EFFECT OF EXTRACORPOREAL SHOCK WAVE VERSUS PULSED ELECTROMAGNETIC FIELD ON DIABETIC FROZEN SHOULDER IN ELDERLY

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ABSTRACT

Background & Objective: A link between frozen shoulder and diabetes has been described by many authors, with the most accepted values 10-20% incidence of frozen shoulder in diabetic patients. The therapeutic effect of extracorporeal shock wave therapy is to aid revascularization and reactivation of the bones and connective tissues healing, which lead to controlling pain and regain the functions. Pulsed electromagnetic field therapy stimulates the healing process and generation of the injured tissues and it has analgesic and anti-inflammatory effects. So, this study is conducted to compare between the effect of extracorporeal shock wave and pulsed electromagnetic field in treatment of diabetic frozen shoulder in elderly.

Methods: Randomized controlled trial. Sixty elderly male patients with Diabetic frozen shoulder, aged from 65 to 70 years participated in this study. They were randomly assigned into two groups: Group (A): received extracorporeal shock wave plus exercise program. Group (B): received pulsed electromagnetic field plus exercise program. All groups were received 2 sessions weekly for one month, for total of 8 sessions. All patients were assessed by shoulder pain and disability index (SPADI), pressure algometer and universal goniometer.

Results: Comparing both groups post treatment revealed statistically significant increased in abduction (P=0.0001; P<0.05), external rotation (P=0.0001; P<0.05), and internal rotation (P=0.0001; P<0.05) within group A and group B. There were statistically significant decreased in pain scale (P=0.0001; P<0.05), disability scale (P=0.0001; P<0.05), total SPADI (P=0.0001; P<0.05), and pressure algometer (P=0.0001; P<0.05) within group A and group B, In favour of group (A).

Conclusion: Extracorporeal shock wave was more effective in all measured variables (Range of motion, pain severity and shoulder pain disability index) than pulsed electromagnetic field in treatment of patients with diabetic frozen shoulder.

Key words: Diabetic frozen shoulder, Extracorporeal shock wave, Pulsed electromagnetic field, Elderly

I. INTRODUCTION

Diabetes Mellitus is a metabolic condition that causes a rise in blood glucose levels due to defects in insulin production, insulin effect, or both. Diabetes causes chronic hyperglycemia, which causes damage, disability, and insufficiency in many organs, particularly the nerves, muscles, joints, and blood vessels. [1]

Frozen Shoulder is a musculoskeletal condition characterized by thickening of joint synovial membranes and attachment of glenohumeral joint surfaces, which results in a progressive decrease in the range of motion of the shoulder joint in flexion, abduction, and external rotation, as well as increased shoulder pain. The shoulder girdle
flexibility and elasticity are reduced as a result of inflammation and fibrosis of the joint, making daily tasks difficult. The magnitude of FS is determined by the patient's age and the length of time they have had diabetes mellitus. [2]

The exact cause of frozen shoulder has yet to be identified. According to some research, ageing induces a decrease in blood flow to tendons, ligaments, and joint capsules, resulting in articular tissue degeneration and local necrosis. [3]

Extracorporeal shock wave therapy got its start in the mid-1980s with an unintentional discovery of an osteoblastic response pattern during animal experiments, which sparked interest in using ESWT to treat musculoskeletal disorders. Shockwave therapy has been the treatment of choice for many orthopaedic conditions in the last 10 to 15 years. ESWT is a new non-invasive therapeutic modality that has been shown to be reliable, convenient, and healthy. ESWT has the ability to replace surgery in many orthopaedic conditions while avoiding the complications associated with surgery. [4]

Pulsed electromagnetic field therapy has been shown to be both safe and successful in the treatment of bone and cartilage pathologies. [5] Magnetic fields are thus extremely beneficial types of physical therapy. The majority of the advantages are due to a biophysical field that enables cellular functions to significantly improve. As a result, when field lines strike the animal organism, or a portion of it, they fully permeate these regions. Within the magnetic field's radius, all areas of the body are similarly penetrated. [6]

II. SUBJECT AND METHODS

A. Study Design
Two groups pre-test post-test design. It was conducted between July 2019 and December 2020.

B. Subjects:-
- Sixty elderly men patients with diabetic frozen shoulder were participated in this study.
- They were selected from the physical therapy-outpatient clinic of Ahmed Maher Teaching Hospital; their ages ranged from 65 to 70 years.

