Eklem Hastalıkları ve Cerrahisi
Joint Diseases and Related Surgery

Original Article / *Çalışma - Araştırma*

Joint Dis Rel Surg
2006;17(1):33-37

Radiofrequency shrinkage for minor degrees of cruciate ligament injuries

Hafif dereceli çapraz bağ yaralanmalarında radyofrekans ile büzüştürme yöntemi

Young-Lae Moon, M.D., PhD., Dong-Hui Kim, M.D., PhD., Sang-Hong Lee, M.D., PhD.

Department of Orthopedics Surgery, Chosun University, Gwangju, Korea

Objectives: We evaluated the short-term clinical results of thermal shrinkage with radiofrequency for anterior and posterior cruciate ligament laxity in conditions not indicated for reconstructive surgery.

Patients and methods: The study included nine patients (mean age 33 years) with anterior cruciate ligament (ACL), and five patients (mean age 27 years) with posterior cruciate ligament (PCL) injuries, all of whom did not require reconstruction. Three patients had both ACL and PCL injuries. The time from injury to operation ranged from three to 26 months in ACL injuries, and from eight to 17 weeks in PCL injuries. All the patients received conservative treatment before radiofrequency shrinkage. Thermal shrinkage was performed twice in ACL injuries, and four times in PCL injuries. The mean follow-up period was eight months (range 3 to 13 months). Functional evaluations were made according to the modified Lysholm knee scoring scale.

Results: The mean modified Lysholm knee score was 76 prior to operation, and 86 three months after the operation. Scores of instability in daily activities, limping, and pain showed great improvement after the procedure. Efficient thermal shrinkage was observed immediately after the operation. However, recurrent knee laxity was observed subsequently, especially in the PCL injuries.

Conclusion: Thermal shrinkage using radiofrequency is a recommendable procedure in treating active young patients with partial cruciate ligament ruptures which are not indicated for reconstructive surgery.

Key words: Anterior cruciate ligament/injuries; arthroscopy; electrocoagulation/methods; knee injuries; posterior cruciate ligament/injuries; rupture/surgery.

Amaç: Bu çalışmada, rekonstrüktif cerrahi endikasyonu olmayan ön ve arka çapraz bağ laksisitesinde radyofrekans ile termal büzüştürme tekniğininin kısa dönem klinik sonuçları değerlendirildi.

Hastalar ve yöntemler: Çalışmaya, rekonstrüksiyon endikasyonu olmayan, ön çapraz bağ (ÖÇB) yaralanması olan dokuz hasta (ort. yaş 33), arka çapraz bağ (AÇB) yaralanması olan beş hasta (ort. yaş 27) alındı. Üç hastada her iki çapraz bağda yaralanma vardı. Yaralanma ile cerrahi arasında geçen süre ÖÇB yaralanmalarında 3-26 ay, AÇB yaralanmalarında 8-17 hafta arasında değişmekteydi. Radyofrekans ile termal büzüştürmeden önce tüm hastalarda konservatif tedavi denenmişti. Termal büzüştürme ÖÇB yaralanmalarında iki kez, AÇB yaralanmalarında dört kez uygulandı. Ortalama izlem süresi sekiz ay (dağılım 3-13 ay) idi. Fonksiyonel değerlendirmeler modifiye Lysholm diz skorlama sistemiyle yapıldı.

Bulgular: Uygulama öncesinde 76 olan modifiye Lysholm diz skoru ortalaması işlemden üç ay sonra 86'ya yükseldi. Uygulamadan hemen sonra etkili termal büzüştürme elde edildi ve günlük aktivitelerde hissedilen instabilite, topallama ve ağrı skorları önemli düzelme gösterdi. Ancak, özellikle AÇB yaralanmalarında, diz laksisitesinin daha sonra tekrarladığı gözlendi.

Sonuç: Çapraz bağ yaralanması olan ancak rekonstrüktif cerrahi endikasyonu olmayan genç aktif kişilerde, radyofrekans ile termal büzüştürme önerilebilir bir tedavi yaklaşımıdır.

