Original Article

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# Functional Outcome of Anterior Cruciate Ligament Reconstruction by Tibial Attachment Preserving versus Sacrificing Hamstring Graft Technique- A Prospective Interventional Study

Orthopaedics Section

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## ABSTRACT

**Introduction:** Anterior Cruciate Ligament (ACL) is a stout, short intra-articular, extra synovial structure. For a knee with the deficiency of ACL, the ligament reconstruction using an autograft, either a free bone patellar tendon bone graft or a Semi Tendinosus and Gracilis (STG) tendon free hamstring graft, is the most common surgical treatment. Tibial fixation region of the graft is presumed to be a delicate point in arthroscopic ACL reconstruction. There, can be a chance of graft pull out from the tibial tunnel before actual healing of the graft– tunnel can occur. To avoid this problem, the technique of tibial attachment preserved hamstring graft can be used instead of free hamstring graft.

**Aim:** To evaluate and compare the functional outcome of patients who underwent ACL reconstruction with either a free hamstring graft or by tibial attachment preserving hamstring graft.

**Materials and Methods:** A prospective interventional study was conducted in the Department of Orthopaedics, Swami Rama Himalayan University Hospital, Dehradun, Uttarakhand, India, over a period of one year (July 2019-July 2020). A total 52 patients were included and they were divided into two groups. Group A (tibial attachment preserving hamstring graft) and Group B (tibial attachment sacrificing hamstring graft) with each group comprised 26 patients. Patients were assessed with Lysholm score at 6, 12 and 24 weeks of follow-up. For determining the statistical difference between the two groups Independent Student's t-test was used, whereas for more than two groups Analysis of Variance (ANOVA) test was used and a p-value <0.05 was considered to be significant.

**Results:** The mean age of patients in group A was 30.73±10.02 years whereas in group B it was 29.54±9.84 years. For group A, mean Lysholm score at 6 weeks was 73.23±8.37, at 12 week score was 86.85±5.93 and at 24 week score was 95.58±4.91. For group B, mean Lysholm score at 6 weeks was 74.15±5.82, at 12 weeks score was 87.46±5.95 and at 24 weeks score was 96.92±3.61. Post-hoc analysis showed that there was a significant difference in mean Lysholm score {between preoperative and other time points (p<0.001, respectively)} for both the groups but there was no significant difference in Lysholm score at 6 weeks (p=0.646), 12 weeks (p=0.710) and 24 weeks (p=0.265) when compared between the two groups.

**Conclusion:** The ACL reconstruction using hamstring autograft with preserved tibial insertion resulted in no statistically significant difference in functional outcome as compared with free autograft.

**Keywords:** Arthroscopy, Lysholm score, Tibial attachment sacrificing

## INTRODUCTION

The cruciate ligaments are primary stabiliser of knee joint, and are responsible for the anteroposterior translation with the knee joint in flexed position. Depending upon the position of the knee in space, ACL can act as primary or secondary stabiliser of knee. When the knee is in flexion, resistance to anteroposterior translation by ACL is maximum upto 80% in the flexion arc of 30-90° [1].

In knee joint, injuries to the ACL often results in altered movement, frequent joint effusion, reduced performance, and muscle weakness [2]. ACL is a stout, short intra-articular, extra synovial structure [3]. The ACL can be categorised into Posterolateral Bundle (PLB) and Anteromedial Bundle (AMB), which are the two major functional bundles [4].

As per recent studies, incidence of ACL rupture is as high as 36.9 and 60.9 per 100,000 person per year. Approximately, two lac ACL rupture occurs annually in the United States. Furthermore, historically it has been observed that in 75-97% of the cases the reconstruction of ACL along with the satisfactory outcomes has been a successful operation [5]. For a knee with the deficiency of ACL, the ligament reconstruction using an autograft, either a free bone patellar tendon bone graft or a STG tendon free hamstring graft, is the most common surgical treatment [6]. Tibial fixation region of the graft is presumed to be a delicate point in arthroscopic ACL reconstruction. There, can be chances of graft pull out from the tibial tunnel before actual healing of the graft tunnel can occur. To avoid this problem, the technique of tibial attachment preserved hamstring graft can be used instead of free hamstring graft [7].

On reviewing the literature, a study was found wherein the comparison amongst two groups was done with lysohm scoring at sequential time intervals [6]. Hence, present study intended to pursue this study to analyse the results in the cases in the Indian scenario.

