Effects of Short-Term Treatment with Kinesiotaping for Plantar Fasciitis

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ABSTRACT

Objectives: The purpose of this study was to investigate the therapeutic effects of kinesiotaping on plantar fasciitis.

Methods: Fifty-two patients with plantar fasciitis were randomly and equally divided into two groups. The patients in the control group received only daily physical therapy program including ultrasound thermotherapy and low-frequency electrotherapy. The patients in the experimental group received kinesiotaping in addition to the same physical therapy program as the control group. The tape for kinesiotaping was applied on the gastrocnemius and the plantar fascia continuously for one week. For each patient, the therapeutic effects were measured with subjective pain assessment [pain description scores and foot function scores], and ultrasonographic assessment [measuring plantar fascia thickness and structural change].

Results: The reduced pain scores [pain description scores and foot function scores] and the reduced thickness of plantar fascia at the insertion site [ultrasound assessment] after treatment were significantly [$P<0.05$] more in the experimental group than the control group. However, there were no significant [$P>0.05$] differences in the changes of plantar fascia thickness at the site 0.5 cm distal to the insertion site, and hypoechoic phenomena.

Conclusions: It was concluded that the additional treatment with continuous kinesiotaping for one week might alleviate the pain of plantar fasciitis better than the treatment with only physical therapy.

KEY WORDS: Plantar fasciitis, kinesiotaping, plantar fascia, ultrasonography, hypoechoic phenomena

INTRODUCTION

Kinesiotaping was originally developed in Japan by Kase (1). This special technique is very popular in some Asian countries, and now, even in the Europe and United States (2). However, only a few well-controlled studies can be found in the literature (3-5). Kinesiotape is a thin porous cotton fabric with a medical grade acrylic adhesive. The tape can be stretched up to 140 percent of the original length. After taping, the mobility of the applied muscle or joint can still be maintained at full range (6). The mechanism of therapeutic effectiveness of kinesiotaping on pain relief is still uncertain. In 1998, Kase et al. found that the local circulation underneath the taping area was increased in a Doppler study (7). Murray (5) has suggested that kinesiotaping may cause an increase in ankle proprioception through increased stimulation to cutaneous mechanoreceptors (8). A significant effect of applying low-dye tape to enhance the ankle proprioception has been documented. Contradictorily, Halseth (9) showed a negative result of the kinesiotaping in enhancing ankle proprioception.

Plantar fasciitis is a common chronic overuse injury of the plantar fascia. The initial symptom is heel pain at the moment of the first step on the floor when getting out of bed in the early morning. The symptom may be released gradually after walking (10). However, the pain may recur later on, if the stepping force is increased or the continuous weight bearing period is prolonged (11). Repetitive minor trauma may cause persistent chronic pain and may have osteophyte formation in the insertion site of the calcaneal bone (12). Therapeutic interventions include systemic medication, ultrasound (13), deep friction massage (14), plantar fascia stretch (15), strengthening of toe flexors (14), foot arch support (16), heel cushion (2,16), traditional non-elastic taping (17), night splinting (18), and local steroid injection (19).

In 1999, Loh (20) had applied kinesiotaping to treat plantar fasciitis. It is very likely that application of kinesiotaping on the foot may correct the abnormal movement of the foot in

order to prevent foot injury due to repetitive minor trauma from the abnormal foot movement (21). It might also facilitate recovery if injured. Furthermore, taping in a direction parallel to the longitudinal axis of the foot and the leg can create a positive tension to the plantar fascia and a negative tension to the ankle plantar flexors (22), and subsequently, may reduce the muscle pulling force to the plantar fascia. However, as far as we know, the therapeutic effectiveness of kinesiotaping for the treatment of plantar fasciitis has never been scientifically studied. In our current study, we investigated the effects of kinesiotaping on plantar fasciitis compared to a control group.

