Full length article

Randomised comparison of pretensioning using cyclical loading and on tendon board for arthroscopic anterior cruciate ligament reconstruction using hamstring autograft

Rahul Khare^{a,*}, Hitesh Lal^b, Kandarp Vidyarthi^a, Vivek Jangira^c, Deepak Mittal^a

^a Department of Orthopaedics, Dr Ram Manohar Lohia Hospital, New Delhi, Pin-110001, India

^b Department of Orthopaedics, VMMC, Safdarjung Hospital, New Delhi, Pin-110001, India

^c Department of Orthopaedics, Lady Hardinge Medical College, New Delhi, Pin-110001, India

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ABSTRACT

Objective: Pretensioning is usually done using two methods – manual cyclical loading and using tensioner with a tendon board. Both the methods are being used with little knowledge about the superiority of either method. This study was done with the objective of trying to find out the better method.

Methods: A total of 50 patients were selected for the above mentioned study who were randomised into each of the two groups using chit system – In group A patients, cyclical loading was done by twenty times full flexion –extension movements but in group B patients, the graft was placed on a tensioner with 15 pounds tension for 10 minutes. All patients were operated by the same surgeon. The patients were put on a strict rehabilitation protocol. Patients were allowed to bear weight as tolerated. Patients returned for follow up at 6 weeks, 3 months, 6 months and 12 months. At each visit patients were followed with Lysholm's Score and ROLIMETER reading.

Results: The ROLIMETER reading and Lysholm's score were seen to improve from preoperative to postoperative period and improved further over time with the progress of the rehabilitation protocol in both the groups. When compared to each other Group A i.e. patients pretensioned with cyclical loading had better Lysholm scores and ROLIMETER readings with the difference being statistically significant at all time periods except at 1 year when the difference between the ROLIMETER readings in the two groups were no more significant, though the difference of the Lysholm's score was still found to be statistically significant.

Conclusion: It was concluded in this study that cyclical loading is a better method of pretensioning in ACL reconstruction than tensioner on tendon board with 15 pounds of tension for 10 minutes.

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1. Introduction

Anterior cruciate ligament (ACL) is frequently injured during sports participation.^{1,2} Arthroscopic evaluation of knees with heamarthrosis following injury has demonstrated ACL injury in 60%–70% of cases.³ Natural history of the athlete with ACL deficient knees is likely to be dependent on associated meniscal and ligament injuries, age, activity level, and degree of initial ACL injury.^{4–6} There are a lot of controversies related to the management of this injury and more than 2000 papers have been published on the various aspects of the topic.

In ACL reconstruction procedure an anatomically placed, high strength graft with rigid fixation yields the best clinical results. Although many authors have mentioned that the amount and direction of initial graft tension may be of critical importance for the clinical outcome, there remains no clear consensus for the magnitude of force or position of knee during tensioning.

Pretensioning is usually done using 2 methods–manual cyclical loading and using tensioner with a tendon board. Both the methods are being used with little knowledge about the superiority of either method. This study aims to compare the two methods of pretensioning and document the better one for future reference of surgeons.

* Corresponding author.

E-mail addresses: drhulkhare@gmail.com (R. Khare), drhiteshlall@gmail.com (H. Lal), v.kandarp@gmail.com (K. Vidyarthi), vivek.jangira@gmail.com (V. Jangira).

2. Materials and methods

The study has been conducted in Department Of Orthopaedics, PGIMER, Dr. Ram Manohar Lohia Hospital, New Delhi from October 2007 to March 2012.

A total of 50 patients were selected for the above mentioned study. All patients with isolated Anterior Cruciate Ligament tear (more than six weeks old injury) with or without meniscal injuries were included in the study. The patients having the following were excluded from the study.

1. Patients with bilateral Anterior Cruciate Ligament injury and bony avulsions of Anterior Cruciate Ligament.
2. Patients with associated injuries other than stable meniscal injuries (multiligamentous injuries, cartilage lesions, post traumatic osteoarthritis).
3. Intraoperative graft excursion more than 2 mm in 0° to 100° flexion which was measured at the tibial tunnel end.

