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# High Load Strength Training For Pain and Foot Function in a Patient with Plantar Fasciitis: A Case Report

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## Case Report

### ABSTRACT

**Background:** Plantar fasciitis is one of the most common causes of heel pain [1-3]. Stretching exercise is a popular treatment method to alleviate symptoms. However, it may not be appropriate for patients who demonstrate no limitation of metatarsal phalangeal joint (MTPJ) range of motion (ROM) [4]. High-load strength training has shown better treating effect than plantar specific stretching but without consideration of differences between patients with or without ROM limitation. This case report was to investigate the effect of high-load strength exercise in treating a patient who presented without first MTPJ ROM limitation, in terms of pain reduction and foot function improvement.

**Case description:** A 26-year-old female diagnosed with right plantar fasciitis for less than two months. The patient presented with tenderness to palpation at the medial tubercle of the right calcaneus, decreased active ROM on bilateral ankle dorsiflexion and decreased muscle strength of ankle dorsiflexors, plantarflexors and extensor halluces longus. The 1st MTPJ extension was at the higher end of the normal limit.

**Outcomes:** Therapy was administered twice a week for 5 weeks. The treatment plan included the conventional treatment and the high-load strength training. Heel pain decreased from 6/10 to 0, and foot function index decreased from 6.1% to 1.7%. Ankle dorsiflexors and plantarflexors strength increased from 4 to +4, and the extensor halluces longus strength increased from -4 to 4.

**Discussion:** This case supported the point of view that for patients with plantar fasciitis, who demonstrated weak plantarflexors but without 1st MTPJ ROM limitation, treatment should focus more on strengthening exercise instead of stretching exercise.

## BACKGROUND AND PURPOSE

Plantar fasciitis (PF) is one of the most common painful foot conditions. It affects both active and sedentary adults, with a peak incidence between 40 and 60 years of age [1-3]. Each year, about two million individuals suffer from this condition in the United States [5].

The etiology of PF is still not well understood [6]. Any factors, which increase loading or lower the medial longitudinal arch and induce tension in the fascia, can lead to the development of plantar fasciitis. Individuals with high body weight, those spending most of the day on their feet and runners are the high-risk groups [7,8].

The diagnosis of PF is mainly based on clinical presentation with no specific objective or reliable diagnostic test. The typical presentation of patients with PF is pain and palpable tenderness in the area of the medial tubercle of the calcaneus at the heel. The inferior heel is especially painful in the first few steps in the morning or when getting up to walk after prolonged sitting, and it may lessen after further ambulation but increases after continued weight bearing activity. The pain may be exacerbated by walking barefoot, on the toes, or upstairs.

Treatments for patients with PF usually consist of conservative approaches initially, which include stretching, orthotic devices, and manual therapy. But most of them have generated only limited scientific evidence of their effectiveness. Stretching programs are frequently prescribed to alleviate plantar fasciitis symptoms [9,10]. Protocols have varied from

Achilles tendon stretching to plantar fascia-specific stretching. The exercises aim to stretch and increase the flexibility of the plantar fascia, recreating the windlass mechanism so that tissue tension is optimized. Previous studies have suggested that stretching, night splints and heel pads were equally important components of the treatment program. Moreover, there were no differences between the Achilles tendon and plantar fascia stretching. On the other hand, reduced strength of the plantarflexors and toe flexors have been reported to contribute to PF [11]. Nevertheless, studies on whether strengthening exercise should be performed with or without stretching have reached inconclusive results [11-13]. Based on previous research as well as clinical observation 4, patients with PF often demonstrate no limitation or even larger ROM of the 1st MTPJ, raising question that whether the universal use of stretching exercises is indicated for all patients with PF. Howell proposed that if patients with PF demonstrate excessive dorsiflexion of the MTPJ, there may be a stretch weakness of the intrinsic foot muscles [4]. Therefore, strengthening exercises instead of stretching exercise should to be designed so muscles are contracting in a position of maximum plantar flexion [14]. Whereas the indication for stretching exercises should not be the presence of pain, but the presence of limited motion. A recent published randomized controlled trial done by Rathleff et al. [12] found that high-load strength training consisting of unilateral heel raises have a quicker reduction in pain and improvements in function for patients with PF compared with plantar-specific stretching, but there is lacking of information on whether it is effective in treating patients with PF but without limitation of 1st MPTJ ROM.

