Original Article

EFFICACY OF UNDERWATER INTERFERENTIAL CURRENT ON HAND FUNCTION IN PSORIATIC ARTHRITIS PATIENTS

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ABSTRACT

Background: Psoriatic arthritis is an entity of inflammatory joint disease associated with psoriasis.
Purpose: The purpose of this study was to evaluate the efficacy of underwater interferential current therapy on hand function in psoriatic arthritis of both hands.
Method: Thirty patients (18 females and 12 males) had psoriatic arthritis of hands, aged 42 to 50 years with 45.77 ± 3.52 mean, were assigned randomly into two groups of equal number: study group received 20 minutes underwater interferential current for one month, 3 times per week (12 sessions) and control group received placebo interferential current. Visual analogue scale for patient-reported pain, the Disability of Arm, Shoulder and Hand questionnaire score, and hand function (grip force) in Pound of dominant hand were assessed pre-treatment and post-treatment.
Results: showed significant improvement in the 3 outcomes in study group ($p < 0.05$) with non-significant improvement in control group ($p > 0.05$). Visual analogue scale had a strong positive correlation ($p < 0.001$) with the disability score and a strong negative correlation ($p < 0.001$) with the grip force.
Conclusion: Using underwater interferential current therapy in patient with psoriatic arthritis of hands was effective in improvement of hand function and quality of life.
KEYWORDS: Interferential Current Therapy, Psoriatic arthritis.

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Access this Article online

Quick Response code

International Journal of Physiotherapy and Research
ISSN 2321- 1822
www.ijmhr.org/ijpr.html

Received: 03-03-2014 Accepted: 18-03-2014
Peer Review: 03-03-2014 Published: 11-04-2014

INTRODUCTION

Psoriatic arthritis (PsA) is a chronic inflammatory arthropathy of peripheral and axial joints that affects a subset of patients suffering from psoriasis. [1] The broad involvement of articular and non-articular sites can have a significant impact factor on the patients' function and quality of their life (QOL).[2] The presentation of PsA has been categorised into 5 overlapping clinical patterns; oligoarthritis, polyarthritis, arthritis of distal interphalangeal joints, spondylitis, and arthritis mutilans.[3] Heterogeneity is observed not only in disease manifestations but also in severity and course, which can vary from very mild psoriasis or enthesitis to widespread psoriatic plaques, disfiguring nail disease and severe joint inflammation condition with destruction that can result in disability and increased mortality rate.[4] The prevalence of psoriasis ranges from 0.6% to 4.8% [5], whereas prevalence estimates of PsA range from 0.02% to 0.25%.[6] The onset of PsA occurs in the 4th decade of life, with an equal distribution between both sexes. PsA affects 6% to 48% of patients with psoriasis, and rigorous screening has resulted in increased prevalence.[7] Typically, PsA follows the appearance of a skin lesion, but this presentation occurs only in two thirds of patients.[6]

The pathogenesis of psoriatic skin is characterized by angioproliferation and abnormally increa-

sed microvasular permeability as a result of an upregulation of adhesion molecules. PsA synovium has been shown to have increased expression of pro-inflammatory factors such as matrix metalloproteinases, adhesion molecules, and vascular marks.[8] A host of inflammatory cytokines and chemokines are involved, most notably tumor necrosis factor (TNF)- α , interleukin (IL)-1β , IL-6, and IL-13.[9]

The clinical features of PsA patients include inflammatory arthritis of distal interphalangeal (DIP), proximal interphalngeal (PIP), metacarpophalnageal (MCP), and metatarsophalangeal (MTP), knee, hip, and ankle joints.[10] Moll and Eright described 5 distinct clinical features of PsA: (1) asymmetric oligoarticular arthritis primarily affecting DIP, PIP, and MTP joints; (2) DIP predominate arthritis; (3) arthritis multilans; (4) symmetric rheumatoid factor (RF)-negative polyarthritis; and (5) psoriatic spondyloarthropathy.[11]

