Non-steroidal anti-inflammatory phonophoresis versus topical application in improvement of hand grip strength in psoriatic arthritic patients

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Abstract: The purpose of this study was to compare the efficacy of ibuprofen phonophresis versus topical application of ibuprofen in improvement of hand grip strength in psoriatic arthritic patients. Methods: Forty patients who had asymmetrical psoriatic arthritis in hand participated in this study. Their ages ranged from 30 to 50 years. Patients were classified randomly into two groups of equal numbers; group (1) (control group) received routine physical therapy (hot therapy, stretching and strengthening exercises), in addition to sham ibuprofen phonophoresis, while group (2) (studied group): received routine physical therapy, in addition to ibuprofen phonophoresis. Each patient was evaluated for grip strength, tender and swollen joint count before and after one month of treatment. The results revealed that there was a significant difference between both groups regarding to grip strength, tender and swollen joint count, with the percentage of improvement in group 1 were 56%, 54%, and 55% ,while in group 2 were 82%, 80% and 76% respectively. It is concluded that the results of the current study confirms the effectiveness of phonophoresis as a therapeutic modality enhancing the delivery of ibuprofen so increasing the percentage of improvement of grip strength in the studied group .
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1. Introduction:

According to the National Psoriasis Foundation, psoriatic arthritis (PsA) is defined as a type of inflammatory arthritis [1]. It is a chronic inflammatory, seronegative, immunologically triggered arthritis of unknown origin, which have a lasting influence on the quality of life of affected individuals [2,3]. Between 10% and 20% of people with psoriasis develop psoriatic arthritis, for the majority of people this is between the ages of 30 and 50, but it can also affect children. Men and women are equally affected [1, 3].

The cause of PsA is currently unknown. A combination of genetic and immune as well as environmental factors are likely involved. The underlying process in PsA is inflammation, which causes tenderness, pain and swelling in the joints and connective tissue with associated stiffness. PsA commonly affects the ends of the fingers and toes. Therefore, the treatments are directed to reduce and control inflammation [4].

Non-steroidal anti-inflammatory drugs (NSAIDs) are drugs with analgesic, antipyretic and anti-inflammatory effects. The term "non-steroidal" is used to distinguish these drugs from steroids, which have a similar eicosanoid-depressing, anti-inflammatory action [5].

Ibuprofen is a NSAID, which relieves pain and swelling .It works by blocking the enzyme that makes prostaglandins. Decreasing prostaglandins helps to reduce pain, swelling, and fever. It is generally prescribed for arthritis related inflammatory pains [6]. Although NSAIDs are widely used in symptomatic treatment of PsA, they produce potential hazards including gastrointestinal side effects, particularly in the elderly[7]. Physiotherapy may be considered as one of the recommended management option in these patients as phonophoresis with NSAIDs is commonly used to treat inflamed tissues [8].

Phonophoresis is the migration of drug molecules through the skin using ultrasound (US) therapy [9], which is used to enhance percutaneous absorption of drugs. Phonophoresis with anti-inflammatory and local anesthetic agents is used in the management of pain and inflammation in musculoskeletal conditions. This technique is a non-invasive, well tolerated and involves minimal risk of hepatic and renal injury [10].

Restoration of normal hand function in PsA patients is a goal that is necessarily subordinate to sustain life. In daily activity, grasping and transporting object is a frequently encountered task and its dysfunction can severely impact the patient's normal living [11].

Assessment of grip strength with dynamometry was the most common method of reporting motor outcome. Dynamometry is an instrument that is

designed to provide simple, accurate, and reliable method for measuring hand grip strength [12].

Therefore the aim of this study was directed to compare the efficacy of NSAIDs "Ibuprofen" phonophoresis versus topical application of ibuprofen in improvement of hand grip strength in psoriatic arthritic patients.