C. They were assigned to two groups:
- Group (A): received extracorporeal shock wave plus exercise program.
- Group (B): received pulsed electromagnetic field plus exercise program.
- All groups were received 2 sessions weekly for one month, for total of 8 sessions.

D. Ethical consideration and approval:
The whole procedure was explained for every patient. Patients signed on informed consent before the beginning of the study. The study has been approved by The Research Ethics Committee of the Faculty of Physical Therapy, Cairo University (No:P.T.REC/012/002287).

E. Inclusive criteria:
All patients were: Participated in this study were suffered from controlled type 2 diabetes mellitus for 10 years ago. Participated in this study had ideal weight, obesity class I (moderately obese) with body mass index of 30 – 34.9 or obesity class II (severely obese) with body mass index of 35 – 39.9 kg / m². Participated in this study were suffered from chronic mild to moderate diabetic frozen shoulder diagnosed by the orthopaedic surgeon by physical examination, and MRI. Participated in this study were suffered from pain and restricted range of motion of shoulder joint. Their age ranged from 65 to 70 years old and Signed a consent form before starting the program which was included the purpose, natures, and potential risks of the study which were explained to all patients.

F. Exclusive criteria:
Patients having the following conditions were excluded from the study: Primary type of adhesive capsulitis. Past history of shoulder girdle fracture, Glenohumeral dislocation, Concomitant cervical spine symptoms, Shoulder
surgery. Rotator cuff pathology. Patients who had a history of intra-articular injection, Shoulder girdle motor control deficits associated with neurological disorders (e.g. Stroke, Parkinson’s disease), Cognitive impaired patients (e.g. Dementia, Delirium), Patients with history of epilepsy, Patients with cardiac pacemaker, Patients with gallbladder disease and Patients with liver disease.

G. Instruments:

1) Evaluated instruments:
   - Informed consent form.
   - Recording data sheet: All data and information of each patient in this study including name, age, height, weight and BMI was recorded in a recording data sheet.
   - Shoulder Pain and Disability Index (SPADI).

Shoulder Pain and Disability Index: Measurement of pain and impairment in community-based patients with shoulder pain due to musculoskeletal pathology. [7] It's a two-dimensional self-administered questionnaire with one for pain and the other for functional tasks. The pain dimension includes five questions about the severity of a person's pain. The degree of difficulty a person has with different activities of daily living that include upper extremity usage is measured with eight questions designed to evaluate functional activities. The SPADI is the only accurate and valid region-specific measure for the shoulder. It takes a patient 5 to 10 minutes to complete. [8]

   - Algometer to measure pressure pain threshold.
   - Universal goniometer to measure shoulder joint ROMs (abduction, internal rotation and external rotation).
   - The assessment was made before and after treatment.

1) Therapeutic instruments:

   - A) Extracorporeal shock wave therapy (ESWT): Chattanooga Intelect® RPW Shockwave with main power of 120V – 60 Hz (Model 2073) with 28699 D-ACTOR hand piece applicator. It was used in the treatment of patient in group “A”. It was applied on the shoulder region for the time of 2000 impulses in each session.

   - B) Pulsed electromagnetic field therapy (PEMF): Electromagnetic unit ASA magnetic field (Automatic PMT Quattro pro): It consists of an appliance, motorized bed and solenoids. The appliance was connected to electrical mains supplying 230V at a frequency of 50 or 60 Hz with earth connection. It generates pulsed magnetic field up to 100 Hz and intensity varied according to the type of solenoid. It was used in the treatment of patient in group "B”. It was applied on the shoulder region for 20 minutes in each session.

H. Procedures:

2) Evaluative procedures:

   - All patients were referred by the orthopaedic surgeon after being diagnosed as diabetic frozen shoulder by physical examination, and MRI.

