

Original Research Article

Comparative study between aperture and suspensory fixation of hamstring autografts on femoral side in ACL reconstruction: clinical and radiological outcome assessment

Manoj R. Kashid^{1*}, Rahool S.², Amit Chaudhry¹, Rajshekhar¹,
Varunendra Bahadur Singh¹, Ajit Bhaskarwar¹

¹Department of Orthopaedics, Military Hospital Kirkee, Pune, Maharashtra, India

²Department of Orthopaedics, Indian Naval Hospital Ship, Kalyani, Vizag, Andhra Pradesh, India

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*Correspondence:

Dr. Manoj R. Kashid,

E-mail: manojkashid@yahoo.com

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ABSTRACT

Background: Arthroscopically aided anterior cruciate ligament reconstruction using hamstring graft can be fixed to femoral condyle by suspensory and aperture fixation methods. The following study was undertaken to investigate whether there is any difference in functional outcomes with these fixation methods as measured by the Lysholm knee score and to determine tunnel widening post operatively with these two methods and does it affect the functional outcome.

Methods: 50 patients of clinically and radiologic ally diagnosed ACL tear fulfilling the inclusion and exclusion criteria were randomized into two groups to undergo arthroscopic ACL reconstruction using quadrupled hamstring graft with suspensory (n=25) and aperture (n=25) fixation methods on femoral side. They were compared post operatively with Lysholm score, clinical laxity tests and percentage of tunnel enlargement using computed tomograms at 01 year.

Results: At the end of 6 months there was no much difference in Lysholm score between both the groups (P =0.663) and at the end of 01 year aperture group had slightly better outcome. However, the difference was not statistically significant (p =0.173). There was more tunnel widening in the suspensory group especially of the femoral tunnel in the coronal plane. However, the amount of tunnel widening in both the groups was not significant statistically (P =0.071 and P =0.963). Tunnel widening is not associated with inferior clinical outcomes or functional knee score.

Conclusions: Aperture and Suspensory fixation methods of hamstring graft at femoral condyle in ACL reconstruction are comparable clinically and there is no advantage of one particular method over other. Although comparatively more tunnel widening is seen in suspensory fixation methods; it does not affect the final clinical outcomes or functional knee scores.

Keywords: Aperture fixation, Suspensory fixation, ACL reconstruction

INTRODUCTION

The arthroscopically aided reconstruction of the anterior cruciate ligament (ACL) with an autogenous quadrupled hamstring graft has been the standard of treatment in ACL deficient knees, particularly in young and athletic

individuals. A graft with low morbidity; excellent cosmesis, strength, and stiffness; and secure early fixation and incorporation near the joint line are the ultimate goals of anterior cruciate ligament surgery. There are two types of graft fixation at the femoral end, namely: aperture fixation and suspensory fixation.^{1,2}

There is currently no gold standard for the fixation of soft tissue grafts for ACL reconstruction. A major cause for concern with the use of hamstring autografts is, the soft tissue can take up to 12 weeks to heal to the osseous tunnel.^{3,4} Thus, a secure fixation technique is needed to withstand the forces on the graft resulting from current rehabilitation protocols that allow for unrestricted ROM, weight bearing, and early return to athletic activity after ACL reconstruction.^{3,5} The purpose of our study was twofold: (1) to investigate whether there is any difference in functional outcomes with these fixation methods as measured by the Lysholm knee score and (2) to determine whether there is a difference in the tunnel widening with joint line fixation using interference screws (aperture fixation) versus EndoButton (suspensory fixation) of hamstring autografts in ACL reconstruction and does it affect the functional outcome.

