



Anatomical single bundle anterior cruciate ligament reconstruction with three portal technique

Üçlü portal teknik ile anatomik tek bant ön çapraz bağ rekonstrüksiyonu

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Abstract

Objective: Anatomic reconstruction of anterior cruciate ligament is becoming more important as the knee anatomy and biomechanics are being understood much more. In order to place femoral tunnel at its original point, it should be drilled from another porta which is more medial instead of from tibial tunnel. In this article we aimed to present clinical and radiologic results of ACL reconstructions that we placed femoral tunnel from a third anteromedial portal.

Material and methods: The study included 43 patients (four female, 39 males; mean age 29.3 years; range 18 to 42) with ACL injury. ACL reconstruction was performed to all of the patients with the three portal anatomic single bundle technique using hamstring autograft. Preoperative and postoperative clinical evaluation was done by Lysholm knee score, Tegner activity score, International Knee Documentation Committee (IKDC) score. Anteroposterior instability evaluation was done by anterior drawer and pivot shift tests.

Results: According to IKDC score, preoperatively 22 patients were D (51%) and 21 were C (49%) and postoperatively 33 were A (%76), 10 were B (%23) and 1 was C (%2). Preoperative mean Lysholm knee score was 54,87 (45-66) and increased to 89,86 (59-99) at the last control. Tegner activity score was 4,70 preoperatively and 5,22 postoperatively.

Conclusion: In ACL reconstruction, restoring knee biomechanics is possible by placing graft near normal anatomy. As defined for this purpose, three portal technique can place tibial and femoral tunnel as anatomic as possible. This technique is an applicable technique with good results.

Keywords: Anterior Cruciate Ligament; Knee Injuries; Arthroscopic Surgical Procedures.

Öz

Amaç: Diz anatomisi ve biyomekaniğinin daha iyi anlaşılmasıyla birlikte son zamanlarda ön çapraz bağın (ÖÇB) anatomik rekonstrüksiyonu önem kazanmıştır. Femur tünelinin anatomik açılabilmesi için tibia tüneline bağsız olarak ayrı drillenmesi önerilmiştir. Biz de bu çalışmada üçüncü bir anteromedial portalden femur tüneli açarak anatomik ÖÇB rekonstrüksiyonu uyguladığımız hastalarımızın klinik ve radyolojik sonuçlarını sunmayı amaçladık.

Gereç ve Yöntemler: ÖÇB rekonstrüksiyonu uygulanan 43 hasta (dört kadın, 39 erkek; ortalama yaş 29,3 yıl; dağılım 18-42 yıl) çalışma grubunu oluşturdu. Tüm hastalara artroskopik üçlü portal anatomik rekonstrüksiyon tekniği ile hamstring otogrefti kullanılarak ÖÇB rekonstrüksiyonu uygulandı. Ameliyat öncesi ve sonrası klinik değerlendirme Lysholm diz skoru, Tegner aktivite skoru ve Uluslararası Diz Dokümantasyon Komitesi Değerlendirme Formuna (IKDC) göre yapıldı. Anteroposterior stabilite değerlendirilmesi ön çekme testi ve pivot shift testi ile yapıldı.

Bulgular: Ameliyat öncesi IKDC skorlamasında 22 olgu D (%51) 21 olgu C (%49) grubundayken ameliyat sonrası 33 olgu A (%76), 10 olgu B (%23) ve 1 olgu C (%2) grubundaydı. Ameliyat öncesi ortalama 54,87 olan (45-66) Lysholm skorunun son kontrolde 89,86'ya (59-99) yükseldiği görüldü. Tegner aktivite skorları ortalaması ameliyat öncesi 4,70 iken ameliyat sonrası 5,22 olarak değerlendirildi.

Sonuç: ÖÇB rekonstrüksiyonunda diz biyomekaniğini normale tekrar getirmek greftin anatomiye en yakın şekilde yerleştirilmesi ile mümkündür. Bu amaçla tanımlanan üçlü portal teknik hem tibial hem de femoral tüneli anatomiye yakın açılabilir. Bu teknik iyi sonuçları ile uygulanabilir bir teknik olarak değerlendirilmelidir.

Anahtar Kelimeler: Anterior Cruciate Ligaman; Diz Yaralanmaları; Artroskopik Cerrahi Prosedürler-Girişimler.

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INTRODUCTION

Anterior cruciate ligament (ACL) is defined as the most frequently injured ligament in the body. Complete ACL injury is known to lead to knee instability, meniscus injury and cartilage degeneration. Recovery is not expected if the ligament is completely ruptured and surgical reconstruction is the standard treatment in that case (1). Moreover, injury is seen mostly in the active young man who do sport actively, this injury may lead to life style changes which could cause limitation in daily activities (2). Reconstruction aims to prevent a future cartilage injury through reforming the stability and kinematics of the injured joint (3).

