The Longitudinal Course of Conservative Treatment for Plantar Fasciitis

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The Longitudinal Course of Conservative Treatment for Plantar Fasciitis

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ABSTRACT

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Introduction: Although previous studies have revealed the risk factors related to the development of plantar fasciitis, little is known about the predictive factors for early outcome and recurrence of conservatively treated plantar fasciitis. This study evaluated the predictive factors for early outcome and recurrence during a longitudinal course of conservatively treated plantar fasciitis.

Materials and Methods: In the retrospective analysis, 429 feet of 276 patients were included. The unfavorable early outcomes were defined as no improvement in the visual analog scale (VAS) at 1 month after treatment. Possible predictive factors were included in the analysis of the unfavorable early outcomes. To evaluate recurrence, 290 feet of the 184 patients who achieved complete remission (CR) of the symptoms after conservative treatment were analyzed using the possible predictive factors.

Results: By the last follow-up, CR was achieved in 377 feet (87.9%). The mean time to reach CR was 4.4 months after treatment. The rate of recurrence was 51.0%. An age-matched analysis showed that the body mass index (BMI), symptom duration before treatment, and daily total standing time (TST) were significant predictive factors for an unfavorable early outcome. With regard to recurrence, TST was the only covariate that was significant after the adjustment. TST ≥120 min/day was significant in the analyses of early outcome and recurrence with an odds ratio of 9.256 (95% confidence interval [CI], 4.801-17.844) and a hazards ratio of 2.760 (95% CI, 1.841-4.139).

Conclusions: To achieve favorable early outcomes and no recurrence, conservatively treated plantar fasciitis patients should be informed about modifiable factors (e.g., lowering their BMI, scheduling early clinic visits before the disorder becomes chronic, and shortening their daily TST).

Key words : Early outcome; Recurrence; Conservative treatment; Plantar fasciitis

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I. INTRODUCTION

Plantar fasciitis, the most common cause of inferior heel pain, is one of the most frequent disorder treated in ≥2 million patients in the Unites States annually.[1-3] Approximately one in ten adults experience heel pain in his or her lifetime.[3] A study on United States military service members revealed that the overall unadjusted incidence rate of plantar fasciitis was 10.5 per 1,000 persons per year.[4] In their matched case-control study, Riddle et al. reported that a decrease in the range of ankle dorsiflexion, prolonged weight bearing, and a body mass index (BMI) >30 kg/m2 are risk factors for plantar fasciitis.[5] Additionally, poor cushioning of the heel and abnormal foot biomechanics were suggested as other potential risk factors for plantar fasciitis.[6]

Plantar fasciitis is commonly treated in a conservative manner, which

includes non-steroidal anti-inflammatory drugs (NSAIDs), exercises for stretching the Achilles tendon, night splint therapy, steroid injections, extracorporeal shockwave treatment (ESWT), orthoses and footwear modification.[2,6-8] However, little is known about the course of conservative treatment in plantar fasciitis, which is the treatment of choice in the clinical setting. Surprisingly, a study that systematically reports the success rates, prognostic factors related to success, rates of complete remission (CR) of the symptoms, and recurrence during the longitudinal course of conservative treatment does not exit. Because many plantar fasciitis patients consider the disorder a minor yet annoying condition of the heel that can be treated fast and easily, early treatment outcomes and the prevention of symptom recurrence are important. Although plantar fasciitis is a self-limiting condition, Wolgin et al. reported that the prolonged period before seeking medical attention is related to its continued symptoms.[2,9] After taking every aforementioned point into account, it was thought to be necessary to evaluate the longitudinal course of conservative treatment in plantar fasciitis. Therefore, the current study aimed to determine the predictive factors for early outcomes and recurrence during the longitudinal course of conservatively managed plantar fasciitis.

II. MATERIALS AND METHODS

1. Patients and early outcome measurements

The medical records and radiographic findings of 539 plantar fasciitis patients (840 feet; 301 patients with bilateral involvements) who were treated in our foot and ankle clinic from March 2008 to December 2012 were reviewed retrospectively. To evaluate the early responsiveness of conservative treatment,

the inclusion criteria were as follows:

- Clinically diagnosed as inflammation of plantar fascia[2,6]
- ≥12 months of follow-up
- Conservative treatment only (i.e., NSAIDs and stretching exercises for the plantar fascia and Achilles tendon)

Since the current study aimed to evaluate the longitudinal course of conservative treatment for plantar fasciitis in terms of early outcome and recurrence, the exclusion criteria were:

- Other causes of painful heel syndrome such as entrapment of the fist branch of the lateral plantar nerve, tumors, infections or stress fracture[2,6]
- <12 months of follow-up
- Received any other type of treatment during the follow-up period (e.g., insole application, steroid injection, ESWT, etc.)
- Treatment history at another institution before or during treatment at our hospital
- Any event that required a prolonged period of immobilization or non-ambulatory status (e.g., fracture of the lower extremity or spine, abdominal surgery, etc.)
- A dramatic change in the daily total standing time (TST) after diagnosis of plantar fasciitis

After applying these criteria, 276 patients (429 feet; 100 males and 176 females) were included (Fig. 1).

