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Functional outcomes of quadrupled semitendinosus vs. four strand semitendinosus / Gracilis graft for arthroscopic ACL reconstruction

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Abstract

Introduction: Anterior cruciate ligament is a commonly disrupted ligament causing anterior instability of knee. Arthroscopic ACL reconstruction is the treatment of choice. Many graft options are available most common being the four-strand hamstring autograft. Four strand hamstring graft can be made either by doubling both Semitendinosus and Gracilis tendon (STG) or by quadrupling Semitendinosus tendon (ST4).

Aim: To compare functional outcomes following ACL reconstruction with STG graft vs ST4 graft using femoral adjustable loop button and tibial bio-screw fixation.

Material and Methods: This was a prospective cohort study in which 68 patients with isolated ACL tear with knee instability were enrolled during 2017-2018. Patients with multi-ligamentous injury, associated meniscal tears, chondral lesions, juxta-articular fractures and previous surgery on same knee were excluded. Patients were randomly allocated into two groups in which Group one patient underwent Arthroscopic ACL reconstruction by autologous four strand STG graft and Group two patients using quadrupled ST4 graft. Functional evaluation was done using Lysholm scoring system preoperatively and postoperatively at 1 year. Knee flexion strength was measured post-operatively at 1 year as maximum standing knee flexion angle. The side to side ratio of knee flexion angle was used for comparison. Appropriate statistical analysis of the data was done.

Results: 68 patients were enrolled for the study in which, 38 patients underwent Arthroscopic ACL reconstruction by Autologous four strand STG graft and 30 patients using quadrupled ST4 graft. Out of 68 patients 52(76.47%) were male and 16 (23.53%) were female. 50 (73.5%) patients had right sided involvement and 18 (26.4%) had left side involvement. Mean age of patients was 29 years ranging from 19-45 years. Mean follow-up duration was 20 months (14-32 months). Average duration since injury was 6.22 ± 4.68 months (2-24 months). Mean Pre-operative Lysholm score in STG and ST4 groups were 69.78 ± 8.46 and 68.6 ± 10.41 respectively. Mean post-operative Lysholm scores at 1 year in STG and ST groups were 91.5 ± 6.13 and 92.96 ± 6.00 respectively. Lysholm score was reported as excellent in 49 patients (72%), good in 12 patients (17.6%) and fair in 7 patients (10.2%) with none of the patients reporting poor outcome. Mean maximum standing knee flexion angle ratio of operated knee compared to non-operated knee at 1 year was $90.51 \pm 6.37\%$ and $94.45 \pm 2.89\%$ in STG and ST4 groups respectively. There were no major complications reported with the procedure.

Conclusion: Quadrupled Semitendinosus graft is a viable alternative to Semitendinosus/Gracilis graft for ACL reconstruction. Preserving Gracilis tendon results in better knee flexion. Hence Gracilis tendon harvest must be avoided whenever possible.

Keywords: Anterior cruciate ligament, semitendinosus, Gracilis, graft

1. Introduction

Anterior cruciate ligament is the most commonly disrupted ligament in the knee with reported annual incidence of 29 to 38 per 100,000 people worldwide [1, 2]. With the advent of arthroscopic techniques, arthroscopic ACL reconstruction has become the treatment of choice to prevent recurrent knee instability and further damage to the joint.³ Various techniques of arthroscopic ACL reconstruction have been devised using autografts of bone patellar bone (BTB) graft, Hamstring graft, and allografts [4]. Different graft options have their own advantages and disadvantages. BTB graft have become less popular as they have been shown

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to be associated with anterior knee pain, kneeling discomfort, extensor deficits and osteoarthritis [5-8]. Allograft have been associated with higher failure rates and are not easily available.⁹ Due to these reasons quadrupled Hamstring graft has become the graft of choice for ACL reconstruction as they have strength comparable to BTB graft with low donor site morbidity and smaller incision [10, 11]. Quadrupled hamstring graft can be achieved by either using doubled semitendinosus with Gracilis graft (STG) or by using four stranded quadrupled Semitendinosus (ST4). Studies have shown that harvesting both Semitendinosus and Gracilis hamstring graft has been associated with knee flexion weakness [12, 13]. Quadrupled semitendinosus graft provides thicker graft as compared to STG graft but is shorter in length [14]. With the introduction of adjustable loop devices recently, it has become possible to perform ACL reconstruction using shorter graft with adequate graft inside bone tunnels on both sides. But there have been concerns regarding lengthening of the adjustable loop devices [15, 16].

