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Proprioceptive neuromuscular facilitation technique versus kinesiotaping on lymphedema after mastectomy

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Background: Breast cancer is the most frequently occurring cancer in women. With this transformation of the disease into a chronic condition that focus of attention is being directed towards late post treatment sequelae like lymphedema which is a swelling of a part of the body secondary to accumulation of interstitial fluid (ISF) due to malformation or malfunction of the lymphatic system.

Purpose: This study was designed to compare the therapeutic effect of the PNF technique and Kinesiotaping on lymphedema after mastectomy. **Materials and Methods:** Thirty patients who had lymphedema post mastectomy were participated in this study. Their ages ranged from 40-55 years. The participants were selected from National Cancer Institute and randomly distributed into two equal groups: Group (A): Proprioceptive Neuromuscular Facilitation (PNF) Technique group, they received PNF plus the traditional physical therapy protocol for 3 months (3 sessions of 30 minutes/week) and Group (B) Kinesio taping (KT) technique group They received kinesio tape plus the traditional physical therapy protocol for 3 months once weekly. Tape measurement was used to assess the edema volume according to edema equation: $V = h \times (C^2 + Cc + c) / (\pi \times 12)$ and Universal goniometer to assess shoulder flexion range of motion (ROM). Evaluations were done before starting the treatment then after the end of the treatment course. **Results:** Both PNF technique and kinesiotape have a significant improvement on arm lymphedema post mastectomy and shoulder flexion ROM. **Conclusion:** Both PNF and KT have an effect on decreasing upper limb lymphedema and increasing shoulder flexion ROM.

Key words: Lymphedema, Proprioceptive Neuromuscular Facilitation Technique, Kinesiotaping.

Introduction

Breast cancer operations have led to more patients with maintaining lymph balance, by absorbing unnecessary properties in lymphoid tissues, subsequently cause edema in the arms or legs. This symptom is called lymphedema. Lymphedema is the accumulation of protein-rich fluids in the interstitium due to the lack of transport ability in the lymphatic system, and usually develops in one or more areas (1). Lymphedema is a swelling of a part of the body secondary to accumulation of interstitial fluid due to malformation or malfunction of the lymphatic system (2).

The purpose of the treatment for lymphedema is not to cure it completely but to reduce the size of the edema. Medication is insufficiency effective enough and surgery has its limits. A lasting condition of edema and chronic inflammation from the abnormal accumulation of tissue protein due to lymphedema is loss of muscle flexibility, and as result, limitations in making movements, Therefore, proper exercise plays a role in maintaining the optimal range of motion (ROM), and applying PNF autogenic inhibition technique can produce a negative pressure as contraction followed by relaxation improves the pumping mechanism enhancing the lymphatic drainage, PNF stretching involves moving within a range without causing pain (3).

PNF has become an important element in reducing and preventing exercise injuries through enhanced flexibility. PNF stretching involves moving within a range without causing pain, and has become an important element in reducing and preventing exercise injuries through enhanced flexibility and the increase in blood flow (4).

Moreover, PNF stretching heightens the accuracy of exercise and muscle activity, in addition to improving body coordination. Therefore, for lymphedema patients, the improvement of their motor competency and ROM in the body parts that develop limited exercise performances may be urgently required (5).

KT for lymphatic drainage is a new choice in the field of physical therapy. KT had been designed to allow 30-40% longitudinal stretch. It is composed of 100% cotton fibers and acrylic heat sensitive glue (6).

KT is theorized to have several therapeutical functions: restoring correct muscle function by supporting weakened muscles, improve the flow of blood and lymphatic fluid, decrease pain, and correct misaligned joints also KT has an effect on blood flow and pain, which may be the basis for increases in ROM on unhealthy shoulders (7).

Therefore, the purpose of the study was to compare the therapeutic effect of the PNF technique and KT on lymphedema after mastectomy.

Patients and methods:

I- Subjects:

Thirty female patients, who had upper extremity lymphedema post mastectomy were participating in this study, they were selected from surgical department- National Cancer Institute- Cairo University. They aged from 40-55 years. System was in the period from June to December 2016. These patients were divided randomly into two equal groups in number- Group (A): They were treated with PNF plus the traditional physical therapy protocol (Manual lymph therapy (MLT), Compression Garments and Wall bar) to manage lymphedema for 3 months (3 sessions of 30 minutes/week). Group (B): They were treated by kinesio tape plus the traditional physical therapy protocol to manage lymphedema for 3 months once weekly. Subjects were evaluated before starting the treatment then after the end of the treatment course.