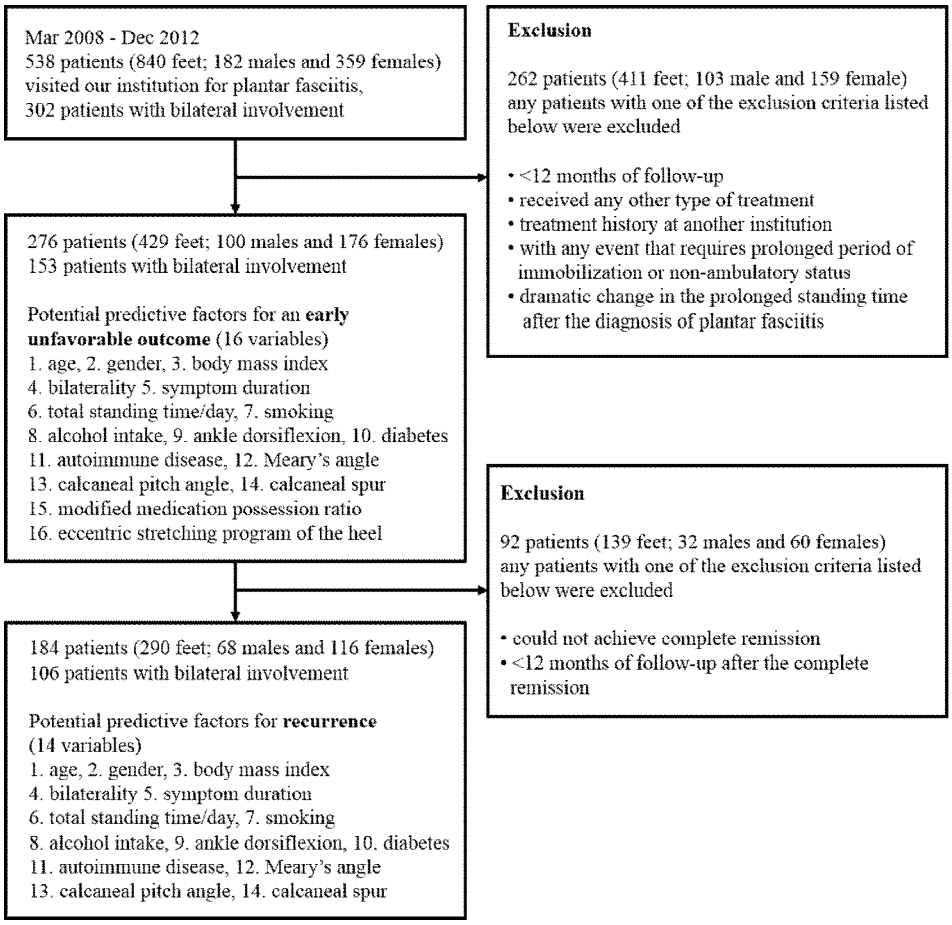

Fig. 1. Schematic flow diagram of the current study.

The mean age was 50.3 years (S.D., 13.8; range, 16-89). The mean follow-up was 22.4 months (S.D., 7.8; range, 12-53). There were 153 patients with plantar fasciitis in both feet, and the rate of bilateral involvement was 55.4%. Since the clinical courses for the right and left foot of a single patient may have different courses, bilateral involvement was considered as two separate cases. Therefore, the analyses were conducted using 429 cases. The basic characteristics of the 429 cases are summarized in Table 1.

Table 1. Basic characteristics of the cases according to each cohort.

	Cohort for first analysis (early outcome, n = 429 feet)	**Cohort for second analysis** (recurrence, n = 290 feet)
Age, years		
10 – 19, n (%)	10 (2.3)	8 (2.8)
20 – 29, n (%)	32 (7.5)	21 (7.2)
30 – 39, n (%)	49 (11.4)	32 (11.0)
40 – 49, n (%)	94 (21.9)	63 (21.7)
50 – 59, n (%)	151 (35.2)	108 (37.2)
60 – 69, n (%)	62 (14.5)	44 (15.2)
70 – 79, n (%)	30 (7.0)	13 (4.5)
80 – 89, n (%)	1 (0.2)	1 (0.3)
Gender; male, n (%), female, n (%)	151 (35.2), 278 (64.8)	103 (35.5), 187 (64.5)
Involved side; right, n (%), left, n (%)	198 (46.2), 231 (53.8)	134 (46.2), 156 (53.8)
Bilaterality, n (%)	306 (71.3)	206 (71.0)
Body mass index, kg/m^2		
< 18.5, n (%)	8 (1.9)	4 (1.4)
18.5 – 23, n (%)	182 (42.4)	134 (46.2)
23 – 25, n (%)	106 (24.7)	67 (23.1)
25 – 30, n (%)	124 (28.9)	77 (26.6)
≥ 30, n (%)	9 (2.1)	8 (2.8)

Symptom duration before the first OPD visit, months		
< 1, n (%)	85 (19.8)	54 (18.6)
1 – 3, n (%)	86 (20.0)	55 (19.0)
≥ 3, n (%)	258 (60.1)	181 (62.4)
Total standing time, minutes/day		
< 30, n (%)	247 (57.6)	167 (57.6)
30 – 120, n (%)	111 (25.9)	74 (25.5)
≥ 120, n (%)	71 (16.6)	49 (16.9)
Smoking		
Never, n (%)	336 (78.3)	225 (77.6)
Quit before more than a month, n (%)	28 (6.5)	19 (6.6)
Quit after OPD visit, n (%)	6 (1.4)	2 (0.7)
Current smoker, n (%)	59 (13.8)	44 (15.2)
Alcohol intake, g/day		
Never or former	263 (61.3)	178 (61.4)
0.1-to-10.0	99 (23.1)	70 (24.1)
10.1-to-20.0	47 (11.0)	29 (10.0)
≥ 20.0	20 (4.7)	13 (4.5)
Ankle dorsiflexion, °		
≥ 0, n (%)	319 (74.4)	223 (76.9)
< 0, n (%)	110 (25.6)	67 (23.1)
Diabetes mellitus		

No, n (%)	384 (89.5)	252 (86.9)
Yes, n (%)	45 (10.5)	38 (13.1)
Autoimmune disease		
No, n (%)	419 (97.7)	284 (97.9)
Yes, n (%)	10 (2.3)	6 (2.1)
Mean lateral talar-first metatarsal angle, ° (S.D.)	3.3 (6.7)	3.3 (6.6)
Mean calcaneal pitch angle, ° (S.D.)	20.1 (4.3)	20.5 (4.3)
Calcaneal spur		
No	252 (58.9)	173 (59.7)
Yes	176 (41.1)	117 (40.3)
Mean modified medication possession ratio: (total prescribed days – remained days) / 30 days, ratio (S.D.)	0.5 (0.4)	0.5 (0.4)
Eccentric stretching program of heel, minutes/day		
Never	90 (21.0)	64 (22.1)
< 30, n (%)	287 (66.9)	194 (66.9)
≥ 30, n (%)	52 (12.1)	32 (11.0)
Mean period of follow-up, months (S.D.; range)	22.1 (7.5; 12 – 53)	20.6 (6.2; 12 – 41)*

OPD = outpatient department

* The mean follow-up period for the second cohort: the follow-up period after complete remission of symptoms