Anahtar sözcükler: Ön çapraz bağ/yaralanma; artroskopi; elektrokoagülasyon/yöntem; diz yaralanması; arka çapraz bağ/yaralanma; yırtık/cerrahi.

• *Received: February 5, 2005 Accepted: May 17, 2005*

• *Correspondence: Dong-Hui Kim, MD, PhD. Department of Orthopedics Surgery, Chosun University Hospital 588, Seosuk-dong, Dong-gu, Gwangju, 501-717, Korea. Tel: +00 - 62 - 220 3140 Fax: +00 - 62 - 226 3379 e-mail: osbaggu@hanmail.net*

In parallel with industrial developments, the incidence of traffic accidents and sport injuries increases, resulting in a considerable rise in the incidence of knee joint injuries such as those to the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL).

Both the ACL and PCL are crucial structures that contribute to the stability of the knee joint, and are responsible for the rotational axis of the knee joint. They prevent anterior and posterior translation of the tibia, respectively.

With the growing number of procedures pertaining to the knee joint, more and more ligament reconstructions are performed. Nevertheless, the results of PCL reconstruction largely rely on the operator's skill and PCL reconstructions particularly have the possibility of many complications. For mild PCL injuries and partial ACL ruptures, there is controversy as to the most suitable treatment option especially for the young, requiring further studies in this field.

We evaluated the short-term results of thermal shrinkage using radiofrequency in patients with ACL or PCL injuries where ACL reconstruction was not indicated.

PATIENTS AND METHODS

The study included nine patients with ACL, and five patients with PCL injuries, all of which did not require reconstruction. There were five males and four females in the ACL group with a mean age of 33 years (range 17 to 43 years). The PCL group consisted of four males and one female with a mean age of 27 years (range 23 to 32 years). Three patients had combined anterior and posterior cruciate ligament injuries. In the ACL group, six patients had associated meniscus injuries. The time interval from injury to operation ranged from three to 26 months in ACL injuries, and from eight to 17 weeks in PCL injuries. Partial ruptures involving the ACL were evaluated according to the criteria proposed by Barrack et al.[1] Inclusion criteria for PCL injuries were the following: Posterior drawing of 10 mm or less compared to the healthy side, no rotational instability, and no avulsion fracture.

All the patients received conservative treatment for three months before thermal shrinkage. Thermal shrinkage was performed using ArthroCare (ArthroCare Corp., Sunnyvale, CA, USA) generating bipolar radiofrequency. The power was set at level 2, the temperature was maintained at 65 °C, and the contact speed to each part was 10 mm/sec. For each patient, thermal shrinkage was performed twice in ACL injuries, and four times in PCL injuries. Through the arthroscopic procedure, a bipolar radiofrequency tool (ArthroCare) was inserted and the procedure was performed in the flexed and extended state depending on the ligament composition (Fig. 1, 2).

In partial ACL injuries, posterior translation was applied to the tibia during the procedure. While the knee joint was immobilized at 10°, thermal shrinkage was performed on the posterolateral side at 90° flexion followed by the anteromedial side at 10° flexion. For PCL injuries, with force applied to the anterior translation state, the procedure was performed on the posteromedial side at 90° flexion, and on the anterolateral side at 10° flexion.

All the knees were immobilized with a brace for six weeks at 10° flexion for postoperative rehabilitation. Partial weight-bearing was allowed after four weeks followed by full weight-bearing at six weeks. The mean follow-up period was eight months (range 3 to 13 months). Postoperative functional evaluations were made according to the modified Lysholm knee scoring scale.[2]

RESULTS

The mean modified Lysholm knee scores were 76 prior to operation and 86 three months after the operation. Instability experienced at everyday activities (10 points) improved to instability after exercise and severe fatigue (15 points). Claudication that was mild or severe (0-3 points) prior to the operation improved to mild or no claudication (3-5 points). Pain perceived by the patient after rigorous exercise improved from mild or moderate (15-20 points) to mild (20 points).

