Transtibial versus transportal techniques for anterior cruciate ligament (ACL) reconstruction: a clinical study of military patients

Abstract

Background: Reconstruction of anterior cruciate ligament (ACL) injuries using arthroscopic single-bundle method is a common procedure with a success rate of 83% to 95%. Some studies have shown that the transportal method for drilling the femoral tunnel results in a higher success rate than transtibial approach. Other studies show equal rate of success in both approaches. The aim of this study was to investigate which one of the two methods has nearest biomechanics to the original ACL and better outcome for patients.

Methods: This study was a cross sectional (prospective) follow up. The clinical results of the ACL reconstruction in military patients with pure ACL rupture were evaluated and followed up. In one group 26 ACL reconstruction was done using the transportal (TP) technique and in the other group 20 ligaments were reconstructed using the transtibial (TT) method.

Results: At the final follow-up, eight patients (40%) in the TT group and five cases (19.23%) in the TP group had a positive pivot test. Three patients (15%) in the TT group and nine patients (34.61%) in the TP group had a positive Lachman test. There was no statistically significant difference in the pivot test (P=0.06) and Lachman test (P=0.35) between the two groups. Mean Lysholm scores were 92.8 ± 2.5 and 93.2 ± 2.8 in the TT and the TP groups, respectively (P = 0.51). The averages of the graft angle were 68.7 ± 2.9 and 43.6 ± 4.1 in TT and the TP groups, respectively (p = 0.001). Correlation between the graft angle and the patients' concurrence (Lysholm score) after surgery (P>0.05) and correlation between the graft angle and the instability testes (P>0.05) observed between the two groups.

Conclusion: No significant clinical difference was found between the two techniques.

No significant clinical found between two techniques and therefore, both of them can create good results.

Key words: Knee, Anterior Cruciate Ligament (ACL), Anterior Cruciate Ligament Reconstruction, Arthroscopy, Anterior cruciate ligament injury

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Introduction

The knee ligament damage is increasing in recent years due to the expansion of professional sporting activities. The most common of these injuries is rupture of anterior cruciate ligament (ACL). If the ruptured ACL is not treated, it may lead to knee osteoarthritis and loss of patients' ability to exercise and perform the military duties and activities. The exact incidence of ACL rupture is unknown. In the United States, in each year, near 200000 cases of ACL ruptures occur and near 100000 surgeries for ACL reconstruction are done.[1-4]

ACL is the first important ligament to limit the tibia's movement to the anterior side. As a secondary function, ACL stabilizes the rotational and the varus-valgus movements of the tibia at the full extension position.[1, 5-7]

Two major bundle of ACL are the anteromedial (AM) and posterolateral (PL) bundles. While the knee extends, the AM is moderately lax and prevents the anterior-posterior movements of the knee. While in knee

flexion, the PL is relax and gives rotational stability to the knee.[1,4,5,8] In young patients and military officers, ACL reconstruction by surgery is important to prevent instability secondary to ACL deficiency and to prevent the knee instability, meniscus tear and chondral lesions.[9-10]

Various surgical methods and different grafts have been used for ACL reconstruction.[1] The two main methods for ACL reconstruction are open and arthroscopic surgery methods. Open and arthroscopic surgery method is classified into several subgroups based on the selected graft, the manner to create the tunnel in tibia and femur, and the method of graft fixation.[1-2, 11] The two methods differ in terms of how they are performed, the place of the created tunnels, and the graft position. They may have different outcomes for patients based on the closeness of the anatomy and biomechanics of the repaired ligament to the primary ACL.[1-2, 11]

Nowadays, the arthroscopic reconstruction methods are increasingly used since they are fast and less invasive, result in faster recovery and have lower costs. Among them, transportal (TP) and transtibial (TT) are two standard methods that are widely used by orthopedic surgeons.[7, 12] Recent studies have shown that the two-bundle method for ACL reconstruction, compared to single-bundle method, is stronger for knee-rotation stability.[13, 14] Suitable places of femoral and tibial tunnels and proper fixation of a graft are essential factors to obtain good outcome for the ligament reconstruction.[4, 15]

ACL reconstruction can be performed through TT technique.[1, 2, 11] Drilling of femoral tunnel by TT technique is extensively utilized in ACL reconstruction. Some reports suggest that using the TT technique may place the graft in a non-anatomical location resulting in instability. Using an anteromedial portal or TP technique to drill the femoral tunnel may place the graft in a more anatomical location, leading to better knee stability .[1-2, 11] The details of ACL reconstruction by TT and TP techniques ,have been explained in orthopaedic literature.[6, 16-17]

Considering the high prevalence of ACL injuries, in young and active military personnel, there is often a need for surgical reconstruction of ACL. Hence, finding the best method with the best post-surgery knee function, less complications and lower costs is crucial. The aim of this study was to determine the clinical results of arthroscopic transtibial and transportal techniques for ACL reconstruction.