   - The procedure of the study was explained for all patients.

   - Shoulder Pain and Disability Index (SPADI) to assess pain and disability of shoulder joint.

   - Algometer to measure pressure pain threshold.

Pressure algometer was performed on the same day under quiet and non-stressful conditions. The tip of the algometer was positioned on this specific point. By pushing the algometer, the force applied to the acromion process gradually increased. The participants were not allowed to see the algometer display in any moment, and,
as soon as the volunteers experienced a painful sensation, they said “stop”, the algometer was immediately released and the force (in Kg) was red from the display.

- Universal goniometer to measure shoulder joint ROM (abduction, internal rotation and external rotation).

3) Therapeutic procedures:

- Thirty men patients suffering from pain and restricted range of motion of shoulder joint as a result of Diabetic frozen shoulder were received shock wave therapy in sitting with shoulder abducted at 45º, elbow flexed and the forearm rested on flat surface. The shock wave hand piece applicator was applied on most tender point near the insertion of rotator cuff at greater tuberosity under the acromion at the shoulder region. The shock wave therapy was administrated using head applicator with frequency of 20 Hz for the time of 2000 impulses in each session for 8 sessions (2 sessions per week). The treatment area was prepared with a coupling gel to minimize the loss of shock wave energy at the interface between applicator tip and skin.

- Thirty men patients suffering from pain and restricted range of motion of shoulder joint as a result of Diabetic frozen shoulder were received pulsed electromagnetic field in the side lying position, with frequency of 50 or 60 Hz and with earth connection for 20 minutes in each session for 8 sessions (2 sessions per week) and the solenoid was applied on the shoulder region.

- The exercise program was applied as follows:

  I. Exercises to mobilize the body in the following ways: The posterior shoulder capsule and surrounding musculature were treated with continuous mobilization techniques with grades (I, II, II, and IV) and oscillatory mobilization techniques in the form of inferior, anterior, and posterior glide, as well as passive stretching exercises. The mobilization was repeated 2-4 times with a 30-second hold time and a 10-second rest interval in between. [9]

  J. Shoulder joint stretching exercises were performed passively on a chair and actively with instruments (shoulder wheel and stall bar). [10]

  K. Exercises to strengthen shoulder flexion and horizontal abduction. The maximum number of repetitions for each exercise was set at ten. [10]

- The assessment was made before and after treatment.

L. Statistical analysis:

Data were screened, for normality assumption test and homogeneity of variance. Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed (P>0.05) after removal outliers that detected by box and whiskers plots. Additionally, Levene's test for testing the homogeneity of variance revealed that there was no significant difference (P>0.05). So, the data are normally distributed and parametric analysis is done. The statistical analysis was conducted by using statistical SPSS Package program version 25 for Windows (SPSS, Inc., Chicago, IL). Data are expressed as mean and standard deviation for demographic data (age, weight, height, and BMI). Multivariate analysis of variance (MANOVA) used to compare the tested major variables of interest at different tested groups and measuring periods. Mixed design 2 x 2 MANOVA-test was used, the first independent variable (between subject factors) was the tested group with 2 levels (A and B). The second independent variable (within subject factor) was measuring periods with 2 levels (before and after treatment). Bonferroni correction test was used to compare between pairwise within and between groups of the tested variables which F was significant from MANOVA test. All statistical analyses were significant at level of probability less than an equal 0.05 (P ≤ 0.05).

III. RESULTS

In the current study, a total of 60 patients participated and they were randomly distributed into 2 groups (30 patients/group). No significant differences (P>0.05) in demographic data for age (P=0.878), weight (P=0.514), height (P=0.421), and BMI (P=0.707) between group A and group B (Table 1).