First, using the cohort of 429 feet, the factors related to early unfavorable outcomes after the conservative treatment of plantar fasciitis were analyzed. At the first outpatient department (OPD) visit, the following 14 variables were recorded:

- Age
- Gender
- BMI (kg/m^2; < 18.5, 18.5-23, 23-25, 25-30, and ≥ 30.0)
- Bilaterality
- Symptom duration before the first OPD visit (SxD, months; < 1, 1-3, and ≥ 3)
- TST per day (min/day; < 30, 30-120, and ≥ 120)
- Smoking (never, quit more than a month before the OPD visit, quit after OPD visit, and current smoker)
- Alcohol intake (calculated based on consumption of the regionally traditional beverage called soju, [1 unit of soju = 10g of ethanol, g/day]; never or former drinker, 0.1-10.0, 10.1-20.0, and ≥ 20.0)
- Ankle dorsiflexion (°; < 0 and ≥ 0)
- Presence of diabetes mellitus (DM)

- Presence of an autoimmune disease (e.g., ankylosing spondylitis, Reiter's syndrome, and rheumatoid arthritis)
- Lateral talar-first metatarsal angle (Meary's angle, °; a positive value indicates convex upward) (Fig. 2; A)[10]
- Calcaneal pitch angle (°; a positive value indicates higher anterior process of the calcaneus than the postero-inferior corner of the calcaneus) (Fig. 2; B)[10]
- Presence of a calcaneal spur (Fig. 2; C).

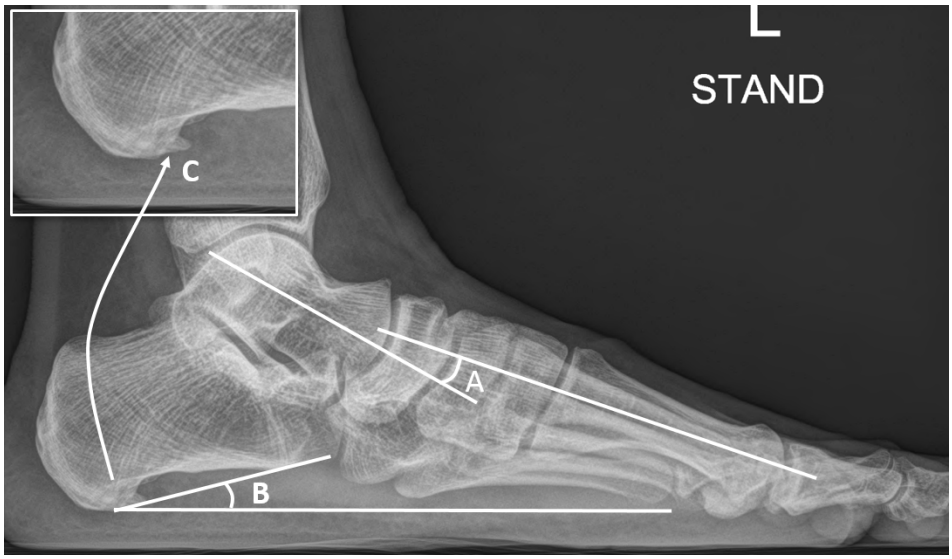

Fig. 2. Values measured from a standing lateral radiograph of the foot. (A) lateral talar-first metatarsal angle (a positive value indicates convex upward), (B) calcaneal pitch angle, which is the angle between a line tangent to the plantar border of the calcaneus and a line from the plantar-most point of the calcaneus to the plantar-most point of the distal fifth metatarsal, (C) calcaneal

spur (arrow).

For the daily TST, patients were asked about their sum duration of silent weight bearing (i.e., without movement of the lower extremities). The lateral talar-first metatarsal angle, calcaneal pitch angle, and presence of a calcaneal spur were measured from lateral standing radiographs.

The conservative treatment consisted of NSAIDs and eccentric stretching of the plantar fascia and Achilles tendon. Patients were recommended to repeat the Achilles tendon stretching using a wall, perform plantar fascia-specific stretching prior to weight bearing, and perform dynamic stretching over an iced 15-oz can at least 30 min/day.[1,7,11,12] Patients were taught how to maintain a single stretching maneuver for 30 sec and to repeat it 10 times as one set of stretching. At least six sets of stretches were recommended daily.

At the next OPD visit after 4 weeks from the initial visit, two more variables were assessed:

- Modified medication possession ratio (modified MPR; [(total prescribed days – remaining days) / 30 days]: e.g., for a 30-day oral pill prescription, if the remaining oral pills were 20 days, than (30 – 20)/30 = 0.33)[13]
- Eccentric stretching program of the heel (ESP, min/day; never, <30, and ≥30)

After 4 weeks of treatment, the responsiveness to the treatment was assessed. The outcome measurement was performed using a 10-point visual analog scale (VAS). A change in the VAS at 4 weeks of the same or higher value relative to

the initial VAS was defined as an unfavorable early outcome. Any improvement in the VAS at 4 weeks compared to the initial VAS was classified as a control.

2. Measurement of recurrence

Further OPD follow-ups were continued every month for the first 3 months and every 3 months for the next 9 months. However, not all patients adhered to our treatment schedule because of their individual condition and circumstances. We encouraged patients to continue the treatment programs until CR of the symptoms. In addition, we recommended that patients maintain follow-ups for at least 12 months after achieving CR. The overall number of feet that achieved CR was 377 (87.9%), whereas the symptoms were sustained in 52 feet (12.1%) at the last follow-up. In 377 feet, the mean time to achieve CR was 4.4 months after treatment initiation (S.D., 3.6; range, 0.25-20).

For the subsequent analysis of recurrence, 377 feet were assessed. We applied the second set of inclusion criteria:

- Achievement of CR
- At least 12 months of follow-up after CR

Ninety-two patients who were unable to achieve CR or who could not be followed for >12 months were excluded.

Finally, 290 feet (184 patients; 68 males and 116 females) were included in the second analysis of recurrence after conservative treatment of plantar fasciitis (Fig. 1). The mean age of the 184 patients was 49.8 years (S.D., 13.3; range, 16-89), and the mean follow-up was 24.6 months (S.D., 7.1; range, 13-53). The end point of the analysis for recurrence was defined as any re-appearance of

previous inferior heel pain. In the analysis, the 14 variables, which were recorded at the initial OPD visit, were only considered. Since patients do not usually continue our conservative treatment modality after CR, the two variables, modified MPR and ESP, evaluated at the second OPD visit (4 weeks after treatment initiation) were not considered as potential predictive factors in the recurrence analysis. The basic characteristics of the second cohort are also summarized in Table 1.

