

Comparitive Study of Treatment of ACL Tear Treated by Reconstruction with Anteromedial Portal Technique vs Trans Tibial Technique

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Abstract

Background Although the true natural history remains unclear, ACL disruptions are functionally disabling, they predispose the knee to subsequent injuries such as tears of the menisci, and they are associated with the early onset of osteoarthritis. The objective of the study is to compare the results of ACL reconstruction by two different techniques i.e anteromedial portal technique and transtibial technique.

Material and Methods The study was conducted on 60 clinico radiological cases of ACL tear which were randomly divided into two groups, half of them were operated by anteromedial technique (AMP) and another half by transtibial technique (TT) of ACL reconstruction. Assessment was done preoperatively and immediate postoperatively by clinical examination of the knee, Lysholm score, IKDC scale and MRI. Follow up assessment was done by knee examination, Lysholm score and IKDC scale.

Results The difference between mean Lysholm score and IKDC scale after 12 to 17 months of follow up was not statistically significant. The pivot shift test was negative in all cases in both TT and AMP group whereas Lachmans test was negative in 77 % of TT group patients and 80% of AMP group patients. On post op MRI mean inclination angles of ACL in sagittal view were 53.22° in normal knees, 55.85° in TT and 53.81° in AMP group of patients. And in coronal views they were 72.77°, 77° and 70.63° in normal, TT and AMP group respectively. In both sagittal and coronal views the difference between normal and TT group, and TT vs AMP group was significant. But it was not statistically significant between normal and AMP group.

Conclusion post operative mri showed that TT produces more vertical and non anatomical tunnel whereas AMP produces more anatomical tunnel but the difference in functional score was statistically not significant. Therefore this study doesn't guarantee the superiority of one technique over the other.

Keywords: ACL Tear, Reconstruction, Anteromedial Portal Technique, Trans Tibial Technique

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INTRODUCTION

Anterior cruciate ligament (ACL) is an important structure to stabilize the knee joint and its injury can induce knee joint laxity and pain. ACL injuries are common among athletes. The arthroscopic single-bundle (SB) autograft has been a widely used technique for ACL reconstruction.² Initially the most popular femoral drilling method was the two-incision technique, where the femoral tunnel is created outside-in.³ The Transtibial (TT) technique was the subsequent method of choice for the femoral tunnel placement. Although there is no definitive evidence to support a clear benefit of the one-incision over the two-incision technique.⁴ The TT drilling method was adopted to obviate the necessity for the lateral incision and to, potentially, reduce operative time and surgical morbidity. Moreover, good clinical outcomes were reported with the TT technique.⁵ However, recently it has been postulated that the SB TT ACL reconstruction places the graft in a non-anatomical femoral insertion site which has been blamed to be the cause of non reproducible results and poor pivot control in the knee.⁶⁻¹³

The use of the Anteromedial portal (AMP) for drilling the femoral tunnel in the SB technique was suggested as a method to place the single bundle graft in an anatomical position and improve rotational stability, without increased complexity of double bundle reconstruction. With the TT technique, the position of the femoral tunnel is dictated by the tibial tunnel, whereas the AMP technique provides the surgeon with a greater freedom to place the graft in the anatomical position on femoral side.^{15, 16}

There has been an increased recognition of ACL reconstruction failure attributable to vertically oriented grafts in recent years. Although anterior tibial translation can be well controlled with isometric femoral positioning and a vertical graft orientation, patients often have residual rotational instability and a persistent pivot shift postoperatively that preclude their ability to return to previous level of athletic activity. The restoration of normal knee kinematics and improvement in tibial rotational control with greater femoral tunnel obliquity have been recently established in a number of biomechanical studies.^{13, 17-19}

Although significant anatomic and biomechanical differences between Transtibial and Anteromedial portal ACL reconstructions are evident in various cadaveric studies, the clinical significance of these findings is unclear. It is certainly possible that these differences may not translate into improved patient satisfaction or better functional outcomes.²⁰ There is no question that successful outcomes after Transtibial ACL reconstruction have been well established in the literature.^{21,22} Buchner et al²¹ have reported 85% nearly normal or normal International Knee Documentation Committee scores at a mean of 6 years follow-up after Transtibial ACL reconstruction in 85 patients, with 75% showing a difference of less than 3 mm in KT-1000 measurements between normal and operated knees. Maletis et al.²² Similarly reported excellent subjective and objective outcomes as well as restoration of knee stability as assessed by KT-1000 arthrometer in 96 patients with Transtibial ACL reconstruction at 24 months' follow-up. Randomized, prospective studies with validated functional outcome tools are necessary to further define the clinical relevance of these biomechanical cadaveric studies findings. Comparative prospective studies comparing the results of TT and AMP technique have shown varied results with no definite advantage of either of them.²⁹⁻³⁴

Both the semitendinosus and gracilis graft are double looped and their free ends whip stitched using no.5 ethibond (FIG. 4). Sizing was done using tendon sizer. The usual thickness obtained was 8-9 mm.