Methods

This study was a randomized and double-blinded clinical trial. The ethics committee of Baqiyatallah University of Medical Sciences, Tehran, Iran provided ethics approval. The patients referred to the orthopedic clinic of Baqiyatallah Hospital, who were diagnosed with ACL rupture, were randomly selected for ACL reconstruction using either TT or TP methods. The patient data remained confidential and written informed consent was obtained from the patients. The study was approved by the ethical committee of Baqiyatallah University of Medical Sciences (code: IR.BMSU.REC.1397.003).

A five -parts form was prepared for each patient. The first part included the pre-operation information. The second to fifth parts included post-operation information in four stages after surgery.

Data including range of the joint movement, pain, ACL examinations were recorded per visit. Moreover, the degree of the patients' satisfaction (based on the score of Lysholm table) at the end of 6 months after the ACL surgery (through transtibial or transportal techniques) was compared. Lysholm table is a standard and global table to calculate the knee function score.

In this study, in the TP group, the anatomic site of the posteromedial bundle was used to create the tunnel. The mentioned site is located at the rupture stamp area, at the posterior of "resident ridge" and above the articular surface. In order to have a consistent

tunnel placement, the mentioned anatomic markers were used to create the tunnel in all patients of the TP group. Moreover, considering the length of the obtained hamstring autograft and the anatomical characteristics of each patient, it was attempted to create a femoral canal with a depth between 20 to 25 mm in all patients.

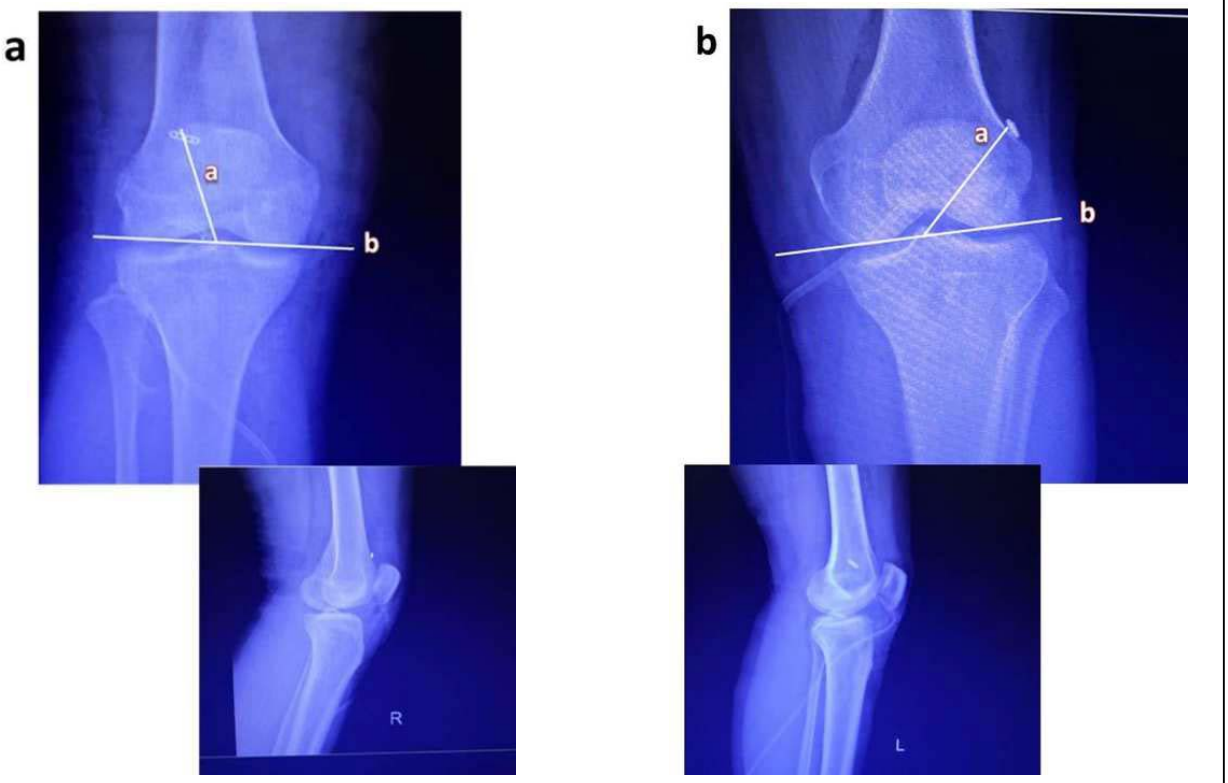
The Pivot-shift, Lachman, anterior drawer test (ADT), knee range of motion (ROM), infection rate, the amount of knee instability after the ACL surgery (using TT or TP techniques) were also compared.