No study has been conducted to compare the functional and anatomical results of ACL reconstruction using STG vs ST4 with adjustable loop. The aim of our study was to compare functional outcomes following ACL reconstruction with STG graft vs ST4 graft using femoral adjustable loop button and tibial bioscrew fixation.

Material and Methods

This was a prospective cohort study. 68 patients with isolated ACL tear with knee instability were enrolled from 2017-2018 after taking clearance from the ethical committee. They underwent arthroscopic ACL reconstruction using hamstring graft. Patients with multiligamentous injury, associated meniscus tears, chondral lesions, juxta-articular fractures and previous surgery on same knee were excluded from the study. Patients were randomly allocated into two groups. Group one patients underwent Arthroscopic ACL reconstruction by autologous four strand STG graft and group two using quadrupled ST4 graft. All patients were assessed using clinical parameters like Lachman test, anterior drawer test and pivot shift test. Antero-posterior and Lateral knee roentgenogram and MRI evaluation was done in all patients. Functional evaluation was done using Lysholm scoring system¹⁷ preoperatively and postoperatively at 1 year. Knee flexion strength was measured post-operatively at 1 year as maximum standing knee flexion angle.¹⁸ Knee flexion angle was measured by making patient stand on the contralateral leg with ipsilateral hip joint extended against the wall. Patient was then asked to flex the ipsilateral knee keeping ankle plantarflexed to neutralize action of iliopsoas and gastrocnemius and knee flexion angle was measured. The side to side ratio of knee flexion angle was used for comparison. Written and oral consent was taken from all patients explaining risks and benefits of surgery in their own language. Out of 68 patients, 38 patients underwent Arthroscopic ACL reconstruction by Autologous four strand STG graft and 30 patients using quadrupled ST4 graft.

Surgery was performed under spinal anesthesia. Standard anteromedial and anterolateral arthroscopic portals were made and ACL tear was confirmed before proceeding to graft harvesting. A 4 cm vertical incision was made over anteromedial aspect of the knee 5 cm distal to joint line and 2.5 cm medial to tibial tuberosity (Fig.1). Semitendinosus (ST) and Gracilis (G) tendon were palpated and aponeurosis overlying the tendon was split along the tendons. Distal attachment of tendons was cleared till the periosteal

attachment to get maximum length of the graft. For the STG group, both Semitendinosus graft and Gracilis graft were harvested (Fig. 2). The grafts were cleaned of all the muscle tissue. To prepare STG graft, both the Semitendinosus and Gracilis were placed parallel to each other and their length was made equal by cutting extra Semitendinosus and then the graft was passed through adjustable button loop and doubled on itself making a four strand STG graft. For the ST4 group, Semitendinosus graft was harvested, and the length was verified to be more than 28 cm. If the Semitendinosus length was less than 28cm, then Gracilis was also harvested and STG graft was prepared. For the preparation of ST4 graft, Semitendinosus tendon was doubled on itself, then passed through the adjustable loop button and then doubled again making it a four strand Semi T graft. The graft was then passed through the sizer and femoral and tibial size of the graft was measured (Fig. 3). After measuring the Graft diameter, it was placed on Graft board for pre-tensioning (Fig. 4). Femoral tunnel of same diameter was placed at 10.30 or 1.30 location for right and left knee respectively with knee flexed to 110 degree. Tibial tunnel of the measured diameter was placed on native ACL foot print with the guide set at 55 degree and knee flexed at 70 degree. Graft was passed through the tunnels and fixed with adjustable loop button on femoral side and bioscrew on tibial side keeping knee in 30 degree of flexion (Fig. 5).