No specific tests are diagnostic of PsA, and the diagnosis is made on clinical features. The CASPAR (the CIASsification of Psoriatic ARrthritis) criteria consisted of established inflammatory articular disease with at least 3 points from the following features: current psoriasis, a history of psoriasis, a family history of psoriasis, dactylitis, juxtaarticular new bone formation, rheumatoid factor negativity, and nail dystrophy. [12] PsA remains a clinical diagnosis due to lack of definitive laboratory tests for the condition. Patients may have anemia of chronic disease, elevated erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) level, hyperammaglobulinemia, hypercomplementemia, or an increased uric acid level. Radiographic examinations are more specific than laboratory tests. Plain X-ray of hands and feet to permit differentiation of DIP involvement associated with PsA from that associated with osteoarthritis.[13] For early detection of PsA or enthesitis, MRI is more sensitive than plain radiographs.[14]

Primary therapy for PsA patients includes nonsteroidal anti-inflammatory drugs (NSAIDs) were the most common systemic therapies, intra-articular glucocorticoid injections, and TNF inhibitors. Traditional disease modifying antirheumatic drugs (DMARDs) such as methotrexate (MTX) should be started early when there is evidence of persistent inflammatory, erosive disease, multiple edematous joints, and increase in ESR and CRP level.[15]

PsA affects physical, social, and psychological aspects of a patient's life. PsA negatively affects a patient's physical functioning and QOL. The impact of PsA is comparable to that experienced by patients with other inflammatory arthritic conditions. This negative feedback in QOL of the patients especially when it affects small joints of hand such as DIP, PIP, and MCP joints, in turn PsA patients' hand function could be affected due to pain and swollen joints of the hand.[16] Physical therapy modalities have an important role in decreasing pain of the hand and regain the normal hand function of PsA patients. There are lacks in studies of physical therapy in treatment of PsA. Interferential current (IFC) therapy as a physical therapy modality is the application of alternating medium frequency current (4,000 Hz) amplitude at low frequency (0-250 Hz). IFC decrease the skin resistance, and able to generate an amplitude modulated frequency (AMF) parameter, which is low frequency current generated deep within the treatment area.[17] Several theoretical physiological mechanisms such as gate control theory, increased circulation, reducing pain suppression, block of nerve conduction, and placebo have been proposed in literature to support the analgesic effects of IFC. [18] IFC improve palmar skin manifestations of psoriasis.[19] In vitro studies have suggested that the important mechanism of IFC may be its ability to enhance the intracellular concentration of cyclic AMP (cAMP) and also the ratio of cAMP and cyclic GMP (cGMP). [20] cAMP is a regulator of epidermal proliferation and was found to be lower in psoriatic areas compared to normal skin. cAMP-inducing agents enhance the expression of the antipsoriatic cytokine IL-10 and suppress TNFα, an important cytokine involved in the disease process. It has been supposed that the cAMP-enhancing effect of IFC may be responsible for the beneficial effect on psoriatic skin areas. [21]

The present study is designed to find the efficacy of underwater IFC of the hand in PsA patients to improve hand function and QOL of these patients.

MATERIALS AND METHODS

Sample of this randomized controlled trial was based on 42-50 year's thirty subjects (18 females and 12 males) with psoriatic arthritis (PsA) of both hands (26 right handed and 4 left handed). The present study was performed over the period from June to September 2013 at the physical therapy department of New Kasr El-Aini Teaching Hospital, Cairo University, Egypt.

Subjects were met the following inclusive criteria, which are years between 40 and 50 years old with clinical diagnosis of psoriatic arthritis (PsA) which was manifested by CASPAR criteria for PsA, if they were not willing to take disease modifying anti-rheumatic drugs (DMARDs) and had small joint but no axial involvement. Exclusion criteria consisted patients who had joint surgery within the past 2 months, DMARD treatment within the last 2 months, intraarticular corticosteroid injections, oral corticosteroids above 10 mg prednisone equivalent, or major episodes of infection, all within the last month before beginning of the present study. Patients with a history of IFC in their past treatment and inability to comply with treatment requirements were also excluded. Individuals with pacemakers and other systemic diseases were also excluded. Subjects were instructed not to change their medication during the study period.

