

THE IMMEDIATE EFFECTS OF FOOT MASSAGE WITH COCONUT SHELL ON PRESSURE PAIN THRESHOLD AND FOOT GRIP STRENGTH IN HEALTHY SUBJECTS: A PILOT STUDY

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ABSTRACT: Feet are very important parts of the body because they carry almost all of the body weight and contribute to human locomotion. Daily works in prolonged standing position may cause foot pain and fatigue easily. Currently, foot massage with coconut shells has been practiced in some eastern countries to relieve foot pain and fatigue for a long time without sufficient scientific evidence. This study aimed to preliminarily determine the immediate effects of a foot massage with coconut shell on pressure pain threshold and foot grip strength in healthy subjects. Thirteen healthy volunteers, who worked in standing position mostly, participated in the study and received a 5-minute session of foot massage using coconut shells. Pressure pain threshold and foot grip strength were measured before and 2 minutes after the foot massage. The results showed that foot massage with coconut shells could increase pressure pain threshold and foot grip strength significantly ($P < 0.05$). We suggested that foot massage with coconut shells may raise pressure pain threshold of the feet and provide better effort on foot muscles contraction. Further study with a randomized controlled trial was recommended to verify these effects.

Keywords: Coconut shell, Foot massage, Pressure pain threshold, Foot grip strength

1. INTRODUCTION

Feet are major organs of the body that support the weight of the whole body. They are always tired or fatigue and pain after long hours of working in weight-bearing positions such as standing and walking. A study found prolonged standing may decrease pressure pain threshold of the feet [1]. Untreated foot discomfort and pain may lead to abnormal gait and prone to have the injury and falls especially in the elderly people. Foot massage is one of the commonly used treatments for relieving foot fatigue and pain. It is the systematic and scientific manipulation of the soft tissues and muscles of the body to promote their maintenance, performance, and healing, and improve desirable therapeutic outcomes such as mental and psychological relaxation to increase comfort and healing [2]. More than 7000 nerves exist in each foot; when manipulated by the foot massage, these are stimulated to reduce the stress and relax the body, resulting in body equilibrium. In Chinese medicine, massage is carried out to improve life energy through the release of serotonin and melatonin neurotransmitter mediators, which decreases fatigue, resolves depression and improves sleep [3].

Moreover, foot reflexology on the specific zone on the feet may reflect to normalize the functions of the remote organs on the body such as heart and brain. It has been found that foot massage may be helpful in maintaining health by reducing muscle

fatigue [4] and balancing the autonomic nervous system [5]. Some research has shown that foot massage may have a positive effect on type 2 diabetes and exert a beneficial effect on lowering blood pressure and incontinence [6],[7] and to determine immediate effects of foot self-massage in combination with exercise using tennis balls on balance performance in community-dwelling older adults. Materials and methods: This study was a quasi-experimental before/after study without a control group. Thirty healthy elderly adults both male and female (average age: 69.23 ± 7.00 years, BMI: 23.05 ± 3.82 kg/m²) participated. Participants performed foot self-massage combined with tennis ball exercise for 10 positions under researcher's supervision. Timed up and go test (TUG) and functional reach test (FRT) were used to assess functional balance before and after foot massage and exercise. Participants also provided satisfaction survey on the equipment and foot massage with the exercise program after post-test. Data were analyzed by Wilcoxon signed-rank test and dependent t-test to compare differences between pre- and post-test of TUG and FRT respectively. An alpha level of $p < 0.05$ was used to test statistical significance. Findings from this study demonstrated that foot self-massage combined with tennis ball exercise may improve functional balance and also build comfort for the foot in elderly [20]. Combined self-administered foot massage and cognitive behavioral therapy (CBT) led to reductions in

depression, stress, systolic blood pressure (SBP), and blood glucose (BG) levels. Therefore, the intervention could be an effective means of reducing the stress response in middle-aged women [21]. Foot massage using coconut shells has been practiced in many countries in Asia for relieving foot fatigue and reduce pain in lower extremities. However, the effects of foot massage using coconut shells have not been reported.

The current study aimed to preliminary determine study on the immediate effects of the foot massage using coconut shell on pressure pain threshold and foot grip strength in healthy subjects.

2. METHODOLOGY

2.1 Sampling site

Subjects who met the criteria were recruited from students and staff at Prince of Songkhla University, Thailand

2.2 Inclusion criteria

Subjects were included if they were healthy and aged between 20-35 years.