True anteroposterior radiograph of the knee was used to measure the alpha angle (the angle between the femoral tunnel and joint line) for each patient. To measure alpha angle, a tangent line at distal end of the femoral condyle is drawn (line "b" in the Figure 1 a and b). Then, the entrance site of the reamer to the lateral condyle of femur and the endobutton site are connected via a line (line "a" in the Figure 1 a and b). The angle of the intersection of the two lines (lines a and b) is measured as alpha angle and is recorded in the patients' data sheets.

Data analysis was done using SPSS software. The t-test and Chi2 test were performed for data analysis.

Inclusion criteria were as follow: using TT or TP techniques for ACL reconstruction, using the "bio-interference" screw for tibial fixation and "endobutton" for femoral fixation, using hamstring autografts of gracilis and semitendinosus tendons, age less than 40 years, being a male, positive examination for ACL rupture, MRI positive results for ACL rupture, MRI negative results for meniscus rupture (grade 2 or higher) and PCL rupture, negative results of knee radiography, evaluating the varus-valgus alignment, negative results of knee radiography assessing moderate to severe osteoarthritis and absence of the heart disease.

Figure 1. Radiographic images of the knee after ACL reconstruction using transtibial (a) or transportal (b) methods.



The patients were examined one, three and six months after operation,. In order to refine the results, the same rehabilitation protocol was used for all patients. The postoperative data were recorded in the pre-prepared form for each patient. All patients were followed up by an orthopedic specialist in a double-blinded manner to minimize bias in the study. The patients were double-blindly examined before and after the surgery. Obtained data from each patient was recorded into a data sheet. In order to have significance results, the surgeons were not involve in the follow-up the patients and data collection.

Exclusion criteria were as follow: Age more than 40 years, damaged meniscus (grade 2 or higher), simultaneous damage of the chondral or osteochondral, using of non-endobutton methods to fix grafts, non-primary surgery for ACL reconstruction, using allografts instead of autograft, non-TP and non-TT techniques of surgery, infection, using hamstring single-bundle grafts, failure to refer patients for follow-up at determined intervals, failure to perform an exact rehabilitation.

Results

The 53 patients were included into the study and 30 subjects were placed in the TP and 23 in the TT group. 6 cases were excluded from the study: 2 due to post -operative infection and 4 due to meniscus injury which was diagnosed during surgery.

Finally, 26 and 20 patients were remained in the TP and TT groups, respectively. The mean age of the patients in the TP and TT groups were 27.7 and 25.45 (years), respectively, with no statistically significant difference between the two groups (Table 1).

Table 1. Demographic data of the patients

Surgery method	Frequency	Mean age	Standard deviation
Transportal	26	27.7	3.8
Transtibial	20	25.4	5.7

The mean of VAS pain before and after arthroscopic TT and TP surgeries were determined and compared. No significant difference was observed in the VAS score in the TP and TT groups at any time intervals. The level of pain in the two TT and TP groups was the same and the technique did not affect the pain severity. The VAS score of the TP group was lower than TT group after 6 month of the operation. However, P value (0.08) was not significant between the two groups. (Table 2)

The range of motion (ROM) values in both methods were similar at different time intervals. There was no significant difference between the ROM between the two techniques.

Table 2. Determination and comparison the VAS pain before and after the surgery.

VAS pain (Mean) / Surgery method	Before the surgery	One month after the surgery	Three month after the surgery	Six month after the surgery
Transportal	0.96	3.1	0.8	0.23
Transtibial	1.6	3.3	0.9	0.5
P- Value	0.17	0.49	0.59	0.08

Table 3. Comparison of ROM means before and after the surgery.