Table 1: Demographic data comparison between group A and group B.
The statistical analysis using 2x2 mixed design MANOVA (Table 2) indicated that there were significant differences (F-value=3.783; P=0.001; P<0.05) of the tested groups (the first independent variable) on the all tested dependent variables (abduction, external rotation, internal rotation, pain scale, disability scale, total SPADI, and pressure algometer). In addition, there were significant differences (F-value=404.230; P=0.0001; P<0.05) of the measuring periods (the second independent variable) on the tested dependent variables. Moreover, the interaction between the two independent variables was significant (F-value=6.620; P=0.0001; P<0.05), which indicates that the effect of the tested group (first independent variable) on the dependent variables was influenced by the measuring periods (second independent variable).

**Table 2: Main effects of independent variables by 2 x 2 MANOVA test for dependent measuring variables.**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Wilk’s Lambada value</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups effect</td>
<td>0.806</td>
<td>3.783</td>
<td>0.001*</td>
</tr>
<tr>
<td>Period effect</td>
<td>0.037</td>
<td>404.230</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Groups x period effect</td>
<td>0.704</td>
<td>6.620</td>
<td>0.0001*</td>
</tr>
</tbody>
</table>

**Table 3: Inter- and intra-group comparison for universal goniometer variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Items</th>
<th>Group A (n=30)</th>
<th>Group B (n=30)</th>
<th>Mean difference</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abduction</td>
<td>Before-treatment</td>
<td>88.90±13.86</td>
<td>91.27±13.16</td>
<td>2.37</td>
<td>0.521</td>
</tr>
<tr>
<td></td>
<td>After-treatment</td>
<td>141.40±16.86</td>
<td>132.07±12.73</td>
<td>9.33</td>
<td>0.012*</td>
</tr>
<tr>
<td></td>
<td>Mean difference</td>
<td>52.50</td>
<td>40.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>59.06%</td>
<td>44.70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>45.21 – 59.78</td>
<td>33.51 – 48.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>59.06%</td>
<td>44.70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>45.21 – 59.78</td>
<td>33.51 – 48.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External</td>
<td>Before-treatment</td>
<td>33.23±14.14</td>
<td>32.50±14.52</td>
<td>0.73</td>
<td>0.823</td>
</tr>
<tr>
<td>rotation</td>
<td>After-treatment</td>
<td>65.60±11.10</td>
<td>62.93±10.37</td>
<td>2.67</td>
<td>0.040*</td>
</tr>
<tr>
<td></td>
<td>Mean difference</td>
<td>32.36</td>
<td>30.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>97.41%</td>
<td>93.63%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Multiple pairwise comparison tests within each group for shoulder pain and disability index variables (Table 4) showed that there were significantly decreased after treatment in pain scale (P=0.0001; P<0.05), disability scale (P=0.0001; P<0.05), total SPADI (P=0.0001; P<0.05), and pressure algometer (P=0.0001; P<0.05) compared to before-treatment within group A and group B. Group A improved higher pain scale, disability scale, total SPADI, and pressure algometer (62.62, 60.73, 61.46 and 46.62%, respectively) than group B (47.41, 49.57, 48.73, and 31.31%, respectively).

Multiple pairwise comparison tests between both groups for shoulder pain and disability index variables (Table 4) indicated no significant differences before treatment in pain scale (P=0.721; P>0.05), disability scale (P=0.638; P>0.05), total SPADI (P=0.591; P>0.05) and pressure algometer (P=0.754; P>0.05) between group A and group B. However, there were significant differences after treatment in pain scale (P=0.0001; P<0.05), disability scale (P=0.0001; P<0.05), total SPADI, and pressure algometer (P=0.002; P<0.05) between group A and group B.

