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# HAMSTRING TENDON HARVEST IN ACL RECONSTRUCTION, FOLLOW UP STUDY ON RECOVERY OF RANGE OF MOVEMENTS.

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**ABSTRACT**

**BACKGROUND:** Autografts play an important role in ligament reconstruction. The semitendinosus and gracillis have been a significant source of graft material for reconstruction. There are two schools of thought whether to use a doubled semitendinosus and gracillis or a quadrupled semitendinosus graft. Numerous studies have shown that harvesting the semitendinosus and gracillis reduce knee flexion, especially deep flexion angles of the knee. Harvesting the gracillis impacts semitendinosus regeneration and decreases post-operative range of movements hence harvesting the semitendinosus alone maybe the best option for reconstruction in athletes who require high levels of knee flexion strength and a faster recovery from reconstruction. Following graft harvest the hamstring tendons regenerate within 24 months but the degree of recovery and redevelopment of semitendinosus varies from individual to individual. The purpose of this study was to document the recovery of Loss in Range of movements associated with the use of both semitendinosus and gracillis and semitendinosus alone as graft material for ACL reconstruction.

**MATERIALS AND METHODS:** The retrospective study was conducted at Lourdes Hospital, Ernakulam, Kerala. Data regarding preoperative physical examination, Operative technique were gathered from chart reviews Patients who presented with tears were grouped based on the tendon used for reconstruction into ST group in whom the semitendinosus alone was used for reconstruction and STG group in whom the semitendinosus and gracillis was used for reconstruction. To compensate for the recovery of range of movements associated with acute ACL rupture patients was further grouped based on time of injury to reconstruction. GROUP I included patients who underwent ACL Reconstruction within 2 months of injury, GROUP II within 2-6 months of injury and GROUP III within 6-12 Months of injury.

The range of motion of the knee was evaluated in the outpatient department when the patients came for review. Measurement was done with the patient supine on an examination bed using a goniometer. The interlimb difference was recorded. Patients were followed up after reconstruction and range of movements assessed at 3 months,6 months and one year

**RESULTS:** In group 1 There was no significant difference in change between Relative Range of movements (ROM) at 3, 6 or12 months' time in both ST and STG Patients. (All P values>0.05).

The range of movements in Group I Improved steadily with time in all patients who were Operated with semitendinosus (ST) and semitendinosus and gracillis (STG) grafts. But On comparison of ROM with the opposite limb pre-operative levels STG patients could attain only 87% whereas ST patients attained 98% results. In group II There was a significant difference in the relative improvement of ROM at 3rd month($p<0.05$) between patients operated with ST and STG. Pt operated with ST alone showed significant improvement, but there was no difference at 6th Month or 1 year time (other P Values>0.05).In comparison with opposite limb Patients attained more than 90% Rom in ST group compared to STG. In group III the relative improvement of ROM was less in third month (P value>0.05). But there was a significant improvement at 6th month and one year in both ST and STG group (P values<0.05). But On comparison of ROM with the opposite limb in ST patients 13/21 (62%) reached 100% ,6 reached 96%,2 reached 90%. Whereas in STG patients 5 reached 90% and the remaining 2 patients attained 81%, 78%. Statistically minor significant difference between relative Range of Movement was found at 3 months and 6 months of follow up in Group I, II and III but at 1-year period there was no significant difference in relative ROM or on comparison with the opposite limb as all p values were >0

**CONCLUSION:** Irrespective of the graft used at one year there was no statistically significant difference between overall Range of Movement, Relative range of movement at 3,6 and one year follow up and functional loss compared to opposite limb (p values>0). We did not find significant differences with the final outcome but the rate of recovery was better with the use of semitendinosus alone hence surgeon may always consider reconstruction using semitendinosus, especially in athletes demanding deep flexion of the knee.

**KEYWORDS :** Anterior cruciate Tear, ACL Reconstruction, Hamstring tendon harvest, ACL Reconstruction, Semitendinosus, Gracillis

## BACKGROUND

Autografts have played an important role in ligament reconstruction over the years, as they have a lesser chance of rejection compared to allografts and also increased strength with lesser chance of rupture, Autograft harvest has been associated with strength deficits in the donor limb with associated loss of range of motion based on the graft used for harvest.