Efficient thermal shrinkage was observed immediately after the operation. However, two patients in the ACL group and two patients in the PCL group developed recurrent knee laxity after the operataion.

DISCUSSION

Thermal shrinkage is known as a new technique that shortens the collagen fiber by heat created by laser or radiofrequency energy to treat shoulder instability.[3-7]

The number of ACL and PCL injuries is on the incline due to increases in traffic accidents and sports injuries. However, the treatment of these structures is still controversial.

The definition of ACL partial ruptures is still debatable. We defined ACL partial ruptures according to that proposed by Barrack et al.,[1] which includes the following criteria: 1) at least one continuous ligament bundle is observed during arthroscopy and continuity is observed in the arthroscopic anterior drawer test; 2) the presence of less than 5 mm translation in the Lachman test and 3) elicitation of an insignificant or negative result in the pivot-shift test.

Partial ruptures can also be divided into two groups. The first group encompasses partial ruptures within the synovial membrane, thereby causing mild to no bleeding and mild functional defect. The diagnosis of these ruptures is difficult and they are frequently misdiagnosed. The second group represents more important defects with mild joint effusion, which yield a normal result in the anterior drawer test, but are associated with defective joint movements, thereby leading to a misdiagnosis of a meniscus injury.[8] Meniscus ruptures were observed in 53% of patients with partial ruptures of the cruciate ligaments, and in a few cases (13%), cartilage fractures were detected.[9] In our study, six patients with ACL injuries also had a meniscus injury.

Sufficient protection is required in partially ruptured patients due to the progression of the rupture to a complete ACL rupture in 50% of the cases. In addition, partial ruptures recurred in 75% of the cases within two years.[10]

Compared to ACL injuries, PCL injuries are much less frequent, but their incidence is on the increase and their contribution is about 2% to 23% to total knee joint injuries. In the past, the importance of PCL injuries was somewhat ignored and

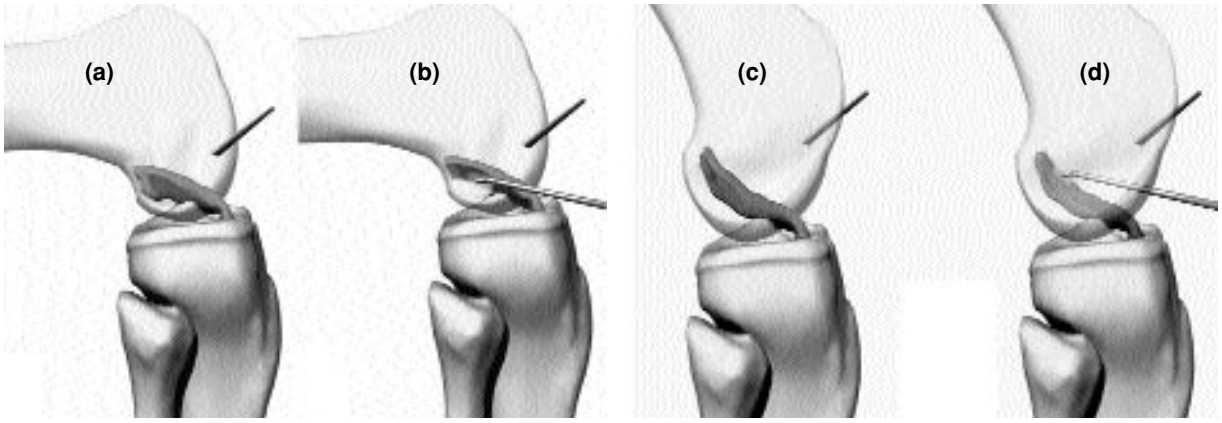

Fig. 1. (a) Posterolateral band of the ACL is relaxed at 90° flexion and **(b)** radiofrequency shrinkage was performed. **(c)** Anteromedial band of the ACL is relaxed at 10° flexion and **(d)** radiofrequency shrinkage was performed.