ARTHROSCOPIC TECHNIQUE

A complete diagnostic arthroscopy was performed first for every patient in this study to confirm the ACL tear and possible other findings (meniscal or chondral injury) inside the injured knee. The ruptured ACL was examined with an arthroscopic probe, dissected, and debrided. The tibial footprint of the ACL was left intact. The femoral footprint was also identified and minimally debrided and marked with radiofrequency probe or awl.

In patients of group A (Transtibial technique):

Standard anterolateral and anteromedial portal were made. The tibial tunnel was drilled first using ACL tibial jig set at 55 degree. Reaming was done to make the tibial tunnel of size dictated by the thickness of the graft. The centre of femoral tunnel was then marked using a femoral offset jig through the tibial tunnel, trying to reach the ACL footprint centre as far as possible (FIG. 6). Femoral tunnel was then drilled according to the size of graft and after ensuring the length of atleast 20 mm of graft in the tunnel, a 4.5 mm cannulated drill bit was used to create the channel for the Endobutton CL passage from the roof of femoral tunnel till the femoral cortex. The Endobutton CL size was selected depending upon overall length/distance between intra articular femoral tunnel aperture and femoral cortex.

The double looped hamstring graft was then pulled through the tibial tunnel into femoral tunnel over appropriate size Endobutton CL and then the button was flipped over the femoral cortex.

In patients of group B[(AMP) Technique]:

In this technique the anteromedial portal was made a little distal and medial then in Transtibial technique (FIG.5). In AMP technique femoral tunnel was constructed first. While keeping knee in 110 degrees flexion and looking from the arthroscope in anterolateral portal, a guide wire was passed from anteromedial portal using a appropriate sized AMP femoral offset jig. By this method of using anteromedial portal for femoral drilling, we found that one could easily reached the femoral ACL foot print in most of cases i.e. low lateral or 9-9:30 o' clock position in right knee and 2:30-3 o'clock position in left knee (FIG. 7, 8). Over this guide wire 4.5 mm cannulated drill bit was used to drill upto lateral femoral cortex. Depth guage was used to measure the total length of tunnel which came out to 35-40 mm (FIG. 9) in most cases. Since Endobutton CL comes in size of 15 and 20 mm loop (smallest size), and it was ensured to keep atleast 20mm graft in femoral tunnel, we made the appropriate sized femoral tunnel (both in terms of length and width). Beath pin was used to pass suture loop of no. 5 ethibond from Anteromedial portal through femoral tunnel and brought out the skin overlying lateral femoral cortex.

Now the knee was extended upto 90 degrees flexion and tibial tunnel was made using ACL jig, set at 55 degrees to make appropriate sized tibial tunnel. Through this tibial tunnel a grasper was used to pull through the suture loop from inside the knee. Over this suture loop the graft along with Endobutton CL was pulled through

tibial and femoral tunnels (FIG. 10, 11). And then the Endobutton CL was flipped over the lateral femoral cortex. This ensured fixation of graft at femoral side.

Fixation of graft on tibial side using intrafix

After passage of the graft by either technique, the four graft strands (2 of gracilis and 2 of semitendinosus) which were coming out of tibial tunnel were pulled firmly and the knee was cycled through full range of motion 10-12 times. The knee was then brought in full extension and appropriate sized biodegradable tibial Intrafix (Mitek - USA) was used to fix the graft in the tibial tunnel.

Standard instrumentation of Mitek – USA was used to insert the Intrafix sheath and screw while applying 15-20 pounds of traction to the four graft strands using the graft tension device.

The wound and portal were closed using 1-0 vicryl and silk, standard antiseptic dressing was done and crepe bandage applied. The tourniquet was deflated after application of crepe bandage. Long knee immobiliser was applied in full knee extension.

