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Comparison Between Functional Outcomes of Bone Patellar Tendon Bone Autografts versus Semitendinosus Autografts for Reconstruction of Anterior Cruciate Ligament

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Abstract

Purpose: Our study of comparison of functional outcomes and complications of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction. **Material and Methods:** 60 patients were operated for ACL reconstruction in a tertiary health care setup, out of them 30 were operated with semitendinosus graft and 30 were operated with bone-patellar tendon-bone graft and were reviewed at 3 months, 6 months, 9 months and 12 months. After the procedure, the patients were assessed for the functional outcome using Tegner-lysholm knee scoring scale and also with International Knee Documentation Committee (IKDC) Scoresat. **Results:** Mean lysholm score was comparable between STA and BPTB groups at baseline (41.50 vs 41.77; p-0.81). The mean scores significantly improved in both group at each follow up and was recorded as 93.43 and 90.6 by the end of one year in STA and BPTB group respectively. The improvement was slightly better in STA group at each follow up. **Conclusion:** Arthroscopic/open anterior cruciate ligament reconstruction by either semitendinosus autograft or bone patellar tendon graft gives satisfactory results in short term follow up in terms of knee functions. However, Rehabilitation with bone patellar tendon bone autografts group was accelerated in balance proprioception and running as compared to semitendinosus autografts also creep of graft is mostly seen in semitendinosus autografts which is less likely to be seen in bone patellar tendon bone autografts.

Keywords: Anterior Cruciate Ligament Injury, Arthroscopic Repair, Bone Patellar Tendon Bone Autografts, Semitendinosus Autografts

1. Introduction

Anterior Cruciate Ligament (ACL) is a ligament of knee joint. It is major stabilizer of knee joint and prevents anterior tibial displacement. The ligament passes from medial part of intercondylar area of tibia upwards, backwards and laterally to insert into the posterior part of medial surface of the lateral femoral condyle. Anterior cruciate ligament injury remains a common orthopaedic problem and is often associated with meniscal pathology[1]. These tears can occur during the initial traumatic event, or subsequently over time due to altered biomechanics and the ongoing instability it causes. It has been established that standard of care for ACL injury is ligament reconstruction aiming to halt or minimize the number of instability episodes[2].

The ultimate goal of ACL reconstruction is to restore normal knee kinematics in patients with functionally

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unstable ACL deficient knees. ACL reconstructions fail at a rate which is small but not insignificant. Despite advances, failure rate after ACLR ranges from 0.7% to 10%[3].

The use of the central third of the patellar tendon with bone blocks at either end (Bone-patellar Tendon-Bone, or BTB) as an autograft for arthroscopic reconstruction of the ruptured ligament has become a standard procedure during the past decade, sometimes even called the "gold standard". However, well-known problems have been reported in conjunction with this method, especially in terms of donor-site morbidity, such as anterior knee pain, disturbances in knee sensitivity, and kneeling discomfort. It has been suggested that by obtaining full extension of the knee postoperatively, anterior knee pain can be prevented[4].

A frequently used alternative to the BTB autograft is the use of Semi-Tendinosus (ST) or ST/gracilis autografts. In a meta-analysis of available studies, Freedman *et al.*[5] reported that reconstruction using BTB autografts has a lower rate of graft failure, less objective knee laxity, and increased patient satisfaction; however, it results in an increased rate of anterior knee pain compared with the use of hamstring tendon auto-grafts. In another meta-analysis, Yunes *et al.*[6] found a trend toward improved stability using the BTB autograft compared with the hamstring tendon autograft and no significant differences in either complications or failure rate. Recently, in a meta-analysis of all prospective randomized clinical trials comparing BTB and ST autografts with a minimum of 2 years of follow-up, Goldblatt *et al.*[7] found 11 studies fulfilling the criteria for inclusion. The maximum follow-up time in this meta-analysis was a mean of 52 months. In their analyses, the BTB graft was found to be more likely to result in a normal Lachman test, normal pivot-shift test, better KT-1000 arthrometer values, and fewer patients with loss of flexion. The ST graft, on the other hand, resulted in a lower incidence of patellofemoral crepitance, less kneeling pain, and fewer patients with loss of extension. In an extensive review, Beynnon *et al.*[8] found that reconstruction using the 4-strand hamstring graft results in similar clinical and functional outcomes compared with the BTB graft.

