ACL injuries arises because, untreated complete injury to the ligament leads to progressive symptomatic instability leading to recurrent injury and damage to the menisci and articular cartilage thus resulting in early osteoarthritis. The bone-patellar tendon-bone auto graft has been widely accepted as the gold standard for ACL reconstruction with a high success rate.
Aim: To study the functional outcome of ACL reconstruction using BPTB graft, various advantages and complications following ACL reconstruction using BPTB graft.
Methods: The present study was carried out at Department of orthopaedics, Navodaya Medical College and Hospital, Raichur. It is a Descriptive observational study. All patients (30) with diagnosis of ACL tear are included during the period of September 2017 to August 2019.
Results: Majority of the patients *i.e.* 12 (40%) were from 15-25 years age group Male predominance was found in our study. 24 (80%) patients were males and 1 (20%) patient were females. Male to female ratio was 4:1.Right knee involvement was seen in 18 patients *i.e.* 60% and left sided knee involvement was seen in 12 (40%). In majority of the patients *i.e* 15 (50%), sports was the commonest mode of injury. Knee pain was commonest symptom in 15 *i.e.* 50% patients. Instability was complained by 9 (30%), knee pain with instability by 4 (13.3%) and locking by 2 (6.7%). Mean score at 3 months was 80.2±12.3. At 6 months was 85.3±9.2. At 1 year was 91.1±8.7. At 18 months was 94.2±8.1 and at 2 years it was 95.8±7.1. When we compared the mean XIV score at different follow up periods, it was found to be statistically significant (p<0.05). Outcome evaluation after surgery was assessed by using Lysholm & Gillquist Knee Scoring Scale. The result was found to be good in 14 *i.e.* 46.7%, excellent in 12 *i.e.* 40% and fair in 4 *i.e.* 13.3% patients. Results of Anterior Drawer test at 3 months was negative in 27 *i.e.* 90% patients and 1+ in 3 *i.e.* 10% patients, at 6 months was negative in 29 *i.e.* 96.7% patients and 1 + in 1 *i.e.* 3.3% patients. Results of Anterior Drawer test at one year was negative in 29 *i.e.* 96.7% patients and 1+ in 1 *i.e.* 3.3% patients. In 29(96.7%) of patients, there was no decrease in range of movement whereas in 1(3.3%) the movement was restricted at ≥ 20 degree at the end of 1 years follow up. Prevalence of complications was reported as 23.3% in our study. In 4 patients *i.e.* 13.3% anterior knee pain was commonly observed complication. Superficial infection, deep infection and extensor leg was seen in 1 patient each *i.e.* 3.3%.
Conclusions: Most commonly affected age group was 15-25 years with male preponderance. Commonest cause of ACL tear was sports injury. In 86.7% cases, good to excellent result was observed. Prevalence of complications was reported as 23.3%.

Keywords: Anterior cruciate ligament tears, outcome, bone patellar tendon bone graft

Introduction
Anterior cruciate ligament ruptures are “the beginning of the end of Knee” The knee joint is the most commonly injured of all joints and the anterior cruciate ligament is the most commonly injured ligament. The modern high speed vehicular trauma and sporting life style has led to in-creased ligament injuries of the knee. The anterior cruciate ligament forms the pivot in the functional congruence and stability of the knee in association with the other ligaments, capsule, muscles and bone.

Anterior cruciate ligament (ACL) is an intra-articular, extra synovial structure present in the central complex of the knee joint which along with other structures in and around knee joint controls, limits motion and maintains static and dynamic equilibrium of knee joint. ACL is commonly injured in athletic activities and in road traffic accidents example: when a sudden loading or tension is placed on the ligament as when a running athlete plants a foot to suddenly decelerate or change direction.

Anterior knee instability associated with rupture of ACL is a disabling clinical problem in general and especially in athletic individuals. ACL has a poor capacity of healing. The need for surgical correction of ACL injuries arises because, untreated complete injury to the ligament leads to progressive symptomatic instability leading to recurrent injury and damage to the menisci and articular cartilage thus resulting in early osteoarthritis.

Reconstruction of ACL allows the patient to return to a pre trauma activity level and delays the occurrence of associated meniscal injury and on-set of osteoarthritis. 10 The incidence of associated cartilage damage in acute tears is reported at 15 - 40% whereas it increases to 79% in chronic tears.

Numerous authors have described successful reconstruction of ACL (ACLR) with use of auto grafts (e.g. Patellar tendon, hamstring tendons, distally based ilio tibial band (ITB), fascia late etc) and allografts (e.g. Achillis tendon, tibialis anterior, patellar tendon, hamstring tendons etc.)

The Bone-Patellar tendon-Bone auto graft the most commonly used auto graft for reconstruction. The bone-patellar tendon-bone auto graft has been widely accepted as the gold standard for ACL reconstruction with a high success rate.