METHODS

We carried out a prospective randomized study of 50 skeletally mature male serving soldiers with clinically and radiologically proven Anterior cruciate ligament tear from Aug 2014 to June 2016. Approval of hospital ethical committee from the institution was taken and informed, valid consent from the patients taken before surgery. 50 patients were divided into two groups of 25 each by computer generated random number table. Patients in both groups were between 20 to 40 years age group. All the patients underwent arthroscopic ACL reconstruction using quadrupled hamstring autograft. ACL auto graft in group A fixed to lateral femoral condyle with suspensory fixation method using EndoButton (Smith and Nephew). In group B, aperture fixation method using Bioscrew is utilized for fixation of hamstring graft to lateral condyle of femur. In all the patients graft on tibial side is fixed by Bioscrew (Smith and Nephew). All male patients with clinical and MRI diagnosis of exclusive anterior or anterolateral instability with or without meniscal injuries which do not alter postoperative rehabilitation were included in the study. Patients with multi ligaments injury, previous knee surgeries, postoperative infection, meniscal injuries requiring repair were excluded from the study. 01 patient developed superficial postoperative infection in this study and hence excluded from the study. All the patients evaluated clinically for laxity by Lachman, ant drawer by rollimeter, pivot shift test, and assessed by Lysholm and Gillquist knee scoring system. All the patients also evaluated by X-ray and MRI of knee preoperatively. Operations were done by different surgeons using anteromedial portal technique. All patients are subjected to same rehabilitation protocol for 06 weeks. Patients were hospitalized for 2 weeks post operatively and was sent on 6 weeks medical leave for convalescence and reviewed at 08 weeks, 6 months and at 01 year post operatively. All the patients evaluated by laxity tests, Lysholm and Gillquist functional scoring system at these intervals. Initial diameters of femoral and tibial tunnels were taken as per the drill bit used to make the tunnel, in turn based up on graft thickness used. On

follow up patients underwent a computed tomography scan at the end of 12 months to measure the amount of tunnel widening. Tunnel widening was measured by measuring the widest tunnel diameter on coronal and sagittal views on CT. All patients underwent CT using same machine and measurements were performed by the same independent observer, who was a radiologist. For the femur, the widest diameter of the whole tunnel was measured in coronal and sagittal plane. For the tibia, the widest diameter above the Bioscrew was measured in both planes. Tunnel widening was expressed as a percentage of the diameter of the drill bit used to create the tunnel. The percentage change in tunnel diameter at follow-up was compared between the EndoButton (suspensory) and interference screw (aperture fixation) groups at the end of 12 months for 47 patients. 3 patients (2 from aperture group and 1 from suspensory group) could not be followed up for tunnel widening with CT scan as the patients were unwilling to undergo the CT scan as given in Figure 1.

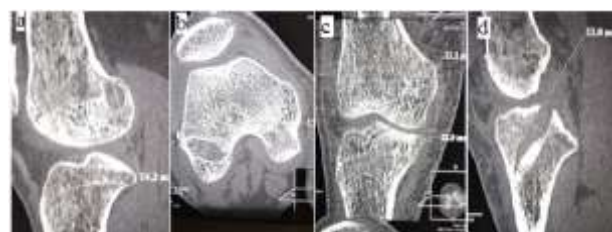


Figure 1: CT scan images showing method of measurement of tunnel diameter in sagittal. (a) coronal (b) plane of femur and coronal (c) sagittal (d) plane of tibia.

Statistical analysis

Statistical analysis was done using SPSS software (IBM Version-20). Statistical difference between continuous variables was assessed using Student t-test. Categorical variables were compared using Chi square test. Statistical significance was set at P value of 0.05 or less.

RESULTS

All the patients included in the study were serving male soldiers. This was largely attributed to high prevalence of ACL tear among young active soldiers by virtue of their sports and training participation including strenuous physical activities involving jumping, running and obstacle courses. Both the groups are having nearly similar age distribution. The most common mode of injury was sports injury (football, basketball and volley ball game). Second most common mode of injury was during military training (fall during 9 feet ditch jump, BPET) in which soldier has to jump across a 9 feet long ditch with his rifle and backpack. In our study 40% patients in Aperture group and 48% patients in suspensory group had involvement of the right knee. 60% patients in aperture group and 52% in suspensory group

had involvement of the left knee. They are homogenous in both groups. Preoperative Lysholm and Gillquist score for aperture group was 45.32 ± 4.75 and for suspensory group was 46.16 ± 4.60 , statistically not significant ($P = 0.630$). Both the groups are homogenous regarding clinical tests such as anterior drawer test by rollimeter, Lachman test and pivot shift test preoperatively as given in Figure 2. Preoperative anterior drawer, Lachman and pivot shift test in both groups.