Pes anserinus tendons namely the semitendinosus and gracillis has been a significant source of graft material for reconstruction of the anterior cruciate ligament (ACL) in the recent years due to their less invasive nature on the donor site during harvest compared to other autografts. Flexion strength, Active knee flexion and internal rotation loss has been attributed to their harvest

There are two schools of thought whether to use a doubled (STG) semitendinosus and gracillis graft or a quadrupled (ST) semitendinosus graft. Noyes et al. reported that a single stranded semitendinosus graft had 49 and gracillis 70 percent the strength of the native ACL but also postulated that the graft would lose its strength during normal healing process. Biological grafts lose their strength during the normal healing process as demonstrated in numerous animal models[,].It has been suggested that the mechanical properties of graft strands are additive , Hence surgeons have attempted to increase strength with use of four-strand hamstring grafts.

Hamstring Muscles the semitendinosus and gracillis have an important role in internal rotation and flexion of the knee. Numerous studies have shown that harvesting the semitendinosus and gracillis reduce knee flexion, especially deep flexion angles of the knee. Tashiro et al demonstrated significant loss of hamstring strength and flexion in using both the semitendinosus and gracillis while Adachi et al reported that the peak torque value was not statistically different from a normal knee. In summary the loss of active knee flexion increased with harvesting more than one tendon

The gracillis due to biomechanical alterations reinforce the action of the hamstrings during deep knee flexion despite being a hip adductor, knee flexion alters the insertion of the gracillis with respect to the centre of the knee joint due to the line of pull acting on the muscle.

The gracillis is believed to facilitate anatomic regeneration of the semitendinosus and undergoes compensatory hypertrophy following semitendinosus harvest.Hence harvesting the gracillis impacts semitendinosus regeneration and decreases post-operative range of movements which points to the fact that harvesting the semitendinosus alone is the best option for reconstruction in athletes who require the high levels of knee flexion strength and a faster recovery from reconstruction,.

Following graft harvest the hamstring tendons pass through the neo tendon phase and regenerate within 24 months after surgery but the

degree of recovery and redevelopment of semitendinosus was not equal as shown by Leis et al [16].

The purpose of this follow up study was to document the recovery of Loss in Range of movements associated with the use of both semitendinosus and gracillis and semitendinosus alone as graft material for ACL reconstruction. Patients were grouped based on the tendons used namely semitendinosus and gracillis and gracillis alone. Taking into consideration the recovery of ROM following Acl Injury, Patients were also grouped based on the time of injury to reconstruction Acute (Reconstruction within 2 months of injury), Subacute (Reconstruction within 2-6 months of injury), Chronic (Reconstruction within 6-12 Months of injury) phases

## MATERIALS AND METHODS

The study is retrospective undertaken during a three-year period in the department of orthopaedics at Lourdes hospital, Ernakulam, Kerala starting from March 2008 to February 2011 a total of 150 patients with ACL tears who required surgical intervention were treated in this institution .Appropriate consent was obtained from institutional ethical committee and from the patients included in the study.

Data regarding preoperative physical examination, Operative technique, and subjective reports of pain dysfunction or limp were gathered from chart reviews. Diagnosis was confirmed with an MRI in all Patients and also included patients in whom the diagnosis was made by arthroscopy. The age at diagnosis, gender, presenting complaints with duration and symptoms, the side involved, the presence or absence of meniscal tear, type and location of meniscal tear, Duration between ACL rupture and reconstruction and also the height, weight and similar complaints in the family were collected

Mode of injury was documented and Road traffic accidents constituted more than 53% of the injury. Another 36% of the patients had a history of contact sports and in the remaining 20 % the cause could not be ascertained but were included in the study as they satisfied the inclusion criteria The patients were selected based on the following inclusion criteria which included males and females between 16 and 60 years who underwent primary Acl Reconstruction with or without associated meniscal injury. Patients with Collateral ligament injury's, posterior cruciate injuries or revision ACL surgeries were excluded of the 150 patients 49 patients were excluded from the study as they did not fit the inclusion criteria and the injury date could not be properly estimated, the remaining 101 patients were assessed. The diagnosis was confirmed in the operating room by examination under anaesthesia and by arthroscopy.