Postoperative care

1. Patients were given intravenous antibiotics for three days.
2. Rehabilitation protocol :-
 - a. Immediate quadriceps and hamstrings exercises.
 - b. Partial weight bearing with crutches / walker in first post operative week.
 - c. After first week; range of motion in arc of 0-90° (closed kinetic chain) was started.
 - d. Progression of range of motion was on tolerated basis, guided by presence and degree of pain and swelling.
 - e. Full weight bearing by 3-4 weeks as per patient tolerance.
 - f. Running and cycling after one month.
 - g. Return to sports not before six months.

Follow up

All patients were followed up for minimum of one year, thereafter 15th day for stitch removal, 15th day follow up for 2 months. After that follow up of the patient was done at 4th, 7th and 12th months.

Methods of post operative evaluation

In each follow up visit, clinical examination was performed and the parameters of Lysholm score and IKDC scale were recorded. MRI scan was done at 4-6 months follow up to document graft orientation.

In MRI scan we measured the sagittal and coronal tibial graft angles. Sagittal ACL tibial angle is the angle created between line paralleling the midlateral tibial plateau and a line demarcating the anterior most margin of the ACL, drawn on the midline sagittal image best depicting the ACL. Coronal ACL tibial angle is the angle created between a line demarcating the medial most margin of the long axis of the ACL and a line connecting the medial and lateral most margins of the tibial plateau on the same section.

In each follow up visit clinical examination was performed according to the Lysholm score, IKDC scale (subjective and objective) and knee examination test (Lachman and Pivot shift).

Lachmans test

For the test, the knee is unlocked in 20° flexion. The patient's heel rests on the couch. The examiner holds the patient's tibia, with the thumb on the tibial tubercle. The examiner's other hand is placed on the patient's thigh, a few centimetres above the patella. The hand on the tibia applies a brisk anteriorly directed force to the tibia. The quality of the endpoint at the end of the movement is described as either "firm" or "soft." Grading depends on the quality of the endpoint observed, and on whether there is a difference of 3-5 mm between the affected and the unaffected knee. A soft endpoint will make the grading "abnormal" rather than "nearly normal."

Pivot shift test

With the knee extended, the foot is lifted and the leg internally rotated, and a valgus stress is applied to the lateral side of the leg in the region of fibular neck with the opposite hand. The knee is flexed slowly while the valgus and internal rotation is maintained. With the knee extended and internally rotated, the tibia is subluxed anteriorly in ACL tear. As the knee is flexed past approximately 30 degrees the iliotibial band provides the force that reduces the lateral tibial plateau on the lateral femoral condyle.³⁵ The scoring system is conventional: + = glide; ++ = clunk; +++ = gross.

Lysholm score

The Lysholm knee score is a measure of knee function, symptoms and disability. This questionnaire is constituted of eight questions, with closed answers alternatives.⁷Recording of the Lysholm score was done preoperatively and postoperatively.

Limp (5 Points)		Pain (25 Points)	
None	5 ____	None	25 ____
slight or periodical	3 ____	Inconstant and slight during severe exertion	20 ____
Severe and constant	0 ____	Marked during severe exertion	15 ____
Support (5 Points)		Marked on or after walking more than 2 km	10 ____
None	5 ____	Marked on or after walking less than 2 km	5 ____
Stick or crutch	2 ____	constant	0 ____
Weight-bearing impossible	0 ____		
		Swelling (10 Points)	
Locking (15 points)		None	10 ____
No locking and no catching sensations	15 ____	On severe exertion	6 ____
Catching but no locking	10 ____	On ordinary exertion	2 ____
Locking	6 ____	constant	0 ____
Frequently	2 ____	Stair climbing (10 points)	
Locked joint on examination	0 ____	No impairment	10 ____

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Instability (25 points)		Slightly impaired	6__
Never giving way	25__	One step at a time	2__
Rarely gives way except for athletic or other severe exertion	20__	Impossible	0__
Gives way frequently during athletic events or severe exertion	15__		
		Squatting (5 points)	
Occasionally in daily activities	10__	No problem	5__
Often in daily activities	5__	Slightly impaired	4__
Every step	0__	Not beyond 90 degrees	2__
		Impossible	0__
Total			

Excellent: 95 – 100; Good: 84 – 94; Fair: 65 – 83; Poor: ≤ 64

IKDC scale

The IKDC rating scale consists of both a subjective questionnaire and an objective evaluation.³⁸

Subjective IKDC Score

The subjective IKDC score is a questionnaire with different subjective factors such as symptoms, sports activities, and ability to function.