Study design: Randomized controlled trial.

Inclusion Criteria:

- Age range between 40-55 years.
- All patients had unilateral arm lymphedema after cancer.
- The grades of lymphedema for all patients were ranged from mild (Grade 1) to moderate (Grade 2) Lymphedema.

Exclusion criteria:

- Diabetes mellitus.
- Patients who had pain or redness in the area of lymphedema.
- Patients with musculoskeletal disorder of upper limb.

II- Materials:

Evaluation:

- 1- Elastic tape measurement for edema: Round measurement of the upper limb at two ends of the area and the height between the two ends. It was used to measure the amount of lymphedema of arm and forearm (8).
- 2- A universal goniometer for ROM: it is a pair of elongated arm members, arm attached at one of the ends of each by pin. At least one side of each arm member is straight so that when both arms are rotated so that an angle of 0 angular degrees is formed between them, at least one straight side is formed, both opposing of each arm are approximately straight and sides parallel and in line with the side of the other arm when the angle is 0 (or 180) degrees (9).

Treatment:

1- PNF: The form of PNF has known as the hold-relax technique (6-10 seconds) of the muscle being. An isometric contraction is defined as one in which the muscle develops tension but does not shorten which the muscle is passively stretched, held in a sustained isometric contraction (10).

2- Kinesio taping:

It has roughly the same thickness as the epidermis and can be stretched between 30% and 40% of its resting length longitudinally, proposed several benefits, depending on the amount of stretch applied to the tape during application. It is latex free and the adhesive is 100% acrylic and heat activated and 100% cotton fibers allow for evaporation and quicker drying (11,6).

III- Procedures:

Evaluation procedures:

1- Edema assessment:

- Sterilized the arm, use tape measurement to calculate circumferences measurements computed on the basis of distances from elbow joint. The first truncated cone was taken from 20 cm of the elbow (olecranon process) to wrist, and the last truncated cone was taken from the adjacent most proximate circumferential measurement, which is about 20 cm from the olecranon process toward the shoulder because the upper boundary is less than 60 cm for most of the women and it is little more than 60 cm for the other women. For circumferential measurements based on anatomic landmarks, the lower boundary and the upper boundary are as previously described. The volume of a truncated cone was calculated according to this equation: $V = h \times (C^2 + Cc + c) / (\pi \times 12)$, where: V the volume of the segment of the limb 'C' and 'c' are the circumference at each end, and "h is the distance between them. The sum of these volumes gives a surprisingly accurate estimate (12, 13).

2- Range of motion assessment:

The patient was put in a suitable position, which is supine lying or sitting position. The axis of the goniometer was placed over the axis of movement of the joint, a specific bony prominence or anatomical landmark could be used to represent the axis of motion which is head of humerus. The stationary arm of the goniometer was parallel to the mid axillary line and the movable arm of the goniometer was parallel to the midline of humerus, then patient was asked to move the arm forward and the value of the range of motion of the joint was determined (14).

Treatment Procedures:

1- Procedures of Proprioceptive Neuromuscular Facilitation:

- They performed wrist turning, basic massage, joint exercise for about five minutes before the main stretching, Then we applied PNF autogenic inhibition specific techniques of rhythmic initiation (RI), hold-relax, contract-relax then combination of isotonic (CI) or alternating isometrics and slow reversal, the procedure was repeated three times weekly for three months. (5)

2-Procedures of kinesiotaping technique:

- The tape was cut into a fan shape with several strips cut, leaving a shorter length of tape to act as abase fixed on the limb before application of tape. It was applied once weekly (9).

Results:

The collected data for all patients who completed the procedures of the study were presented and discussed under as following:

The AGE mean value was 48.67 ± 5.39 years for Group (A), and 48.73 ± 5.23 years for Group (B). There was non-significant difference in AGE between both groups.

