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Impact of Manual Therapy, Supervised Exercises and Electro Acupuncture Versus Well-Designed Home Exercise Program on Pain and Physical Functions among Female Patient with Knee Osteoarthritis: A Comparative Study

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Abstract: Osteoarthritis of knee joint is the most form of arthritis. To compare the impact of clinical physical therapy program versus home-based physical therapy program among female with knee osteoarthritis. Forty females with knee osteoarthritis were randomly assigned to clinic and divided into two equal groups. Group (A) received manual therapy, supervised exercises and electro-acupuncture like TENS and home exercise program, and group (B) received the same exercises as group A. Participants were evaluated by measuring knee range of motion, pain and use Arabic version of Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Group A, showed increase in knee flexion by 18.14%, and extension by 78.60%, reduction in pain by 51.90%. WOMAC demonstrated 53.07% pain reduction, 58.94% in stiffness and 49.30% increase in physical function. For group B, knee flexion was increased by 4.20%, knee extension by 24.66% and pain decreased by 23.94%. WOMAC reported reduction 31.81% in pain, 30.09% in stiffness and 12% increased physical function. Both clinical and home exercise programs were effective in improving knee osteoarthritis. The home exercise program can be used to reduce cost, save time and reduce OA patient's waiting list in physical therapy clinic.

Key words: Knee osteoarthritis · Manual therapy · Exercises · Electro-acupuncture · Home exercise program

INTRODUCTION

Osteoarthritis (OA) is the most common joint disease. Articular cartilage in OA has shown to loss its mechanical resistance, elasticity and smoothness and consequently worn out by the movement of the joint. This leads to reactive bone remodeling, forming osteophytes, micro fractures and finally exposure of the articular end of the bone [1].

The etiology of OA of knee or hip is not entirely clear and its incidence increase with age and in women [2]. Pain, stiffness and disabilities are the major symptoms of OA and should be assessed when evaluating the impact of OA [3]. Relationships have been reported between decrease of joint range of motion (ROM), angular deformities, muscle weakness and disabilities. These symptoms can severely impair or limit the ability to climb flight of stairs, rise from a chair and walk ultimately leading to a loss of independence [4].

The treatment of OA is largely symptomatic and includes analgesics, non steroid anti-inflammatory drugs (NSAIDs), glucosamine, topical analgesics such as capsaicin cream, exercises, behavioral interventions and surgical treatment [5]. Currently, the aim of the treatment is to control the symptoms of OA because as yet there is no disease modifying OA drugs [6]. Patients have to learn to live with the consequences: impairments (such as pain), activity restrictions (such as decreased ROM) and participation problems (such as restricted mobility). These consequences can negatively affect the quality of the life (QOL) of older people [7].

Long term use of NSAIDs is discouraged [8] and studies show that patients generally do not like taking drugs [9]. People with knee OA want non-pharmacological options for pain relief [10] and often choose complimentary medicine [11]. Acupuncture is one of the most popular options but the place of acupuncture within mainstream health care remains controversial [12, 13].

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Systemic reviews concluded that acupuncture is more effective than placebo for OA of the knee. However the questions about the benefits of adding acupuncture to main stream, recommended treatments for this population remain unanswered [13].

A growing body of evidence shows that exercise improves knee joint function and decreases symptoms. However, the most effective types and combinations of exercises and dosage are unclear. The setting in which the exercises should be performed and the level of professional attention required to initiate and maintain the exercise program also should be the subject of further investigation [14, 15].

The need for cost effectiveness throughout the health care system emphasizes the importance of knowing whether patients require numerous visits to physical therapist or whether they might receive a similar benefit from a well-designed home program [16]. In a qualitative evaluation of physical therapist-supervised home exercise program using weighted knee extension and subjective reporting, the researchers demonstrated a great positive effect of the home program as the same program was performed in physical therapy clinic [17]. Another study by Fisher *et al.* 1994, quantified the effect of 3 month home exercise program on patients with knee osteoarthritis. They found a slight increase in functional capacity and they failed to demonstrate significant or statistical improvement in overall function after home exercise [18].