3. Statistical analysis

Demographic data of each group were compared using independent *t*-test and Fisher's exact test. The two-tailed values of $p < 0.05$ were considered significant. For the main purposes of the current study, the predictive factors of early unfavorable outcomes in patients conservatively treated for plantar fasciitis were analyzed firstly. As described earlier, 490 feet were included, and 16 candidate variables were analyzed using univariable and multivariable logistic regression. Covariates with a p-value < 0.10 were entered into a multivariable logistic regression analysis. Backward elimination was then used to remove non-significant variables. In a multivariable logistic regression analysis, a p-value < 0.05 was considered significant. The associations were estimated according to odds ratio (OR) and 95% confidence intervals (CI).

To take into account the time from CR to recurrence, unlike the analysis for early outcome, the Cox proportional hazards model was used in the analysis of recurrence. Again, univariable and multivariable Cox analyses were performed with significance of 0.10 and 0.05, respectively. The associations were estimated according to the relative hazards ratio (HR) and 95% CIs. For the

significant categorical variables from multivariable analysis, the survival times were calculated from the date of CR and were considered censored for cases that had no recurrence at the last follow-up. The recurrence-specific survival curve was generated by the Kaplan-Meier product-limit method and was compared using the log-rank test. Statistical analysis was performed using SPSS v20.0 (SPSS Inc., Chicago, Illinois, USA).

III. RESULTS

1. Demographic data of investigated subjects

The mean initial VAS and the mean VAS after 4 weeks of treatment were 2.9 (S.D., 0.9; range, 1-6) and 1.9 (S.D., 1.3; range, 0-6), respectively. The VAS improved after 4 weeks of treatment to 1.0 (mean difference, -1.0; S.D., 1.2; paired *t*-test, *p*-value < 0.001). In 47 feet (11.0%), the symptoms completely disappeared before the second OPD visit (i.e., CR was achieved within 1 month). A comparison between the improved VAS and unimproved VAS groups showed that bilaterality, BMI, SxD, daily TST, smoking, modified MPR, and ESP were significantly different (Table 2).

Table 2. Demographic data of the VAS-improved and –unimproved groups (n = 429 feet).

	VAS improved group (n = 248 feet)	**VAS unimproved group** (n = 181 feet)	***p*-value**
Age, years			0.076*
10 – 19, n (%)	4 (1.6)	6 (3.3)	

20 – 29, n (%)	16 (6.5)	16 (8.8)	
30 – 39, n (%)	23 (9.3)	26 (14.4)	
40 – 49, n (%)	58 (23.4)	36 (19.9)	
50 – 59, n (%)	97 (39.1)	54 (29.8)	
60 – 69, n (%)	29 (11.7)	33 (18.2)	
70 – 79, n (%)	20 (8.1)	10 (5.5)	
80 – 89, n (%)	1 (0.4)	0 (0)	
Gender; male, n (%), female, n (%)	79 (31.9), 169 (60.8)	72 (39.8), 109 (60.2)	0.102*
Involved side; right, n (%), left, n (%)	114 (46.0), 134 (54.0)	84 (46.4), 97 (53.6)	1.000*
Bilaterality, n (%)	162 (65.3)	144 (79.6)	0.002*
Body mass index, kg/m2			< 0.001*
< 18.5, n (%)	7 (2.8)	1 (0.6)	
18.5 – 23, n (%)	125 (50.4)	57 (31.5)	
23 – 25, n (%)	58 (23.4)	48 (26.5)	
25 – 30, n (%)	55 (22.2)	69 (38.1)	
≥ 30, n (%)	3 (1.2)	6 (3.3)	
Symptom duration before the first OPD visit, months			0.027*
< 1, n (%)	60 (24.2)	25 (13.8)	
1 – 3, n (%)	48 (19.4)	38 (21.0)	
≥ 3, n (%)	140 (56.5)	118 (65.2)	
Total standing time, minutes/day			< 0.001*

< 30, n (%)	185 (74.6)	62 (34.3)	
30 – 120, n (%)	44 (17.7)	67 (37.0)	
≥ 120, n (%)	19 (7.7)	52 (28.7)	
Smoking			0.035*
Never, n (%)	206 (83.1)	130 (71.8)	
Quit before more than a month, n (%)	14 (5.6)	14 (7.7)	
Quit after OPD visit, n (%)	2 (0.8)	4 (2.2)	
Current smoker, n (%)	26 (10.5)	33 (18.2)	
Alcohol intake, g/day			0.341*
Never or former	158 (63.7)	105 (58.0)	
0.1-to-10.0	55 (22.2)	44 (24.3)	
10.1-to-20.0	27 (10.9)	20 (11.0)	
≥ 20.0	8 (3.2)	12 (6.6)	
Ankle dorsiflexion, °			0.738*
≥ 0, n (%)	186 (75.0)	133 (73.5)	
< 0, n (%)	62 (25.0)	48 (26.5)	
Diabetes mellitus			0.114*
No, n (%)	227 (91.5)	157 (86.7)	
Yes, n (%)	21 (8.5)	24 (13.3)	
Autoimmune disease			0.334*
No, n (%)	244 (98.4)	175 (96.7)	
Yes, n (%)	4 (1.6)	6 (3.3)	
Mean lateral talar-first metatarsal angle, ° (S.D.)	2.8 (7.4)	4.0 (5.5)	0.072†

Mean calcaneal pitch angle, ° (S.D.)	19.9 (4.2)	20.5 (4.3)	0.151†
Calcaneal spur			0.320*
No	140 (56.7)	112 (61.9)	
Yes	107 (43.3)	69 (38.1)	
Mean modified medication possession ratio: (total prescribed days – remained days) / 30 days, ratio (S.D.)	0.5 (0.3)	0.5 (0.4)	0.015†
Eccentric stretching program of heel, minutes/day			0.002*
Never	39 (15.7)	51 (28.2)	
< 30	182 (73.4)	105 (58.0)	
≥ 30	27 (10.9)	25 (13.8)	
Mean period of follow-up, months (S.D.)	22.4 (7.6)	21.7 (7.2)	0.320†