Ideally, the graft used for ACL reconstruction should reproduce the anatomic and biomechanical properties of the native ligament, and allow solid fixation and rapid biological integration, with minimal donor-site morbidity. To date, no graft fully meets all these desiderata[9,10]. Both B-PT-B and HT transplants have their pros and cons that need to be taken into account in relation to the individual patient. There are presently no clear evidence-based guidelines in favor of one or the other. The present study thus aimed to compare between functional outcomes of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction.

2. Aims and Objectives

1. To compare between functional outcomes of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction.
2. To study complications of Anterior Cruciate Ligament reconstruction using bone patellar tendon bone autograft and semitendinosus autograft.

3. Methodology

3.1 Study Duration

August 2018 to December 2020.

3.2 Inclusion Criteria

1. Age >18 years, irrespective of sex.
2. Complete anterior cruciate ligament tear confirmed clinically and radiologically on MRI.
3. Patients with Knee instability.

3.3 Exclusion Criteria

1. Patients below 18 years of age.
2. Neuro-vascular compromise.
3. Multi-ligament injuries.
4. ACL avulsion injuries.
5. Fractures around knee.

3.4 Bone Patellar Tendon Bone Autografts

A 8-cm longitudinal incision is made from the inferior pole of the patella to approximately 2 cm distal to the tibial tubercle, along the medial aspect of the patellar tendon. Small skin flaps can be created to allow for adequate visualization of the medial and lateral borders of the patellar tendon.

A thin osteotome (Arthrex) or the No. 238 saw blade (Stryker, Kalamazoo, MI) can be used as a template for the planned harvest width. Care is taken to leave at

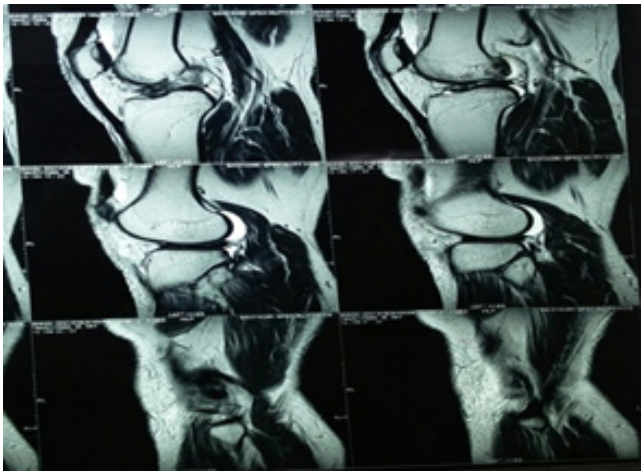

Figure 1. Pre-operative MRI.

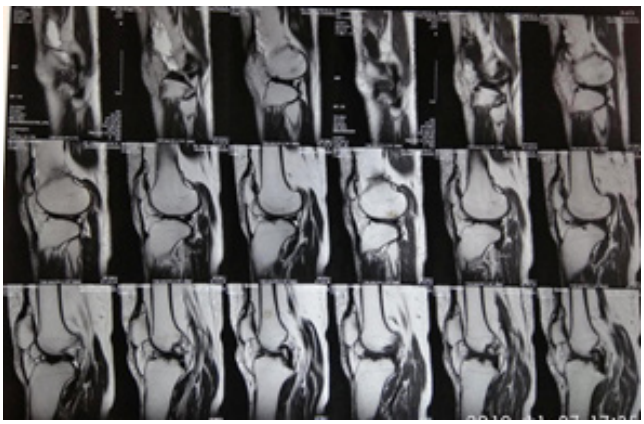

Figure 2. Pre-operative MRI.

least 10 mm of tendon medially. Next, starting either medially or laterally, a scalpel is used to incise the tendon longitudinally from proximal to distal, keeping the knife blade moving smoothly in line with the fibers of the tendon until the tibia is reached.

This step is then repeated on the other side of the tendon graft. Care should be taken not to narrow or widen the second incision relative to the initial incision.

3.5. Semitendinosus Autografts

For hamstring tendon autografts, the ST and/or Gra-Cilis (GC) can be harvested from the same limb. Incision of 3 m taken medial to tibial tuberosity superficial dissection done and semitendinous tendon identified, it should be tied using fiber wire or ethibond and then after separating graft from attachments cut tendon at insertion and stripping of tendon done using graft open/close stripper, GC tendon graft is also harvested in similar fashion,

Figure 3. BTB Graft harvesting.