The purpose of this study was to compare the impact of clinical physical therapy program versus home-based physical therapy program among female with knee osteoarthritis.

Our hypothesis was that physical therapy consisting of manual therapy, supervised exercises and electro-acupuncture like TENS (EA like TENS) conducted in the clinic would be more effective than exercise program performed at home for decreasing pain and improving function.

MATERIAL AND METHODS

Forty female patients with osteoarthritis of the knee with age (49.975±6.982) year, weight (73.3±2.556) Kg, height (155.825±5.033) cm, were randomly assigned to the study. Physicians at various clinics of the university hospital who normally see patients with osteoarthritis of the knee were informed about the study so that appropriate referrals could be made. All patients referred by physicians to physical therapy clinic in the university hospital were met the inclusion criteria. The main inclusion criterion was a diagnosis of osteoarthritis of the knee based on fulfillments of one of the following clinical criteria developed by Altman and colleagues1986, [19]: (1) knee pain, age 38 years or younger and bony enlargement; (2) knee pain, age 39 years or older, morning stiffness for more than 30 minutes and bony enlargement; (3) knee pain, crepitus on active motion, morning stiffness for more than 30 minutes and bony enlargement; or (4) knee pain, crepitus on active motion, morning stiffness for more than 30 minutes and the age 38 years or older. Altman and colleagues found these criteria to be 89% sensitive and 88% specific. Patients were excluded if they could not attend the required number of visits, had received a cortisone injection to the knee joint within the previous 30 days or had a surgical procedure on either lower extremity in the past 6 months. All patients instructed to continue taking any medications that had been initiated 30 days or more prior to enrollment in this study.

The ethical approval was obtained from the hospital university research center. All patients were asked to sign a consent form to be enrolled in the study. All data collection and clinical treatment sessions were conducted in the physical therapy clinic of the university hospital.

The patients were randomly assigned equally to two groups. Clinic treatment group (Group A) designed to receive clinical based physical therapy program consists of manual therapy, supervised exercises and EA like TENS. The total treatment session was 30 to 40 minutes three times per week conducted for 8 weeks.

Manual therapy (Mobilizing exercises) for increasing the knee range of motion and reducing pain were made (three mobilizing exercises, knee distraction, dorsal glide and ventral glide). In knee distraction the patient was sit with the knee off the edge of the treatment Table, the therapist was sit in front of the patient's knee distally. The dorsal and ventral glide were done with patient in supine and her knees in resting position, the therapist stride standing facing the patient's knee, the stabilizing hand support the femur from the distal dorsal side and hold it in position. The manipulating hand grasps the proximal tibia from the ventral side and glides the tibia in dorsal direction. Ventral glide of the tibia on the femur from the same position with both hands grasp the proximal tibia from the dorsal side and glide tibia in ventral direction [20].

Supervised exercises include flexibility, strength, endurance and active range of motion. Flexibility exercises were done to gastrocnemius-soleus, hamstring and quadriceps muscle by ask patient to hold the muscle stretch for 30 seconds and do three repetitions with each

muscle group on each leg. The strengthening exercises consisted of quadriceps and hamstring "sitting" followed by maximal isometric contractions of the quadriceps and hamstrings. The active range of motion maneuvers performed with straight leg raises (hip), abduction/adduction (hip), short arc extension (knee), leg extensions (knee) and leg curls (knee), strength, endurance and active range of motion activities [21, 22].

The EA like TENS using [SOLITENS model NO. SW-103B], applied to acupuncture points selected on the Traditional Chinese Medicine Meridian Theory to treat knee joint pain. These points consists of 5 local points (Yanglinquan [gall bladder meridian point 34], Yinlinquan [spleen meridian point9], Zhusanli [stomach meridian point 36], Dubi [stomach meridian point35] and extra point Xiyan) and 4 distal points (Kunlun [urinary-bladder meridian point 60], Xuanzhong [gall-bladder meridian point 39], Sunyinjiao [spleen meridian point 6] and Taixi [kidney meridian point 3] [23-26]. The skin was cleansed with an alcoholic swab. EA like TENS, with frequency of (15) Hz and maximum intensity can be tolerated was applied to the 9 selected acupuncture points. The intensity was increased slowly up to a tolerable, non-painful "pounding" sensation level [27]. The treatment lasted for 20 minutes and the intensity of the EA was readjusted, if necessary. The patients were treated 3 times a week for 8 weeks.