SYMPTOMS*:

*Grade symptoms at the highest activity level at which you think you could function without significant symptoms, even if you are not actually performing activities at this level.

1. What is the highest level of activity that you can perform without significant knee pain?

4= Very strenuous activities like jumping or pivoting as in basketball or soccer

3= Strenuous activities like heavy physical work, skiing or tennis

2= Moderate activities like moderate physical work, running or jogging

1= Light activities like walking, housework or yard work

0=Unable to perform any of the above activities due to knee pain

2. During the past 4 weeks, or since your injury, how often have you had pain?

	10	9	8	7	6	5	4	3	2	1	0	
Never												Constant

3. If you have pain, how severe is it?

	10	9	8	7	6	5	4	3	2	1	0	
No pain												Worst pain imaginable

4. During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

4=Not at all

3=Mildly

2=Moderately

1=Very

0=Extremely

5. What is the highest level of activity you can perform without significant swelling in your knee?

4=Very strenuous activities like jumping or pivoting as in basketball or soccer

3=Strenuous activities like heavy physical work, skiing or tennis

2=Moderate activities like moderate physical work, running or jogging

1=Light activities like walking, housework, or yard work

0=Unable to perform any of the above activities due to knee swelling

6. During the past 4 weeks, or since your injury, did your knee lock or catch?

0=Yes 1=No

7. What is the highest level of activity you can perform without significant giving way in your knee?

4=Very strenuous activities like jumping or pivoting as in basketball or soccer

3=Strenuous activities like heavy physical work, skiing or tennis

2=Moderate activities like moderate physical work, running or jogging

1=Light activities like walking, housework or yard work

0=Unable to perform any of the above activities due to giving way of the knee

Sports activities:

8. What is the highest level of activity you can participate in on a regular basis?

4=Very strenuous activities like jumping or pivoting as in basketball or soccer

3=Strenuous activities like heavy physical work, skiing or tennis

2=Moderate activities like moderate physical work, running or jogging

1=Light activities like walking, housework or yard work

0=Unable to perform any of the above activities due to knee

9. How does your knee affect your ability to:

	Not difficult at all	Minimally difficult	Moderately difficult	Extremely difficult	Unable to do
	4	3	2	1	0
a. Go up stairs					
b. Go down stairs					
c. Kneel on the front of your knee					
d. Squat					
e. Sit with your knee bent					
f. Rise from a chair					
g. Run straight ahead					
h. Jump and land on your involved leg					
i. Stop and start quickly					

Function:

10. How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

CURRENT FUNCTION OF YOUR KNEE:

	10	9	8	7	6	5	4	3	2	1	0	
No limitation												Can't perform daily activity

The Subjective IKDC score was evaluated by summing the scores for the individual items and then transforming the score to a scale that ranges from 0 to 100. To calculate the final subjective IKDC score simply add the score of each item and divide by the maximum possible score which was 87.

$$\text{Subjective IKDC score} = [\text{Sum of items} / \text{Maximum possible score}] \times 100$$

The score is interpreted as a measure of function such that higher scores represent higher levels of function and lower levels of symptoms. A score of 100 is interpreted to mean no limitation with activities of daily living or sports activities and the absence of symptoms.

Objective IKDC Scale

GROUPS	A (normal)	B (nearly normal)	C (abnormal)	D (severely abnormal)
1. Effusion	None	Mild (< 25cc)	Moderate (25-60cc)	Severe (tense knee)
1. Ligament examination a. Lachman test	-1 to 2mm	3 to 5mm (1 ⁺)	6 to 10mm (2 ⁺)	>10mm (3 ⁺)
b. Pivot shift	Equal	Glide	Gross	Marked
1. Passive motion defect 2. Lack of extension 3. Lack of flexion	< 3° 0 to 5°	3 to 5° 6 to 15°	6 to 10° 16 to 25°	>10° >25°

*Group grade: The lowest grade within a group determines the group grade

RESULTS

Results of ACL reconstruction after 12-17 months of follow up were evaluated and showed excellent & good results in all patients of both groups according to Lysholm score. All patients were males; with mean age 24.76 years in TT group and 23.73 in AMP group.

Mean Lysholm score postoperatively were 94.54 and 95.13 in TT and AMP group respectively. Their difference was not statistically significant.

All patients had normal or nearly normal (grade A+B) knee except one patient TT and one in AMP group according to the post operative objective IKDC score. In the present study all patients were males; with mean age 24.76 years in TT group and 23.73 in AMP group.