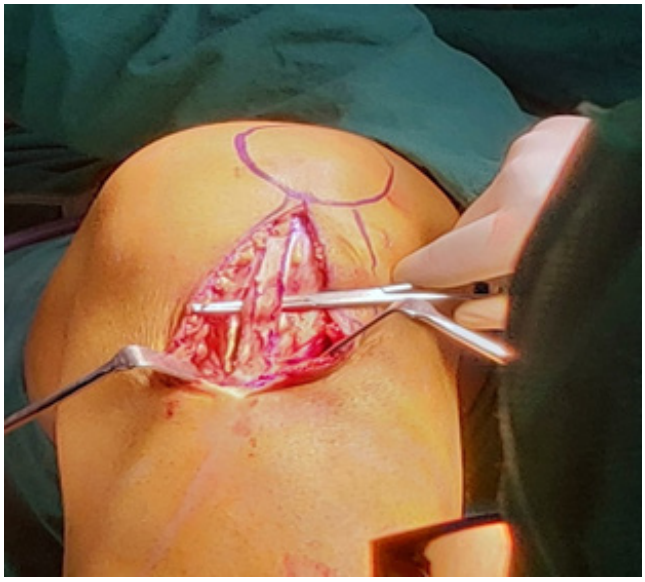

Figure 4. Semitendinosus autograft harvesting.

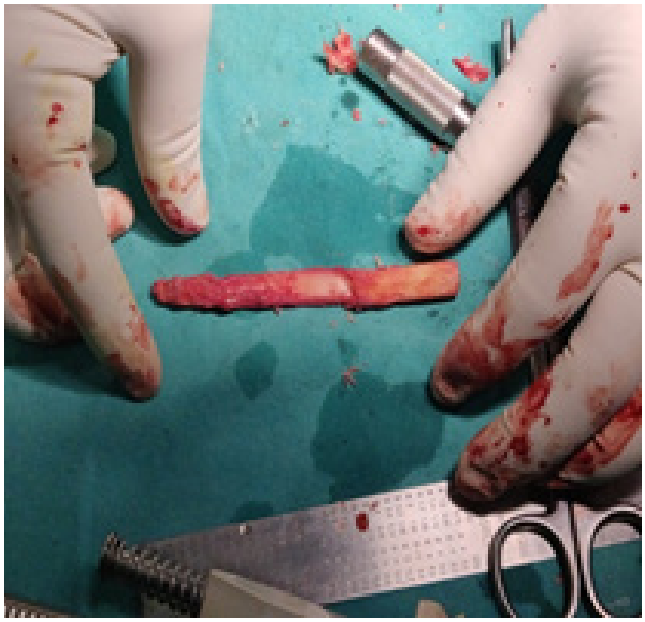

Figure 5. BTB graft.

Figure 6. 3 months follow-up.

Figure 7. 3 months follow-up.

Figure 8. 12 months follow-up.

Figure 9. 12 months follow-up.

harvested graft is cleaned and then running whipstitch sutures are passed along graft, prepared graft is then twisted in a reverse orientation in order that the proximal end of the ST is adjacent to the distal end of the GC graft and vice versa.

4. Results

Present study included a total of 60 patients undergoing anterior cruciate ligament reconstruction in our hospital. They were randomly divided into following two groups of 30 each and were managed by either bone patellar tendon bone autograft (BPTB) or by Semi-Tendinosus Autograft (STA).

Out of the total 60 cases, 52 were males (86.7%) while remaining 8 were females (13.3%).

Mean age of the study group was 28.2 years with no difference between the study groups (p-0.97).

Out of the 60 cases, left side was involved in 35 cases (58.3%) while left side was involved in 25 cases (41.7%).

Most common mode of injury was during sports activity (38.3%) followed by road traffic accidents (33.3%) and domestic falls (28.3%).

Table 1. Mean comparison of baseline IKDC and lysholm score

Baseline	Group	N	Mean	SD	p- value
IKDC Score	BPTB	30	32.77	3.75	0.84
	STA	30	32.97	3.95	
Lysholm Score	BPTB	30	41.77	4.03	0.81
	STA	30	41.50	4.57	

Mean baseline International Knee Documentation Committee (IKDC) score and Tegner-lysholm knee score were comparable between the study groups (p>0.05).

All the cases had positive Lachman test at the baseline. Grade I was observed in 6.7% cases while grade II and III was observed in 80% and 13.3% cases respectively. No difference was observed between study groups with respect to Lachman test results (p-0.78).

