

The use of dacron synthetic ligament prosthesis in the reconstruction of anterior cruciate ligament

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Ön çapraz bağ rekonstrüksiyonunda dacron sentetik ligaman protezinin kullanımı

Serimizde kronik ÖÇB instabilitesi olan 33 hastaya dakron ligament protezi uygulandı. 4 değişik teknik uygulandı; sadece dacron ligament, iliotibial bantla hazırlama, m. sartoriusun anteriora nakli ve pes plasti girişimleri ile kombine dacron ligaman uygulanması, dacron ligamanın Mac Intosh tekniği gibi uygulanması. Lysholm skoru preop 24-64, postop ortalama 91 idi. Tegner aktivite skoru preop 3-10 ve postop en az 4 idi. Dakron ligamanın, bizim serimizde önemli komplikasyonu olmayan ÖÇB rehabilitasyonu için iyi bir metod olduğuna inanıyoruz.

Anahtar kelimeler: Dacron sentetik ligamanı, ön çapraz bağ, diz eklemi

Dacron ligament prosthesis was applied to 33 cases for chronic ACL instability, in our department. We used four different techniques; only dacron ligament, preparation with iliotibial band, dacron ligament prosthesis application with anterior transfer of m. sartorius with combination of pes plasty procedures, the application of dacron ligament like Mac Intosh technique. Lysholm score was preoperatively 24-64, postoperatively average 91. Tegner activity score was preoperatively 3-10 and postoperatively at least 4. We believe that dacron ligament prosthesis is useful in ACL reconstruction without important complications.

Key words: Dacron synthetic ligament, ACL, knee joint

The dacron ligament prosthesis application is a new procedure in the treatment of chronic instabilities of the knee; since the tissues severely injured require reconstruction and the autogenic tissues are insufficient for the control of laxity.

Dacron ligament protheses were applied to 33 cases with chronic knee instability because of the anterior cruciate insufficiency between January 1986 and January 1991 in Orthopaedics and Traumatology Department of Gülhane Military Academy during 60 months period.

All of our cases were men. Their age range was between 21 and 39 (mean 23.71) and follow-up period was between 3 and 57 months (mean 39) postoperatively.

With four different technique we applied dacron ligament prosthesis;

1. Only the use of dacron ligament.
2. Preparation with iliotibial band.
3. Dacron ligament prosthesis application with anterior transfer of m. sartorius or with combination of pes plasty procedures.
4. The application of dacron ligament similar Mac Intosh technique.

Patients knee stabilities are controlled with Stryker knee laxity tester. They were evaluated by Lysholm knee score and Tegner activity score in the pre-and postoperative period as preoperative Lysholm score was 24-64 (mean 52) the postoperative average 91. Tegner activity score was between 3 and 10 preoperatively and was at least 4 postoperatively.

As a postoperative complication, superficial infection in 2 cases, chronic synovitis in 3 cases, staple breakage as result of fall down in case, excessive force manipulation during the rehabilitation caused anterior laxity in one case were seen.

As a results, the findings we obtained showed us that dacron ligament prosthesis is useful for the reconstruction of anterior cruciate lesions and we have not seen any important complication during the postoperative period.

Introduction

Surgical interventions to reconstruct the ACL rupture or insufficiency are among the most important orthopaedic problems which should be solved immediately today. Whereas isolated ACL rupture is often

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seen after athletic injuries, the adjacent tissue, the other ligaments and menisci injuries are usually seen after traffic accidents and other traumatic injuries.

For this reason, the reconstruction methods with autogenic tissues, with allogenic tendon grafts and with synthetic materials are developed for the ACL insufficiency. In contrast with the good results achieved by the reconstruction operations with autogenic tissues, it has been reported that a decrease at the effectiveness, rate and the relapse of instability could be seen during the longterm follow up. In these cases, the use of allogenic tendon grafts (5, 13, 19, 20, 21) and artificial materials (2, 3, 4, 6, 9, 10, 11, 12, 18) at the ACL reconstruction are being considered. Demichew (5) and Shino (19, 20, 21) reported good results after the use of allografts which were taken from fresh uninfected cadavera but is still an uncommon method.

The most effective treatment way could not be found because of the various number of reconstruction methods of ACL rupture or insufficiency and the demoralizing affect of the longterm follow up. We can say that "The best way of reconstruction of ACL rupture or insufficiency is to prevent its occurrence". Because of these conflicts, biomechanical and laboratory studies about the synthetic ligament applications were being held and it still continues. In this study, we tried to analyze the most commonly used synthetic ligaments of today and report the results of dacron synthetic ligament prosthesis applications in our clinic.