The mean subjective IKDC after 12-17 months follow up were 93.54 and 94.93 in TT and AMP group respectively. Their difference was not statistically significant.

In the present study all patients were pivot shift negative in both TT and AMP group. Lachman test was negative in 77% cases in TT and 80% cases in AMP group. When patients were grouped according to associated meniscal injury; the difference in mean Lysholm and mean subjective IKDC score in TT and AMP group was not statistically significant (p value >0.05). When patients were grouped according to the time elapsed since injury; the difference of mean post op subjective IKDC score was statistically not significant (p value >0.05). In TT group most of the patients

20(66%) regained very good range of motion (0-120° or above), 6(20%) cases had 15 degree loss of terminal flexion. In AMP group most of the patients 26(86.7%) regained very good range of motion (0-120° or above), 2 (6.7%) cases had 15 degree loss of terminal flexion and 2(6.7%) case could not flex his knee beyond 90°, because he was very apprehensive and not done exercises as instructed. In present study 6(20%) cases in Transtibial group and 4 (13.3%) cases in AMP group complained of mild knee pain. No case developed superficial stitch infection. 8(27%) cases in Transibial group and 4(13.3%) cases in AMP group had sensory loss over upper medial tibia.

On post op MRI mean inclination angles of ACL in sagittal view were 53.22° in normal knees, 55.85° in TT and 53.81° in AMP group of patients. And in coronal views they were 72.77°, 77° and 70.63° in normal, TT and AMP group respectively. In both sagittal and coronal views the difference between normal and TT group, and TT vs AMP group was significant. But it was not statistically significant between normal and AMP group, meaning thereby that in AMP group of patients, the graft inclination in the notch (both sagittal and coronal sections), resembles the native ACL in contralateral normal knee, while it isn't in TT group.

DISCUSSION

The ACL injury is not only immediately problematic because of functional instability but it is the source of long term complications such as meniscus tears, failure of secondary stabilizers and early onset of osteoarthritis. Reconstruction of the ACL allows patients to resume their active life style and can delay the onset of osteoarthritis.⁴⁰

ACL reconstruction can be done either by Transtibial technique (TT) or by Anteromedial portal (AMP) technique of drilling of femoral tunnel. ACL reconstruction by TT technique has several advantages such as it is technically less demanding, shorter operative time with less chances of posterior wall of femur blow out and a long femoral tunnel length. But by this technique reconstructed ACL has improper insertion site. And the reconstructed ACL is more vertically oriented and has larger tibial graft angles which is thought to impart less rotational stability.²³

Anatomy is the basis of any orthopaedic surgery. That is why anatomic ACL reconstruction strives to restore as accurately as possible the native ACL anatomy. In anatomic ACL reconstruction, following fundamental principles are applied - restoring the insertion sites, matching the graft orientation to the native ACL size and correctly tensioning the graft.

The anatomic ACL reconstruction through AMP technique has several advantages. Accurate independent femoral tunnel placement, proper graft insertion site, replication of native anatomy and tibial graft angles which is thought to have better restoration of normal knee kinematics.²³ Another advantage is that anatomic tunnel placement exposes the graft to normal biomechanical stimuli and in this way creates a more favourable environment for healing and remodelling.⁴¹

By AMP technique it is feasible to put the graft in a more anatomical orientation but this technique of ACL reconstruction has some disadvantages like it is technically more demanding which leads to more operative time so surgical expertise is must. Other disadvantages are short femoral tunnel length and more chances of posterior femoral wall blow out.²³

AMP technique, effect of meniscus tear and duration of injury on the results..By doing MRI scan of operated and contralateral normal knee, this study also

tries to objectively show the inclination angle of the ACL graft as compared to normal ACL, in both groups of patients i.e. Transtibial and AMP.

CONCLUSION

Our study, shows a significant finding that TT technique produces a vertical and a non anatomical graft, while in AMP technique the grafted ACL resembles very closely (in a statistically significant manner) to the native ACL in contralateral knee.

This anatomical reconstruction of ACL by AMP technique, has shown better functional scores (higher mean Lysholm and IKDC scores), but the difference was lacking in statistical significance. This could be pertinent reason for this could be that either of the technique including AMP technique is not truly anatomical. ACL actually is not a single bundle ligament but is composed of two functioning bundle – anteromedial and posterolateral. So a real anatomical reconstruction would be anatomical double bundle reconstruction using the Anteromedial portal technique.