PNF group: Group (A): As showed in table (1): The mean value of pre and post treatment lymph measurement (LM) were 451.20 ± 81.22 /ml and 311.00 ± 44.29 /ml respectively. There was significant difference between the means of pre and post treatment of LM ($P < 0.0001$). The mean values of ROM of shoulder flexion pre and post treatment were 76.66 ± 5.56 and 132.66 ± 6.51 respectively. There was a significant increase in ROM of shoulder flexion data post- treatment when compared with the corresponding mean pre-value, P-value was (0.0001)

KT group: Group (B): As showed in table (1): The mean value of LM of pre and post treatment were 450.93 ± 79.06 / ml and 319.06 ± 44.59 /ml respectively. There was significant difference between the means of LM of pre and post treatment ($P = 0.0001$). As shown in table (1) the mean value of ROM of shoulder flexion of pre and post treatment were 66.66 ± 5.23 , and 118.00 ± 14.11 respectively. Which reflected a significant increase in ROM of shoulder flexion data of post treatment when compared with the corresponding mean value of pre- treatment, P-value was (0.0001).

Table (1): Statistical analysis of pre and post LM and shoulder ROM in Group (A) and Group (B).

Items	Group (A)				Group (B)			
	Pre-LM/ml	Post-LM /ml	Pre-shoulder flexion ROM(°)	Post-shoulder flexion ROM(°)	Pre-LM/ml	Post-LM/ml	Pre-shoulder flexion ROM(°)	Post-shoulder flexion ROM(°)
Mean	451.20	311.00	76.66	132.66	450.93	319.06	66.66	118.00
±Standard deviation	81.22	44.29	5.56	6.51		44.59	5.23	14.11
Mean difference	140.20		56.01		131.86		51.33	
t. value	10.953		46.09		12.57		15.95	
p. value	< 0.0001		0.0001		0.0001		0.0001	
Level of significance	Significant		Significant		Significant		Significant	

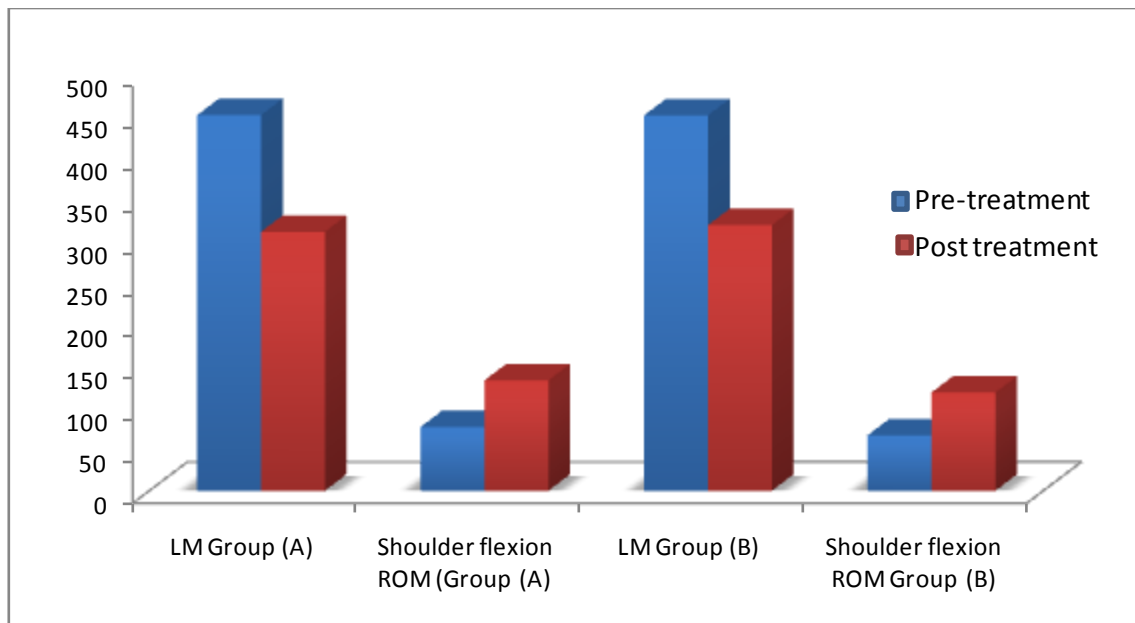


Fig. (1): Pre and post LM and shoulder ROM in Group (A) and Group (B).

