Dynamic Taping for medial longitudinal arch support reduces pain, increases navicular height and maintains an increase after three days of intense exercise and twenty four hours after removal of tape in a plantar fasciitis patient: a case study

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Abstract

Purpose: To investigate the effect of a novel taping approach on pain and foot posture pre and post vigorous exercise and over several days' duration in an athlete with plantar fasciitis.

Background: The use of tapes has been shown to alter medial longitudinal arch height, lower limb muscle activity and pain in several overuse conditions of the lower limb. A preliminary study using a strongly elastic, four-way stretching tape has demonstrated significant changes in static foot postures in both non weight bearing (NWB) and weight bearing (WB) however the effect of exercise and time on the magnitude of this change has not been investigated.

Case presentation: A 37 year old female, marathon runner presented with a three month history of left plantar heel pain which commenced follow an increase in plyometric training. Management including calf stretching, foot arch and calf strengthening exercises and relative rest had failed to improve symptoms.

Methods and measures: Foot length and navicular height were measured before tape, immediately after the application of tape, Day 1 - after a 16km run and yoga session, Day 3 - after another 12km run and yoga session, one hour after removal of tape and 24 hours after removal of tape. Visual analog scale (VAS) was used to record pain on initial weight bearing in the morning and pain on running.

Results: A 28% increase in arch height was recorded immediately following taping in NWB and 40% increase in WB. Following the exercise challenge on Day 1, increases of 20% and 31% were observed in NWB and WB measures and after a further exercise challenge on Day 3, arch height increase in NWB was 12% and WB was 23%. One hour after removal of the tape, arch height remained 14% higher than the pre-tape level and this was maintained at 24 hours post removal.

VAS of pain was reported at 6 prior to application both on initial weight bearing and during running. In the taped conditions VAS was 0. Following removal of the tape VAS for initial weight bearing pain was 2.

Conclusions: Dynamic Taping creates an initial reduction in foot length and elevation in arch height. A significant change in arch height is maintained following vigorous exercise and after 3 days continual wear. Pain associated with plantar fasciitis was reduced. Further studies are required with larger sample sizes, 3D kinematics and EMG to validate these observations and to provide further insight into possible mechanical and neurophysiological mechanisms responsible.

Keywords: taping, arch height, plantar fasciitis

Introduction: Excessive changes in medial longitudinal arch height and velocity of this change have been implicated in overuse conditions of the lower limb including medial tibial stress syndrome and plantar fasciitis. Rigid taping, most commonly a low-dye or low-dye plus reverse 6's technique have been employed to provide pronation control with studies reporting increases in navicular height, reductions in local muscle activity e.g. tibialis anterior and tibialis posterior and EMG changes further up the kinetic chain. Plantar pressure changes have also been reported.

Some of these changes persist once the tape is removed however they are substantially reduced in magnitude.

Corresponding clinical improvement has also been reported in MTSS, plantar fasciitis and Sever's disease.

Rigid taping is thought to provide a passive restriction of movement with 3D kinematic studies demonstrating a general reduction in rear foot motion (not limited to pronation) as well as mid foot control. The role of load in tendinopathy has been described by Cook and Purdham and McPoil and Hunt also proposed a tissue stress model to explain overuse injuries of the lower limb. They suggest that when loading takes the tissues beyond the elastic region of the load-deformation curve, micro-failure results. Overuse injuries may result if load and damage exceeds the capacity of the tissues to accommodate that load and to regenerate.

Low-dye taping and similar acts to restrict motion to prevent stress being applied to the tissues and the subsequent soft tissue creep and hysteresis that results. Restricting movement, however may lead to unwanted effects elsewhere in the kinetic chain in an attempt to dissipate load. It is often reported as being uncomfortable and it cannot directly absorb load or decelerate movement.

Dynamic Tape has strong recoil properties, stretches in all directions and does not have a rigid endpoint. It is designed to permit full range of motion but when applied correctly creates a 'bungee' effect to decelerate motion thereby reducing the load absorption requirements of the tissues while allowing desirable movement to accommodate to ground surfaces or to further dissipate load.

