

# Change of Plantar Pressure and Foot Arch After Juveniles Doing Sports Physical Therapy for Foot and Ankle with Resistance Band

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## **Abstract:**

It is very common that flat foot occurs in juveniles. This study analyze the data of plantar pressure and foot arch to observe the effect of doing sports physical therapy for foot and ankle with resistance band in juveniles with flatfoot. First we recruited an experimental group of 30 flatfeet and a control group of 30 normal feet. Plantar pressure of mid foot and height of foot arch were measured respectively in two groups. Then experimental group started doing foot and ankle exercise using resistance band for 12 weeks. The plantar pressure of mid foot and height of foot arch were measured in experimental group after 12-week-exercise. Finally the SPSS were performed to analyze the data. It was shown from the results that plantar pressure of mid foot after 12-week exercise were significantly reduced compared with pre-exercise data. The height of foot arch after 12 weeks exercise was significantly higher than pre-exercise data. Furthermore, there was no significant difference between after-exercise data and the control-group data. Foot and ankle exercise using resistance band can significantly improve plantar pressure of mid foot for juveniles with flatfoot. Sports physical therapy of foot and ankle can effectively raise the height of foot arch.

**Keywords:** *Foot arch, Physical therapy, Exercise training, Data analysis, conservative treatment.*

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## I. INTRODUCTION

As the living conditions get better, the incidence of flat foot is also increasingly higher in adolescents [1]. Because of the lack of the foot arch, flatfoot can deform the structure of the foot bone [2], further increase the plantar pressure of mid foot [3], and finally result in ankle [4], knee [5] and even hip diseases [6]. Therefore, the treatment of flatfoot in adolescents is particularly important.

Generally, most flat feet are flexible ones which suit for conservative treatment. Resistance band is one kind of sports physical therapy. This study aimed to observe the change of plantar pressure and the height of foot arch after juveniles were doing sports physical therapy for foot and ankle with resistance band.

## **II. MATERIALS AND METHODS**

### **2.1 Subjects**

This study recruited 30 flatfeet in experimental group, and 30 normal feet in control group. All the subjects did not have lower limb diseases in recent 6 months. All of them had signed the written informed consent prior to the study participation. To exclude inter-group interference factors, one-way ANOVA was performed for information on age, height, weight, foot length in two groups. There was no statistical difference between experimental group and control group.

### **2.2 Procedure**

At first, four plantar pressure data and height of foot arch were measured respectively in two groups. Then subjects of experimental group started doing foot and ankle exercise with resistance band for 12 weeks. After 12-week sports physical therapy, four plantar pressure data and height of foot arch were measured again. The ANOVA of repeated measures was used to analyze the data.

### **2.3 Data**

It is a consensus that [7] the main difference part of plantar pressure between flat foot and normal foot is mid foot. In this case, this study compared four plantar pressure of mid foot between flatfoot and normal foot to find out the effect of sports physical therapy. Four plantar pressure were measured by RSscan force plate, including arch index, contact area of mid foot, peak plantar pressure of mid foot, load rate of mid foot.

Besides, to compare the effect of sports physical therapy in foot and ankle more intuitively, the height of foot arch was measured. The height of foot arch measured in the study is the distance between medial protrusions of navicular bone to the floor.

### **2.4 Sports Physical Therapy**

Subjects were indicated to do dorsiflexion of foot, plantar flexion of foot, valgus exercise of foot and varus exercise of foot using uniform resistance band. Before doing the resistance band exercise, subjects were told to do the short foot exercise. Varus exercise of foot and plantar flexion of foot required mainly

eccentric contraction in the first eight weeks. While during the last four weeks of training, the times of eccentric contraction and concentric contraction were comparable. The specific arrangement is shown from TABLE I.

**TABLE I. Arrangement of sports physical therapy**

<b>SPORTS</b>	<b>1-4WEEKS</b>	<b>5-8WEEKS</b>	<b>9-12WEEKS</b>
VARUS EXERCISE WITH RESISTANCE BAND	10/Groups, 3 groups/times, 2 times/day. eccentric contraction primary	15/Groups, 3 groups/times, 2 times/day. eccentric contraction primary	15/Groups, 5 groups/times, 2 times/day. concentric –eccentric comparably
VALGUS EXERCISE WITH RE.SISTANCE BAND	10/Groups, 3 groups/times, 2 times/day. concentric –eccentric comparably	15/Groups, 3 groups/times, 2 times / day. concentric –eccentric comparably	15/Groups, 3 groups/times, 2 times / day. concentric –eccentric comparably
PLANTAR FLEXION OF FOOT WITH RESISTANCE BAND	10/Groups, 3 groups/times, 2 times/day. eccentric contraction primary	15/Groups, 3 groups/times, 2 times/day. eccentric contraction primary	15/Groups, 5 groups/times, 2 times/day. concentric –eccentric comparably
DORSIFLEXION FLEXION OF FOOT WITH RESISTANCE BAND	10/Groups, 3 groups/times, 2 times/day. concentric –eccentric comparably	15/Groups, 3 groups/times, 2 times / day. concentric –eccentric comparably	15/Groups, 3 groups/times, 2 times / day. concentric –eccentric comparably
SHORT FOOT EXERCISE	10/Groups, 2 groups/times	15/Groups, 3 groups/times	20/Groups, 4 groups/times

### III. RESULTS AND DISCUSSION

After 12 weeks sports physical therapy, four plantar pressure of mid foot were reduced, and the height of foot arch was raised. It was shown from Table II that the arch index after sports physical therapy was reduced from 31.187% to 28.874%. Contact area of mid foot after training was declined from 46.234 cm<sup>2</sup> to 40.467 cm<sup>2</sup>. Peak plantar pressure of mid foot was decreased by 7 Newton. Load rate of mid foot was decrease by 0.8 N/ms. Besides, the height of foot arch in experimental group after

training was increased from 4.143cm to 4.817cm. The details are as below.