As shown in table (2): the mean value of pre- LM of Group (A) was 451.2 ± 81.22 , while the mean value of group (B) was 450.93 ± 78.99 . There were non-significant differences in pre- LM, between Group (A) and Group (B) ($P > 0.0001$). Also, Table (2) showing the mean value of post-LM of Group (A) was 311.00 ± 44.29 , while the mean value of group (B) was 319.07 ± 44.59 . There were non-significant differences in post- LM, between Group (A) and Group (B).

As shown in table (2) the mean value of pre shoulder flexion ROM of Group (A) and Group (B) were 76.66 ± 5.56 and 66.66 ± 5.23 respectively. There were non-significant differences in the pre-shoulder flexion ROM between both groups ($p < 0.0001$). Also, The mean value of post ROM of shoulder flexion Groups (A) and (B) were 132.66 ± 6.51 and 118.00 ± 14.11 respectively. There were significant differences in the post shoulder flexion ROM between both groups ($p < 0.0001$).

Table (2): Comparison Statistical analysis between pre and post LM and shoulder ROM in Group (A) and Group (B).

Items	LM /ml				Shoulder Flexion ROM(°)			
	Pre-Group (A)	Pre-Group (B)	Post-Group (A)	Post-Group (B)	Pre-Group (A)	Pre-Group (B)	Post-Group (A)	Post-Group (B)
Mean	451.20	450.93	311	319.06	76,66	66.66	132.66	118
±Standard deviation	81.22	78.99	44.29	44.59	5.56	5.23	6.51	14.11
Mean difference	0.27		-8.07		10		14.66	
t. value	0.0092		0.6102		5.0738		3.6538	
p. value	0.9927		0.5467		0.3721		0.0011	
Level of significance	Non-significant		Non-significant		Non-significant		Significant	

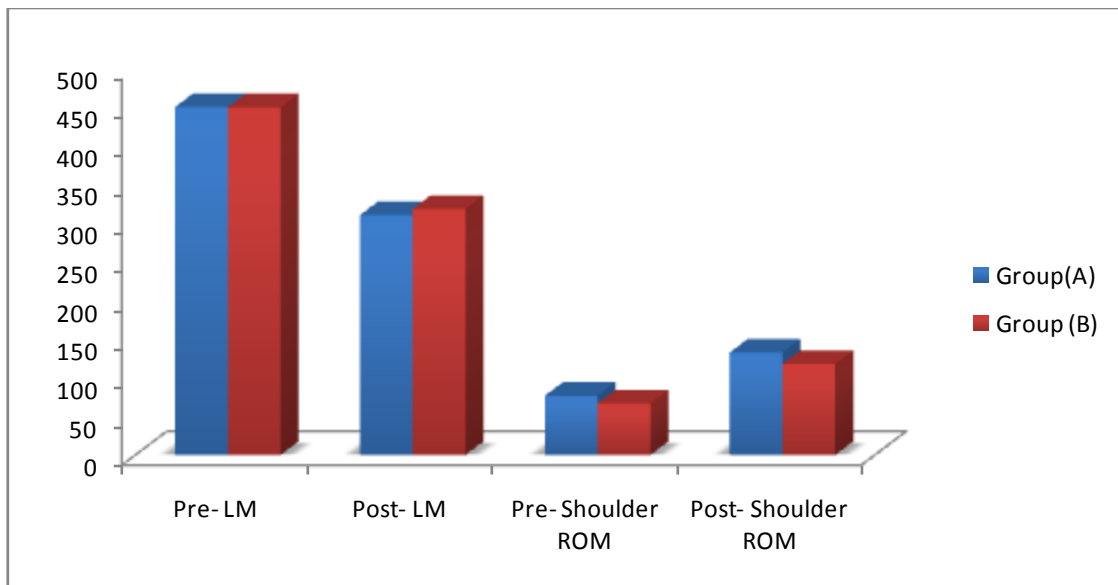


Fig. (2): Pre and post LM and shoulder ROM in Group (A) and Group (B).

