Effect of Electro Acupuncture TENS, Stretching Exercises and Prefabricated Insole in Patients With Plantar Fasciitis

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Abstract

Background and Purpose : *Plantar fasciitis is one of the most common soft tissue disorder of the foot. The purpose of the study was to detect the effect of electro acupuncture TENS, stretching exercises of Achilles tendon and plantar fascia and prefabricated in-sole on patients suffering from plantar fasciitis.* ***Subjects :*** *Twenty three participants with plantar fasciitis were randomized divided into three groups. Group (A), 8 patients received electro acupuncture TENS, Achilles tendon and plantar fascia stretching and prefabricated insole. Group (B), 8 patients received calf muscle and plantar fascia stretching with prefabricated insole. Group (C), 7 patients received only prefabricated insoles.* ***Methods :*** *All participant were asked to assess their first-step pain in the morning with pain score (VAS), ankle dorsiflexion range of motion and foot peak plantar pressure were measured before and after 8 weeks of treatment.* ***Results :*** *A highly significant difference between group A and B for pain score ($p<0.0001$), ankle dorsiflexion ($p<0.01$) and peak plantar pressure ($p<0.05$). The comparison of means between group A and C recorded a highly significant difference for pain and ankle dorsiflexion ($p<0.0001$), and a significant difference for peak plantar pressure ($p<0.01$). There is no significant difference between group B and C regarding the results of pain and peak plantar pressure ($p>0.05$) and a highly significant difference for ankle dorsiflexion range of motion ($p<0.001$).* ***Conclusion :*** *The program of electro-acupuncture TENS, achilles tendon and plantar fascia stretch with prefabricated insole were effective in the treatment of plantar fasciitis. The prefabricated insole only was not effective in reducing pain or peak plantar pressure in this study.*

Key words : *Plantar fasciitis , Electro-acupuncture TENS , Achilles tendon stretch , Plantar fascia stretch , Prefabricated insole.*

Introduction

Plantar fasciitis (plantar heel pain) is an inflammation of plantar fascia attached to the heel causing sharp pain and discomfort localized along the middle to posterior aspect of the sole of the foot and at the bottom of the heel bone. Plantar fasciitis is a common foot disorder encountered in the outpatient clinics [(1-5)]. The prevalence reported in many studies varied in range from 8% to 15% of all ankle and foot injuries [(6-8)]. Plantar fasciitis affects active and sedentary adults of all ages and more likely to occur

in persons who spend most of the day on their feet or who have limited ankle flexion[9]. Repetitive activities like walking or running for a long distance, inadequate or non-supportive foot wear, biomechanical defects of the foot, or structural imbalance as very high or very low arches can cause uneven distribution of pressure over the sole of the foot and excessive wear to the plantar fascia of the foot[10].

Tightness of the Achilles tendon will predispose to plantar fasciitis because limited dorsiflexion of the foot strains the plantar fascia. Furthermore, in plantar fasciitis the foot tends to remain in an equines position during the night and the fascial tissues contract. In the morning, putting weight on the foot puts the plantar fascia under tension, aggravating the pain. This cycle of heel cord tightness and plantar fasciitis should be interrupted as soon as possible by exercises to stretch the heel cord and by using night splints [8-11].

Numerous non-operative modalities have been developed and used to treat plantar fasciitis as iontophoresis [11,12], passive and active mobilization[13], night splint[14], extracorporeal shock wave[15,16] and taping[12,17]. Crowford and Thomson 2003 [14] published a systemic review about different conservative treatments recommended for the treatment of plantar heel pain. The review found that although there is limited evidence for the effectiveness of local corticosteroid therapy, the effectiveness of other frequently employed treatment in altering the clinical course of plantar heel pain had not been established. Radford et al 2007[18], randomly allocated 46 patients with plantar heel pain as intervention group that were prescribed calf muscle stretches and sham ultrasound and 46 patient as control group who received sham ultrasound alone. The intervention period was two weeks. The results concluded that a short-term program of calf muscle stretch is not recommended for plantar heel pain.