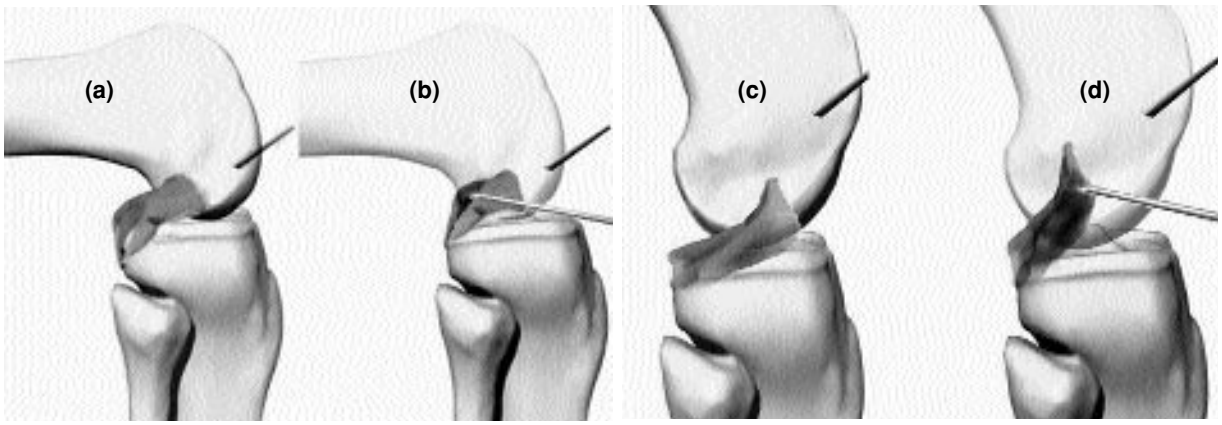

Fig. 2. (a) Posteromedial band of the PCL is relaxed at 90° flexion and **(b)** radiofrequency shrinkage was performed. **(c)** Anterolateral band of the PCL is relaxed at 10° flexion and **(d)** radiofrequency shrinkage was performed.

they were not treated except in cases of displaced avulsion fractures of the tibia. However, many reports drew attention to the possibility of early degenerative arthritis caused by chronic posterior instability, and emphasized the need for early PCL repair or reconstruction, especially in multidirectional instability.[11-13]

The posterior cruciate ligament is a structure outside the synovial membrane of the knee joint. The treatment is known to be similar to treating the medial collateral ligament. Abundant blood supply gives the PCL a superior healing potential compared to that of the ACL.[6,14,15] It is composed of the anterolateral and posteromedial bundles. The anterolateral bundle is known to play a more important role in stabilizing the knee.[16] In our patients, stability was accomplished by performing thermal shrinkage to the anterolateral bundle showing laxity at the flexion state, and to the posteromedial bundle at the extended state. In addition, thermal shrinkage was performed to the anterolateral and posteromedial parts in the flexed and extended states, respectively, to correct asymmetric changes and restore stability. In the early follow-up, recovery resistance to posterior translation was observed.

Techniques for PCL reconstruction have undergone significant development, with varying results. Injuries accompanying PCL ruptures can also influence the outcome. There are many reports of good results, especially in isolated PCL injuries treated with conservative therapy.[12,17] However, Keller et al.[11] reported that, following conservatively treated isolated PCL injuries, 90% of patients complained of pain, and 65% of patients showed limitation of movement, and degenerative changes in radiographic studies. Torg et al.[13] noted that, in the natural history of PCL injuries, accompanying multidirectional instability resulted in poor prognosis, justifying the need for operative treatment.[13] In our study, patients with posterior instability of grade 3 or higher and posterolateral instability were excluded.

Treatment with thermal shrinkage in patients with a partial ACL rupture, or grade 1-2 PCL injury was associated with improvement in instability, pain, and claudication, all of which persisted when treated with conservative therapy.[18-21]

In conclusion, thermal shrinkage using radiofrequency is a recommendable procedure in treating active young patients with partial cruciate ligament ruptures, showing symptoms of ligament laxity, which is not indicated for reconstruction. Yet, concerning this procedure, long-term follow-up and case-control studies are needed.