Although ACL reconstruction is one of the frequently performed operation, results are usually reported from good to excellent. However outcomes were mostly seen to good varying from 69% to 95% (4-6). Although conventional reconstruction techniques are successful to prevent anterior translation of tibia, they are insufficient to control rotational translations when valgus and internal rotation forces are applied to knee (7,8). In addition, vast majority of the patients who underwent ACL reconstruction were seen not to return to their previous sports activity level (7,9-11). These conditions suggest the presence of the problems that should be solved in ACL reconstruction.

It is known that ACL reconstruction should be anatomic in order to normalize knee kinematics and functions (12). Although isometric femoral graft location and vertical graft orientation obtained with transtibial technique provides anteroposterior stability, rotational instability and pivot shift test positivity were seen to continue post-operatively (13). The surgical technique that should be selected for making femur and tibial tunnels in accordance with the real anatomic ACL anatomy is still of debate. ACL is known to be composed of two bundles which are anteromedial and posterolateral bundles and double bundle reconstruction is considered to normalize knee stability better than conventional methods (14). However the superiority of double bundle reconstruction to anatomic single bundle reconstruction is controversial. There are studies reporting that double bundle restores rotational control better however, also studies reporting no difference between them are present (12,15).

Anatomic single bundle ACL reconstruction is a method defined by modification of transtibial method for restoring a more original femur foot print and thus drilling an oblique femur tunnel. Making changes in transtibial technique like opening tibial tunnel 65-70 degrees coronally are insufficient for obtaining an anatomic femur foot print and femoral tunnel obliquity for anatomic reconstruction. Dargel showed that femur tunnel opened with transtibial technique is more anterior than the original foot print and extends toward notch ceiling (16). Pearle reported that conventional transtibial technique leads to an inconsistent graft location extending from posterolateral tibia foot print to anteromedial femur foot print (17). In addition, Heming showed that making a graft location consistent with tibia

and femur foot print using transtibial method could only be achieved through opening tibial tunnel very close to joint line and consequently through a short tibial tunnel (18).

Femur tunnel was proposed to be drilled separately and independent from tibial tunnel in order to overcome this problem in ACL reconstruction. Medial arthroscopy portal may be used for drilling and it may also be provided by opening a third medial para-patellar portal (19,20). Opening a tunnel from anteromedial portal is considered to restore natural ligament anatomy and knee stability, particularly rotational knee stability better. In this study, we aimed to present clinical and radiologic outcomes of our patients who underwent anatomical ACL reconstruction through opening femur tunnel from a third anteroportal.

MATERIAL and METHODS

Forty three patients who underwent operation due to ACL injury from 2009 to 2014 were included in the study. The patients who had multiple ligament injury, meniscus injury, cartilage injury, bilateral ACL injury and revision ACL injury were excluded from the study. Autologous hamstring graft was used for all patients. Fixation with suspending system was applied to femur and tibia was fixed with bio-absorbable screw and staple.

Diagnostic arthroscopy was applied first and reconstruction was performed after ACL injury had been verified. Femur tunnel was opened first. It was aimed to open femur tunnel inferior to inter-condylar ridge and just on the bifurcation ridge which separates anteromedial and posterolateral band. A third portal was opened medially in order to open femur tunnel to a proper point at horizontal plane and to get out guide pin from lateral cortex. The third portal was opened after it had been confirmed by a needle reaching the marked point and not injuring the cartilage of medial femur (Figure 1 and 2). Thereafter a guide was sent from this portal, the knee was taken to flexion and femur tunnel was opened so as to keep at least 2 mm healthy cortex posteriorly (Figure 3). Tibial tunnel was opened targeting the midpoint of tibial stump of ACL after the guide had been adjusted to 55 degrees, so as to stay anterior to medial collateral ligament. The graft was fixed to femur using ToggleLoc™ (Femoral Fixation Device with ZipLoop™ Technology) suspension system (Figure 4). The patients were applied locked knee brace however knee movements were left free and allowed to bear weight as tolerated. Active and passive knee movements and quadriceps isometric exercises were started on the first day.

Pre-operative and post-operative clinical evaluations were done according to Lysholm knee score, Tegner activity score and International Knee Documentation Committee Assessment Form (IKDC). In Lysholm scoring system, scores 95-100 out of 100 were evaluated as "excellent", 84-94 as "good", and 65-83 as "moderate" and below 65 as "poor". Anteroposterior stability was evaluated with pivot shift test.

