Conventional trans-tibial versus anatomic medial portal technique for femoral tunnel preparation in anterior cruciate ligament reconstruction; comparison of clinical outcomes

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Abstract

Aim: Method of femoral tunnel preparation in anterior cruciate ligament (ACL) reconstruction is controversial. In this study, we aimed to determine if there is any difference between the clinical outcomes of two most commonly used drilling techniques; which are conventional trans-tibial (TT) drilling of femoral tunnel and anatomic preparation of femoral tunnel through medial portal (MP), in patients who underwent ACL reconstruction.

Material and Methods: One hundred and twenty-nine male patients who underwent ACL reconstruction between 2010 and 2012 were included in the study. Single-bundle reconstruction with a quadrupled autologous hamstring graft was performed in all patients. Femoral tunnel was drilled by the conventional TT technique in 58 patients (Group 1) and through MP in 71 patients (Group 2). Functional evaluation was made about 12 months postoperatively. Functional evaluation included the Lysholm Knee Scale, International Knee Documentation Committee Scoring (IKDC), and Tegner Activity Level Scale were used for assessment. The anteroposterior stability was assessed using KT-1000 arthrometer and the pivot shift test for assessment of rotational stability.

Results: Interval between injury and surgery was similar between two groups (median 8.0 vs. 10 weeks, for TT vs. MP, respectively). One hundred twenty-five patients attending the final follow-up examination (96.8%) were evaluated. The results of Lysholm, IKDC, and Tegner scales were found to be similar. According to KT-1000 arthrometer results, MP group revealed slightly better results than TT group. Regarding pivot shift, MP group showed significantly better stability than TT group ($P < 0.001$).

Conclusion: The anatomical single-bundle femoral tunnel preparation in the reconstruction of the ACL seems as effective as the conventional technique in terms of functional stability in the midterm. The technique better preserved the rotational stability in non-professional athletes.

Key words: Anterior cruciate ligament reconstruction, arthroscopy, medial portal, trans-tibial

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Introduction

Single-bundle anterior cruciate ligament (ACL) reconstruction became one of the most frequently performed surgical procedures of sports medicine worldwide.[1] In single-bundle ACL reconstruction, the aim is to create a near anatomic femoral tunnel preparation mimicking all bundles and components of native ACL. Numerous methods were defined for femoral tunnel preparation in single-bundle ACL reconstruction. The importance of creating a more anatomically oriented (distal and posterior) oblique tunnel has gained interest owing to the increased number biomechanical and radiographic studies published.[2-4] Conventional trans-tibial (TT) drilling facilitates femoral tunnel preparation through drilled tibial tunnel with flexion of the knee approximately 80–90°. This technique facilitates a creation of a standard, long enough, and safe femoral tunnel, whereas creation of an anatomic (low-posterior) tunnel by this technique is challenging and usually not possible. In late 2000's by the introduction of double-bundle ACL reconstruction, the importance of anatomic low-posterior placement of femoral tunnel was emphasized. This could be achieved by utilization of medial portal (MP) for the introduction of the guidewire. Anatomical MP (AMP) femoral tunnel preparation not only better restores the isometry of ACL, but also facilitates more oblique oriented graft and achieve a better rotatory and anteroposterior stability. Potential drawbacks of AMP drilling are an iatrogenic injury to medial femoral condyle and creation of the critically-short femoral tunnel. There are few studies comparing different femoral preparation techniques, reporting similar outcomes.[5]

In this retrospective study, we aimed to compare the results of ACL reconstructed patients operated with either conventional TT technique or anatomical MP technique for femoral tunnel preparation.

Materials and Methods

Following approval of the Local Ethics Committee, data of ACL reconstruction cases of the institute, operated between years 2010 and 2012 were reviewed. The inclusion criterion was; isolated ACL tear cases undergoing single-bundle, double autologous hamstring reconstruction. Exclusion criteria were defined as; bilateral cases, multiple ligamentous injuries of the knee, and those who need any meniscal or cartilage repair. None of the patients were professional athletes.