Acl Tears and the associated meniscal injury was identified by the operating surgeon. Meniscal injury location and grade of injury was noted. All patients were treated with Arthroscopic ACL Reconstruction and Grade II and III meniscal tears were treated with menisctomy or repair. Tendon used for reconstruction were noted and patients grouped into ST group in whom the semitendinosus alone was used for reconstruction and STG group in whom the semitendinosus and gracillis was used for reconstruction. To compensate for the recovery of range of movements associated with acute ACL rupture patients was further grouped based on time of injury to reconstruction. GROUP I included patients who underwent ACL Reconstruction within 2 months of injury, GROUP II within 2-6 months of injury and GROUP III within 6-12 Months of injury.

The range of motion of the knee was evaluated in the outpatient department when the patients came for review. Measurement was done with the patient supine on an examination bed using a goniometer. The interlimb difference was recorded. Patients were followed up after reconstruction and range of movements assessed at 3 months,6 months and one year

**Statistical Methods**:

The ratio of the patients in the three groups whose data was compared was done using the chi square test. And proportion of patients in each age group distributed across the three groups were verified using Kolmogrov-Smirnov test. The average age of the patients was verified Using the F test and The recovery of range of movements across the three groups based on the graft used for reconstruction was analysed using the t-test and determining the associated P Values.

## RESULTS

A total of 101 patients were available for follow up. The patients ere divided into three groups based on their time of injury to ACL econstruction. as depicted in chart 1.

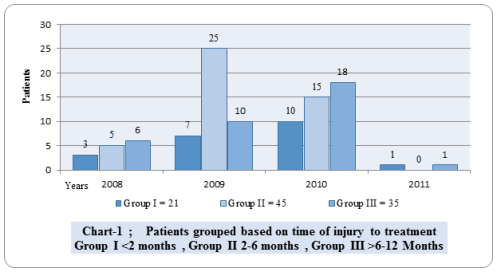


Chart-1 ; Patients grouped based on time of injury to treatment Group I <2 months , Group II 2-6 months , Group III >6-12 Months

GROUP I included 21 patients in the acute phase who underwent reconstruction within 2 months of injury, GROUP II with 45 patients in the subacute phase who had surgery within 2-6 months and GROUP III included 35 chronic cases who underwent Reconstruction late within 6-12 Months of injury. The ratio of patient in Group1, Group2 and Group3 is 1:2:2 and it is verified using chi square test as chi square $\chi 2 = 1.2772$ with p value=0.5280>0.05. The study Population included 91 male and 10 female patients. Group1 included 16 male and 5 female patients, Group II 43 male and 2 female and Group III with 32 male and 3 females as shown in table 1.

**Table – 1: Distribution of patients based on gender across three groups**

| Sex | Group 1 | Group II | Group III | Total |
|---|---|---|---|---|
| Male | 16 | 43 | 32 | 91 |
| Female | 5 | 2 | 3 | 10 |
| Total | 21 | 45 | 35 | 101 |
| Male % | 76 | 95 | 91 | 90 |
| Female % | 23 | 5 | 9 | 10 |

Males constituted 90% of all the patients with injuries and the remaining 10 % females. In group I 76% were male and 23% female, in group II 95% were male and 5% female and in Group III 91 % were male and 9 % female (Table -1).

