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Comparison of Transfix Screw Technique and Endobutton Technique in Terms of Tunnel Widening and Clinical Results in Anterior Cruciate Ligament Reconstruction

Ön Çapraz Bağ Rekonstrüksiyonunda Transfiks Vida Tekniği ile Endobutton Tekniğinin Tünel Genişlemesi ve Klinik Sonuçlar Yönünden Karşılaştırılması

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Abstract

Objective: The aim of the present study was to compare transfix screw technique and endobutton technique in terms of femoral and tibial tunnel enlargement and clinical outcomes in anterior cruciate ligament (ACL) surgery and to discuss nonanatomic transtibial system under current circumstances.

Method: This retrospective study was conducted on 50 patients who had ACL reconstruction in SCI Göztepe Training and Research Hospital between September, 1999 and March, 2003. Among the patients enrolled, 17 patients had endobutton and 33 had transfix screw technique for ACL reconstruction. The mean age of the patients who underwent ACL reconstruction through endobutton technique was 27.2 years whereas the mean age of those who had transfix screw method was 29.9 years. Femoral and tibial tunnel enlargement rates were reviewed for radiological comparison. Harner's quadrant location, Frontal femoral tunnel angles and Frontal tibial tunnel angles were similar in both groups, and they were found comparable radiologically. The differences between the early postoperative and late postoperative tunnel widths of both groups were compared. Clinical comparison was performed through the Hospital for Special Surgery Knee score (HSSKS).

Results: Tunnel widening was detected in a significant part of the cases who had both endobutton and transfix screw methods; and the cases with a tunnel dilatation difference at and over 2 mm were accepted as tunnel enlargement and evaluated in consideration of standard deviation. Consequently, significant tunnel enlargement was detected in 47% of the cases in endobutton continuous loop (CL) reconstruction group and

Öz

Amaç: Bizim bu çalışmamızdaki amacımız ön çapraz bağ (ÖÇB) cerrahisinde transtibial sistemle yaptığımız transfiks vida tekniği ile endobutton tekniğini radyolojik ve klinik olarak karşılaştırmak ve bugünün koşullarında tartışmaktır.

Yöntem: Çalışma retrospektif olarak SSK Göztepe Eğitim ve Araştırma Hastanesi'nde Eylül 1999 ile Mart 2003 yılları arasında non-anatomik ÖÇB rekonstrüksiyonu yapılan 50 hasta ile yapıldı. Bunların 17'si endobutton, 33'ü ise transfiks vida tekniği ile ÖÇB rekonstrüksiyonu yapılan hastalardı. Endobutton tekniği ile ÖÇB ameliyatı yapılan hastaların ortalama yaşı 27,2 iken transfiks vida tekniği ile yapılan hastaların ise 29,9'du. Radyolojik karşılaştırmada femoral ve tibial tünel genişleme oranlarına bakıldı. Her iki teknikte Harner's kadranı dağılımı, Frontal tibial tünel açıları ve Frontal femoral tünel açıları benzer olup radyolojik olarak femoral ve tibial tünel genişleme oranları karşılaştırılabilir bulundu. Erken postoperatif ve geç postoperatif tünel genişlik oranları birbiriyle karşılaştırıldı. Klinik karşılaştırma ise Hospital for Special Surgery Knee Score (HSSKS) ile yapıldı.

Bulgular: Hem endobutton hem de transfiks olgularının önemli bir kısmında tünel genişlemesi bulundu ve standart sapma dikkate alınarak 2 mm ve üzerinde tünel genişlik farkı olan olgular anlamlı tünel genişlemesi olarak kabul edilip değerlendirmeye alındı. Sonuç olarak endobutton CL'deki olguların %47'sinde, transfiks tekniğindeki olguların % 51,5'inde anlamlı tünel genişlemesi bulundu. Her iki teknik arsında tünel genişlemesi bakımından anlamlı istatiksel bir fark bulunmadı (p>0,05). Transfiks tekniğinde femoral tünel genişlik farkı 2 mm ve üzerinde olan