## MATERIALS AND METHODS

A prospective interventional study was conducted in the Department of Orthopaedics, Swami Rama Himalayan University hospital Dehradun, Uttarakhand, India, from July 2019-July 2020. The study was approved by the ethical committee (SRHU/HIMS/ETHICS/2020/129) of our institution. Informed consent was obtained from all the patients who participated in the study.

**Inclusion criteria:** All the cases who underwent primary arthroscopic ACL reconstructive surgery using hamstring tendon autograft during the stated study duration were included in the study.

**Exclusion criteria:** All those cases with immature skeleton, multiligament injury, any associated injury due to which postoperative rehab protocol needs to be changed were excluded from the study.

Single blinded randomisation was performed with 60 sealed envelopes containing the name of groups (Group A or Group B), with 30 envelopes belonging to each group: Group A (tibial attachment preserving hamstring graft); Group B (tibial attachment sacrificing hamstring graft). Each patient was asked to pick an envelope. The surgeon was preoperatively informed regarding the group in which the patient was selected and patient was operated accordingly. The technique for obtaining the grafts, consists of an oblique incision over anteromedial part of the proximal tibia, at the level of the insertion of the STG muscles followed by the dissection of the tendon of the semitendinosus muscle and using open ended tendon stripper graft of gracilis and semitendinosus were harvested but the tibial attachment was left intact in the experimental group A and sacrificed in group B. Arthroscopic ACL reconstruction was done using the standard accessory medial femoral portal for femoral tunnel drilling. The femoral end was fixed cortically using endobutton and tibial end of the graft was fixed with interference screw. The same technique was followed in all the cases included in the study. The functional status of cases using Lysholm score was followed [8] at interval of 6-week, 12-week, and 24-week post surgery.The questionnaire or Lysholm scale: Constituted of eight questions, with closed answers/alternatives, of which final score was expressed nominally and ordinally, with a score ranging from:

- 95-100 points regarded as "excellent"
- 84-94 points regarded as "good"
- 65-83 points regarded as "fair", and
- "poor" when values were equal or below 64 points.

Out of total 60 envelops, 58 envelops were picked during the study period (30 envelops of group A and 28 envelops of group B). Three subjects of group A and two subjects of group B were lost to follow-up. One subject of group A was excluded from the study, as intraoperatively it was assessed as a bony avulsion of ACL with intact ligament. All theses six subjects (4 of group A and 2 of group B) were excluded from study. Thus, 26 subjects in each group were included with complete follow-up as per protocol, who underwent arthroscopic ACL reconstruction as per the designated group protocol. At the end of study period, 52 cases were available for statistical analysis with complete postoperative follow-up.

The surgical procedure was performed by the same surgeon in all cases. All patients underwent a standard postoperative rehabilitation protocol for six months. The postoperative rehabilitation protocol consisted of [9]:

**Stage 1:** 0-2 weeks- Quadriceps sets; Hamstring strengthening exercises; Knee Range of Motion exercises (ROM)- 10-60°;

**Stage 2:** 2-4 weeks- Progressively increasing ROM- 0-120°; Gait training;

4-6 weeks Progress to full ROM by 6 weeks; Progress closed chain exercise

8-10 weeks Isokinetic exercises; Begin lunges

**Stage 3:** 12-16 weeks- Knee extension machine with low weight/ thigh repetitions

Progress isokinetic quadriceps to full extension by 16 weeks

**Stage 4:** 16-18 weeks- Begin jogging programme

**Stage 5:** 5-6 months- Agility training; Retest quadriceps if necessary

**Stage 6:** After 6 months- Return to sports if: Motion >130°, Hamstrings >90%, Quadriceps >85%

## STATISTICAL ANALYSIS

The results obtained in the study were subjected to standard statistical analysis using Software "International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 22.0. Categorical variables were expressed in terms of frequency and percentages whereas continous variables were expressed using mean and Standard Deviation (SD). For comparing the difference of mean between two independent groups, student's independent t-test was used. Chi-square test was used for categorical variables. ANOVA was used for more than two groups.