The bone - patellar tendon - bone graft usually is an 8- to 11-mm-wide graft taken from the central third of the patellar tendon, with its adjacent patella and tibial bone blocks. This graft's attractive features include its high ultimate tensile load (approximately 2300 N), its stiffness (approximately 620 N / mm), and the possibility for rigid fixation with its attached bony ends and early incorporation. However, donor site morbidities and extensor mechanism problems associated with the use of the bone-patellar tendon-bone are the two most commonly encountered problems.

With this background, in our study we have analyzed the outcome of surgical management of ACL reconstruction using autologous ipsilateral bone patellar tendon bone graft (BPTB).

Methodology

This study was carried out in Narayan Medical College and Hospital, Jamuhar. This is a Descriptive observational study, period from December 2019 to August 2021, with Anterior cruciate ligament tear, minimum of 30 patients who attended in the OPD and casualty were admitted in this hospital and were evaluated clinically and radio graphically.

Inclusion criteria

1. Anterior cruciate ligament tear confirmed by Latchman test, anterior drawer test, classic pivot shift maneuver of Macintosh and Galway, flexion-rotation drawer test, Mcmurrays test, valgus and varus test and MRI
2. Age between 15-50 years
3. Those willing to participate after informed consent

Exclusion criteria

1. Below 15 and above 50 years age
2. Patients with immunocom promised status
3. Pregnant and lactating mothers
4. ACL injury associated with bone injury around knee Osteoarthritic changes on x ray
5. Those who are not willing to participate

Results

Data was analysed using Statistical Package for Social Sciences (SPSS) version 21, IBM Inc. Descriptive data was reported for each variable. Descriptive statistics such as mean and standard deviation for continuous variables was calculated.

Summarized data was presented using Tables and Graphs. Shapiro Wilk test was used to check the normality of the data. As the data was found to be normally distributed bivariate analyses was performed using Independent test and. Comparison of categorical variables was done using Chi square test. Level of statistical significance was set at p-value less than 0.05 and was denoted as *.

Table 1: Distribution according to age

		Frequency	Percent
Age group in years	15-25	12	40.0
	26-35	8	26.7
	36-45	6	20.0
	45-55	4	13.3
	Total	30	100.0

We included total 30 patients in our study according to eligibility criteria.

In our study, majority of the patients *i.e.* 12 (40%) were from 15-25 years age group followed by 8 *i.e.* 26.7% from 26-35 years, 6 (20%) from 36-45 years group. Least were from 45-55 years age group *i.e.* 4 (13.3%)

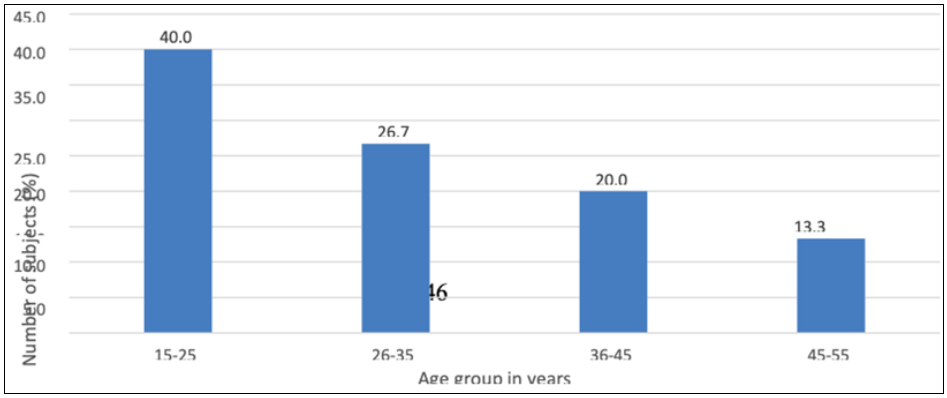

Fig 1: Bar diagram showing Distribution according to age

Table 2: Distribution according to gender

		Frequency	Percent
Gender	Male	24	80.0
	Female	6	20.0
	Total	30	100.0

Male predominance was found in our study. 24(80%) patients were males and 1 (20%) patient were females. Male to female ratio was 4:1

This was probably because males are more frequently involved in sports and road traffic accidents.

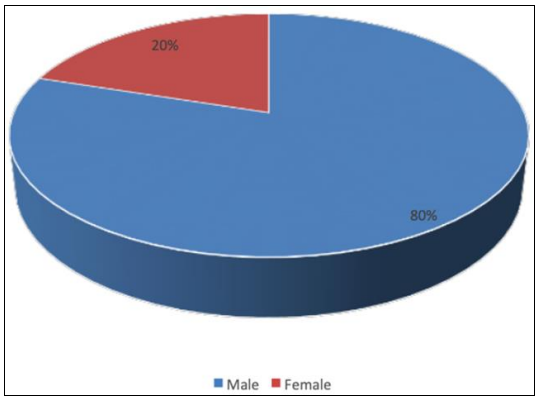

Fig 2: Pie diagram showing Distribution according to gender

Table 3: Distribution according to knee involved

		Frequency	Percent
Knee involved	Right	18	60.0
	Left	12	40.0
	Total	30	100.0

Out of 30 knee injuries, right sided involvement was seen in 18 patients *i.e*. 60% and left sided knee involvement was seen in 12 *i.e* 40%.