2. Subjects, Material and Methods

Subjects:

Forty patients from both sex participated in this study, who had asymmetrical psoriatic arthritis in hand referred by physician of dermatology. The study was done in out clinic of physical therapy (Faculty of Physical Therapy –Cairo University). Informed written consent was obtained from all participants. At the time of this study there was no Human Research Ethics Committee had been established in the faculty. The patients were randomly classified into 2 groups of equal number. Group 1 (control group): received routine physical therapy in the form of hot therapy, stretching and strengthening exercises[13], in addition to sham ibuprofen phonophoresis (i.e. topical application). Group 2 (studied group): received routine physical therapy, in addition to ibuprofen phonophoresis. The patient's age ranged from 30 to 50 years. Elapsed time since the beginning of the disease was less than 1 year. All patients received the same medication. Patients were excluded if they had one or more of the following: positive rheumatic factor, circulatory disorders, diabetes, pregnant woman or skin diseases like urticaria

Measurement procedures:

Each patient was evaluated for hand grip strength, tender joint count and swollen joint count before and after one month of treatment. Hand held Jamar dynamometer device 12-0600 was used to measure hand grip strength. The readout of dynamometer dial is represented in pounds and in kilograms. It is graded from zero till two hundred pounds and from zero to ninety kilograms [12]. Grip measurement was performed with the elbow at about 90° according to the American Society of Hand Therapists (ASHT) recommendations [14]. The patients were instructed to assume the sitting position while the affected limb was placed in shoulder adduction and internal rotation, elbow flexion, forearm in mid position and wrist in neutral position. The patients were instructed to squeeze the dynamometer as much as possible. Three consecutive measurements were performed with a 2 minutes inter-measurement interval. The mean strength value of the three trials was calculated and considered as the hand grip measure [15]. Joint counts for tenderness and swelling were the sum of the number of affected joints [16].

Treatment procedures:

All patients of control and studied group received the same routine physical therapy program in form of hot therapy, stretching and strengthening exercises. Strengthening exercise in form of isometric exercise for hand muscles and fingers, which can help to maintain muscles strength and joints flexibility. Hot therapy in form of warm baths (10 minutes) would be applied before stretching exercise for wrist joint and fingers to relieve joint pain and increase range of motion. Routine physical therapy program would be done daily as a home routine along the treatment time [13]. Sham ibuprofen phonophoresis was applied to control group while studied group received ibuprofen phonophoresis using ultrasonic therapy unit (Nonius, sonopuls 434, S. No. 03-202 type 1463.900 manufactured by Enraf Holland), which was set at frequency of 1MHz, the intensity at 1.5 w/cm2, and with continuous mode. A 5cm long strip of cream containing 5% ibuprofen was applied over the affected area. The treatment was given 3 sessions / week, 5 minutes for each session and for one month. [17].

3. Results

The results of this study showed that there were no significant differences between both groups in relation to patients' age and the elapsed time since the beginning of the disease. The results showed that the mean of patients' age were 38.4±5.99 and 38.95±6.18 years for group (1) and group (2), respectively with P value= 0.78, while the mean of the elapsed time were 5.55±3.5 and 5.95±3.3 respectively with P value equal 0.71. The results also presented that there was no significant difference in the patients' sex between both groups with the P= 0.752.

As shown in table 1 the mean value and standard deviation of hand grip strength ,tender joint count and swollen joint count for control group at the beginning of the study (pre) were 2.49±0.57 kg, 16.5±1.85, and 14.75±3.63, respectively, while they were 3.9±0.63Kg, 7.65±2.37, and 6.6±1.98, respectively after treatment (post). The results revealed a statistically significant improvement ($P<0.05$) in hand grip strength and tender as well as swollen joint count joint between pre and post treatment. Fig 1 represented the percentage of improvement of group 1 (control)

Table (1): The statistical analysis of mean differences of grip strength, tender joint and swollen joint count in control group (1) pre &post-treatment

Statistics	Grip strength(Kg)		Tender joint count		Swollen joint count	
	Pre	Post	Pre	Post	Pre	Post
Mean	2.49	3.9	16.5	7.65	14.75	6.6
S.D±	0.57	0.63	1.85	2.37	3.63	1.98
T- value	-9.411		12.69		9.35	
Level of significance	P<0.05		P <0.05		P <0.05	