A poor response to treatment may be due to inappropriate and non specific stretching techniques. Stretching protocols emphasized mainly on the Achilles tendon and not specifically address the plantar fascia [19,20]. DiGiovanni et al 2003,[21] in a study of 101 patients with chronic proximal plantar fasciitis divided into two groups, group A received tissue-specific plantar fascia stretching and group B applied weight-bearing Achilles tendon stretching. Both groups received pre-fabricated insoles, three weeks course of non-steroidal anti-inflammatory medications and viewed an educational video abut plantar fasciitis. After eight weeks of treatment, the group managed with plantar fascia-stretching exercises exhibited enhanced outcomes with regard to pain, function and overall satisfaction.
Pfeffer et al[22] conducted a randomized multicenter trial of 236 patients with plantar fasciitis for 8 weeks. They evaluate 5 programs of treatment on the patients, 1) stretching of calf muscle, 2) stretching of calf muscle with a silicon heel pad, 3) stretching of calf muscle with a felt arch insert, 4) stretching of calf muscle with a rubber heel cup, 5) stretching of calf muscle with a custom functional foot orthoses. The outcome measures showed that the group treated with the prefabricated inserts (silicon pas, felt arc insert, rubber heel cup) had significantly better results than the group treated with stretching only and the group treated with custom orthotics. Another randomized controlled trial by Winemiller et al 2003[23], showed that magnet-embedded insoles were no more effective than placebo insoles in alleviating pain.
Recent studies[24,25] have shown that acupuncture - with or without electrical stimulation - can be an effective form of pain relief for a variety of musculoskeletal

conditions, but research regarding its use for plantar fasciitis is scant. Perez-Millan and Foster 2001, examined the role of electro-acupuncture in the management of plantar fasciitis, the results of their study suggest that electro-acupuncture is an effective form of care for plantar fasciitis, producing marked reductions in foot pain and improved function in a relatively short amount of time.

Material and Methods

Subjects

23 Participants (14 males and 9 females) were recruited from the orthopedic clinic of the hospital university with a clinical diagnosis of plantar fasciitis (heel pain). Participants were included if diagnosed with Plantar fasciitis (plantar heel pain) defined as (i) localized pain at the plantar heel; (ii) history of intense sharp heel pain with the first couple of steps in the morning that was worst when first standing or walking after rest; and (iii) that improved initially after first standing but worsened with increasing activity. Patients were excluded from the trial if patient history revealed any inflammatory, osseous, metabolic or neurological abnormalities. They were also excluded if they had received a corticosteroid injection within the past three months. Participants were encouraged not to commence use of any new treatments during the trial (e.g. anti-inflammatory medication)[18]. The participants provided informed consent and were randomly allocated to one of three groups. Group (A), 8 patients (16 feet) with mean age (43.7±8.2), mean weight (77.9±12.4), and mean height (163±13.5) received electro-acupuncture, plantar fascia stretch, Achilles tendon stretching, and wearing prefabricated insoles. Group (B), 8 patients (13 feet) with mean age (47.1±5.9), mean weight (74.5±9.6) and mean height (161.9±14.3), received plantar fascia stretch, calf muscle stretch and wearing prefabricated insoles. Group (C), as a control group of 7 patients (12 feet) with mean age (42,2±9,1), mean weight (82.4±19.4), and mean height (165.6±11.7) wearing prefabricated insoles only (table 1).

Table 1. Characteristics of the participants.

group	male	female	Number of legs affected	Age (Y) ($\bar{X}$±SD)	Weight (Kg) ($\bar{X}$±SD)	Height (cm) ($\bar{X}$±SD)	Duration of heel pain (months)
A	5	3	16	43.7±8.2	77.9±12.4	163±13.5	11±3
B	5	3	13	47.1±5.9	74.5±9.6	161.9±14.3	11±5
C	4	3	12	42,2±9,1	82.4±19.4	165.6±11.7	10±6

Procedure

The treatment procedure was given to the patients three times per week for about 40 to 45 minutes for 8 weeks. Electro acupuncture TENS treatment was carried out for group (A) on the affected side at the rate of three treatment sessions per week using SOLITENS (Model No. SW-103B). First start treatment with cleaning the plantar surface with alcohol then determine of acupuncture points (KI 1,3,6, BL60,67, GB 44 and local a-shi) by the audible tone indicator of the device then start the treatment by increasing the intensity to the maximum tolerance of the patients for 20 minutes per session (Devitt 2001)[25].