Home program exercise group (group B), received detailed verbal and hands-on instructions in a home based-program of the same exercises as the clinical treatment group to maintain and improve muscle strength flexibility around the knee joint. The home program consists of exercises that are considered standard home program [21, 22]. They have been studied previously by Chamberlain *et al.* [17] and include: flexibility, strength, endurance and active range of motion activities. Each subject was taught the outline of the exercise program and provided with a written copy of the exercises with details on how to perform them at home. Throughout the 8 weeks, the patients began the daily program with flexibility exercises of the gastrocnemius-soleus, hamstring and quadriceps muscle. They were asked to hold the muscle stretch for 30 seconds and do three repetitions with each muscle group on each leg. The strengthening exercises consisted of quadriceps and hamstring "sitting" followed by maximal isometric contractions of the quadriceps and hamstrings. The active range of motion maneuvers performed were straight leg raises (hip), abduction/adduction (hip), short arc extension (knee), leg extensions (knee) and leg curls (knee). The exercises progressed from one set to three sets within first 4 weeks, followed by increases in resistance during the range of motion activities in the second 4 weeks. The appropriate ankle weights were supplied to each subject to take home. Functional activities (stair climbing, rising from a chair) were progressively added during the last 2 weeks to better integrate the other three components (flexibility, strengthening and endurance) of the program. The patients were instructed to perform the exercises two times daily for 20 minutes or as long as there was no exacerbation of symptoms. The physical therapist reassessed the exercise program after 4weeks for each patient to keep the program challenging and beneficial. The patients were made aware of the side effects and contraindications (swelling, increase joint pain) of excessive exercise and were to teach how to stretch their quadriceps and hamstring [22].

Evaluation and Assessment: Patients self assessment were based on Western Ontario Mc Master's Arthritis Index (WOMAC) questionnaire (Arabic translation, appendix I) [4]. The WOMAC is divided into three dimensions: pain, stiffness and physical function listed in 24 items. The Likert scale (a verbal scale of five points: none = 0, slight =1, moderate = 2, severe = 3, extreme = 4) is used for scoring each item [4]. The knee range of motion was assessed by a universal goniometer to measure flexion and extension of both knees. The mean change of pain scores was assessed on 100 mm visual analogue scale (VAS). All measurements were done at the beginning and at the end of 8 weeks of treatment.

Statistical Analysis: A descriptive statistical analysis of all data was presented by mean and standard deviation. To test the hypothesis, paired t- test was used to determine the difference between the studied groups. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 18.

RESULTS

Forty female patients participated in the study, there were no reported treatment complains and no patients dropped out because of adverse effects at base line, the two groups were comparable with respect to age, weight, height, body mass index and severity of OA. the characteristics of subjects were shown in Table (1) the mean age of all subjects was 49.975 year, the mean BMI 30.15 indicated that the subjects are obese, the period of complain was about 7 years. There was no significant difference in the average age, weight, height and duration of knee pain.

Table 1: Characteristics of clinic treatment group (group A) and home exercise program group (group B) with confirmed diagnosis of the knee joint

	Group A	Group B
Number	20	20
Age, year,mean(±SD)	50.45±6.786	49.6±7.316
Sex	female	female
Body mass index mean(±SD)	29.8±1.281	30.5±1.357
Duration of complain mean(±SD)	6.15±0.813	5.9±0.788

Table 2: Results on the outcome variables: flexion ROM, extension ROM, VAS and WOMAC index (pain, stiffness and physical functions)