In a preliminary study, Dynamic Taping was shown to be effective at reducing foot length and raising the navicular height in both non-weight bearing and weight bearing. Furthermore, those subjects taped with the foot in a 'short' position i.e. to create the greatest load absorption and resistance to pronation resulted in a greater change than those taped in a neutral position.

Cowley and Marsden reported a 5mm drop in navicular height after running a half marathon. Vicenzino and co-workers showed that the increase in arch height created by a rigid, augmented low-dye technique was significantly diminished after just ten and twenty minutes of jogging. No previous studies have investigated the effective of Dynamic Taping on navicular height following an exercise challenge.

Methods and measures: Consent for inclusion in this study was obtained by a 37 year old, female marathon runner with a 3 month history of plantar heel pain. Her pain commenced following the addition of three sessions per week of plyometric and high intensity interval training to her exercise regime. Pain had continued to worsen despite cessation of these sessions followed by the cessation of running and the inclusion of calf stretching and arch and calf strengthening exercises.

The subject attended on four occasions and measures of foot length and arch height with the use of vernier callipers to gauge the distance from the floor to the tubercle of the navicular were taken pre-tape, immediately after tape, after 12 hours and 72 hours (subsequent to exercises challenges) with the tape in situ, 1 hour after removal of the tape and 24 hours after removal of the tape. Weight bearing and non-weight bearing measures were recorded at all time periods (Table 1).This measurement technique has been previously described by Vicenzino et al, 1997 and was shown to be reliable.

Visual Analogue Scale was used to record pain levels.

The exercise challenge on day 1 (Ex 1) consisted of a 16 km run followed by a one hour yoga session with a three hour rest period in between. The exercise challenge on day 3 (Ex 2) consisted of a 12 km run followed by a yoga session with a three hour rest interval between.

The taping technique employed has been described in the Dynamic Tape Quick Start Guide. A double layer of 5cm Dynamic Tape was laminated together to create a PowerBand prior to application. The technique is applied with the foot in plantar flexion, forefoot adduction, inversion and great toe flexion. The tape commences on the plantar aspect of the great toe and runs towards along the medial longitudinal arch (MLA) towards the medial aspect of the calcaneum such that the line of pull creates a flexion moment at the great toe, adduction of the forefoot relative to the calcaneum and a shortening of the MLA. The tape then continues behind the calcaneum and obliquely across its lateral aspect before sweeping under the foot to emerge under the navicular medially. This is aimed to resist valgus at the calcaneum. Finally the foot is positioned in maximal inversion as the tape lifts the navicular, passes over the dorsum of the foot and anchors over the dorsal aspect of the cuboid. This final loop creates a compressive force designed to help stabilise the mid foot by providing some external force closure in a similar way to a sacroiliac joint belt. This technique creates an external windlass mechanism to short the foot and raise the arch.

An additional strip of 7.5cm wide Dynamic Tape was used to provide further deceleration to the navicular drop. A reverse six was applied with the foot in dorsiflexion and inversion. A similar technique has been described by Cornwall and co-workers, 2013 using an elastic adhesive bandage. This was shown to be reliable and also result in an increase in navicular height but of lesser magnitude than that found in this investigation.

Both strips were applied with only sufficient tension to ‘take up the slack’ in the tape. This allows the tape to work in its ‘elastic’ zone and maintain good energy absorption and recoil properties without limiting desirable range of motion at all. By placing the tape on in the ‘short’ position as described, the tape is immediately under tension and therefore presumed to be providing a resistance or deceleration force as soon as the foot is placed on the ground.

Results: Pre-tape levels of navicular height and foot length were not significantly different from side to side. Arch height measures were in accordance with those previously reported (Swedler). All measures are documented in Table 1. Foot length was significantly reduced immediately post taping. In NWB, foot length reduced from 242mm to 230mm and arch height was increased from 42mm to 54mm. A similar change was observed in weight bearing with foot length reducing from 248mm to 237mm and a raise in arch height from 35mm to 49mm (Table 2).

