INCIDENCE OF LOW FEMORAL TUNNEL WIDENING FOLLOWING RECONSTRUCTION OF ACL WITH PRESS FIT FIXATION AND PATELLAR TENDON GRAFTS

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ABSTRACT

Background: Low femoral tunnel widening following ACL [anterior cruciate ligament] reconstruction is a common event. Existing literature data is scarce concerning the effect of reconstructing ACL with press fit fixation and Patellar tendon grafts.

Aim: The present study aimed to assess the incidence of low femoral tunnel widening following reconstruction of ACL with press fit fixation and Patellar tendon grafts.

Methods: The study assessed 233 subjects that underwent ACL surgery, of whom 109 underwent ACL surgery with patellar tendon graft and 124 underwent ACL surgery with hamstring tendon. Femoral tunnels were assessed on lateral and anteroposterior radiographs 6 months postoperatively. Tunnel widening was assessed and measured by two orthopaedic surgeons who are experts in the field.

Results: Tunnel widening incidence rate was 2% (n=2) and 17% (n=19) in the patellar tendon graft group and was 83% (n=102) and 88% (n=108) subjects in hamstring tendon group in lateral and anteroposterior femoral groups respectively. A significant difference was seen in lateral and anteroposterior radiographs with $p<0.001$.

Conclusions: The present study concludes that the incidence rate of femoral tunnel widening during the ACL reconstruction surgery is significantly higher during the hamstring tendon with the suspensory fixation method compared to the Patellar tendon with the femoral press-fit fixation technique.

Keywords: ACL reconstruction, Femoral tunnel widening, patellar tendon, press-fit fixation.

INTRODUCTION

The widening of the tunnel following ACL (anterior cruciate ligament) reconstruction surgery is a common phenomenon that is routinely performed. The incidence of tunnel widening following ACL reconstruction lies in the range of 0% to 74%. The tunnel widening is more prominent while using the hamstring graft compared to the patellar graft. Also, along with the type of graft, various other factors can affect tunnel widening, including the higher cytokine activity, different types of devices and types of graft fixation, position and size of the drilled holes, accelerated rehabilitation, age of the subjects, and movement of graft within the tunnel.[1]

The exact and complete etiology of tunnel widening is unknown to date. A commonly considered theory behind tunnel widening is that an inflow of synovial fluid is seen inside the tunnel between the bone and the graft, which leads to a series of disorders in the normal healing process of the bone tendon. After the surgery, an improvement is seen in the levels of pro-inflammatory cytokines, including IL-6, IL-1b, and TNF-α in the intra-articular fluid. The presence of these cytokines stimulates the osteoclastic activity that leads to bone resorption.[2]

With the movement of the graft in the tunnel, the leakage of synovial fluid is seen in the tunnel. As suggested by the observation, greater tunnel widening is seen as secondary to accelerated rehabilitation. The synovial fluid movement and tunnel widening can prolong or increase the adjacent bone exposure to the synovial fluid in cases where there is a round bone tunnel and the graft is relatively flat. This effect is termed as a synovial-bathing effect. When the graft movement is reduced in the bone tunnel by the windshield wiper effect using a fixation method such as the press-fit technique or interference screw adjacent to the joint line which can decrease the inflow of synovial fluid.[3]

The most commonly used cannulated interference screw in ACL reconstruction surgery has a central hole along with the space between the bone and the screw thread, and both of these can lead to the inflow of synovial fluid. On using the press-fit fixation technique, the aperture of the femoral tunnel can be closed using the base of the bone block.[4]

Also, the existing literature is scarce concerning the effects of reconstructing ACL using the patellar tendon with the press-fit technique and the incidence of the femoral tunnel widening.[5] Hence, the present study aimed to comparatively assess the femoral tunnel widening following ACL reconstruction using suspensory hamstring tendon with press-fit patellar graft.

MATERIALS AND METHODS

The present retrospective clinical study was aimed at comparatively assessing the femoral bone tunnel widening following ACL reconstruction using suspensory hamstring tendon with press-fit patellar graft. The study was done at the Department of Orthopaedics of the Institute. All the study subjects were recruited after obtaining written and verbal informed consent from participants.

The inclusion criteria for the study were subjects who underwent ACL reconstruction surgery at the institute and gave informed consent for study participation. The exclusion criteria for the included subjects who were not willing to participate in the study, subjects showing evidence of osteoarthritis on the radiographs, having multiple ligament injuries, and subjects with a history of ACL reconstruction in either of the knees.

After the final inclusion of the study subjects, a detailed history followed by clinical examination were recorded for every subject. Concomitant meniscal injuries were not taken as an exclusion criteria. The study subjects were then divided into two groups: Group I subjects were treated with a hamstring graft and included 124 subjects. Group II subjects were managed using a Patellar tendon graft and included 109 subjects.

In the hamstring tendon group, the surgery was done using the gracilis tendon and quadrupled semitendinosus graft with a suspensory fixation system having two spiked staples at the tibial end and endobutton at the femoral end. The single-button reconstruction used here was one described by Kawaguchi et al[6] in 2011.