So our study doesnot show superiority of one technique over the other and it seems that there is no correlation between the inclination angle of the tunnel and functional results in ACL reconstruction techniques. It is truly on the surgeons preference to choose any of the above technique in which he is more familiar.

BIBLIOGRAPHY

1. Beynonn BD, Johnson RJ, Abate JA, Fleming BC, Nichols CE. Treatment of anterior cruciate ligament injuries, part I. Am J Sports Med 2005;33:1579-1602.
2. Duquin TR, Wind WM, Fineberg MS, Smolinski RJ, Buyea CM. Current trends in anterior cruciate ligament reconstruction. J Knee Surg 2009;22:7-12.
3. Bach BR. Arthroscopy assisted patellar tendon substitution for anterior cruciate ligament reconstruction. Am J Knee Surg 1989;2:3-20.
4. Harner CD, Fu F, Irrgang JJ, Vogrin TM. Anterior and posterior cruciate ligament reconstruction in the new millennium: a global perspective. Knee Surg Sports TraumArthrosc 2001;9:330-36.
5. Williams RJ, Hyman J, Petrigliano F, Rozental T, Wickiewicz TL. Anterior cruciate ligament reconstruction with a four strand hamstring tendon autograft. J Bone Joint Surg Am 2004;86:225-32.
6. Arnold MP, Kooloos J, van Kampen A. Single-incision technique misses the anatomical femoral anterior cruciate ligament insertion: a cadaver study. Knee Surg Sports TraumatolArthrosc 2001;9:194-9.
7. Chhabra A, Kline AJ, Nilles KM, Harner CD. Tunnel expansion after anterior cruciate ligament reconstruction with autogenous hamstrings: a comparison of the medial portal and Transtibial techniques. Arthroscopy 2006;22:1107-12.
8. Giron F, Buzzi R, Aglietti P. Femoral tunnel position in anterior cruciate ligament reconstruction using three techniques. A cadaver study. Arthroscopy 1999;15:750-56.
9. Hantes ME, Zachos VC, Liantsis A, Venouziou A, Karantanis AH, Malizos KN. Differences in graft orientation using the transtibial and anteromedial portal technique in anterior cruciate ligament reconstruction: a magnetic resonance imaging study. Knee Surg Sports TraumArthrosc 2009;17:880-86.
10. Heming JF, Rand J, Steiner ME. Anatomical limitations of Transtibial drilling in anterior cruciate ligament reconstruction. Am J Sports Med 2007;35:1708-15.
11. Loh JC, Fukuda Y, Tsuda E, Steadman RJ, Fu FH, Woo SL. Knee stability and graft function following anterior cruciate ligament reconstruction: comparison between 11 o'clock and 10 o'clock femoral tunnel placement. Arthroscopy 2003;19:297-304.
12. Paessler H, Rossis J, Mastrokalos D, Kotsovolos I. Anteromedial versus Transtibial technique for correct femoral tunnel placement during arthroscopic ACL reconstruction with hamstrings: an in vivo study. J Bone Joint Surg Br 2004;86:234-6.
13. Scopp JM, Jasper LE, Belkoff SM, Moorman CT. The effect of oblique femoral tunnel placement on rotational constraint of the knee reconstructed using patellar tendon autografts. Arthroscopy 2004;20:294-9.
14. Meredith RB, Vance KJ, Appleby D, Lubowitz JH. Outcome of single-bundle versus double-bundle reconstruction of the anterior cruciate ligament: a meta-analysis. Am J Sports Med 2008;36:1414-21.
15. Bottoni CR, Rooney RC, Harpstrite JK, Kan DM. Ensuring accurate femoral guide pin placement in anterior cruciate ligament reconstruction. Am J Orthop 1998;27:764-6.
16. Harner CD, Honkamp NJ, Ranawat AS. Anteromedial portal technique for creating the anterior cruciate ligament femoral tunnel. Arthroscopy 2008;24:113-5.
17. Howell SM, Gittins ME, Gottlieb JE, Traina SM, Zoellner TM. The relationship between the angle of the tibial tunnel in the coronal plane and loss of flexion and anterior laxity after anterior cruciate ligament reconstruction. Am J Sports Med 2001;29:567-74.