At one year of follow up, Lachman test was negative in 30% cases of STA group and 23.3% cases of BPTB group. Grade I and II results were observed in 70% and 0% cases of STA as compared to 73.3% and 3.3% cases in BPTB group respectively (p-0.83).

Table 2. Mean comparison of IKDC score during follow up

IKDC score	Group	N	Mean	SD	p- value
Baseline	BPTB	30	32.77	3.75	0.84
	STA	30	32.97	3.95	
3 months	BPTB	30	60.03	6.47	0.67
	STA	30	62.17	6.71	
6 months	BPTB	30	70.43	8.11	0.39
	STA	30	74.23	8.01	
9 months	BPTB	30	77.93	8.04	0.31
	STA	30	81.70	7.96	
12 months	BPTB	30	82.43	7.99	0.47
	STA	30	84.17	7.94	

Mean IKDC score was comparable between STA and BPTB groups at baseline (32.97 vs 32.77; p-0.84). The mean IKDC scores significantly improved in both group at each follow up and was recorded as 84.17 and 82.43 by the end of one year in STA and BPTB group respectively. The improvement was slightly better in STA group at each follow up, however it was not statistically significant (p>0.05).

Table 3. Mean comparison of lysholm score during follow up

Lysholm Score	Group	N	Mean	SD	p- value
Baseline	BPTB	30	41.77	4.03	0.81
	STA	30	41.50	4.57	
3 months	BPTB	30	71.77	5.88	0.73
	STA	30	73.00	5.89	
6 months	BPTB	30	83.77	6.35	0.51
	STA	30	86.00	6.51	
9 months	BPTB	30	87.60	5.38	0.58
	STA	30	89.43	5.02	
12 months	BPTB	30	90.60	5.38	0.49
	STA	30	93.43	5.02	

Mean lysholm score was comparable between STA and BPTB groups at baseline (41.50 vs 41.77; p-0.81). The mean scores significantly improved in both group at each follow up and was recorded as 93.43 and 90.6 by the end of one year in STA and BPTB group respectively. The improvement was slightly better in STA group at each follow up, however it was not statistically significant (p>0.05).

No complication was observed in 90% cases of STA and 83.3% cases of BPTB group respectively (p-0.919). Superficial infection were seen in 10% and 6.7% cases of STA and BPTB while kneeling pain was associated only with BPTB group (3 cases; 10%).

5. Discussion

Anterior cruciate ligament injuries are significant when they involve a complete intrasubstance tearing of the Anterior Cruciate Ligament (ACL) in the knee. The injury is characterized by joint instability that leads to pain, decreased activity and function, poor-knee-related quality of life, and an increased risk of osteoarthritis of

the knee. The ultimate goal of for the reconstruction of ACL is the restoration of normal knee kinematics. Various options for the graft are available for the treatment and each option has its own set of advantages and limitations.

Present hospital based randomized control study aimed to compare between functional outcomes and complications of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction. Study included a total of 60 patients undergoing anterior cruciate ligament reconstruction in our hospital. They were randomly divided into following two groups of 30 each and were managed by either Bone Patellar Tendon Bone (BPTB) autograft or by semitendinosus autograft (STA). After the procedure, the patient was assessed for the functional outcome using Tegner-lysholm knee scoring and also with IKDC scores at post-operative interval of 3, 6, 9 and 12 months.

5.1 Demography

Mean age of the study group was 28.2 years with no difference between the study groups (p-0.97). Out of the total 60 cases, 52 were males (86.7%) while remaining 8 were females (13.3%).

In a large study by Mei *et al.*[11] a total of 4355 ACL deficient inpatients (612 athletes and 3743 non-athletes) were registered. Of all the 4355 cases, the mean age at the time of first injury was (25.4±8.8) years (range: 8 years to 63 years). Totally 3078 patients (70.68%) were male and 1277 (29.32%) were female. Deo *et al.*[12] in their study observed average age as 28.3 years. Out of 30 patients operated 4 were women and remaining 26 were men. Our results are also consistent with Haitao *et al.*[13], who found ACL tears to be 2.5 times more in boys than girls.

These observations can be explained as men and boys are more involved in highly competitive and contact sports games, for example, soccer, basketball, skateboarding

5.2 Mode of Injury

In present study, most common mode of injury was during sports activity (38.3%) followed by road traffic accidents (33.3%) and domestic falls (28.3%).

