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Effect of range of motion exercises and high voltage tiny impulses electrical stimulation on functional activity of the upper limb postmastectomy

Mohamed Bahaa Eldeen Boghdady Alasar[1]*, Zakaria Mowafy Emam Mowafy, Mohamed[1] Gamil Abd-El Monem[2] , Walid Ahmed Ibrahim Abo El Naga[2]

[1]Physical therapy department for surgery, faculty of physical therapy, Cairo University, Egypt.
[2]National Cancer institute, Cairo University, Egypt.

Abstract : Purpose: to evaluate effect of range of motion exercises and high voltage tiny impulses electrical stimulation on functional activity of the upper limb postmastectomy. **Methods of evaluation:** Visual analouge scale (VAS) and functional assessment of the simple shoulder test (SST). Thirty female patients with postmastectomy shoulder pain were recruited from the National Cancer Institute and Beni-Sewaf University Hospitals. Their ages were ranged from 40 to 55 years old: Group (1) "Study group": Fifteen patients who received range of motion exercises and high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment. Group (2) "Control group": Fifteen patients who received only the traditional medical treatment. PGP stimulation was applied in the form of 10 clicks on the shoulder tip and another 10 clicks on the centre of deltoid muscle, three sessions per week, every other day, for three months, while the shoulder wheel range of motion exercises (15 minutes for three times weekly for 3 months). **Results:** results showed that range of motion exercises and high voltage electrical stimulation were effective in decreasing pain and improving the functional activity of the upper limb postmastectomy as evidenced by the highly significant decreases in visual analouge scale and the highly significant increases in functional assessment of the simple shoulder test.
Key words: (Shoulder wheel exercises, Functional activity, Functional assessment of the simple shoulder test, High voltage tiny impulses electrical stimulation and Visual analouge scale)

Introduction

Cancer rehabilitation has been defined as " The dynamic process directed toward the goal of enabling persons to function at their maximum level of their disease or disability in terms of their physical, mental, emotional, social, and economic potential. Four major problems presented to the rehabilitation team by patients with breast cancer populates include: lymphedema, decreased shoulder mobility, pain and fatigue, and need for psychosocial support to foster good functional outcome and independence.[11.13.21,22].

After mastectomy and the accompanying excision or radiation of adjacent axillary lymph nodes a patient is at risk of developing upper extremity lymphedema, shoulder pain and loss of shoulder motion. Physical therapists often become involved in the postoperative management of patients who have undergone a

mastectomy. Therapeutic exercise is an important part of the patient's postoperative plan of care to prevent or minimize lymphedema, shoulder pain or loss of shoulder motion[3,8,10.11,13].

Early physical therapy intervention for the postmastectomy patients will make a significant contribution to the return of patient's functional level and ultimately her quality of life. It is probable that the refinement of treatment techniques will further improve the outcome for these patients, and that without increasing the incidence of postoperative complications or prolonged hospital stay. Immediate postoperative mobilization of the affected arm has been recommend after mastectomy to avoid shoulder pain and limitation in R.O.M of the shoulder. Full range of motion of the shoulder is often needed in order to obtain necessary positioning for post-operative radiation therapy, [7.8,12,22].

Electrical stimulation is based on the fact that human body has an endogenous bioelectric system that enhances healing of bone fracture, soft tissue lesions and decreasing the postoperative pain. The external current may serve to mimic the failed natural bioelectric currents, so that postoperative pain can be inhibited. It was reported that the pain gone pen is a new pain relief device which is better in enhancing cellular physiology processes than other current of higher amplitude, the piezo-electronic crystal placed in the pain gone pen device works by producing a piezoelectric stimulation in the form of high voltage, low frequency pulse for a brief period (15.000 V, 0.006 mA, 1-2 Hz). Clicking on the painful area , the device transmits electrical impulses to the skin surface and then to the body's pathway for pain relief, [2.5,9,14,16,17,18,19].