2.3 Exclusion criteria

Subjects were excluded if they met one of the exclusion criteria:

1. Physical fatigue or fever
2. Pregnant
3. Having menstruation
4. Hypersensitive to pressure massage
5. An open wound in the foot.

3. MEASUREMENT INSTRUMENTS AND PROCEDURES

3.1 Pressure pain threshold (PPT)

A calibrated pressure algometer (WE Algometer, Thailand) was used to measure PPT of the feet. A research assistant marked the ten locations on the plantar surface of the feet for measurement of the PPT (Fig. 1). Each of the subjects was rested in the prone lying position and carried a control switch of PPT in a hand. Then, the research assistant carried the handle of the algometer and gradually applied perpendicular pressure through the probe on each marked location. When the subject had a sensation of pain distinct from pressure or discomfort [6] on the applied pressure location, he/she pushed the stop button and got the reading of PPT. At this point, the algometer pressure was immediately released. The measurement was done twice and the average of the readings was recorded.

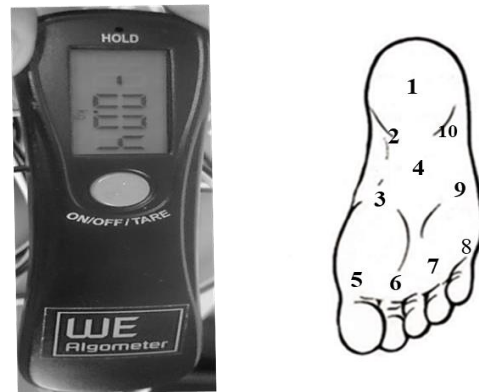


Fig.1 The WE algometer (left) and point of measurement of PPT.

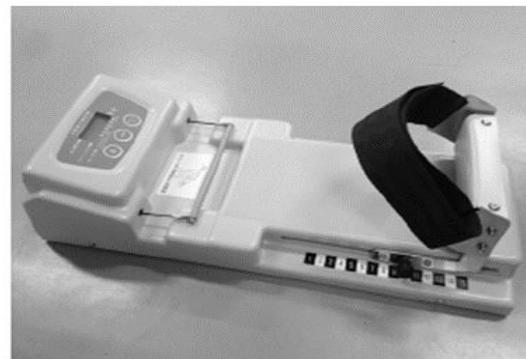


Fig.2 Toe Grip Dynamometer.

3.2 Foot grip strength

Isometric measurement of foot grip strength was performed using a Toe Grip Dynamometer (TAKEI SCIENTIFIC INSTRUMENTS CO., LTD, Japan). Each of the Subjects was instructed to stand upright on the measuring plate where both feet were placed shoulder-width apart. The handle of the force meter or grip bar was set underneath the 1st metatarsophalangeal joint and the heel stopper was adapted to fit the heel of the participant (Fig.2). When the subject was ready to start, the dynamometer was set to zero. Then the subject was asked to squeeze and pull the grip bar with the toes as hard as possible and get the reading. After the adequate number of practice and rest, the actual toe grip strength was measured twice, each time maintained the maximal force about 3 seconds and rested 10 seconds between times, the mean value of the foot grip strength was calculated [9], [11]. Using this method of measurement, "Uritani [10] reported that the interrater reliability of foot grip strength was high in young adult and middle-aged adult (ICC=0.76-0.95)".

3.3 Procedure

After the participants underwent screening procedures by interview, they gave informed consent. After the baseline was measured each subject received 5 minutes of self-foot massage using coconut shells and followed by 2-minute rest on a chair. To perform self-foot massage, the subject stood on one foot while placing another foot of a prepared half-sized coconut shell and gradually increasing pressure to the plantar surface of the foot until he/she felt a little discomfort then releases the pressure. This procedure of self-foot massage had been repeated for 2.5 minutes and ensures to cover the whole area of the plantar surface of the foot and then swabbed to massage on another foot for 2.5 minutes. After 2 minutes of rest on a chair, the subject was measured again. The procedure of data collection was summarized in Figs. 3,4.