The dependant and outcome variable were visual analogue scale (VAS) for patient-reported pain, the DASH (Disability of Arm, Shoulder and Hand) questionnaire score in the evaluation of hand and wrist disorders, and hand function (grip force) in Pound of dominant hand. The independent variable was underwater IFC on both hands.

Procedure

The subjects were assessed and informed consent with ethical approval was taken. Subjects were told that one group of patients would receive inactive treatment. They were randomly divided into 2 groups, study group which received IFC and control group, which received placebo IFC. Outcomes measures were performed before and after treatment intervention. Baseline demographic variables include age, gender, and time of psoriasis (whether currently evident or previously observed) carried out.

Three criteria were used to evaluate the outcome in intent to treat analysis. First, visual analog scale (VAS) was used by patients to assess the presence of pain in both hands. The VAS score ranges from 0 to 10, where 0 is the absence of pain and 10 reflects a very strong feeling of pain.[22] Second, the DASH (Disability of Arm, Shoulder and Hand) questionnaire score in the evaluation of hand and wrist disorders, a self-administrated questionnaire which includes 30 items related to functional activities and symptoms in activities of daily living (ADL). The patient is asked to attribute a score of 1 to 5 on all 30 items. The raw score obtained is converted into a 0 to 100 scale by DASH DISABILITY/SYMPTOM SCORE = [(sum of n responses)/n - 1] x 25, where n is equal to the number of completed responses. A DASH score may not be calculated if there are greater than 3 missing items. Scores rise with increasing disability.[23] The Arabic version of DASH was conducted in the study. Third, hand function (grip force) in Pound of dominant hand using Baseline Adult Smedley® Evaluation/Instruments Spring Hand Dynamometer 220 Pound (New York - USA).[24] The subjects were seated in an adjustable chair with back support, feet on the floor, and elbows flexed at 90°. Before performing the test, the subjects' fingertips and the objects' grasping surfaces were cleaned with alcohol swabs to remove any grease. The subjects were instructed to grasp the hand dynamometer' grasping surfaces by four fingers and the thumb positioned on them. The subjects were informed to maximally pull the grasping surfaces of the hand dynamometer and hold then the reading was recorded by Pound, subjects were asked to repeat the procedures 3 times and the mean of them was calculated as the final record.

Study group: Fifteen PsA of both hand' patients were treated by underwater IFC therapy [25] (Endomed 682 Platinum Interferential Modular – Enraf-Norius®, Netherland). Subjects were comfort-ably seated in an adjustable chair with back support and feet on the floor, 4 superficial 4X6 cm electrodes were immersed in warm water (38°C) plastic baths and connected to IFC machine and subjects were informed to put both hands on the 4 electrodes underwater. Both the electrodes and hands of each subject must be

covered by warm water. The areas of skin to be treated of both hands were cleaned with soap and water to reduce electrical resistance and the electrodes were padded with sponge pads. The electrodes were orientated so that the two currents intersect within the target structure (both hands). Both thumbs must touch each other to concentrate IFC in both hands. The electrodes of each pair are placed diagonally opposite one another in such way that interference effect on beat frequency is produced in the hands' tissues. Each subject received IFC therapy at a modulation frequency of 100 Hz. The procedure consisted of 12 sessions of IFC for 20 minutes each for one month, 3 times per week (day after day). Subjects had to regulate the current to a comfortable intensity (just above the sensory threshold). The intensity of the current is increased gradually until the patient reports that a further rise would cause discomfort. The typical effective current density was as low as 100 µA/cm^2. [19]

The control group: Fifteen PsA of both hand' patients were treated by underwater IFC application with no current output to subjects, as a placebo treatment. The type of generator, time of sessions and number of session were as in the study group.