Treatment by stretching exercises of the Achilles tendon and plantar fascia were given to group A and B. Both groups received instructions in a plantar fascia tissue-stretching program. They were instructed to perform this exercise while sitting and by first crossing the affected leg over the contra-lateral leg. Then, while using the hand on the affected side, they were to place the fingers across the base of the toes on the bottom of the foot (distal to the metatarso-phalangeal joints) and pull the toes back toward the shin until they felt a stretch in the arch of the foot (Figs. 1). The therapist was to confirm that the stretching was correct by palpating the tension in the plantar fascia with her hand while patient was performing the stretching. Patients were received instructions in an Achilles tendon-stretching program. They were taught to perform this exercise while standing and leaning into the wall with the affected leg placed behind the contra-lateral leg. Patients were asked to place the shoe insert under the affected foot in order to minimize excessive mid-foot pronation while stretching. They were also instructed to "toe in" or point the toes of the affected foot toward the heel of the front foot. Patients were told to bend the front knee while keeping the back knee straight and the heel firmly on the ground [21,27,28]. Group (C) just asked to wear with group A and B, a prefabricated in-sole (Scholl TM) according to their arch height.

Figure 1. Plantar fascia stretch.

Measurements

Measure the level and severity of heel pain. First, patients were asked to assess their level of heel pain as a first-step pain in the morning before the start of treatment and at the completion of 8 weeks program using a 10-point visual analogue scale (VAS), with 10 representing severe pain. The second measure was the ankle dorsiflexion range of motion measured by universal goniometer. The third measurement was peak plantar pressure distribution (barefoot) by using Novel EMED (Munich, Germany) before the start of treatment. The I Novel Pedar (Munich, Germany) system was used after 8 weeks of treatment to measure the insole dynamic peak plantar pressure [26]. Both barefoot and in-sole plantar pressure was measured during normal walking speed and with patient's own footwear. Three steps were recorded for each affected foot for each subject. The graphs were collected, and the peak plantar pressure was defined as the maximum pressure recorded by any sensor during the stance phase of the walking cycle. The researcher toke the average feet pressure distribution of the three steps of the affected feet before and after treatment measurement.

Statistical Methods

The individual group difference on before and after treatment scores were analyzed by using unpaired t test. The P-value is obtained using analysis of variance (ANOVA) between groups test and post hoc (Tukey-Kramer multiple comparison test). The level of significance was set at $P \leq 0.05$. Statistical analysis was undertaken with GraphPad InStat and Micro Soft Excel 2007.

Results

The mean values of foot pain score measured by VAS before treatment were (7.41±0.745, 7.8±0.407, 7.65±0.777) and after treatment were (3.538±0.877, 6.96± 1.013, 7.57±0.60) for group A, B, and C respectively. The measured dorsi-flexion range of motion before treatment for group A, B, and C were (12±1.31, 11.375±1.923, 11±1.414) and after treatment were (19.25±1.49, 16.25±1.389, 11.214±0.91). The foot peak plantar pressure mean values before treatment were (703.67±97.997, 738.08± 130.47, 708.36± 106.28) and after treatment were (457.50±96.25, 614.97±81.47, 656.87± 50.18) for group A, B, and C respectively (table 2).

The comparison of means before and after treatment by using the unpaired t-test showed that the group (A) reported a highly significant reduction in pain score and ankle dorsi-flexion range of motion as p value <0.0001, and highly significant reduction in foot peak plantar pressure (p<0.0002). There is a highly significant increase in ankle dorsi-flexion range of motion in group (B) as the p value <0.0001, and a significant difference for pain and foot peak plantar pressure (p<0.0477, 0.04) respectively. There are no significant changes for group (C) between before and after treatment for either pain score, ankle dorsi-flexion range of motion or foot peak plantar pressure (table 2 and figures 1,2,3).

Table (2): Mean values and unpaired t-test for the VAS, dorsiflexion and foot peak plantar pressure before and after treatment of the three groups.

Measurement			Group A	Group B	Group C
Pain (VAS)	Before	$\bar{X}$±SD	7.41±0.745	7.8±0.407	7.65±0.777
		SEM	0.2634	0.1439	0.2939
	After	$\bar{X}$±SD	3.538±0.877	6.96±1.013	7.57±0.60
		SEM	0.3099	0.358	0.2268
	Unpaired t-test	t	9.525	2.170	0.03848
		P value	P<0.0001	P<0.0477	P >0.9699
Ankle DF-ROM	Before	$\bar{X}$±SD	12±1.31	11.375±1.923	11 ±1.414
		SEM	0.463	0.680	0.5345
	after	$\bar{X}$±SD	19.25±1.49	16.25±1.389	11.214±0.91
		SEM	0.5261	0.491	0.3426
	Unpaired t-test	t	10.346	5.814	0.2582
		P value	P<0.0001	P<0.0001	P>0.8006
Foot PPP (KPa)	Before	$\bar{X}$±SD	703.67±97.997	738.08±130.47	708.36±106.28
		SEM	34.647	46.128	40.17
	after	$\bar{X}$±SD	457.50±96.25	614.97±81.47	656.87±50.18
		SEM	34.030	28.802	18.965
	Unpaired t-test	t	5.069	2.264	1.159
		P value	P<0.0002	P<0.04	P>0.269