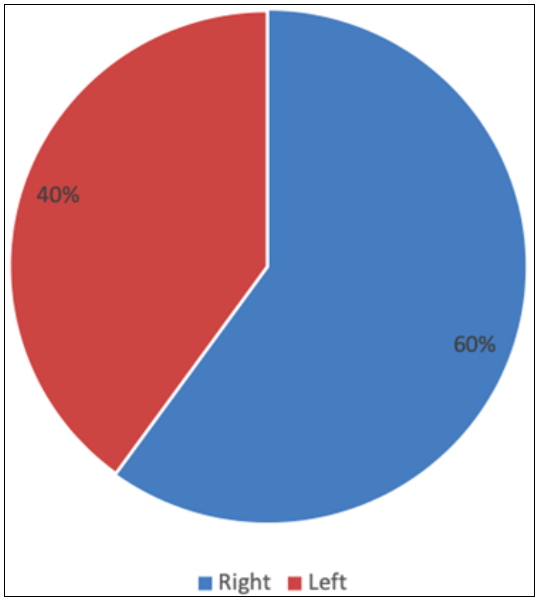

Fig 3: Pie diagram showing Distribution according to knee involved

Table 4: Distribution according to associated knee injury

		Frequency	Percent
Associated injury	Isolated tear	14	46.7
	ACL+LM	3	10.0
	ACL+MM	13	43.3
	Total	30	100.0

Isolated ACL tear was found in 14 (46.7%) patients. ACL and medial meniscus injury was seen in 13 *i.e*. 43.3%. ACL and lateral meniscus tear reported in 3(10%) patients.

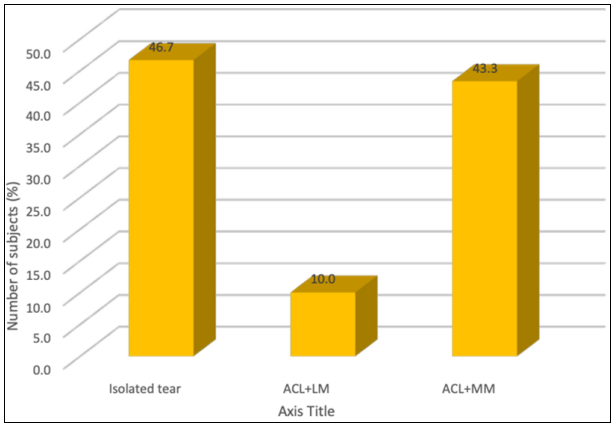

Fig 4: Bar diagram showing Distribution according to associated knee injury

Table 5: Distribution according to mode of injury

		Frequency	Percent
Mode of injury	Sports	15	50.0
	RTA	12	40.0
	Fall	3	10.0
	Total	30	100.0

In majority of the patients *i.e* 15 (50%), sports was the commonest mode of injury, followed by raod traffic accidents in 12 *i.e*. 40% and falls in 3 *i.e*. 10% patients.

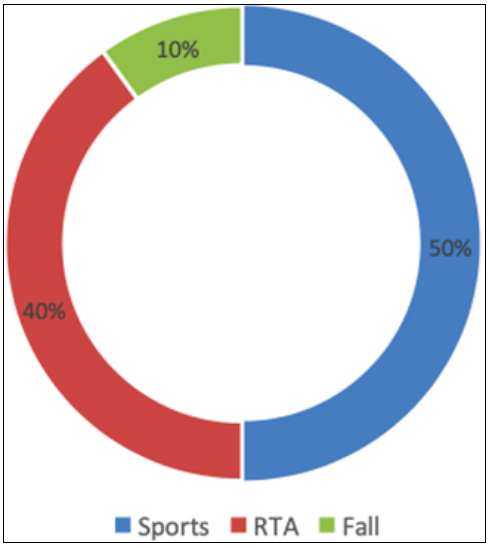

Fig 5: Pie diagram showing Distribution according to mode of injury

Table 6: Distribution according to duration of injury

		Frequency	Percent
Duration of injury	Up to 6 weeks	12	40.0
	6 weeks to 3 months	7	23.3
	3 months to 6 months	6	20.0
	6 months to 1 year	3	10.0
	More than 1 year	2	6.7
	Total	30	100.0

Majority of patients were reported within 6 weeks of injury *i.e*. 12 (40%). 23.3% were reported between 6 weeks to 3 months of injury. Only 2 patients (6.7%) were observed to have more than one year duration of injury.