Patients were allowed partial weight bearing from next day with straight knee brace. Isometric quadriceps, ankle mobilization and heel slides, knee range of motion exercises were started from 2nd Post-op day. Brace was discontinued after 6 weeks. Closed chain exercises were started at 6 weeks followed by open chain exercises at 3 months. Patients were allowed to start jogging at 6 months and return to sports after 9-12 months. Patients were followed up at 6 weekly intervals till 6 months, and then at 3 monthly intervals. Patients were evaluated at 1 year, using clinical tests like Lachman test, Anterior drawer test, Pivot shift test and functional evaluation was done using Lysholm knee score and deep knee flexion test.

Statistical analysis

All the collected data was entered into excel sheets and statistical analysis was done using SPSS software. Pre-operative and post-operative data were compared using paired 't' test. Comparison between the two cohorts was done using unpaired 't' test for continuous data and chi square test for categorical data. Postoperative results of both the groups were compared using unpaired 't' test. A p value of < 0.05 was considered significant for the study.

Results

The study included 68 patients who had undergone arthroscopic ACL reconstruction with hamstring graft from 2017 to 2018 were enrolled. All the patients were reviewed and analyzed using pre-operative and post-operative Lysholm score and maximum standing knee flexion angle at 1 year. Out of 68 patients 38 patients underwent Arthroscopic ACL reconstruction by Autologous four strand STG graft and 30 patients using quadrupled ST4 graft. Out of 68 patients 52(76.47%) were male and 16 (23.53%) were female patients. 50 (73.5%) patients had right sided involvement and 18 (26.4%) had left sided involvement. Mean age of patients was 29 years ranging from 19-45 years. Mean follow-up duration was 20 months (14-32 months). Average duration since injury was 6.22 ± 4.68 months (2-24 months). Most common mode

of injury was road traffic accident (48.5%) followed by sports injuries (20.6%) (Table 1). Mean Pre-operative Lysholm score in STG and ST4 groups were 69.78 ± 8.46 and 68.6 ± 10.41 respectively. Mean post-operative Lysholm scores at 1 year in STG and ST groups were 91.5 ± 6.13 and 92.96 ± 6.00 respectively. Lysholm score was reported as excellent in 49 patients (72%), good in 12 patients (17.6%) and fair in 7 patients (10.2%) with none of the patients reporting poor outcome. The improvement in Lysholm scores was statistically significant in both the groups ($p < 0.0001$). ST4 group had slightly better mean Lysholm score than STG group but the difference was not statistically significant (TABLE 2, chi square, p value 0.646). Mean maximum standing knee flexion angle ratio of operated knee compared to non-operated knee at 1 year was $90.51 \pm 6.37\%$ and $94.45 \pm 2.89\%$ in STG and ST4 groups respectively (Table 3). The difference in the maximum standing knee flexion angle of operated vs non-operated knee between STG and ST4 group was statistically significant (p value < 0.05).

There were no major complications in any of the groups. 2 patients in STG group and 1 patient in ST4 had superficial graft harvest site infection (4.4%) which was treated with debridement and prolonged antibiotic. 2 patients in STG group and 1 in ST4 group complained of knee stiffness (4.4%) and 1 in each group had minimal residual instability (2.9%).

Discussion

Arthroscopic ACL reconstruction using hamstring graft has become the preferred technique world over. However, there is still no consensus over which type of hamstring graft, STG or ST4, is better. The introduction of adjustable loops has further broadened the surgeon's armamentarium. This clinical study was conducted to compare the functional results of ACL reconstruction using STG vs ST4 with adjustable loop. The results show that functional outcomes of quadrupled ST4 graft are comparable to STG graft when fixed with adjustable loop button for femoral side and Bioscrew for tibial side.

There have been previous studies comparing the use of STG and ST4 graft for arthroscopic ACL reconstruction but none using adjustable loop device on femoral side and Bioscrew on tibial side. Gobbi *et al* did a comparative analysis of STG vs ST4 graft using fixed loop button on femoral side and bioscrew on tibial side and found no statistically significant difference in functional outcomes in both the groups similar to our study [19].