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Abstract

in 51.5% of the cases in transfix screw technique group. There was not any statistically significant difference in tunnel enlargement between two techniques (p>0.05). In the transfix technique, the HSKSS scores of the patients with femoral tunnel width difference over 2 mm were 90.2 whereas in cases without femoral tunnel width or minimal, this score was 91.1. In Endobutton technique, HSKSS scores of the patients with the femoral tunnel enlargement were 91, HSKSS scores of the cases without femoral tunnel enlargement were 91.25. There was no relation between femoral tunnel widening and HSKSS scores due to the value of p>0.005 in the Mann-Whitney U test. Postoperative rehabilitation period was similar in both groups; HSSKS scores of the cases who underwent transfix and endobutton techniques were compared (Table 9 and 10). The p>0.05 meant that there was not any clinically significant difference between two groups.

Conclusion: Significant tunnel widening was found in both endobutton CL and transfix technique (using transtibial method) in ACL reconstruction with the hamstring tendon graft. However, there was no significant difference between the two techniques in terms of tunnel widening. It was observed that tunnel enlargement had no significant effect on clinical results in both groups. There was no significant difference between the two groups in terms of clinical results. Successful outcomes were obtained in ACL reconstructions through transtibial technique where extraarticular fixation was done. Recognition of both transtibial techniques for anatomic ACL reconstruction is essential for ACL revision procedures.

Keywords: Anterior cruciate ligament, endobutton technique, transfix technique, transtibial technique, tunnel widening

Öz

hastaların HSKSS puanları 90,2 bulunurken femoral tünel genişlik farkı olmayan veya minimal olan olgularda bu puan 91,1 idi. Endobutton tekniğinde femoral tünelde genişleme olan hastaların HSKSS puanları 91, tünel genişlemesi olmayan olguların ise 91,25 idi. Bu durumun kliniğe yansımadığı Mann-Whitney U testinde p>0,005 değerinin bulunmasıyla anlaşıldı. Her iki grupta da ameliyat sonrası rehabilitasyon süresi benzer olup, transfiks ve endobutton teknikleriyle yapılan olguların HSSKS puanları karşılaştırıldı (Tablo 9, 10). P>0,005 olup her iki teknik arasında klinik olarak anlamlı bir fark saptanmadı.

Sonuç: Hamstring tendon grefti kullanılarak, transtibial yöntem ile yapılan hem endobutton CL, hemde transfiks tekniğinde anlamlı tünel genişlemesi bulundu. Fakat her iki teknik arasında tünel genişlemesi yönünden anlamlı bir fark yoktu. Her iki grupta da tünel genişlemesinin klinik sonuçlara yansımadığı tespit edildi. Her iki grupta da klinik sonuçlar bakımından anlamlı bir fark bulunmadı. Transtibial tekniğin kullanıldığı ve tespitin ekstraartiküler yöntemle yapıldığı ÖÇB rekonstrüksiyonunda geçmişte başarılı sonuçlar alınmıştır. Anatomik ÖÇB rekonstrüksiyonların yapıldığı günümüzde transtibial her iki tekniği bilmenin ÖÇB revizyonları için önemli olduğunu düşünüyoruz.

Anahtar kelimeler: Endobutton teknik, ön çapraz bağ, transfiks teknik, transtibial teknik, tunel genişlemesi

Introduction

Surgical procedures of anterior cruciate ligament (ACL) gathered speed by the replacement of extraarticular techniques with intraarticular techniques for ACL procedures in 1990s (1,2). ACL reconstruction was performed non-anatomically first; when importance of rotational stability in the knee was noticed after 2000s, anatomic ACL reconstruction procedures started and almost all procedures are performed through anatomic ACL reconstruction approach today. Although successful results are obtained by former transtibial technique, this method has been begun to be forgotten currently. We believe that this method should be recognized in detail and performed compulsorily due to increasing ACL revision surgery rates.

Many problems have been encountered in ACL reconstruction surgery from past to present. One of them is femoral and tibial tunnel enlargement. Many biological and mechanical factors have been blamed for tunnel widening. Antigenic immune response, nonspecific inflammatory reaction, toxic substances created by materials, cell necrosis during the use of drill and synovial cytokines are biological factors that can cause bone tunnel enlargement. Unsuitable tunnel placements, stress loads and movement made by the graft in the tunnel, characteristics of fixation materials, excessive rehabilitation are the factors that are suggested to cause tunnel enlargement as mechanical reasons (3,4). Each of these factors that can reason for tunnel widening may impair bone tendon union. 10% failure and recurrent instability develop after ACL surgeries due to graft non-union.