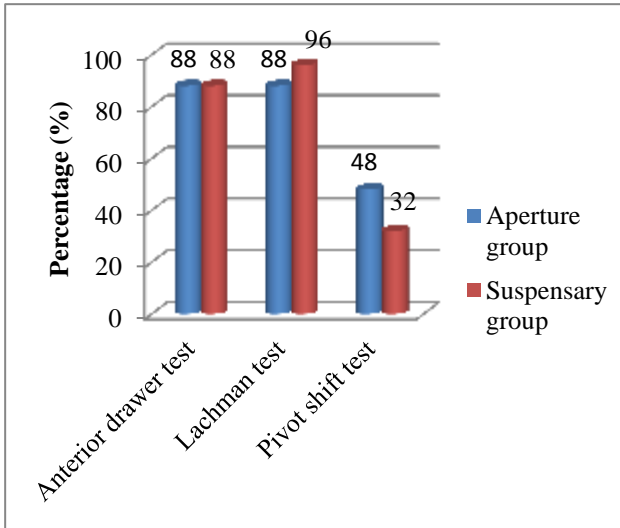


Figure 2: Preoperative anterior drawer, Lachman and pivot shift test in both groups.

50 cases underwent arthroscopy based on clinical examination and diagnosed as pure ACL. However during routine diagnostic arthroscopy before ACL reconstruction many cases were detected with associated meniscal injuries. 68 % (17 out of 25 cases) suspensory group and 56% (14 out of 25 cases) aperture group were detected with pure ACL tear. 32% cases of suspensory group and 44% cases of aperture group were detected with medial, lateral or combined meniscal injuries. As associated meniscal injuries are very common with ACL they were included in inclusion criteria. One patient in suspensory group had post op infection and eliminated from the analysis. No subjects in both groups had postoperative thromboembolism or pressure sores. Table 1 presents the associated meniscal injuries in both groups.

Final outcome measures measured at the end of 6 months and 01 year of follow up. Five patients in aperture group and seven patients in suspensory group had pain occasionally on exertion at the end of 12 months. Two Patients in aperture group and three patients in suspensory group have to take support of walking aid 12 months after surgery. Three patients each in aperture and suspensory group returned to pre injury status 12 months after surgery. There was no significant difference with respect to postoperative knee pain or pain at follow up and of usage of walking aids in both the group. Out of 50 patients operated five (20%) patients of aperture group and six (24%) patients of suspensory group had anterior

drawer test positive with p-value of 0.733. Five (20%) patients of aperture group and seven (28%) patients of suspensory group has Lachman test positive with p value of 0.508. They had grade 1-grade 2 ligament laxity and most of them had laxity with firm end point. However, two (8%) patients of aperture group and four (16%) patients of suspensory group had laxity with loose end point with pivot shift with the p-value of 0.384. Comparatively aperture group had better clinical outcome but the difference was not statistically significant. Clinical outcome at the end of 6 months & 01 year was measured in terms of Lysholm and Gillquist knee Score, at the end of 6 months there was no much difference between both the groups ($P = 0.663$) and at the end of 01 year aperture group had slightly better outcome. However, the difference was not statistically significant ($P = 0.173$) as shown in Figure 3.

Table 1: Associated meniscal injuries in both groups.

Arthroscopy findings	Suspensory fixation-A	Aperture fixation-B	Total
ACL tear	17	14	31
ACL + Lateral meniscus tear	3	5	8
ACL + Medial meniscus tear	4	4	8
ACL + Medial + Lateral meniscus tear	1	2	3

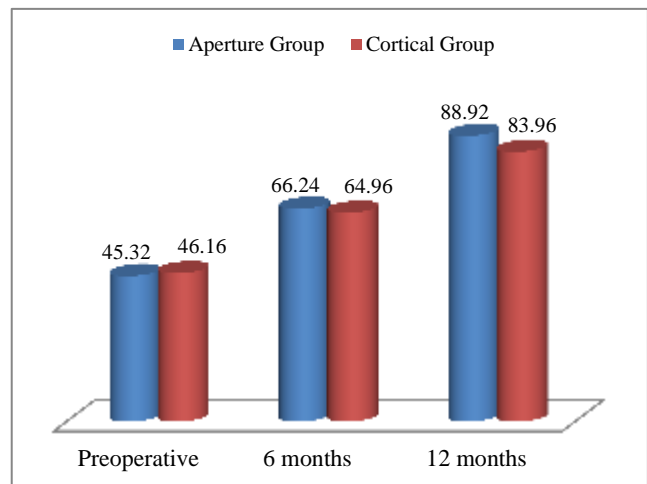


Figure 3: Change in Lysholm and Gillquist knee score at 6 and 12 months in both groups.