This case report is to investigate the effect of high-load strength exercise in treating a patient with PF, who presents with weak plantarflexors but without 1st MTPJ ROM limitation, in terms of pain reduction and foot function improvement.

## CASE DESCRIPTION

The patient was a 26-year-old female, who was a nurse before and now is a graduate student. The patient complained of onset of right heel pain 3 months after beginning kickboxing. She experienced the most pain in the morning or when wearing certain footwear. She described the pain as sharp pain at the medial arch of the foot close to the tubercle of the calcaneus. She denied any numbness or tingling. She received the short-term steroid injection for heel pain relief 5 weeks ago. Now she is currently taking anti-inflammatories, uses a night splint and orthotics that have decreased her pain. The patient had bilateral Achilles tendinitis and right hip flexor tendinitis 7 years ago. The patient denied any other pertinent health issues.

Upon evaluation, the patient verbally reported pain at the sole of the right foot through Numeric Pain Rating Scale (NPRS). The heel pain was 4/10 at rest, and 6/10 at worst. The patient demonstrated tenderness to palpation at the medial tubercle of the right calcaneus, decreased active ROM on bilateral ankle dorsiflexion (3 degree on the right side and 4 degree on the left side with knee extended, 10 degrees for each side with the knee flexed) and decreased muscle strength of ankle plantarflexors (Manual muscle testing (MMT) 4/5 on the right side, 5/5 on the left), ankle dorsiflexors (MMT 4/5 on right side, 5/5 on the left) and extensor hallucis longus (MMT -4/5 on the right side). The 1st MTPJ extension is at the higher end of the normal limit (AROM: 74 degree for the right side and 72 for the left; passive range: 88 degree for the right side and 80 for the left side). The score of foot function index (FFI) was 6.1%.

The patient's primary functional limitation is that she cannot perform lunges without aggravating heel pain, and also she has limited participation in vigorous sports activities due to heel pain. The patient's goal for physical therapy is to decrease pain and return to prior activity level.

## CLINICAL IMPRESSION

The patient presented with pain on the right heel, decreased bilateral ankle dorsiflexion and decreased muscle strength of right ankle and foot muscles, limiting her participation in hobbies and sports activities. Based on the high prior level of function, good understanding of the pathology and high motivation, the patient was considered as a good candidate for physical therapy. The patient would benefit from skilled physical therapy to manage pain, increase ankle ROM and muscle strength of foot and ankle, and return to prior level of function. As patient's presentation of no limitation on 1st MTP extension and decreased muscle strength of ankle and foot muscles, we hypothesized that strengthening exercise rather than stretching exercise would bring more treatment benefit.

## EXAMINATION

During the examination, pain, ROM, muscle strength and foot function were evaluated respectively. Numeric Pain Rating Scale (NPRS) was used to evaluate the intensity of pain. It is a self-rated 11-point unidimensional scale. The NPRS has good sensitivity while producing data that can be statistically analysed. The minimally clinically important difference (MCID) in population with chronic musculoskeletal pain is 1 point or 15% change [15]. It has excellent interrater reliability and higher test-retest reliability [16,17]. Range of joint motion was measured using a universal goniometer (Baseline, New York) [18]. The subject was supine lying with the knee in extension, and was instructed to dorsiflex the ankle and to extend the first MTPJ as far as possible for the active joint range measurements. For passive joint motion, the examiner moved

the tested joint until resistance was felt [19]. Three trials were performed measuring the active and passive ranges of the ankle and the first MPT joints of each foot. Averaged values were computed from 3 trials. Manual muscle testing was used to assess the strength of ankle plantarflexors (gastrocnemius, soleus) and dorsiflexors (anterior tibialis) and extensor halluces longus [20]. The patient was in supine lying, and was asked to maintain the test position. The tester added resistance gradually to allow the patient to "set" the muscles. The grading followed the standardized rating method. The Foot Function Index was used to assess foot function [21]. It is a clinically useful 23-item self-administered questionnaire. It comprises pain, disability and activity limitation subscales, and a higher score indicates greater dysfunction. It has been found to have good reliability and validity, with a minimal detectable difference of 7 and high test-retest reliability. It has been used widely in evaluating foot function especially in patients with PF [22,23].

