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Functional Outcome of Arthroscopic Anterior Cruciate Ligamaent Reconstruction by Anatomical Single Bundle Hamstring Allograft – A Prospective Study

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I. Introduction

Over the last few decades injuries of the knee joint have played a major role, due to many popular knee pivoting sports including soccer, skiing and basketball.[1]

Anterior Cruciate Ligament (ACL) injury is a ligamentous injury that has been studied extensively all over the world in the past 20 years. It is more frequently torn than the posterior cruciate ligament.

The ACL has a poor capacity for intrinsic repair. Thus, patients who have knee symptoms related to ACL deficiency may consider ligament reconstruction as a means of stabilizing the tibiofemoral joint and restoring high-level function of the knee joint. Ligament injury accounts for nearly 40% of all knee injury problems and isolated ACL injury constitutes nearly 50% of all knee ligament injuries[2,3,4]. Approximately 3,00,000 ACL reconstructions are performed in the USA alone each year[5].

Better understanding[6] of injury mechanisms lead to prevention strategies against ACL injury with some effectiveness although, its injury is still not fully preventable.

Earlier open arthrotomy and reconstruction of the ACL was done. However excessive soft tissue dissection led to complications like increased post-operative pain, infection, knee stiffness and prolonged duration of rehabilitation. Advances made in arthroscopy, understanding of technical issue of graft selection, placement, tensioning,fixation, postoperative rehabilitation and early return to full range of motion has led to evolution of arthroscopic techniques.

ACL was considered of little importance for the long-term function of the knee in the past[7].Studies have shown that ACL deficient knees are prone to greater risk of meniscal and articular injuries in short term progressing to joint degeneration in the long term compared to subjects with normal anterior cruciate ligament function[8,9].

Non-operative management has not been proven to prevent or delay long term sequelae of anterior cruciate ligament deficiency[10]. Early surgical methods such as primary repair of ACL injury with or without augmentation[11] showed a modest to poor improvement over non-operative management in terms of subjective and functional outcome of symptomatic knee instability[12]. Numerous authors have described successful reconstruction of the ACL with use of a donor auto graft(patellartendon, hamstringtendon or quadriceps tendon) and allograft (Achilles, patellar tendon, hamstring tendon or tibialis anterior) tendons. ACL reconstruction has been attempted using silverwire, fascialata[13] and Iliotibialband[14].

To date more than 400 different techniques have been described for ACL reconstruction from open to arthroscopic technique[15]. The bone-patellar tendon-bone is the most commonly used graft in ACL reconstruction. However, concerns regarding problems with the loss of motion, patellarfracture, extensor mechanism of the knee and the development of chronic anterior knee pain have promoted surgeons to seek other graft materials for use in ACLreconstruction. As such, the semitendinosus and gracilis tendon represent an alternative auto graft donor material without disturbance of the extensor mechanism.

In1954, the development of successful arthroscope brought new possibilities to the field of knee surgery[16]. Since 1982, the ACL reconstruction has often been performed arthroscopically[17].

ACL reconstruction with Hamstring tendon is becoming increasingly popular in patients with symptomatic instability and in appropriately selected patients can yield successful and satisfactory results[18].

Arthroscopically assisted A C L reconstruction has the advantage of being minimally invasive, accurate graft placement, less disturbance of normal tissue resulting in quicker recovery and rehabilitation, minimal hospital stay and very less infection rate.

Biau et al, in 2007 performed a meta-analysis to provide qualitative data to ascertain whether bone-patellar tendon-bone graft or hamstring graft provided superior knee function as determined by final overall IKDC evaluation and return to pre-injury level of activity. They found no difference in the final number of patients restoring to full activity after hamstring tendon graft and bone-patellar tendon- bone graft reconstruction.[19]

This study is an effort to assess the clinical outcome of arthroscopic ACL reconstruction using semi-tendinosus autograft at our centre using IKDC score. There is a fair evidence that the patients who were reconstructed with hamstring graft report less morbidity than those reconstructed with bone-patellar tendon-bone graft. The improvement of stability with bone-patellar tendon-bone graft compared with 4 strand hamstring auto graft remains of questionable importance for most of the patients. However, functional results between the two types of reconstruction remain unclear.

II. Aim Of The Study

1) To evaluate the functional outcome of arthroscopic anterior cruciate ligament reconstruction by quadrupled single bundle hamstring graft through accessory antero-medial portal by clinical outcome score IKDC.
2) To study the complications following arthroscopic anterior cruciate ligament reconstruction using semi-tendinosus autograft.

III. Materials And Methods

- A Prospective study
- 30 patients were studied
- Study period was between January 2016 – June 2017

Inclusion criteria

1. Complete ACL tear confirmed by MRI requiring primary ACL reconstruction
2. Radiographic evidence of skeletal maturity
3. Patients between 18 and 55 years of age.

Exclusion criteria

1. Anterior cruciate ligament tear of less than 3 weeks.
2. Anterior cruciate ligament tear associated with other ligament injuries (posterior cruciate ligament tear, collateral ligament and postero-lateral corner injuries).
3. Anterior cruciate ligament tear associated with bony injury around the knee.
4. Patients with ACL avulsion injury.

Surgical Technique

Initial arthroscopy:

The patient receives intravenous antibiotics preoperatively. After induction of anaesthesia, the patient is positioned supine and a tourniquet applied on the upper thigh of the operative leg.

An examination under anaesthesia is performed. Diagnostic arthroscopy is performed through antero-medial and antero-lateral portals, and any chondral or meniscal procedures are performed at this time.

A minimal soft tissue notch-plasty is performed for visualization purposes only.

Graft harvest and preparation:

Make a 3-4cm incision anteromedially on the tibia starting approximately 4 cm distal to the joint line and 3 cm medial to the tibial tuberosity.

Expose the pes-anserinus insertion with subcutaneous dissection. Palpate the upper and lower borders of the Sartorius tendon, and identify the palpable gracilis and semitendinosus tendons 3 to 4cm medial to the tendinous insertion. Make a short incision in the line with the upper border of the gracilis tendon and carry the incision just through the first layer, taking care not to injure the underlying medial collateral ligament.

With the pes retracted medially, the gracilis and semitendinosus tendons are visible on the medial side. The more proximal thicker of the two tendons is the gracilis and below it is the more horizontal semitendinosus tendon. After the tendons have been positively identified, the semitendinosus tendon is pulled forward with a curved clamp or a mixtar and snared with a braided suture.With Metzenbaum scissors, carry the dissection proximally up the thigh.Then semitendinosus tendon is released from its tibial insertion. The insertion site, including the periosteum, is widely circumscribed with a knife and undermined with a periosteal elevator.

After carefully releasing the tendon from its insertion, place a double Krackow–type whipstitch with vicryl near the insertion of the tendon and release its fibrous extension to the gastrocnemius and semimembranosus muscles.

Palpate all sides of the tendon to ensure there are no fibrous extensions before releasing it with an open–end tendon stripper. A firm resistance is felt, redissect around the tendons with a periosteal elevator and Metzenbaum scissors. Release the tendon proximally by controlled tension on the tendon, while advancing the stripper proximally. The muscle should slide off the tendon as the stripper is advanced proximally.

The surgical assistant prepares the tendons on the ACL Graftmaster on the back table that allows for pre-tensioning and control of the tendons during preparation. Residual muscle tissue is stripped from the tendon with a blunt elevator. The overall length of the tendon is measured. The tendon is cut in half to make two segments of equal length. Place a double Krackow-type whip stitch in both ends of each tendon with No.2 Ethibond. Each segment will be looped to create a total off our strands and graft size measured with the tendon sizer. Place a running, interlocking No. 2-0 non-absorbable Krackow-type whip stitch in each end of the loop so that the gaft can be passed as a single quadruple graft. The prepared graft is then placed under tension, covered by a wet saline gauze for 20 to 30 minutes on the graft master.

Tibial and femoral tunnel preparation:

When placing the tibial guide, beaware of the intended tunnel length and direction, so that the graft can be secured in a physiometric, impingement free position. Intraarticular reference points that can serve as guides include the ACL stump, the inner edge of the anterior horn of the lateral meniscus, the medial tibial spine and the posterior cruciate ligament.

Next a cannulated reamer or trephine of the appropriate diameter is advanced over the guide pin. The diameter of the reamer used for the tibial tunnel is determined by sizing the harvested hamstring graft.

With the knee flexed to 90 degrees, confirm the previously chosen femoral pilot hole with an Arthrex 7-mm offset femoral guide passed through the tibial tunnel. Ensure that 1 to 2mm of bone remains as a posterior wall. The starting point is at the 10:30'o clock position on the right knee(1:30-o'clock position on the left knee) approximately 8 mm lateral to the PCL.

Advance along guide wire through the guide to the chosen physiometric point on the postero-lateral portion of the femoral condyle, so that it exits the distal antero-medial femoral cortex. Use wire plier handles to stabilize the skin and soft tissues, so that wire advances externally and does not traverse the thigh more proximally. The femoral tunnel length to be reamed is measured with a depth gauge and then calculated according to the length of the graft material. Using the appropriate diameter reamer, the femoral tunnel is reamed based on graft size. A beath pin passed into the tibial tunnel, femoral tunnel and then through the skin.The pre-tensioned graft with endo-button and its threads are passed through the beath pin tibial end loop and is pulled out of the femoral tunnel so that the thread is out of the thigh. Under arthroscopic visualization in the joint, the threads of the endobutton is pulled using the principle of flipping the endobutton. The femoral fixation is confirmed by togging of the endo-button. In many cases, femoral fixation was done with interference screw. When tension is placed on the grafts, the knee is taken through approximately 15 to 20 cycles of complete flexion and extension. This helps to align the grafts and also tests for impingement between the grafts and bony structures. The tibial side of the graft is fixed with interference screw after inserting a guide wire in tibial tunnel.