Table 4: Inter- and intra-group comparison for shoulder pain and disability index variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Items</th>
<th>Groups (Mean±SD)</th>
<th>Mean difference</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Group A (n=30)</td>
<td>Group B (n=30)</td>
<td></td>
</tr>
<tr>
<td>Pain scale</td>
<td>Before-treatment</td>
<td>81.67 ±8.85</td>
<td>80.87 ±8.13</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>After-treatment</td>
<td>30.53 ±8.58</td>
<td>42.53 ±7.93</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td>Mean difference</td>
<td>51.14</td>
<td>38.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>62.62%</td>
<td>47.41%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>46.84 – 55.42</td>
<td>34.05 – 42.62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td></td>
</tr>
<tr>
<td>Disability</td>
<td>Before-treatment</td>
<td>78.08 ±6.19</td>
<td>77.33 ±6.01</td>
<td>0.75</td>
</tr>
<tr>
<td>scale</td>
<td>After-treatment</td>
<td>30.66 ±6.56</td>
<td>39.00 ±5.85</td>
<td>8.33</td>
</tr>
<tr>
<td></td>
<td>Mean difference</td>
<td>47.42</td>
<td>38.33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>60.73%</td>
<td>49.57%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>44.26 – 50.56</td>
<td>35.18 – 41.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Before-treatment</td>
<td>79.43 ±4.59</td>
<td>78.68 ±4.58</td>
<td>0.74</td>
</tr>
<tr>
<td>SPADI</td>
<td>After-treatment</td>
<td>30.61 ±6.00</td>
<td>40.34 ±6.09</td>
<td>9.73</td>
</tr>
<tr>
<td></td>
<td>Mean difference</td>
<td>48.82</td>
<td>38.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement %</td>
<td>61.46%</td>
<td>48.73%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>46.07 – 51.57</td>
<td>35.60 – 41.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>0.0001*</td>
<td>0.0001*</td>
<td></td>
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<tr>
<td>Pressure</td>
<td>Before-treatment</td>
<td>1941.13 ±768.32</td>
<td>1890.66 ±483.65</td>
<td>50.46</td>
</tr>
<tr>
<td>algometer</td>
<td>After-treatment</td>
<td>1036.26 ±662.61</td>
<td>1298.66 ±538.84</td>
<td>262.39</td>
</tr>
</tbody>
</table>
### IV. DISCUSSION

This study was conducted to compare between the effect of extracorporeal shock wave and pulsed electromagnetic field in treatment of diabetic frozen shoulder in elderly.

According to these results, it could be concluded that both extracorporeal shock wave and pulsed electromagnetic field are effective in treatment of diabetic frozen shoulder in elderly. However, extracorporeal shock wave was more effective in all measured variables (Range of motion, Pain severity and Shoulder disability index) than pulsed electromagnetic field in treatment of patients with diabetic frozen shoulder, So the degree of diabetic frozen shoulder symptoms was reduced.

The previous results of this study comes in agreement with Gerdesmeyer et al. [11] who reported that shock waves, across all of their generations, have a positive impact on shoulder functions, as well as self-reported pain and calcification size reduction. The high-intensity ESWT produces substantially better results.

Also, Park et al. [12] reported that when ESWT was used to treat frozen shoulder patients for two sittings a week for six weeks, with a mean age of 54.25.7 years, and it demonstrated a substantial reduction in pain on both the Visual Analogue Scale (VAS) and the Patient-Specific Functional Scale (PSFS).

This is confirmed by the work of Rompe et al. [13] who stated that, shock waves caused analgesia by over stimulating axons and thereby raising the pain threshold, And the work of Malay et al. [14] who mentioned that shock waves cause physical changes to small axons, which impede pain impulse conduction, as well as chemical changes to pain receptors and neurotransmitters, which prevent pain perception.

These results come in agreement with Arno et al. [15] who reported that (SWT) improves function by increasing perfusion in ischemic tissues, stimulating growth factors, reducing inflammation, and speeding up healing. These results come in agreement with HO and Hsu, Cacchio et al. [16,17] who revealed that for patients with shoulder pain, the application of (SWT) resulted in substantial functional change.

In addition, Babak et al. [2] supported our results as they founded that after four weeks of twice-weekly ESWT, there was a significant increase in SPADI and shoulder motion (p 0.05). They came to the conclusion that ESWT helps to speed up the healing process of frozen shoulder.

Also, these results were clarified by the work of Pan et al. [18] who suggested that hyper stimulation analgesia provides pain relief after ESWT for calcific tendonitis of the shoulder. The pain threshold will rise, and shoulder range of motion and movement will rise with it.