MATERIALS AND METHODS

Subjects

Male and female patients with confirmed diagnosis of plantar fasciitis were recruited from the rehabilitation clinic of a teaching hospital. For every subject, the onset of the symptoms was within 10 months at the time of this study, since kinesiotaping is most effective during this period (2). They were randomly divided into two groups: the experimental group and the control group. Patients with history of foot surgery or any significant foot disorder such as arthritis, trauma, tumor, etc. were excluded from this study.

This study was approved by the Institutional Review Board on Human Subjects Research in a university. After receiving an explanation about the study in detail, every subject signed the informed consent forms as approved by the review board.

The basic data for each group were demonstrated in the Table 1. Statistically, there were no significant differences between two groups although the mean age of the patients in the control group was older than the experimental group. There was no significant difference in the location of pain between two groups.

Treatments

During the study period, all patients received no any other treatment such as oral medication, foot support, heel cushion, stretching exercise, or Chinese medical intervention. They were allowed to maintain regular daily activity. Patients in the control group received a course of physical therapy only, and those in the experimental group received kinesiotaping therapy in addition to the same physical therapy program as the control group.

Physical Therapy Program for All Patients

The physical therapy program included therapeutic ultrasound [US700, ITO, Japan] and low-frequency electrotherapy [TENS/SW32010, Shinmed, Taiwan] to the plantar fascia. Initially, ultrasound with an intensity of 3MHz was given to the painful site of the plantar fascia for five minutes. Then low-frequency TENS [120 Hz/40ms] was applied on the same site for 15 minutes. This treatment was given to every patient six times per week for one week.

Kinesiotaping

The whole procedure of taping was performed by one physical therapist for every patient immediately after the first treatment of physical therapy. This physical therapist was not involved in the patient assessment. The tape [Kinesio Tex, Kinesio Taping®, USA] used for this study was waterproof, porous, and adhesive. The tape with a width of 5 cm and a thickness of 0.5 mm was selected for this study.

Taping on the Gastrocnemius Muscle

The reference points for taping were marked on the skin of the posterior leg. As shown in Figure 1, the original site for taping was marked on the Achilles tendon at the level of medial and lateral malleoli. The two end sites of taping were marked on both medial and lateral heads

[most prominent area] of the gastrocnemius muscle. During taping, the patient was in a prone position on a table with feet placed outside the end edge of the table. The knee joints were fully extended and the ankle joints were maintained at the neutral position. The procedure of "Y-shape" taping was applied to the gastrocnemius muscle in the affected side. The tape was cut longitudinally up to about two-third of the whole length of the tape to be used. The common end of the tape was firmly adhered to the marked original site on the Achilles tendon and then stretched proximally to stick the two ends of the bivalve tape on the marked sites of two gastrocnemius heads. The tape was stretched to be one-third longer than the original length, so that the length was increased to about 133 percent of the original length in order to provide a negative tension to the muscle. Figure 1 showed the original and stretched length of the tape. The original length of the tape was about one-half of the leg length measured from the fibular head to the lateral malleolus.

Taping on the Plantar Fascia

Figure 2 showed the reference points for taping. The original site for taping was marked on the posterior margin of the calcaneal bone. The four end sites of taping were marked on the metatarsal joints of the first to fifth toes, except the third. During the taping, the patient was in a prone position with the knee joints at 90 degrees of flexion and the ankle joints at a neutral position. As shown in Figure 2, the procedure of "palm-shape" taping was applied to the plantar fascia. The tape was cut longitudinally into four slices of equal width extended up to about two-thirds of the whole length of the tape to be used. The common end of the tape was firmly adhered to the marked original site over the calcaneal bone and then stretched distally to stick the four ends of the sliced tape on the marked sites of forefoot. The tape was stretched so that the length was increased to about 133 percent of the original length in order to provide a negative tension to the plantar fascia. The original and stretched [taped] length of the tape

was demonstrated in Figure 2. The original length of the tape was about one-half of the foot length measured from the calcaneal end to the tip of the big toe.

Assessments

Each patient was assessed before and one week after the treatment. The assessments included the subjective pain intensity, and the changes in the ultrasonography [measuring plantar fascia thickness and structural changes]. The investigators who performed the assessment were blinded as to the group assignment of the subject.