Following 24 hours and the initial exercise challenge consisting of a 16km run and 1 hour of yoga considerable differences remained when compared to the pre taped condition. In NWB, foot length was 237mm representing a shortening of 5mm over the pre taped measure while arch height was recorded at 50mm, 8mm higher than the pre tape measurement. The same pattern existed in weight bearing only with a greater magnitude of change over the pre taped recordings with foot length of 237 (-11) and arch height of 46mm (+11) as shown in Table 3.

The effect was slightly diminished after the additional wear time and second exercise challenge (Table 4) but still significant with regard to arch height in NWB and arch height and foot length in weight bearing.

Table 5 and 6 show the measurements at one hour and 24 hours after the removal of the tape. Interestingly a change of 3 to 5mm was still present in weight bearing.

VAS score of 6 was recorded on initial weight bearing in the morning and during running untaped. This reduced to 0 with tape in situ and morning pain returned to 2. In this case, taping was repeated after the conclusion of the data collection however it can be reported that the subject resumed pain free running immediately (with tape) and increased overall weekly running distance by approximately 8 km over the course of four weeks however ran 3 longer sessions each week instead of the 5 shorter sessions that she was doing pre-injury. This allowed longer recovery periods between sessions. Taping ceased after six weeks and at last follow up eight weeks later there had been no recurrence.

TABLE 1
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measurements in the Taped and Untaped Conditions

	Time = 0 UNTAPED		Time = 1 hr TAPED		Time = 12 hrs TAPED		Time = 72 hrs TAPED		Time = 73 hrs UNTAPED		Time = 96 hrs UNTAPED	
(mm)	NWB	WB	NWB	WB	NWB	WB	NWB	WB	NWB	WB	NWB	WB
FL L	242	248	230	237	237	237	241	243	241	244	241	245
AH L	42	35	54	49	50	46	47	43	44	40	44	40
FL R	244	249			244	249						
AH R	43	35			43	36						

NWB = non weight bearing, WB = weight bearing, FL = foot length, AH = arch height

TABLE 2
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measures Immediately Before and After Tape Application

Left Foot	Day 0 - NWB		Day 0 - WB	
(mm)	FL	AH	FL	AH
Pre Tape	242	42	248	35
With Tape	230	54	237	49
Change	-12	+ 12	-11	+14

TABLE 3
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measures Immediately Before and 1 Day After Tape Application (after Ex 1)

Left Foot	Day 0 vs Day 1 NWB		Day 0 vs Day 1 WB	
(mm)	FL	AH	FL	AH
Pre Tape	242	42	248	35
Post Ex 1	237	50	237	46
Change	-5	+ 8	-11	+11

TABLE 4
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measures Immediately Before and 3 Days After Tape Application (after Ex 2)

Left Foot	Day 0 vs Day 3 NWB		Day 0 vs Day 3 WB	
(mm)	FL	AH	FL	AH
Pre Tape	242	42	248	35
Post Ex 2	241	47	243	43
Change	-1	+ 5	-5	+8

TABLE 5
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measures Immediately Before Tape and 1 hour After Removal of Tape

Left Foot	Day 0 vs Day 3 NWB		Day 0 vs Day 3 WB	
(mm)	FL	AH	FL	AH
Pre Tape	242	42	248	35
1 hr after removal	241	44	244	40
Change	-1	+ 2	-4	+5

TABLE 6
Weight Bearing and Non Weight Bearing Foot Length and Arch Height Measures Immediately Before Tape and 24 hours After Removal of Tape

Left Foot	Day 0 vs Day 4 NWB		Day 0 vs Day 4 WB	
(mm)	FL	AH	FL	AH
Pre Tape	242	42	248	35
24 hrs after removal	241	44	245	40
Change	-1	+ 2	-3	+5