Data analysis

All statistics were calculated by using the statistical package of social sciences (SPSS) version 16. Descriptive statistics (mean and standard deviation) were computed for all data. Paired t- test was applied within the group for VAS, the DASH questionnaire score, and grip force in Pound of dominant hand. Unpaired t- test was applied for age, time of psoriasis, VAS, the DASH questionnaire score, and grip force of dominant hand between groups. Pearson correlation coefficient (r) was applied to find a relationship between VAS and the DASH questionnaire score and also between VAS and grip force of dominant hand.

RESULTS AND TABLES

The mean age was 45.4 ± 3.2 years of the study group and was 46.13 ± 3.83 years of the control group. There were no significant differences in age between the study and control group as P-value was 0.49 (p>0.05). The mean time psoriasis was 3.87 ± 1.6 years and was 3.13 ± 1.77 years of the control group. There were no significant differences in age between the study and control group as P-value was 0.17 (P> 0.05). So there was a homogenous between the two groups of the study.

The mean changes in VAS, the DASH questionnaire score, and grip force in Pound of dominant hand for the study and control group pre and post-treatment in both groups are summarized in table 1. Comparison revealed that there were no significant differences in mean changes for all measurements between the two groups pre-treatment (P>0.05). Results of the same three parameters showed that there was a significant difference pre and post-treatment in study group (P<0.05) while there was no significant difference in control group (p> 0.05). Fig.1 demonstrates the mean values difference of VAS pre and post-treatment in both groups, Fig. 2 demonstrates the mean values difference of the DASH questionnaire score pre and post treatment in both groups. Fig. 3 demonstrates the mean values difference of grip force in Pound of dominant hand pre and post treatment in both groups.

Table 1: VAS, the DASH questionnaire score, and grip force in Pound of dominant hand for the study and control group.

Parameters	Time of evaluation	Study group	Control group	
		Mean ± SD	Mean ± SD	P- value
VAS	Pre-treatment	8.4 ± 1.24	8.8 ± 1.01	0.921
	Post treatment	1.4 ± 2.38	8.4 ± 1.24	0.001
	P- value	0.003	0.21	
DASH questionnaire score	Pre-treatment	65.13 ± 3.72	65.8 ± 3.75	0.983
	Post treatment	9.73 ± 20.88	65.13 ± 3.72	0.001
	P- value	0.0002	0.478	
Grip force in Pound of dominant	Pre-treatment	20.4 ± 3.6	21.6 ± 3.64	0.864
	Post treatment	65.6 ± 18.85	21.8 ± 3.96	0.001
	P- value	0.0003	0.51	

Fig. 1: VAS pre and post-treatment in both groups.

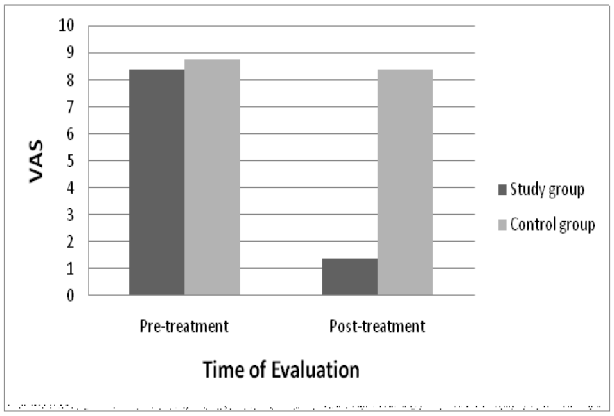


Fig. 2: DASH questionnaire score pre and post-treatment in both groups.

