Is in-vivo 80 N tensioned quadrupled hamstring graft better than conventional unmeasured pull for arthroscopic ACL reconstruction

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ABSTRACT

Purpose: To find clinical outcome of in-vivo standard 80 N tensioning of quadrupled hamstring graft during arthroscopic single bundle ACL reconstruction in comparison to traditional graft tensioning.

Methods: Sixty cases of isolated ACL tears were included in this study. All cases underwent Arthroscopic ACL reconstruction with Tibial attachment sparing quadrupled hamstring graft. Cases were divided into group I and group II (30 cases each). Graft Tensioning in group I was conventional one-handed unmeasured pull and in group II it was measured tension of 80 N with tensionometer during graft fixation. Pre-operative and post-operative (12 months) Anterior tibial translation (ATT) was measured with KT-1000 arthrometer. Clinical outcome was measured using Lysholm knee scoring system at 6 weeks, 3 months, 6 months, 12 months and compared statistically among both groups.

Results: The mean pre-op ATT of 10.6 ± 2.04 mm (group I) & 10.83 ± 2 mm (group II) improved to 3.63 ± 1.16 mm (group I) & 3.63 ± 0.92 (group II) respectively at one year without significant difference (p value 1). The mean pre-op Lysholm score was 46.73 ± 6.77 (group I) and 45.97 ± 8.68 (group II). The mean Lysholm score at 6 weeks was 91.5 ± 2.78 (group I) and 93.43 ± 3.02 (group II) with significant difference (p value 0.014). At 3 months it was 95.4 ± 2.99 (group I) and 97.07 ± 2.07 (group II) with significant difference (p value 0.025). At 6 months it was 95.53 ± 2.46 (group I) and 97.5 ± 1.2 (group II) with significant difference (p value 0.0002). At 1 year it was 95.73 ± 2.22 (group I) and 97.8 ± 0.979 (group II) with significance (p value 0.0001).

Conclusion: The clinical score of ACL reconstruction is better when in-vivo 80 N tension is applied using tensionometer during graft fixation in comparison to conventional manual tensioning but there is no difference in ATT.

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1. Introduction

Outcome of ACLR is dependent on many surgical variables and in vivo tensioning of graft at the time of fixation is an important one.^{1,2}

Initial tension of graft can affect the clinical outcome of arthroscopic ACL reconstruction. If graft tension is inadequate then it may lead to knee joint laxity post reconstruction, which ultimately results in degenerative arthritis in long term.^{3,4} If graft tension is in excess, then it may hamper the revascularization of graft and can result in graft failure. It can also lead to abnormal

pressure on cartilage, meniscus and result in joint stiffness.⁵

In regards of optimal initial tension which could be given to graft at the time of fixation is still a matter of research, as till now optimum initial tension which would be required to obtain a stable and intact knee is not known. Some studies are in favour of low initial tension to graft, which may decrease the stresses within the graft, to avoid over constraining of knee as well as prevent frictional force of articular surfaces^{2,6–8} whereas others are in favour of high tension to obtain a stable knee.^{9,10} A graft tension of 20–90 N is supposed to be adequate but Arenja et al. reported 80 N to be an effective tension for ACL reconstruction.^{10,11}

At present commonest method is one-handed pull technique. Manual feedback is used to determine the amount of tension applied to graft at the time of fixation. It is unmeasured initial tension but has generally produced good clinical results. The

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average initial tension used by orthopedic surgeons trained in sports medicine is 60 ± 29 N.¹²

There are studies suggesting no postoperative difference in clinical outcome or knee laxity between cases where measured tension was applied to hamstring grafts during fixation and conventional manual tensioning.^{13,14}

There is paucity of literature that prospectively serially analyses clinical outcome of measured graft tension vis a vis unmeasured graft tension in ACLR with tibial attachment preserving hamstring graft.

The main purpose of this study was to find clinical outcome of in-vivo standard 80 N tensioning of quadrupled hamstring graft during arthroscopic single bundle ACL reconstruction in comparison to traditional graft tensioning. We hypothesize that 80 N of tension applied to quadrupled hamstring graft is effective to obtain satisfactory clinical outcome.

2. Methods

This prospective observational study was conducted between November 2013 to December 2015 at tertiary care center. An Institutional approval was obtained from the Ethics Committee before initiation of the study. Sixty matched skeletally mature cases with isolated symptomatic ACL tears were included in the study and were divided into two groups non randomly. In the first group I (30 cases) conventional unmeasured free one hand pull force was used for tensioning of graft and in group II (30 cases) tensionometer was used to apply 80 N pull force for fixation of graft. Cases with ACL and bony avulsion, associated with other knee ligament and meniscal injuries, fractures or cartilage lesion and osteoarthritis were excluded from the study. All cases were operated by the same surgical team. All cases underwent quadrupled single bundle tibial attachment sparing hamstring graft anterior cruciate ligament reconstruction by outside-in technique femoral tunnel creation method.¹⁵ Detailed history and clinical examination were recorded in all cases. Magnetic resonance imaging (MRI) of the knee was done to document the diagnosis of ACL tear and other concomitant intra articular pathologies in all cases. Preoperative assessment was done using Lysholm's knee scoring system for functional assessment. Objective measurement of tibial translation (ATT) or anterior knee laxity was performed with KT-1000 arthrometer (MEDmetric, San Diego, CA) at manual maximum pull, being expressed as the difference between the injured and uninjured legs in 0.5-mm increments.

