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Research Article

THERAPEUTIC EFFECTS OF LOW-LEVEL LASER AND REFLEXOLOGY ON ADHESIVE CAPSULITIS IN ELDERLY TYPE 2 DIABETIC PATIENTS

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ABSTRACT

Objective: Adhesive capsulitis is common in Type 2 diabetic patients. The painful nature of adhesive capsulitis and the lack of effective therapy for improving motion and diminishing pain demonstrate the demand for a new effective therapeutic intervention. The current study aimed to determine the efficacies of low-level laser therapy (LLLT) and reflexology for improving range of motion (ROM) in diabetic patients with adhesive capsulitis.

Methods: Forty volunteer patients of both sexes with proven Type 2 diabetes and adhesive capsulitis were included in the current study. The patients were divided into two groups each comprising 20 patients as follows; Group I (LLLT): Patients received LLLT for 15 minutes and Group II (Reflexology): Patients received reflexology in the form of thumb walk for 15 minutes. Therapy was applied 3 times/week for 8 weeks with concurrent 15 minutes exercise.

Results: Patients received LLLT showed a significant increase in ROM of abduction, internal rotation, flexion, and external rotation at the end of 4 and 8 weeks. Reflexology induced a significant improvement in shoulder ROM at 8 weeks posttreatment, however, its effect on internal rotation ROM was non-significant at the end of 4 weeks period.

Conclusion: LLLT and reflexology significantly improved ROM and reduced pain severity in diabetic patients with adhesive capsulitis; LLLT seemed to be more effective. Thus, both therapies may be recommended in the treatment of frozen shoulder, pending further investigations to trace out their exact efficacies.

Keywords: Adhesive capsulitis, Diabetes complications, Laser, Reflexology.

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both [1]. Type 2 diabetes mellitus is the most prevalent form, responsible for 90% of the disease prevalence [2,3]. Abnormal regulation of glucose and defective carbohydrate metabolism that result from a defective or deficient insulin are the crucial pathogenic events in Type 2 diabetes mellitus [4]. Diabetes can affect the shoulder in several ways [5]. It has been reported that adhesive capsulitis (frozen shoulder) is common in Type 2 diabetic patients [6] and patients report shoulder stiffness, along with decreased range of motion (ROM) [5].

Adhesive capsulitis is a frequent health problem in general practice, and its incidence is estimated to be 2-5% [7,8]. It is a common, yet poorly understood, condition causing pain and loss of ROM in the shoulder [9]. Several studies demonstrated that the etiology and pathogenesis of primary adhesive capsulitis are not recognized, but patients with hemiplegia and diabetes are predisposed [6,10,11]. In addition, Wolf and Green [12] reported that the adhesive capsulitis is a common problem occurs in patients with certain medical comorbidities and is usually correlated with increased pain and dysfunction with these comorbid medical factors. Modesto *et al*. [13] recoded that adhesive capsulitis is rare in children and peaks between 40 and 70 years of age.

Currently, no therapeutic intervention is universally accepted as most efficient for improving motion and diminishing pain in patients with adhesive capsulitis [14]. Multiple protocols have been proposed for the treatment of adhesive capsulitis, though there is no high-level evidence to support or refute the efficacy of any of the commonly used treatments [9,15,16]. The often prescribed treatments include analgesics, intra-articular corticosteroid injections, surgical manipulation of the joint under anesthesia and capsular release, and physiotherapy regimens [9,15-17]. Low-level laser therapy (LLLT) has been recommended as a non-invasive, non-thermal modality to treat various musculoskeletal conditions [18-20]. Therefore, the current study aimed to determine the efficacies of LLLT and reflexology, with concomitant exercise program, for improving ROM in diabetic patients with adhesive capsulitis.

METHODS

Patients

Totally, 40 volunteer patients of both sexes (22 men and 18 women) with proven Type 2 diabetes and frozen shoulder who were selected from the outpatient clinic of internal medicine in El-Abary Medical Center, Alexandria (Egypt) were included in the study. Following the approval of the study protocol by the institutional ethical committee, which conformed to the ethical guidelines of the 1975 Declaration of Helsinki, all volunteers signed informed consents. The practical work was carried over a period of 6 months.

Inclusion criteria

Patients fulfilled the following criteria were included:

- Type 2 diabetes mellitus for ≥4 years,
- Mean postprandial blood glucose ≥290 mg/dl,
- Age range of 55-65 years old,
- Frozen shoulder for 2-7 months.