## INTERVENTION

The patient came to the orthopaedic outpatient clinic twice a week for 5 weeks and each session lasted 50 to 60 minutes. The treatment plan included the conventional treatment i.e. manual therapy, therapeutic exercises, interferential current therapy and heat pack. High-load strength training, which was based on Rathleff et al.[11] protocol was added into the therapeutic exercises since the second treatment session. It consisted of unilateral heel raises with a towel roll inserted under the toes to further activate the windlass mechanism. Every heel rise consisted of a 3-second going up and a 3-second coming down phase with a 2-second pause at the top of the exercise. The patient performed heel rises with the guidance of the physical therapist to ensure the toes maximally dorsiflexed at the top of the heel rise. The patient was not able to perform the right heel raises for 12 repetitions at the beginning, therefore, the exercises started with double heel raises for 12 repetitions and 3 sets. After 3 weeks, the patient was able to do right heel rise at 12 repetitions for 3 sets. The strength training was progressed by using a backpack with books approximately 5 pounds to increasing the load, and reducing the number of repetitions to 10 and increasing the number of sets to 4. The patient was instructed to keep adding books to the backpack as she became stronger. All information about the heel raise exercises was given to patient as a one page home exercise sheet, which included the pictures quoted from Rathleff et al. [11] paper that illustrated the exercise, key points such as frequency, intensity, time and how to progress **(Figure 1).**

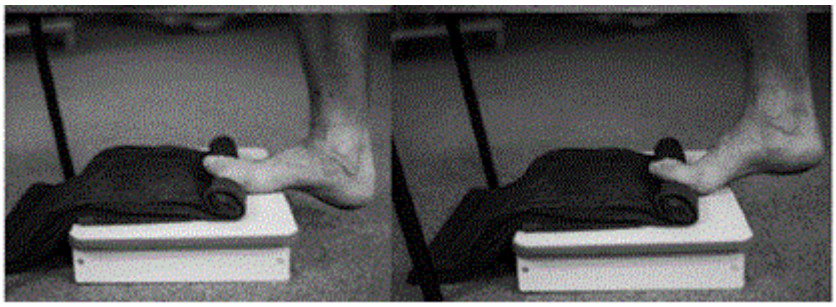

**Figure 1:** Home exercise: Unilateral heel raises exercise.

*Put a towel under the toes to increase dorsiflexion of the toes during heel raises.

**Key Points:**

1) Every heel rise consisted of a 3-second going up and a 3-second coming down phase with a 2-second pause at the top of the exercise.

2) Toes maximally dorsal flexed at the top of the heel rise.

3) 12 repetitions for 3 sets, once a day, exercise every other day.

**Progression:**

Start the exercise using both legs until you are strong enough to perform unilateral heel raises.

Start with 12 repetitions for 3 sets As you become stronger (about 2-3 weeks), increase load by using a backpack with books, 10 reps 4 sets (about 2 weeks) progress to 8 reps for 5 sets.

In addition to this strengthening exercise, the patient continued receiving conventional therapy each time she was in the clinic, including stretching of the plantar fascia and calf muscles to increase joint mobility, tissue mobility, and passive range of motion; therapeutic exercises e.g. stationary bike, single leg standing on foam and digits picking up marbles, to increase ROM and strength in the affected ankle, modalities such as interferential current therapy and heat pack to promote soft tissue healing and decrease pain in the affected ankle.