Wound Closure:

Thorough lavage of the joint is done to clear off the debris. Graft harvest site is sutured in layers with no 2-0 vicryl. Skin sutured with ethilon/skin staples. Compression bandage dressing done and long knee extension brace is applied.

Figure no 1: ACL jig

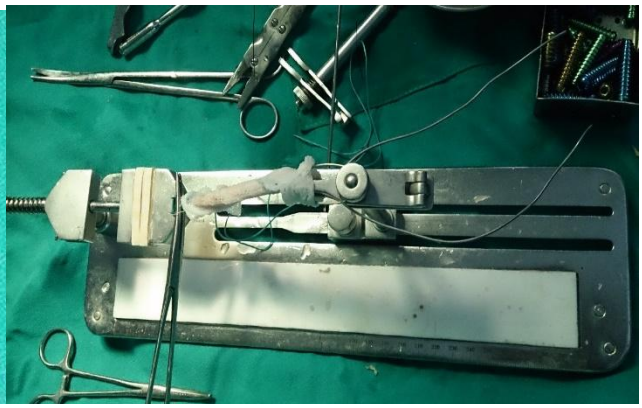


Figure no 2: Graft master with attachments

Figure no 3: Femoral offset

Figure no 4: Tendon strippers

Figure no 5: Tendon sizer

Figure no 6: Tunnel reamers

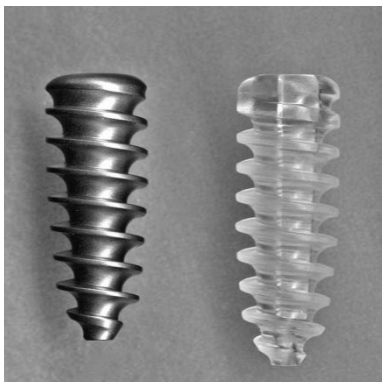


Figure no 7: interference screw

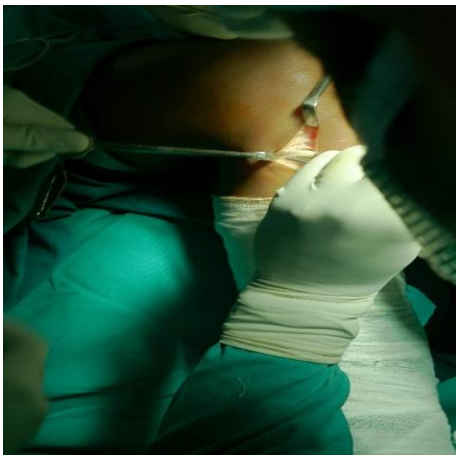



Figure No 8: Patient positioning **Figure No 9: Skin incision for graft harvest**


Figure No 10: Identification of Hamstring tendon **Figure No 11: Separation of semitendinosus tendon**


Figure No 12: Tendon stripping **Figure No 13: Release of adhesions**

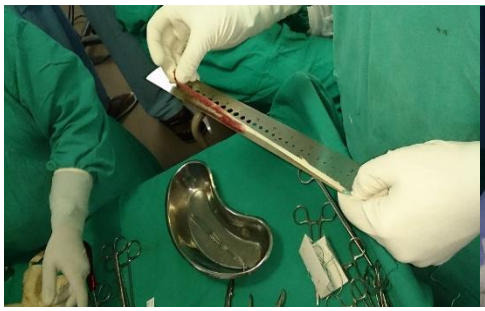
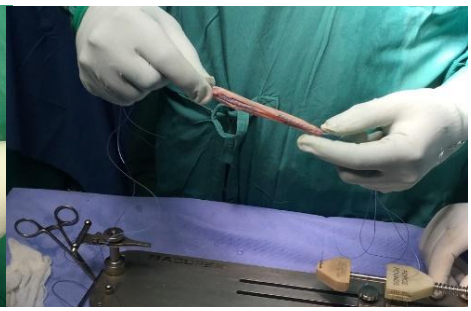



Figure No 14: Harvested tendon **Figure No 15: Preparation of tendon**

Figure No 16: Prepared quadrupled graft with endobutton

Figure No 17: Pre-tensioning of the graft

Figure No 18: Graft passage

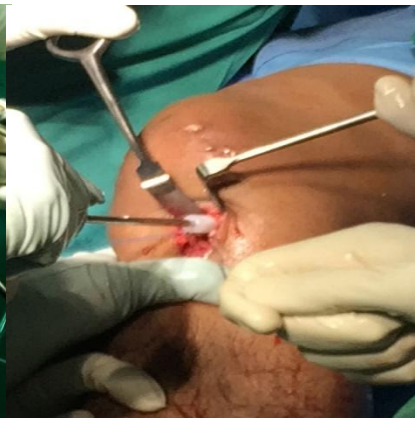


Figure No 19: Tibial tunnel interference screw fixation

Postoperative management:
All patients were initiated on postoperative ACL Protocol [adaptedfrom Wilketal] on postoperative day 1.

[Annexure 2]

On the operative day, after patient recovers from anaesthesia, patient is taught to do foot and ankle pump movements. The next day patient was taught static quadriceps exercises. On the 2nd postoperative day, active knee bending with gradual increase of 10-20degrees of flexion/day was started. On the 3rd postoperative day, assisted SLRT, abduction and adduction exercises of thigh and hamstring strengthening exercises were started. By the end of1st week, patient will be able to walk full weight bearing with long knee brace. Sutures are removed on the10th postoperative day and patient is discharged with the advice to continue exercises as per the protocol given to them in the form of a booklet.

Patients were advised to wear long knee brace for 2 months to protect the knee from getting injured. Patients were followed up every month for the first 6 months and the progresses are assessed. Patients are subject to single hop test at 4, 5 and 6 months of postoperative period and at the end of 6thmonth, patients are subjected to IKDC.

Single Hop test:

The subjects performed one practice trial for each limb, followed by measured and recorded trials. The subjects were instructed to begin with the nonoperative limb. Subjects started each test with the lead toe behind a clearly marked starting line. No restrictions were placed on arm movement during testing and no instructions were provided regarding where to look. Subjects were encouraged to wear the foot wear they would normally wear during their rehabilitation sessions.

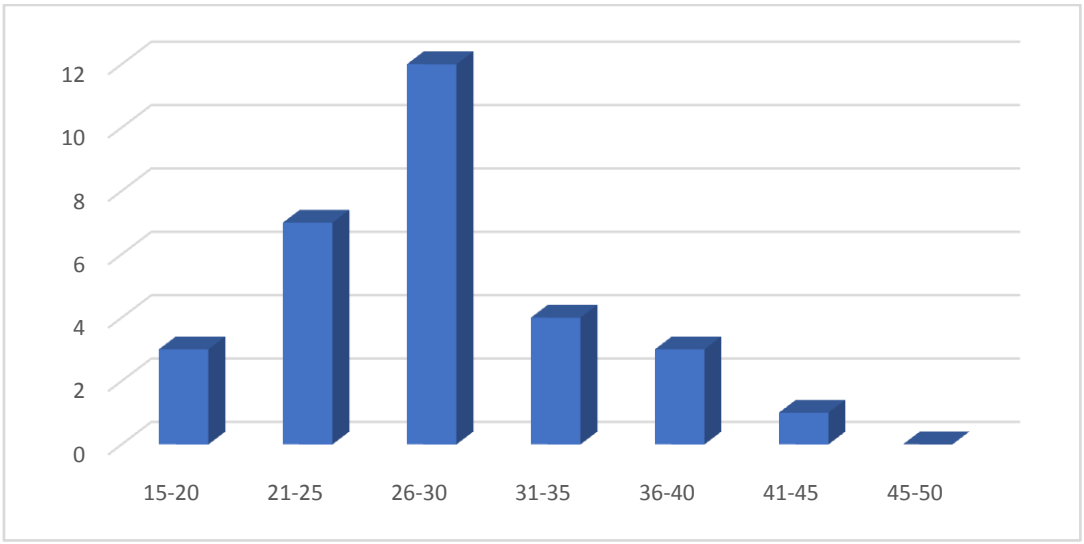
For the hop test to be deemed successful, the landing must have been maintained for 2sec. A non-successful hop was classified by any of the following: touching down of the contralateral lower extremity, touching down of either upper extremity, loss of balance, or an additional hop on landing. If the hop was unsuccessful, the subject was reminded of the requirement to maintain the landing and the hop was repeated.

IV. Observations & Results

Table No 1: Age Distribution

Age in years	Number	Percentage
15 – 20 yrs	3	10
21 – 25 yrs	7	23.34
26 – 30 yrs	12	40
31 - 35 yrs	4	13.33
36 – 40 yrs	3	10
41 – 45 yrs	1	3.33
46 – 50 yrs	0	0
Total	30	100

Figure No: 20

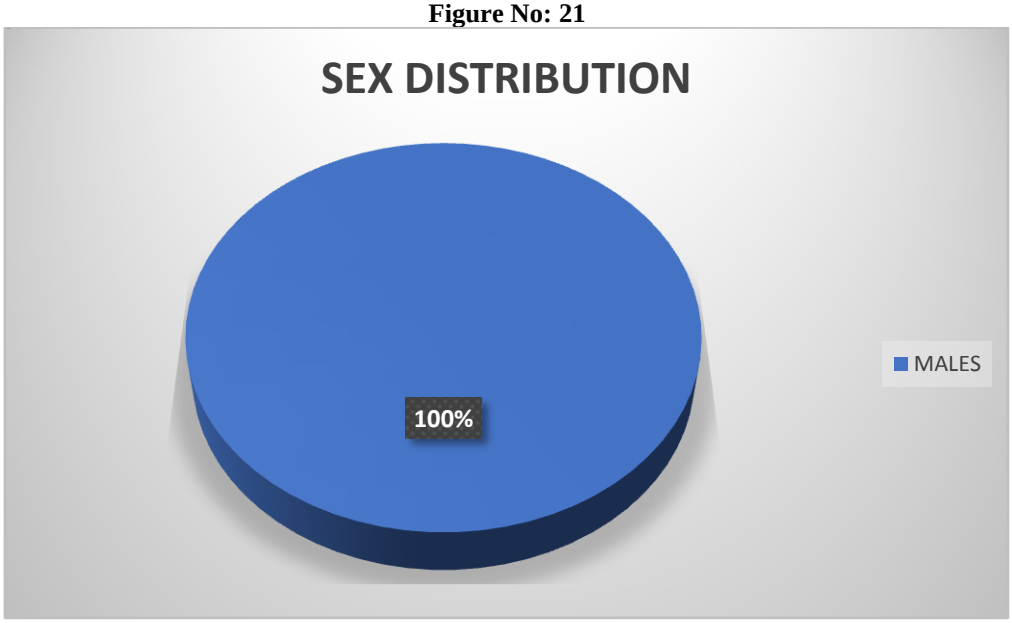


The mean age in our study was(29.6) years. The youngest patient was20 yrs and the oldest patient was 45 years old. The maximum number of patients were in the age group of 26-30yrs (40%) followed by the age group 21-25yrs (23.34%).