## RESULTS

No significant difference was observed in age distribution of the patients between the group A and group B (p=0.719). It was found that mean age of patients in group A was 30.73±10.02 years whereas the mean age of patients in group B was 29.54±9.84 years. Thus, there was no significant difference in the mean age of patient in group A and group B (p=0.667) [Table/Fig-1].

| Age groups (years) | Group A | | Group B | | p-value |
|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | |
| 15-25 | 8 | 30.8 | 11 | 42.3 | 0.719 |
| 26-35 | 9 | 34.6 | 7 | 26.9 | |
| 36-45 | 8 | 30.8 | 6 | 23.1 | |
| >45 | 1 | 3.8 | 2 | 7.7 | |
| Total | 26 | 100 | 26 | 100 | |
| **Mean±SD (years)** | 30.73±10.02 | | 29.54±9.84 | | 0.667 |

**[Table/Fig-1]:** Age distribution between the group A and group B. (p-value determined using Chi-squared test).

It was found that in group A, total of 18 (69.2%) patients were males while 8 (30.8%) were female whereas in group B total of 19 (73.1%) patients were males while 7 (26.9%) were females. Thus, it was found that there was no significant difference in gender distribution between group A and group B (p=0.760).

It was observed that under group A, 61.5% of the patients had Road Traffic Accident (RTA) as mode of injury while 19.2% had injury during playing. Under group B, 46.2% of the patients had RTA as mode of injury while 34.6% had injury during playing, It was observed that there was no significant association between mode of injury and the two study groups (p=0.446) [Table/Fig-2].

| Mode of Injury | Group A | | Group B | | p-value |
|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | |
| Fall at home | 4 | 15.4 | 2 | 7.7 | 0.446 |
| Fall from height | 0 | 0 | 1 | 3.8 | |
| Injury during exercise | 1 | 3.8 | 2 | 7.7 | |
| Injury during playing | 5 | 19.3 | 9 | 34.6 | |
| Road traffic accident | 16 | 61.5 | 12 | 46.2 | |
| **Total** | 26 | 100 | 26 | 100 | |

**[Table/Fig-2]:** Mode of injury between study group A and group B. (p-value determined using Chi-squared test)

The mean diameter of final graft in group A patients was 7.98±0.67 mm while for group B was 8.10±0.69 mm. There was no significant difference of mean diameter when compared between the two groups (p=0.545) [Table/Fig-3].

The mean length of final graft in group A patients was 10±1.57 cm while for group B was 9.33±1.26 cm, there was no significant difference when compared between the two groups (p=0.096).

| Diameter (mm) | Group A | | Group B | | p-value |
|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | |
| 7 | 6 | 23.1 | 5 | 19.3 | 0.927 |
| 8 | 14 | 53.8 | 13 | 50.0 | |
| 8.5 | 1 | 3.8 | 1 | 3.8 | |
| 9 | 5 | 19.3 | 7 | 26.9 | |
| Total | 26 | 100 | 26 | 100 | |
| **Mean±SD (mm)** | 7.98±0.67 | | 8.10±0.69 | | 0.545 |

**[Table/Fig-3]:** Comparison of graft diameter (mm) between group A and group B. (p-value determined using Chi-squared test)

On comparison of mean Lysholm score from baseline to 24 weeks in group A, it was observed that there was an increasing trend of mean Lysholm score from baseline to 24 weeks i.e., Lysholm score at preoperative was 55.88±7.37, at 6 weeks was 73.23±8.37. There was a significant difference in mean Lysholm score when compared from baseline to other three time points (p=0.001) [Table/Fig-4].

| Group A | | | p-value |
|---|---|---|---|
| Lysholm score | N | Mean±SD | |
| Preoperative | 26 | 55.88±7.37 | 0.001 |
| 6 weeks | 26 | 73.23±8.37 | |
| 12 weeks | 26 | 86.85±5.93 | |
| 24 weeks | 26 | 95.58±4.91 | |

**[Table/Fig-4]:** Lysholm score in group A. (p-value determined using repeated measures ANOVA test)

On comparison of mean Lysholm score from baseline to 24 weeks in group B it was observed that there was an increasing trend of mean Lysholm score from baseline to 24 weeks i.e., Lysholm score at preoperative was 51.92±8.38, at 6 weeks was 74.15±5.82. There was a significant difference in mean Lysholm score when compared from baseline to other three time points (p<0.001) [Table/Fig-5].

| Group B | | | p-value |
|---|---|---|---|
| Lysholm score | N | Mean±SD | |
| Preoperative | 26 | 51.92±8.38 | <0.001 |
| 6 weeks | 26 | 74.15 ±5.82 | |
| 12 weeks | 26 | 87.46±5.95 | |
| 24 weeks | 26 | 96.92±3.61 | |

**[Table/Fig-5]:** Lysholm score in Group B. (p-value determined using repeated measures ANOVA test)

It was observed that there was no significant difference in Lysholm score at 6 weeks (p=0.646), 12 weeks (p=0.710) and 24 weeks (p=0.265) when compared between the two groups [Table/Fig-6].