2.1. Operative procedure

Semitendinosus-gracilis tendons from the ipsilateral side were harvested with an open-loop tendon stripper from anteromedial incision on proximal leg and quadrupled graft was prepared keeping the natural tibial insertion of the tendon intact (Figs. 1 and 2). The diameter of the quadruple graft was measured.

A standard arthroscopic approach of the knee was performed through the anteromedial and anterolateral portals. After diagnostic arthroscopy, the femoral tunnel was created in an outside in fashion (Arthrex outside in jig) according to the graft thickness. The tibial tunnel was created with the help of a separate tibial guide. The quadrupled hamstring graft was then passed from the tibial tunnel to the external aperture of the femoral tunnel under arthroscopic vision. The proper seating of the graft on the tibia was checked and full knee range of motion was performed to rule out any form of impingement. The graft was tensioned at this stage by repeated cycling (20 cycles). A nitinol wire was passed through the femoral tunnel besides the graft and while maintaining a constant pull of 80 N using custom spring type tensioner along the long axis

of graft for group II (Fig. 3) and free one hand pull force was applied in group I for graft tensioning. An interference (Biocomposite) screw (Smith- Nephew) was inserted with the knee in about 20° of flexion. Stability was checked by doing the Lachman and Pivot shift test after surgery. Patients in both groups were subjected to the similar postoperative protocol, which included early weight bearing with the help of crutches from day two of surgery. Active straight leg raise in all planes were started from day 2 after surgery. ROM knee brace was used for ambulation till the patient regained quadriceps control. At 6 weeks, 3 months 6 months and 12 months functional outcome was assessed by Lysholm knee scoring system. At 12 months anterior tibial translation was measured by KT1000 arthrometer. Proprioception was measured by active reproduction of passive movement.

2.2. Statistics

Preoperative and postoperative findings were compared using paired *t*-test. A *p* value of <0.05 was considered statistically significant. Statistical Package for Social Sciences (SPSS) version 21.0 was used for analysis. To compare anterior knee laxity the Mann-Whitney *U* test was used.

3. Results

In the present study thirty patients treated with an 80 N pull force for fixation of graft and thirty patients treated with the one hand pull were included. The two cohorts had similar baseline characteristics. The mean age of the patients of both groups was 29.83 ± 9.34 years in group I and 27.03 ± 7.71 years in group II which was comparable. The mean preoperative anterior tibial translation as measured by KT-1000 Arthrometer was 10.6 ± 2.04 mm in the group I and 10.83 ± 2 mm in the group II were also comparable (*p* value 0.667). There was significant improvement in the anterior tibial translation of affected knee at 12 months when comparing with its preoperative status in both the groups. The mean postoperative anterior tibial translation was 3.63 ± 1.16 mm in group I and 3.63 ± 0.92 mm in group II were similar (*p* value 1). Pivot shift test was negative in all cases of both groups at one year.

The preoperative Lysholm score was 46.73 ± 6.77 in group I and 45.97 ± 8.68 in group II was comparable between the two groups. However, mean postoperative Lysholm score at 6 weeks was 91.5 ± 2.78 and 93.43 ± 3.02 for group I and II respectively which was statistically significant (*p* value 0.014). The mean postoperative Lysholm score at 3 months was 95.4 ± 2.99 and 97.07 ± 2.07 for group I and II respectively which was statistically significant (*p* value 0.025). The mean postoperative Lysholm score at 6 months was 95.53 ± 2.459 and 97.5 ± 1.204 for group I and II respectively which was statistically significant (*p* value 0.0002). The mean postoperative Lysholm score at 12 months was 95.73 ± 2 and 97.5 ± 1.204 for group I and II respectively which was statistically significant (*p* value of 0.0001).

All the patients achieved quadriceps control in the form of sustained unassisted Active Straight Leg raising within 2 weeks Post-operative period (Table 1).

The mean follow up period was 16.5 ± 3.4 months in group I and 15.5 ± 3.6 months in group II was comparable between the groups.

4. Discussion

In this study there was no case of graft laxity in either group despite allowing the patients to undergo accelerated rehabilitation protocol. None of the cases in either group reported of any instability till final follow up. There was no laxity objectively also, as KT-

Fig. 1. Tibial attachment sparing harvest of Hamstring tendons.

Fig. 2. Quadrupled hamstring graft.