The initial femoral and tibial tunnel diameters were taken as per the diameter of the drill bit used to make the tunnel and there was no significant difference between the tunnel diameters. Amount of tunnel widening of femoral and tibial tunnels expressed as percentage of initial tunnel widths at the end of 12 months. There was more tunnel

widening in the suspensory group especially of the femoral tunnels, over all maximum tunnel widening was seen in the coronal plain of the femoral tunnel in suspensory group. However, the amount of tunnel

widening in both the groups was not significant statistically ($P=0.071$ and $P=0.963$). Table 2 presents the comparison of tunnel widening in both groups at 12 months.

Table 2: Comparison of tunnel widening in both groups at 12 months.

Fixation method	Initial tunnel measurements postoperatively in mm		Tunnel widening (mean percentage) at the end of 12 months			
	Femoral tunnel (mean) in mm	Tibial tunnel (mean) in mm	Femoral tunnel	Tibial tunnel	Femoral tunnel	Tibial tunnel
			Coronal	Coronal	Sagittal	Sagittal
Suspensary A	8±0.589	8.33±0.481	42.321±3.787	27.492±2.060	37.252 ±2.262	30.679 ±2.176
Aperture B	7.95±0.474	8.957±0.705	34.778±2.113	25.404±1.384	28.991±2.285	26.758 ±2.015
P value	0.521	0.605	0.071		0.963	

DISCUSSION

There are two widely used methods for graft fixation namely aperture fixation (fixation of the graft to the bone through the tunnel at the joint level in the intercondylar notch) and suspensory fixation (fixation of graft to bone at lateral cortex of the femur). However debate continues about which technique is better. Some studies are in favor of aperture fixation and some studies showed there is no significant difference between both fixation types.⁶ All these studies are new and long term follow up is still awaited. Continuing research in the same field, the purpose of our study was to compare of functional outcome of arthroscopic ACL reconstruction using aperture and suspensory fixation and to determine the amount of tunnel widening in both the groups.

All subjects in our study were young male serving soldiers. By virtue of their job profile, soldiers in Indian army go through rigorous training and sports activities like football, volley ball and basketball to keep them fit. Therefore, male serving soldiers were selected for ease and homogeneity of patient population and to eliminate possible bias in the study. According to internationally published studies ACL injuries are very common in football players. In our study most common mode of injury was sports injury (68% of aperture group and 60% of suspensory group) which included football, volley ball, basketball, kabaddi mainly where patient sustained twisting injuries. Next common mode of injury was during training in our set up mostly during 9 feet ditch jump (24% of aperture group and 28% of suspensory group). In this event a soldier has to jump across a nine feet pit with his rifle and back pack. Mostly injured soldiers fell down during this jump and sustained injury of knee.

In our study postoperative Lysholm score was calculated at 6 months and 12 months interval and compared with various studies available at present. At 6 months interval there was no significant difference in functional outcome between both the groups as assessed by the Lysholm

score. This suggests that in early stages there is no significant difference in outcome from surgery in both groups. There was significant improvement in Lysholm score after surgery in both groups from preoperative Lysholm score. In our study at a 12 months interval, comparative postoperative Lysholm score between aperture and suspensory group was not statistically significant ($p=0.173$). Ping et al conducted a similar study with follow up of 29.5 months (12-46 months) on average.⁷ Lysholm, International Knee Documentation Committee (IKDC) and Larson scoring were used to compare the therapeutic effects experienced at the knee. Lysholm scores were 93.26±2.67 (group A) and 93.81±2.42 (group B); Larson scores were 91.91±2.29 (group A) and 92.81±2.39 (group B); IKDC scores were 93.89±1.88 (group A) and 94.15±1.77 (group B). None of the scoring differences between groups were statistically significant at the end of follow up period.