Material and Methods:

Subjects:

Thirty female patients with postmastectomy shoulder pain after were participated in this study. They were recruited from the National Cancer Institute and Beni-Sewaf University Hospitals. Their ages were ranged from 40 to 55 years old: **Group (1) "Study group**": Fifteen patients who received range of motion exercises and high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment. **Group (2) "Control group**": Fifteen patients who received only the traditional medical treatment. PGP stimulation was applied in the form of 10 clicks on the shoulder tip and another 10 clicks on the centre of deltoid muscle, three sessions per week, every other day, for three months, while the shoulder wheel range of motion exercises (15 minutes for three times weekly for 3 months), [5.7.8,14,21,22].

Instrumentation:

Pain gone pen (PGP) unit is a new pain relief device which has lately become available. The piezo-electronic crystal placed in the product works by producing a high voltage, low frequency pulse for a brief period. Clicking on the painful area, the device transmits electrical impulses to the skin surface and then to the body's pathway for pain relief. Pain gone pen unit (it has been manufactured in UK for medi-direct international Ltd. Unit 17; Wilford industrial estate and business park, Ruddiington Lane, Nottingham, NG 11 7EP. UK) with the following technical specifications: Hand-held, pen-like, piezoelectric stimulator. Device name: Pain ®Gone. Classification: Class IIa medical device (CE0086).Length: 132 mm in length. Diameter: 20mm in diameter. Power requirements: No power source is required. Energy output: 2.6 mJ at 2000Ω. Operating life: 2-3 years under normal application of three treatments per day of 30-40 clicks per treatment. Voltage: High voltage of 15.000 V. Frequency: Low frequency of 1-2 Hz and intensity of 0.006 mA. In addition to the shoulder wheel for application of the range of motion shoulder exercises (15 minutes for three times weekly for 3 months), [2,5,8,9,14,16,17,18,19].

Measurement equipment and tools:

1. Visual Analogue Scale (VAS): Pain level was assessed by visual analogue scale. VAS is a ten cm line anchored at each end with wards such as no pain and the worst pain possible,[8,12],[22].
2. Functional Assessment of the Simple Shoulder Test (SST): By using the simple shoulder test (SST) which is a shoulder function scale consisting of 12 items that ask people about their ability to tolerate or perform 12 activities of daily Living (ADL). The individual indicates that she is able or is not able to do the activity. The SST scores range from 0 to 100 and they are reported as the percentage of answered items to which the person responds in the affirmative. SST was done before starting treatment (first record) and at the end of the total period of treatment after 3 months (second record),[7,8],[12,22].

Treatment:

All patients in the 2 groups (A) and (B) received the same traditional medical treatment, same nursing care and described diet. patient sit on a chair with back support and the PGP stimulation was applied (for a brief period) one (10 clicks) on the shoulder tip and the other (for a brief period) (10 clicks) on the centre of deltoid muscle. The PGP stimulator was applied according to the following parameters, high voltage of 15.000 V, amplitude (intensity) 0.006 mA, 1-2 HZ for frequency. The frequency of this treatment protocol for each patient of this group was three sessions per week, every other day, for three months, while the shoulder wheel range of motion exercises (15 minutes for three times weekly for 3 months), [2,5,7, 8,12,,14,18,19,22.]

Data analysis:

Visual analouge scale and simple shoulder test records were measured before treatment and after cessation of the treatment program in both groups. Collected data were fed into computer for the statistical analysis; descriptive statistics as mean, standard deviation, minimum and maximum were calculated for each group. The t-test was done to compare the mean difference of the two groups before and after application and within each group. Alpha point of 0.05 was used as a level of significance[, 15,20].

Results:

In the present study, effects of the range of motion exercises and high voltage tiny impulses electrical stimulation on functional activity of the upper limb postmastectomy were investigated. As shown in table (1) and figure (1), the mean value of the visual analouge scale in degrees (VAS) before treatment was (8.522 ± 0.155) degrees in the study group, while after treatment was (2.224 ± 0.242) degrees. These results revealed a highly significant reduction in VAS, (P<0.0001). But in the control group, the mean value of the visual analouge scale in degrees (VAS), before treatment was (8.520 ± 0.132) degrees, while after treatment was (8.518 ± 0.128) degrees, and these revealed non-significant difference in VAS, (P > o.o5).