1000 arthrometer showed a statistically significant reduction in anterior tibial translation (ATT) after ACLR along with negative pivot shift test. This finding supports the hypothesis that in-vivo 80 N tensioning of quadrupled hamstring graft is effective to obtain a satisfactory clinical outcome.

Tensioning of graft at the time of its fixation is one of the important surgical variables, which can influence the clinical outcome of ACL reconstruction. The tension of an ACL graft can be influenced by, diameter and graft length, type of graft, tunnel sizes of femur as well as tibia and accuracy in tunnel placement. In order

to reduce variability, the surgical technique and postoperative rehabilitation protocol were standardized. Same team operated all cases by outside in technique from tibial footprint to femoral footprint graft placement. In order to reduce variability further, the same surgeon tensioned the graft in all cases. It is impossible to compare the graft tension with tension in native ACL of the uninjured side so the comparison was done using various parameters between pre-operative and post-operative status and also to the normal knee.

Arenja et al. reported 80 N to be an effective magnitude of

Fig. 3. Showing use of tensionometer to exert calibrated tension on hamstring graft during interference fixation on femoral side.

Table 1

Comparative clinical outcome of conventional and calibrated graft tension groups.

		Group I (Conventional method) n = 30	Group II (Tensionometer) n = 30	P value
Pre-operative	Mean $\pm$ SD	10.6 $\pm$ 2.04	10.83 $\pm$ 2.10	0.667
Anterior Tibial Translation	Range	8–14	7–14	
	Mean $\pm$ SD	3.63 $\pm$ 1.16	3.63 $\pm$ 0.92	1
Post-operative	Range	2–6	2–6	
Anterior Tibial Translation				
12 months	Mean $\pm$ SD	46.73 $\pm$ 6.77	45.73 $\pm$ 8.68	0.704
	Range	37–62	30–62	
Pre-operative				
Lysholm score	Mean $\pm$ SD	91.5 $\pm$ 2.78	93.43 $\pm$ 3.02	0.014
Post-operative	Range	86–98	87–100	
Lysholm score				
6 weeks	Mean $\pm$ SD	95.4 $\pm$ 2.99	97.07 $\pm$ 2.07	0.025
Post-operative	Range	91–100	91–100	
Lysholm score				
3 months	Mean $\pm$ SD	95.53 $\pm$ 2.459	97.5 $\pm$ 1.204	0.0002
Post-operative	Range	91–100	91–100	
Lysholm score				
6 months	Mean $\pm$ SD	95.73 $\pm$ 2.22	97.8 $\pm$ 0.979	0.0001
Post-operative	Range	91–100	91–100	
Lysholm score				
12 months				
Quadriceps control (days)	Mean	16.5 $\pm$ 3.4	15.5 $\pm$ 3.6	

tension for ACL reconstruction using hamstring polyester graft.¹⁰ Yasuda et al. noticed a decreased laxity when 80 N tension was applied to the graft as compared to 20 N tension.¹⁶ Similar finding in terms of ATT was reported by Nicholas et al. while comparing 90 N group (2.2 ± 1.6 mm) to 45 N group (3.0 ± 2.2 mm).¹⁷ There is no benefit if graft tension is increased any further.¹⁸

A higher rate of failure with manual tensioning as compared to device-assisted tensioning has been reported¹⁹ but we could not validate the same in this study as there was no case of graft failure in the manual tensioning group also. Because of the fact that most surgeons apply a variable graft tension of 20–80 N while tensioning manually,²⁰ it is wiser to use a tensionometer to apply calibrated and constant tension over graft.

If graft tension is more than the optimum, it will translate the femur anteriorly on to the tibia resulting in an over constrained knee, increase the joint reaction force and limit the range of motion of the knee. In this study there was no case of restricted range of motion in either group. All the cases could achieve full range of

motion by 6 weeks.

Findings of this study are not in conformity with Grunau et al.,¹⁴ who reported no difference in clinical outcome between measured tensioning of hamstring ACL grafts and conventional tensioning maneuver. The Lysholm score showed statistically significant improvement serially in both groups but it was significantly better in the calibrated tension group supporting its superiority.

With respect to the knee range of motion, there was no loss of extension or flexion in either group. In contrast Kondo et al. observed a significant loss of knee extension of 5–10° when 40 N tension applied to each graft at 30° of knee flexion in comparison to 30 N tension.²¹ Post-operative quadriceps control was also obtained in the same duration in both groups.

4.1. Limitation of the technique

The graft preparation and arthroscopy are done sequentially not parallel therefore duration of surgery was slightly prolonged with

mean tourniquet time of 54.73 ± 8.33 .

5. Conclusion

Though calibrated tension of hamstring graft (80 N) in ACLR provides comparable stability and anterior tibial translation as traditional method of graft tensioning manually but has slightly better clinical scores. It has potential to improve outcome especially in early stage of learning curve.

Declaration of competing interest

None.

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