Patients were evaluated preoperatively with pre-anaesthetic checkups and measuring of the joint laxity clinically with Lachman Test and Anterior Drawer Test. Radiographs of the knee, Antero posterior and lateral views was done. MRI was done if required in patients of doubtful diagnosis. These were the patients who had a complaint of instability but clinically were not positive for ACL tear, as in partial tears. Patients were also evaluated with ROLIMETER (See) and Lysholm's score.

All the patients were randomly divided into 2 groups with chits-group A in which pretensioning was done using cyclical loading (20 times full excursion of flexion and extension) and group B in which pretensioning was done using tensioner with a tendon board (15 pounds for 10 min).

The basic steps of arthroscopic Anterior Cruciate Ligament reconstruction were as under:

1. Diagnostic arthroscopy
2. Graft harvesting and preparation
3. Notch debridement and notchplasty
4. Tibial tunnel
5. Femoral tunnel

Photo 1. Application of Rolimeter.

Photo 2. Application of Rolimeter.

Photo 3. After Anterior Drawer test with Rolimeter.

6. Graft insertion and fixation
7. Closure

The patients were taken up for surgery after pre-anaesthesia fitness of the patient under spinal, epidural or general anaesthesia. Tourniquet was applied high up on the thigh in a supine position and the limb prepared.

Surface marking of the knee was done i.e. the patella, tibial tuberosity, patellar tendon, medial and lateral joint lines were marked.

Photo 4. Anterior Drawer test with Rolimeter.

2.1. Diagnostic arthroscopy

Anterolateral portal for the scope was made and the scope was passed into the joint and a diagnostic arthroscopy was done.

An anteromedial portal was made for examination of the lateral compartment and for probing the structures. On confirming the tear of ACL we proceeded for ACL reconstruction.

The gracilis and semitendinosus tendons were harvested through an oblique incision centered approximately 4 cm medial and just distal to the tibial tubercle.

The tendons were sewn beginning at the distal end, with a Ethibond no. 5, extending proximally for 4 to 5 cm, then returning to the distal end. The released tendons were cleared off muscle tissue and whip stitched on the other end with a Ethibond no. 5 after placing it on a tendon board. They were turned on to

Photo 5. Pre Tensioning of the graft on tension board.

Photo 6. Setting the tension on the tension board.

themselves to make a quadrupled graft of minimum 10–11 cm. Once the tendons were prepared they were pretensioned with 15 pounds for 10 min in group A (See) and in group B they were just kept moist in a wet gauze.

Markings were made on the graft with methylene blue at 3 cm and 5.5 cm. The graft size was measured with a sizer. Next the ACL remnant was shaved off and notchplasty (if required) was done with a shaver to avoid impingement of the graft in the femoral tunnel.

Tibial tunnel preparation—The pretibial periosteum was incised longitudinally with electrocautery, beginning at the superior margin of the sartorius insertion and the medial margin of the patellar tendon. This incision was taken 2 cm to 3 cm proximally toward the joint line. Limited subperiosteal elevation was performed with a periosteal elevator at this anteromedial incision. The endoscopic aimer for the tibial tunnel was adjusted to the 45° position, and the guide-tip was positioned intra-articularly through the anteromedial portal.

The 45° orientation produces an ovoid intraarticular aperture that more closely approximates the anatomic ACL footprint of the tibia and was 7 mm anterior to PCL. The guide pin typically was angulated 45° to the anterior cortex of the tibia when viewed

Photo 7. Graft being tensioned on tension board.

laterally placing the tibial tunnel approximately 3.5 cm below the joint line. The guide-tip was positioned with the tip impaling the posterior fibers of the tibial ACL stump. A cannulated reamer corresponding to the size of the graft was used to drill the tibial tunnel.