The aim of the present study was to make a radiological and clinical comparison of transfix screw technique through transtibial system and endobutton technique in ACL surgery of which we used to perform by non-anatomic approach, and to discuss the results under current conditions.

Materials and Methods

This retrospective study was conducted on 50 patients who had ACL reconstruction in SCI Göztepe Training and Research Hospital between September, 1999 and March, 2003. The study was conducted with the consent of all patients. Among the patients enrolled, 17 patients had endobutton and 33 had transfix screw technique for ACL reconstruction. The mean age of the patients who

underwent ACL reconstruction through endobutton technique was 27.2 years whereas the mean age of those who had transfix screw method was 29.9 years. The duration between first trauma and ACL reconstruction was 24.3 months in transfix screw technique, and 30.9 months in endobutton technique. The distribution of meniscus rupture and chondral lesion was similar in two groups. Partial menisectomy was performed on all of the cases with meniscus rupture.

Bioabsorbable screws with a diameter of 1 mm larger than tibial tunnel diameter were used to fix the tibial tunnels in both groups. One staple was used additionally in transfix technique whereas 2 staples or washers were used in addition to bioabsorbable screw in endobutton technique. The mean follow-up periods were similar in both groups as 2.8 years for transfix screw method and 2.9 years for endobutton technique.

Radiological comparison of both groups was performed by anterior posterior (AP)/lateral X-rays and magnetic resonance imaging of the knee. Frontal femoral tunnel angle (Figure 1), frontal tibial tunnel angle (Figure 2), disintegration angle (Figure 3) and Harner's quadrants were reviewed by direct X-ray. The angles reviewed and Harner's quadrant location were similar in both groups, and they were found comparable radiologically. Femoral and tibial tunnel widening ratios were assessed for radiological comparison. Radiological measurement was standardized by placing a square iron of 1 cm² into the film cassette.

Clinical comparison was performed through the Hospital for Special Surgery Knee score (HSSKS). HSSKS is a comprehensive measurement tool including subjective, objective and functional tests. Subjective complaints include pain, swelling, locking, release and frequent release. Objective issues include any previous surgical procedures (i.e. partial menisectomy), date of injury, surgery date, surgical procedure and examination of knee ligaments (Lachman, anterior drawer, posterior drawer tests and pivot shift etc). Functional assessment includes daily activities as well as working status, sports, running, jumping, standing and leaning onto the side. They are evaluated over 100 points. The ranging was assessed as follows; 96 to 100 points, quite good; 91 to 95 points, good; 86 to 90 points, moderate; 76 to 85 points, bad; and below 76, very bad. The highest score (approximately 40 to 50%) was obtained by functional activity and test response of the patient.

Figure 1. Frontal femoral tunnel angle in AP X-ray of the knee

FTT: Failure to thrive, AP: Anterior posterior

Statistical Analysis

Mean, standard deviation, median, minimum, maximum value frequency and percentage were used for descriptive

Figure 2. Frontal tibial tunnel angle in AP X-ray of the knee

FTT: Failure to thrive, AP: Anterior posterior

Figure 3. The disintegration angle between FFT and FTT

FTT: Failure to thrive

statistics. The Mann-Whitney U test was used for the comparison of quantitative data. Paired sample T test was used to detect standard deviation. SPSS 26.0 was used for statistical analyses.

Results

The difference between early postoperative and late postoperative tunnel width was evaluated by the Paired samples t-test. Accordingly, tunnel enlargement was detected in a significant part of endobutton and transfixes cases; the cases with tunnel enlargement difference at and over 2 mm were accepted as tunnel widening and evaluated in consideration of standard deviation. In this case, tunnel enlargement differences of 8 cases presented minimal increase or presented no change in Endobutton CL whereas a significant enlargement of both femoral and tibial tunnel was seen in 7 cases and of femoral tunnel was seen only in 2 cases (Table 1). The largest width difference was found as 6 mm in the femoral tunnel, 4 mm in the tibial tunnel; the mean width difference of the tunnel was found as 3.8 mm and 2.6 mm in the femoral tunnel and tibial tunnel, respectively (average of the cases with significant tunnel widening). There was not any significant tunnel widening in 15 cases who had transfix technique; however, a significant enlargement was detected in both femoral and tibial tunnel in 14 cases, for femoral tunnel only in 3 cases and for tibial tunnel only in 1 case (Table 2). Accordingly, it was detected that femoral tunnel was dilated by 5 mm and tibial tunnel was dilated by 7 mm. The mean dilatation measure of femoral tunnel and tibial tunnel was 3.6 mm and 3.8 mm, respectively.