Exclusion criteria

Patients were excluded if they had:

- Mental disorders,
- Developing cancer,
- Cardiopulmonary diseases,
- Uncontrolled hypertension,
- Neurological disorders.

Study design and treatment protocol

Full history of each patient was recorded carefully, and each patient was subjected to shoulder region evaluation to measure the ROM and diagnose any abnormalities, and foot and sole evaluation.

Included patients were randomly divided into two groups, each comprising 20 patients as follows:

Group I (LLLT): Patients received LLLT for 15 minutes using the Chattanooga 27808 Vectra Genisys Laser Applicator (USA).

Group II (reflexology): Patients received reflexology in the form of thumb walk for 15 minutes in upward, downward and diagonal directions over the shoulder area on the bottom of the foot under the little toe.

Therapy was applied 3 times/week for 8 weeks with concurrent 15 minutes exercise. The applied exercise program included the following:

1. External rotation-passive stretch: By standing in the doorway, bend affected arm 90° to reach the doorjamb, keep hand in place and rotate the body, hold for 30 seconds then relax and repeat 10 times.
2. Forward flexion-supine position: By lying on back with legs straight, use unaffected arm to lift affected arm overhead until feel a gentle stretch, hold for 15 seconds and slowly lower to start position then relax and repeat 10 times.
3. Crossover arm stretch: By gently pulling one arm across chest just below the chin as far as possible without causing pain, hold for 30 seconds, relax and repeat 10 times.
4. Pendular exercise: By leaning forward with good forearm supported on a table or bench, keep back straight and shoulder relaxed, gently swing affected arm forward and backward as far as possible pain-free and repeat the exercise swinging arm side to side as far as possible pain-free. Repeat 10 times each provided that there is no increase in symptoms.
5. Hand behind back: By standing tall, with neck and back straight and gently take a hand behind back and up spine as far as possible, provided that there is no increase in symptoms then repeated 10 times.

Measurement of shoulder joint ROM

Shoulder joint ROM of each patient was recorded pre-treatment and at 4 and 8 weeks post-treatment using a goniometer as follows:

1. Forward flexion: Is the motion of the shoulder when lifting the arm in front of the body, such as to point at something in front of you. ROM was measured with the palm facing the side of the body and the arm straight. It was measured from neutral (the arm hanging loosely at the side of the body) to the highest point the arm can be lifted over the head. Normal forward flexion ROM is 180°.
2. Abduction: Refers to a body part moving laterally away from the body. In the case of the shoulder, this refers to the arm swinging out from the side of the body, in an arm-flapping motion. ROM was measured with the palm facing the side of the body and the arm held straight. It was measured from neutral (the arm hanging loosely at the side of the body) to the highest point the arm can be lifted. Normal abduction ROM is 150°.
3. Internal rotation: Is a motion that performed with the elbow bent to 90° and swinging the forearm toward from the body, such as when closing an open cabinet door. ROM was measured with the elbow bent to 90° and from neutral (with the elbow against the body and the forearm in front of the body) to the widest point that the forearm can move toward the body. Normal internal rotation ROM is 70-90°.
4. External rotation: Is a motion that is performed with the elbow bent to 90° and swinging the forearm away from the body, such as when opening a cabinet door. ROM was measured with the elbow bent to 90° and from neutral (with the elbow against the body and the forearm in front of the body) to the widest point that the forearm can move away from the body. Normal external rotation ROM is 90°.

Statistical analysis

The data were statistically analyzed using SPSS v.16. Results were expressed as mean±standard error, and all statistical comparisons were made by means of Student's *t*-test and two-way ANOVA test followed by Bonferroni *post-hoc* analysis. A $p<0.05$ was considered significant.

RESULTS

Data describing the general characteristics of the LLLT and reflexology groups of patients are summarized in Table 1. The pre-treatment age distribution revealed non-significant ($p>0.05$) difference between the studied groups. The sex distribution of LLLT group revealed that there were 14 women with reported 70% while the number of men patients was six with reported 30%. The sex distribution of reflexology group revealed that there were four women with reported 20% while the number of men patients was 16 with reported 80%. The ROM of shoulder flexion, abduction, internal rotation, and external rotation of the LLLT showed a non-significant ($p>0.05$) difference when compared to the reflexology group as revealed in Table 1.