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## OUTCOMES

During the course of 5 weeks in physical therapy, the patient demonstrated significant decrease in heel pain from 6/10 to 0, and improved foot function from 6.1% to 1.7% on FFI. The patient also demonstrated increased muscle strength of ankle dorsiflexors, plantarflexors and extensor halluces longus, i.e from 4 to +4, and -4 to 4 respectively **(Table 1).**

**Table 1.** Comparison of outcome measures before and after treatment.

| | Pre-intervention | | Post-intervention | |
|---|---|---|---|---|
| **AROM** | **Right** | **Left** | **Right** | **Left** |
| **Ankle DF** | 3 | 4 | 5 | 5 |
| **Ankle PF** | 60 | 60 | 58 | 58 |
| **1st MPTJ** | 74 | 72 | 75 | 74 |
| **PROM** | **Right** | **Left** | **Right** | **Left** |
| **Ankle** | 10 | 12 | 10 | 12 |
| **1st MPTJ** | 88 | 80 | 90 | 83 |
| **MMT** | **Right** | **Left** | **Right** | **Left** |
| **Ankle DF** | 4 | 5 | 4+ | 5 |
| **Ankle PF** | 4 | 5 | 4+ | 5 |
| **Extensor hallucus longus** | 4- | 5 | 4 | 5 |
| **Pain (NPRS)** | 6 | | 0 | |
| **Foot Function Index** | 6.10% | | 1.70% | |

AROM: Active Range of Motion, MPTJ: Metatarsal Phalangeal Joint, PROM: Passive Range of Motion, DF: Dorsiflexion, PF: Plantarflexion, NPRS: Numeric Pain Rating Scale

## DISCUSSION

This case report is to investigate the effect of high-load strength exercise in treating a patient with PF, who presents with weak plantarflexors but without 1st MTPJ ROM limitation, in terms of pain reduction and foot function improvement. The patient in this case report demonstrated significantly decreased pain and improved foot function within 5 weeks of strength training in addition to conventional physical therapy.

Increased BMI is reported frequently in patients with PF. Theoretically, heavier individuals place more loading on the medial longitudinal arch, and this might increase the risk of developing PF [24]. It is not surprising that the patient in this case report has a BMI of 29.1kg/$m^2$, which categorizes her as pre-obese category according to WHO criteria. This result is in line with previous findings [25]. Riddle et al. reported that an increase of BMI by more than 30 kg/$m^2$ predicts a 5.6 fold increase in the risk of having PF. Recommendation of losing body weight and target BMI to less than 25kg/$cm^2$ was discussed between physical therapist and the patient during treatment. With less body weight, there will be less strain and stress on the plantar fascia, which will definitely help with tissue healing. Especially for this patient who stands and walks in most of her daytime, less body weight means less loading on the plantar fascia.

Hicks, in 1954 proposed the "*windlass*" effects of the foot during locomotion, i.e. an increase in foot arch as a result of digital dorsiflexion (extension) would induce greater stress to the plantar fascia [26]. Many years later, Allen et al. found comparable passive ROMs of the first MTPJ in affected and unaffected feet. Moreover, based on the clinical observation, Howell et al. [13]found that patients with PF even have larger ROM of 1st MTPJ. There is a possibility that an increased ROM in the 1st MTPJ might induce greater stress to their plantar fascia during locomotion. With time, this might lead to PF. On the other hand, heavier people will also load the fascia more and lead to greater toe extension as the fascia is lengthened. However, the cause and effect of increased 1st toe extension and incidence of PF requires longitudinal study to confirm.