Next, the femoral tunnel was prepared. A femoral tunnel guide with an offset of 4 or 5 mm—next size of the graft thickness in mm divided by 2 (e.g. if the graft thickness is 9 then offset will be $9/2 = 4.5$, 5 being the next size) was inserted through the tibial tunnel and placed on the over the top position.

The femoral guide pin was then inserted at the 11 o'clock position for the right knee (1 o'clock for the left knee) and advanced 2 cm to 3 cm into the femur while maintaining the knee at 90° of flexion. A calibrated, cannulated, reamer sized to match the graft's proximal diameter was placed manually through the tibial tunnel and abutted against the femur.

The intra-articular graft length was estimated from the calibration lines on the reamer. The tunnel prepared was checked with a probe for blowout of the wall. The tunnel ends were cleaned of any bony debris with a curette. The graft was passed through the tibial and femoral tunnels with the help of an eyed wire and the threads were passed out from the thigh.

We used a BIO RCI (SMITH AND NEPHEW) screw for graft fixation for both femoral and tibial ends. Once the femoral end of the graft was fixed the strength of fixation was tested firmly pulling the graft. The tibial screw was fixed at 30° of knee flexion.

In the patients in group B cyclical loading was done under constant traction to the graft by taking the joint through full range of flexion and extension 20 times. The tibial end of the graft was then also fixed in 30° of knee flexion.

Rehabilitation Protocol: We followed the following rehabilitation protocol.

Up to 2 weeks—Full extension of the knee and gradual 0 to 90° of flexion. Edema control and partial weight bearing with knee immobilizer.

2–4 weeks—Achieve full flexion and full weight bearing ambulation as tolerated.

4–6 weeks—The patients had to work on hamstrings, stair master, close chain exercises and begin lunges

8–10 weeks—Progress with exercises, begin slide board and slow form running

12–14 weeks—Initiate jogging program and light polymetrics

16–18 weeks—Continue with above

FOLLOW UP: Patients were followed up at 6 weeks, 3 months, 6 months and after 1 year of surgery. They were examined clinically for any laxity of the knee, ROLIMETER readings (See Pictures 1,2,3 and 4) were taken and Lysholm's scoring was done.

3. Ethics

The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional) and with the Helsinki Declaration of 1975, as revised in 2000 when reporting on human studies. Institutional Ethics Committee permission was taken before undertaking the study.

4. Results

In the present study 50 cases were included according to the inclusion criteria mentioned above. The age of the patients ranged from 19 years to 41 years with average age being 27.7 years. All the cases in our study were males. Many of our patients were professionals like paramilitary forces and police (30%) who had a troubled professional life due to ACL injury. Others were sports

people and self-employed people who were having trouble in their daily activities due to the injury. 65% had a right knee involvement. Majority (50%) of the cases had injury due to sports related activity. Football was most common. In road traffic accidents group (30%) fall from bike was the most common cause of ACL tear. Majority of cases (75%) had no associated injury. Others were associated with stable medial meniscus injury for which partial medial meniscus shaving was done at the time of surgery as none of them were repairable.

4.1. Lachman Test in cases pretensioned by cyclical loading

Among the cases fixed with cyclical loading 20 patients had grade 3 Lachman Test pre operatively. Postoperatively, after 1 year, 23 patients had a Grade 0 Lachman Test as depicted in [Table 1](#).

4.2. Lachman Test in patients pretensioned with tendon board with tensioner

In patients treated with tensioner on tendon board preoperatively 15 patients had grade 3 Lachman positive and 10 patients had grade 2 positive. All 25 patients had Lachman test Grade 0 at the end of 1 year as depicted in [Table 2](#).

4.3. Improvement in average Lysholm score in cases pretensioned with cyclical loading

The average Lysholm's score preoperatively in this group of patients was 72.2 (fair/poor) which increased to 94.4 (excellent) in 1 year postoperatively, as can be seen in [Table 3](#).