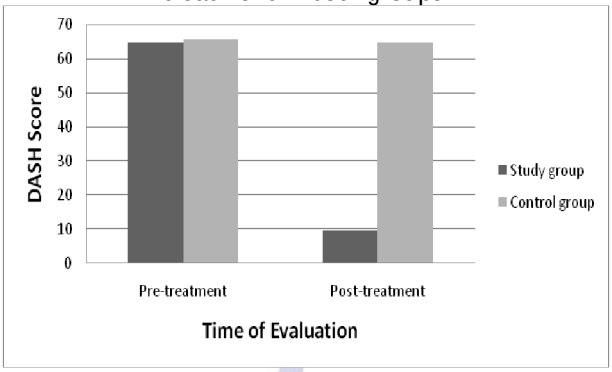
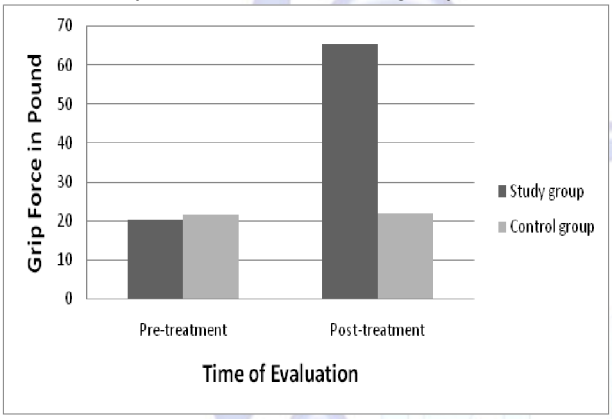


Fig. 3: Grip force in pound of dominant hand pre and post-treatment in both groups.



VAS and the DASH questionnaire score were correlated ($r = 0.962, p<0.001$) indicating a strong positive correlation and the coefficient correlation was significantly different. Fig.4 illustrates the positive correlation between VAS and the DASH questionnaire score. VAS and grip force in Pound of dominant hand were correlated ($r = -0.932, p<0.001$) indicating a strong negative correlation and the coefficient correlation was significantly different. Fig.5 illustrates the negative correlation between VAS and grip force in Pound of dominant hand.

Fig.4: The positive correlation (r = 0.962) between VAS and the DASH questionnaire score.

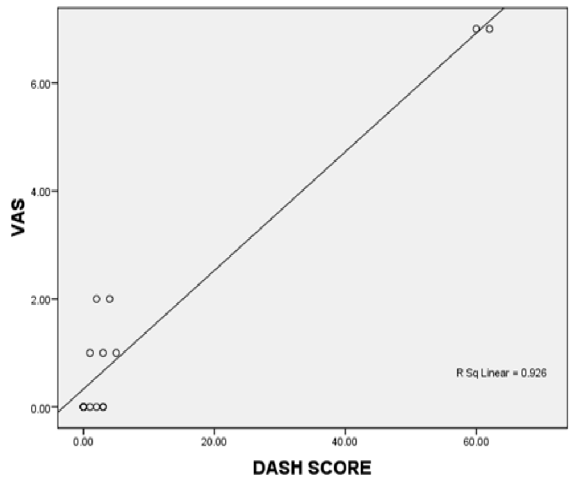
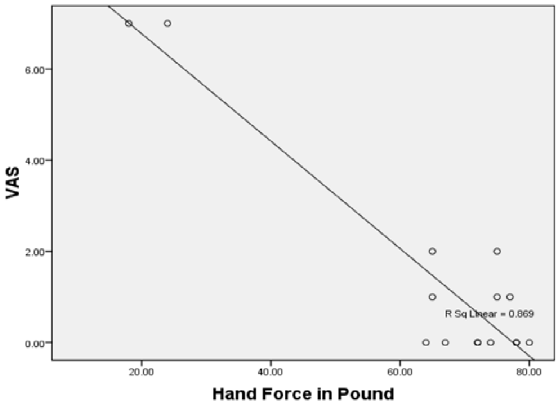


Fig.5: The negative correlation (r = -0.932) between VAS and hand function (grip force) in Pound of dominant hand.