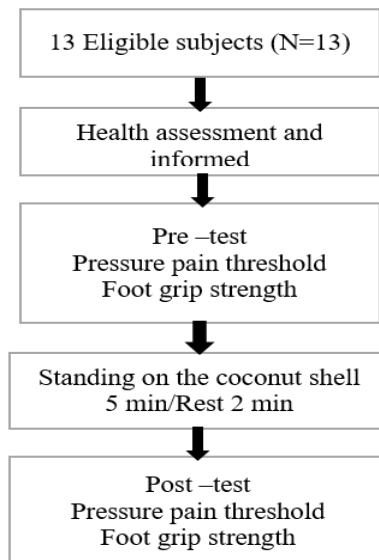


Fig. 3 A diagrammatic presentation of data collection procedure.

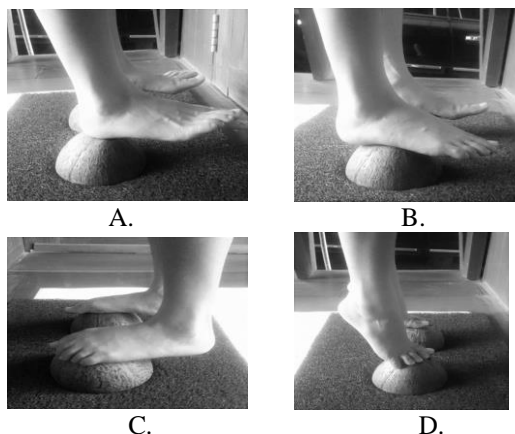


Fig.4 The massage points were located on the plantar surface. Mark the four test locations; A; P1: heel. B; P2: medial plantar arch point. C; P3: center of the four foot. D; P4: metatarsal head.

3.4 Data analysis

All data were expressed using descriptive statistics as the means and the standard deviation (mean \pm SD). Pair t-test was used to compare outcome measures between baseline and after the treatment. All p-values were two-tailed, and the level of significance was set at 0.05. All statistical analysis was performed with IBM SPSS statistics 20 software (SPSS Inc., Chicago, IL, USA)

4. RESULTS AND DISCUSSION

Demographic data of the subjects were presented in Table 1. Most of the subjects were females, aged ranged 20-30 years, and had normal range of body mass index.

Table 1 Characteristics of healthy subjects.

Item		N=13	Percentage
Sex	Female	8	62
	Male	5	38
Age	20 – 25	3	23
	26 - 30	10	77
Weight (Kg)	41 -50	5	38
	51-60	3	23
	61-70	3	23
	71-80	1	8
	81-90	-	-
	91-100	1	8
Height (cm)	141-150	1	8
	151-160	8	62
	161-170	2	15
	171-180	2	15
Body mass index (kg/cm ²)	< 18	1	8
	18.5– 23.4	8	62
	23.5– 28.4	3	22
	28.5– 34.9	1	8
	35.0– 39.9	-	-
	> 40	-	-

The results of the paired t-test revealed a significant changes in PPT mostly after the treatment ($P \leq 0.05$) (Table 2). PPTs of the left leg were increased at Seven out of ten locations ($p \leq 0.5$) whereas three locations were decreased. The low PPT at location P1, P3, P4 after foot massage may be due to overpressure during the procedure of applying foot massage using the coconut shells. For

the right foot, almost all the locations (9 out of 10) were found with significantly increased in PPT after having the foot massage. It was noted that at P5 the PPTs were not significantly increased for both feet. This may be due to the location of P5 that was underneath the first metatarsal joint and has less muscle mass than the others. The response to foot massage was lower than the locations with relatively more muscle mass in the foot. The intrinsic muscles of the feet that were prone to get fatigue during stance may respond to massage quicker than the area with fewer muscles.

Although the results of the current study were in line with those of previous studies, it was also noted that the overall changes in PPT after foot massage were less than 1 kg/cm². The effect size was relatively small which may be due to a single session of foot massage may provide the small effect. If more sessions of foot massage were administered, more effect size may occur. The algometer being used to measure (PPT) in this study had high precision with two decimals of digital reading and well calibrated, it was unlikely that the small effect sizes were due to the instrumental error.

The purposes of this study preliminarily determined the immediate effect of a foot massage with coconut shell on pressure pain threshold and foot grip strength in healthy subjects. To our knowledge, this is the first study on the effect of a foot massage with coconut shell on plantar surface muscles after immediate. This study showed a significant increase in pressure pain threshold, and foot grip strength after treatment compared with the score.