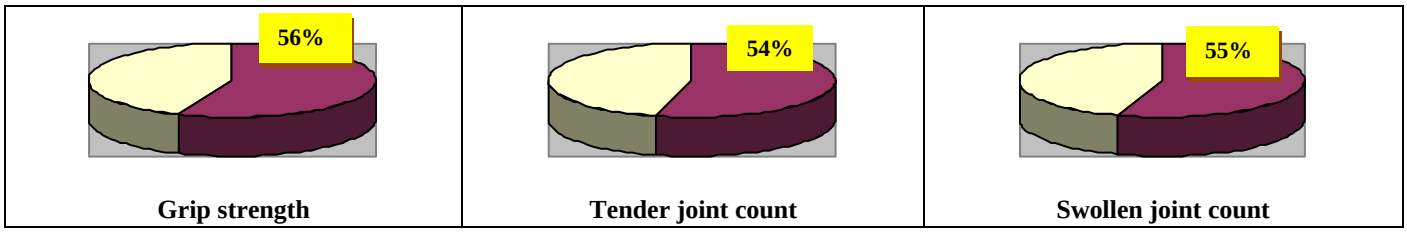

Fig (1): The percentage of improvement of grip strength, tender joint count and swollen joint count for group 1 (control)

Table (2) showed that the mean value and standard deviation of grip strength ,tender joint count and swollen joint count for the studied group at the beginning of the study were 2.75±0.72Kg, 17.35±1.34, and 15.7±1.91, respectively, while they were 5.01±0.99Kg, 3.4±1.66, and 3.7±2.38 respectively post treatment. The results revealed a highly statistically significant improvement (P<0.05) in hand grip strength and tender as well as swollen joint count joint between pre and post treatment. Fig (2) represented the percentage of improvement for group (2) (studied group).

Table (2): The statistical analysis of mean differences of grip strength , tender joint and swollen joint count in studied group (2)pre &post-treatment.

Statistics	Grip strength(Kg)		Tender joint count		Swollen joint count	
	Pre	Post	Pre	Post	Pre	Post
Mean	2.75	5.01	17.35	3.4	15.7	3.7
S.D±	0.72	0.99	1.34	1.66	1.91	2.38
T- value	-9.44		26.05		19.78	
Level of significance	P <0.01		P <0.01		P <0.01	

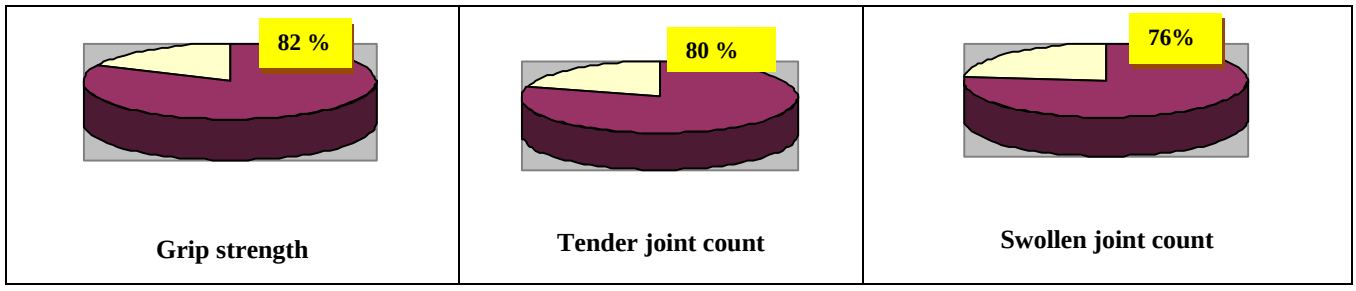

Fig (2): The percentage of improvement of grip strength, tender joint count and swollen joint count for group 2 (studied group)

The mean differences of hand grip strength and tender as well as swollen joint count between both groups before treatment showed statistically non significant difference (t value= -1.244 & P <0.221, t value= -1.66 & P < 0.105, and t value= -1.091 & P <0.28, respectively), while after treatment the mean difference showed statistically highly significant difference (t value= -4.199& P<0.01, t value= 6.65& P<0.01, and t value= 4.179 & P<0.01, respectively).