Measurements	Mean (±SD)	t-value	P- value	% of Difference
Flexion ROM				
Group A	Pre 107.5±6.782	12.808	<0.0001	8.14%
	Post 127.8±3.197			
Group B	Pre 117.75±7.86	5.423		4.20%
	Post 122.7±5.74			
Extension ROM				
Group A	Pre 2.95±2.505	5.417	<0.0001	-78.60%
	Post 0.68±1.003			
Group B	Pre 3.65±2.46	9.200		-24.66%
	Post 2.6±2. 234			
VAS				
Group A	Pre 6.55±1.85	17.228	<0.0001	-51.90%
	Post 3.15±1.42			
Group B	Pre 7.1±1.71	13.309		-23.94%
	Post 5.4±1.57			
WOMAC index Pain				
Group A	Pre 11.4±1.96	20.5	<0.0001	-53.07%
	Post 5.35±1.82			
Group B	Pre 12.1±18.32	16.56		-31.81%
	Post 8.25±1.25			
WOMAC index Stiffness				
Group A	Pre 4.75±1.37	11.9	<0.0001	-58.94%
	Post 1.95±0.686			
Group B	Pre 5.65±1.27	11.5		-30.09%
	Post 0.95±0.887			
WOMAC index Physical function				
Group A	Pre 44.75±10.87	15.9	<0.0001	-49.30%
	Post 22.35±6.13			
Group B	Pre 47.5±6.08	14.8		-12%
	Post 41.8±6.169			

Outcome Variables: Table (2) represents all the results of the outcome variables.

ROM measurements: the results revealed that there was significant difference between pre and post measurements (P<0.0001) in both groups A and B. The percentage of difference from base line in knee flexion was18.14% and 4.20% and for knee extension the percentage of difference was -78.60% and -24.66% for group A and B respectively.

Pain: results as measured with VAS indicated positive effect of physical therapy intervention and home care program where there was significant differences between pre and post measurements in both groups A and B (P <0.0001) while the percentage of difference was -51.90% and -23.94% for groups A and B respectively.

Physical Function: as measured by WOMAC index showed significant difference between pre and post values in both group A and B. The percentage of difference for pain, stiffness and physical function for group A were -53.07%, -58.94% and -49.30% respectively. On other hand for group B the percentage of differences was -31.81%, -30.09% and -12% respectively.

DISCUSSION

The goal of the present study was to compare the impact of clinical physical therapy program versus home-based physical therapy program among female with knee osteoarthritis. Both clinical based physical therapy group (group A) and home based physical therapy group (group B) experienced clinically and statistically significant improvement in self perception of pain, stiffness and functional ability.

The difference between groups is likely attributable to the additional of effects of clinical intervention consisting of manual therapy and supervision of the exercises that group B was performing unsupervised at home with respect to the beneficial effect of adding EA like TENS to a course of manual therapy and exercises for group A.

This study attempted to be objective with respect to the out come measures as a validated index questionnaire and quantified active/passive range of motion. It is the first study that used the Arabic version of WOMAC index; its validity and reliability were tested by Guermazi, 2004 [4].

The patients had symptoms of OA of the knee for about 7 years with the treatment protocol described above, most symptoms were improved in 8 weeks with the percentage of difference from base line in flexion 18.14% for group A in contrast to 4.20% for group B. Regarding to knee extension ROM the percentage of difference for group A was -78.60% while for group B it was -24.66% only.

The benefits of treatment were achieved in 24 clinic visits most of previous studies have demonstrated the benefits of exercises in 36 to 48 clinic visit [28]. Previous reports of average improvement with exercises have ranged from 8% to 27% decrease in pain and 10% to 39% improvement in function [28-29]. The total improvement in WOMAC score in present study averaged 53%; average subscale improvement were 58% for pain, 53% for stiffness and 49% for functional disability. Most important, these changes can be compared with those in home exercise group who experience less improvement 31.81%, 30.09% and 12% for pain, stiffness and physical function respectively. A recent best evidence summary of systematic reviews concluded that exercise therapy (strengthening, stretching and functional exercises) compared with no treatment is effective for patients with knee OA [30]. A reduction of pain may result from improvement of muscle strength and this come with the results of O'Reilly *et al.* [31] and Balint *et al.* [32] who concluded that improved quadriceps strength is associated with less knee pain and less disability.

