



Fibrin sealant in the treatment of acute ruptures of the Achilles tendon: long-term results

Akut Aşil tendon yırtıklarının tedavisinde fibrin yapıştırıcı uygulaması:
Uzun dönem sonuçlar

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Objectives: This study aims to point out the long-term results of fibrin sealant in the treatment of acute ruptures of the Achilles tendon.

Patients and methods: Between January 1998 and December 2007, 42 patients (42 males; mean age 37.8 years; range 27 to 56 years) admitted to our clinic for acute ruptures of the Achilles tendon were treated with a fibrin sealant. The average time to surgery from injury was 2.0 (range 1 to 4) days. The patients were divided into two groups; in the first 32 patients fibrin sealant was used which was heated for preparation. In the second group of 10 patients we used fibrin sealant which did not require heating for preparation.

Results: The mean follow-up period was 51.5 (range 24 to 92) months. The Thermann scoring system was used to evaluate the patients postoperatively in both the early and the final follow-ups. We found that the Thermann scores of some patients slightly decreased in the advanced age group when compared to younger patients long-term, but the overall result remained unchanged by time. Only one patient needed to be re-operated for a re-rupture resulting from resumption of daily work and sports activities.

Conclusion: Treatment of acute Achilles tendon ruptures with fibrin sealant can be one of the first choices selected because of its lower complication rate and equal results when compared to other treatment options.

Key words: Achilles tendon; fibrin tissue adhesive; rupture.

Amaç: Bu çalışmada Aşil tendonunun akut yırtıklarının tedavisinde fibrin yapıştırıcının uzun dönem sonuçlarına dikkat çekildi.

Hastalar ve yöntemler: Ocak 1998 - Aralık 2007 tarihleri arasında Aşil tendonunun akut yırtıkları nedeni ile kliniğimize başvuran 42 hasta (42 erkek; ort. yaş 37.8 yıl; dağılım 27-56 yıl) fibrin yapıştırıcı ile tedavi edildi. Yaralanmadan sonra ameliyata kadar geçen süre ortalama 2.0 (dağılım 1-4) gün idi. Hastalar iki gruba ayrıldı; ilk 32 hastada hazırlanma aşamasında ısıtılması gereken fibrin yapıştırıcı kullanılırken, 10 kişilik ikinci grupta ısıtma gerektirmeyen fibrin yapıştırıcı kullanıldı.

Bulgular: Ortalama izlem süresi 51.5 (dağılım 24-92) ay idi. Hastalar ameliyat sonrası erken ve son izlemde Thermann puanlama sistemi kullanılarak değerlendirildi. İleri yaş grubundaki bazı hastalarda Thermann puanının, genç hastalara göre uzun dönemde hafif azaldığı saptandı, fakat genel sonuç zaman içinde değişiklik göstermedi. Sadece bir hasta günlük işine ve sportif faaliyetlerine geri dönme sonucu yeniden oluşan yırtılma nedeniyle tekrar ameliyat edildi.

Sonuç: Fibrin yapıştırıcı ile akut Aşil tendon yırtıklarının tedavisi, diğer tedavi seçeneklerine göre düşük komplikasyon oranı ve eşdeğer sonuçlar vermesi nedeniyle, ilk seçilebilecek yöntemlerden biri olabilir.

Anahtar sözcükler: Aşil tendonu; fibrin doku yapıştırıcısı; yırtık.

There is still controversy regarding the optimal treatment option for acute Achilles tendon ruptures. Recent treatment choices can be categorized as operative (open or percutaneous) and non-operative (conservative). Each option has advantages and disadvantages.^[1-3] Although open operative repair of a ruptured Achilles tendon has a lower re-rupture rate when compared to conservative treatment, patients usually suffer from wound problems with open repair.^[4] Percutaneous repair is quite practical but its rate of sural nerve morbidity and re-rupture rate is higher than other open management modalities.^[5] As an alternative to surgical treatment methods, minimally invasive (limited open) surgical repair techniques by using fibrin sealant have also been reported.^[6-8] Fibrin sealant has been used for many years and has a wide range of medical applications.^[9-15] This study has one of the highest numbers of Achilles tendon rupture treated with fibrin sealant. The aim of this study is to point out the long-term results of fibrin sealant in the treatment of acute ruptures of the Achilles tendon while eliminating the potential complications of the other surgical repairs or conservative treatment.