* Fisher's exact test

† Independent *t*-test

2. Risk factors for unfavorable early outcome

Table 3 shows the predictive factor analysis of unfavorable early outcomes in conservatively treated plantar fasciitis. The covariates of the univariable analysis used in the multivariable analysis were gender, bilaterality, BMI, SxD,

daily TST, smoking, DM, lateral talar-first metatarsal angle, modified MPR, and ESP. According to multivariable analysis, bilaterality, BMI, SxD, and TST were significant factors for unfavorable early outcomes. A BMI more than 30 kg/m^2 and a daily TST more than 120 min/day had the highest ORs of 33.951 (95% CI, 2.197-524.641) and 9.256 (95% CI, 4.801-17.844), respectively. The significant covariates with multiple categories showed proportionally increasing ORs in each variable.

Table 3. Factors predictive of unfavorable early outcome at 1 month from the initiation of conservative treatment.

	Univariable analysis		**Multivariable analysis**	
	Unadjusted OR (95% CI)	***p*-value**	**Adjusted OR** (95% CI)	***p*-value**
Age, years		0.119		-
10 – 19	Reference		-	
20 – 29	0.667 (0.158 – 2.821)		-	
30 – 39	0.754 (0.189 – 3.007)		-	
40 – 49	0.414 (0.109 – 1.567)		-	
50 – 59	0.371 (0.100 – 1.373)		-	
60 – 69	0.759 (0.195 –		-	

	2.956)			
70 – 79	0.333 (0.076 – 1.458)		-	
80 – 89	0.000 (0.000)		-	
Gender		0.090*		0.683
Male	Reference		Reference	
Female	0.708 (0.474 – 1.056)		1.127 (0.634 – 2.005)	
Bilaterality		0.001*		0.002†
Unilateral	Reference		Reference	
Bilateral	2.066 (1.323 – 3.227)		2.339 (1.378 – 3.970)	
Body mass index, kg/m2		< 0.001*		< 0.001†
< 18.5	Reference		Reference	
18.5 – 23	3.192 (0.384 – 26.555)		4.799 (0.460 – 50.050)	
23 – 25	5.793 (0.689 – 48.744)		10.344 (0.976 – 109.569)	
25 – 30	8.782 (1.049 – 73.532)		13.364 (1.269 – 140.751)	
≥ 30	14.000 (1.135 – 172.642)		33.951 (2.197 – 524.641)	
Symptom duration before		0.030*		0.004†

the first OPD visit, months				
< 1	Reference		Reference	
1 – 3	1.900 (1.010 – 3.573)		2.101 (0.988 – 4.466)	
≥ 3	2.023 (1.194 – 3.426)		2.864 (1.540 – 5.328)	
Total standing time, minutes/day		< 0.001*		< 0.001†
< 30	Reference		Reference	
30 – 120	4.544 (2.820 – 7.320)		5.354 (3.131 – 9.154)	
≥ 120	8.166 (4.486 – 14.865)		9.256 (4.801 – 17.844)	
Smoking		0.042*		0.704
Never	Reference		Reference	
Quit before more than a month	1.585 (0.732 – 3.431)		1.376 (0.547 – 3.466)	
Quit after OPD visit	3.169 (0.572 – 17.549)		2.904 (0.345 – 24.470)	
Current smoker	2.011 (1.150 – 3.517)		0.976 (0.494 – 1.930)	
Alcohol intake, g/day		0.354		-
Never or former	Reference		-	

0.1-to-10.0	1.204 (0.755 – 1.920)			-				
10.1-to-20.0	1.115 (0.594 – 2.090)			-				
≥ 20.0	2.257 (0.892 – 5.709)			-				
Ankle dorsiflexion, °			0.722				-	
≥ 0	Reference			-				
< 0	1.083 (0.699 – 1.677)			-				
Diabetes mellitus			0.112				-	
No	Reference			-				
Yes	1.652 (0.889 – 3.072)			-				
Autoimmune disease			0.259				-	
No	Reference			-				
Yes	2.091 (0.582 – 7.522)			-				
Lateral talar-first metatarsal angle, °	1.026 (0.996 – 1.056)		0.087*	1.028 (0.993 – 1.065)			0.120	
Calcaneal pitch angle, °	1.034 (0.988 – 1.081)		0.152	-			-	

Calcaneal spur		0.281			-
No	Reference		-		
Yes	0.806 (0.545 – 1.192)		-		
Modified medication possession ratio	1.937 (1.136 – 3.302)	0.015*	1.328 (0.690 – 2.553)		0.396
Eccentric stretching program of heel, minutes/day		0.003*			0.074
Never	Reference		Reference		
< 30	0.441 (0.273 – 0.714)		0.529 (0.300 – 0.934)		
≥ 30	0.708 (0.357 – 1.405)		0.765 (0.339 – 1.727)		

* Significant variables according to univariable logistic regression analysis (p-value < 0.10)

† Significant variables according to multivariable logistic regression analysis (p-value < 0.05)

2. Risk factors for recurrence

The second study cohort was compared in accordance with recurrence. The rate of recurrence after CR of the initial symptoms was 51.0% (148 / 290 feet). The comparisons showed a significant difference in TST, mean follow-up

period after the CR, and mean symptom-free period after the CR (Table 4).

Table 4. Demographic data of the non-recurred and recurred groups.