DISCUSSION

This study was carried out to examine the efficacy of underwater IFC of the hand in PsA patients to improve hand function and QOL of these patients. PsA of the small joints of the hand leading to destructive arthritis in which the inflammatory process leads to bony erosion and loss of joint architecture. [26] A high proportion of patients suffering from PsA may develop persistent inflammation with progressive joint damage that can lead to severe physical limitations and disability. [27] The DASH questionnaire is an appropriate tool in the evaluation of the wrist and hand disability. Reliability and reproducibility have been reported in several studies. It has been translated in numerous languages; in the present study Arabic model was used. Its validity has been proven and the correlation with other outcome scales is high.[23] In study by Amirtharajah et al DASH questionnaire was used as on the methods of evaluation for good function and pain relief in 15 patients underwent PIP arthroplasty on a total of 18 joints. Of these patients, 8 had post-traumatic arthritis, one had rheumatoid arthritis, one had psoriatic arthritis, and one had erosive arthritis.[28] Assessment of pain due to arthritis is part of the core set of measures for the American College of Rheumatology score. Patient pain due to hand arthritis is assessed by means of a 0-10 visual analog scale (VAS), where 0 “no pain” and 10 “most severe pain” that day. The minimum clinically important difference of pain VAS is considered to be 1 cm.[16] The application of IFC is a well known tool in physical therapy and other fields as it is a non-invasive modality to relieve pain (acute or chronic) of different musculoskeletal disorders.

There are several theoretical physiological mechanisms support the analgesic effects of IFC such as gate control theory, increased circulation, reducing pain suppression, and block of nerve conduction.[29] The possible therapeutic mechanisms of IFC in the treatment of psoriasis might involve activation of 2nd messenger-dependent cell signaling processes. Specifically it has been found that the messenger cyclic AMP is upregulated in cells exposed to IFC at 10 and 100 Hz modulation. Also the ratio cAMP/cGMP is increased at these frequencies.[30] cAMP and cAMP/cGMP, both involved in control of proliferation, are reduced in cells from psoriatic areas. In addition, antipsoriatic effects of dibutyryl-cAMP have been reported. This suggests that repeated stimulation of cAMP or of cAMP/cGMP towards the normal skin values during the therapy sessions might remove psoriatic hyperproliferation.[31] Underwater IFC was used to treat PsA of both hands; this technique was used in two previous studies. First, by Philipp et al, who used underwater IFC to treat palmar psoriasis for 6 minutes with modulation frequency of 100 Hz in the morning and 10 Hz in the evening for 12 weeks at home. The results of this study were highly encouraging the IFC therapy as a new modality in treatment of palmar psoriasis which in contrast to the other treatment was not associated with side effects and discomfort.[19] Second study by Walker et al, who used IFC therapy to treat PsA to all the affected joints in a bipolar mode; hands and feet were immersed in water bath for 5 minutes with modulation frequency of 100 Hz in the morning and 10 Hz in the evening for 16 weeks at home. This study concluded that IFC has analgesic effects in PsA. [25]

In the present study patients received under warm water IFC therapy at a modulation frequency of 100 Hz. The procedure was under complete supervision of physical therapist. In comparing with the previous studies, the time of IFC session was longer and the overall period of treatment was reduced. The data analysis revealed that study group which received active underwater IFC therapy showed highly significant improvement in VAS that was used to assess pain in both hands, DASH questionnaire score which used in the evaluation of hand and wrist disorders, and hand grip force in Pound of dominant hand before and after treatment. On the other hand the data analysis of the control group which received placebo underwater IFC showed non-significant improvement in the same three parameters. Moreover the analysis between the two groups showed highly significant improvement in favor to study group. The improvement of pain assessment of both hands by VAS in study group revealed that IFC therapy had a good analgesic effect in relieving pain associated with PsA of hand. The reduction in DASH questionnaire score and the increase of grip force of dominant hand in study group which in turn leading to increase in hand function revealed that pain relief with IFC therapy may improve hand function and improve ADL and QOL of PsA patients.