Discussion:

Lymphedema in women treated for breast cancer is accumulation of protein-rich fluid in the arm that occurs when axillary lymphatic drainage from the arm is interrupted because of axillary lymph node dissection or axillary radiation, or both (15). Lymphedema as a complication resulting after breast cancer surgery is caused by the decreased tissue dispensability around joint and the increased weight of extremity (16).

Physical therapy has important roles in helping women with breast cancer overcome their most obvious disability. Physical therapy involvement in the preoperative and postoperative management of patients with breast cancer can be a major factor in the early attainment and maintenance of full functional upper extremity range of motion and strength (17).

The results of the current study were recorded as a non-significant difference in the second records of LM, between Group (A) and Group (B). The mean values of LM of post treatment were 311.00 ± 44.29 , and 319.07 ± 44.59 respectively, ($P > 0.0001$).

The mean value of the second records of shoulder flexion ROM of group (A) was 132.66 ± 6.51 , while the mean value group (B) post-treatment was 118.00 ± 14.11 with a non-significant differences between both groups.

According to the statistical results, this study showed both PNF and KT have an effect on decreasing upper limb lymphedema and increasing in shoulder flexion ROM.

The results of this study agreed with the results and researches recorded by: **Godges et al. 2003 (3); Golshan and Smith, 2006 (18); Kaya et al., 2012(16) and Lipinska et al., 2007 (19).**

Godges et al. 2003 (3) documented that proper exercise plays a role in maintaining the optimal range of motion (ROM), and applying PNF autogenic inhibition technique can produce a negative pressure as contraction followed by relaxation improves the pumping mechanism enhancing the lymphatic drainage PNF stretching involves moving within a range without causing pain. His study was on twenty patients (10 males, 10 females; age range, 21–83 years) with limited glenohumeral external rotation and overhead reach of 1 year duration or less served as subjects. The subjects were randomly assigned to a treatment group, which consisted of

soft tissue mobilization to the subscapularis and proprioceptive neuromuscular facilitation to the shoulder rotators, or a control group. The treatment group improved by a mean of 16.4° (95% confidence interval [CI], 12.5°–20.3°) of glenohumeral external rotation.

Golshan and Smith, 2006 (18) stated that PNF has become an important element in reducing and preventing exercise injury through flexibility and the increase in blood flow. Moreover, PNF stretching heightens the accuracy of exercise and muscle activity, in addition to improving coordination. Therefore, for lymphedema patients, the improvement of the motor competency and ROM in the body parts that develop limited exercise performances may be urgently required.

Kaya et al., 2012 (16) used kinesio taping for the treatment of left upper extremity lymphedema after mastectomy. They reported three cases, which have used kinesiotaping for the treatment of left upper extremity lymphedema after mastectomy and found that kinesiotaping effectively decreases disability in the treatment of lymphedema by creating alternative drainage pathways.

Lipinska et al., 2007(19) concluded lymphatic applications of KT reduce lymph congestion in intercellular spaces and the reduction of lymphedema contributes to the mobility range improvement in all upper limb joints in patients with breast cancer related lymphedema. The study consisted of 25 women at the age of 40 to 70 years old (the average of their age 55,16 years) treated because of breast cancer with oedema lymphatic. Every woman taking part in the experiment was subjected to kinesiotaping therapy. . Assessment of the efficiency of an upper limb at women after mastectomy shows that a 20 - day cycle of improving with the use of lymphatic applications of the kinesiotaping method.

PNF based on the principle that an isometric contraction increases the firing rate of its own muscle spindles. They in turn send stimuli to Ia-inhibitory interneurons, presumably inhibiting alpha motor neurons of the antagonistic muscles. This leads to relaxation of the antagonistic muscles and/or a depression of the amplitude of the muscle stretch-reflex response. The Contract-relax antagonist contract (CRAC) technique is said to take advantage of this occurrence **(20)**.

All of the PNF stretching techniques incorporate alternating periods of contraction and relaxation of the agonist and antagonist muscles. The slow-reversal-hold-relax is an isometric contraction of the antagonist followed by a contraction of the agonist muscle. The process is typically repeated 3 times with each repetition beginning at a new joint angle .The contract-relax and hold-relax methods are variations of the slow-reversal-hold-relax. The contract- relax method involves isotonicly contracting the antagonist followed by a relaxation phase. Whereas, the hold-relax method involves isometrically contracting the antagonist followed by a relaxation phase**(21)**.