	Non-recurred group (n = 142 feet)	**Recurred group** (n = 148 feet)	***p*-value**
Age, years			0.530*
10 – 19, n (%)	2 (1.4)	6 (4.1)	
20 – 29, n (%)	7 (4.9)	14 (9.5)	
30 – 39, n (%)	17 (12.0)	15 (10.1)	
40 – 49, n (%)	32 (22.5)	31 (20.9)	
50 – 59, n (%)	56 (39.4)	52 (35.1)	
60 – 69, n (%)	23 (16.2)	21 (14.2)	
70 – 79, n (%)	5 (3.5)	8 (5.4)	
80 – 89, n (%)	0 (0.0)	1 (0.7)	
Gender; male, n (%), female, n (%)	48 (33.8), 94 (66.2)	55 (37.2), 93 (62.8)	0.624*
Involved side; right, n (%), left, n (%)	64 (45.1), 78 (54.9)	70 (47.3), 78 (52.7)	0.725*
Bilaterality, n (%)	93 (65.5)	113 (76.4)	0.052*
Body mass index, kg/m2			0.046*
< 18.5, n (%)	2 (1.4)	2 (1.4)	
18.5 – 23, n (%)	74 (52.1)	60 (40.5)	
23 – 25, n (%)	36 (25.4)	31 (20.9)	
25 – 30, n (%)	27 (19.0)	50 (33.8)	

≥ 30, n (%)	3 (2.1)	5 (3.4)	
Symptom duration before the first OPD visit, months			0.219*
< 1, n (%)	32 (22.5)	22 (14.9)	
1 – 3, n (%)	24 (16.9)	31 (20.9)	
≥ 3, n (%)	86 (60.6)	95 (64.2)	
Total standing time, minutes/day			< 0.001*
< 30, n (%)	106 (74.6)	61 (41.2)	
30 – 120, n (%)	26 (18.3)	48 (32.4)	
≥ 120, n (%)	10 (7.0)	39 (26.4)	
Smoking			0.921*
Never, n (%)	111 (78.2)	114 (77.0)	
Quit before more than a month, n (%)	8 (5.6)	11 (7.4)	
Quit after OPD visit, n (%)	1 (0.7)	1 (0.7)	
Current smoker, n (%)	22 (15.5)	22 (14.9)	
Alcohol intake, g/day			0.292*
Never or former	81 (57.0)	97 (65.5)	
0.1-to-10.0	40 (28.2)	30 (20.3)	
10.1-to-20.0	16 (11.3)	13 (8.8)	
≥ 20.0	5 (3.5)	8 (5.4)	
Ankle dorsiflexion, °			0.487*
≥ 0, n (%)	112 (78.9)	111 (75.0)	

< 0, n (%)	30 (21.1)	37 (25.0)	
Diabetes mellitus			0.728*
No, n (%)	122 (85.9)	130 (87.8)	
Yes, n (%)	20 (14.1)	18 (12.2)	
Autoimmune disease			0.114*
No, n (%)	137 (96.5)	147 (99.3)	
Yes, n (%)	5 (3.5)	1 (0.7)	
Mean lateral talar-first metatarsal angle, ° (S.D.)	3.4 (6.8)	3.1 (6.3)	0.638†
Mean calcaneal pitch angle, ° (S.D.)	20.4 (4.1)	20.6 (4.6)	0.627†
Calcaneal spur			0.120*
No	78 (54.9)	95 (64.2)	
Yes	64 (45.1)	53 (35.8)	
Mean time to achieve the complete remission of symptom, months (S.D.)	3.5 (3.1)	4.0 (3.0)	0.219†
Mean follow-up period after the complete remission of symptom, months (S.D.)	19.6 (6.4)	21.6 (5.8)	0.005†
Mean symptom-free period after the complete remission of symptom, months (S.D.)	19.6 (6.4)	7.9 (4.2)	< 0.001†

* Fisher's exact test

† Independent *t*-test

Univariable analysis of recurrence showed that bilaterality, BMI, and daily TST were significant covariates (Table 5). However, daily TST was the only covariate that was significant after the adjustment (*p*-value < 0.001).

Table 5. Predictive factors for recurrence after conservative treatment of plantar fasciitis.

	Univariable analysis		**Multivariable analysis**	
	Unadjusted HR (95% CI)	***p*-value**	**Adjusted HR** (95% CI)	***p*-value**
Age, years		0.159		-
10 – 19	Reference		-	
20 – 29	0.756 (0.290 – 1.968)		-	
30 – 39	0.473 (0.184 – 1.221)		-	
40 – 49	0.486 (0.202 – 1.165)		-	
50 – 59	0.456 (0.196 – 1.063)		-	
60 – 69	0.448 (0.181 – 1.111)		-	

70 – 79	0.604 (0.210 – 1.742)		-	
80 – 89	4.226 (0.499 – 35.793)		-	
Gender		0.611		-
Male	Reference		-	
Female	0.917 (0.657 – 1.280)		-	
Bilaterality		0.039*		0.055
Unilateral	Reference		Reference	
Bilateral	1.491 (1.020 – 2.178)		1.452 (0.992 – 2.125)	
Body mass index, kg/m2		0.045*		0.123
< 18.5	Reference		Reference	
18.5 – 23	0.786 (0.192 – 3.219)		0.952 (0.228 – 3.971)	
23 – 25	0.917 (0.219 – 3.833)		1.060 (0.249 – 4.518)	
25 – 30	1.393 (0.339 – 5.728)		1.495 (0.356 – 6.276)	
≥ 30	1.578 (0.306 – 8.142)		2.006 (0.386 – 10.425)	
Symptom duration before		0.317		-

the first OPD visit, months				
< 1	Reference		-	
1 – 3	1.499 (0.868 – 2.589)		-	
≥ 3	1.366 (0.859 – 2.172)		-	
Total standing time, minutes/day		< 0.001*		< 0.001*
< 30	Reference		Reference	
30 – 120	2.209 (1.511 – 3.230)		2.231 (1.525 – 3.263)	
≥ 120	2.828 (1.887 – 4.237)		2.760 (1.841 – 4.139)	
Smoking		0.989		-
Never	Reference		-	
Quit before more than a month	1.108 (0.597 – 2.058)		-	
Quit after OPD visit	1.136 (0.159 – 8.143)		-	
Current smoker	0.999 (0.633 – 1.577)		-	
Alcohol intake, g/day		0.252		-
Never or former	Reference		-	

0.1-to-10.0	0.693 (0.460 – 1.043)		-	
10.1-to-20.0	0.799 (0.448 – 1.426)		-	
≥ 20.0	1.249 (0.607 – 2.569)		-	
Ankle dorsiflexion, °		0.477		-
≥ 0	Reference		-	
< 0	1.145 (0.789 – 1.661)		-	
Diabetes mellitus		0.473		-
No	Reference		-	
Yes	0.835 (0.510 – 1.367)		-	
Autoimmune disease		0.172		-
No	Reference		-	
Yes	0.254 (0.036 – 1.817)		-	
Lateral talar-first metatarsal angle, °	0.998 (0.974 – 1.023)	0.886	-	-
Calcaneal pitch angle, °	1.010 (0.973 – 1.047)	0.610	-	-