The increase in nearly pressure pain threshold after foot massage may be a sign of recovery from muscle fatigue and let the subject exert more muscle power than baseline and have more foot grip strength on both feet. The findings of this study were consistent with the study of Eungpinichpong [12] which found that foot massage increased blood circulation, reduce the tension and pain of the muscles, and increases the skin temperature in the area being massaged. When considering the appearance of the coconut shell, it is an object with an embossed curve. When standing or walking on a coconut shell, the pressure on the foot is a message. This can help stimulate the senses increased blood flow and nutrient uptake [13], [14], [15]. Massage also stretches the muscles of the feet and improved ankle motion [16].

The result from the paired t-test of foot grip strength revealed significantly different after the foot massage. ($p < 0.05$) (Table 3). The higher score of foot grip strength after foot massage reflected that less fatigue so that the subjects could exert more forces than those of baseline.

Table 2 Pressure pain threshold (PPT) measured on the plantar surface of the foot with at the 10 test locations.

Location	Base line	Post	Difference	p-value	
Left	P1	5.44± 1.98	5.12± 1.67	-0.32	0.001*
	P2	4.45± 1.70	4.55± 1.96	0.10	0.001*
	P3	4.49± 1.89	4.16± 1.83	-0.33	0.001*
	P4	4.90± 1.91	4.71± 1.78	-0.19	0.001*
	P5	4.77± 1.58	4.82± 1.72	0.05	0.001*
	P6	5.04± 2.04	5.25± 1.98	0.21	0.001*
	P7	5.07± 2.29	5.29± 1.95	0.22	0.001*
	P8	5.17± 2.42	5.28±1 .99	0.11	0.001*
	P9	4.81± 2.21	5.13±2 .02	0.32	0.001*
	P10	4.99± 2.20	5.23±1 .95	0.24	0.001*
Right	P1	5.60± 2.19	6.25± 1.99	0.65	0.003*
	P2	5.05± 2.39	5.29± 1.92	0.24	0.005*
	P3	4.58± 1.94	4.86± 1.74	0.28	0.008*
	P4	5.18± 2.21	5.38± 1.53	0.20	0.004*
	P5	5.03± 1.84	5.21± 1.59	0.18	0.082
	P6	5.24± 2.11	5.59± 1.94	0.35	0.021*
	P7	5.30± 2.12	5.74± 2.03	0.44	0.001*
	P8	5.31± 2.35	5.70± 2.18	0.39	0.001*
	P9	5.16± 2.31	5.53± 2.04	0.37	0.002*
	P10	5.47± 2.31	5.80± 2.05	0.33	0.006*

*sig $p < 0.05$, Mean PPT (kg/cm²).

Table 3 Foot grip strength.

Location	Base line	Post	Difference	p-value
Left	12.74± 4.32	13.79± 2.80	1.04	0.001*
Right	13.12± 4.42	15.54± 4.57	2.33	0.001*

*sig p<0.05, Mean foot grip strength(kg).

In addition, standing on a coconut shell with a narrow and high combined with weight-bearing training in different it adds to the challenge of controlling posture. So standing or walking on a coconut shell is a practice that encourages a controlled posture of the body. When weight is transferred to the points while standing on the coconut shell, it stimulates the ankle and hip muscles to control the ankle and hip strategy [17]. The foot massage with coconut shell can help restore the strength of the toe flexor muscles. Thus, the mechanism used in foot massage with coconut shell, it helps increase blood circulation and reduce the number of substances in the massage area. So, this area has been given oxygen, nutrients and other energy causes the muscles to be strong. In addition, the foot massage with coconut shell mechanism strengthens the muscle contraction of the toe flexor muscles. Foot massage with coconut shell reduces the stiffness soft tissue resistance around the ankle and the foot. It also helps to increase the elasticity of the muscles. As a result, the length of the muscles can be in the range of the optimal length, making the muscles stronger [18], [19]. Therefore, coconut shell pedals can stimulate blood circulation, as the coconut shell has a pointed part that can stimulate the foot. The blood is able to transport oxygen to different parts of the body, increasing the strength and flexibility of muscle feet and muscles.

Some limitations of this study were noted. First, this was only a pilot study in 13 healthy volunteers and small sample size may provide the limitation on the conclusion. Second, the pre-post study design in this study could not provide a definite conclusion. However, results of this study could provide a clue that foot massage with coconut shell may result in immediately increased pressure pain threshold and foot grip strength. Finally, we also do not know the long-term effects.

5. CONCLUSION

Based on the results of this study, we conclude that the foot massage with coconut shells may

increase the (PPT) and foot grip strength. Further study with a larger sample size and the randomized controlled trial is suggested.

6. ACKNOWLEDGMENTS

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