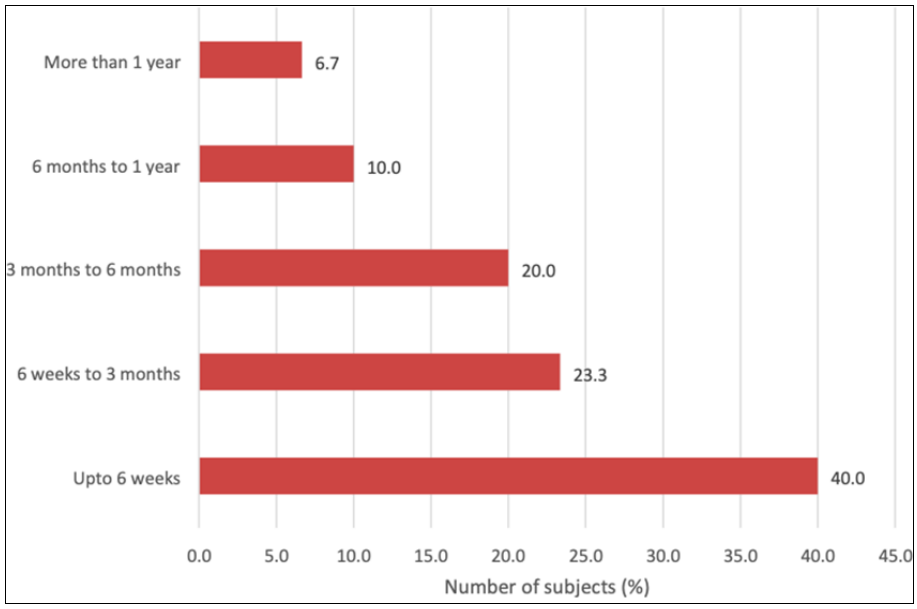

Fig 6: Bar diagram showing Distribution according to duration of injury

Table 7: Distribution according to symptoms at presentation

		Frequency	Percent
Symptoms at presentation	Knee pain	15	50.0
	Instability	9	30.0
	Locking	2	6.7
	Knee pain and instability	4	13.3
	Total	30	100.0

When we enquired about chief complaints, knee pain was commonest in 15 *i.e.* 50% patients. Instability was complained by 9 (30%), knee pain with instability by 4 (13.3%) and locking by 2 (6.7%)

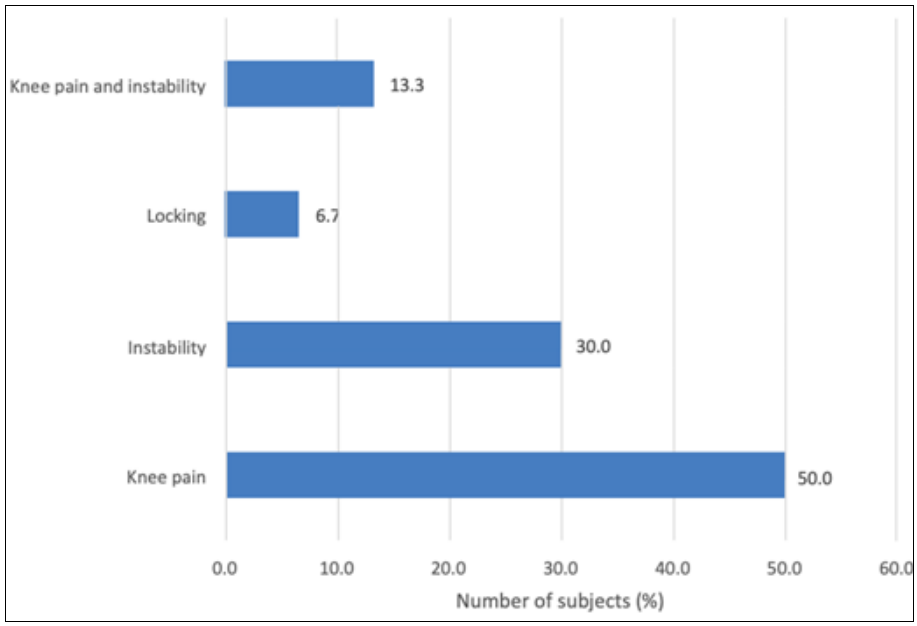

Fig 7: Bar diagram showing Distribution according to symptoms at presentation

Table 8: Distribution according to Lyshlom score

	Mean	SD	F	p	Inference
At 3 months	80.2	12.3	8.2	0.032 (<0.05)	Significant
At 6 months	85.3	9.2			
At 1 year	91.1	8.7			
At 18 months	94.2	8.1			
At 2 years	95.8	7.1			

Mean score at 3 months was 80.2±12.3. At 6 months was 85.3±9.2. At 1 year was 91.1±8.7. At 18 months was 94.2±8.1 and at 2 years it was 95.8±7.1.