Compared to pre-treatment, abduction ROM of patients received LLLT showed a significant ($p<0.001$) increase at the end of 4 and 8 weeks post-treatment (Fig. 1). The abduction ROM revealed a significant ($p<0.05$) increase at the end of 8 weeks of LLLT compared to its values at 4 weeks post-treatment. The effect of reflexology therapy on abduction ROM exhibited the same pattern (Fig. 1); it was significantly increased at the end of 4 weeks ($p<0.05$) as well as 8 weeks ($p<0.001$) compared to the pre-treatment values.

Similarly, external rotation ROM demonstrated a significant ($p<0.001$) increase at the end of 4 and 8 weeks post-treatment with LLLT when compared to the pre-treatment data (Fig. 2). The effect of LLLT on external rotation ROM at the end of 8 weeks seemed to be more effective. On the other hand, the ameliorative effect of reflexology therapy on external rotation ROM has been shown to be less effective at both 4 and 8 weeks post-treatment when compared to LLLT.

Concerning internal rotation ROM, LLLT showed a significant ($p<0.001$) alleviation at both 4 and 8 weeks post-treatment when compared to the pre-treatment records, as depicted in Fig. 3. The effect of LLLT at 8 weeks post-treatment was more potent. Reflexology therapy, on the other hand, produced a non-significant ($p>0.05$) effect on internal rotation ROM at the end of 4 weeks period, however, its effect was significant ($p<0.05$) at 8 weeks post-treatment (Fig. 3).

Table 1: General characteristics of the LLLT and reflexology groups

	LLLT	Reflexology	F-Prob.
Age (years)	59.55±3.03	57.7±7.98	0.33
Sex			-
Men	6 (30%)	16 (80%)	
Women	14 (70%)	4 (20%)	
Flexion ROM (degrees)	87.5±15.17	87±14.17	0.91
Abduction ROM (degrees)	83±17.2	82±15.42	0.84
Internal rotation ROM (degrees)	18.5±8.75	17.5±7.16	0.69
External rotation ROM (degrees)	26±8.82	26.5±6.7	0.84

Data are expressed as mean±standard error. ROM: Range of motion, LLLT: Low-level laser therapy

As represented in Fig. 4, flexion ROM of the patients received LLLT exhibited a significant (p<0.001) amelioration at 4 and 8 weeks post-treatment, with more potent effect recorded at the end of 8 weeks treatment period. Reflexology therapy showed a significant increase in flexion ROM at the end of the 4 (p<0.05) and 8 weeks (p<0.001) treatment periods. The effect of Reflexology on flexion ROM at 4 weeks period was significantly (p<0.05) lower when compared to LLLT at 4 weeks post-treatment (Fig. 4).

DISCUSSION

Diabetes mellitus has been reported to affect the musculoskeletal system in various ways and musculoskeletal complications were most commonly seen in patients with established Type 1 and Type 2 diabetes [5]. Bridgman [21] first described the association between diabetes and adhesive capsulitis after observing a 10.8% incidence among 800 diabetic patients and only a 2.3% incidence in 600 non-diabetic patients; with high rate of bilateral frozen shoulder among diabetic patients. This observation has been supported by subsequent studies [22-24].

In diabetic patients, the biochemical rationale for the high incidence of frozen shoulder is unproved. In this regard, Brownlee *et al*. [25] thought that excessive glucose concentration in diabetic patients can lead to a faster rate of collagen glycosylation and cross-linking in the shoulder capsule, restricting shoulder ROM. In addition, Kim *et al*. [5] stated that the microvascular abnormalities, glycosylation of proteins, and collagen accumulation in the skin and periarticular structures associated with diabetes result in changes in the connective tissue. Moreover, Rodeo *et al*. [26] suggested that cytokines such as platelet-derived growth factor, tumor necrosis factor α, transforming growth factor β and interleukin 1β are involved in synovial hyperplasia and capsular fibrosis. Furthermore, increased neovascularization in the synovium of diabetic frozen shoulders has been shown [27].