| Lysholm score | Group A | Group B | p-value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| Preoperative | 55.88±7.37 | 51.92±8.38 | 0.076 |
| 6 weeks | 73.23±8.37 | 74.15±5.82 | 0.646 |
| 12 weeks | 86.85±5.93 | 87.46±5.95 | 0.710 |
| 24 weeks | 95.58±4.91 | 96.92±3.61 | 0.265 |

**[Table/Fig-6]:** Comparison of Lysholm score between study groups at different time intervals. (p-value determined using independent student's t-test)

It was observed that within all the time points mean Lysholm score was comparable across all the graft diameters in group A. The p-value for Lysholm score at 6 weeks was 0.579; at 12 weeks 'p' was 0.145 and at 24 weeks 'p' was 0.394 [Table/Fig-7].

It was observed that within all the time points mean Lysholm score was comparable across all the graft diameters in group B. The p-value for Lysholm score at 6 weeks was 0.324; at 12 weeks 'p' was 0.16 and at 24 weeks 'p' was 0.904 [Table/Fig-8].

| Lysholm score | Diameter (in mm) | N | Mean±Std. Deviation | p-value |
|---|---|---|---|---|
| Baseline | 7 | 6 | 56±7.04273 | 0.759 |
| | 8 | 14 | 54.7857±7.10556 | |
| | 8.5 | 1 | 62±0 | |
| | 9 | 5 | 57.6±9.78775 | |
| 6 weeks | 7 | 6 | 71.5±6.189 | 0.579 |
| | 8 | 14 | 72.14±7.315 | |
| | 8.5 | 1 | 76±0 | |
| | 9 | 5 | 77.8±13.387 | |
| 12 weeks | 7 | 6 | 86±5.329 | 0.145 |
| | 8 | 14 | 85.14±5.545 | |
| | 8.5 | 1 | 90±0 | |
| | 9 | 5 | 92±6.124 | |
| 24 weeks | 7 | 6 | 95±3.162 | 0.394 |
| | 8 | 14 | 94.57±5.983 | |
| | 8.5 | 1 | 96±0 | |
| | 9 | 5 | 99±1.732 | |

**[Table/Fig-7]:** Comparison of Lysholm score with various diameter in group A. (p-value determined usingANOVA test)

| Lysholm score | Diameter | N | Mean±Std. Deviation | p-value |
|---|---|---|---|---|
| Baseline | 7 | 5 | 49.4±8.26438 | 0.203 |
| | 8 | 13 | 51.8462±9.13643 | |
| | 8.5 | 1 | 69±0 | |
| | 9 | 7 | 51.4286±5.09435 | |
| 6 weeks | 7 | 5 | 74.6±4.827 | 0.324 |
| | 8 | 13 | 72.62±5.738 | |
| | 8.5 | 1 | 83±0 | |
| | 9 | 7 | 75.43±6.294 | |
| 12 weeks | 7 | 5 | 92.2±4.97 | 0.16 |
| | 8 | 13 | 86.54±5.158 | |
| | 8.5 | 1 | 92±0 | |
| | 9 | 7 | 85.14±6.89 | |
| 24 weeks | 7 | 5 | 96.8±4.087 | 0.904 |
| | 8 | 13 | 96.54±3.755 | |
| | 8.5 | 1 | 99±0 | |
| | 9 | 7 | 97.43±3.69 | |

**[Table/Fig-8]:** Comparison of Lysholm score with various diameter in group B. (p-value determined using ANOVA test)

## DISCUSSION

In ACL reconstructive surgeries, for better postoperative functional outcome, some key factors should be taken into consideration like, graft strength, stiffness of the graft, characteristics similar to native ACL, revascularisation potential, anatomical position, and biological integration. Henceforth, in present study, authors aimed at comparing the short-term functional outcome of ACL reconstruction by tibial attachment preserving versus sacrificing hamstring graft.

In present study, the age group ranged from young adult (15-25 years) to middle age group (>45 years). Maximum number of patients was found to be young adults in the age group of 15-25 {19 patients (08 group A and 11 group B)}. Meuffels DE et al., also reported that most of the patients belonged to the same age group with the mean age of 27 years [10], while Abebe ES et al., reported a mean age of 31 years [11]. This was because most of the people in this age group are vulnerable to RTAs and also due to the demand of maintaining an active lifestyle in this age group.