4.4. Improvement in average Lysholm score in cases pretensioned with tensioner on tendon board

The average preoperative Lysholm score was 68.5 (Fair/Poor) preoperatively, which improved to 94.1 (Excellent) 1 year postoperatively as can be seen in [Table 4](#).

4.5. Improvement in average difference in Rolimeter

4.5.1. Reading between both legs in patients pretensioned with cyclical loading

The average Rolimeter reading difference between both legs in patients pretensioned with cyclical loading has been shown. Preoperatively reading was 8.2 which improved to 0.8 at 1 year as depicted in [Table 5](#).

4.6. Improvement in average difference in Rolimeter reading between both legs in patients pretensioned with tensioner on tendon board

The average Rolimeter reading difference between both legs in patients pretensioned with tensioner on tendon board has been shown. Preoperatively reading was 7.6 which improved to 0.6 at 1 year as shown in [Table 6](#).

Table 1
Lachman Test In Cases Pretensioned By Cyclical Loading.

	TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
LACHMAN TEST						
NEGATIVE		0	20	20	23	23
GRADE 1		0	5	5	2	2
GRADE 2		5	0	0	0	0
GRADE 3		20	0	0	0	0

Table 2

Lachman Test In Patients Pretensioned With Tendon Board With Tensioner.

LACHMAN TEST	TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
NEGATIVE		0	20	20	25	25
GRADE 1		0	5	5	0	0
GRADE 2		10	0	0	0	0
GRADE 3		15	0	0	0	0

Table 3

Improvement In Average Lysholm Score In Cases Pretensioned With Cyclical Loading.

TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
LYSHOLM'S SCORE	72.2	75.5	84.3	88.9	94.4

Table 4

Improvement In Average Lysholm Score In Cases Pretensioned With Tensioner On Tendon Board.

TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
LYSHOLM'S SCORE	68.5	73.5	81.5	86.9	94.1

Table 5

Improvement In Average Difference In Rolimeter Reading Between Both Legs In Patients Pretensioned With Cyclical Loading.

TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
ROLIMETER READING	8.2	2	1.4	1.4	0.8

Table 6

Improvement In Average Difference In Rolimeter Reading Between Both Legs In Patients Pretensioned With Tensioner On Tendon Board.

TIME	PREOP	6WKS	3MTHS	6MTHS	1YR
	7.6	1.8	0.8	0.6	0.6

Complications—The following were the operative complications in our study.

1. Two patients had superficial infection of the stitch line of the graft site which resolved uneventfully in two weeks' time with regular dressing and antibiotics.
2. One patient had a deep infection of the knee with persistent fever and swelling of the joint. An arthroscopic lavage of the joint was done with thorough washing of the joint to clear the infection, which also resolved uneventfully.

One patient developed a sore on the posterior aspect of upper thigh due to tourniquet pressure though no neurovascular deficit developed. The sore healed leaving a superficial scar in 2 weeks' time.

5. Discussion

ACL injuries were once considered career ending. These days with the advances in our knowledge in all the aspects of ACL injury and its appropriate management it's now considered a mere blip in the career path. Surgical reconstruction of the ligament allows the patient to achieve preinjury professional levels of performance and

uninhibited daily and recreational activities. Similar results have been achieved in the group of patients in our study which has been elaborated above.

In our study the most common age group to which the patients belonged to was from 26 to 30 years of age constituting 40%. As per the western literature, athletes sustain this injury usually during the peak of their sporting career in the mid third decade.⁷

All the patients in our study were males denoting the low participation of females in high level competitive contact sports in our country.

Consideration of the occupation of patients in our study shows that most of our patients were self-employed (35%) followed by policemen and other armed personnel (30%). Professional sports-person were only 15% in our study. Mode of injury was most commonly sports related activities, competitive or recreational (50%) followed by road traffic accidents in 30% cases. This is in complete contrast to western data where most patients (around 90%) are sportsperson.¹¹

The outcome of the study has been objectively analyzed using 2 methods; the first being Lysholm Score and the other being ROLIMETER reading which is just a difference of the anterior translation of both the knees in millimetres at frequent intervals. In our study the preoperative average was 72.2 and 68.5 for patients in group A i.e. pretensioned with cyclical loading and in group B i.e. pretensioned with tensioner on tendon board, respectively.