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18. Yamamoto Y, Hsu WH, Woo SL, Van Scyoc AH, Takakura Y, Debski RE. Knee stability and graft function after anterior cruciate ligament reconstruction: A comparison of a lateral and an anatomical femoral tunnel placement. *Am J Sports Med* 2004;32:1825-32.
19. Lee MC, Seong SC, Lee S, Chang CB, Park YK, Kim CH. Vertical femoral tunnel placement results in rotational knee laxity after anterior cruciate ligament reconstruction. *Arthroscopy* 2007;23:771-8.
20. Bedi A, Musahl V, Steuber V, Kendoff D, Choi D, Allen AA, et al. Transtibial versus Anteromedial portal reaming in anterior cruciate ligament reconstruction: an anatomic and biomechanical evaluation of surgical technique. *Arthroscopy* 2011;27:380-90.
21. Buchner M, Schmeer T, Schmitt H. Anterior cruciate ligament reconstruction with quadrupled semitendinosus tendon-Minimum 6 year clinical and radiological follow-up. *Knee* 2007;14:321-7.
22. Maletis GB, Cameron SL, Tengan JJ, Burchette RJ. A prospective randomized study of anterior cruciate ligament reconstruction: A comparison of patellar tendon and quadruple-strand semitendinosus/gracilis tendons fixed with bioabsorbable interference screws. *Am J Sports Med* 2007;35:384-94.
23. Bedi A, Raphael B, Maderazo A, Pavlov H, Williams RJ. Transtibial versus Anteromedial portal drilling for anterior cruciate ligament reconstruction: a cadaveric study of femoral tunnel length and obliquity. *Arthroscopy* 2010;26:342-50.
24. Tudisco C, Bisicchia S. Drilling the femoral tunnel during ACL reconstruction: Transtibial versus Anteromedial portal techniques. *Orthopedics* 2012;35:1166-72.
25. Illingworth KD, Hensler D, Working ZM, Macalena JA, Tashman S, Fu FH. A simple evaluation of anterior cruciate ligament femoral tunnel position: the inclination angle and femoral tunnel angle. *Am J Sports Med* 2011;39:2611-8.
26. Marchant BG, Noyes FR, Barber-Westin SD, Fleckenstein C. Prevalence of non-anatomical graft placement in a series of failed anterior cruciate ligament reconstructions. *Am J Sports Med* 2010;38:1987-96.
27. Bowers AL, Bedi A, Lipman JD, Potter HG, Rodeo SA, Pearle AD, et al. Comparison of anterior cruciate ligament tunnel position and graft obliquity with Transtibial and Anteromedial portal femoral tunnel reaming techniques using high-resolution magnetic resonance imaging. *Arthroscopy* 2011;27:1511-22.
28. Alentorn GE, Lajara F, Samitier G, Cugat R. The Transtibial versus the Anteromedial portal technique in the arthroscopic bone-patellar tendon-bone anterior cruciate ligament reconstruction. *Knee Surg Sports TraumatolArthrosc* 2010;18:1013-37.
29. Jepsen CF, Lundberg-Jensen AK, Faunoe P. Does the position of the femoral tunnel affect the laxity or clinical outcome of the anterior cruciate ligament-reconstructed knee? A clinical, prospective, randomized, double-blind study. *Arthroscopy* 2007;23:1326-33.
30. Zhang Q, Zhang S, Li R, Liu Y, Cao X. Comparison of two methods of femoral tunnel preparation in single-bundle anterior cruciate ligament reconstruction: a prospective randomized study. *Acta Cir Bras* 2012; 27:572-6.
31. Kim MK, Lee BC, Park JH. Anatomic single bundle anterior cruciate ligament reconstruction by the two Anteromedial portal method: the comparison of transportal and transtibial techniques. *Knee SurgRelat Res* 2011;23:213-9.
32. Mirzatooei F. Comparison of short term clinical outcomes between transtibial and transportaltransFix® femoral fixation in hamstring ACL reconstruction. *Acta OrthopTraumatolTurc* 2012;46:361-6.
33. Alentorn GE, Samitier G, Alvarez P, Steinbacher G, Cugat R. Anteromedial portal versus transtibial drilling techniques in ACL reconstruction: a blinded cross-sectional study at two- to five-year follow-up. *Int Orthop* 2010;34:747-54.
34. Mardani KM, Madadi F, Keyhani S, Karimi MM, Hashemi MK, Sahe EK. Antero-medial portal vs. transtibial techniques for drilling femoral tunnel in ACL reconstruction using 4-strand hamstring tendon: a cross-sectional study with 1-year follow-up. *Med Sci Monit* 2012;18:74-9.