VAS= visual analogue scale- DF-ROM= dorsiflexion range of motion- Foot ppp= foot peak plantar pressure.

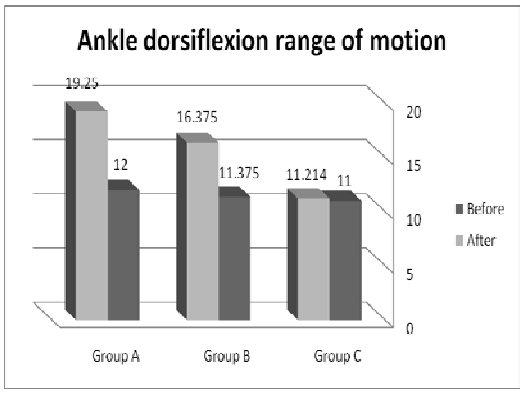

Fig. (1): Mean values of ankle dorsiflexion before and after treatment of the three groups.

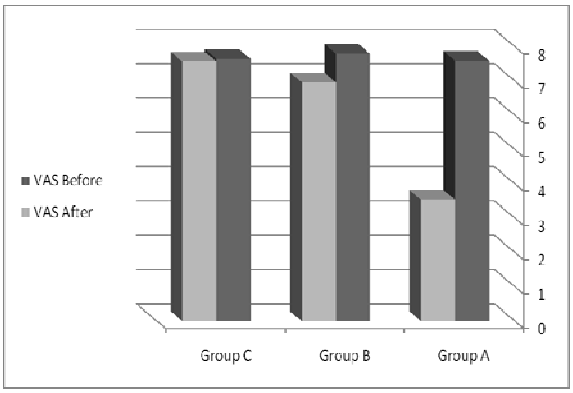

Fig.(2): Mean value of pain (VAS) before and after treatment .

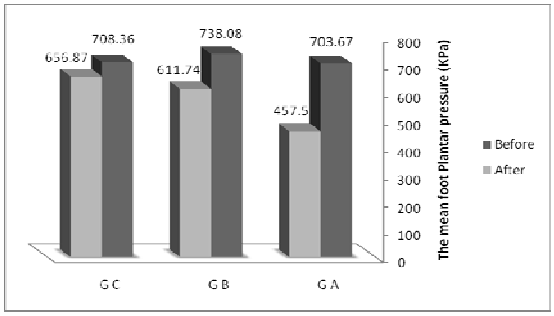

Fig.(3): Mean values of foot plantar pressure (KPa) of the three groups before and after treatment.

The results of ANOVA and post hoc, (Tukey-Kramer multiple comparison test) indicated a non significant difference between the three groups before treatment for the three measurements of pain (VAS), dorsi-flexion range of motion and peak plantar pressure (P>0.05). The comparison of means between the three groups after treatment showed a highly significant difference between group A and B for the measurement of pain (p<0.001), a significant difference for ankle dorsi-flexion range of motion (p<0.01), and peak plantar pressure (p<0.05). The comparison of means between group A and C recorded a highly significant difference for pain and ankle dorsi flexion (p<0.001), and significant difference for peak plantar pressure (p<0.01). There were no significant difference between group Band C regarding the results of pain and peak plantar pressure (p>0.05) and a highly significant difference for ankle dorsi-flexion range of motion (p<0.001) (table 3).