When we compared the mean score at different follow up periods, it was found to be statistically significant (p<0.05).

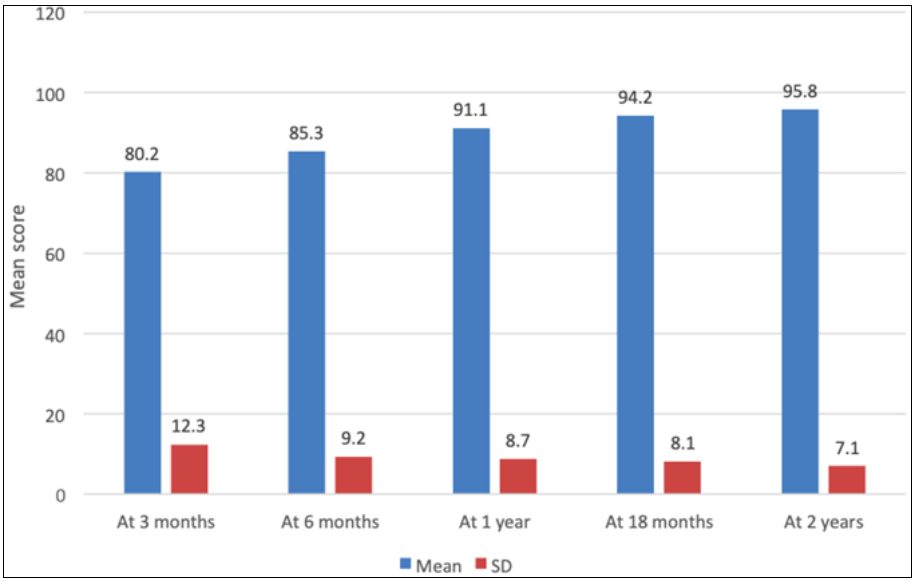

Fig 8: Bar diagram showing Distribution according to Lyshlom score

Table 9: Outcome assessment according to Lysholm & Gillquist Knee Scoring Scale

		Frequency	Percent
Lysholm & Gillquist Knee Scoring Scale	Excellent	12	40.0
	Good	14	46.7
	Fair	4	13.3
	Total	30	100.0

Outcome evaluation after surgery was assessed by using Lysholm & Gillquist Knee Scoring Scale. The result was found to be good in 14 *i.e.* 46.7%, excellent in 12 *i.e.* 40% and fair in 4 *i.e.* 13.3% patients

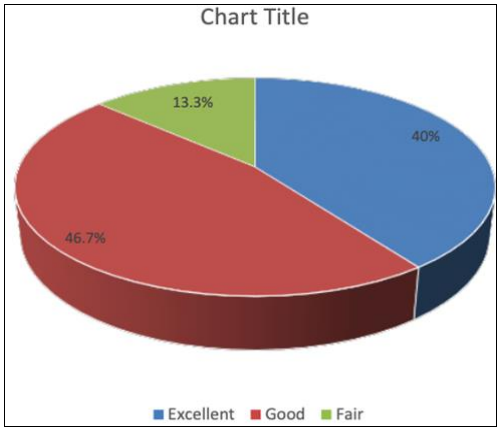

Fig 9: Pie diagram showing Outcome assessment according to Lysholm & Gillquist Knee Scoring Scale

Table 10: Outcome assessment of anterior knee pain questionnaire

		Frequency	Percent
AKP outcome	None	19	63.3
	Mild	5	16.7
	Moderate	4	13.3
	Severe	2	6.7
	Total	30	100.0

Anterior knee pain revealed that in majority of the patients *i.e.* 19 (63.3%), pain was absent. Mild pain was seen in 5 *i.e.* 16.7%, moderate in 4 *i.e.* 13.3 and severe in 2 *i.e.* 6.7% patients.

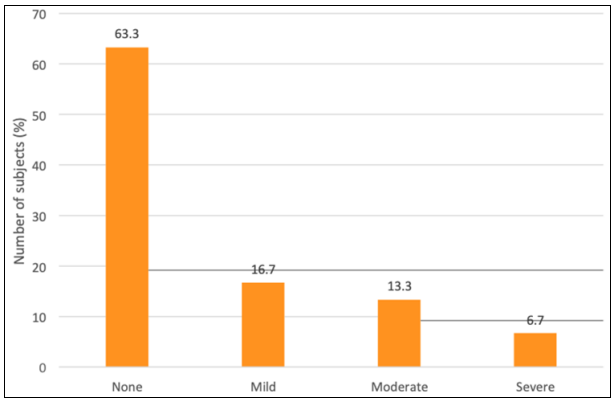

Fig 10: Bar diagram showing Outcome assessment of Anterior knee pain questionnaire

Table 11: Evaluation by Anterior Drawer test at 3 months

		Frequency	Percent
Anterior Drawer test at 3 months	Negative	27	90.0
	1 +	3	10.0
	Total	29	96.7