Coming to statistical analysis of tunnel widening of femoral and tibial tunnels in suspensory and aperture fixation groups, follow up was done at 12 months and tunnel widths were measured in both femur and tibia in coronal and sagittal planes in each case. Tunnel widening after anterior cruciate ligament (ACL) reconstruction is a well-described phenomenon.⁸ The basis of tunnel widening is multifactorial, with several possible mechanical and biological contributing factors.⁹ Among the possible causes, mechanical factors such as graft tunnel motion, stress deprivation of bone within the tunnel wall, improper graft tunnel placement, tunnel positioning, graft fixation method, resorbable implant degradation, access of joint fluid to the graft-bone interface, and bone quality and aggressive rehabilitation have been considered.^{10,11} EndoButton is a device placed against the anterolateral cortex of the distal femur, suspending the graft inside the femoral tunnel. Suspensory graft fixation results in a more elastic graft construct and may contribute to the so-called bungee effect whereby the graft moves longitudinally within the tunnel which has been suggested to contribute to tunnel widening.^{9,12} Sagittal graft motion, known as the

“windshield wiper effect” can also occur leading to tunnel widening.¹² Tunnel widening after ACL reconstruction can be clinically problematic, with excessive tunnel widening resulting in increased knee laxity and poor bone stock for revision reconstruction procedures.¹³ In this type of fixation, vectors of resistance are parallel to and opposite the external forces, and they concentrate on the cortical bone of the distal femur, on the bone-device surface. Buelow et al performed a prospective nonrandomized trial comparing femoral fixation with a bioabsorbable interference screw with an EndoButton.¹⁴ The results demonstrated ACL reconstruction with a doubled semitendinosus and gracilis tendon graft and associated femoral and tibial tunnel enlargement. The authors found considerably more tunnel widening in the grafts fixed with extracortical fixation. However, there was no correlation between tunnel enlargement and clinical scores or laxity measurements. Fauno and Kaalund performed a prospective randomized study comparing femoral fixation of a hamstring autograft using the TransFix and the EndoButton.¹⁵ Tunnel widening, measured on standardized radiographs, and clinical outcomes, including KT-1000™ data, IKDC ratings, and Lysholm score, were assessed. One hundred patients were randomized and 87 patients were assessed at 1-year follow up. Considerably more tunnel widening was found in the group in which fixation was away from the joint line in both the femur and the tibia (EndoButton and screw and washer). However, there was no correlation between tunnel widening and clinical outcome. Ma et al performed a prospective non-randomized study comparing aperture fixation with bioabsorbable interference screws in both femoral and tibial tunnels versus distant fixation using the EndoButton for femoral fixation and a screw-post for tibial fixation.¹⁶ There were 15 patients in each arm with a minimum 2-year followup (mean, 35 months). Follow up evaluation included arthrometer measurements, radiographs and MRI, and IKDC score. There was more femoral tunnel widening in the sagittal plane in the EndoButton group; otherwise, there were no differences between the two groups. Furthermore, there were no major differences in clinical outcomes at 24 to 40 months. Thus, there is no clear biomechanical advantage to one method of fixation versus another. It is also unknown whether these biomechanical differences result in fewer surgical failures and/or improved functional outcome scores. In our study 47 patients (24 are patients in whom suspensory fixation was done and 23 are patients in whom aperture fixation was done) were evaluated at follow up period of 12 months for determining the tunnel widening in both groups. There was no statistically significant difference in tunnel widening in coronal plane ($P=0.071$) and sagittal plane ($P=0.963$) in both the groups in our study. Prospective nature of study and randomization of the patients strengthened the study. However smaller sample sizes, shorter duration of follow-up are limiting factors.

CONCLUSION

This study shows that the results of suspensory and aperture fixation of hamstring graft at femoral condyle in ACL reconstruction are comparable clinically and there is no advantage of one particular method over other. More tunnel widening in patients suspensory fixation group at the end of 12 months is not statistically significant and is not associated with inferior clinical outcomes or functional knee scores. Relatively shorter follow-up, different operating surgeons, smaller groups and subjective observation of the tunnel width are few of the limitations of the study.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee, Command Hospital, Lucknow

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