Both conventional TT technique and anatomical MP technique have been used in ACL reconstruction procedures of institute. In earlier cases of the database, TT technique was used. As anatomic MP technique gained popularity, more cases were operated using this technique. The decision of the technique to be used is totally based on surgeon's preference. Therefore, no method of sampling can be mentioned.

The patients were divided into two groups based on whether they received the conventional TT technique (Group 1, $n = 58$) or the anatomic MP technique (Group 2, $n = 72$) for ACL reconstruction. All of the operations were performed by the same surgical team with participation of two surgeons.

Operative procedure

All operations were performed under spinal/epidural anesthesia. First, diagnostic arthroscopy was performed to look for accompanying meniscal and chondral lesions. After confirmation of ACL tear, hamstring autograft was harvested through a 3–4 cm incision medial to the tibial tuberosity. The graft was prepared by quadrupling the tendons, and a no. 2 polyester suture was passed through each loop. Graft fixation was achieved using ToggleLoc™ Femoral Fixation Device with ZipLoop™ Technology at the femoral site and using bioabsorbable interference screws and staples at the tibial site.

In Group 1 (conventional TT femoral tunnel), after debridement of the remnants of the torn ACL, the tibial tunnel was prepared at routine fashion on the tibial footprint. Then, the knee was placed in 90° of flexion [Figure 1a]. With use of the femoral offset guide, the femoral guidewire was introduced aiming toward 10:30 or 1:30 O'clock position, followed by appropriate reaming. After passing the graft, fixation was achieved using ZipLoop™ technology with a minimum 2.5 mm of its femoral end placed within the tunnel. Then, the knee was placed in 20° flexion, and the tibial fixation was performed after appropriate tensioning of the autograft.

In Group 2 (anteromedial portal tunnel), the tibial tunnel was created in the same fashion as described for TT technique. Then, an anteromedial portal was

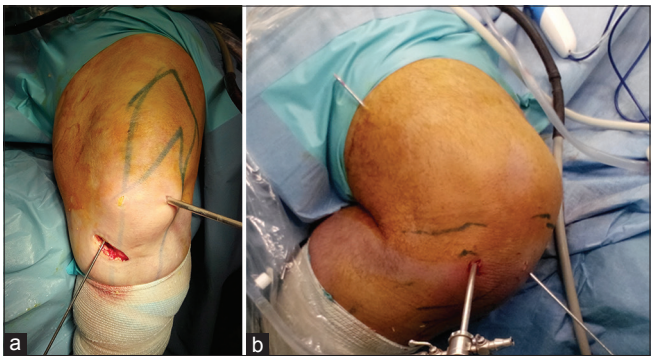

Figure 1: (a) Position in transtibial technique (b) position in medial portal technique

Table 1: Outcomes comparing two techniques

	Preoperative conventional (n=58)	Postoperative conventional (n=58)	Preoperative anatomic (n=71)	Postoperative anatomic (n=71)
Lysholm score	67.8±11.7	89.9±7.6	69.5±12.4	90.4±4.7
IKDC score				
A	0	48 (82.7)	0	62 (87.3)
B	0	9 (15.6)	0	9 (12.7)
C	43 (74.1)	1 (1.7)	60 (84.5)	0
D	15 (25.9)		11 (15.5)	0
Pivot shift				
0	0	30 (51.7)	0	51 (71.8)
1	7 (12.1)	23 (39.7)	9 (12.7)	18 (25.4)
2	49 (84.4)	5 (8.6)	59 (83.1)	2 (2.8)
3	2 (3.5)	0	3 (4.2)	0
Tegner score	3.1 (1-7)	5.7 (3-9)	2.9 (1-7)	6.1 (4-9)
KT-1000	7.5±3.2	2.1±0.8	8.2±3.1	1.9±0.9

IKDC=International Knee Documentation Committee

opened 1.5 cm medial to the patellar tendon and above to the anterior horn of the medial meniscus.[6,7] To reach anaomical low-posterior placement, the knee was flexed at least 110°. The femoral guide was aimed at the center (middle point of both bundles) of the femoral footprint [Figure 1b]. The guidewire was drilled, and the tunnel was reamed according to the measured graft size and tunnel length for each individual patient. Remainder of the procedure and fixation devices was same as the conventional technique.