Results of Anterior Drawer test at 3 months was negative in 27 *i.e.* 90% patients and 1+ in 3 *i.e.* 10% patients

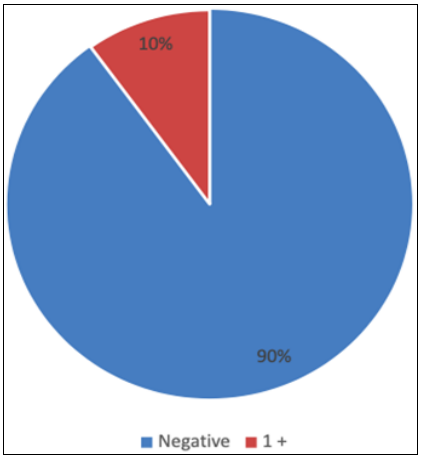

Fig 11: Pie diagram showing Evaluation by Anterior Drawer test at 3 months

Table 12: Evaluation by Anterior Drawer test at 6 months

		Frequency	Percent
Anterior Drawer test 6 months	Negative	29	96.7
	1 +	1	3.3
	Total	30	100.0

Results of Anterior Drawer test at 6 months was negative in 29 *i.e.* 96.7% patients and 1+ in 1 *i.e.* 3.3% patients

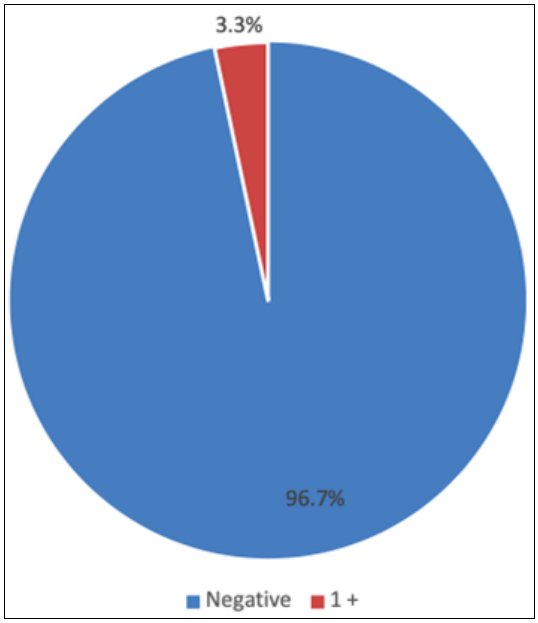

Fig 12: Pie diagram showing Evaluation by Anterior Drawer test at 6 months

Table 13: Evaluation by Anterior Drawer test at 1 year

		Frequency	Percent
Anterior Drawer test at 1 year	Negative	29	96.7
	1+	1	3.3
	Total	30	100.0

Results of Anterior Drawer test at one year was negative in 29 *i.e.* 96.7% patients and 1+ in 1 *i.e.* 3.3% patients

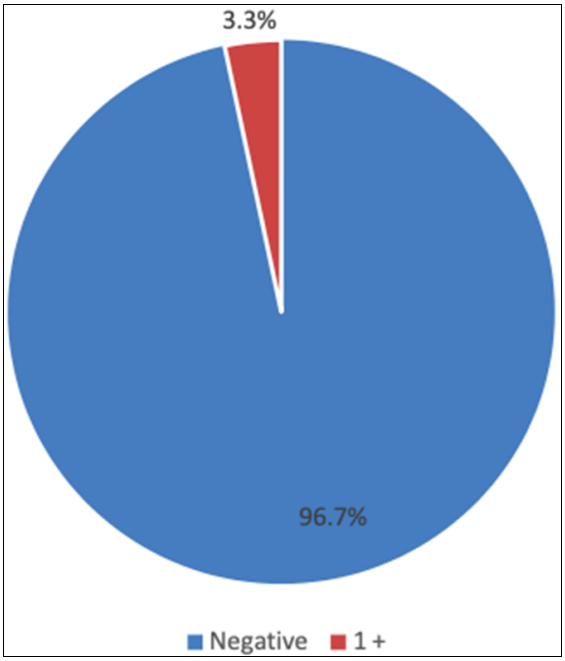

Fig 13: Pie diagram showing Evaluation by Anterior Drawer test at 1 year

Table 14: Evaluation by Range of movement at 3 months

		Frequency	Percent
Range of movement at 3 months	No decreased ROM	27	90.0
	Unto 10 degree	3	10.0
	Total	30	100.0

We assessed the outcome in terms of range of movement at knee joint. In 27 (90%) of patients, there was no decrease in range of movement whereas in 3 (10%) the movement was restricted upto 10 degree.