PATIENTS AND METHODS

This prospective study included 42 patients (42 males; mean age 37.8 years; range 27 to 56 years) with complete acute ruptures of the Achilles tendon who were treated surgically with fibrin sealant between November 1998 and December 2007 (Table I). Written consents were obtained from all patients. In all cases, injury happened as a feeling of "pop" sound heard around the ankle followed by pain during sports-related activity. Achilles tendon ruptures were initially diagnosed by physical examination and clinical tests. Active plantar flexion of the ankle was found defective and the Thompson test was positive in all patients. Ultrasonography was also performed to support the diagnosis. Prior to surgery all patients were immobilized in an above-the-knee splint with the foot in plantar flexion. The average time to surgery from injury was 2.0 (range 1 to 4) days.

The medial incision in classic fashion was used for the surgical exposures with a simple incision about 5 to 7 cm long in order to see both ends of the ruptured tendon. To preserve the integrity of the paratenon, it was dissected longitudinally. The patients were divided into two groups; in the

first 32 patients fibrin sealant was used which was heated (Tisseel, Baxter Healthcare Corp., Deerfield, IL, USA) for preparation. In the second group of 10 patients we used fibrin sealant which did not require heating (Beriplast P, Aventis Behring GmbH, Germany) for preparation. The fibrin sealant kit was prepared in a sterile fashion and injected into the surgical area with sterile syringes (Figure 1). Both ends of the ruptured tendon were trimmed and their fibers were gradually re-attached with fibrin sealant beginning from the deep toward the superficial layers (Figure 2, 3). The ankle was held in plantar flexion for about five minutes to allow the fibrin sealant to stiffen. The paratenon was carefully closed with 4/0 vicryl over the restored area. Finally we tested the ankle movements as well as the stability of repair by the sites' firmness since we did not use any core sutures. An above-the-knee cast was applied while holding the ankle in slight plantar flexion and the knee at 30 degrees of flexion. Two weeks after the surgery a second below-the-knee cast was applied which was worn for an additional four weeks. Once the cast was removed, a walker boot was applied which allowed full plantar flexion with zero degree dorsal flexion. During these two weeks, patients wore a walker boot which allowed full range of motion and complete weight-bearing. After the end of the second month of surgery patients were allowed complete weight-bearing without any supportive devices.

For complete clinical healing, patients were examined for the absence of "gap" formation and asked for the presence of any pain with full weight-bearing. Two assessments were performed according to the Thermann scoring system in all patients for comparison of the results. Assessment were collected at 12 months after surgery and at the last or the control visit (mean 51.5 months).^[15]

RESULTS

The mean interval between injury and surgery was 2.0 (range 1 to 4) days. The average operation time was 22.9 (range 20 to 30) minutes (casting time not included). The mean follow-up time was 51.5 (range 24 to 92) months. According to the Thermann scoring system, early postoperative results were excellent in 33 patients and good in nine patients. The mean of the early postoperative Thermann score was 91.2 (range 83 to 96). All patients stood on their toes with the operated extremity in three

months after surgery. One patient had a re-rupture of the Achilles tendon three weeks after surgery because the below-the-knee cast was removed earlier and the patient was treated with a second application of fibrin sealant using the same method. Only one patient had a re-rupture; he returned to work six months after the second surgery and had also resumed his amateur sports activities by the 8th month. Average clinical healing was obtained at 4.3 (range 2 to 8) months. In the latest control, the average Thermann score was 91.4 (range 81 to 97; Table I). But we observed that the number of excellent scores (90-100) were 28 and, good results (80-89)

were 14. There was no persistent pain, deep infection, wound site problem or any disease transfer due to the fibrin sealant use in the latest follow-up.