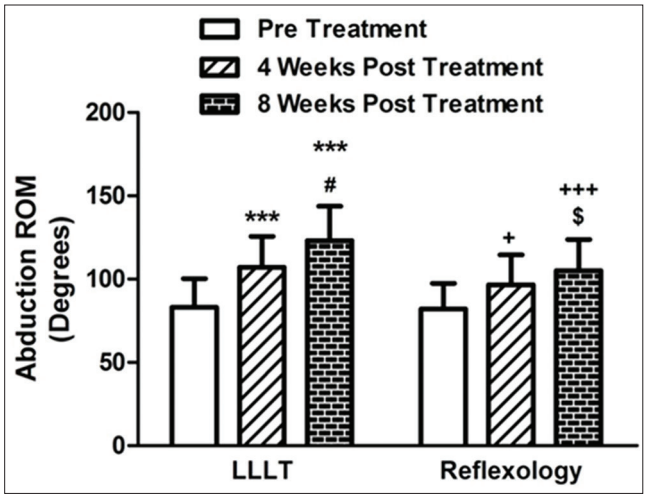

Fig. 1: Pre and post-treatment values of abduction range of motion in low-level laser therapy (LLLT) and reflexology groups. Data are expressed as mean±standard error. ***p<0.001 versus LLLT pre-treatment, #p<0.05 versus LLLT 4 weeks post-treatment, +p<0.05, +++p<0.001 versus reflexology pre-treatment and $p<0.05 versus reflexology 4 weeks post-treatment

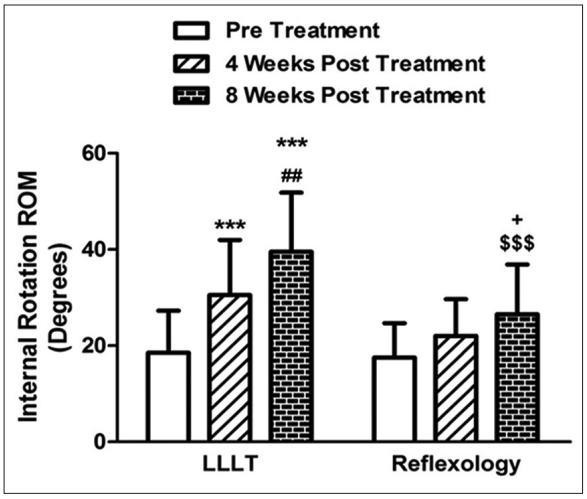

Fig. 3: Pre and post-treatment values of internal rotation range of motion in low-level laser therapy (LLLT) and Reflexology groups. Data are expressed as mean±standard error. ***p<0.001 versus LLLT pre-treatment, ##p<0.01 versus LLLT 4 weeks post-treatment, +p<0.05 versus reflexology pre-treatment and $$$p<0.001 versus reflexology 4 weeks post-treatment

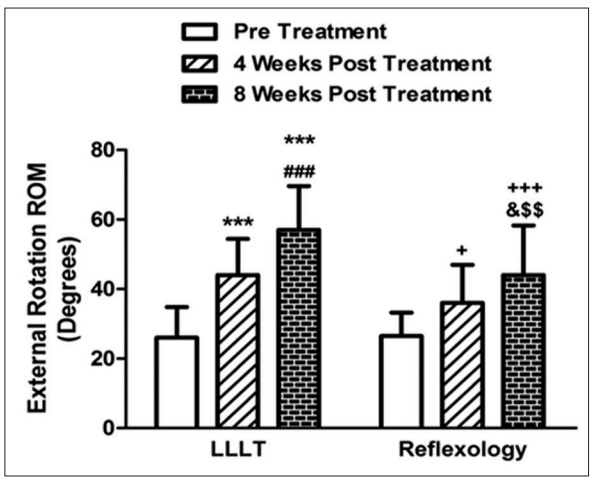

Fig. 2: Pre and post-treatment values of external rotation range of motion in low-level laser therapy (LLLT) and reflexology groups. Data are expressed as mean±standard error. ***p<0.001 versus LLLT pre-treatment, ###p<0.001 versus LLLT 4 weeks post-treatment, +p<0.05, +++p<0.001 versus reflexology pre-treatment, $$p<0.01 versus reflexology 4 weeks post treatment and and p<0.05 versus LLLT 8 weeks post-treatment