Table No 2: Sex Distribution

	FREQUENCY	PERCENT
MALE	30	100%
FEMALE	0	0
TOTAL	30	100%

Figure No: 21

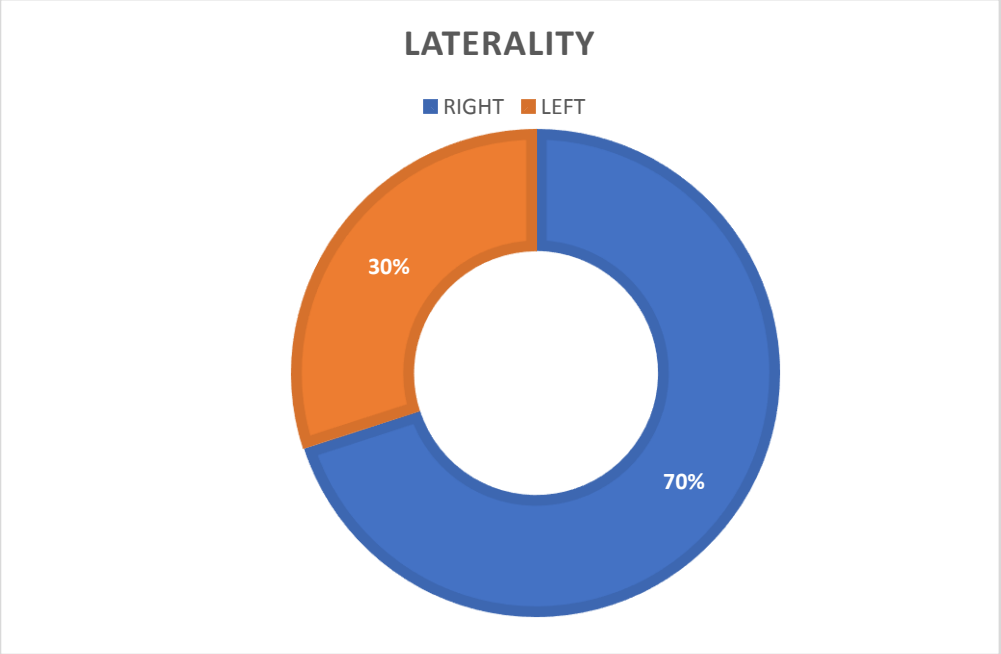


In our series of 30patients, all 30 (100%) were males. It may be because of the involvement of males in outdoor activities like sports, farming and road traffic accidents.

Table No: 3 Side of Injury

	FREQUENCY	PERCENT
RIGHT	21	70%
LEFT	09	30%
TOTAL	30	100%

Figure No: 22

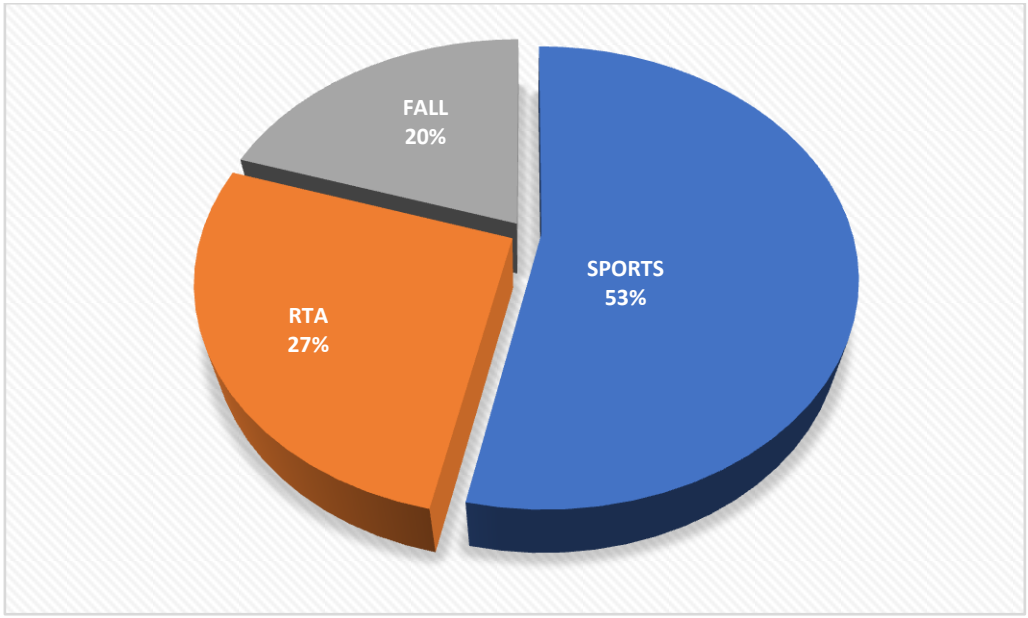


Right knee was injured in 21patients(70%) and left knee was injured in 9 patients (30%).

Table No 4: Nature of Injury

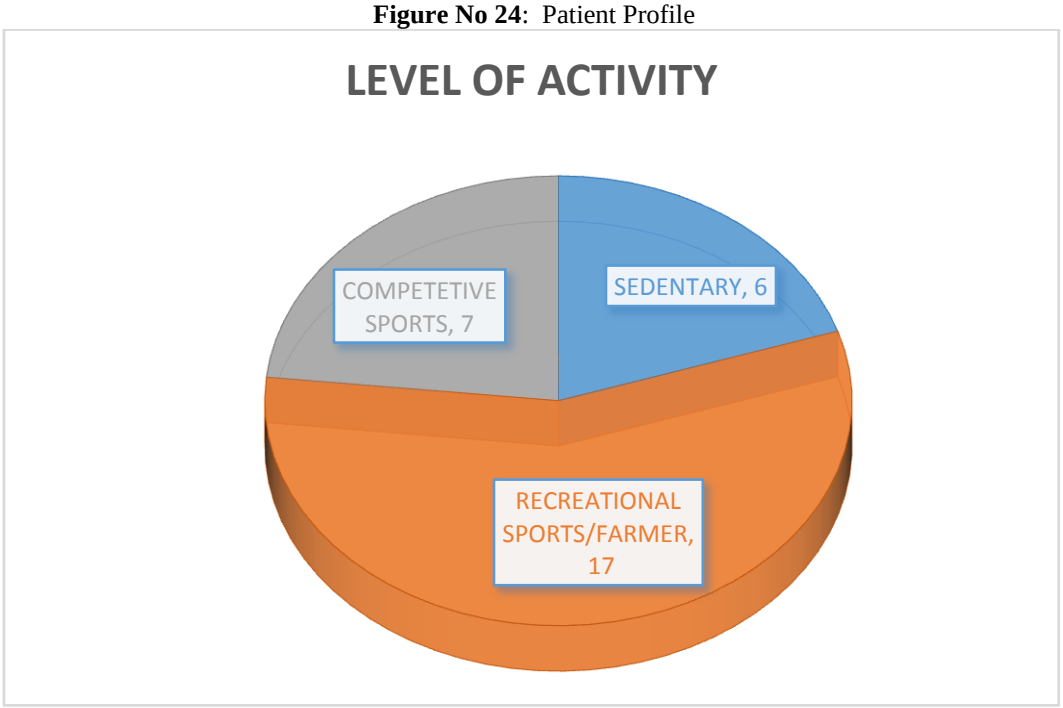
	FREQUENCY	PERCENT
SPORTS	16	53.34%
RTA	08	26.66%
FALL	06	20%

Figure No 23: Nature of Injury



Most common cause was sports activities like football, kabbaddi and athletics like jumping, police physical training, etc (53.33%). Next, the ACL tears were caused by road traffic accidents (26.66%). Some patients(20%) has fall while walking/ climbing down stairs. Twisting of the knee was noted in most of the patients (63.33%) followed by twisting in flexion (36.67%).