ROM mean / Surgery method	Before the surgery	One month after the surgery	Three month after the surgery	Six month after the surgery
Transportal	144.2±3.6	106.3±11.9	140.9±6.4	145
Transtibial	143.50.±4.005	109.2±14.8	137.5.±9.9	144.25±2.44
P- Value	0.43	0.61	0.28	0.1

Before the surgery, the mean ROM in the TT and TP groups were 143.5 and 144.2, respectively (P-value = 0.43). One month after the operation, the mean of ROM were 109.2 and 106.3 in the TT and TP groups respectively without any significant difference (P-value = 0.61). Three months after the operation, the mean ROM in the TP and TT groups were respectively 140.9 and 137.5 and had no significant difference (P-Value = 0.28). Six month after the operation, the mean of ROM in the TP and TT groups were respectively 145 and 144.25 and had no significant difference (P-Value = 0.1)(Table 3).

At different time intervals post surgery using TT or TP methods, there was no significant difference in the Pivot-shift results. (Table 4).Before surgery, Pivot-shift test was positive in 26 subjects of the TP group and 19 subjects of the TT group. At the end of the study, the test was positive in the 5 cases of the TP group and in the 8 people of the TT group. There was no significant difference between the two groups in the results of the Pivot-shift test (P-value = 0.06). (Table 4) One month, 3 months, and 6 months after the operation, there was no significant difference between the two groups in terms of Pivot-shift results (P-value = 0.07, 0.06 ,and = 0.06 respectively) (Table 4).

There was no significant difference in the Lachman test results between the two groups with different surgical techniques and in different time intervals.

Before the operation, the Lachman test was positive in 9 patients of TP group and in 3 patients of TT group. There was no significant difference between the two groups (P value> 0.05). One month after the operation, the Lachman test was positive in 25 patients (54.3%) of TP group and in 19 patients (41.3 %) of the TT group. There was no significant difference between the two groups (P-Value = 0.2). Three months after the operation, the Lachman test was negative in 21 patients (45.7%) of TP group and in 17 patients (37.0 %) of the TT group. There was no significant difference between the two groups (P value=0.28). Six month after the surgery, the Lachman test was negative in 17 patients (37.0%) of TP group and in 17 patients (37.0 %) of the TT group. There was no significant difference between the two groups (P value=0.35). (Table 5)

Table 4. Results of the Pivot-shift test before and after the surgery (as percentages of the TP and TT groups)

Pivot-shift test / Surgery method		Before the surgery		One month after the surgery		Three month after the surgery		Six month after the surgery	
		Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)
Transportal	Positive	26	100%	0	0%	2	7.69%	5	19.23%
	Negative	0	0%	26	100%	24	92.31%	21	80.77%
Transtibial	Positive	19	95%	3	15%	9	45%	8	40%
	Negative	1	5%	17	85%	11	55%	12	60%
P- Value		0.4		0.07		0.06		0.06	

able 5. Results of the Lachman test before and after the surgery (as percentages of the TP and TT groups).

Lachman test / Surgery method		Before the surgery		One month after the surgery		Three month after the surgery		Six month after the surgery	
		Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)
Transportal	Positive	25	96.16%	1	3.84%	5	19.23%	9	34.61%
	Negative	1	3.84%	25	96.16%	21	80.77%	17	65.39%
Transtibiall	Positive	19	95%	1	5%	3	15%	3	15%
	Negative	1	5%	19	95%	17	85%	17	85%
P- Value		0.2		0.2		0.28		0.35	

Table 6. Results of the ADT test before and after the surgery (as percentages of the TP and TT groups)

ADT test / Surgery method		Before the surgery		One month after the surgery		Three month after the surgery		Six month after the surgery	
		Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)	Number	Frequency (Percentage)
Transportal	0	0	0%	21	80.76%	9	34.61%	5	19.23%
	1+	1	3.84%	5	19.23%	17	65.38%	21	80.76%
	2+	4	15.38%	-	-	-	-	-	-
	3+	21	80.76%	-	-	-	-	-	-
Transtibial	0	-	-	14	70%	6	30%	8	40%
	1+	1	5%	6	30%	14	70%	12	60%
	2+	6	30%	-	-	-	-	-	-
	3+	13	65%	-	-	-	-	-	-
P- Value		0.7		0.4		0.1		0.71	

Results of the ADT test before and after ACL reconstruction

There was no significant difference in the results of the ADT test between the two group, and both groups were similar (Table 6).

Before the operation, in the TP group, 21 patients had the ADT score 3+, four patients had the ADT score 2+and one patient had the ADT score 1+. In the TT group, 13 patients had the ADT score 3+, 6 patients had the ADT score2 +, and two patients had the ADT score +1. One month after the operation, in the TP group, five people had the ADT score +1. In the TT group, 6 patients had ADT score + 1. Overall, there was no significant difference in ADT results between the two groups (P-value = 0.4).

Three months after the operation, in the TP group, 17 subjects (37%) had the ADT score +1. In the TT group, 14 cases (30.4%) had the score +1. There was no significant difference in ADT between the two groups (P-Value = 0.1).