Table (1): Comparison of the mean values of the VAS in degrees, before and after treatment in both groups

	Before treatment		After treatment		Mean difference	T.value	P.value
	Mean in degrees	± SD	Mean in degrees	± SD			
Study group	8.552	0.155	2.224	0.242	6.32800	85.28	< 0.0001
Control group	8.520	0.132	8.518	0.128	0.002000	0.04	0.967

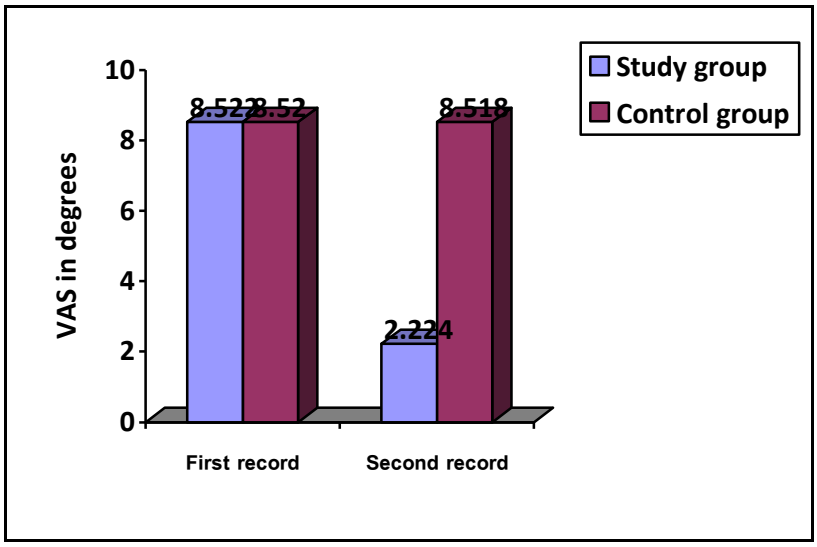

Fig (1) : Mean values of VAS in degrees before and after treatment in both groups.

In the present study, effects of the range of motion exercises and high voltage tiny impulses electrical stimulation on functional activity of the upper limb postmastectomy were investigated. As shown in table (2) and figure (2), the mean value of the scores percentage of the functional assessment of the Simple Shoulder Test (SST) before treatment was (33.500 ± 7.714) in the study group, while after treatment was (78.30 ± 7.99). These results revealed a highly significant increase in the mean value of the scores percentage of the functional assessment of the Simple Shoulder Test (SST), (P<0.0001). But in the control group, the mean value of the scores percentage of the functional assessment of the Simple Shoulder Test (SST), before treatment was (33.433 ± 7.655), while after treatment was (32.982 ± 6.991), and these revealed non-significant difference in the mean value of the scores percentage of the functional assessment of the Simple Shoulder Test (SST), (P > o.o5).

Table (2): Comparison of the mean values of the percentage scores of the functional assessment of the SST, before and after treatment in both groups

	Before treatment		After treatment		Mean difference	T.value	P.value
	Mean in Percentage scores	± SD	Mean in percentage scores	± SD			
Study group	33.500	7.714	78.30	7.99	-44.8000	-15.62	< 0.0001
Control group	33.433	7.655	32.982	6.991	0.451000	0.17	0.867