**TABLE II. Plantar pressure and arch height of two groups**

PLANTAR PRESSURE/ ARCH HEIGHT		MEAN	STD. ERROR	95% CONFIDENCE INTERVAL	
ARCH INDEX (%)	Before	31.187	0.106	30.971	31.404
	After	28.874	0.074	28.723	29.025
	Control	28.864	0.083	28.695	29.033
CONTACT AREA (CM <sup>2</sup> )	Before	46.234	0.195	45.835	46.634
	After	40.467	0.217	40.022	40.912
	Control	40.545	0.174	40.190	40.901
PEAK PRESSURE (NEWTON)	Before	267.358	0.898	265.522	269.195
	After	220.024	0.769	218.451	221.598
	Control	219.786	0.703	218.348	221.224
LOAD RATE (N/MS)	Before	1.685	0.013	1.663	1.707
	After	0.992	0.012	0.969	1.014
	Control	0.988	0.014	0.966	1.011
HEIGHT OF FOOT ARCH (CM)	Before	4.143	.014	4.114	4.172
	After	4.817	.017	4.783	4.851
	Control	4.853	.016	4.821	4.885

Before equals experimental group before sports physical therapy

After equals experimental group after sports physical therapy

Control equals control group

Statistical analysis was performed on the data of experimental group before training, experimental group after training, and control group to analyze if there was significant difference among the changes. It was revealed from TABLE III that there was significant difference between arch index before training and the data after training. Meanwhile, contact area after training was significantly different from the data before. It was also shown from TABLE III that there was significant difference between peak

plantar pressure before training and after training. Moreover, load rate after training was significantly different from the data before. Furthermore, the height of foot arch after training significantly differed from the data before.

Besides, there was no significant difference between data after training and data in control group.

**TABLE III. Differences among data after training, data before training and data in control group**

PLANTAR PRESSURE/ ARCH HEIGHT			MEAN DIFFERENCE	STD. ERROR	SIG. <sup>A</sup>
ARCH INDEX	After	Before	-2.313*	0.088	0.000
		Control	0.010	0.037	0.791
CONTACT AREA	After	Before	-5.767*	0.237	0.000
		Control	-0.078	0.149	0.602
PEAK PRESSURE	After	Before	-47.334*	1.075	0.000
		Control	0.239	0.242	0.333
LOAD RATE	After	Before	-0.693*	0.012	0.000
		Control	0.003	0.004	0.364
ARCH HEIGHT	After	Before	0.673*	0.017	0.000
		Control	-0.037	0.019	0.062

Based on estimated marginal means

\*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

The current method to evaluate flat feet is the plantar pressure analysis [8]. And the main different part in plantar pressure between flatfoot and normal foot is mid foot [7]. This study therefore measured arch index, contact area of mid foot, peak plantar pressure of mid foot and load rate of mid foot.

Arch index [9] is the ratio of mid foot area to full foot area when in load bearing position. Contact area of mid foot is the area contacting the ground with mid foot in load bearing position [10], which is shown as cm<sup>2</sup>. Peak plantar pressure of mid foot, indicated by Newton, refers to the maximum plantar pressure in mid foot [11]. Load rate means the maximum plantar pressure in mid foot in unit time, which is shown as N/ms [12]. Due to the low-flat collapse of the foot arch, the foot bone deformed and caused abnormal compression in the mid foot [13], which finally led to the increase of arch index, contact area [14], peak plantar pressure and load rate [15]. The results from this study were consistent with the previous study content. Four plantar pressure of mid foot before sports training were significantly larger than normal data in control group.

After 12-week training, all the plantar pressure data were significantly decreased and the height of foot arch was apparently raised compared with the data before training. Furthermore, all the data after training were not significantly different from the normal data in control group. The results from this experiment included that sports physical therapy in foot and ankle could raise the foot arch, and reduce the plantar pressure of mid foot.

It is reported that [16] the main reason for the flat foot is the relaxation of the ankle muscles such as posterior tibial muscle, which cannot suspend the foot arch and eventually lead to the collapse of the arch [17]. During 12 sports physical therapy in foot and ankle, the muscles strength around the ankle joint were exercised, which could support and suspend the flat arch to normal height. That was the reason why sports physical therapy could restore the foot bone, raise the foot arch and reduce the plantar pressure of the mid foot.

#### **IV. CONCLUSION**

Foot and ankle exercise using resistance band can significantly improve plantar pressure of mid foot for juveniles with flatfoot. Sports physical therapy of foot and ankle can effectively raise the height of foot arch.

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