Six months after the operation, 21 subjects (45.7%) in the TP group, and 12 subjects (26.1%) in the TT group had ADT score +1. There was no significant difference in ADT between the two groups (P-Value = 0.71)

Measurement of the angle between the graft region and joint line (alpha angle) using true anteroposterior knee radiograph were not similar between both surgical techniques. There was a significant difference between the TT and TP groups at the measured angle. The mean of the measured angles in the TP and TT groups were 43.6° and 68.7°, respectively(P-value = 0.001).

Lysholm score and patients' satisfaction after the surgery in the TT group was 92.8 (good) and in the TP group was 93.2 (good). There was no significant difference in postoperative satisfaction between the two groups (p = 0.51)

There was a weak correlation between the Lysholm score (LS) and the measured angle between the TT and TP groups, but this correlation was not statistically significant. The P value for the TP group was 0.204. In the TT group P value was 0.420.

Results of the correlation analysis showed that there was no significant correlation between the alpha angle and Pivot-shift, Lachman and ADT tests between the TP and TT groups (p> 0.05).

Discussion

As far as we know, there is no published article comparing the patients' satisfaction after using the arthroscopic TP or TT methods for ACL reconstruction. In this study, the patients' satisfaction was investigated. We also attempted to investigate the relationship between the alpha angle and the knee stability between the TT and TP groups.

Considering our results, at the end of the sixth month, there were differences for each group in the Lachman, Pivot-shift, and ADT tests. For example, at the end of the study, the Pivot-shift test of the TT group was about 6% higher than the TP group. However, this difference was not statistically significant. The results of the Lachman and ADT tests for the TP group were respectively 18% and 20% higher than the TT group. However, these differences were not statistically significant.

The calculated Lysholm scores for the two groups were good without any significantly difference.

Considering to the Lachman and ADT results, TT method may provide a little more stability in anterior-posterior extension and translation of the knee since the graft is located at the most vertically anteromedial aspect of the area. However, this was not statistically significant in the current and other studies .[2, 18]

Compared to TT method, TP method may also create a little more stability in the knee flexion and rotation, since the graft is located at the most horizontally posterolateral aspect of the area. However, this was not statistically significant in our study and other reports.[2, 18]

In a study on the biomechanical aspects of the two TP and TT methods for the ACL reconstruction, Riboh et al. did not find any significant difference between the two methods [2] confirming the results of this study.

Mirzatolooei et al. studied the two mentioned methods of ACL reconstruction. They found that the TP method had significantly better clinical results than TT technique.[11] Their results are in contrast to our findings that showed no significant differences in terms of clinical findings between the TT and TP groups.

In 2015, Chalmers et al. conducted a systematic review on biomechanical studies and clinical outcomes of both TT and TP methods. Some studies reported better clinical outcomes of the TP method, while other studies did not mention any differences between the two methods.[19]

There was no study to report better clinical outcomes of the TT method compared to the TP method. In sum, it was indicated that ACL reconstruction using TP could possibly improve the clinical and biomechanical outcomes, but the TT method could also have similar results.[19] Results of our study showed that there is no clear difference in the outcome of both TT and TP techniques.

Cury and colleagues compared TT and TP surgery methods performed for 90 patients (from 2009 to 2011). There were no significant differences in the results of Pivot-shift, ADT, giving way and ROM. Postoperative satisfaction was the same in both TT and TP groups. The mentioned results are in accordance with the results of our study.[3]

In 2011, in a study, two TP and TT surgery techniques for ACL reconstruction were compared. There was no difference in the outcomes of the two techniques of the surgery. The percentage of the negative Lachman test was 80% to 85% in both groups. The percentage of the negative Pivot-shift test was similar in both groups (between 75% and 80%).[12] In our study, the Lachman and Pivot-shift tests were not significantly different in both groups.

In a meta-analysis, Riboh and colleagues showed that there was no significant clinically difference between these two surgical techniques.[2]

Conclusion

Considering the results of this study, same patients' satisfaction, the same results of Pivot-shift, Lachman and ADT tests after both surgical methods, with no significant correlation between the alpha angle and the clinical tests were observed. It seems that both mentioned techniques may have the same outcome as well as clinical satisfaction for the patients.

Abbreviations

TT: transtibial; TP: transportal; ACL: Anterior cruciate ligament; AM: the anteromedial; PL:

posterolateral; ADT: anterior drawer test; ROM: knee range of motion; LS: Lysholm score; VAS: visual analog scale for pain

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