Subjective Pain Assessment

The subjective pain intensity was assessed with the McGill Melnack pain questionnaire (23) for the "pain description scores" and the foot function index (15) for the "foot function scores." The McGill Medlnack pain questionnaire included 20 questions to describe the perception and the influences of pain. The patient was requested to select the items that could exactly describe patient's pain or discomfort. It was not necessary to select one if no correct answer in the question. Only one choice for each question could be selected. The total number of selected items would indicate the pain intensity. Regarding the foot function index, seven items of different foot functions were listed in the questionnaires. These items included: pain intensity at the most painful moment, pain intensity during the first step on the floor in the morning, pain intensity at the end of the day, pain intensity during walking with bare foot, pain intensity during standing with bare foot, pain intensity during walking with shoes, and pain intensity during standing with shoes. For each item, the patient used a score of 0 to 100 to describe the pain intensity [0 = no pain and 100 = the worst pain in the whole life]. The site of pain should also be indicated in a picture of foot.

Ultrasonographic Assessment

A diagnostic ultrasonographic machine [HDI 3500, Philips, Japan; HDI transducers: L12-5, 38 mm, Philips, Japan] was used for this assessment. For every patient, this procedure was performed by one physician who was also blinded as to the group assignment. For this test, the patient was in a prone position with the knees at 90 degrees of flexion and the ankles at neutral position. The ultrasound probe was placed on the plantar surface and moved along the mid-axis in a longitudinal direction from the calcaneal end to the toe end of the foot to identify the plantar fascia. The measuring sites for the plantar fascia thickness were determined according to that defined by Wall (24) [Figure 3]. The first measured site was at 0.5 cm distal to the anterior calcaneal margin where inflammation is usually found. The secondary site was over calcaneus where the plantar fascia was inserted. The sign of hypoechoic was expressed as "+" [positive]. If no hypoechoic sign was found, it was marked as "-" [negative].

Data Analysis

The collected data were analyzed with SPSS 11.0 Software Top to compare the differences between the pre-treatment data and the post-treatment data for each group. To compare the differences between the control and experimental groups, data were further normalized into the percentages of changes [percent difference] as shown below: % difference = [(Post-treatment data – Pre-treatment data) / (Pre-treatment data)] x 100%. For the continuous variables, nonparametric test, Mann-Whitney U test was used to assess the significance of differences [$\alpha = 0.05$]. For categorical variables, Fisher exact test was used to test the difference [$\alpha = 0.05$].

RESULTS

Fifty-two patients [19 males and 33 females] participated in the study [Table 1]. The experimental group consisted 26 patients with 29 foot-samples [three patients with bilateral

involvement], and the control group included 26 patients with 28 foot-samples [two patients with bilateral involvement].

Subjective Pain Assessment

Based on the assessment with the McGill Melnack Pain Questionnaires [pain description scores], the control subjects had significantly higher pain scores than the experimental patients [Table 2]. After treatment, the mean pain score reduced significantly in both groups. The amount of improvement [percent difference] in the pain description scores were significantly more in the experimental group than the control group.

Regarding the foot function index, there was no significant difference in total foot function scores between two groups. There was significant improvement after treatment in the experimental group, but not in the control group. The percent difference after treatment were significantly more in the experimental group than the control group [$P<0.05$] for either total scores [Table 2] or each single item [Tables 3 and 4].

Ultrasonographic Assessment

As shown in Table 5, the reduced fascia thickness at the insertion site after treatment was significantly higher [$P<0.05$] in experimental group than the control group. However, there was no significant difference between two groups at the site 5 cm distal to the insertion site.

In the control group, hypoechoic phenomena were found in 20 of the 28 foot-samples and two of them disappeared after treatment. However, in the experimental group, hypoechoic phenomena were found in 22 of the 29 foot-samples and six of them disappeared after treatment. There was no statistical difference between two groups [Table 6].