Figure No 24: Patient Profile

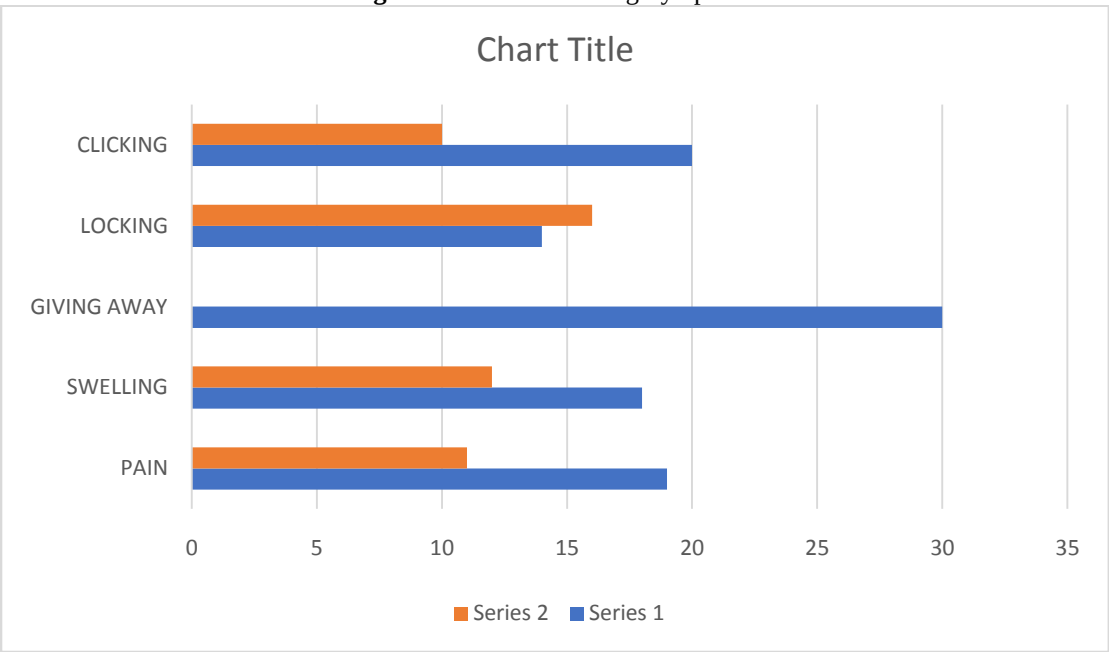


Majority of the patients 17(57%) were from sports and farming community in our study followed by some patients 6(20%) having sedentary lifestyle and 7(23.33%) were into competitive sports.

Table No 5: Presenting Symptoms

	FREQUENCY	PERCENT
PAIN	19	63.33%
SWELLING	18	60%
GIVINGWAY	30	100%
LOCKING	14	46.66%
CLICKING	20	66.66%

Figure No 25: Presenting Symptoms

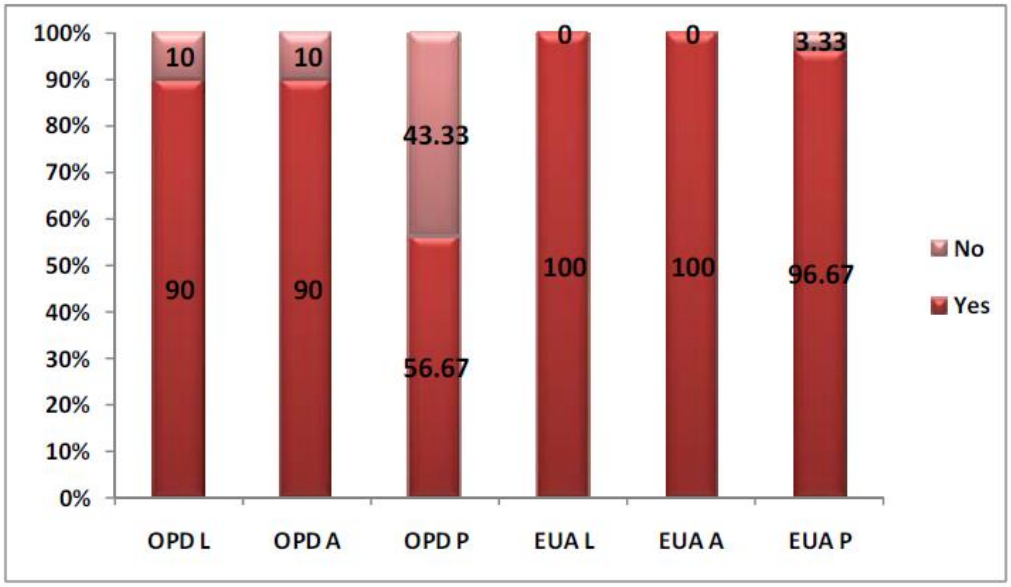


All patients presented with complaints of giving way of the knee. 66.66% of the patients were able to appreciate the clicking of knee. 60% cases were having swelling and 60% cases presented with complaint of pain. 46.66% gave history of locking of knee which was correlated with associated injuries in the knee.

Table No 6: Results of clinical evaluation of laxity in OPD and under anaesthesia

	YES No %		NO No %	
	No.	%	No.	%
OPD L	25	83.33	5	16.67
OPDA	26	86.67	4	13.33
OPD P	16	53.33	14	46.67
EUA L	30	100	-	-
EUA A	30	100	-	-
EUA P	28	93.33	2	6.67

Figure no 26: Results of clinical evaluation of laxity in OPD and under anaesthesia

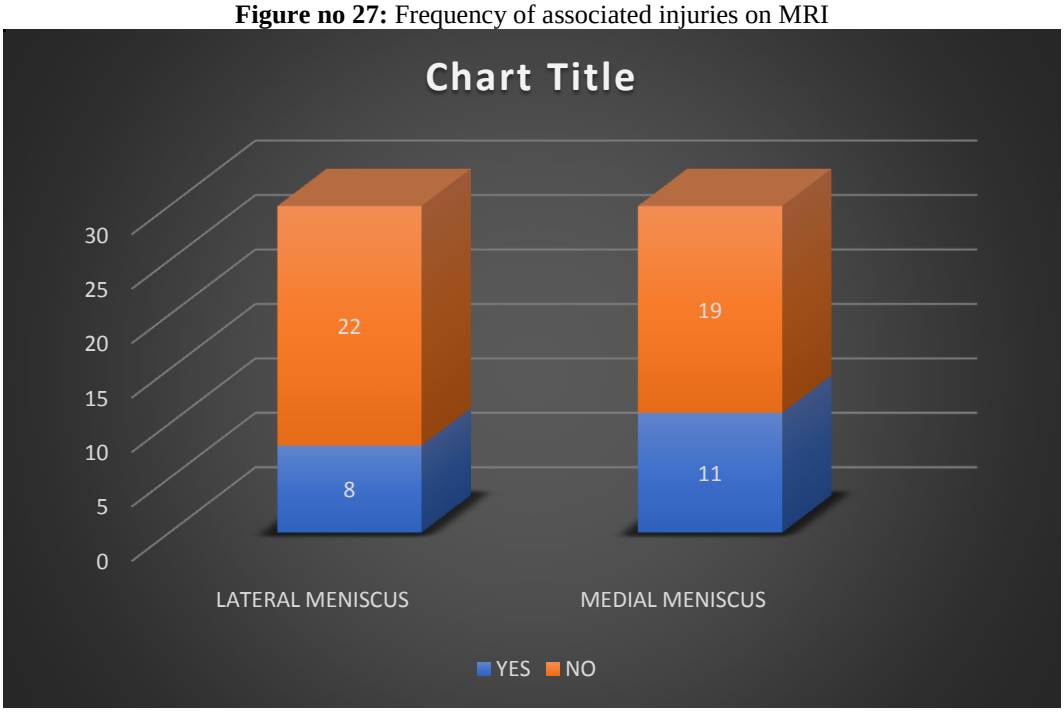


Lachman test and Anterior drawer test was found to be 90% positive which was grade 3 in 46.67% and grade 4 in 53.33% and pivot shift test, 56.67% sensitive by clinical examination which was 100% and 96.67% respectively by evaluation under anaesthesia.

Table no 7: Frequency of associated injuries on MRI

	Yes	%	No	%
LM (lateral meniscus)	8	26.67	22	73.33
MM(medial meniscus)	11	36.67	19	63.33

Figure no 27: Frequency of associated injuries on MRI

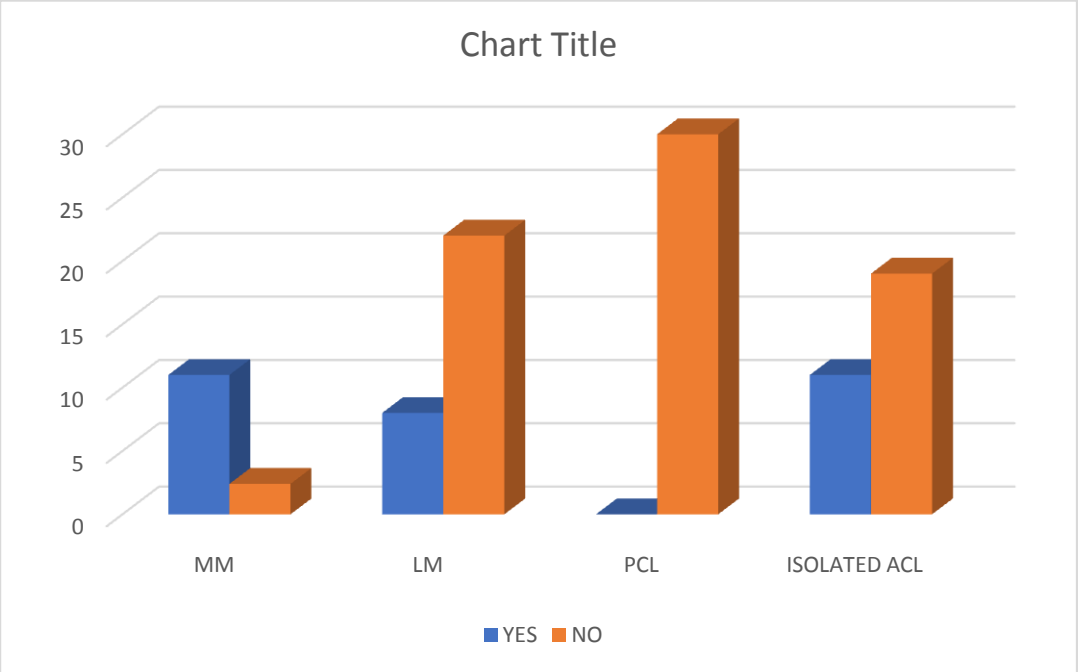


Medial meniscal tear was the commonest associated injury (36.67%) detected by MRI followed by lateral meniscus (26.67%).