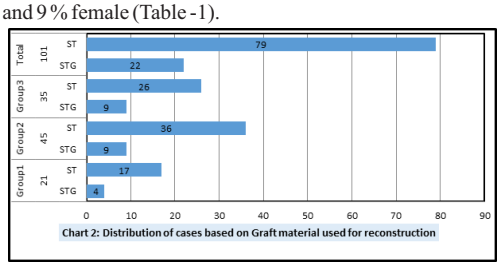


Chart 2: Distribution of cases based on Graft material used for reconstruction

In 79 of the total 101 patients the ACL was reconstructed using the semitendinosus (ST) graft and 22 with both the semitendinosus and gracillis (STG). In group I 26 with ST and 9 with STG, In group II 36 with ST and 9 with STG In group III 17 with ST and 4 with STG

**Comparison of Range of Movements (ROM) in the three groups**
**Relative improvement in ROM Group I**

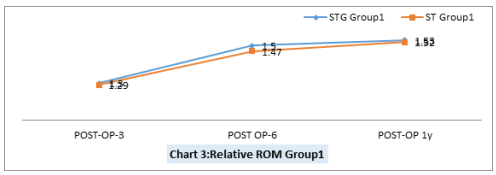


Chart 3:Relative ROM Group1

**Table – 2: Relative improvement in ROM Group I**

| Group1 | | 3 Months | 6 Months | 1 Year | Relative to opposite Limb |
|---|---|---|---|---|---|
| N cases | | Post Op | Post Op | Post Op | Pre-Op |
| 4 | Min | 1.22 | 1.33 | 1.33 | 0.81 |
| | Max | 1.43 | 1.71 | 1.71 | 0.89 |
| STG | Aver | 1.3 | 1.5 | 1.53 | 0.87 |
| 17 | Min | 1.11 | 1.33 | 1.33 | 0.83 |
| | Max | 1.43 | 1.85 | 1.85 | 1 |
| ST | Aver | 1.29 | 1.47 | 1.52 | 0.98 |
| | pval | 0.93549 | 0.679545 | 0.860152 | 0.112151 |
| | t | 0.082019 | 0.419515 | 0.178588 | 1.66582 |
| Group1 | Aver | 1.29 | 1.47 | 1.52 | 0.99 |
| 21 | SD | 0.08 | 0.13 | 0.13 | 0.16 |

In group 1 Of the 21 patients 4 belonged to the STG group and 17 to the ST group. In Group I the patients showed a steady improvement with an increase to 29% from first month to third month which progressed to 47% at six months and 52% at one year. At one-year (10/12)83% of patients belonging to the ST group reached full range of movements compared to the opposite limb whereas in STG group all four did not achieve full range of movements 3 patients reached 89% and one reached 81%. There was no significant difference in Relative Range of movements (ROM) at 3, 6 or12 months' time in both ST and STG Patients. (All P values>0.05). As shown in Table 2 and depicted in chart3.The range of movements in Group I Improved steadily with time in all patients who were Operated with ST and STG grafts. But On comparison of ROM with the opposite limb pre-operative levels STG patients could attain only 87% whereas ST patients attained 98% results. The Recovery of ROM was better in patients operated with semitendinosus alone.

**Relative improvement in ROM Group II**

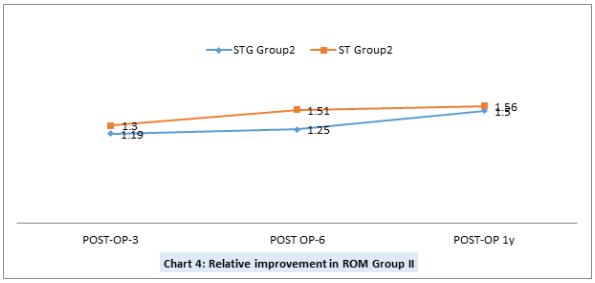

Chart 4: Relative improvement in ROM Group II

**Table – 3: Relative improvement in ROM Group II**

| Group2 | | 3 Months | 6 Months | 1 year | Comparison with Opp Limb |
|---|---|---|---|---|---|
| No. of cases | | Post OP | Post OP | Post OP | Pre-Op |
| 9 | Min | 1.07 | 1.11 | 1.33 | 0.74 |
| | Max | 1.33 | 1.67 | 2 | 0.93 |
| STG | Aver | 1.19 | 1.25 | 1.5 | 0.85 |
| 36 | Min | 1.11 | 1.22 | 1.22 | 0.91 |
| | Max | 1.57 | 1.83 | 1.93 | 1 |
| ST | Aver | 1.3 | 1.51 | 1.56 | 0.96 |
| | pval | 0.032562 | 0.05559 | 0.949968 | 0.599924 |
| | t | 2.208867 | 1.967566 | 0.063114 | 0.528421 |
| Group2 | Aver | 1.28 | 1.48 | 1.56 | 0.94 |
| 45 | SD | 0.137422 | 0.178585 | 0.18195 | 0.09 |