Due to their functions, the synthetic ligaments are studied in three different classifications (4).

I. Stable prostheses

Gore-Tex (Polytetrafluoroethylene=Teflon)
 Gore-Tex CD
 Stryker-Dacron (Polyester)
 Stryker-ligament reconstruction device
 (Generation II)
 Telos Trevira (Polyester)
 Richards PACL (Polyethylene)
 Orthomed ligastic (Polyester)
 Lig Aid (Polyarilamid)
 Proflex Protek (Polyester)
 Apex Thackray (Polyester)

II. Stents

LAD-3 M (Polipropilen)
 StrykerPolyester LigamentAugmentation Graft
 Lig Aid
 Ligapro Protex
 Telos Trevira

III. Scoffolds

Leeds-eion dacron ligament (Polyester)
 Garbon

ABC Surgicrat (Dacron+Garbon) PDS

The synthetic ligaments which are approved by FDA (Foot and Drug Administration) are as follows:

1. Gore-Tex (October 1986)
2. LAD (November 1986)
3. Stryker Dacron (January 1989)

The main function of stents is based on stress shearing. They show their function by taking some of the stress of autologous grafts. Scaffolds have the property of fibrous tissue induction. The aim of these replacements is to construct a new ligament and to make it stronger by stress shearing. By the way, prostheses do not have this property. They only show their function as a replacer.

Meadox-Dacron vascular graft is constructed after the use of grafts at acromioclavicular separation. It is used at different tendons for reconstruction. There obtained some problems because of the weakness and easy abrasion of dacron. Gillquist used dacron graft as a stent (8). The 100 micron sized micropores of graft causes easy fibrous tissue ingrowth (4). There are two commercial types: One is only for intraarticular use and 20 cm long and the other one (Mac Intosh Type) is for both intra-extra articular use and 40 cm long. At the strain velocity of 110 % per second, the maximum breakage power is 3045 N and elongation is 15 %. This value is much lower than normal ACL (Normal 44%). Toughness value is two times higher than normal ACL. The use of graft as a scaffold has some disadvantages because of these properties. The high modulus of toughness and elasticity causes high risk of abrasion and stress shielding problem of fibrous tissue (4).

Dacron manufactured as a scaffold at the beginning. But some of the European Orthopaedic Surgeons and also the Gillquist preferred to use it as a permanent prosthesis. It is still used with iliotibial band in States (6). Lukianov et al, analyzed the dacron in use for both purposes and decided that it believe as permanent prosthesis rather than scaffold or stent (17) Dacron is approved by FDA at 1989.

Indications of synthetic ligament application (10, 11):

1. If the reconstruction with autologous tissue at the ACL absence or insufficiency is unsuccessful.
2. If the tissue which will be used for reconstruction is destroyed during the primary injury.
3. Primary at the absence or insufficiency of ACL.
4. Acute injury of ACL.

Contraindications of synthetic ligament application (10, 11):

1. Infection

Osteoarthritis

We applied the Stryker Meadox Dacron Velour graft to the patients with chronic ACL insufficiency with respect to this data and knowledge. We compared our results with the other authors studies and offered a result with the average of 29 months follow-up rate to the orthopaedic surgeons.

Material and method

We applied Dacron ligament prosthesis to the 33 patients with chronic knee instability because of ACL insufficiency at the Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between January 1986 and January 1991 in a 60 months period (average 29 months). All of the patients were male and their ages were between 21 and 39 (average 23.7). All of them are reexamined under general anaesthesia for instability. In order to not to skip anything.

Trauma was the primary cause of instability and athletic injuries were 25 %.

The most imported complications of patients were giving-way, swelling, pain, locking and crepitation.

The methods of diagnosis were;

1. History: Primary complaint, the type and duration of trauma, the treatment applied.

2. Physical examination:

Anterior drawer test

Rotatory instability test of Slocum

Varus and valgus stress test

Knee jerk test

3. Radiologic examination:

Instability is classified according to stress X-ray graphies

4. Arthrography

5. Evaluation with knee test equipment

6. Arthroscopy

We applied this method to 33 patients and incision type was chosen according to the instability and the surgical method planned before the operation. We observed menisci, joint faces, synovium and ligaments carefully when we entered joint space. One of the main reasons of the failure of synthetic ligament applications was false alignment of tendon rather than its isometric and anatomic position. We believe that we found the optimum position with the drillisation of tunnels at the lateral condyl of femur and proximal and of tibia with the help of Nisonson Drill Guide System (7, 10, 11). The important point here, is the availability of tunnel diameter to the choosen method and the ligament. Also lessening the sharpness of

tunnel edges prevents the abrasion risk. Since Indelicato (12) reported that most of the head results were the early cases that he did not applied notchplasty, we applied notchplasty before insertion of ligament (10, 11). Because of the probability of locked knee as a complication of ACL rupture, we applied excision to the all fragments of ruptured ACL. The other pathologic situations (Such as menisci tear etc.) were also treated before the reconstruction procedure. Reconstruction is applied according to the instability type and preoperative planning with the following methods:

1. At the cases with pure anterior instability; Dacron graft is passed through the prepared tunnels and fixed with a staple to the proximal end of tibia. Then by bringing the knee to 5-10 degrees of flexion (in the way instructed at Stryker Dacron graft booklet) we obtained maximum strength at the ligament and fixed it with another staple to the femoral condyl.

2. The follow-up results of this method showed that Dacron caused synovitis and 5-10 degrees of flexion did not let enough range of motion during the rehabilitation, so we modified it. In this method we prepared a 20 cm long and 2 cm. Wide band from iliotibial band letting its end at gerdy tübercule intact. We wrapped Dacron synthetic ligament over this prepared band and sutured them with usp "o" vicryl. In this way dacron graft became a tube wrapped with iliotibial band. This tube is passed through the prepared tunnels at the proximal tibia, (between the gerdy tübercule and insertion of ACL) and the lateral condyl of femur and then fixed at 30 degrees of flexion as the way mentioned before.

3. At the cases with anteromedial instability we applied anterior transfer of sartorius and pes plasty in addition to the method mentioned before.

4. We used 40 cm long Dacron synthetic ligament to the cases which showed necessity to lateral reconstruction. The graft wrapped with iliotibial band fixed to the lateral condyl of femur and then passed under fibular collateral ligament, later on it fixed with third staples to the lateral of tibia proximal in a stretched way (Modified Mac Intosh Method).

It is advised to use the ligament as over-the-top way in order to prevent the abrasion of synthetic ligament. It is impossible to apply an isometric alignment in this way. This is one of the most important causes of failure at reconstruction with synthetic ligaments. So we preferred the modification of this method. We applied a long leg cylindrical cast at the knee in 35-40 degrees of flexion and tibia in external rotation after the operation. We used broad spectrum antibiotic before the application of tourniquet and during the first 24 hours after the surgical intervention for prophylaxis. We used suction drain for all of the cases. We redrievied the drain at the postoperative first day and began the rehabilitation program under the control of a physiotherapist. We applied this program by choo-

sing the cases according to the programmes of Judy L. Seto et al (1, 15), and K. Donald Shelburne. We have taken the sutures away at the 12th postoperative day. We used the brace adapted from Lenox Hill (14) brace for 6 months duration.

Results

Instability:

Anterior: 11 cases

Anteromedial: 10 cases

Anterolateral: 6 cases

Combined: 7 cases

Intraarticular lesions observed:

Preoperative evaluation of patients: showed that;

ACL rupture: 23 cases

Fibrotic ACL: 10 cases

Medial meniscus tear: 11 cases

Lateral meniscus tear: 9 cases

Degeneration of lat. condyl: 5 cases

Degeneration of med. condyl: 8 cases

We tested our patients preoperatively for anterior laxity with laxity tester (Stryker Kalamazo Michigan). We found Grade I laxity at 20 cases Grade II laxity at 8 cases and Grade III laxity at 5 cases before reconstruction.

Subjective results:

Activity level and subjective results are evaluation according to the pain, crepitation, swelling, tackling, locking and instability bases. We used a 100 point scala for subjective results (23).

90 - 100 points	Verr good
80 - 89 points	Good
70 - 79 points	Satisfactory
< 79 points	Poor

Using this scala we obtained;

28 very good and good, 3 satisfactory and 2 poor results. 2 of the 3 satisfactory results happened chronic synovitis and the other one showed superficial infection. One of the 2 poor results broke the staple by falling on it and the other developed laxity because of over use during treatment. Our patients are evaluated according to Lysholm Knee Score (22). Lysholm Score contains 6 parameters: Pain, tackling, locking, swelling, instability, difficulty in stair climbing.

Patients are evaluated according to Lysholm Score as follows:

95 - 100	Very good
84 - 94	Good
65 - 83	Poor
> 64	Bad

Lysholm Score was between 24 and 64 (average 52) preoperatively. Postoperative average score was 91 (good). Our patients were between 3 and 10 according to activity level scala of Tegner preoperati-

vely (22). But except the two bad results, our cases reached to minimum 4 level postoperatively.