DISCUSSION

In this study, it was found that the pain intensity and the thickness of plantar fascia at the insertion site were significantly [$P<0.05$] reduced after kinesiotaping as compared to the control group, although no significant changes were found in the plantar fascia thickness at the site 0.5 cm distal to the insertion site. There was also no significant difference in the existence of hypoechoic phenomena [ultrasound assessment] between two groups.

Possible Mechanism of Kinesiotaping in Treating Plantar Fasciitis

The technique of kinesiotaping, including selection of taping site, pulling direction, and pulling force, is critical in treating soft tissue lesions. It should follow the principle of motion analysis and biomechanics. Usually, kinesiotaping can control the pulling force to a certain tendon or ligament in order to avoid further injury so that the tissue repair can be facilitated.

In most cases, the cause of plantar fasciitis is due to the abnormal force to the plantar fascia. When a patient has a high foot arch, the plantar fascia becomes too tight, and the calf muscles and the Achilles tendon are also too tight. The plantar fascia cannot be effectively extended in the heal strike phase of walking. Therefore, the angle of foot-anterior-rocking is reduced. Furthermore, the counter force from the floor cannot be adequately absorbed by foot arch due to tight plantar fascia. Therefore, the plantar fascia is over-stretched. On the other hand, when a patient has a low foot arch [flat foot], foot ligaments are loose and the supporting force to the foot arch is weak. The weight loading shifts to the plantar fascia. The angle of foot-anterior-rocking is too big. The foot is not stable during the stance phase of the other foot, and the plantar fascia is also over-stretched (25). Either way, the plantar fascia may be over-stretched to cause plantar fasciitis. By applying kinesiotaping on the plantar fascia and calf muscles, the pulling force of the plantar flexors and the plantar fascia can be reduced. Therefore, repetitive injury to the plantar fascia can be avoided and the tissue repair can be facilitated.

Changes in Subjective Pain after Kinesiotaping

The decreases in pain scores were significant more in the experimental group than the control group. The reduction in pain intensity was probably due to the reduced pulling force to the plantar fascia [negative tension from taping]. The improvement in focal circulation (7) might be also an important factor for pain relief. It is unclear whether the direct mechanical stimulation [from the shearing force of taping] to the nociceptors and/or mechanoceptors plays any role in pain relief.

Changes in Plantar Fascia Morphology and Thickness after Kinesiotaping

To assess the morphological changes in the plantar fascia, either magnetic resonance imaging [MRI] or ultrasonography can be used. The MRI is expensive, but ultrasound is cheap and convenient. Therefore, we applied ultrasonography to investigate the morphological changes of plantar fascia. By using ultrasonography, Sabir et al. (26) found that the thickness of the inflamed plantar fascia was increased and the margin of the fascia was blurring with hypoechoic changes. In a normal plantar fascia, the sonographic image is homogeneous parallel fibrous structure with normoechoic reflection. There are two distinct parallel hyperechoic margins in the normal fascia. In an inflammatory fascia, there was anisotrophy with hypoechoic regions. In this study, we observed similar findings in the plantar fasciae as previously reported. Cardinal et al. (27) has suggested that a hypoechoic region can be the image of an area with hyaline change, granulation tissue or hematomas. In this study, only one foot had complete disappearance of the hypoechoic region after kinesiotaping, and the pain of that foot was also reduced completely after taping. The reason for the poor result in sonographic findings is probably due to the small sample size in this study. A long follow-up period may be necessary to see the changes.

In both groups of our study, the mean thickness of the plantar fascia at the proximal insertion site of calcaneus [before treatment] was within normal range based on the data measured by Chen et al. (28). However, the thickness at 0.5 cm distal to the anterior calcaneal

line was thicker than the data of Chen, probably due to inflammatory reaction. In clinical practice, the most painful site is at the insertion region, but not the site with most remarkable inflammatory reaction in the plantar fascia. Therefore, Wall (24) suggested measuring two different sites. After kinesiotaping, the thickness at the insertion site was significantly reduced as compared to the control group. It appears that kinesiotaping can effectively reduce the inflammatory reaction in a certain region [the insertion site] of the plantar fascia. However, the difference was not significant at the most inflamed site. This is probably due to the small sample size in our study. The mechanism of such anti-inflammatory effect is unknown. Further study is required to clarify that.