Consequently, significant tunnel enlargement was detected in 47% of the cases in endobutton CL reconstruction group, and in 51.5% of the cases in transfix screw technique group.

In Table 1, p<0.001 was detected in paired sample t-test with standard deviation of 20,598. A significant tunnel enlargement difference was detected with these findings. Same p-value was found for Table 2, below with standard deviation of 178,895.

In Tables 3 and 4 below, 63% of the cases with femoral tunnels on Harner's quadrant 3 through transfix technique presented a femoral tunnel width difference over 2 mm; however, such rate for the cases with the tunnels on Harner's quadrant 4 was 37%. It was investigated whether such tunnel width difference ratios were associated with Harner's quadrant. The Mann-Whitney U test was applied for this. The p-value is >0.005 in this test and there was not

Table 1. Distribution of the cases with tunnel enlargement over 2 mm in endobutton technique

Endobutton CL			
Amount of femoral tunnel enlargement	**n=9**	**Amount of tibial tunnel enlargement**	**n=7**
2	1	2 mm	3
2.5 mm	-	2.5 mm	2
3 mm	1	3 mm	1
3.5 mm	4	4 mm	1
4	-	-	-
4.5 mm	1	-	-
5 mm	1	-	-
6 mm	1	-	-

CL: Continuous loop

Table 2. Distribution of the cases with tunnel enlargement over 2 mm in transfix screw technique

Transfix technique			
Amount of femoral tunnel enlargement	**n=17**	**Amount of tibial tunnel enlargement**	**n=15**
2	2	2	2
2.5 mm	1	3	8
3	6	3	1
4	3	5	1
4.5 mm	1	6	2
5	4	-	-

Table 3. Distribution of femoral tunnel width difference over 2 mm according to Harner's quadrant in transfix screw technique

Transfix technique (n=17)			
Amount of femoral tunnel enlargement	**Harner quadrant 2**	**Harner quadrant 3**	**Harner quadrant 4**
2 mm	1	1	-
2.5 mm	-	-	1
3 mm	-	6	-
4 mm	-	1	2
4.5 mm	-	1	-
5 mm	-	3	1

Table 4. Distribution of the cases without significant tunnel widening according to Harner's quadrants in transfix screw technique

Transfix technique (n=16)	
Amount of femoral tunnel enlargement less than 2 mm or absent	
Harner quadrant 3	**Harner quadrant 4**
7	9

any connection between Harner's quadrant and tunnel enlargement.

HSSKS scores of the patients with femoral tunnel width difference at and over 2 mm through transfix technique were found 90.2 whereas such score was 91.1 in the cases with none or minimal femoral tunnel width difference (Table 5 and 6). The p>0.005 value detected by the Mann-Whitney U test meant that this was not reflected to the clinical presentation. There was not any significant difference in score comparison of the cases with femoral tunnel width difference at and over 2 mm (Table 7) and in the cases with none or minimal tunnel width (Table 8) (p>0.005).

Postoperative rehabilitation period was similar in both groups; HSSKS scores of the cases who underwent transfix and endobutton techniques were compared (Table 9 and 10). The comparison was performed through the Mann-Whitney U test. The p>0.05 meant that there was not any clinically significant difference between two groups.