Functional results:

Functional results are evaluated on a 100 point scala. Activity evaluation is done according to criteria such as pain during running, stair climbing and jumping.

90 - 100	Very good
80 - 89	Good
70 - 79	Poor
> 69	Bad results

2 cases bad (one was broken staple and the other was developed laxity during treatment), 4 were poor (3 of them developed chronic synovitis and the other showed superficial infection) and 27 were good and very good.

Objective results:

The average flexion degree was 135 (between 115 and 150). 2 of the patients showed flexion less than 125 degrees. At three patients there were crepitation at the medial joint line and the 2 patients showed crepitation at the patello-femoral joint.

At 31 patients the pivot shift phenomenon was eliminated completely during the laxity tests for the determination of anterior laxity. We observed (+++) laxity in two patients. Medial and lateral laxity was less than 5 mm. on all of the cases. The one with chronic synovitis, the other one with broken staple and the one who developed laxity during treatment negatively affected the objective results.

Complications:

There were two kinds of complications; early and late. Early complications were, headache at 5 patients because of spinal anesthesia, superficial infection at 2 patients and hematoma at one patient. All of them eliminated at the later stages. Late complications were, chronic synovitis at 3 patients, staple breakage at one patient, ligament breakage at one patient and laxity development at one patient.

Discussion and conclusion:

The patients with knee instability must be more carefully evaluated because low grade collateral lesions may accompany to these lesions. If you overlooked these lesions, whatever the achievement rate of ACL reconstruction is, the result would never be satisfactory. For this reason the physical examination must be renewed before the surgical operation when the patient is under general anesthesia.

We reached 85 % good results at our series of 33 patients which we applied Dacron prostheses. To wrap the prostheses with iliotibial band is lowenford the synovitis incidence. The other combined methods chosen according to the instability type (i. e. Mac In-

tosh, Pesplasty) positively affected the final results. At 6 patients we followed for 5 years, the achievement rate was 85 %. Hart and et al. reported 84. 2% (52 cases). Jiunn-Jerwu 80 % (45 cases) and Gillquist 85 % (61 cases at 5 year follow-up) good results. The early results are hopeful, but at the later stages, still here is presence of high probability of breakage or risk of abrasion and synovitis. Because of these disadvantages, we believe that synthetic ligament must be applied according to the indication below and by giving at most attention to technical applications risk.

Genkins and Kennedy (16) often used synthetic materials at the acute ACL injuries or at chronic instabilities for the primary repairment device. But Woods (24) and us offer (10, 11) the use of synthetic materials if there is no autogenous tissue left for the primary repairment. (if all of the tissue disturbed during the initial trauma). Also you may use these implants if you had already used autogenous tissue for repairment but obtained bad results. We offer to keep this method as a saver for the future. Implant must carry the mechanic properties of normal tissue. It must have fibrinogenic capacity for collagen induction, and the developed fibrinogenic tissue must be at the same character with the morphologic properties of normal tissue (10, 11). We observed that Dacron graft have all of these properties but caused synovitis (10, 11). We concluded that wrapping it with iliotibial band is enough to prevent this complication and it must be applied in this way. Also this kind of application increases the stabilisation. We believe that Nisanson drill guide system help to achievement of good stabilisation and prevent the laxity development. Isometric points must be pointed out even with drill guide system or by observing with oyc or by manually and then the tunnel must be drilled. These are necessary for obtaining optimal ROM and maximum stability. It is very useful to lessen the sharpness of tunnel edges with a rasp in order to prevent abrasion risk. We believe that nochplasty also serves the same goal and it is very useful. 30 degrees of knee flexion during the implantation of ligaments is ideal and it is decided at our postoperative laxity test. We concluded that dacron synthetic ligament prosthesis is reliable at ACL reconstruction if you obey the rules mentioned above.