Follow-up and assessment

The active and passive knee range-of-motion exercises were started on the 1st day after the operation as drains were removed. The patients were encouraged for full weight bearing as tolerated during hospitalization. No method of splint or brace was used. All patients underwent a supervised physiotherapy program, starting 2 weeks after the operation. The patients were invited for assessment at the end of the 2nd week and 1 year after surgery. The assessments were performed by an independent and blinded observer to who did not take part in the operation.

Functional evaluation consisted of the Lysholm Knee Scale, International Knee Documentation Committee Scoring (IKDC), and Tegner Activity Level Scale. The anteroposterior stability was assessed using KT-1000 arthrometer and the pivot shift test was used for assessment of rotational stability.

Statistical analysis

All statistical analyses were performed using SPSS (SPSS version 16.0 Inc. Chicago, IL. USA) packaged software. Continuous variables were defined by the mean ± standard deviations. Parametric data were compared using independent sample *t*-test and nonparametric data were compared using Mann–Whitney test. A $P < 0.05$ was considered to be statistically significant.

Results

The two groups were similar in terms of age (27.2 ± 9.3; range, 16–38 years vs. 28.3 ± 8.8; range 18–39 years for Groups 1 and 2, respectively). The reconstruction was performed 8 weeks (range 2–18) and 10 weeks (range 2–21) after the traumatic injury occurred in Groups 1 and 2, respectively. None of the patients had major complications involving neurologic and vascular systems. One patient in Group 1 and two patients in Group 2 had skin infections, which improved with wound care and antibiotics. The mean time of surgery was 41 ± 8 min (range 30–55) in Group 1 and 49 ± 12 min (range 30–70) in Group 2. During follow-up, one patient had re-ruptured due to a vehicle accident.

Preoperative versus postoperative Lysholm Knee Scale score showed statistically significant improvement. The differences in Tegner activity scores and KT-1000 arthrometer scores were also significant between the preoperative and postoperative period ($P < 0.001$ for all paired measurements).

Both groups were similar in terms of Lysholm Knee Scale, IKDC, and Tegner activity scores. The KT-1000 arthrometer revealed slightly less anterior sliding in anatomic group than in conventional group despite insignificant. In the pivot shift testing, the anatomic group showed significantly better rotational stability than conventional group ($P < 0.001$) [Table 1].

Discussion

The use of the AMP technique has several advantages for femoral tunnel preparation and allows more anatomic placement of the graft during single-bundle ACL reconstruction. Anatomic placement of the single-bundle

ACL graft was shown to be associated with improved knee kinematics and stability, not only due to the placement of optimal ligamentous insertions but also due to the optimal obliquity of tunnels for improved tension and integrity.[2-4] Several studies reported that free-hand drilling of the femoral tunnel through AMP provided a more anatomical positioning of the graft.[8,9] Bowers *et al*. demonstrated that AMP technique, compared to TT, better preserved the sagittal obliquity of the graft.[10] Although the clinical relevance of creating an anatomic ACL reconstruction has not been well implicated in clinical settings, authors of some cadaveric studies concluded that the near-normal ACL functions may be achieved by creating anatomic femoral tunnels.[3,11] In addition, the AMP technique was showed to cause lower stress on the graft at the edge of the tunnel which may be accepted as an advantage in the prevention of graft impingement on long-term.[12]

Although various data regarding the effectiveness of AMP technique is available, significant scarcity is present about the studies comparing the AMP technique with conventional TT technique.[13,14] In a meta-analysis, comparing the outcomes of the AMP technique (eight studies, 257 patients) with those of the TT technique (13 studies, 602 patients), the patients undergoing the AMP technique had more satisfactory clinical outcomes at 1–2 year follow-up.[15] Another meta-analysis of 15 studies showed that IKDC scores or Tegner scores were similar between TT technique and free-hand drilling techniques and regression analysis of 22 studies also showed that failure rates and objective IKDC scores were also similar between two techniques.[16] Concordant with the recent data, we achieved similar 1-year clinical outcomes using both techniques, except for the rotational instability in pivot shift test was better in the AMP group. The great majority of our patients had a normal or almost normal subjective outcomes in IKDC score at follow-up. Our results revealed that the anteromedial portal technique better preserves anterior laxity after ACL reconstruction.