Discussion

L'insalata et al. (5) detected in their study conducted on ACL reconstructions through hamstring tendons that tunnel enlargement was more common than those performed by using patellar tendon graft. However, they did not explain that this was clinically meaningful. Similarly, Clatworthy et al. (6) detected in a study (in reconstructions on hamstring tendons) that the most enlargement of tunnel was in those using bioabsorbable screw, which was followed by metal interference screw, Bone Mulch screw and Endobutton CL. Clatworthy et al. (6) demonstrated in the aforesaid study that femoral tunnel enlargement could not be explained

Table 5. HSSKS distribution scores of the cases with femoral tunnel enlargement at and over 2 mm in transfix screw technique

Transfix technique (n=17)				
	HSSKS			
Amount of femoral tunnel enlargement	**81-85 point**	**86-90 point**	**91-95 point**	**96-100 point**
2 mm	-	1	1	-
2.5 mm	-	-	1	-
3 mm	-	2	2	**1**
4 mm	-	-	2	**1**
4.5 mm	-	-	1	-
5 mm	**1**	**2**	**1**	-

HSSKS: Hospital for Special Surgery Knee score

Table 6. HSSKS distribution scores of the cases without femoral tunnel widening at and below 2 mm in transfix screw technique

Transfix technique			
Amount of femoral tunnel enlargement minimal or absent			
HSSKS			
80-85	86-90	91-95	**96-100**
2	5	6	3

HSSKS: Hospital for Special Surgery Knee score

Table 7. HSSKS distribution scores of the cases with femoral tunnel widening at and over 2 mm in endobutton technique

Endobutton CL (n=9)					
Amount of femoral tunnel enlargement	**HSSKS**				
	70-80 point	**81-85 point**	**86-90 point**	**91-95 point**	**96-100 point**
2 mm	-	-	-	-	**1**
3 mm	-	-	-	1	-
3.5 mm	-	-	2	2	-
4.5 mm	-	-	-	1	-
5 mm	-	-	1	-	-
6 mm	-	-	**1**	-	-

HSSKS: Hospital for Special Surgery Knee score, CL: Continuous loop

Table 8. HSSKS distribution scores of the cases without femoral tunnel widening at and below 2 mm in endobutton technique

Endobutton CL (n=8)				
Amount of femoral tunnel enlargement minimal or absent				
HSSKS				
70-80	81-85	86-90	91-96	**96-100**
1	1	1	3	2

HSSKS: Hospital for Special Surgery Knee score, CL: Continuous loop

Table 9. Distribution of HSSKS scores in the cases operated with transfix screw technique

Transfix technique				
HSSKS points				
70-80	81-85	86-90	91-96	**96-100**
1	3	10	14	5

HSSKS: Hospital for Special Surgery Knee score

Table 10. Distribution of HSSKS scores in the cases operated with Endobutton technique

Endobutton technique				
HSSKS points				
70-80	81-85	86-90	91-96	**96-100**
1	2	5	6	3

HSSKS: Hospital for Special Surgery Knee score

by ''bunge-cord'' effect in the cases in which Endobutton CL was used (6). The findings obtained in the present study were consistent with those obtained by Clatworthy et al. (6) detection of similar results in tunnel enlargement ratios of our cases both in Transfix and Endobutton CL techniques appears to prove that femoral tunnel enlargement by 65% of former tunnel diameter is due to tight rope effect. Because, tunnel enlargement occurs by 55% of former tunnel diameter in Transfix technique.

Moreover, the tibial tunnel was fixed by 1 staple and 1 bioabsorbable screw in majority of the cases with Transfix technique. However, double staples or washer were used in our Endobutton CL cases. This allowed us to compare tibial tunnel enlargement in both cases. The outcomes that we obtained were interesting because, some tibial tunnel enlargement quantity exceeded femoral tunnel width in Transfix screw technique. The mean tibial tunnel enlargement quantity was 2.6 mm in endobutton (calculated from those with significant tunnel enlargement), and 3.8 mm in Transfix screw technique. This was also consistent with the study conducted by Clatworthy et al. (6) However, tibial tunnel did not expand much although bioabsorbable screw was used in the cases without femoral tunnel enlargement.