In group II of the 45 patients 9 belonged to the STG group and 36 to the ST group. There was a steady improvement in the overall range of movements which increased gradually attaining 28 % at 3 months, 48% at six months and 56% at the end of one year. But On comparison of ROM with the opposite limb pre-operative levels in ST patients (20/33)61% reached 100% ,7 reached 96%,5 reached 90% and 1 patient 83%. Whereas in STG patients 6 reached 90% and the remaining 3 patients attained 81%, 78% and 74% respectively. There was a significant difference in the relative improvement of ROM at 3rd month($p<0.05$) between patients operated with ST and STG as shown in table 3 and chart 4. Pt operated with ST alone showed significant improvement, but there was no difference at 6th Month or 1-year time (other P Values>0.05). In comparison with opposite limb Patients attained more than 90% Rom in ST group compared to STG.

**Relative improvement in ROM Group III**

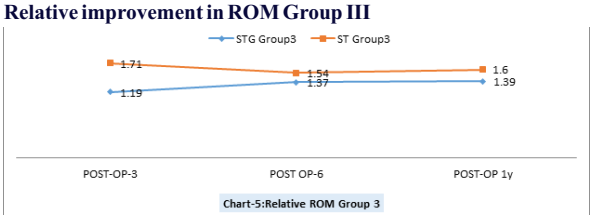

Chart-5:Relative ROM Group 3

**Table – 4: Relative improvement in ROM Group III**

| Group3 | | 3 Months | 6 Months | 1 Year | Comparison with Opp Limb |
|---|---|---|---|---|---|
| No. of cases | | POST-OP | POST OP | POST-OP | Pre-Op |
| 9 | Min | 1.11 | 1.22 | 1.22 | 0.77 |
| | Max | 1.42 | 1.71 | 1.78 | 0.92 |
| STG | Aver | 1.19 | 1.37 | 1.39 | 0.85 |
| 26 | Min | 1.11 | 1.33 | 1.38 | 0.88 |
| | Max | 1.57 | 1.92 | 1.93 | 1 |
| ST | Aver | 1.26 | 1.54 | 1.6 | 0.97 |
| | pval | 0.139332 | 0.009496 | 0.002226 | 2.3E-08 |
| | t | 1.514845 | 2.75423 | 3.316416 | 7.28964 |
| Group3 | Aver | 1.25 | 1.5 | 1.55 | 0.94 |
| 35 | SD | 0.13 | 0.18 | 0.19 | 0.07 |

In group III of the 35 patients 9 belonged to the STG group and 26 to the ST group. ROM increased steadily from 1st month to 3rd month at 26% in ST group and 19% in STG patients. And from 3rd months to 6th months at 28% and 18% respectively while at 1 year there was a change of 6% and 2% respectively. Overall improvements in ROM in Group III showed 25% change in 1st to 3rd month, 50% in sixth months and 55% at 1 year. The relative improvement of ROM was less in third month (P value>0.05). But there was a significant improvement at 6th month and one year in both ST and STG group (P values<0.05). But On comparison of ROM with the opposite limb pre-operative levels in ST patients 13/21 (62%) reached 100% ,6 reached 96%,2 reached 90%. Whereas in STG patients 5 reached 90% and the remaining 2 patients attained 81%, 78%. As shown in table 4 and chart 5.

**Table – 5: Comparison of relative ROM between Group I, II and III**

| Between | | 3 Months | 6 Months | 1 Year | relative to opposite limb |
|---|---|---|---|---|---|
| G1 G2 | Pval | 0.70581 | 0.846014 | 0.4487124 | 0.513558 |
| | t | 0.379178 | 0.194995 | 0.76224759 | 0.656966 |
| G1 G3 | Pval | 0.14496 | 0.571931 | 0.60270546 | 0.122755 |
| | t | 1.478966 | 0.56868 | 0.52359079 | 1.567864 |
| G2 G3 | Pval | 0.314056 | 0.728418 | 0.78407221 | 0.982597 |
| | t | 1.014255 | 0.348665 | 0.27510178 | 0.021893 |

Statistically significant difference between relative Range of Movement was not found in Group I, II or III at 3 months 6 months or 1-year follow up period and also in comparison with the opposite limb as all p values were >0. Depicted in table 5.