Mei *et al.*[11] in their study observed that most of the subjects (77.68%) were injured in sports activities, 8.82% in daily living accidents, and 4.66% in traffic accidents. Our results are also consistent with Haitao *et al.*[13], who found ACL tears to more common with sports injury (58%). National Collegiate Athletic Association also reported that ACL tear mainly occurs during sports activities, especially in basketball, gymnastics, rugby and soccer[14].

5.3 Lachman Test

All the cases had positive Lachman test at the baseline. Grade I was observed in 6.7% cases while grade II and III was observed in 80% and 13.3% cases respectively. No difference was observed between study groups with respect to Lachman test results (p-0.78). At one year of follow up, Lachman test was negative in 30% cases of STA group and 23.3% cases of BPTB group. Grade I and II results were observed in 70% and 0% cases of STA as compared to 73.3% and 3.3% cases in BPTB group respectively (p-0.83).

In the study by Shaktawat *et al.*[15], postoperatively 2 cases (10%) in STA group and 5 cases (25%) in BPTB group had no laxity (negative). 17 cases (85%) in HT group and 14 cases (70%) in BPTB group had grade -I laxity but with firm end point. 01 case (5%) in both the groups had grade-II laxity. The results of Pre and post-operative Lachman test were statistically analyzed and there was no statistical significance in both the groups with P= 0.999 preoperatively and P=0.695 postoperatively. Deo *et al.*[12] and Jasoliya *et al.*[16] in their studies also observed no difference between the study groups with respect to results of Lachman test (p>0.05).

5.4 Functional Outcome

The functional outcome was measured by Lysholm knee scoring scale and International Knee Documentation Committee score. Lysholm knee scoring scale is a score which gives information as to how the knee problems have affected the patient's ability to manage things in everyday life. IKDC score was used for subjective knee evaluation of difficulty in daily activities. It is the standard score used for treatment of knee ligament injuries.

ACL reconstruction with BPTB graft was initially thought to be the gold standard method because of theoretical advantage of early graft integration in tunnels and mechanical strength when compared to two stranded hamstring tendon graft. Studies by Aglietti *et al.*[17] and Beynnon *et al.*[18] reported better results for BPTB grafts in terms post-operative sagittal knee laxity studied by manual and instrumented Lachman tests. Later on, with understanding and improvement of graft fixation such as by aperture fixation method and newer devices and equal

tensioning of parallel strands of quadrupled hamstring tendon grafts, no significant differences were found between the two types of grafts in short-term studies[19].

In present study, mean IKDC score and lysholm score were comparable between STA and BPTB groups at baseline (32.97 vs 32.77; p-0.84 and 41.50 vs 41.77; p>0.05). The mean IKDC and lysholm scores significantly improved in both group at each follow up and was recorded as 84.17 vs 82.43 and 93.43 vs 90.6 (p>0.05) by the end of one year in STA and BPTB group respectively. The results were not statistically different (p>0.05).

Deo *et al.*[12] observed mean post-operative Lysholm score in BPTB graft group as 76.33 with median value 86 and range 25-99 (SD = 16.6) and mean post-operative score in STA graft group as 81.23 with median value 93 and range 25-100 (SD = 26.6). Similarly, IKDC scores were also comparable between the groups (65.96 vs 68.97; p>0.771). Jasoliya *et al.*[16] in their study observed mean postoperative lysholm score in Hamstring graft group as 81.13 with median value 92 and range 23 to 100. Mean postoperative score in bone patellar tendon bone graft group was 76.13 with median value 85 and range 27 to 99. Shaktawat *et al.*[15] in their study observed mean lysholm score changed from 56.8 to 87.8 in STA group and from 54.7 to 87.9 in BPTB group at 2 year follow up. There is no statistical significance in the mean pre- and post-operative Lysholm scores in both the groups (p-0.28 and p-0.95). Results of recent short term study by Laxdal *et al.*[20] also showed that no clinically significant differences could be found between two groups. In a similar study, Good *et al.*[19] found that the two grafts did not differ in terms of clinical stability, range of motion and general symptoms.

5.5 Complications

No complication was observed in 90% cases of STA and 83.3% cases of BPTB group respectively (p-0.919). Superficial infection was seen in 10% and 6.7% cases of STA and BPTB while kneeling pain was associated only with BPTB group (3 cases; 10%). Cases with superficial infections were managed by course of antibiotics while NSAIDs was given as and when required for cases with knee pain.