We compared the early and the 1-year clinical outcomes of two different techniques for single-bundle autologous hamstring ACL reconstruction. Our experiences regarding the use of AMP femoral drilling increased in time. In our series, we did not experience any major technical issues that might be contributed to learning curve. We think that the learning curve for anterior MP drilling is not so much steep, despite its own important considerations and potential complications that had been reported.[7]

The increasing trend toward the use of AMP technique over TT technique has been well documented in the USA; the most recent survey in 2013 showed that 68% of the surgeons have shifted toward using freehand AMP drilling techniques whereas 90% used TT method in 2006.[17-19] The trend toward using AMP technique has emerged from the concerns of producing an anatomical graft orientation. However, TT technique also has procedural tips that can lead the creation of a well oriented ACL graft and improvement in knee stability.[20] Piasecki *et al*.[21] achieved success with TT technique by creating anatomical tunnels in an experimental study. These authors pointed out the importance of the tibial tunnel starting position to achieve better results. In contrast to the idea that femoral footprint should necessarily be hit when drilling through the femoral tunnel, Bowers *et al*.[10] showed in a clinical study that TT technique could capture the native femoral footprint, but the anatomy could be better restored using AMP technique. Rue *et al*.[22] reported that the creation of an obliquely oriented single-bundle TT tunnel is achievable if the tibial tunnel is angled approximately 60° from the proximal tibial surface at 10:20 O'clock position. These results were consistent with those of Simmons *et al*.[23] who showed that tibial tunnel orientation was in close relationship with ACL graft tension. Based on our results, the transition from TT technique to AMP technique should not be considered mandatory. We observed comparable results with both techniques. Regardless of the data reported, the controversy seems to continue because both techniques have its own technical tips and issues that should be taken into consideration.

The common conclusion in literature was that the TT technique has no superiority over the AMP technique, but the opposite may be justified up to a point. The most favorable results regarding the superiority of AMP technique was reported by Alentorn-Geli *et al*.[24] Using bone-patellar tendon-bone grafts in both techniques, the authors obtained better clinical results with AMP technique in terms of early return to normal activities, to jogging, to play, and to training. However, Kim *et al*.[25] found no difference between two techniques in regard to Lachman test and KT-2000 arthrometer. Furthermore, two techniques achieved similar benefit in clinical results; similar to our results, better pivot-shift performance in AMP group was the only difference found between two techniques. In a more recent study, Mardani-Kivi *et al*.[26] presented similar results to that of Alentorn-Geli *et al*.[24] in terms of early return to physical activity.

To the best of our knowledge, there have been only a few prospective randomized clinical studies which compared the TT technique with AMP technique. Hussein *et al*.[13] randomized patients into three different arms; anatomic double-bundle, anatomic single-bundle, and conventional single-bundle reconstruction. In a smaller series, Zhang *et al*.[14] randomized the patients into TT and AMP technique. Both studies reported similar conclusions that AMP technique was not associated with better clinical outcomes at last follow-up. Similar to our study, Hussein *et al*.[13] concluded that AMP technique was associated with better rotational and anteroposterior stability whereas

the study of Zhang *et al*.[14] did not include the pivot-shift testing as an outcome measure despite being more identical to the present study with regard to the population, the other follow-up measures and the autologous graft used for reconstruction. In a more recent study by Youm *et al*. reported similar outcomes by TT and AMP technique. The only significant difference between two methods was coronal obliquity of the tunnel which was more horizontal in AMP group as expected.[5]

There are some limitations of our study. A prospective randomized design would give a much more high level of information. A longer follow-up would also be more valuable to observe the results of ligament function after ligamentization period of autograft.

Conclusion

We have obtained similar clinical and functional results as the previous studies reported recently. Although AMP technique exhibited better rotational knee stability than TT technique, this difference in stability did not translate to functional outcomes. Because of a similar clinical outcome obtained by both techniques, the surgeon should not hesitate to use conventional TT technique.

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Conflicts of interest
There are no conflicts of interest.

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