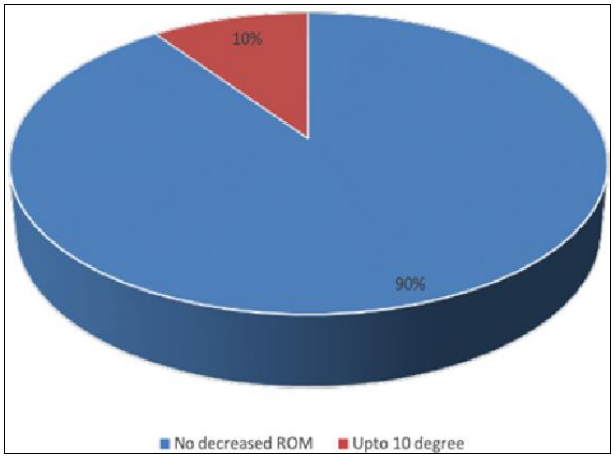

Fig 14: Pie diagram showing Evaluation by Range of movement at 3 months

Table 15: Evaluation by Range of movement at 6 months

		Frequency	Percent
Range of movement at 6 months	No decreased ROM	28	93.3
	Up to 10 degree	1	3.3
	? 20 degree	1	3.3
	Total	30	100.0

We assessed the outcome in terms of range of movement at knee joint. In 28(93.3%) of patients, there was no decrease in range of movement whereas in one patient each *i.e.*3.3% the movement was restricted upto 10 degree and ≥ 20 degree.

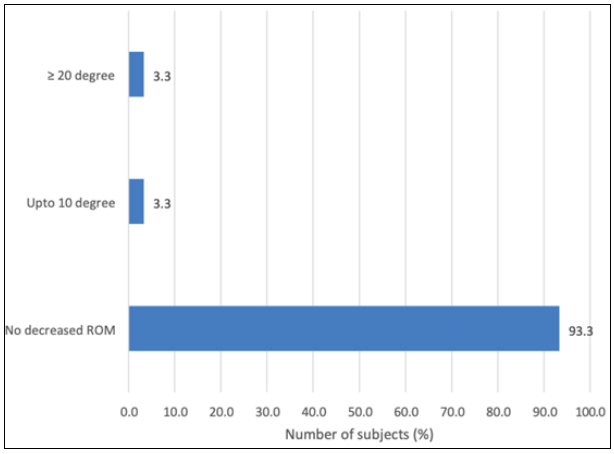

Fig 15: Bar diagram showing Evaluation by Range of movement at 6 months

Table 16: Evaluation by Range of movement at 1 year

		Frequency	Percent
Range of movement at 1 year	No decreased ROM	29	96.7
	a 20 degree	1	3.3
	Total	30	100.0

We assessed the outcome in terms of range of movement at knee joint. In 29(96.7%) of patients, there was no decrease in range of movement whereas in 1(3.3%) the movement was restricted at ≥ 20 degree.

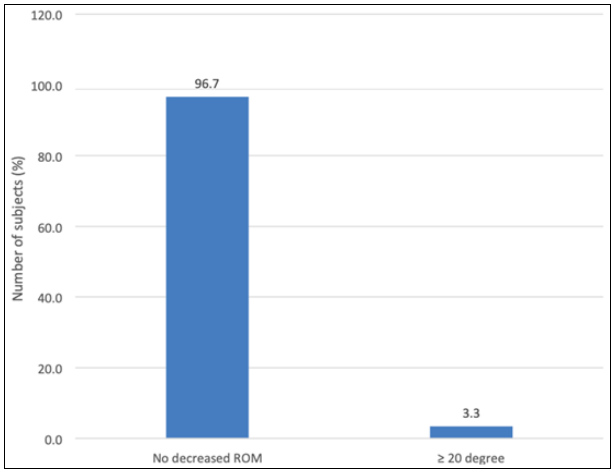

Fig 16: Bar diagram showing Evaluation by Range of movement at 1 year

Table 17: Complications in patients

	(n=30)	Frequency	Percent
Complications	Anterior knee pain	4	13.3
	Superficial infection	1	33
	Deep infection	1	13
	Extensor leg	1	3.3

Out of 30 patients who underwent surgery, complications were seen in only 7 patients. So prevalence of complications was reported as 23.3% in our study.

In 4 patients *i.e.* 13.3% anterior knee pain was commonly observed complication. Superficial infection, deep infection and extensor leg was seen in 1 patient each *i.e.* 3.3%.

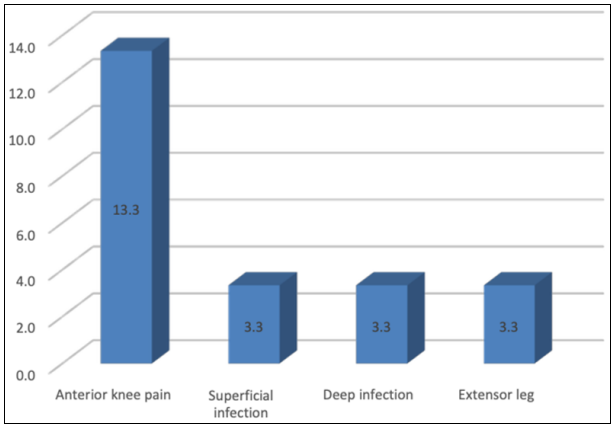

Fig 17: Bar diagram showing complications in patients

Discussion

At present the most commonly used grafts for ACL reconstructions are bone patellar tendon-bone auto graft and hamstring tendon grafts.