Statistical analysis were done using SPSS version 21.0 (SPSS, Chicago, IL). Data were given as mean \pm standard deviation. Independent sample t-test was used for comparison of groups. A p level of <0.05 was accepted as statistically significant. Written informed consent was obtained from all patients. Local ethics committee approval was obtained prior to the study.



Figure 1. Third portal which is more medial



Figure 2. Arthroscopic control of the third portal placement with a needle



Figure 3. Drill guide sent from third portal and getting out from lateral cortex

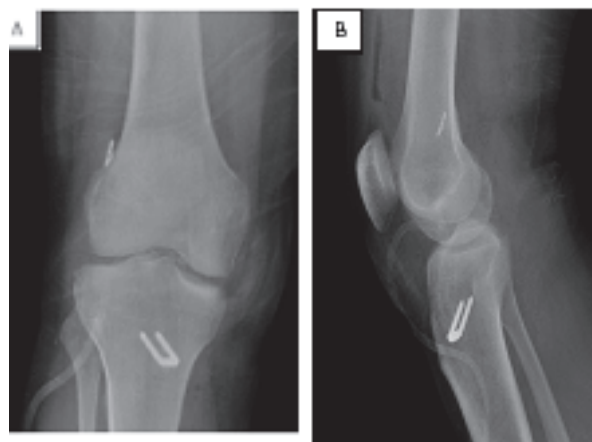


Figure 4. Postoperative anteroposterior (a) and lateral (b) radiographs

RESULTS

Totally 43 patients were included in the study and 39 (91%) were male and 4 (9%) were female. Mean age of the patients was 29.3 (18-42), mean follow up was 25

months (range 16-28). The right knee was injured in 21 (48%) of the patients and the left knee was injured in 22 (52%) of the patients. While injury occurred during sports activity in 36 (84%) of the patients, the reason was fall from a height in 4 (9%) of the patients and traffic accident in 3 (6%) of the patients.

Evaluations were done pre-operatively and on controls, while mean pre-operative Lysholm score was 54.87 (45-66) and was increased to 89.86 (59-99) on the last control. Pre and post-operative Lysholm scores were evaluated with paired samples test and the difference was statistically significant ($p < 0.001$). While mean Tegner activity score was 4.70 pre-operatively, it was found as 5.22 after the operation. According to IKDC knee ligaments standard assessment system, while preoperatively 22 cases were D (51%), 21 cases were C (49%) after the operation 33 cases were included in A group (76%), 10 cases in B group (23%) and 1 case in C group (2%). Pre and post-operative IKDC scores were evaluated with Wilcoxon Signed Rank test and the difference was found statistically significant ($p < 0.001$) (Table 1).

Table 1. Preoperative and postoperative clinical scores

	Preop	Postop	p value
Lysholm	54,87	89,86	$p < 0.05$
A	0	33	
B	0	10	
IKDC			$p < 0.05$
C	21	1	
D	22	0	
Tegner score	4,7	5,22	$p > 0,05$

On pre-operative examinations, Lachman test was 3+ in 22 patients (52%), 2+ in 18 patients (42%) and 1+ in 3 patients (6%). Pivot shift test was positive in 36 patients (83%) and negative in 7 patients (16%). Anterior drawer test was 3 + in 26 patients (60%), 2+ in 17 patients (40%). On final assessment after the operation, Lachman test was negative in 36 patients (83.5%), 1+ in 5 patients (11.6%) and 2+ in 2 patients (4%). Pivot shift test was negative in all patients. Anterior drawer test was negative in 36 patients (84%) and 1+ in 7 patients (16%). Superficial wound infection developed in 2 patients. Superficial wound debridement was done for one of these patients. Antibiotic treatment was sufficient for another. Eight (19%) patients reported numbness on anterior of the knee. Complications like DVT, compartment syndrome or arthrofibrosis was not developed in the patients.

DISCUSSION

Increasing number of people are doing various sports as amateur or professional with the increasing interest to sports in the community. Meanwhile this condition caused the increase in ACL injuries. Ratio of sports injury among causes of ACL injury was reported above 90% (21). This ratio was found as 84% in our study. Gender was reported to be effective on ACL injury. The factors like narrower notch, more ligament laxity and smaller surface area of the ligament are suggested to lead to

higher ratios of ACL injury among women. Estrogen was also reported to inhibit fibroblast proliferation and pro-collagen synthesis (22,23). Male patients consisted 91% of the subjects in our study. While Howell reported this ratio as 71%, Tashiro reported as 56% (21,24). In our country, women participate in sports as hobby less beside the lower ratio of licensed female athletes. This condition leads to significantly higher male ratio in the studies conducted in our country.