In this case, the patient demonstrated no limitation, but even excessive extension at the affected foot's 1st MPTJ, i.e. 74 degrees on the affected side (70 degrees is normal). Moreover, muscle strength test revealed decreased muscle strength on the ankle dorsiflexors, plantarflexors, especially extensor hallux longus (i.e. MMT -4/5). All of them indicated a length associated muscle weakness (stretch weakness) of the intrinsic foot muscle. Therefore, we hypothesized our patient would benefit more from strengthening exercise compared to stretching [14]. When making the patient's plan of care, besides the conventional methods such as modalities, heat and stretching exercises, we added strengthening exercise to the home exercise program, which aimed to strengthen the plantarflexors during maximal toe extension in order to use the windlass mechanism in combination with loading of the Achilles tendon. A previous study has shown that large tensile forces have been associated with improvements in symptoms in patients with PF as well as other conditions involving degenerative changes. The plantar fascia is made up of collagen type I fibers, which responds to high-load through increased collagen synthesis [12,27,28]. Therefore, increased collagen synthesis may help promote tissue healing, decrease symptoms and improve foot function. In Rathleff's study, compared with plantar-specific stretching, the simple progressive strengthening exercise protocol was performed every second day, and demonstrated a superior self-reported outcome after 3 months in patients with PF regardless of 1st MTPJ ROM [12]. Therefore, we hypothesized our patient would benefit more from the strengthening program because she had no ROM limitations in 1st MTPJ. Note that Rathleff's protocol is for patients who have chronic symptoms e.g. more than 3 months and have thick plantar fascia of 4.0 mm or greater. The strengthening training lasted for 3 months and was progressed gradually every two weeks. In our case, the patient was in the sub-acute stage (had symptoms less than two months), and due to the time limitation of data collection scheduling, the strengthening training only lasted for 5 weeks. As our patient was not able to perform single heel raise at the beginning, we started from bilateral heel raises and progressed to add weight after 3 weeks. In addition, during the 3rd week, the patient reported regression of the symptoms due to inappropriate footwear in a friend's wedding. All these factors may have negatively affected the effectiveness of this high-loading strengthening exercise in treating this patient population.

Regarding the muscle strength improvement, it is known that for muscle strengthening exercise, it usually takes about 6 weeks to see the effect. In our case, it is a little bit surprising to see that only with 5 weeks training, muscle groups including ankle dorsiflexors, plantarflexors and extensor hallux longus all showed improvements [29]. While, as the assessor was not blind to the experiment during data collection, and MMT is a relatively subjective grading, the increase in muscle strength may need further investigation to assure, such as use of dynamometer to get an objective value for comparison in future study.

Based on earlier work by Salaffi et al. [16] the MCID of NPRS in population with chronic musculoskeletal pain is 1 point or 15% change. Moreover, it has been established that a change in pain score of 2 or a decrease of 30% of the initial score was taken as indicating clinical improvement. In our case, during the 5-week treatment period, the worst pain decreased from 6 to 0, which indicated that the pain reduction not only meets the MCID but also reached clinical significant level [30]. Second, the patient's foot function index (FFI) improved from 6.1% to 1.7%. While the minimal detectable change of FFI is 7%, due to the severity level of this patient at baseline (less than 7%), it is not applicable to reach the 7% cut-off point at post-intervention assessment.

While the improvement in pain and foot function observed in this case report are encouraging, the study design prevents us from comparing with a normal control group or inferring any cause-and-effect relationship. Therefore, it is difficult to generalize the outcomes in this case study to the outcomes of other patients with PF but without 1st MTPJ ROM limitation. Second, regarding the foot function, as the patient's initial rating is less than the level of minimal detectable change, although FFI is widely and specifically used in patients with PF, in this case, it may be not sensitive enough to pick up the subtle improvements and functional changes. Third, due to time constraints, the data collection period was only 5-week. Longer time strengthening with appropriate weight progression and follow-up is essential to assure the long-term effect of high-load training in this patient. A randomized clinical trail that compares patients with PF but without 1st MTPJ ROM limitation with high-load strengthening training to those who are without strengthening training is needed before definitive conclusion regarding effectiveness can be made.

## CONCLUSION

This case report describes the high-load strength training in treating a patient with plantar fasciitis but without 1st MTP ROM limitation. The improvements in pain and foot function demonstrate by the patient support the proposal that the universal use of stretching exercises is not indicated for all patients with PF. For patients with plantar fasciitis, who demonstrated weak plantar flexors but without 1st MTPJ ROM limitation, treatment should focus more on strengthening exercise instead of stretching exercise. Further studies are needed to utilize this approach in a larger patient population and to investigate the long-term effect.