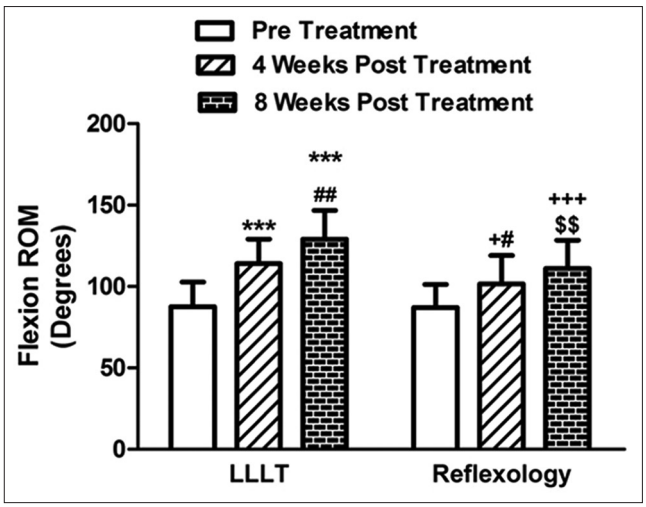

Fig. 4: Pre and post-treatment values of flexion range of motion in low-level laser therapy (LLLT) and reflexology groups. Data are expressed as mean±standard error. ***p<0.001 versus LLLT pre-treatment, #p<0.05, ##p<0.01 versus LLLT 4 weeks post-treatment, +p<0.05, +++p<0.001 versus reflexology pre-treatment and $$p<0.01 versus reflexology 4 weeks post-treatment

The debilitating and painful nature of frozen shoulder and the lack of high-level evidence to support or refute many of the commonly used treatments for adhesive capsulitis [9] demonstrate the demand for a new effective therapeutic intervention. To our knowledge, there has been no report comparing the effects of LLLT and reflexology in the treatment of frozen shoulder in Type 2 diabetic patients. Therefore, the current study was conducted to evaluate the efficacies of LLLT and reflexology in the treatment of adhesive capsulitis in Type 2 diabetic patients. Our study revealed significantly increased ROM and decreased pain severity in patients received LLLT. While LLLT for 4 weeks showed a significant improvement in abduction, internal rotation, flexion, and external rotation ROMs, the 8 weeks treatment period seemed to be more effective. The recorded improvement in shoulder ROM coincide with the study of Stergioulas [28] who reported that a course of LLLT for 8 weeks in patients with frozen shoulder is superior to treatment with placebo for improving pain, disability, and ROM at the end of 4 and 8 weeks of treatment.

The mechanisms by which laser therapy can improve shoulder movement and pain severity in frozen shoulder patients are unknown. However, the studies conducted by Bjordal *et al.* [29] and Albertini *et al.* [30] stated that laser irradiation can reduce inflammation and pain by changing prostaglandin E2 concentrations or by removing algesiogenic substances with an increase in the microcirculation. In addition, laser has been demonstrated to reduce muscle pain by reducing oxidative stress [31] or by blocking axonal transport [32]. Moreover, Reddy *et al.* [33] reported that the laser facilitates collagen production and tendon healing. Collagen, located in the ligaments of the glenohumeral joint and the synovia, is significantly restricted in frozen shoulder, and this causes restriction of movement [34]. Furthermore, Saunders [35] recorded a significant improvement in range of movement and strength of shoulder muscles in patients with supraspinatus tendinitis received low-power laser irradiation and Vecchio *et al.* [36] reported that laser increased the ROM and muscle strength, and decreased pain intensity in 30 patients with rotator cuff tendinitis.

On the other hand, patients received reflexology therapy showed a marked improvement in ROM at the end of 8 weeks. Compared to reflexology, LLLT seemed to be more effective in improving shoulder ROM and pain severity in diabetic patients with frozen shoulder. Reflexology has been reported as a non-invasive complementary therapy for several medical conditions [37,38]. The beneficial effects of reflexology observed in the current study may be explained according to Pitman and Mackenzie [39] who stated that reflexology therapy may amend the organ dysfunction and provide homeostasis in the organ function. In addition, reflexology therapy has been reported to reduce pain and anxiety for patients with breast and lung cancer [40]. Reflexology is hypothesized to act by generating impulses through the external stimulation of the skin areas of hands and feet representative of the target body parts. The generated impulses arrive the target body parts through neural pathways or hormone-like activities. These impulses are thought to improve the corresponding abnormally functioning status [41].

In conclusion, the current study demonstrated that both laser and reflexology significantly improved shoulder ROM and reduced pain severity in diabetic patients with adhesive capsulitis. The provided analgesia allows other therapeutic protocols, including exercise, to be performed comfortably. Laser therapy seemed to be more effective in frozen shoulder treatment. Thus, both therapies may be recommended in the treatment of frozen shoulder, pending further investigations to trace out their exact efficacies.

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