**Table – 6: Comparison of Overall ROM between 3 groups**

| comparison | Between | Z | P Value |
|---|---|---|---|
| ST | 1Vs2 | 1.0835 | 0.27 85 |
| ST | 1Vs3 | 0.3124 | 0.7547 |
| ST | 2Vs3 | 0.9123 | 0.3616 |
| STG | 1 Vs 2 | 1.0353 | 0.3009 |
| STG | 1 Vs 3 | 1.8142 | 0.0696 |
| STG | 2 Vs 3 | 0.9925 | 0.3209 |
| Group1 | STG Vs ST | 0.5933 | 0.5529 |
| Group2 | STG Vs ST | 0.1614 | 0.8717 |
| Group3 | STG Vs ST | 2.4623 | 0.0138<0.05 |
| All | STG Vs ST | 0.2555 | 0.7982 |

Mean range of movements in patients operated with Semitendinosus and Gracillis was found to be less than in those operated by Semitendinosus alone.

At one year, no Statistically significant difference was found between patients in the STG group on comparison with ST group. Depicted in table 6.

## DISCUSSION

**Outcome on ROM associated with Graft material used for reconstruction.**

The current surgical techniques, immediate mobilization and full weight-bearing allowed earlier and much more intense rehabilitation. Comparison of Range of movements in Group I, II, and III showed no significant loss of range of movements using either semitendinosus and Gracillis or semitendinosus alone at one-year post rehabilitation. Even though the recovery of ROM (Relative ROM) In patients who was operated with semitendinosus alone was better initially at 3-month and 6 months.

In Group I the relative ROM improved steadily from 3rd month to 1 year in all patients irrespective of the graft used. Rate of recovery was better in ST compared to STG. On Comparison with the opposite limb STG patients reach 87% pre op levels whereas ST patients reached 98%. In Group II There was a significant difference in the relative improvement of ROM at 3rd month, between the two groups (ST, STG). Pt operated with ST alone showed better recovery, but there was no

significant difference after six months of follow up whereas In Group III there was a significant difference in the relative improvement of ROM even up to six months and one year between the two groups (ST, STG). The recovery of ROM was slower in patients in the STG group (19%) compared to ST (26%)

There was an overall poor recovery in patients operated with both the semitendinosus and gracillis (STG) graft compared to patients operated with semitendinosus alone (ST). The use of hamstring tendons resulted in loss of knee flexion as shown by by Eriksson[17] et al.2001 and Yasuda[18] et al. However, knee exion shows However, knee flexion shows considerable recovery during the first postoperative year. Range of Movements in patients operated with a Semitendinosus graft alone was better than patients operated with Semitendinosus and Gracillis which gradually improved over time. Also, the Relative improvements of ROM was better in patients operated with ST alone as they recovered their Rom significantly within 3 months($p<0.05$) but there was no statistically significant difference at 6 months and one year (other P values>0.05).Use of both Semitendinosus and Gracillis resulted in lack of deep flexion of the knee but the loss recovered with time.

## CONCLUSION

Irrespective of the graft used at one year there was no statistically significant difference between overall Range of Movement, Relative range of movement at 3,6 and one year follow up and functional loss compared to opposite limb (p values>0).

The use of Semitendinosus alone or Semitendinosus and Gracillis for ACL reconstruction offered good clinical results but Use of both Semitendinosus and Gracillis resulted in greater loss of knee movements especially deep flexion. and duration of recovery following reconstruction was high. We did not find significant differences with the final outcome but the rate of recovery was better with the use of semitendinosus alone hence surgeon may always consider reconstruction using semitendinosus, especially in athletes demanding deep flexion of the knee.

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