Table 3. Tukey-Kramer multiple comparison test of the three groups before and after treatment

Comparison of means between the three groups before treatment									
Measurement	Group A vs group B			Group A vs group C			Group B vs group C		
	VAS	DF	PPP	VAS	DF	PPP	VAS	DF	PPP
Mean difference	-0.3875	0.625	-34.41	-0.173	1.000	-4.686	0.214	0.375	29.721
q	1.433	1.142	0.998	0.619	1.766	0.131	0.766	0.6621	0.833
P value	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
Comparison of means between the three groups after treatment									
Measurement	Group A vs group B			Group A vs group C			Group B vs group C		
	VAS	DF	PPP	VAS	DF	PPP	VAS	DF	PPP
Mean difference	-3.425	3.00	-157.46	-4.063	8.036	-199.37	-0.638	5.036	-41.903
q	12.667	5.483	4.566	14.515	14.188	5.585	2.278	8.891	1.174
P value	<0.001	<0.01	<0.05	<0.001	<0.001	0.01	>0.05	<0.001	>0.05

Discussion

The present study was conducted to show the effect of different non-invasive interventions (electro-acupuncture, stretching of calf muscle and plantar fascia and prefabricated in-soles) on patients suffering from plantar fasciitis. The results of the present study demonstrated that there was a significant reduction in first-step pain measured by VAS for group A and a small but significant beneficial effect for group B and no significant difference found for group C. Also the first-step pain score between groups after treatment showed a greatest superiority of group A on group B and C (as p<0.0001). The measurement of first-step pain measured by VAS is important because it is a validated instrument. Recent studies including the multicenter clinical trial on acute plantar fasciitis by Pfeffer et al [(22)], have used the first seven items of the pain subscale of the Foot Function Index as a primary numeric outcome using VAS, as patients routinely complain from the severe pain with the first-step in the morning and focus on the pain when it is at its worst. In the current

study, the chose to analyze the pain with first-step in the morning is thought to be more clinically relevant to patient's complaints. The superiority of relieving pain for group (A) may be due to the use of electro-acupuncture TENS. Several theories were proposed to explain electro acupuncture's effects as in addition to the inflammation brought about by plantar fasciitis, the condition causes myofascial pain due to the development of trigger points in the foot muscles. The researchers [24,25], suggested that these points could be deactivated by acupuncture with electrical stimulation providing an "additive" effect. Deactivation of trigger points could also relieve the noxious stimulation leading to central sensitization in the spinal cord and central nervous system. Since there is scientific evidence supporting a link between electrical stimulation of acupuncture points and the release of endorphins, natural substances that relieve pain, they also theorized that electro-acupuncture could activate the body's pain relief system, increasing the concentration of endorphins in the central nervous system and decreasing the amount of pain signals that arrive at the spinal cord level[29,30].

The results demonstrated that the Achilles tendon stretching and plantar fascia stretching over eight-weeks period produced a highly statistically significant beneficial effects ($p<0.0001$) for ankle dorsiflexion range of motion for group A and B compared with no change in ankle dorsiflexion range of motion for group C. The stretching exercises serve to improve the elasticity and load to failure of the fascial components, thus raising the threshold for injury and micro trauma to the fascial insertion. Many researchers reported that these stretching exercises have been shown to be the most effective conservative treatment for plantar fasciitis. DiGiovanni et al [21], compared calf muscle stretching with plantar fascia tissue stretches over eight weeks. Both groups experienced reductions in pain, however the plantar fascia stretches were found to provide a statistically significant greater reduction in pain when compared to the calf muscle stretches. Porter et al [31], compared sustained 3 minute calf stretches with intermittent 20 second calf stretches for plantar heel pain and found no significant differences in improvement between groups. Radford et al 2006 [32], concluded that calf muscle stretches provide a small but statistically significant increase in ankle dorsiflexion, particularly after 5-30 minutes of stretching. A large, prospective, randomized study of more than 200 patients showed that an 8-week treatment course of Achilles tendon stretching and plantar fascia stretching improved 72% of patients. Stretching and the addition of a silicone or rubber heel cup yielded improvement in more than 90% of patients[33].

This study has shown that the prefabricated in-sole combined with electro-acupuncture and stretching of the Achilles tendon and plantar fascia intended for plantar fasciitis patients can reduce the peak plantar pressure significantly. It is obviously demonstrated that such alterations are important and sufficient to reduce peak plantar pressure, as in group (C) who used prefabricated in-sole only showed no significant difference in any measurement. This current study was in agreement with many studies used different types of shoe inserts to manage plantar fasciitis [22,32]. One randomized controlled trial (RCT) [23], showed that magnet-embedded in-soles were no more effective than placebo in-soles in alleviating pain. Another study[22] that compared custom orthotics and prefabricated shoe inserts combined with stretching found that the use of prefabricated in-soles plus stretching was significantly more effective than custom orthotics plus stretching. The discrepant results from these various studies are likely a function of different approaches to insole manufacture, subject selection, and experimental procedure. More studies are needed to compare

the effect of these non-invasive methods of treatment on patients with different foot pathologies and different foot types. Further trials are necessary for evaluating the role of different types of in-soles in the treatment of plantar fasciitis.