Calcaneal spur		0.129	-
No	Reference		-
Yes	0.771 (0.551 – 1.079)		-

* Significant variables according to univariable Cox proportional hazards model analysis (p-value < 0.10)

† Significant variables according to multivariable Cox proportional hazards model analysis (p-value < 0.05)

The longer the patients were weight bearing, the higher the HR. Cases with a daily TST > 120 min/day showed an HR of 2.760 (95% CI, 1.841-4.139). The daily TST was the only covariate that was a significant predictive factor for early unfavorable outcome and recurrence. The least standing time group (< 30 min/day) showed a significantly lower recurrence rate compared to the longer standing time groups (Fig. 3).

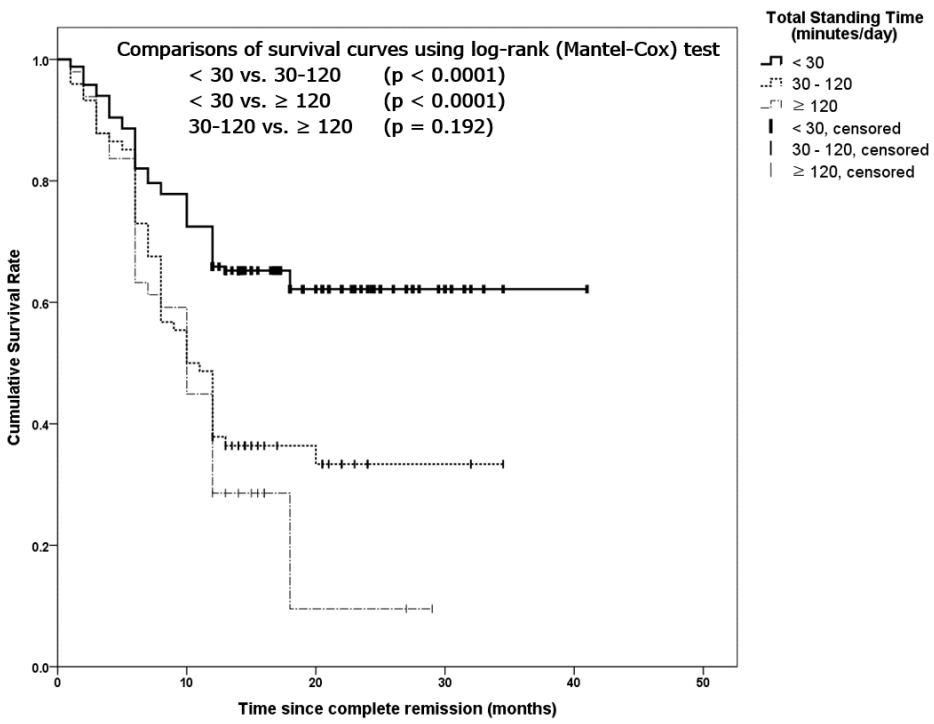

Fig. 3. Kaplan-Meier analysis of the recurrence of plantar fasciitis. The estimated cumulative survival rate is shown with respect to the total standing time (min/day). The least standing time group (< 30 min/day) showed a significantly lower recurrence rate compared to the longer standing time groups.

The mean survival times (recurrence-free) of the < 30 min/day, 30-120 min/day, and ≥120 min/day groups were 28.5 months (S.E., 1.3; 95% CI, 26.0-31.0), 16.8 months (S.E., 1.5; 95% CI, 13.7-19.8), and 11.6 months (S.E., 1.2; 95% CI, 9.3-13.9), respectively.

IV. DISCUSSION

1. Early outcome

The significant predictive factors of early unfavorable outcome in conservatively treated plantar fasciitis patients were bilateral involvement, a higher BMI, longer SxD, and longer TST. Although Wolgin et al. reported a long-term response, which was different from that observed in our study, they noted that continued symptoms limiting activity resulted from overweight, bilateral plantar fasciitis, and presence of symptoms for a prolonged period before seeking medical attention.[9] All these three factors were also significant for early outcome in our study. However, they did not consider the daily TST related to patient's occupation and activity. The highest OR for unfavorable early outcome was found in patients with the longest daily TST (≥ 120 min/day). Compared with the risk factors related to the development of plantar fasciitis, our results showed that the BMI and activity level also contributed to early outcome.[5,14] A decreased range of ankle dorsiflexion had no influence on the early outcome of conservatively treated plantar fasciitis.

In terms of reliability and validity, there is skepticism with using the VAS for clinical research.[15,16] Since the most prominent symptom that irritates patients with plantar fasciitis is pain (i.e., painful heel syndrome), it was supposed that the improvement in pain would be a representative end point of the study.[17] Riddle et al. and Wang et al. used the Lower Extremity Functional Scale and the 100-point scoring system for plantar fasciitis to evaluate the disability, which is derived from symptoms (pain).[8,18] However, the absolute levels of the individual VAS can be different among patients with distinct pain thresholds. Therefore, the VAS between each group in relation to the early outcome were not

compared; a change in the VAS after conservative treatment was only considered.

2. Recurrence

In addition to analyzing the early outcome, the recurrence of symptoms for conservatively treated plantar fasciitis was evaluated. The predictive factor analysis showed that the daily TST was the only significant factor related to recurrence. Patients with a longer daily standing time had a higher risk of developing recurrence compared to those with a shorter standing time. To our knowledge, only one study has described the recurrence of plantar fasciitis after conservative treatment. Wang et al. reported that the rate and mean duration of recurrence in conservatively treated plantar fasciitis were 55% and 5.4 months, respectively.[8] The current study showed similar results; the rate and mean duration of recurrence were 51% and 7.9 months, respectively. However, Wang et al. did not evaluate the factors that contributed to recurrence. They only used the data of recurrence in conservatively treated patients to prove the efficacy of ESWT. The study by Davis et al., which had a similar conservative treatment modality, noted that the rate of successful outcome was 89.5% in 163 feet.[19] However, CR of the symptoms was only achieved in 77 feet (58%). In their study, the average time from the initiation of conservative treatment to complete resolution of symptoms was 5.1 months, which was similar to out finding (4.4 months). As described earlier, the rate and time required for CR in the current study were 87.9% and 4.4 months, respectively. The rate of recurrence in their study was less than ours 27.1% (32 feet out of 118 feet). Since they used a different outcome measurement method (a 4-grade system to evaluate heel

symptoms), the data between their study and ours could not be compared. Although they conducted a slightly longer follow-up (mean, 29 months) than the current study (mean, 22.1 months), their study had several critical shortcomings, which included an inappropriate statistical study design, a mixed cohort in terms of treatment modalities, and no description of the regular follow-ups. Additionally, predictive factor analysis was not performed. Therefore, the current study has advantages over Davis et al.'s study in terms of a uniform treatment protocol and proper statistical analyses.