In the study by Deo *et al.*[12], overall complications noted in BPTB graft group was anterior knee pain (10%) and numbness lateral to patella seen in one patient (3.3%). In Hamstring tendon graft group early infection was seen in one patient (3.3%), pain at terminal 10° of extension was seen in one patient (3.3%). Good *et al.*[19] in their study found that the STA group had a lower graft harvest site morbidity at 1 year follow up. A recent meta-analysis by Biau *et al.*[21], of individual patient data shows with newer surgical techniques no significant difference could be found between the two groups in terms of complications.

Thus, to summarize, in our study of comparison of functional outcomes and complications of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction, we found no statistically significant difference between the two modalities. Thus, ACL reconstruction with both the grafts gives satisfactory results in short term follow up. However, Healing of bone patellar tendon bone autografts occur with creeping substitution analogous to fracture healing so rehabilitation with bone patellar tendon bone autografts group was accelerated in balance proprioception and running as compared to semitendinosus autografts and the semitendinosus group had lower graft harvest site morbidity as demonstrated by less kneeling pain at 1 year.

6. Summary and Conclusion

A hospital based Randomized control study was conducted at Department of Orthopaedics, Medical College and Hospital, Study aimed to compare between functional outcomes and complications of bone patellar tendon bone autograft and semitendinosus autograft for Anterior Cruciate Ligament reconstruction. Study included a total of 60 patients undergoing anterior cruciate ligament reconstruction in our hospital. They were randomly divided into following two groups of 30 each and were managed by either BPTB autograft or by STA. After the procedure, the patient was assessed for the functional outcome using Tegner-lysholm knee scoring and also with IKDC scores at post-operative interval of 3, 6, 9 and 12 months. Following observations were made during the study:

1. Mean age of the study group was 28.2 years with no difference between the study groups (p-0.97).
2. Out of the total 60 cases, 52 were males (86.7%) while remaining 8 were females (13.3%).
3. Out of the 60 cases, left side was involved in 35 cases (58.3%) while left side was involved in 25 cases (41.7%).

4. Most common mode of injury was during sports activity (38.3%) followed by road traffic accidents (33.3%) and domestic falls (28.3%).
5. All the cases had positive Lachman test at the baseline. Grade I was observed in 6.7% cases while grade II and III was observed in 80% and 13.3% cases respectively. No difference was observed between study groups with respect to Lachman test results (p-0.78).
6. At one year of follow up, Lachman test was negative in 30% cases of STA group and 23.3% cases of BPTB group. Grade I and II results were observed in 70% and 0% cases of STA as compared to 73.3% and 3.3% cases in BPTB group respectively (p-0.83).
7. Mean IKDC score was comparable between STA and BPTB groups at baseline (32.97 vs 32.77; p-0.84). The mean IKDC scores significantly improved in both group at each follow up and was recorded as 84.17 and 82.43 by the end of one year in STA and BPTB group respectively. The improvement was slightly better in STA group at each follow up, however it was not statistically significant (p>0.05).
8. Mean lysholm score was comparable between STA and BPTB groups at baseline (41.50 vs 41.77; p-0.81). The mean scores significantly improved in both group at each follow up and was recorded as 93.43 and 90.6 by the end of one year in STA and BPTB group respectively. The improvement was slightly better in STA group at each follow up, however it was not statistically significant (p>0.05).
9. No complication was observed in 90% cases of STA and 83.3% cases of BPTB group respectively (p-0.919). Superficial infection was seen in 10% and 6.7% cases of STA and BPTB while kneeling pain was associated only with BPTB group (3 cases; 10%).

7. Conclusion

The outcome for patients in this study undergoing ACL reconstruction with a semitendinosus autograft did not differ from that of patients with a patellar tendon graft in terms of clinical stability, range of motion, and general symptoms. However, the semitendinosus group had lower graft harvest site morbidity as demonstrated by less kneeling pain at 1 year.

Thus, to conclude arthroscopic/open anterior cruciate ligament reconstruction by either semitendinosus autograft or bone patellar tendon graft gives satisfactory results in short term follow up in terms of knee functions. However, Rehabilitation with bone patellar tendon bone autografts group was accelerated in balance proprioception and running as compared to semitendinosus autografts also creep of graft is mostly seen in semitendinosus autografts which is less likely to be seen in bone patellar tendon bone autografts.

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