The central one third of the bone patellar tendon bone graft was used because of its excellent biomechanical properties. It is the strongest of the immediately available substitute. Precise location of its tissue ends influences joint kinematics. The graft can
be placed accurately during the surgery for it to act isometric ally both in its location and tension. Bone to bone healing is more secure and rapid when compared to other
grafts. It does not sacrifice the knee stabilizers. The bone-patellar tendon-bone graft is
time tested and has lesser complications and less significant morbidity.

Age and gender

we included total 30 patients in our study according to eligibility criteria. In our study, majority of the patients *i.e.* 12 (40%) were from 15-25 years age group followed by 8 *i.e.* 26.7% from 26-35 years, 6(20%) from 36-45 years group. Least were from 45- 55 years age group *i.e.* 4 (13.3%). Mean age of our subjects was 28.46±9.97 years.

Male predominance was found in our study. 24 (80%) patients were males and 6 (20%) patient were females. Male to female ratio was 4:1. This was probably because males are more frequently involved in sports and road traffic accidents. Average age at surgery in the present study group was 28.46±9.97 years and that of Jomha *et al.* was 26 years and Bach *et al.* was 25 years.

Average duration of follow-up of the present study was 12 months with a minimum follow-up period 6 months and maximum follow-up period was 18 months.

Elveos MM *et al.* mentioned 55 women and 45 men in his study. The mean age at surgery was 25 years (range, 16-42 years) for the BPTB group. The mean time from injury to surgery was 40 months (range, 1-180 months) for the BPTB group and 46 months (range, 3-168 months) for the LAD group, and the ACL rupture was detected both clinically and arthroscopically.

Sachin Awasthi *et al.* reported that physically active age group (18-40 years). The age of the patients ranged from 18-45 years. The average age was 32.32 years. 92.19% of patients. Out of the 64 patients, 55 patients (85.93%) were male, and nine patients (14.07%) were female. Our findings are comparable with the findings of above-mentioned authors Chao Lu *et al.* reported that mean age for 35.20±14.92 years.

Knee laterality

In our study, out of 30 knee injuries, right sided involvement was seen in 18 patients *i.e.* 60% and left sided knee involvement was seen in 12 *i.e* 40%. Sachin Awasthi *et al.* 75 reported that right side anterior cruciate ligament deficiency was seen in 36 (56.25%) patients, and left-sided involvement has been observed in 28 (43.75%) patients.

Type of injury

Isolated ACL tear was found in 14 (46.7%) patients. ACL and medial meniscus injury was seen in 13 *i.e.* 43.3%. ACL and lateral meniscus tear reported in 3(10%) patients.

Mode of injury

In majority of the patients *i.e.* 15 (50%), sport was the commonest mode of injury, followed by road traffic accidents in 12 *i.e.* 40% and falls in 3 *i.e.* 10% patients. Sachin Awasthi *et al.* reported most common mode of ACL injury was by road traffic accident (37.50%).

Duration of injury

In our study, majority of patients were reported within 6 weeks of injury *i.e.* 12 (40%). 23.3% were reported between 6 weeks to 3 months of injury. Only 2 patients (6.7%) were observed to have more than one-year duration of injury. Next cause was sports activity (29.68%) like football, kabaddi, and athletics. Rest of patients sustained injury while doing daily

activities like domestic fall and fall from height.
Sachin Awasthi *et al*. reported ACL deficiency of knee of 1-5 months duration (54.68%).
In the study of arthroscopic anterior cruciate ligament reconstruction with bonepatellar tendon-bone graft, Akgun, *et al.* found that the best results could be obtained if the reconstruction was done in the sub-acute period between 3-5 weeks post- injury.
Our findings are comparable with the findings of above-mentioned authors Symptoms at presentation
When we enquired about chief complaints, knee pain was commonest in 15 *i.e*. 50% patients. Instability was complained by 9 (30%), knee pain with instability by 4 (13.3%) and locking by 2 (6.7%).

Conclusion
Based on the study findings, following conclusions can be drawn. Most commonly affected age group was 15-25 years with male preponderance.
Commonest cause of ACL tear was sports injury. In 86.7% cases, good to excellent result was observed. Anterior Drawer test at one year was negative in 29 *i.e*. 96.7% Prevalence of complications was reported as 23.3%. So our study of ACL repair using BPTP gives good to excellent results within a span of one year.

Conflict of Interest
Not available

Financial Support
Not available

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