The present study comes in accordance with Olimpio et al. [19] who studied that ESWT’s effect on twenty patients with NCST (non-calcifying supraspinatus tendinopathy). They divided the patients into two groups: ESWT and sham. Patients in the ESWT community got 3000 shockwave shoots at 0.068 mJ/mm² of energy flux density, with a 7-day rest period. The overall Constant and Murley Score (CMS) and its subscales showed considerable change as compared to the baseline values. When compared to the control group, the ESWT group scored significantly higher on CMS pain and ROM. They suggested that patients with NCST be treated with low-energy ESWT for the time being.
The results showed by the work of Lebrun C. [20] which coincided with the results of the current study in such that, on one level, shock wave therapy treats pain by over stimulating the “pain transmitting nerves” or "hyper stimulation analgesia," as well as local development of a pain-blocking drug. Higher-level shock waves may also cause tissue changes by boosting metabolic activity and blood flow in the region, as well as triggering the body's own repair mechanisms.

In line with the present study, the results by Mohamed et al. [21] showed that ESWT enhanced the treatment of diabetic frozen shoulder by reducing shoulder pain and weakness (SPADI) from 6.86 0.91 to 0.60 0.51 with an IR of 91.26 percent. With 57.95 percent, 73.87 percent, and 53.10 percent, respectively, statistically significant improvements in IR were observed in shoulder flexion, abduction, and external rotation ROM.

In agreement with the current study, Durante et al. [22] studied patients with similar condition. One group of the patients was treated with extracorporeal shockwave combined with physiokinesiotherapy and the second group was treated with physiokinesiotherapy alone. Two sessions a week for two weeks, patients received 2500 shocks from the anterior and lateral directions with energy between 0.07 and 0.11 mJ/mm2. All of the patients were followed for a period of six months. Around 30% of the patients had an outstanding response, while another 30% had a mediocre response. In the second group, 10% of patients had a full response.

Also, Rompe et al. [23] founded that when one-time shock wave therapy was used to treat calcific tendonitis of the shoulder, 60 percent of patients returned to normal states, and 72 percent improved to the point where they only felt occasional pain on the Constant-Murley scale. These findings are consistent with our findings and with Cho et al. [24] who reported that when lateral epicondylitis patients were treated with ESWT, their pain decreased and their muscle strength improved significantly. Likewise, Na J. [25] reported that when ESWT was used to treat chronic low back pain, patients’ pain significant decreased. Lastly, Lee et al. [26] discovered that Patients with chronic low back pain who received an exercise regimen and ESWT had less pain and better dynamic balancing than those who received only an exercise program and conservative physical therapy.

In this study, pain severity reduction in frozen shoulder patients after ESWT could also be attributed to a positive anti-inflammatory effect, antibacterial effect, and neovascularization due to increased nerve impulse disruption. [27]

The fact that high-energy shockwaves generate a sufficient amount of energy that can cause regulated inflammation of the specified tissue could explain the improvement in our research. Many mediators, such as transforming growth factor beta 1 (TGF-B1) and insulin-like growth factor 1 (CGF-I), are stimulated by inflammation, which starts the healing process. [28] ESW improves microcirculation in patients with lower-leg chronic ischaemia, improves myocardial perfusion in patients with extreme coronary artery disease, reduces pain and improves re-epithelialization in chronic leg ulcers, and it may help with bone vascular disorders like osteonecrosis and may have a bactericidal effect against Staphylococcus aureus. [29] This may be due to the effect of ESWT, which causes a decrease in substance P in the target tissue, as well as decreased synthesis of this molecule in dorsal root ganglia cells and selective degradation of unmyelinated nerve fibres within the ESWT focal region. [30]

Furthermore, the improvement in Group (A) can be attributable to the fact that ESWT causes a shift in macrophage phenotype from M1 to M2 and boosts T-cell proliferation as an immunomodulatory impact. [31,32] ESWT enhances the treatment of ischemia muscle by activating the TLR3 signalling system, which modulates inflammation by modulating the expression of interleukin (IL)-6 and IL-10. [33,34]

There is other possibility for explaining our result that was mentioned by Wang et al. [35] who showed that after shock wave treatment, the number of neovessels at the normal tendon–bone interface increases. Rabbit Achilles tendon specimens obtained 4 and 8 weeks after shock wave application revealed new capillary and muscularized capillaries. Early release of angiogenesis-related markers was linked to this ingrowth. In addition, those mice exposed to the shock wave had myofibroblasts with a random appearance and intermediate orientation fibers.