In studying the correlation between VAS and the DASH questionnaire score, there was a strong positive correlation that means, when pain relieved the disability of the hand decreased (improvement in hand function). In studying the correlation between VAS and grip force in Pound of dominant hand were, there was a strong negative correlation that means when pain relieved the grip force of the hand increased (improvement in hand function). The results of the present study were supported by the results of previous studies in correlation between pain relief with physical function in hand arthritis. In study by Barthel et al reported that any intervention to relieve the pain of hand osteoarthritis (OA) may improve function and patient perception of disease severity, despite the absence of a disease-modifying mechanism of action.[32] The results of the present study were supported by the results of previous studies in correlation between the relief of pain and improvement of hand grip force in hand arthritis. In study by Nunes et al observed that strong positive correlations between grip force and hand function in patients with hand OA. The results provided additional information about the functional diagnosis of hand OA. The cause of the deficits in hand function in patients with OA might be partially related to impaired control of grip forces.[24] Because PsA can be a very severe disease with significant functional impairment, early diagnosis and treatment is critical to impro-

ve QOL, improve function, and slow disease progression. Before this present study, there were any previous studies measured thestudy delivered a direct relationship between pain and disability of hands as when pain of hand relieved, disability of hands decreased i.e. improvement of hands' function. Also, the findings of this study reported an indirect relationship between pain and grip force as when pain relieved, grip force increased.

In this study warm water bath was applied with active IFC in study group to facilitate the introduction of IFC to hands' tissue and the benefit of warm water in reducing pain and increase hand function. But the use of warm water only without IFC as in control group as IFC was inactive, has no effect in improvement of PsA of hands. Patients of both groups reported no side effects such as discomfort, erythema, or itching after completion of each session. Patients of control group were applied active underwater IFC therapy as in study group after the end of the study to benefit from the procedure.

PsA of hands' patients suffering from pain and weakness of hand muscles, both of them lead to hand disability and decrease in activity of ADL, hand function, and QOL. In the present study, more than one method of evaluation was used to confirm the efficacy of underwater IFC of the hand in PsA patients for improvement the hand function and QOL of these patients as it is the first time to use under warm water IFC therapy as a short-term study with using Hand Dynamometer for assessment hand function. Using placebo underwater IFC therapy in the control group was non-significant, but the usage of underwater IFC therapy in study group gave a significant improvement.

CONCLUSION

The present study shows that using underwater interferential current therapy in hands of psoriatic arthritis patient was effective for the improvement of hand function and quality of life. There were greater improvement in relieving hands' pain, decreasing hand disability, and grip force in patients with PsA hands underwent IFC therapy in study group compared to control group.

List of abbreviations :

AMF	Amplitude Modulated Frequency
AS	Ankylosing Spondylitis
DMARDs	Disease Modifying Antirheumatic Drugs
cAMP	Cyclic Adenosine Monophosphate
CASPAR	Classification of Psoriatic Arrthritis
cGMP	Cyclic *Guanosine_Monophosphate*
CRP	C-Reactive Protein
DASH	Disability of Arm, Shoulder and Hand
DIP	Distal Interphalangeal
ESR	Erythrocyte Sedimentation Rate
Hz	Hertz
IFC	Interferential Current
(IL)-1β, IL-6, and IL-13	Interleukin
µA/cm2	Micro Empire Per Square Centimeter
MCP	Metacarpophalnageal
MRI	Magnetic Resonance Image
MTP	Metatarsophalangeal
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
MTX	Methotrexate
OA	Osteoarthritis
PIP	Proximal Interphalngeal
PsA	Psoriatic Arthritis
P-value	Probability
QOL	Quality of Life
RF	Rheumatoid Factor
SD	Standard Deviation
SPSS	Statistical Package of Social Sciences
(TNF)-α	Tumor Necrosis Factor
VAS	Visual Analogue Scale

Conflicts of interest: None

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How to cite this article:

Ahmed Fathy Samhan. PhD PT, EFFICACY OF UNDERWATER INTERFERENTIAL CURRENT ON HAND FUNCTION IN PSORIATIC ARTHRITIS PATIENTS. Int J Physiother Res 2014;2(2):466-473.