REFERENCES

1. Barrack RL, Buckley SL, Bruckner JD, Kneisl JS, Alexander AH. Partial versus complete acute anterior cruciate ligament tears. The results of nonoperative treatment. J Bone Joint Surg [Br] 1990;72:622-4.
2. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med 1982;10:150-4.
3. Allain JC, Le Lous M, Bazin S, Bailey AJ, Delaunay A. Isometric tension developed during heating of collagenous tissues. Relationships with collagen cross-linking. Biochim Biophys Acta 1978;533:147-55.
4. Danielsen CC. Precision method to determine denaturation temperature of collagen using ultraviolet difference spectroscopy. Coll Relat Res 1982;2:143-50.
5. Finch A, Ledward DA. Shrinkage of collagen fibres: a differential scanning calorimetric study. Biochim Biophys Acta 1972;278:433-9.
6. Kronick PL, Cooke P. Thermal stabilization of collagen fibers by calcification. Connect Tissue Res 1996; 33:275-82.
7. Verzar F, Nagy IZ. Electronmicroscopic analysis of thermal collagen denaturation in rat tail tendons. Gerontologia 1970;16:77-82.
8. Ihara H, Miwa M, Takayanagi K, Nakayama A. Acute torn meniscus combined with acute cruciate ligament injury. Second look arthroscopy after 3-month conservative treatment. Clin Orthop Relat Res 1994;(307): 146-54.
9. Lawrance JA, Ostlere SJ, Dodd CA. MRI diagnosis of partial tears of the anterior cruciate ligament. Injury 1996;27:153-5.
10. Fritschy D, Panoussopoulos A, Wallensten R, Peter R. Can we predict the outcome of a partial rupture of the anterior cruciate ligament? A prospective study of 43 cases. Knee Surg Sports Traumatol Arthrosc 1997;5:2-5.
11. Keller PM, Shelbourne KD, McCarroll JR, Rettig AC. Nonoperatively treated isolated posterior cruciate ligament injuries. Am J Sports Med 1993;21:132-6.
12. Miller MD, Bergfeld JA, Fowler PJ, Harner CD, Noyes FR. The posterior cruciate ligament injured knee: principles of evaluation and treatment. Instr Course Lect 1999;48:199-207.
13. Torg JS, Barton TM, Pavlov H, Stine R. Natural history of the posterior cruciate ligament-deficient knee. Clin Orthop Relat Res 1989;(246):208-16.
14. Alm A, Stromberg B. Vascular anatomy of the patellar and cruciate ligaments. A microangiographic and histologic investigation in the dog. Acta Chir Scand Suppl 1974;445:25-35.

15. McDougall JJ, Bray RC. Vascular volume determination of articular tissues in normal and anterior cruciate ligament-deficient rabbit knees. Anat Rec 1998;251:207-13.
16. Harner CD, Janaushek MA, Ma CB, Kanamori A, Vogrin TM, Woo SL. The effect of knee flexion angle and application of an anterior tibial load at the time of graft fixation on the biomechanics of a posterior cruciate ligament-reconstructed knee. Am J Sports Med 2000; 28:460-5.
17. Dandy DJ, Pusey RJ. The long-term results of unrepaired tears of the posterior cruciate ligament. J Bone Joint Surg [Br] 1982;64:92-4.
18. Farng E, Hunt SA, Rose DJ, Sherman OH. Anterior cruciate ligament radiofrequency thermal shrinkage: a short-term follow-up. Arthroscopy 2005;21:1027-33.
19. Lubowitz JH. Thermal modification of the lax anterior cruciate ligament using radiofrequency: efficacy or catastrophe? Knee Surg Sports Traumatol Arthrosc 2005;13:432-6.
20. Roach R, Roberts S, Rees D. The potential benefit of thermal shrinkage for lax anterior cruciate ligaments. Acta Orthop Belg 2004;70:247-52.
21. Carter TR. Anterior cruciate ligament thermal shrinkage. Clin Sports Med 2002;21:693-700.