The bone-patellar-tendon-bone graft was extracted following the technique described by Pavlik et al[7] in 2006. The most vital step in the Pavlik technique was the accurate and precise shape of the patellar bone which is trapezoidal in form with 9mm diameter at the end and 10 mm diameter at the base. In such a case, the patellar bone block was impacted in a femoral tunnel that was 9 mm wide. The patellar bone and femoral tunnel had the same length where the patellar bone base was fitted in the femoral tunnel without using any fixation device. With the trapezoidal form at the tibial tunnel, the same technique was used. All the surgeries were performed by a single Orthopaedic surgeon having expertise in the field.

The rehabilitation protocol used in all the subjects were identical. Following surgery, 0^{o} fixed braces were given to all the subjects for 3 weeks duration. Isometric muscle stretching and 30^{o} - 40^{o} flexion were advised to all the subjects during these 3 weeks. Full weight bearing was allowed for all the subjects after 1 week of the surgery. A full range of movement was initiated on the fourth week postoperatively. Straight-line running, swimming, and bicycling were allowed to the subjects after 12 weeks, 10 weeks, and 3 weeks respectively. Sport-specific exercises were initiated on the 16^{th} week. The return to the sports was allowed on the ninth week postoperatively. In both groups, the same rehabilitation program was adopted.

For radiographic assessment, standard lateral view and anteroposterior view radiographs were taken at 6 months postoperatively. The tibial and femoral tunnel widenings were measured at a 1cm distance from the tunnel apertures, perpendicular to the axis of the tunnels. It was defined as the distance between the two sclerotic bone margins. The comparisons were made between the drilled tunnels and the measured values.

The data gathered were analyzed statistically in the two groups concerning the surgery time and age of the subjects with the t-tests. The tunnel widening ratio was compared with the t-test. The data were analyzed using SPSS software version 21.0 (IBM Corp., Armonk, NY, USA). The significance level was taken at a p-value of <0.05.

RESULTS

The present retrospective clinical study was aimed to comparatively assess the femoral bone tunnel widening following ACL reconstruction using suspensory hamstring tendon with press-fit patellar graft. The 233 study subjects were divided into two groups where Group I subjects were treated with hamstring graft and included 124 subjects, and Group II subjects were managed using Patellar tendon graft and included 109 subjects. The mean age of the study subjects in the patellar tendon and hamstring tendon groups was 27.7±1.2 and 27.2±2.1 years respectively. The difference was statistically non-significant with p=0.54. There were 82.56% (n=90) males and 17.43% (n=19) females in the patellar tendon group, whereas, there were 67.74% (n=84) males and 32.25% (n=40) females in the hamstring tendon group respectively. The difference was statistically significant with p=0.0004. The mean time for the surgery was 53.2 minutes in the range of 32-102 minutes in the patellar tendon group which was significantly higher compared to the hamstring tendon group where it was 44.1 minutes in the range of 23-100 minutes as shown in Table 1.

At the tibial and femoral end, the mean intraoperative tunnel diameter was 7.2 mm in the hamstring tendon 9.96 mm (8-14) at the femoral, and 8.7 mm (7-12) at the tibial end in the patellar tendon group. The mean incidence rate of tunnel widening in the patellar tendon group at tibial lateral radiograph was seen in 84.40% (n=92) subjects and was seen in 96.77% (n=120) subjects which was significantly higher in the hamstring tendon group with p=0.001. On anteroposterior view, at the tibial end, tunnel widening was seen in 93.57% (n=102) subjects in the patellar tendon group which was non-significantly lesser in the hamstring tendon group with 96.77% (n=120) subjects with p=0.18. At the femoral end, in a lateral radiograph, tunnel widening was seen in 1.83% (n=2) subjects from the patellar tendon group which was significantly lesser compared to the hamstring tendon group where it was seen in 82.25% (n=102) subjects with p=0.001. In anteroposterior radiographs, tunnel widening was significantly higher in the hamstring tendon group with 87.09% (n=108) subjects compared to 17.43% (n=19) subjects from the patellar tendon group with p=0.001 (Table 2).

In the lateral and femoral anteroposterior groups, in the hamstring tendon group, the mean tunnel widening was 4.16 mm and 4.13 mm, whereas, on the tibial views, the mean tunnel widening in the hamstring tendon group was 3.02 mm and 2.84 mm respectively. In the patellar tendon group, mean tunnel widening was 2.4 mm and 3.46 mm on the femoral anteroposterior radiograph, whereas, on the tibial view, mean tunnel widening was 3.17 mm and 3.6 mm respectively. All the tunnel widenings were statistically significant with p<0.001 except for the lateral femoral radiograph in the patellar tendon group.

As the tunnel widening incidence was low in the patellar tendon group on the femoral lateral view radiographs, the statistical analysis was not applied to all the subjects. Considering this, tunnel widening was statistically significantly lesser on all the views in the patellar tendon group.