Concerning the present work about the group (B), Multanen et al. [36] looked at the effects of low-energy PEMF therapy on FM in a sample of 108 women (4710) who were randomly assigned to two classes (TG, CG) in a crossover analysis. They discovered that active device treatment had no effect on pain, stiffness, or the FIQ index when compared to sham treatment. There was also no link between the frequency with which the device was used
and the reduction in pain with active (r = 0.11, 95 percent CI [0.31, 0.10]) or sham (r = 0.10, 95 percent CI [0.31, 0.12]) treatment.

The result of this study in group B are in agreement with Rigato et al. [37] who compared the analgesic and therapeutic effects of PEMF of 100 Hz with modulated electromagnetic field on patients suffering from periarthritis shoulder. PEMF was found to be effective in reducing pain and improving range of motion in patients with periarthritis of the shoulder.

These results also come in agreement with Paternostro-Sluga & Zoch, [38] who stated that PEMF was used as a conservative remedy for shoulder problems, with the aim of improving local shoulder joint dysfunction.

The results showed by the work of Binder et al. [39] which coincided with the results of the current study at their randomized double-blind study which looked at the effects of PEMF stimulation (73 Hz; 2.7 mT) on people with rotator cuff tendinitis, found that it reduced pain and increased movement. They discovered that after PEMF treatment, more than 70% of the patients in their sample improved.

In line with the present study, a study done by Quittan, [40] who studied a computer-assisted search to verify the efficacy of PEMF on various diseases including periarthritis shoulder. who choosed clinical trials with at least one control group. The effect of electromagnetic fields on pain relief was verified in the majority of trials. The duration of the application ranged from 15 to 24 minutes a day for three weeks to eighteen months. PEMF of 0.2 mT to 10 mT with a frequency of 12 to 100 Hz was used to treat the patients.

The improvement in Group (B) in our study may be explained by Markove & Colbert, [41] who reported that the primary reason for using PEMF was to alleviate discomfort and tenderness in the musculoskeletal system. Bassett C. A., Vassilenko & Vassilenko, [42,43] stated that PEMF was found to have beneficial effects on shoulder tenderness, pain ranking, range of motion, and function. PEMF stimulates the cell membrane, resulting in:

- Increases the threshold at which pain is perceived. The reduction in cortisol and noradrenaline, as well as an increase in serotonin, endorphins, and encephalin, was thought to cause short-term effects. CNS and peripheral nervous system modulation can have long-term consequences.

- Increases the electric potential of muscle fibres, which helps to reduce pain and improve range of motion by inducing muscular relaxation.

- Improves blood flow, which is needed for tissue oxygenation and the removal of waste products that irritate pain nerve endings.

- Dedifferentiation of fibroblast cells and certain forms of precursor endothelial cells into embryonic-like cells leads to a reduction in scar tissue formation.

Also, Prochazka, [44] stated that pulsed electromagnetic field therapy enhances blood circulation, oxygen supply, Adenosine Triphosphate (ATP) production, and facilitates the healing and regeneration of damaged tissues by increasing the permeability of the cell membrane. It also has analgesic and anti-inflammatory properties, which explains the improvement founded in our research.

V. CONCLUSION

On the basis of this study, it could be concluded that both extracorporeal shock wave and pulsed electromagnetic field are effective in treatment of diabetic frozen shoulder in elderly. However, extracorporeal shock wave was more effective in all measured variables (Range of motion, Pain severity and Shoulder disability index) than pulsed electromagnetic field in treatment of patients with diabetic frozen shoulder, So the degree of diabetic frozen shoulder symptoms were reduced significantly.

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