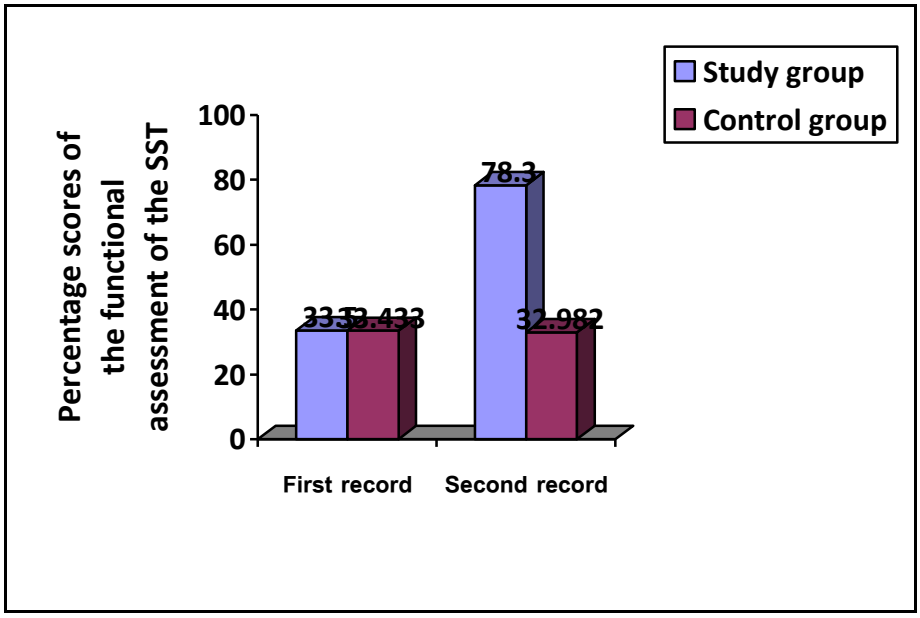

Fig (2) : Mean values of the percentage scores of the functional assessment of the SST before and after treatment in both groups.

Discussion:

The mammary gland is extremely vascular and is supplied mainly by the perforating branches of the internal thoracic artery and by several branches of the axillary (chiefly the lateral thoracic). The venous drainage is important, not only because the veins indicate the lymphatic pathways, but because carcinoma may metastasize by way of veins. Superficial veins drain through the perforating branches of the internal thoracic or the superficial veins of the lower part of the neck, and can be photographed in infrared light. Deep veins from the breast drain into the perforating tributaries of the internal thoracic, into the axillary, and into the intercostal veins. The connections of the last mentioned with the vertebral plexus of veins provide a route for carcinomatous metastasis to bones and to the nervous system[1,3,4,6,11].

Problems presented to the rehabilitation team by patients with breast cancer populates include: lymphedema, decreased shoulder mobility, pain and fatigue, and need for psychosocial support to

foster good functional outcome and independence. Shoulder dysfunction is common complication following treatment of breast cancer. Such dysfunction is not limited to those treated by radical mastectomy. Sometimes there is limitation of shoulder motion after treatment even simple mastectomy or radiation only. It is a common sequel of operations on the breast and axilla. Limitation in flexion, abduction, adduction, and internal and external rotation is readily apparent to the patient and treatment team**.** Shoulder motion is usually affected by the extent of axillary dissection. Flexion, external rotation, and abduction (the true articular shoulder movements) are the most likely to be affected and are often the most difficult to restore if lost. Shoulder pain is a significant clinical problem that requires treatment to improve comfort and function, [10,11,13,21,22].

There are several aspects of conventional treatment of breast cancer that can lead to temporary shoulder and arm dysfunction. Decrease skin mobility of the chest wall and formation of fibrous adhesions resulting from surgical dissection, radiation fibrosis and axillary scarring can cause shoulder joint dysfunction, leading to scapular substitution for proper shoulder motion, which can promote joint contracture. If allowed to progress, adhesive capsulitis or rotator cuff tendonitis can result. The shoulder joint dysfunction can cause pain, muscle spasms, immobility, and a functional loss of range of motion. A significant number of women have limitation in the range of motion of ipsilateral shoulder, although the " frozen shoulder " is seldom encountered today. The causes of restricted range of motion are immobility by dressing, instruction, pain , fear, or scarring [,3,6,10,13,22].

Muscle weakness may result from removal of muscle, prolonged immobilization, or nerve injury. A kinesiological study by Nikkanen et al, reports a 25 percent decrease in muscle strength on the operated side compared with the muscle on the control side . Although there are physical causes for much of the muscle weakness seen after breast surgery, it is not uncommon for women to become " one armed " after a mastectomy or axillary dissection. Pain is a frequent complaint in breast cancer patients and can be of several types, the natural history of the symptom, how soon after surgery it occurs, its distribution, and intensity often indicate its origin. For example, medical arm dysesthesia occurs immediately postoperative and is a result of cutting the medial brachial cutaneous nerve; hand dysesthesia are probably referred from the cervical spine or possibly a carpal tunnel syndrome frequently secondary to arm edema and subsequent to axillary dissection. Tightness from the scar and parasthesia in the intercostal brachial nerve distribution cause discomfort in a significant proportion of women after breast surgery. Less common (4% to 6%) is more severe pain that may be disabling,[4.6.7,8,11,21,22].