CONCLUSION

It is concluded that the treatment with kinesiotaping continuously for one week can provide pain relief in patients with plantar fasciitis with a better effect as compared to those treated with only physical therapy. The plantar fascia thickness at the insertion site may be reduced after kinesiotaping. However, the changes in the plantar fascia thickness at the most inflamed site, and the inflammation changes [hypoechoic] may not be affected after kinesiotaping.

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Table 1. The Basic Data in Two Groups

	Control group	Experimental group
Number of foot samples	28	29
Age	30.50 ± 13.14	52.67 ± 28.75
BMI values	24.07 ± 6.87	24.09 ± 3.77
Duration after onset [months]	4.33 ± 3.01	3.92 ± 1.80
Number of subjects who required daily activity > 8 hours	21/28 [75%]	24/29 [83%]

BMI = body mass index

Table 2. Changes in the Subjective Pain Scores after Treatment in Each Group

Items	Before or after treatment	Control Group	Experimental group	Control vs. Experimental
Pain Description Scores	Before	14.63±2.61	9.29±2.69	P<0.05
	After	11.88±2.36	4.14±3.02	P<0.05
	Difference	-2.75±2.55 P<0.05	-5.14±3.81 P<0.05	
	% difference	17.86±15.56	54.25±33.34	P<0.05
Total Foot Function Scores	Before	54.50±22.02	56.73±14.53	P>0.05
	After	51.23±20.88	31.78±20.48	P>0.05
	Difference	-3.27±5.81 P>0.05	-24.96±20.08 P<0.05	
	% difference	-4.29±17.03	-43.05±34.22	P<0.05

Table 3. Changes in the Foot Function Scores for Different Items of Foot Function after Treatment in Each Group

Items	Before or after treatment	Control Group	Experimental group	Control vs. Experimental
1st item	Before	67.88±12.07	61.14±18.50	P>0.05
	After	60.63±17.32	36.43±17.49	P<0.05
2nd item	Before	49.38±29.09	49.57±16.11	P>0.05
	After	50.63±27.18	20.71±15.39	P<0.05
3rd item	Before	64.75±20.26	59.00±16.29	P>0.05
	After	58.00±20.31	32.14±21.77	P<0.05
4th item	Before	41.88±20.96	55.00±18.48	P>0.05
	After	40.00±18.71	35.00±21.41	P>0.05
5th item	Before	47.38±23.44	53.57±11.80	P>0.05
	After	44.25±19.47	30.00±24.66	P>0.05
6th item	Before	52.50±14.23	60.29±11.35	P>0.05
	After	51.75±14.80	35.71±23.17	P>0.05
7th item	Before	57.75±24.59	58.57±9.45	P>0.05
	After	53.38±25.82	32.43±23.09	P>0.05

Table 4. Percentage of Change in the Foot Function Scores for Different Items of Foot Function after Treatment in Each Group

Values were meant the difference between before and after treatment.

Items	Control Group	Experimental group	Control vs. Experimental
1st item	-12.25±13.23	-40.39±26.41	P<0.05
2nd item	10.21±31.25	-47.44±45.44	P<0.05
3rd item	-11.53±5.99	-44.90±36.86	P<0.05
4th item	-1.10±15.89	-35.28±29.27	P<0.05
5th item	-3.28±13.71	-46.37±40.29	P<0.05
6th item	-1.45±9.39	-40.11±36.70	P<0.05
7 th item	-10.59±11.13	-46.89±35.69	P<0.05

Table 5. Changes in the Fascia Thickness [cm] based on Ultrasonic Assessment after Treatment in Each Group