Similarly, a retrospective study by Boyle MJ *et al* showed no difference in the postoperative knee stability or graft failure rate when adjustable loop or fixed loop button was used for cortical suspension of femoral graft [20]. However, Barrow AE *et al* in a laboratory study demonstrated that there is significant lengthening of adjustable loop during cyclic testing [16]. In our study with adjustable loop button fixation, 89% patients showed excellent or good outcomes. This may be explained by the fact that in vitro lab studies tests are conducted at much higher cyclical loads and it is unlikely to accurately reproduce the complex force vector encountered by the actual graft postoperatively.

Use of adjustable loop button has distinct advantage over fixed loop as it allows for re-tensioning of the graft removing any slack in the graft that occurs after tibial screw fixation as shown by Noonan *et al*. [21]

Buchner *et al* studied ACL reconstruction using ST4 graft fixed with endobutton on femoral side and suture disc on tibial side [22]. The mean Lysholm scores in their study was 83.64 ± 15.9 with 85% patients reporting very good and good

scores, 11% fair and 4% showing poor results. Our study had much better mean Lysholm score (92.96 ± 6.00) with no patient showing poor outcome. This may be the result of using interference screw fixation on tibial side which is a stronger fixation modality as compared to extracortical tibial fixation [23, 24].

Nakamura *et al* studied active knee flexion and hamstring strength after ACL reconstruction and observed significant difference in knee flexion torques at deeper flexion angles between ST4 and STG groups [18]. Other studies also demonstrate that additional Gracilis graft leads to further knee flexion weakness and decrease in internal rotation torque [19, 25]. Our study too, shows that the use of isolated ST4 graft for ACL reconstruction produces functional outcomes similar to STG graft with lesser donor site morbidity and significantly higher deep knee flexion strength. Hence, unnecessary Gracilis graft harvesting should be avoided unless length of ST graft is inadequate.

Limitations

Limitation of our study is the short duration of follow-up, exclusion of patients with meniscus injury and multiple ligament injuries.



Fig 1: Harvesting of hamstring graft



Fig 2: Preparation of the graft



Fig 3: Measurement of graft diameter



Fig 4: Pre-tensioning of graft on

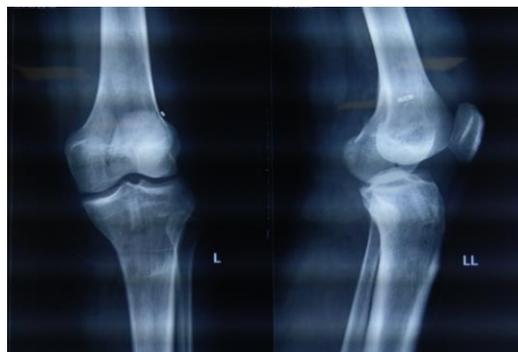


Fig 5: Post-operative X-rays following ACL reconstruction with hamstring graft

Table 1: Baseline parameters in both the groups

Parameters	STG group (n=38)	ST group (n=30)
Age (yrs)		
15-24	9 (23.6%)	6 (20%)
25-34	20 (52.6%)	19 (63.3%)
35-45	9 (23.6%)	5 (16.6%)
Sex		
Male	29 (76.3%)	23 (76.6%)
Female	9 (23.6%)	7 (23.3%)
Side involved		
Right	28 (73.6%)	22 (73.3)
Left	10 (26.3%)	8 (26.6%)
Duration since injury (months)	6.28± 4.64 (2-22 months)	6.13 ± 4.68 (2-24 months)

Table 2: Functional outcomes in both groups

Lysholm score	STG group (n=38)	ST4 group (n=30)
Excellent >90	26	23
Good 85-90	7	5
Fair 65-84	5	2
Poor <65	0	0

Table 3: Maximum standing knee flexion angles

Group	Operated leg (in degrees)	Non-operated leg (in degrees)	Operated / non-operated %
STG (n=38)	103.84 ± 10.50	114.68 ± 7.83	90.51 ± 6.37%
ST4 (n=30)	108 ± 7.12	114.26 ± 5.56	94.45 ± 2.89%

Conclusion

Quadrupled Semitendinosus graft with adjustable loop button for femoral side and Bioscrew for tibial side is a viable alternative to Semitendinosus/Gracilis graft for ACL reconstruction, with similar functional outcomes post operatively. Preserving Gracilis, results in better knee flexion. Hence, Gracilis tendon harvest should be avoided whenever possible.

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