35. Katz JW, Fingerhuth RJ. The diagnostic accuracy of ruptures of ACL comparing lachman test, the anterior drawer sign and the pivot shift in acute and chronic injuries. *Am J Sports Med* 1986;14:88-91.
36. Lemaire M. Old rupture of anterior cruciate ligament of the knee. *J Chir (Paris)* 1967; 93:311-0.
37. Briggs KK, Lysholm J, Tegner Y, Rodkey WG, Koehler MS, Steadman JR. The reliability, validity and responsiveness of the Lysholm score and Tegner activity scale for ACL injuries of the knee. *Am J Sports Med* 2009;37:890-97.
38. Hefti F, Muller W. Current state of evaluation of knee ligament lesions: The new IKDC knee evaluation form. *Orthopaedics* 1993; 22:351-62.
39. Dave YH Lee, Sarina Abdul Karim, Haw Chong Chang. Return to sports after anterior cruciate ligament reconstruction - a review of patients with minimum 5-year follow-up. *Ann Acad Med Singapore* 2008;37:273-8.
40. Muneta T, Koga H, Mochizuki T, Ju YJ, Hara K, Nimura A, et al. A prospective randomized study of 4-strand semitendinosus tendon anterior cruciate ligament comparing single and double bundle techniques. *Arthroscopy* 2007; 23:618-28.
41. Kato Y, Ingham SJ, Kramer S, Smolinski P, Saito A, Fu FH. Effect of tunnel position for anatomic single-bundle ACL reconstruction on knee biomechanics in a porcine model. *Knee Surg Sports TraumatolArthrosc* 2010;18:2-10.
42. Johnson RJ, Eriksson E, Haggmark T, Pope MH. Five to ten year follow-up evaluation after reconstruction of the anterior cruciate ligament. *Clin Orthop* 1984;183:122-40.
43. Specchiulli F, Laforgia, Mucci, Miotta S, Solaring. Anterior cruciate ligament reconstruction: A comparison of 2 techniques. *Clin Orthop* 1995;31:142-7.
44. Bedi A, Musahl V, O'Loughlin P, Maak T, Citak M, Dixon P, et al. A comparison of the effect of central anatomical single-bundle anterior cruciate ligament reconstruction and double-bundle anterior cruciate ligament reconstruction on pivot-shift kinematics. *Am J Sports Med* 2010;38:1788-94.
45. Shelbourne KD, Gray T. Results of anterior cruciate ligament reconstruction based on meniscus and articular cartilage status at the time of surgery: five-to fifteen-year evaluations. *Am J Sports Med* 2000;28:446-52.
46. Kjaergaard J, Faun LZ, Fauno P. Sensibility loss after ACL reconstruction with hamstring graft. *Int J Sports Med* 2008; 29:507-11.
47. Bowers AL, Bedi A, Lipman JD, Potter HG, Rodeo SA, Pearle AD, et al. Comparison of anterior cruciate ligament tunnel position and graft obliquity with Transtibial and Anteromedial portal femoral tunnel reaming techniques using high-resolution magnetic resonance imaging. *Arthroscopy* 2011;27:1511-22.
48. Girou F, Cuomo P, Edwards A, Bull AM, Amis AA, Aglietti P. Double-bundle "anatomic" anterior cruciate ligament reconstruction: A cadaveric study of tunnel positioning with a transtibial technique. *Arthroscopy* 2007;23:7-13.
49. Dargel J, Schmidt WR, Fischer S, Mader K, Koebke J, Schneider T. Femoral bone tunnel placement using the Transtibial tunnel or the Anteromedial portal in ACL reconstruction: A radiographic evaluation. *Knee Surg Sports TraumatolArthrosc* 2009;17:220-27.
50. Ahn JH, Lee SH, Yoo JC, Ha HC. Measurement of the graft angles for the anterior cruciate ligament reconstruction with Transtibial technique using post-operative magnetic resonance imaging in comparative study. *Knee Surg Sports TraumatolArthrosc* 2007;15:1293-1300.
51. Stanford FC, Kendoff D, Warren RF, Pearle AD. Native anterior cruciate ligament obliquity versus anterior cruciate ligament graft obliquity: An observational study using navigated measurements. *Am J Sports Med* 2009;37:114-9.
52. Gavrilidis I, Moutsis EK, Pakos EE, Georgoulis AD, Mitsionis G, Xenakis TA. Transtibial versus Anteromedial portal drilling of the femoral tunnel in ACL reconstruction: A cadaveric study. *Knee*2008;15:364-7.