Also the out standing improvement for patients in this study compared with results of previous studies may be due to the manual mobilizing exercises which allowed the therapist to concentrate treatment on the areas of pain and limited function for each patient. The effect of mobilizing exercise combined with clinical exercise program provide greater improvements in strength, pain and function than did clinical exercise program alone.

One argument for using acupuncture in the management of painful musculoskeletal conditions is that it is safer than standard drug treatment. Serious adverse effects of acupuncture have been reported, although those may be rare [33]. Relative to those of standard drug treatments these may be infrequent or even negligible [34-35]. Several prospective studies have shown that mild adverse effects after acupuncture occur in about 7% of all cases.

In this study low frequency (15 Hz) EA like TENS was used and it was found that it produces analgesia for long duration which out lasts the 20-min stimulation session by about 30 min to many hours. In addition, its effects are cumulative after several sessions of treatment given either daily or less frequently (2-3 times a week) for these reasons the low frequency EA like TENS was therefore given three times a week for eight weeks as commonly recommended in EA like TENS practice.

Although there are several lines of evidence from many controlled and uncontrolled studies from short term and long term effectiveness of acupuncture in relieving clinical pain [36]. The scientific data concerning the efficacy of acupuncture in OA are rare [37]. In addition, there are several systemic flaws among the studies due to inadequate sessions of acupuncture treatment [38]. In addition to all of that there are a few studies which investigate the benefits of adding acupuncture to a course of advice and exercises delivered by physiotherapist for pain relieve in patients with OA of the knee. Few randomized control trials (RCT) studies examined the effect of manual acupuncture for pain reduction of OA of the knee. Yurtkuran and Kocaggil 1999 investigated the effect of EA applied on four acupuncture points for OA of the knee their results showed that the percentage of improvement in pain were 96% and 53% respectively, but the results were without follow up evaluation and unclear if analgesic effect of EA like TENS could be prolonged [39].

Also NG *et al*. 2003 [24] reported that both EA and transcutaneous electrical nerve stimulation (TENS) treatment demonstrated a significant reduction of knee pain after eight sessions of treatment. They suggested that pain modulation by low-frequency EA or low frequency TENS could be caused by the release of endorphins within the central nervous system.

Previous study that was done by foster *at al*. 2007 [13] concluded that acupuncture delivered by physiotherapist as a part of an integrated package of health care with advice and exercises for older adults with OA of the knee provide no additional improvement in pain scores compared with advice and exercise alone as measured with WOMAC index at six and 12 months. In contrast to the previous study, in this trial there was greater improvement in pain scores as measured by WOMAC index and VAS scales for group A as compared to group B.

The home-based exercise program described in this study focused on improving the flexibility, strength, endurance and movement flexibility of the knee mechanism. Effectiveness, safety and patient complain were considered in developing the program. The benefits from this comprehensive clinically instructed home exercise program are consistent with the highest levels of benefit from exercise reported in previously cited studies. This benefit occurred to patients in the current study with only two clinic visits with reassessment of exercise program after four weeks for each patient to keep the program challenging and beneficial. The success of home program may be attributable to any or all of the features designed into the program: careful instruction, minimal exercise performance time, an adherence log, a high quality exercise folder and a comprehensive set of exercise addressing muscle tightness, limitation in joint movement, muscle weakness and general fitness.

Although the exercises of the subjects in clinic treatment group were observed and corrected as necessary, subjects in home exercise group exercised without the supposed benefits of frequent supervision, the received one-to-one supervision only initially and at the four-week follow-up visit.