This is slightly higher than in literature 55–64.¹⁶ The average ROLIMETER reading was 8.2 and 7.6 preoperatively in group A and B respectively.

At six weeks follow up the average ROLIMETER reading dropped phenomenally to 1.8 and 2 respectively in Groups A and B. The difference was found to be statistically significant using unpaired T Test with level of significance 0.008 (well below 95%).

Likewise the Lysholm Score also rose to average 75.5 and 73.5 in both the methods which was also found to be statistically significant; though the rise was not as much as expected.

This was because at 6 weeks interval there was no instability or locking but most had a limp and used crutches for support. Also we did not permit squatting and climbing stairs freely, though most patients were pain free.

At three months interval the ROLIMETER reading reduced further to 0.8 mm and 1.4 respectively.

This was attributed to rigorous physiotherapy with quadriceps and hamstrings muscle strengthening exercises and drills and to probable graft to tunnel healing.¹⁷ This difference between the 2 methods was also found to be statistically significant with level of significance 0.045 (also below 0.05). The Lysholm Score increased to 84.3 and 81.5 for the 2 groups which were not as much as we expected when compared to Western data. This may be due to less aggressive rehabilitation than performed in the west. This difference between the 2 groups was again statistically highly significant.

At six months interval both ROLIMETER reading and Lysholm Score improved further. The ROLIMETER became 0.6 and 1.4 in both the groups which was again statistically significant with significance 0.027.

The average Lysholm Scores became 88.73 and 86.9, the difference being statistically significant.

At one year interval the results were bit contrasting for our 2 methods of evaluation. The ROLIMETER readings were 0.6 and 0.8 mm respectively and the difference was not statistically significant any more (significance being 0.223).

In contrast the Lysholm score values 94.4 and 94.1 continued to be statistically significant, indicating that the two methods of pretensioning lose their difference in due course of time with proper rehabilitation, but cyclical loading being better in the initial period.

To the best of my knowledge there is no study till date which compares or shows results related to the use of different methods of pretensioning for arthroscopic ACL reconstruction.

All patients had a normal or near normal range of motion of 0–120° with minimal thigh wasting at the end of the study of one year. All the patients had no pain, climbed stairs easily and squatted. None of the patients had any swelling of the joint.

6. Conclusions

The results of Anterior cruciate ligament reconstruction using quadrupled hamstring autograft in our study were comparable to the western literature but with slower recovery due to a less aggressive rehabilitation protocol.

There was a definitive statistically significant difference between the two methods of pretensioning, specially in the initial period of postoperative follow up with cyclical loading proving to be superior, but the difference faded away with time as the ROLIMETER failed to show any statistically significant difference between the two methods at one year postoperative follow up. On the contrary the difference in the Lysholm Scores continued to be significant indicating that there was more to the patient evaluation with knee injuries than just anterior translation of the tibia over the femur. When the patients were evaluated with the Lysholms Score a comprehensive evaluation of injury related signs and symptoms are included, we consider it to be more important than just the anterior translation of the knee. Hence we would conclude that pretensioning the graft with cyclical loading is a better method of pretensioning than on a tendon board with tensioner with tension of 15 pounds for 10 min.

Due to the small sample size of the study and a short period of follow up our study may have certain pitfalls. The amount of

tension given has been fixed at 15 pounds for 10 min which may be causing differences in results. We used randomization as a method of subject allocation to a particular group, which may be a good method but not the best in the absence of subject matching which may also cause certain discrepancies. Hence we recommend cyclical loading as a method of pretensioning till long term studies are done on a larger sample size with different amounts of pretensioning forces.

Conflict of interest

None.

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