References

- Allen, F. A., and Brant, L.: Analysis of rehabilitation techniques after anterior cruciate reconstruction. *Am. J. Sports Med.* 17: 154-160, 1989.
- Amis, A. A.: The strength of artificial ligament enclrages. A comparative experimental study. *J. Bone Joint Surg.* 70-B: 397-403, 1988.
- Arnoczky, S. P., Torzilli, P. A., Warren, R. F., Allen, A. A.: Biologic fixation of ligament prostheses and augmentations. An evaluation of bone ingrowth in the dog. *Am. J. Sports. Med.* 16: 106-112, 1988.
- Balduini, F. C., Clemow, A. J. T., Lehman, R. C.: Synthetic ligaments. Scaffolds, stents, and prosthesis. Slack inc. New Jersey, 1986.
- Demichev, N. P.: Tendon hemoplasty in reconstructive surgery. 165-166, MIR Publishers Moscow, 1974.
- Friedman, M. J.: Prosthetic ligament reconstruction of the knee. 7th. International Symposium: Advances in cruciate ligament reconstruction of the knee. Autogenous prosthetic. Palm. Desert, California, March 1-3, 1990.
- George, F., Hewson, J. R.: Drill Guides for improving accuracy in anterior cruciate ligament repair and reconstruction. *Clin. Orthop. and Related Research.* 172: 119-124, 1983.
- Gillquist, J.: Experiences with the stryker-Meadox ligament prosthesis with a 5 year follow-up. 6th International symposium on advances in cruciate ligament reconstruction of the knee. Autogenous vs. Prosthetic Los Angeles C. A, March 3-5, 1989.
- Good, L., Torlow, S. D., Odensten, M., Gillquist, J.: Load tolerance, security, and failure modes of fixation devices for synthetic knee ligament. *Clin. Orthop.* 253: 190-196, 1990.
- Gür, E., Şarлак, Ö., Gürçan, O.: Anterior cruciate ligament rekonstrüksiyonunda sentetik materyaller. X. Millî Türk Ortopedi ve Travmatoloji Kongresi: 392-396, 1987.
- Gür, E., Baydar, M. L.: Anterior cruciate ligament rekonstrüksiyonunda dacron ligament protezi kullanılması. XII. Ulusal Rehabilitasyon Kongresi. 13-18 Kasım 1989.
- Indelicato, P. A., Pascale, M. S., Huegel, M. J.: Early experience with the Gore-Tex polytetrafluoroethylene anterior cruciate ligament prosthesis. *Am. J. Sports Med.* 17: 55-62, 1989.
- Jackson, D. W., Grood, E. S., Arnoczky, S. P., Blutler, D. L., Simon, T. M.: Freeze dried anterior cruciate ligament allograft. *Am. J. Sports Med.* 15: 295-302, 1987.
- James, A., Nicholas, M. D.: Bracing the anterior cruciate ligament deficient knee using the Lenox Hill derotation brace. *Clin. Orthop. and Related Research.* 172: 137-142, 1983.
- Seto, J. L., Brewster, C. E., Lombardo, S. J., Tibone, J. E.: Rehabilitation of the knee after anterior cruciate ligament reconstruction. *The Journal of Orthop. and Sports Physical Therapy.* July: 8-18, 1989.
- Kennedy, J. C.: Application of prosthetics to anterior cruciate ligament reconstruction and repair. *Clin. Orthop.* 172: 125-128, 1983.
- Gillquist, J.: A multicenter study on the results of ACL reconstruction using a dacron ligament prosthesis in "Salvage" cases. *Am. J. Sports Med.* Vol. 17, No 3: 380-386, 1989.
- Olson, E. J., Kang, J. D., Georgeuscu, H. I., Mason, G. C., Evans, C. H.: The biochemical and histological effects of artificial ligament wear particles: In vitro and invivo studies. *Am. J. Sports Med.* 16: 558-570, 1988.
- Shino, K., Kimura, T., Hirose, H., Inoue, M., Ono, K.: Reconstruction of the anterior cruciate ligament by allogenic tendon graft. *J. Bone Joint Surg.* 68-B: 739-745, 1986.
- Shino, K., Inoue, M., Horibe, S., Nagano, J., Ono, K.: Maturation of allograft tendons transplanted in to the knee. *J. Bone Joint Surg.* 70-B: 556-560, 1988.
- Shino, K.: Reconstruction of the anterior cruciate ligament using allogenic tendon: long term follow-up. 8th. Annual Chersy Blossom seminar on anterior cruciate ligament. Washington, T. C. March 31 April 2, 1989.
- Tagner, V., Lysholm, J., Gillquist, J.: Evaluation of cruciate ligament injuries. *Acta Orthop. Scand.* 59 (3): 336-341, 1988.
- Timothy, S., Hunter, E. R.: Acute anterior cruciate ligament repair. *Clinical Orthop. and related research.* 227: 238-250, 1988.
- Woods, Gn. N.: Synthetics in anterior cruciate ligament reconstruction. A review. *Clin. Orthop. North Am.* 162-2: 227-234, 1985.

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