This trial is important for two reasons. Firstly, it provides new information on the effectiveness of EA like TENS for relieving pain on osteoarthritis patients delivered in addition to manual therapy and supervised exercises within mainstream of health care. Secondly, manual therapy reduces pain and stiffness allows patients to participate more successfully in activities of daily living. The manual therapy passive movement techniques were applied to increase excursion in both intra-articular and peri-articular tissues when restricted mobility was judged to be related to the reproduction of symptoms of functional limitation.

Studies on education of arthritis patients had suggested improvements in some aspects of pain, self-efficiency and functional status. Since self-care education is thought to reduce health care utilization, make costs reduction and save patients time with less number of sessions for this population.

CONCLUSION

Clinical physical therapy program of manual therapy, supervised exercises combined with EA like TENS applied by physical therapist was compared with home exercise program for decreasing pain and stiffness and improving function in subjects with knee OA. The comprehensive clinical treatment program resulted in great improvement after eight weeks of treatment. The average improvement in ROM, pain, stiffness and physical function seen in clinic treatment group was twice the magnitude of the improvement observed in home exercise group. The satisfied improvement of home exercise group can encourage physical therapy clinic to organize an instruction lectures about the benefits of home exercise in reducing symptoms of knee OA for subject in appointment waiting list of physical therapy treatment.

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Appendix I
Items of WOMAC Index (Arabic version):

0- Not any.	0- لاشيء
1- A little.	1- قليلة
2- Moderate.	2- متوسطة
3- Important.	3- كبيرة
4- Very important: extreme.	4- كبيرة جدا
Pain subscale:	ا- الأوجاع:
How much pain do you have?	ماهي شدة الأوجاع التي تحس بها؟
1- Walking on flat surface.	1- عندما تمشي على أرض مستوية.
2- Going up or down stairs.	2- عندما تصعد او تنزل الدرج.
3- At night while in bed.	3- في الليل وأنت في فراشك.
4- Sitting or lying.	4- عند الجلوس او الاستلقاء.
5- Standing upright.	5- عند الوقوف.

Stiffness subscale:	ب- الييوسية أو التصلب المفصلي:
How severe is your stiffness	ماهي شدة الييوسية بمفاصلك؟
1- After first wakening in the morning	1- عندما تستيقظ في الصباح.
2-After sitting lying or resting later in the day	2- بعد الجلوس أو الاستلقاء أو الاستراحة أثناء النهار.
Physical function subscale:	ج- الحركة الوظيفية:
What degree of difficulty do you have?	ماهي شدة الصعوبة؟
1- Descending stairs.	1- عندما تنزل الدرج.
2- Ascending stairs.	2- عندما تصعد الدرج.
3- Rising from sitting.	3- عند الوقوف بعد الجلوس.
4- Standing.	4- عند الوقوف.
5- Bending to floor.	5- عندما تنحني الى الأرض.
6- Walking on flat surface.	6- عندما تمشي على أرض مستوية.
7- Getting on or out of car.	7- عندما تركب أو تنزل السيارة.
8- Going shopping.	8- عندما تذهب الى السوق.
9- Putting on socks.	9- عندما تلبس الجوارب.
10- Rising from bed.	10- عندما تقوم من الفراش.
11- Taking of socks.	11- عندما تنزع الجوارب.
12- Lying in bed.	12- عندما تستلقي على الفراش.
13-Getting in/off bath.	13- عندما تدخل أو تخرج من حوض الاستحمام
14- Sitting.	14- عند الجلوس على الكرسي
15- Getting on/off toilet.	15- عندما تجلس أو تقوم من المرحاض.
16- Heavy domestic duties.	16- عندما تقوم بأعمال منزلية كثيرة.
17- Light domestic duties.	17- عندما تقوم بأعمال منزلية خفيفة.

Scoring and interpretation:

Response	Points
None	0
Slight	1
Moderate	2
Severe	3
Extreme	4

Score equal to sum points of relevant items.
Interpretation:
Minimum total score= 0
Maximum total score= 96
Minimum pain subscore= 0
Maximum pain subscore= 20
Minimum stiffness subscore= 0
Maximum stiffness subscore= 8
Minimum physical function subscore= 0
Maximum physical function subscore= 68