Anatomic reconstruction method was defined also in double bundle technique. Yasuda et al. reported that double bundle anatomic technique was significantly better than the others with regard to anteroposterior and rotational stability and there was not a significant difference between non-anatomic double bundle and single bundle in their study comparing anatomic double bundle, non-anatomic double bundle and single bundle techniques (6). Kondo emphasized in his prospective study that anatomic double bundle technique was better than single bundle technique with regard to anterior laxity and pivot shift. However he could not find a significant difference between two methods with regard to IKDC values, subjective scores, knee ROM, muscle torque and time to return to sports (25). Aglietti showed that anatomic bundle method was better with regard to anterior stability in the measurements done with KT-2000 device in the patients who were being followed up to 2 years (26). Studies are also available reporting no difference between single bundle and double bundle with regard to clinical assessments (27). Park et al. reported that there was not a significant difference between single bundle and double bundle techniques with regard to clinical assessments done for stability results or patient satisfaction in their prospective study (28). Kim et al. proposed that there was not a difference between two techniques with regard to Lachman tests and KT2000 measurements, only pivot shift test was different (29).

In the prospective randomized study of Zang conducted with 65 patients, he reported that there was not a significant difference between groups which were followed up for 12 months with regard to Lysholm knee score and KT1000 anterior laxity measurements (30).

Use of anatomic medial portal for ACL reconstruction facilitates the graft's being located close to normal anatomy through providing significant advantages in femur tunnel opening. Providing proper tunnel obliquity and the other anatomic factors was reported to positively affect anatomic placement of the graft, knee kinematic and stability in single bundle reconstruction (7,31,32). Femur tunnel's opening from a more medial portal separately was reported to provide this obliquity and consequently more anatomic placement of the graft (16,33). Bowers showed that anatomic medial portal technique provided the sagittal obliquity of the graft better than transtibial technique (34). Although it is controversial that which method is a more anatomic reconstruction and its influence on clinical outcomes, cadaver studies showed that anatomic femur tunnel opening could enable near-normal ACL function (13,32). In addition anatomic tunnel caused less stress for the

graft in the entrance of the tunnel. This is an important factor in development of long term graft insufficiency (35).

Transtibial technique was shown to lead femur tunnel to open more anterior in a non-anatomic manner (36,37). Beside, creating particularly posterolateral bundle was reported to be very difficult in transtibial technique. Using clockwise concept for describing the location of the tunnels also causes misunderstanding. Describing the three-dimensional structure of the inter-condylar notch with clock may be evaluated wrong particularly in anteroposterior plane (38,39). In the prospective study of Sastre et al., they compared single bundle reconstruction which they performed by opening a more horizontal femur tunnel with anatomic method, and double bundle reconstruction and reported no difference. In that study, the authors proposed that the femur tunnel which was opened more horizontally in the single bundle method provided similar rotational and anteroposterior laxity control (40). Hussein reported that particularly femur anteromedial tunnel was opened more anatomically by using the third portal in double bundle technique and therefore outcomes of double bundle technique were better than those of anatomic single bundle (41).

In a meta-analysis comparing anatomic medial portal (8 studies, 257 patients) and transtibial method (13 studies, 602 patients), anatomic method was reported to yield more satisfactory results (42). In another meta-analysis including 15 studies, IKDC and Tegner activity scores of triple portal technique and transtibial technique were similar in short-term follow ups and prospective randomized studies with long follow ups are recommended to evaluate the long term outcomes (43). Chalmer reported that transtibial technique is still able to be performed although anteromedial portal technique yielded better clinical and bio-mechanic outcomes (44). Use of transtibial technique among orthopedists were seen to reduce to 31% in 2013 from 90% in 2006 (45,46). This decline is suggested to arise from the anxiety for providing an anatomic graft placement. Piasecki showed that an anatomic tunnel could be opened also with transtibial technique in an experimental study and showed that beginning point of tibial tunnel was very important (47). Rue reported that tibial tunnel should be located at 60 degrees to joint line and at 10:20 point in order to open an anatomic femur tunnel (48). There is a consensus showing that transtibial technique is not superior to triple portal anatomic technique. Geli reported fast return to normal activities, sports and running with anatomic medial portal compared to transtibial technique (42).

In conclusion, normalizing knee bio-mechanic in ACL reconstruction can be achieved with placing the graft most close to anatomy. Both tibial and femur tunnel may be opened near anatomy and the graft may be placed near original with triple portal. Debates about the technique also continue beside the debates about graft selection, fixation methods, and rehabilitation in ACL surgery. Valuable studies about this topic and patient-related factors are also effective beside the experience

of the surgeon for making a decision. Outcomes of ACL reconstruction with triple portal technique are successful and new comparative randomized controlled studies are required.

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