Conclusion

Plantar fasciitis is a common cause of heel pain. The use of electro-acupuncture combined with Achilles tendon and plantar fascia stretch with prefabricated in-sole provides a highly significant reduction in pain and foot plantar pressure and increase in ankle dorsi-flexion range of motion. The study revealed that the use of prefabricated in-sole only is not beneficial in treatment of plantar fasciitis.

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تأثير الوخز بالأبر الكهربائى (تنس) وتمرينات الأستطالة والنعل الداخلى الجاهزعلى مرضى إالتهاب غشاء بطن القدم اللفافى

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الخلفية والغرض. إلتهاب غشاء بطن القدم اللفافى هو أكثر أنواع إصابات القدم شيوعا. غرض الدراسة هو تحديد تأثير الوخز بالأبر الكهربائى (تنس) وتمرينات الأستطالة لعرقوب الكاحل وغشاء بطن القدم اللفافى والنعل الداخلى الجاهز على المرضى الذين يعانون من إلتهاب غشاء بطن القدم اللفافى. **الأشخاص.** ٢٣ مشارك مصابون بإلتهاب غشاء بطن القدم اللفافى قسموا عشوائيا إلى ثلاث مجموعات (أ،ب،ج) . **الطريقة.** مجموعة (ا) ٨ مرضى أستخدم معهم وخز بالأبر الكهربائى (تنس) وتمارين الأستطالة لعرقوب الكاحل وغشاء بطن القدم اللفافى والنعل الداخلى الجاهز. مجموعة (ب) مكونة من ثمانية مرضى أستخدم معهم تمارين إستطالة لعرقوب الكاحل و غشاء بطن القدم اللفافى و النعل الداخلى الجاهز. مجموعة (ج) مكونة من سبعة مرضى أستخدم معهم النعل الداخلى الجاهز فقط. كل المشاركين تم تقييم آلام أول خطوة فى الصباح بإستخدام مقياس المناظر البصرى وقياس مدى الثنى الحركى للكاحل بإستخدام الجونيوميتر وقياس أعلى ضغط لبطن القدم بإستخدام جهاز نوڤل إيميد قبل بداية العلاج وجهاز نوڤل بيدار لقياس أعلى ضغط لبطن القدم أثناء أرتداء النعل الداخلى الجاهزبعد إنتهاء العلاج. تمت القياسات قبل بدء العلاج وبعد ثمانية أسابيع من العلاج. **النتائج.** وجد إختلاف ذات دلالة إحصائية عالية بين المجموعة (أ) و (ب) من حيث إنخفاض معدل الألم ($p>٠,٠٠٠١$) وزيادة مدى الثنى الحركى للكاحل ($p>٠,٠١$) وإنخفاض الضغط على بطن القدم ($p>٠,٥$). وأثبتت المقارنة بين المجموعة (أ) و(ج) إختلافا هاما جدا وذات دلالة إحصائية عالية بالنسبة لإنخفاض معدل الألم وإنخفاض الضغط على بطن القدم ($p>٠,٠٠٠١$) وزيادة المدى الحركى لثنى الكاحل ($p> ٠,٠٠١$). لم تثبت النتائج أختلاف بين مجموعة (ب) و (ج) إلا فى زيادة مدى حركة ثنى الكاحل ($p>٠,٠٠١$). **الخاتمة.** النتائج أيدت أن برنامج الوخز بالأبر الكهربائى (تنس) وتمرينات الأستطالة لعرقوب الكاحل و غشاء بطن القدم اللفافى مع إستخدام النعل الداخلى الجاهز كانت أكثر فاعلية من أستخدام تمرينات الأستطالة لعرقوب الكاحل و غشاء بطن القدم اللفافى مع إستخدام النعل الداخلى. كما أثبتت النتائج أن أستخدام النعل الداخلى الجاهز فقط ليس فعال.

الكلمات الدالة. إلتهاب غشاء بطن القدم اللفافى- وخز الأبر الكهربائى (تنس)- أستطالة عرقوب الكاحل- أستطالة غشاء بطن القدم اللفافى- النعل الداخلى الجاهز