4. Discussion:

The main findings of this current study showed that there were statistically significant differences between both groups with the percentage

of improvement in group (2) was more than group (1). This confirm the effectiveness of the phonophoresis as therapeutic modality enhancing the delivery of the drug hence improve patient's grip strength.

Phonophoresis is commonly used in physical therapy practices. The procedure generally utilizes an ultrasound apparatus that generates frequencies of 0.7 to 1.1 MHz and intensities usually range from 0.0 to 3.0 Watts / cm^2 [9,18]. US is often used in physical therapy because of its deep-heat and pain-relieving effects. When US enters the body, it can affect the cells and tissues through its thermal and nonthermal mechanisms [19].

Phonophoresis has been suggested by early studies to enhance the absorption of analgesics and anti-inflammatory agents [9]. Effectively, medicines contained within or under the ultrasound gel are pushed by the sound waves of the US and driven to a much deeper level than those massaged by hand [17]. Researchers have noted varying results with regard to the therapeutic benefits of phonophoresis (such as pain relief and improved range of motion) [6,20,21]. Meshali et al [6], stated that ibuprofen is poorly absorbed transdermally when applied as a gel even in the presence of high levels of alcohol as penetration enhancer and they concluded that treatment with US increased ibuprofen absorption by at least three folds, which demonstrates the potential uses of phonophoresis in transdermal drug delivery. Deniz et al [20], showed that both continuous and pulsed US diclofenac gel phonophoresis is more effective for pain and functional status of patients with knee osteoarthritis than topical application of diclofenac gel. In order to enhance the level of skin permeation of Triamcinolone Acetonide (TA), Yang et al [21], investigated various US conditions such as the frequency (1.0,3.0 MHz), the intensity (1.0, 2.5 W/cm^2), and the duty cycle (continuous, pulse) using a 0.5% TA gel. They concluded that the 1MHz frequency showed a relatively higher transport than either 3 MHz or no-ultrasound treatment.

Meshali et al [22], demonstrated that ultrasound application at 1.5 w/cm^2 continuous mode is optimum for transdermal delivery of the model NSAIDs drugs (ibuprofen, piroxicam and diclofinac sodium) across cellulose and rabbit skin membrane and they stated that the results could be adopted in clinical setting for enhanced management of pain and inflammation by ultrasound.

The phonophoretic effect of US reported that US enabled a greater transport of whole molecules across synthetic or organic semipermeable membranes than was afforded by sham ultrasound [23].

The effect of the US duty cycle on the skin permeation was highest with the continuous mode than with the pulsed mode [21]. There are many explanations for the increased permeability of the membranes. There would be a decrease in the donor solution-membrane interfacial-potential-energy barrier caused by the US treatment. Such a decrease as well as an increase in cavitation might increase the level of drug permeation [24]. A reduction in the boundary layer thickness (close to the membrane), which creates additional resistance to drug transport as a result of mixing the solutions, would also increase the level of drug permeation. The radiation pressure caused by the US wave would exert pressure on the drug molecules as well as on the skin [25] .In addition to the previous, it is known that phonophoresis facilitates the transdermal absorption of a drug as a result of the thermal effects such as an increase in tissue temperature and the mechanical effects such as cavitation and acoustic streaming [26,27]. It is believed that the effect of US might be related to the depth of the vibration as well as the duty cycle. The increased mechanical vibration by the US increases the skin temperature particularly in continuous US mode. This increase in temperature caused by heat liberation using US might increase the level of drug permeability [28].

From the previous it was concluded that, phonophoresis is an effective method to enhance the delivery of ibuprofen and so enhance the improvement of grip strength.

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