3. Characteristics of patients with plantar fasciitis

In my clinical experience, patients with plantar fasciitis usually had several characteristics. First, they considered plantar fasciitis as a minor inflammatory disorder similar to a common cold. Although the disorder itself was annoying to the patients, they did not wish to follow-up with a physician for a long-term period. For this reason, half of the plantar fasciitis cases were excluded. Furthermore, the patients had a tendency to be treated with minimal intervention. Previously, several modalities of treatment for plantar fasciitis, including steroid or platelet-rich plasma injections, immobilization, modification of footwear, physical therapy, and surgery, were proposed and were proven effective and safe.[2,6,8,20-22] Because of costs, fear of treatment, and the cultural attitude, steroid injections, ESWT, and surgical interventions were not favored by the patients. Thus, the mainstream treatment was administration of NSAIDs and stretching exercises, except in intractable cases.[2,9,19] Second, the patients usually expected to be cured in the early phases of treatment (within 1 month) since they felt their plantar fasciitis symptoms were minor. Therefore,

early responsiveness to the treatment course seemed be important. These were all reasons why I thought that a well-structured longitudinal time course study of conservative treatment was needed.

4. Limitations

The current study has several limitations. First, it only included cases from a tertiary referral hospital. Therefore, the cohorts included may only represent part of the general populations with plantar fasciitis. There is a concern that more severe cases were included in the current study. However, from regular meetings with the primary clinicians at in the institute of the present study, a rough estimation of data from primary clinics did not show much differences compared to the results of the current study. Further investigation that includes data from primary and secondary clinics is required. Second, the degree of ankle dorsiflexion, which was suggested as the most significant risk factor in the development of plantar fasciitis by Riddle et al., was measured in a simple category.[5] Riddle et al. divided ankle dorsiflexion into four subdivisions and reported that individuals with less than 0° of dorsiflexion had an OR of 23.3. However, objective of their study was to determine the risk factors for developing plantar fasciitis, whereas I focused on the predictive factors in the treatment course of plantar fasciitis. Third, a sudden increase in athletic activity was not included in the analyses because an objective assessment of its intensity, period, and frequency was difficult. The development of a classification system for a sudden increase in athletic activity seems to be needed. Despite these limitations, the current comprehensive study, to our knowledge, is the first to evaluate the predictive factors of early outcome and recurrence in the

conservative treatment of plantar fasciitis.

V. CONCLUSION

Increasing BMI, a longer duration of symptoms before medical intervention, and a longer daily standing time are significant predictive factors for unfavorable early outcome in conservatively treated plantar fasciitis. For recurrence of heel pain, a longer daily standing time was the only significant predictive factor. The aforementioned factors are all modifiable if patients put in the effort. To achieve favorable early outcome and no recurrence, conservatively treated plantar fasciitis patients should be informed about modifiable factors (e.g., lowering their BMI, scheduling early clinic visits before the disorder becomes chronic, and shortening their daily standing time).

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ABSTRACT (IN KOREAN)

보존적 치료 하 족저근막염의 치료 경과: 조기 결과와 재발에 관여하는 인자

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Ⅰ. 서론

족저근막염은 후족부에 발생하는 통증의 가장 흔한 원인으로 알려져 있다. 미국에서는 100만명이 매년 진단받고 있으며, 전체 인구 중 약 10%에서 생존 기간 중 족저근막염의 영향을 받는다고 보고되고 있다. 족저근막염의 발생에 대한 위험 인자들의 보고는 다양하게 있으나 치료 반응성에 영향을 끼치는 인자에 대한 연구는 선행 연구가 없어 이에 대한 분석을 하고자 하였다.

Ⅱ. 재료 및 방법

전체 임상 사례는 2008년부터 2012년까지 단일 기관에서 치료를

시행 받은 429례의 족저근막염을 대상으로 이 중 보존적 치료(약물치료 및 스트레칭 운동 등)에 치료 1개월 째 반응을 보이지 않은 환자군과 호전이 있었던 대조군의 분석을 통해 예후 인자에 대한 분석을 진행하였다. 이 중에서 증상이 완전 소실된 경우는 Cox 비례위험 분석을 이용하여 재발 요인 분석을 2차적으로 시행하였다.

III. 결과

증상의 완전 소실은 377례(87.9%)에서 이루어 졌으며, 평균 4.4개월이 소요되었다. 최종 추시까지 재발률은 51.0%였다. 로지스틱 회귀분석을 이용한 좋지 않은 조기 결과에는 나이, 비만도, 양측성, 총 기립시간, 증상 발생 후 치료까지의 기간이 관계하고 있었으며, 재발 분석을 위해 포함된 290례의 분석에서는 총 기립시간 만이 유의한 예후 인자로 확인되었다.

IV. 결론

족저근막염의 보존적 치료에서 호전된 조기 결과를 얻고자 하는 데에 비만도, 증상 발생 후 치료까지의 기간, 총 기립시간이 관여하는 바 환자의 교육과 생활 습관의 개선을 통해 나은 결과를 기대할 수 있을 것으로 판단된다. 또한 재발의 방지를 위해서도 총 기립시간이 유의한 인자이므로 환자의 일상 생활에서의 작업 또는 운동 활동의 조절을 통해 치료 경과에 긍정적 영향을 기대할 수 있겠다.

핵심되는 말 : 조기결과; 재발; 보존적치료; 족저근막염