Table no 8: Results of associated injuries on arthroscopy

	YES		NO	
	No.	%	No.	%
MM	11	36.67	19	63.33
LM	8	26.67	22	73.33
PCL	-	-	30	100
Isolated ACL	11	36.67	19	63.33

Figure no 28: Results of associated injuries on arthroscopy

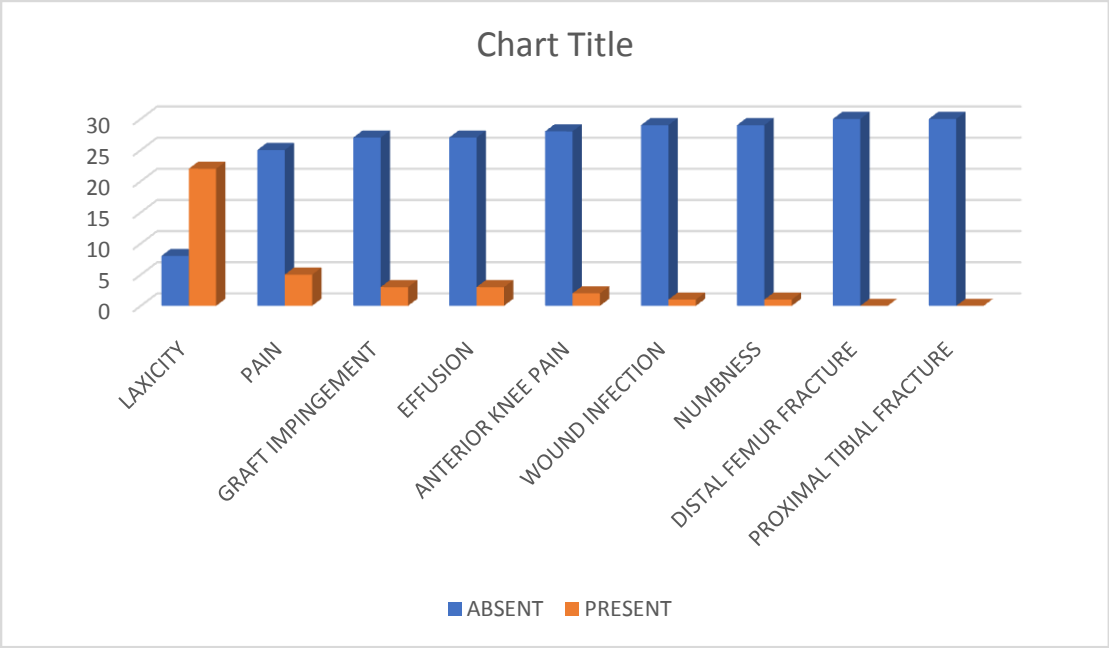


Diagnostic arthroscopy prior to ACL reconstruction confirms the medial meniscal tear in 40% cases and 26.67% lateral meniscal tear. The rest of the cases(43.33%) were isolated ACL injuries. There was no PCL injury in our study.

Table no 9: COMPLICATIONS

	ABSENT	%	PRESENT	%
LAXITY	8	26.67	22	73.33
PAIN	25	83.33	5	16.67
GRAFT IMPINGEMENT	27	90	3	10
EFFUSION	27	90	3	10
ANTIRIOR KNEE PAIN	28	93.33	2	6.67
WOUND INFECTION	29	96.67	1	3.33
NUMBNESS	29	96.67	1	3.33
DISTAL FEMUR FRACTURE	30	100	0	0
PROXIMAL TIBIAL FRACTURE	30	100	0	0

Figure No: 29 COMPLICATIONS

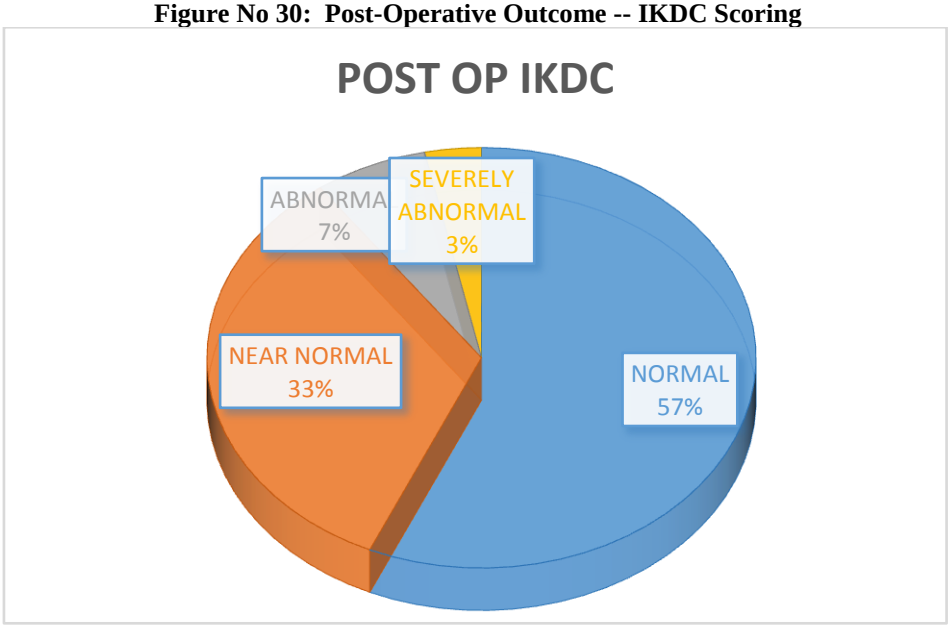


5 patients(16.67%) had pain at the graft site at the end of 6months. Early superficial infection of the site was present in 1 case (3.33%) which delayed wound healing. There was no deep infection. Majority of the patients(73.33%) were having grade I laxity at the end of 6 months but with hard end point. 1 patient (3.33%) had FFD due to noncompliant physiotherapy. 2 patients (6.67%) complaint of click but no instability.

Table no 10: Post-Operative Outcome -- IKDC Scoring

	FREQUENCY	PERCENT
NORMAL	17	56.67
NEARNORMAL	10	33.33
ABNORMAL	2	6.67
SEVERELY ABNORMAL	1	3.33
TOTAL	30	100%

Figure No 30: Post-Operative Outcome -- IKDC Scoring



90% of the patients graded their post-operative recovery as normal 57% and 33% as near normal whereas 3 patients (10%) graded recovery as abnormal according to IKDC score. The abnormal group included three patients with 1 superficial infection, 1 with laxity and 1 with FFD.

Table no 11: Single hop test

Limb Symmetry Index	Minimum	Maximum	Mean
Preoperative	22.72	57.14	44.355
Postoperative	66.36	93.33	83.503

Figure No 31: Preoperative & postoperative Limb Symmetry Indices of all patients

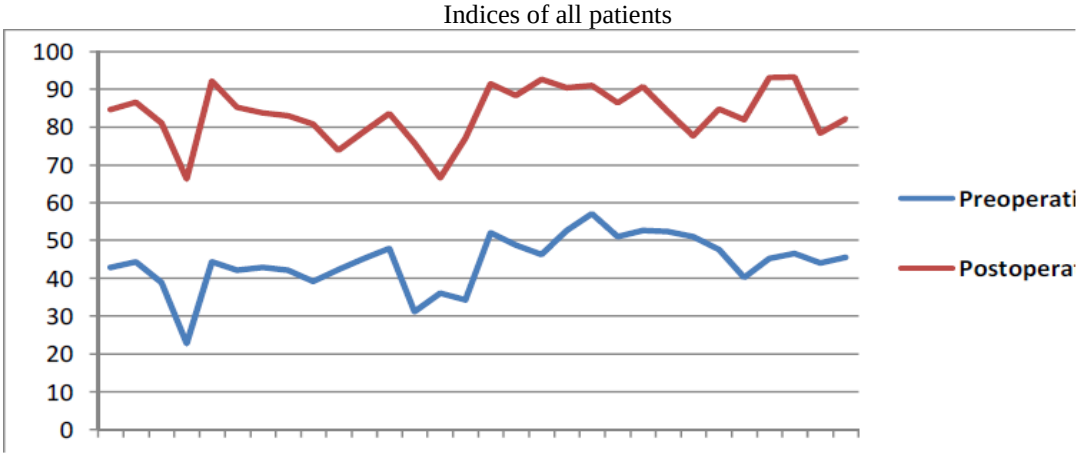
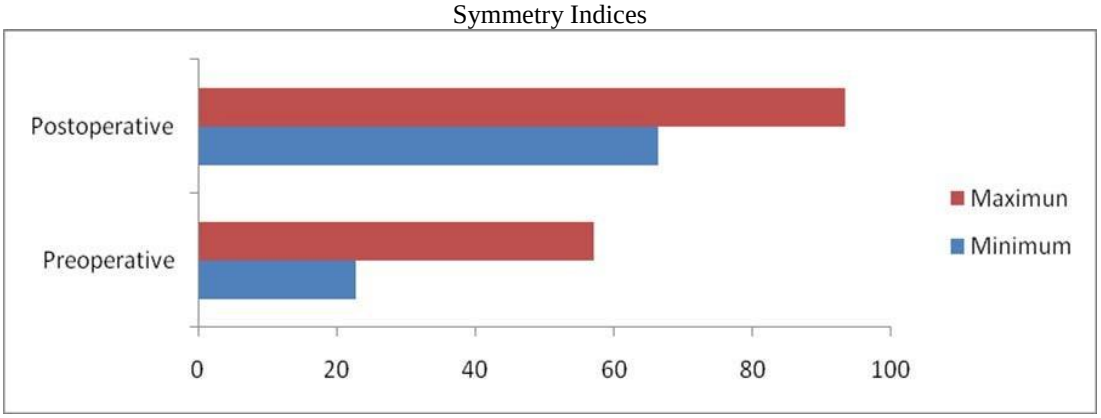
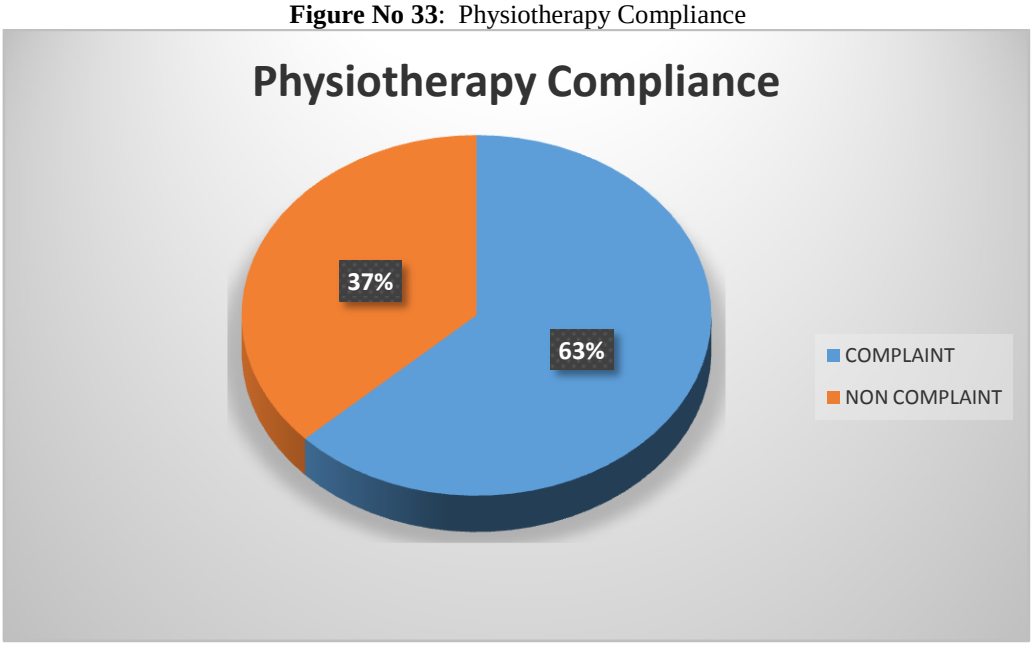