DISCUSSION

The options for optimal treatment of Achilles tendon ruptures and their relative advantages and disadvantages have been discussed in the literature for many years.^[1-5,16] The most important advantages of operative treatment are rigid repair and lower re-rupture rate. Percutaneous techniques have lower wound site problems but they still have potential risk for sural nerve morbidity. On the other hand,

TABLE I

The results of the patients treated with fibrin sealant

No	Age	Time interval from rupture to surgery (days)	Healing time (According to clinical examination), (months)	Follow-up period (months)	Early postoperative score (Thermann) at 12 months after surgery	Latest postoperative score (Thermann) at final visit
1	45	2	5	92	96	89
2	45	3	6	83	94	88
3	38	1	5	73	93	95
4	41	4	5.5	72	84	89
5	40	3	7	54	87	90
6	34	1	6	60	90	92
7	42	1	6.5	46	85	87
8	40	2	8 (Re-rupture)	58	83	81
9	40	3	6	46	92	93
10	39	2	6.5	48	92	91
11	30	2	5.5	49	90	92
12	35	2	6	44	94	95
13	39	2	6	55	96	97
14	36	1	6	38	84	90
15	37	2	6	36	90	93
16	42	1	5	43	96	89
17	35	1	6	37	83	91
18	36	1	5	48	87	93
19	40	1	5.5	39	92	88
20	30	1	3	47	90	94
21	46	1	3	54	92	86
22	49	1	2	46	94	85
23	33	2	2	48	96	97
24	56	2	2	54	93	88
25	30	3	3	55	92	95
26	42	1	3	58	93	90
27	29	3	2	68	94	95
28	34	4	3	63	94	96
29	36	3	5	68	92	92
30	28	1	4	79	87	93
31	31	4	2	89	90	94
32	44	2	3	78	92	89
33	37	3	4	43	92	93
34	36	1	3	44	90	94
35	44	1	3	59	94	89
36	27	1	2	57	96	97
37	43	2	3	32	96	88
38	28	1	3	26	90	93
39	37	3	3	24	96	95
40	47	3	3	30	94	87
41	38	3	3	27	90	92
42	30	4	3	29	87	95



Figure 1. Fibrin sealant kit ready for an application.

with conservative treatment, there are no surgery-related problems but higher re-rupture rates.^[1,4] This fibrin sealant treatment did not show any deterioration in loss of strength and re-rupture of Achilles tendon over long term care.

Fibrin sealants have been used for tendon repairs since 1982. In the literature, positive effects of fibrin sealants on tendon healing have been shown in animal studies.^[9-14,17] Fibrin sealant is a blood-derived product and a biological adhesive tissue which includes thrombin, fibrinogen, aprotinin, factor XIII and CaCl_2 . Both fibrinogen and thrombin components are prepared from

plasma. Fibrin sealant imitates the final stages of the coagulation cascade and converts fibrinogen to fibrin through thrombin. Once the coagulation process is started, thrombin activates factor XIII, which forms covalent cross-bindings with fibrin. Factor XIII stabilizes the fibrin clot by promoting polymerization and cross linking of fibrin chains in the presence of Ca^{+2} ions. To prevent the fibrin from fast fibrinolysis, aprotinin is added the sealant material.^[8,18] Aprotinin produces an antifibrinolytic effect by inhibiting the turnover of plasminogen to plasmin. Fibrin clot organization is completed in two weeks after implementation and then is degraded physiologically.^[19] Fibrin sealants prepared from donors are screened like any other blood products because of the risk of blood-related transition of diseases.

As mentioned above, fibrin has really provocative effects on tendon healing. However, because of its degradation process after two weeks, the body's self healing mechanism replaces the fibrin. During this period, it is important to maintain initial immobilization and to start controlled as well as gradual range of motion. By the end of the second month, we commenced full range of motion in our patients.

Repair of Achilles tendon ruptures with fibrin sealant is a kind of internal splinting.^[5] Both ends of the ruptured tendon are attached to each other in a regular and more appropriate way to their fundamental alignment. There is no vascular supply or circulation problem due to absence of tension related to sutures. Because it requires a relatively short