Does tunnel enlargement make any sense for the patients? If it does, what was the extent of enlargement to increase the instability? Ayala-Majias et al. (7) selected a retrospective cohort of 30 patients undergoing ACL recontruction with double semitendinosus plus double gracilis with longer than 10 -year follow-up to evaluate the relationship between tunnel position and widening and long term clinical results. They found that tibial tunnels widened more than femoral tunnels and tibial tunnel dilation was associated with long term degenerative changes but no with final knee instability (7). Nebelung et al. (8) evaluated 29 knees with a minimum follow-up 2 years after ACL reconstruction with endobutton tecnique. They have found no correlation between enlargement of the tunnel and the International Knee Documentation Comittee score or the residual joint instability (8). Çınar et al. (9) investigated the effects of anatomic and nonanatomic tunnel fixations on femoral tunnel widening and clinical results in ACL reconstruction with hamstring tendon graft. They found that there was marked and excessive tunnel enlargement in anatomic and non-anatomic tunnel fixations. They demonstrated that there was no relationship between tunnel widening and clinical results and ligament laxity (9). We could not find a relationship between tunnel enlargement and clinical outcomes in the both groups too; however, we detected that clinical status was moderate in the cases with tunnel widening by 50% and more of former tunnel diameter and HSSKS scores accumulated around 86 to 88. Majority of them were without instability; however, it was observed that they abstained from previous sports that they used to make before the surgery and they perform different sports. Furthermore, it should be stressed out that tunnel enlargement exceeding 50% of former enlargement diameter was 16% of our cases only.

Endobutton and Transfix screw are the materials providing extraarticular femoral fixation. The most superior characteristics include their resistance, strength against loading during femoral fixation with the strongest scraping forces (10-12). Another superior feature is not leading to posterior cortex wall fracture during fixation. Endobutton also has two other superior characteristics. One of them is serving as a material used for both hamstring tendons and patellar tendon bone graft, and the other is providing external rotation to the graft during tibial fixation of the graft. Despite such additional superior characteristics of Endobutton, usage was not common among surgeons in the past. Two settled views caused this. One view was that Endobutton causes tunnel enlargement more than transfix due to tight rope effect; and it was shown that this was not correct. The second view was the desire to keep Endobutton as a priceless option for revision ligament surgery in the future. Femoral tunnel fixations were mostly used to be done inside the tunnel for that reason, and fixation failure was detected frequently (13). Furthermore, removal of femoral tunnel screws located intraarticularly is difficult and results with significant tunnel dilatation when removed (14). Anatomic ACL reconstruction is done nowadays and transtibial technique has almost been abandoned. Endobutton fixation material is commonly used to fixate femoral tunnel. Revision of ACL becomes difficult due to current femoral tunnel widening in the patients who had anatomic ACL reconstruction before with accurate femoral tunnel location. At this point, we believe that dominating transtibial technique is important. Because, the new femoral tunnel to be opened inside former tibial tunnel by keeping the frontal tibial angle at 60 degrees in average would be closer to anatomic location and longer than former tunnel. It is reported that if failure to thrive angle is over 75 degrees, it increases anterior laxity and causes loss of flexion (15). Furthermore, opening new femoral tunnel in transtibial technique allows an increase in disintegration probably due to the dilated tibial tunnel. This would enable to open the femoral tunnel more anatomically. Femoral tunnel grafting

may not be needed. We observe better results of a patient whom we have performed ACL reconstruction 20 years ago and still follow up (Figure 4 and 5). In the AP/lateral X-rays of the knee, femoral and tibial tunnels appear not to be enlarged. The knee examination revealed that Lachman 1 was positive, and the patient did not have any problem in the daily life. Furthermore, one of the noticeable points is the absence of osteoarthritis complaints.

Conclusion

Comparison of both techniques in the present study revealed no difference radiologically and for tunnel dilatation; and both fixation materials may be easily used if transtibial ACL revision would be done.

Figure 4. The AP knee X-ray of the patient who had non-anatomic ACL reconstruction through transtibial technique after 9 years; femoral tunnel was fixated by transfix screw. The patient has no complaint; he plays football etc

AP: Anterior posterior, ACL: Anterior cruciate ligament

Figure 5. Lateral knee X-ray of the same patient, femoral tunnel appears to be opened at Harner's quadrant 4. no enlargement in femoral and tibial tunnels

Ethics

Ethics Committee Approval: This retrospective study was conducted on 50 patients who had ACL reconstruction in SCI Göztepe Training and Research Hospital between September, 1999 and March, 2003.

Informed Consent: The study was conducted with the consent of all patients.

Peer-review: Externally peer-reviewed.

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