In present study, authors used 7 mm, 8 mm, 8.5 mm and 9 mm diameter of grafts in both the groups. Out of total 52 cases, in 27 cases (14 of group A and 13 of group B) 8 mm graft used,

in 12 cases (5 of group A and 7 of group B) 9 mm graft used, in 11 cases (6 of group A and 5 of group B) 7 mm graft were used which shows that there was no significant difference in distribution of patients according to diameter when compared between the two study groups (p=0.927). In a study done by Challa S and Satyaprasad J, concluded that 42% of patients had a graft diameter between 7 and 8 mm, 12% of patients' grafts were less than 7 mm, while 46% were greater than 8 mm in diameter [12]. In the Western literature [13,14], the mean sizes of hamstring grafts range from 7.9-8.6 mm and in present study mean size of diameter was 8 mm in more than 50% cases."

Many previous studies also support the superiority of Lysholm scoring for knee functional assessment. Studies by Lysholm J and Gillquist J; and Briggs KK et al., evaluated the validity, reliability and responsiveness of the Lysholm score [8,15].

Present study shows that the overall Lysholm score was statistically significant when their preoperative scores (p=0.0001) when compared to postoperative scores at 6, 12 and 24 weeks post reconstruction in both the groups. In a study done by Sinha S et al., using tibial attachment preserving technique preoperative Lysholm scores was in range of 25-66 and postoperative Lysholm scores was in range of 91-100 in a period of one year [7]. In present study, Lysholm scores 6 months after surgery for both groups were found to be in range of 91-100. But on comparing the Lysholm score at preinjury, 6 weeks, 12 weeks and 24 weeks duration in between the groups, it was observed that there was no significant difference in Lysholm score at preinjury (p=0.076), 6 weeks (p=0.646), 12 weeks (p=0.710) and 24 weeks (p=0.265) between the two groups (group A and group B)."

There is paucity of similar studies done by other authors comparing the functional outcome after arthroscopic ACL surgery done either by tibial attachment sacrificing hamstring graft or tibial attachment preserving surgery. Authors extensively searched papers and online resources for data related to this subject but could find only one study done by Gupta R et al., they concluded that- using hamstring autograft with preserved insertions resulted in statistically better anterior stability, a superior functional outcome, and an easier return to the preinjury level of sports activity as compared with free autograft [16].

From present study, it was observed that within all the time points mean Lysholm score was comparable across all the graft diameters. But on comparing every graft diameter at particular time period there was no significant difference in Lysholm score.

In present study, all possible confounding factors were excluded by including only patients without articular cartilage injury or any pre-existing knee pathology. In addition, authors minimised the potential bias of other variables that may influence outcome by reviewing patients from a single surgeon, using the particular surgical technique and fixation methods according to the allotted group, and the same postoperative rehabilitation program in all the patients. Statistically there was no anthropometric difference between either group. Average duration of present study was 12 months with a minimum follow-up period of six months in each patient.

Short-term complications following ACL reconstruction include infection and deficits to knee motion and strength, whereas long-term complications include secondary ACL injury to either the involved or contralateral knee and lack of ability to return to high-level sports following this procedure [17]. In present study, there was no significant complication. Only complaint seen was persistent dull anterior knee pain till 6 weeks follow-up. This might be because of regular follow-up and aggressive rehabilitation program of each individual patient.

Authors propose, that for confirmation of the graft vascularity at 6-10 weeks the ideal test would be histopathological examination of the graft during this period. Since, it has its own practical limitation we cannot confidentially say that vascularity is severely hampered in graft detached cases. It is also concluded that in any arthroscopy ACL surgery, even if graft vascularity issue persists the final function outcome can be still achieved in excellent to good range by taking care of all other above mentioned associated factors.

### Limitation(s)

Present study had following limitations associated with it. First, a 24 weeks follow-up is a short-term follow-up. A longer follow-up is required to compare the long-term results of ACL reconstruction using hamstring autograft with preserved insertions and free hamstring autograft. Second, sample size was not quite enough to have greater impact on the results. Third, present study signifies the belief of persevering the insertions of the hamstring tendons to the tibia retains the blood supply to the tendons and prevent postoperative necrosis and revascularisation phase that usually happens in free hamstring graft can be surpassed. To prove this, histopathological investigation of the graft at different time interval is to be done. One of the drawback of present study was, the tibial attachment preserving technique is associated with increased surgical time, as graft preparation and arthroscopy is done sequentially not side by side as in case of free hamstring graft preparation.

## CONCLUSION(S)

The ACL reconstruction using hamstring autograft with preserved insertions resulted in no significant difference in functional outcome as compared with free autograft. Although Lysholm score per se had a significant improvement in each subsequent follow-up which signifies the success of this surgery and improved patient outcome.

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