## REFERENCES

1. Cole C, et al. Plantar fasciitis: Evidence-based review of diagnosis and therapy. Am Fam Physician. 2005;72:2237-2242.
2. Gill LH, et al. Outcome of nonsurgical treatment for plantar fasciitis. Foot Ankle Int. 1996;17:527-532.
3. Neufeld SK, et al. Plantar fasciitis: Evaluation and treatment. J Am Acad Orthop Surg. 2008;16:338-346.
4. Kamonseki DH, et al. Effect of stretching with and without muscle strengthening exercises for the foot and hip in patients with plantar fasciitis: A randomized controlled single-blind clinical trial. Man Ther. 2016;23:76-82.
5. Riddle DL, et al. Volume of ambulatory care visits and patterns of care for patients diagnosed with plantar fasciitis: A national study of medical doctors. Foot Ankle Int. 2004;25:303-310.
6. Wearing SC, et al. The pathomechanics of plantar fasciitis. Sports Med. 2006;36:585-611.
7. Cullen NP, et al. Plantar fasciitis: A review. Br J Hosp Med. 2006;67:72-76.
8. League AC. Current concepts review: Plantar fasciitis. Foot Ankle Int. 2008;29:358-366.
9. Digiovanni BF, et al. Plantar fascia-specific stretching exercise improves outcomes in patients with chronic plantar fasciitis. A prospective clinical trial with two-year follow-up. J Bone Joint Surg Am. 2006;88:1775-1781.
10. Martin RL, et al. Outcome study of subjects with insertional plantar fasciitis. Foot Ankle Int. 1998;19:803-811.
11. Goncalves GA, et al. Effect of stretching with and without muscle strengthening exercises for the foot and hip in patients with plantar fasciitis: A randomized controlled single-blind clinical trial. Man Ther. 2016;23:76-82.
12. Rathleff MS, et al. High-load strength training improves outcome in patients with plantar fasciitis: A randomized controlled trial with 12-month follow-up. Scand J Med Sci Sports. 2015;25:292-300.
13. Allen RH, et al. Toe flexors strength and passive extension range of motion of the first metatarsophalangeal joint in individuals with plantar fasciitis. J Orthop Sports Phys Ther. 2003;33:468-478.
14. Sahramann Shirley. Diagnosis of movement impairment syndrome. 2001.
15. Williamson A, et al. Pain: A review of three commonly used pain rating scales. J Clin Nurs. 2005;14:798-804.
16. Salaffi F, et al. Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. Eur J Pain. 2004;8:283-291.
17. Herr KA, et al. Pain intensity assessment in older adults: Use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults. Clin J Pain. 2004;20:207-219.
18. Jensen MP, et al. Increasing the reliability and validity of pain intensity measurement in chronic pain patients. Pain. 1993;55:195-203.
19. Pascual HJ, et al. Relationship of body mass index, ankle dorsiflexion and foot pronation on plantar fascia thickness in healthy, asymptomatic subjects. J Am Podiatr Med Assoc. 2008;98:379-385.
20. Rome K, et al. Risk factors associated with the development of plantar heel pain in athletes. The Foot. 2001;11:119-125.
21. Hazel M, et al. Musculoskeletal Assessment: Joint Motion and Muscle Testing. Wolter Kluwer Health. 2000.
22. Budiman-Mak E, et al. The Foot Function Index: A measure of foot pain and disability. J Clin Epidemiol. 1991;44:561-570.
23. Landorfa KB, et al. Minimal important difference: Values for the Foot Health Status Questionnaire, Foot Function Index and Visual Analogue Scale. The Foot. 2008;18:15-19.
24. Riddle DL, et al. Risk factors for plantar fasciitis: a matched case-control study. J Bone Joint Surg Am. 2003;85:872-877.
25. http://apps.who.int/bmi/index.jsp?introPage=intro_3.html
26. Hicks JH. The mechanics of the foot. II. The plantar aponeurosis and the arch. J Anat. 1954;88:25-30.
27. Stecco C, et al. Plantar fascia anatomy and its relationship with Achilles tendon and paratenon. J Anat. 2013;223:665-676.

28. Langberg H, et al. Eccentric rehabilitation exercise increases peritendinous type I collagen synthesis in humans with Achilles tendinosis. Scand J Med Sci Sports. 2007;17:61-66.

29. Schobersberger W, et al. Consequences of 6 weeks of strength training on red cell 02 transport and iron status. Eur J Appl Physiol Occup Physiol. 1990;60:163-168.

30. Farrar JT, et al. Clinical importance of changes in chronic pain intensity measured on an 11 point numerical pain rating scale. Pain. 2001;94:149-158.