Items	Before or after treatment	Control Group	Experimental group	P value
Fascia thickness at site 1	Before	0.55±0.16	0.57±0.19	P>0.05
	After	0.50±0.18	0.49±0.17	P>0.05
	Difference P value	-0.05±0.02 P>0.05	-0.08±0.07 P>0.05	
	% difference	-10.72±6.50	-13.38±11.79	P>0.05
Fascia thickness at site 2	Before	0.34±0.06	0.39±0.07	P>0.05
	After	0.33±0.05	0.33±0.08	P>0.05
	Difference P value	-0.01±0.03 P>0.05	-0.06±0.04 P>0.05	
	% difference	-3.46±81.36	-16.41±9.91	P<0.05

Measuring site 1: at 0.5 cm distal to the anterior calcaneal margin.
Measuring site 2: at the anterior calcaneal margin [facial insertion site].

Table 6. Changes the Hypoechoic Phenomena on Ultrasonic Assessment after Treatment in Each Group

Items		Before treatment	After treatment	P value
Control Group	No. hypoechoic phenomena[+]	20	18	
	No. hypoechoic phenomena[-]	8	10	

	Ratio of disappearance		2/20	
Experimental group	No. hypoechoic phenomena[+]	22	16	
	No. hypoechoic phenomena[-]	7	13	
	Ratio of disappearance		6/22	P>0.05

Ratio of disappearance: numbers of disappeared hypoechoic phenomena [after treatment- before treatment]/ numbers of hypoechoic phenomena[+]

FIGURE LEGEND

Figure 1. Length of tape for kinesiotaping on the gastrocnemius muscle. The leg length was measured from the lateral malleolus [LM] to the fibular head [FH]. The original length of tape was half of the leg length [1/2 LM-FH]. The original site of taping was on the Achilles tendon

at the level of medial and lateral malleoli, and the end of sliced tape was stretched distally for a total length of three-quarters of the leg length [3/4 LM-FH].

Figure 2. Kinesiotaping on the plantar fascia. The foot length was measured from the posterior margin of calcaneus [PMOC] to the tip of big toe [TOBT]. The original length of tape was half of the foot length [1/2 PMOC-TOBT]. The original site of taping was at the proximal one-eighth of foot [1/8 PMOC-TOBT], and the end of sliced tape at the distal one-eighth margin of the foot [7/8 PMOC-TOBT].

Figure 3. Measurement of the thickness of plantar fascia [P]. The first distance [D1] was at 0.5 cm distal [0.5D] to the anterior calcaneal margin [C] and the secondary distance [D2] was over the edge of calcaneus.

Figure 1.

Figure 2.