The use of exogenous electrical potentials, fields and currents in order to facilitate tissue healing or pain management is becoming a clinically accepted technique. An injury to a living system initiates a series of complex electrical currents at the site of injury, which are directly responsible for changes in both cell type and number. The local electrical effect (the current of injury), is the primary response that is responsible for the appearance of new cells. Electrical stimulation may mimic the current of injury restarting or accelerating the wound healing process and decreasing pain perception (e.g., cells may be stimulated to move along the path of the electrical current, and this migration of cells may be important in the inflammatory and proliferative stage of the healing process). Electrical currents are believed to stimulate several cell activities (e.g., deoxyribonucleic acid [DNA] synthesis, cell proliferation, synthesis of extracellular matrix, collagen, expression of growth factors and receptors). The flow of electrical current through a biological conductive medium result in three basic effects; electrochemical, electro physical and electrothermal, theoretically, every time electrical current flows through the body, all three effects occur. Electrochemical effects: The unidirectional flow of the direct current (DC) redistributes sodium and chlorine to form a new chemical compounds in the tissue under the electrodes,[2.5,9,14].

Electric fields impact cellular functions by activation of ion channels and/or interfering with cell membrane actions. This impact differs according to the intensity used (micro-amperes). It also depends on the used type of electrical stimulation (direct, pulsed, or alternating current), the frequency and duration of treatment, and the type and exact placement of the electrodes. The mechanism of the analgesic action of pain gone pen might be similar to the neuromodulatory effect of TENS. But pain gone pen does not require application of gels, pads and wires and there are no on-going costs, its use may decrease the need for pain reducing drugs,[16.17,18,19,22].

Findings of the present study showed that there was a highly significant decrease between the means of the second record VAS (2) (after 3 months application of the shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment) and the

first record VAS (1) (pre- application of the shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment LILT). Findings of the present study showed that there was non-significant differences between the means of the second record VAS (2) (after 3 months of the traditional medical treatment application) and the first record VAS (1) (pre-application of the traditional medical treatment).

While findings of the present study showed that there was a highly significant increase between the means of the second record of the percentage scores of the functional assessment of the SST (2) (after 3 months application of the shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment) and the first record of the percentage scores of the functional assessment of the SST (1) (pre- application of the shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment). Findings of the present study showed that there was non- significant differences between the means of the second record of the percentage scores of the functional assessment of the SST (2) (after 3 months of the traditional medical treatment application) and the first record the percentage scores of the functional assessment of the SST (1) (pre- application of the traditional medical treatment).

Comparison between the means of the first pre-treatment records of the VAS in the two groups revealed that there were non-significant differences. But comparison between the means of the second records of the VAS in the two groups showed that there was a highly significant decrease in the second records of VAS, between the study and control groups.

While comparison between the means of the first pre-treatment records of the percentage scores of the functional assessment of the SST in the two groups revealed that there were non-significant differences. But comparison between the means of the second records of the percentage scores of the functional assessment of the SST in the two groups showed that there was a highly significant increase in the second records of the percentage scores of the functional assessment of the SST, between the study and control groups.

These significant differences, between the study group and the control group, which were in the form of a highly significant decrease in VAS and a highly significant increase in percentage scores of the functional assessment of the SST, were consistent with those observed and recorded by Akai and Hayashi, 2006; Box et al., 2002; Brennan and Garden, 2006; Cleary, 2002; Griffin and Clifft, 2011; Kitchen and Dyson, 2002; Waston and Wall, 2009 and Benedetti et al., 2011.

Eventually, after the discussion of the results and according to reports of the previous investigators in fields related to this study, it can be claimed that application of the shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment had a valuable effects on functional activity of the upper limb postmastectomy as evidenced by the highly significant decreases in VAS and the highly significant increases in the percentage scores of the functional assessment of the SST.

Conclusion

Shoulder wheel exercises and the high voltage tiny impulses electrical stimulation of pain gone pen (PGP) in addition to the traditional medical treatment had a valuable effects on functional activity of the upper limb postmastectomy as evidenced by the highly significant decreases in VAS and the highly significant increases in the percentage scores of the functional assessment of the SST.

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