Applications of KT reduce lymph congestion in intercellular spaces and the reduction of lymphedema contributes to the mobility range improvement in all upper limb joints in patients with breast cancer related lymphedema. **(19)**.

Application of tape is widely used in rehabilitation and prevention of these shoulder complaints. The rationale for taping is that it affords protection and support for a joint during functional movement. Although it is unclear if tape protects the glenohumeral joint position, immediate symptoms improve with scapular taping and relief of symptoms is greater during functional movement than in static positions **(22)**.

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الملخص العربي

لقد قامت هذه الدراسة لتقييم تأثير التنبيه العضلي العصبي مقابل الشريط اللاصق المرن على الورك الليفي للذراع ما بعد استئصال الثدي.

وشملت الدراسة 30 مريضة، تعانين من ورم ليفي بالذراع بعد عملية استئصال الثدي للمشاركة في هذه الدراسة تتراوح أعمارهم ما بين 40-55 عاما من قسم جراحة الأورام بالمعهد القومي للأورام-جامعة القاهرة.

تم تقسيم هؤلاء المرضى عشوائيا إلى مجموعتين متساويتين في العدد كالاتي:

المجموعة الأولى:

تتكون هذه المجموعة من خمسة عشر مريضة يعانون من ورم ليفي بالذراع بعد عملية استئصال الثدي وقد تلقوا العلاج بالتنبيه العضلي العصبي بالإضافة إلى بروتوكول العلاج الطبيعي لعلاج الورك الليفي لمدة 3 أشهر (3 جلسات/ 30 دقيقة/ أسبوع) وقد تم تقييم الحالات قبل البدء في العلاج ثم في نهاية دورة العلاج.

المجموعة الثانية:

تتكون هذه المجموعة من خمسة عشر مريضة يعانون من ورم ليفي بالذراع بعد عملية استئصال الثدي وقد تلقوا العلاج بالشريط اللاصق المرن بالإضافة إلى بروتوكول العلاج الطبيعي لعلاج الورك الليفي لمدة 3 أشهر وقد تم تقييم الحالات قبل البدء في العلاج ثم في نهاية دورة العلاج.

نتائج الدراسة:

سجلت نتائج الدراسة الحالية تحسنا في حجم الورك الليفي للذراع وكذلك مستوي حركة مفصل الكتف في كلا المجموعتين ، ولكن وفقا للنتائج الإحصائية لهذه الدراسة، فقد أظهرت أن نسبة التحسن غير ذات أهمية في تقليل حجم الورك الليفي للذراع وكذلك مستوى حركة مفصل الكتف بين كلا المجموعتين.

الاستنتاج:

تقنية بالتنبيه العضلي العصبي بالإضافة إلى بروتوكول العلاج الطبيعي لعلاج الورك الليفي جاءت الخيار الأول بينما تقنية الشريط اللاصق المرن بالإضافة إلى بروتوكول العلاج الطبيعي لعلاج الورك الليفي في الخيار الثاني التي تؤثر على الورك الليفي للذراع ما بعد استئصال الثدي.

التوصيات:

تتطلب نتائج هذه الدراسة ضرورة الأخذ في الاعتبار بالتوصيات التالية:

1. ينبغي إجراء دراسات أخرى باستخدام عدد كبير من المرضى للحصول علي بيانات إحصائية أكبر في النتائج.
2. الأبحاث المماثلة يجب زيادة فترة العلاج أكثر من 3 أشهر.
3. الدراسات التالية يجب أن تتطلع لقياس القوة العضلية للكتف والكوع ومنطقة الرسغ.
4. الأبحاث التالية يجب أن تتطلع إلى مزيد من أساليب مختلفة للتقييم للوصول إلى مزيد من البيانات والاعتمادات.
5. يجب عمل دراسات لاكتشاف تأثير التنبيه العضلي العصبي و الشريط اللاصق المرن على مناطق مختلفة من الجسم تعاني من الورك الليفي.
6. ينبغي إجراء مزيد من الدراسات لمعرفة تأثير التنبيه العضلي العصبي و الشريط اللاصق المرن على درجات أخرى من الورك الليفي للذراع ما بعد استئصال الثدي.