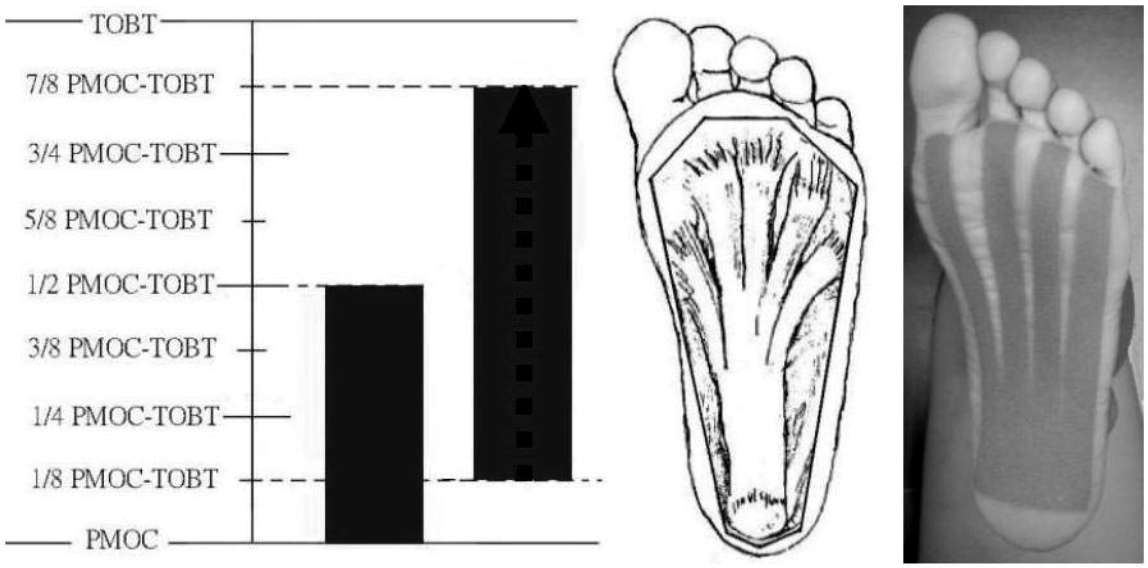
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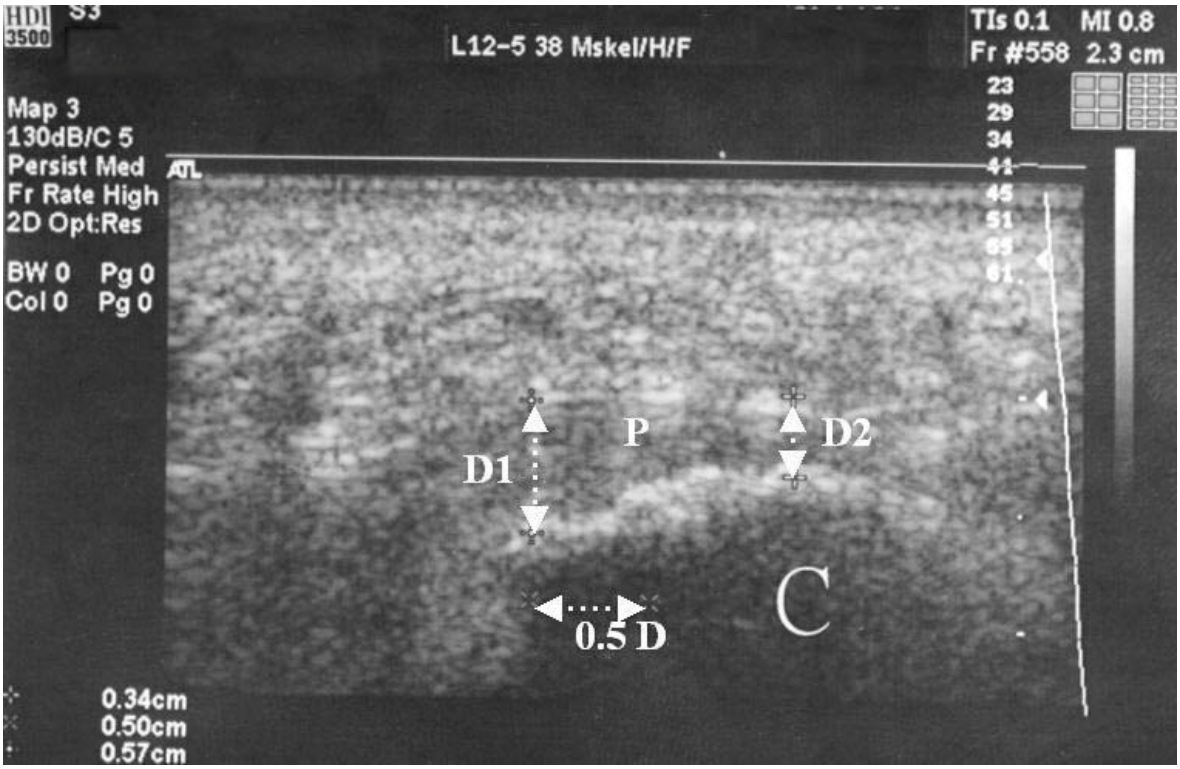
Figure 3.


HDI 3500
L12-5 38 Mskel/H/F
TIs 0.1 MI 0.8
Fr #558 2.3 cm
Map 3
130dB/C 5
Persist Med
Fr Rate High
2D Opt:Res
BW 0 Pg 0
Col 0 Pg 0
ATL
23
29
34
41
45
51
55
61
D1
P
D2
0.5 D
C
0.34cm
0.50cm
0.57cm