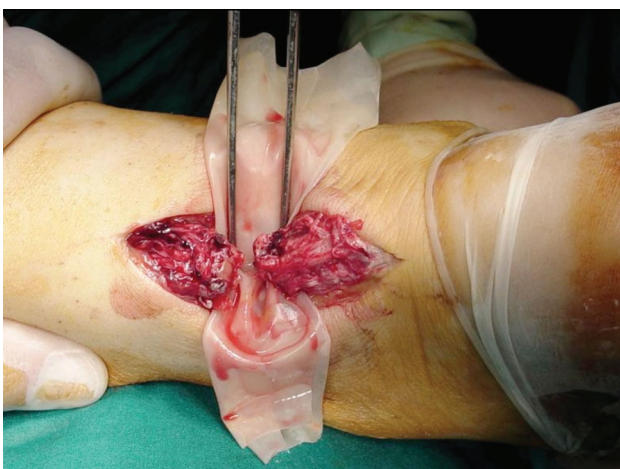


Figure 2. Ruptured ends of Achilles tendon preoperatively.



Figure 3. Immediate postoperative appearance of the ruptured ends.

incision and it has less wound site complications, the repair of the tendon is considered a “minimally invasive” surgical treatment method.

A biomechanical study of Thermann et al.,^[9] compared the results of three different management methods for the repair of rabbit tendon models (a surgical repair with polydioxanone sutures, surgical repair with fibrin sealant and conservative treatment). They reported that results of tendon repairs in the polydioxanone suture group and fibrin sealant group were superior to conservative treatment groups at the early period of repair but this superiority was not continued at further period of healing. With this knowledge and at this point, we believe that repair of acute Achilles tendon ruptures with fibrin sealant is a minimally invasive and a conservative treatment method. Owing to fibrin sealant, Achilles tendon fibers can be arranged in the appropriate alignment and complications related with surgery can be avoided.

Haas et al.^[20] reported quite successful results in 35 patients treated by fibrin sealant. Similarly, Kuskucu et al.^[6] also reported successful results and low complication rates (re-rupture complication in one case) in 32 cases with fibrin sealant. Opinions of both authors are that fibrin sealant has a positive contribution and enough healing potential in acute Achilles tendon ruptures and it generates a matrix for favorable tendon healing.^[6,9-15,21] Redaelli et al.^[22] compared the results of 20 patients treated with fibrin sealant and 25 patients treated surgically with Kessler suture. The rate of complications was lower and the results were better in patients treated with fibrin sealant. In the literature re-rupture rates of Achilles tendon repairs were reported as 1.4% in surgically treated groups and 13% in conservatively treated groups.^[4,5,8] In our patients, there was one re-rupture (2.4%) in the 3rd week after the repair because the patient did not follow the treatment protocol. Our rehabilitation protocol was compliant with the findings of Atik et al.^[23] suggesting early and aggressive rehabilitation after Achilles tendon surgery to prevent adhesions between tendons and surrounding soft tissues, and weakness of the muscles.

In a recent research, Hohendorff et al.^[7] treated 42 patients (31 patients treated with fibrin sealant and 11 patients treated with suture) and this also demonstrated a successful outcome after long follow-up period. There were no differences between

the two groups of isokinetic strength measurements; however the Thermann scores and the complication rates were better for patients who were treated with the fibrin sealant.^[7] These same authors conducted another study whether augmentation with the plantaris tendon is necessary or not in patients treated with fibrin sealant.^[8] The fibrin sealant only group consisted of 16 patients and the fibrin sealant group augmented with plantaris tendon consisted of 15 patients. After comparing the two groups, they made a conclusion that augmentation with plantaris tendon is not necessary when the Achilles tendon ruptures and is treated with fibrin sealant. Based on our study's results, we also believe that augmentation is not necessary and that fibrin sealant alone maintains enough strength for the treatment of acute Achilles tendon ruptures.

While the mean of the early postoperative Thermann score was 91.2 (range 83 to 96), the average Thermann score was found as 91.4 (range 81 to 97) in the latest control. Since the overall Thermann score remained unchanged in the long-term, we assumed that slight decrease in some of the cases were due to advanced age of the patients which were over 40 at the time of injury.

In conclusion, fibrin sealant has been used for a considerably long period of time in the treatment of acute Achilles tendon ruptures. The results of our study are consistent with previous studies and we observed affirmative results with unchanged Thermann scores in the long term. The treatment of acute Achilles tendon ruptures with fibrin sealants should be one of the first selected methods considering its lower complication rates and equal or better outcomes compared to other treatment methods.

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