On femoral anteroposterior group, femoral lateral group, tibia anteroposterior group, and tibial lateral group with $p<0.001$.

DISCUSSION

The present study assessed 233 subjects that were divided into two groups where Group I subjects were treated with hamstring graft and included 124 subjects, and Group II subjects were managed using Bone Patellar tendon graft and included 109 subjects. The mean age of the study subjects in the patellar tendon and hamstring tendon groups was 27.7±1.2 and 27.2±2.1 years respectively. The difference was statistically non-significant with p=0.54. There were 82.56% (n=90) males and 17.43% (n=19) females in the patellar tendon group, whereas, there were 67.74% (n=84) males and 32.25% (n=40) females in the hamstring tendon group respectively. The difference was statistically significant with p=0.0004. The mean time for the surgery was 53.2 minutes in the range of 32-102 minutes in the patellar tendon group which was significantly higher compared to the hamstring tendon group where it was 44.1 minutes in the range of 23-100 minutes. These results were similar to the studies of Buelow JU et al[8] in 2002 and Webster KE et al[9] in 2001 where authors assessed subjects with comparable demographic and disease characteristics as in the present study.

The study results showed that at the tibial and femoral end, the mean intraoperative tunnel diameter was 7.2 mm in the hamstring tendon 9.96 mm (8-14) at the femoral, and 8.7 mm (7-12) at the tibial end in the patellar tendon group. The mean incidence rate of tunnel widening in the patellar tendon group at tibial lateral radiograph was seen in 84.40% (n=92) subjects and was seen in 96.77% (n=120) subjects which was significantly higher in the hamstring tendon group with p=0.001. On anteroposterior view, at the tibial end, tunnel widening was seen in 93.57% (n=102) subjects in the patellar tendon group which was non-significantly lesser in the hamstring tendon group with 96.77% (n=120) subjects with p=0.18. At the femoral end, in a lateral radiograph, tunnel widening was seen in 1.83% (n=2) subjects from the patellar tendon group which was significantly lesser compared to the hamstring tendon group where it was seen in 82.25% (n=102) subjects with p=0.001. In anteroposterior radiographs, tunnel widening was significantly higher in the hamstring tendon group with 87.09% (n=108) subjects compared to 17.43% (n=19) subjects from the patellar tendon group with p=0.001. These results were consistent with the previous studies of Shanmugaraj A et al[10] in 2020 and Sarzaeem MM et al[11] in 2014 where similar results concerning tunnel widening were seen in study subjects of the authors as seen in the present study.

It was also seen that in the lateral and femoral anteroposterior group, in the hamstring tendon group, the mean tunnel widening was 4.16 mm and 4.13 mm, whereas, on the tibial views, the mean tunnel widening in the hamstring tendon group was 3.02 mm and 2.84 mm respectively. In the patellar tendon group, mean tunnel widening was 2.4 mm and 3.46 mm on the femoral anteroposterior radiograph, whereas, on the tibial view, mean tunnel widening was 3.17 mm and 3.6 mm respectively. All the tunnel widenings were statistically significant with $p<0.001$ except for the lateral femoral radiograph in the patellar tendon group. These findings were in agreement with the findings of Widuchowski W et al[12] in 2012 and Hertel P et al[13] in 2005 where tunnel widening similar to the present study were reported by the authors in their respective studies.

The study results showed that as the tunnel widening incidence was low in the patellar tendon group on the femoral lateral view radiographs, the statistical analysis was not applied to all the subjects. Considering this, tunnel widening was statistically significantly lesser on all the views in the patellar tendon group. On femoral anteroposterior group, femoral lateral group, tibia anteroposterior group, and tibial lateral group with $p<0.001$. These findings correlated with the studies of Arnold MP et al[14] in 2017 and Xiaobo X et al[15] in 2015 where the authors suggested a low incidence of patellar tendon graft as seen in the present study.

CONCLUSIONS

Considering its limitations, the present study concludes that the incidence rate of femoral tunnel widening during the ACL reconstruction surgery is significantly higher during the hamstring tendon with the sensory fixation method compared to the Patellar tendon with the femoral press-fit fixation technique. However, further longitudinal studies are needed to reach a definitive conclusion.

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TABLES

Characteristics	Patellar tendon (n=109)	Hamstring tendon (n=124)	p-value
Mean age (years)	27.7±1.2	27.2±2.1	0.54
Gender			
Males	90 (82.56%)	84 (67.74%)	**0.0004**
Females	19 (17.43%)	40 (32.25%)	
Surgery time (min)	53.2 (32-102)	44.1(23-100)	**0.001**

Table 1: Demographic and disease data in study subjects

Radiograph	Patellar tendon		Hamstring tendon		p-value
	n=109	**%**	**n=124**	**%**	
Tibial lateral	92	84.40	120	96.77	**0.001**
Tibial AP	102	93.57	120	96.77	0.18
Femoral lateral	2	1.83	102	82.25	**0.001**
Femoral AP	19	17.43	108	87.09	**0.001**

Table 2: Incidence of the tunnel widening in two groups of study subjects