Figure No 32: Preoperative & postoperative Mean Limb Symmetry Indices



Limb symmetry index was calculated by the percentage of affected limb over the normal limb. The preoperative index ranges from 22.72 to 57.14 with a mean of 44.355. Post operatively the index improved to a mean 0f 83.503 ranging from 66.36 to 93.33.

Figure No 33: Physiotherapy Compliance

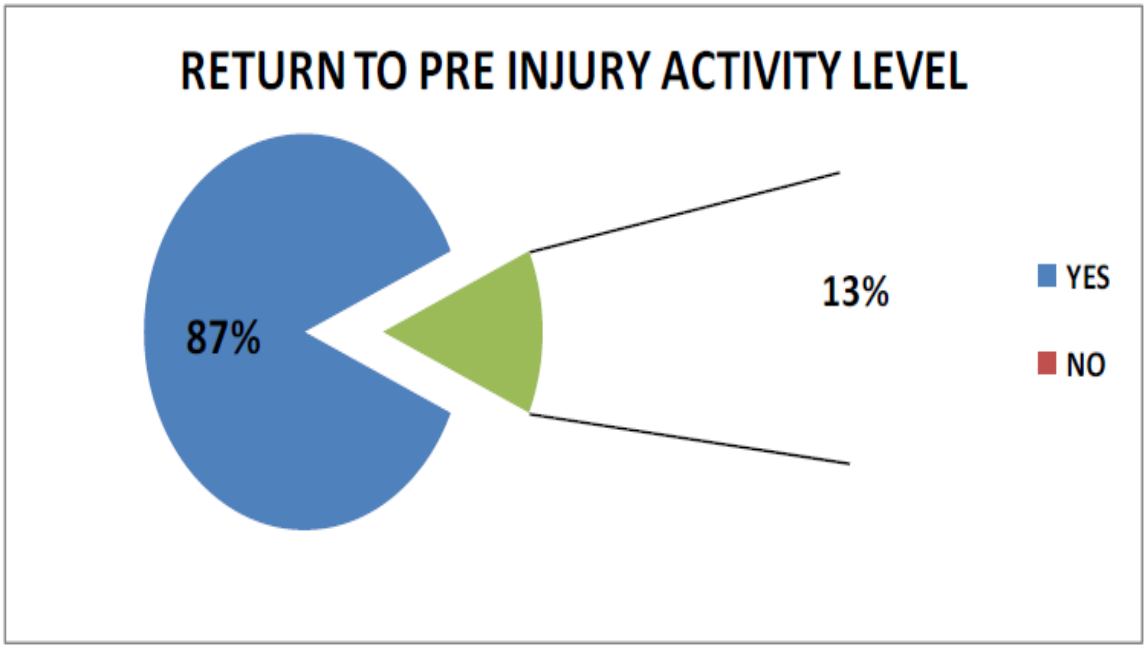


63% of the patients were complaint with the post-operative rehabilitation protocol. The percentage was higher initially but with the improvement in the daily life activities, the patients gradually decreased their physiotherapy intensity and thus the final non-compliancy was 37%.

Table No 12: Return to pre-injury level of activity

	Yes		No	
	No.	%	No.	%
Return to pre-injury level of activity	**26**	**87**	**04**	**13**

Figure No 34: Return to pre-injury level of activity



87% of the patients were able to return to their pre-injury activity including farming and to competitive sports. 4 patients(10.33%) were not satisfied with physiotherapy regimen and these patients were noncompliant to the protocol.

Table No 14: Comparison between single leg hop test and IKDC

IKDC Hop test	Normal 85.7 +/- 8.7	Near Normal 84.7 +/- 20.23	Abnormal 77.1 +/- 3.3	p value p >0.05

Table No 15: Correlation between IKDC and single leg hop test

Correlations			
		IKDC	SINGLE LEG HOP
IKDC	Pearson Correlation	1	-.192
	Sig. (2-tailed)		.418
	N	30	30
SINGLE LEG HOP	Pearson Correlation	-.192	1
	Sig. (2-tailed)	.418	
	N	30	30

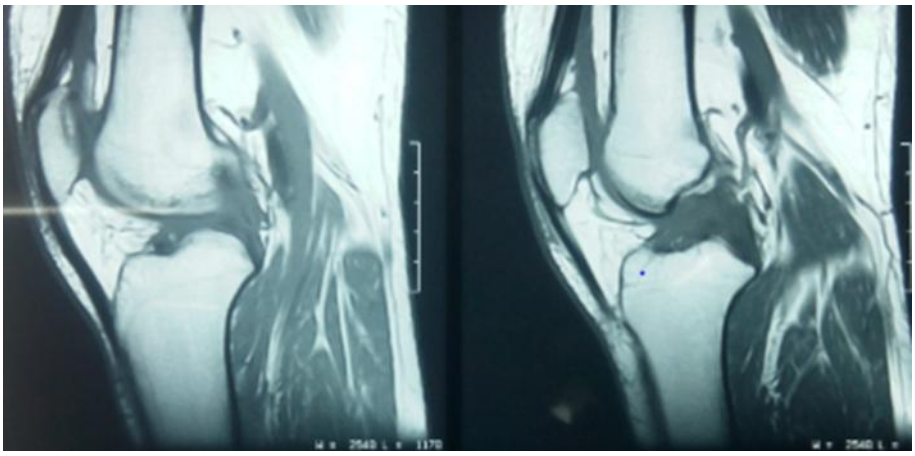
EXAMPLES

Case 1:

Akash chandra patro/23yrs/ male/Right Knee

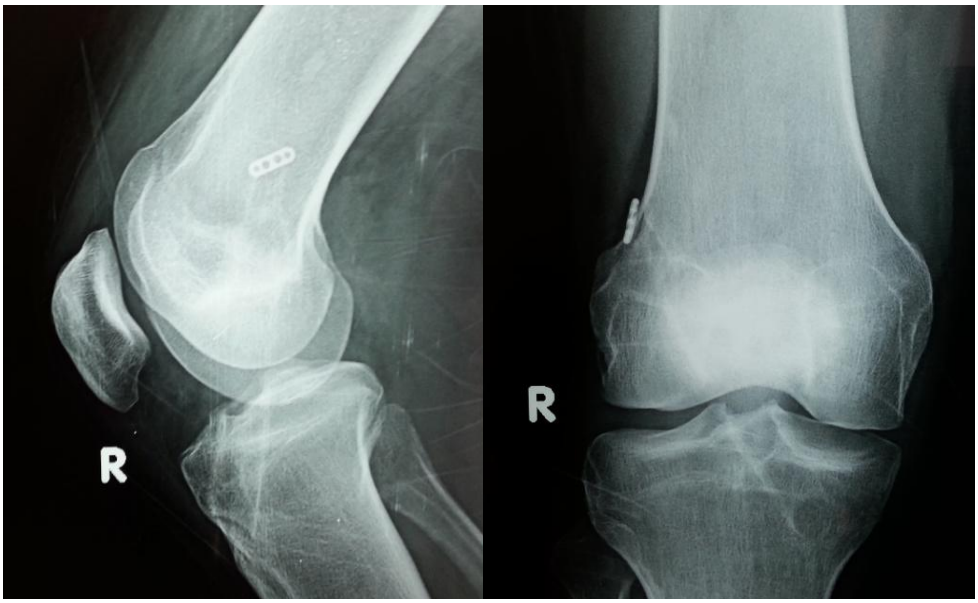
Anterior drawers test

Pivot shift test



MRI images

Single hop test



Post-operative x rays

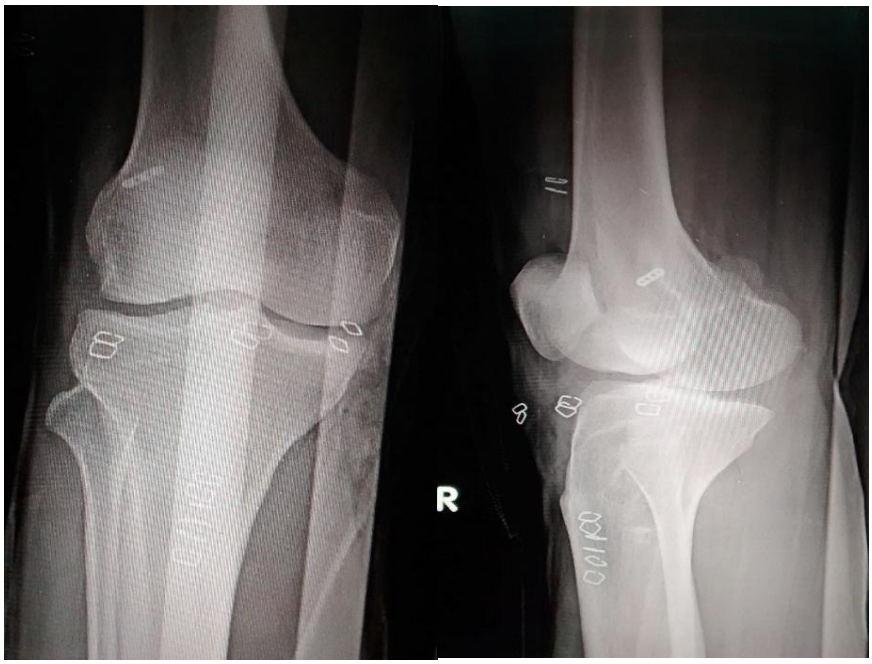
Case no: 2
P. Nuka Apparao/25yrs/ male/Right Knee

Anterior Drawer Test

Pivot shift test

MRI image

Single hop test



POST OP X RAYS

CASE 3: K.Vasantha Rao/28yrs/ male/Right Knee

Pivot shift test

Anterior Drawer Test

Lachman test

MRI Image

Single leg hop test

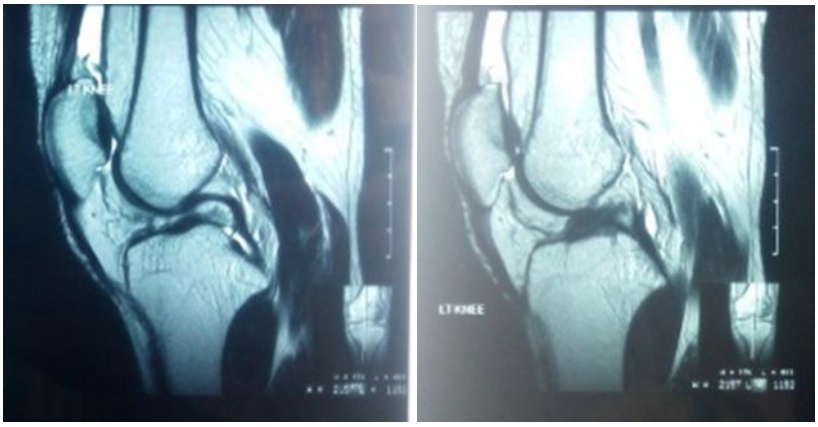
Post-operative x rays

Case no 4

Ashok kumar/26yrs/ male/Left Knee

Anterior drawers test

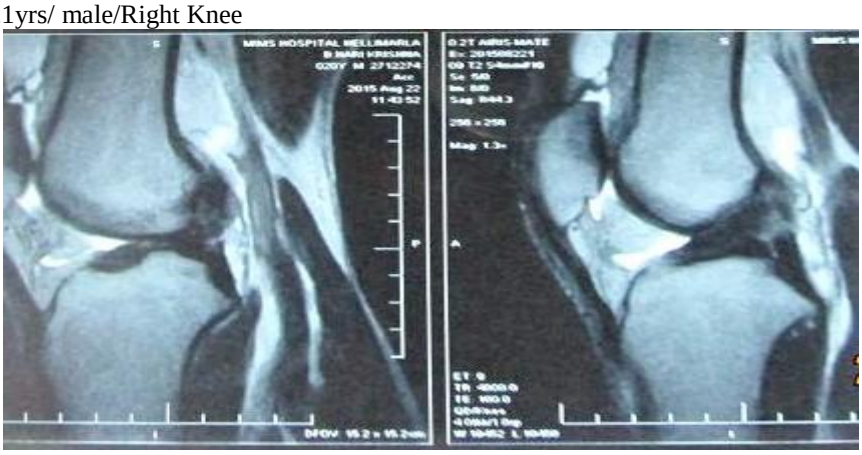
Single hop test



MRI image

Post-operative x ray

Case no 5
B hari krishna/21yrs/ male/Right Knee



MRI images

Figure No: 29

Full range of motion post-operative at 6 weeks

Single hop test at 24 weeks

Post-operative x ray

V. Discussion

Anterior cruciate ligament (ACL) ruptures if left untreated lead to subsequent knee disability, with potentially devastating long-term consequences which can be severe enough interfering with day to day daily activities. With improving results and increasingly reliable outcomes, patient and physician expectations have evolved to include the goal of return to activities and sports to pre-injury level at normal or near normal levels. Physiotherapy based rehabilitation programs are often used after ACL reconstruction surgery. In general, these programs are designed to maximize function by restoring range of motion, strength and neuromuscular coordination.Harvest of hamstring tendon auto-grafts also yield less donor site morbidity than that of patellar bone-tendon-bone grafts and carries no risk of patellar fracture, however remote. Technical factors, specifically the absence of adequate fixation techniques, initially limited the use of hamstring grafts for ACL reconstruction. New techniques focus on optimizing graft strength and stiffness.

Although there are many potential graft choices from which to choose for ACL reconstruction, hamstring autografts have increasingly become more popular over the past decade. Several studies have shown that multiple-strand hamstring tendon ACL reconstructions have higher strength, stiffness, and cross-sectional area compared with patellar tendon grafts.

Stable initial graft fixation is required for a successful ACL reconstruction with hamstring autograft and ultimately graft-to-bonehealing. Hamstring reconstruction using femoral endobutton fixation has been shown to have excellent initial mechanical properties, including pullout strength. Tibial fixation is done with interference screw.

In our study 31male patients underwent ACL reconstruction using quadrupled semi tendinosus tendon auto graft. All the patients underwent graft fixation using endo button in the femoral tunnel and interference screw for the tibial tunnel. Among 31patients, 1patient had lost the follow up. Thus, the total number of patients in the study were limited to thirty. A statistical trend towards a better outcome in all three scoring systems was seen with injury to the dominant lower limb but this was not significant in the study regarding outcome. Arthroscopic ACL reconstruction was done as an in-patient procedure in all patients under spinal anaesthesia.
In Maurilio Marcacci et al study, out of fifty patients 40 were men and 10 were women.[78]
In Vassilios S Nikolaou et al study, there are 30 males and 16 females among 46 patients with ACL injuries.[75]
In the present study all 30 patients were male.
In Brown et al study mean subject age was 28.8 +/- 12.8 years.[74]
In Maurilio Marcacci et al study, mean age was 28 years, ranging from 18–39 years.[78]
In Vassilios S Nikolaou et al study, the mean age was 32 (18 – 45) years.[75]
In the present study mean age was 27.66 years(15-45 years).
In Maurilio Marcacci et al study, there were 29 right knees and 21 left knees.[78]
In Vassilios S Nikolaou et al study, right knee was injured in 21 whereas left knee in 25 patients.[75]
In the present study 70%[21patients] had right knee injurywhile30% [9patients] injured their left knee.

TYPE OF INJURY	VassiliosSNikolaou et al study[75]	Present study
SPORTS	16	16
NON-SPORTS	18	14
NO H/O INJURY	12	0

According to Vassilios S Nikolaou et al study[75], 16 were injured in sports activities, 18 in non-sport activities like road traffic accidents or fall from stairs etc and 12 had no history of any injury.

In our study 16 patients had sports injury, 14 had non-sport injury and we had no patients without any history of injury. Vassilios S Nikolaou et al in June 2008 after a retrospective analysis of MRI efficiency in diagnosing internal lesions of the knee, reported that the accuracy for tears to the medial, lateralmeniscus, anterior and posterior cruciate ligaments and articular cartilage was 81%, 77%, 86%, 98% and 60% respectively[75]. They concluded that MRI is very helpful in diagnosing meniscal and cruciate ligament injuries and found that the clinical examination had significant lower reliability in the detection of these injuries. But, its importance is still vague in a countable percentage reports with false results and in chondral defects. The arthroscopy still remains the gold standard for definitive diagnosis. Clinical evaluation of the patients for instability was an essential component in our study.

In our study, MRI showed complete ACL tear in all patients and Medial Meniscus was most commonly associated followed by Lateral Meniscus which correlated with arthroscopy with accuracy more than 90%. So, in our study, as MRI may help to look out for other lesions and repair them, we conclude that MRI is preferable to arthroscopy before surgery, which improves clinical outcome of the patients.

In 2009, Brown[74] and others studied the incidence of sex and limb differences in anterior cruciate ligament injury and stated that even though females are prone for injury due their less exposure to strenuous environment makes the incidence of males more than females. They also concluded that limb differences have no influence either during injury or in the recovery period.

Arthroscopic findings	Vassilios S Nikolaou et al study[75]	Present study
Medial meniscus tears	29	11
Lateral meniscus tears	21	8
ACL injuries	23	11
PCL injuries	3	0

In Vassilios S Nikolaou et al study, there are 29 Medial meniscus tears, 21 Lateral meniscus tears, 23 isolated ACL injuries and 3 PCL injuries noticed during arthroscopy.
In our study there are 11 Medial meniscus tears, 8 Lateral meniscus tears, 11 isolated ACL injuries and no PCL injuries in arthroscopy.
In the present study among the athletes, only two were into competitive sports-the others were involved in recreational sporting activity. Majority of our patients (57%) are from farming community and the rest (23%) are having sedentary lifestyle. Once the day to day activities of walking, squatting and climbing stairs returned, it was observed that adherence to physiotherapy gradually waned in most of the patients after following patients according to Wilk et al, rehabilitation protocol for 6 months during immediate postoperative and follow up period.

Lachman test and Pivot shift test was more specific in diagnosing ACL injury which were further confirmed by arthroscopy, unlike anterior drawer test which in most of the patients was inconclusive as no correlation between pre-operative evaluation and examination under anaesthesia.

In 2003, Fareed H et al reported the results of a retrospective study on patients who underwent arthroscopic ACL reconstruction[76].

The purpose of their study was to evaluate their initial experience with this procedure. Between July 97 and march 2001, 29patients underwent arthroscopic ACL reconstruction with 4 strand hamstring tendon graft. 25 were available for follow-up. Same rehabilitative program was followed by all the patients. Patients were evaluated using the IKDC ligament evaluation system. The average follow-up was 25.4 months.

Similarly, Button K[77] and others in 2005 evaluated the outcome of ACL reconstruction with semitendinosus tendon autograft with same rehabilitation protocol in 48 patients at 20 months. The results of these study were compared to our study is tabulated below.

Table no 16: Comparison of our study with Fareed H et al And K Button & others

	Fareed H[76]et al (2003)	**K Button & Others[77](2005)**	**Present study**
Number of patients	25	48	30
Average followup	25.4 weeks	20 weeks	24 weeks
IKDC Normal	12 (48%)	26 (54%)	17(56.66%)
Near Normal	12 (48%)	18 (38%)	10 (33.33%)
Abnormal	01 (4%)	04 (8%)	03 (10%)

In their study, a satisfactory outcome was seen in 96% & 92% respectively while it was 90% in our study. Quite similarly, 66.67%[20patients] were very satisfied as per the subjective questionnaire and 30% [9 patients] were satisfied. One patient was noticed dissatisfied. This was probably due to the laxity and the fact that most of the patients were keen on normal day to day activities than return to sports. The two scoring systems had a very high correlation as evidenced by the Kendal- tau values ranging from 0.647 to 0.923. Statistically, this was found to be highly significant [p value 0.000-0.0001]. 87% of the patients were able to return to the pre- injury activity level.

The hop test was performed in all the patients in the postoperative four to six months period. The mean limb symmetry index of the single hop test was 83.503. Gradual reduction in these values was noticed when the outcome became poorer on the two scorings sytems. Statistically the hop test was more of a trend with regards to IKDC. Andrea Reid et al, in March 2007, published their results of a series of hop tests on 42 patients, 15 – 45 years of age who had undergone ACL reconstruction[48].

The mean limb symmetry index in above study was calculated at the 22nd postoperative week against 24th postoperative week in our study.The mean values of above study were all above 85%. In our study the mean value is around 83%. The reason behind this could be due to much limb symmetry indices in some patients, especially the ones with a poorer outcome which was skewing the mean to the lower side. Moreover, many patients were quite apprehensive in performing the hop test, thereby increasing the disparity between the normal and the operated limb scores.

Table No 17: Comparison of our results with Andrea reid et al & Gulick TD studies

	Andrea reid[48]et al. study,2007	Gulick TD[77] Study, 2002	Present study
Number of Patients	42	57	30
Average age	26 years	27 years	29 years
Rehabilitation protocol	4 – 6 months	4 – 6 months	4 – 6 months
Hop test- Mean Limb Symmetry	88.2 +/- 9.5 (63.8 – 103.2) At 22 weeks	-	83.503 +/- 3.65 (66.36–93.33) At 24 weeks
Laxity	72%	74.6%	76.67%
Return to prior	-	84%	86.67%

Time period elapsed between the injury and the ACL reconstruction ranged from 1 1/2 months to 2 1/2 years with a mean value of 6.6 months. The duration of surgery ranged from 95 minutes to 140 minutes with a mean of 112.33minutes.

Gulick TD[77]and others in 2002 studied on 57 patients and concluded that 84% of their patients returned to pre-injury level of function.

In Paolo Aglietti et al study[79] 56% of participants were found to have returned to their pre injury sports participation level following ACL reconstruction surgery.

In a systematic review and meta-analysis in Sebastián Irarrázaval et al study, 93 with a mean follow-up of 40 months after ACL reconstruction, 81% of patients returned to sport, 65% returned to their preinjury level of sport and 55% returned to competitive level sport after surgery.[80]

In our study 86.67% patients returned to their previous level of function with 63% of the patients complain with the physiotherapy regimen.

Post-Operative Outcome -- IKDC Scoring

	Paolo Aglietti et al study[79]	Kyung-Wook Nha et al study[82]	present study
NORMAL	37	42	17
NEARNORMAL	25	13	10
ABNORMAL	3	0	2
SEVERELY ABNORMAL	4	0	1
TOTAL	69	55	30

In Paolo Aglietti et al study[79]39 (56%) normal, 24 (35%) nearly normal, 2 (3%) abnormal and 4 (6%) severely abnormal regarding IKDC scoring in post-operative period.

In Kyung-Wook Nha et al study[82], 42 (76.36%) normal, 13 (23.6%) nearly normal, and no abnormal or either severely abnormal in postoperative period.

In present study 17 (56.6%) were found to be normal 10 (43.3%) are near normal 2 (6.66%) are abnormal 1 (3.33%) is severely abnormal.

	Andrew D Lynch et al study[81]	Present study
Absence of giving away	96.6%	100%
Absence of joint effusion	84.1%	90%
Return to sports	91.1%	87%
Laxity	72.9%	73.33%

In Andrew D Lynch et al study[81], there is absence of giving away in 96.6%, 84.1% have absence of joint effusion, 91.1% returned to sports and there is laxity in 72.9% patients who has been operated.

In present study no patient had post-operative giving away, 90% have no joint effusion, 87% returned to sports activities, 4 patients (13.33%) had pain at the graft donor site. One patient (3.33%) had numbness around the graft donor site which gradually resolved completely. 22 patients (73.33%) had laxity of up to grade 1. In spite of this, Lachman test was hard end and itis the reason for the success of the surgery.

Two patients (6.67%) had superficial skin infection resulting in delayed wound healing and thus resulting in decreased post-operative scores.

	Kyung-Wook Nha et al study[82]	Present study
No. of patients	55	30
Age (yrs)	35.6 (19-46)	27.66 (15-45)
Gender (M: F)	36: 19	30: 0
Meniscal injury	35	19
MCL injury	13	0
Follow-up (months)	14 (12-23)	4- 6

In Kyung-Wook Nha[82] et al study, all the patients were followed for a minimum of 12 months post-operatively. The patients' average age was 35.6 years (range, 19 to 46 years). The mean follow-up period was 14 months (range, 12 to 23 months). Among 55 patients, 36 are male and 19 are female. 13 are associated with medial collateral ligament injury. 35 patients presented with meniscal injury.
In present study, patients are followed up within 4-6 months postoperatively. Average age was 26.6years.19 have meniscal injuries. No patient had medial collateral ligament injury.

VI. Conclusion

- This study was conducted on 30 patients who were suffering from ACL deficiency during the period of January 2016 to June 2017.
- All the patients were selected into the study based on inclusion and exclusion criteria. The type of surgery was arthroscopic guided ACL reconstruction with hamstrings tendon autograft.
- The fixation of the graft is achieved with femoral endo button along with tibial interference screw in almost all the cases.
- More number of patients come under the age group of 21-40yrs with the peak incidence between 26-30yrs.
- Nature of the injury in our series was sports in16 (53.3%) comprising 54% of the patients and road traffic accidents in 7 (23.3%). Farming and recreational sports is the common occupation followed by competitive sports and others.
- Giving way of the knee is the main presenting symptom (100%) in our study.
- Evaluation with Lachman test under anesthesia equates with arthroscopic evaluation (100%). Medial meniscus was the commonest associated injury (40%).
- All the 30 cases underwent arthroscopic ACL reconstruction with quadrupled semitendinosus tendon autograft and were given Wilk et al, rehabilitation protocol for a period of 6months from postoperative day1 and the results were evaluated periodically at 16 wks, 20 wks and 24 wks by IKDC & single hop test. 90% of the patients had excellent to good results. 87% of the patients were able to return to preinjury level of activity. Full range of motion attained in 90% of patients at 3 months, 93.34% of patients at 6 months and at 1 year 96.67% of patients. Postoperatively no patient had pivot shift positive. Mild residual laxity was noted in the follow-up period. Superficial infection (1patient) was the complication encountered in our study.
- We conclude that ACL reconstruction with quadrupled semitendinosus graft has high success rate with good functional results. MRI is very helpful in diagnosing meniscal, cruciate ligament injuries and extra-articular ligament injuries like medial and lateral collateral ligaments and plan surgery accordingly.
- This study was conducted on 30patients suffering from ACL deficiency in the age group of 20 - 45 years. Majority of the study subjects are males may be due to their out-door activities i.e almost 30 out of 31 in which one patient lost the follow-up.
- Only eleven patients had isolated ACL injuries and remaining 19 had ACL associated injuries including medial and lateral menisci.
- Right side was affected in 21 patients and left in 9 patients. All patients had instability of knee in the form of giving way evaluated by Lachman test and confirmed by arthroscopy.
- The functional outcome is excellent to good (90%) with mild laxity at the end of 6 months in few cases. Delay in surgery did not affect functional outcome of the patients when they effectively followed the rehabilitation protocol. Adherence to physiotherapy gradually waned as they returned to their pre-injury activity level and their respective occupation.

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