STUDY REGARDING THE FUNCTIONAL LEVEL OF THE UPPER LIMB AFTER MASTECTOMY

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Abstract. *The complex treatment applied to breast cancer patients consists of mastectomy, chemotherapy and local radiation therapy and affects the functional level of the upper limb on the side of the mastectomy. Physical therapy plays an important role in increasing the functionality of the upper limb after treatment. The purpose of the study is to verify the effectiveness of an individualised therapeutic exercise programme aimed at increasing the range of motion of the upper limb. Five participants who had undergone mastectomy surgery 6 months earlier were included in the study and each received an individualised rehabilitation programme that was performed twice a week for 6 months. The patients were assessed using three functional tests: test 1 - bringing the hand to the back of the neck, test 2 - touching the scapula with the hand by performing flexion, adduction and internal rotation, and test 3 - touching the scapula with the hand by performing extension, adduction and external rotation. These tests are quantified on a scale of 0 to 4. Early application of an individualised kinetic programme improves the functional capacity of the upper limb on the side of the surgery and contributes to reintegration into daily and socio-professional activities. We consider it important to train patients through educational monthly sessions that address issues such as: maintaining body weight, allowed food and nutritional management for side effects during adjuvant treatment, prevention of chronic diseases.*

Keywords: *mastectomy, functionality of the upper limb, physical therapy.*

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Introduction

Post-mastectomy adjuvant treatment is designed to minimise the risk of cancer recurrence in the breast, chest, or lymph nodes. Although the administration of chemotherapy and local radiation therapies reduces mortality, they have negative effects on the human body.

Shapiro and Recht (2001) systematised these effects as follows:

- conditions that occur secondary to the application of local radiotherapy: cardiac toxicity, pneumonia, rib fractures, pain, lymphoedema, decreased mobility of the shoulder joint;
- systemic conditions that occur following the administration of chemotherapy: myelosuppression, peripheral neuropathy, premature menopause, infertility, weight

gain, cardiovascular disease, nausea and vomiting, anxiety, depression, insomnia, fatigue, fear of recurrence.

Surgery for mastectomy and axillary lymph node dissection generates pain and keloid scars that lead to a decrease in the range of possible movements of the scapulohumeral joint. According to Jung et al. (2003), the pain reported by patients after surgery is transient and occurs as a result of muscle and ligament injuries. Post-operative chemotherapy and radiation therapy may increase the intensity of pain. Chronic pain, which can be a disabling factor, is classified as neuropathic pain and phantom pain (experienced in the removed breast).

Karlsen et al. (2016) analysed how receiving a diagnosis of cancer affects patients' quality of life compared to a benign tumour. The study included 542 patients with breast cancer and 729 with benign breast disease. Quality of life was assessed based on a questionnaire. According to this study, a significant decrease in quality of life was observed for older patients with chronic conditions compared to patients with benign disease.

A study conducted in Denmark by Gartner et al. (2012) shows that multiple factors contribute to the persistence of post-mastectomy pain: nerve damage, sensory disturbances (hyperpathy, allodynia, burning sensation). After processing the collected data, it was noted that 47% of patients complained of pain in one or more body areas (breast, axilla, arm, torso).

Decreased mobility of the shoulder joint and therefore a decrease in the functionality of the upper limb is the most annoying complication of breast cancer treatment, with a major impact on patients' quality of life (Kaya et al., 2010).

Ewertz and Jensen (2011) state that the reduced mobility of the upper limb on the side of the mastectomy and implicitly its limited functionality are part of the long-term side effects of surgical and oncological treatments, pointing out that rehabilitation is "aimed at enabling patients to reach and maintain optimal physical, intellectual, psychological, social, and spiritual levels of functioning" (p. 187).

According to Harrington et al. (2013), upper limb disability following breast cancer treatment occurs as a result of a decrease in strength, endurance and range of motion of the joints making up the upper limb.

Early physical activity stops the side effects of the treatment and contributes to regaining the functionality of the upper limb (Soares Falcetta et al., 2018).

Decreased shoulder mobility is considered by Lauridsen et al. (2008) as a consequence of axillary lymph node dissection in association with local radiotherapy. The authors used the Constant Shoulder Score (CSS) questionnaire to assess the shoulder function "including both subjective parameters on pain and ability to perform the normal tasks of daily living, and objective parameters assessing active range of motion and muscle strength" (Lauridsen et al., 2008, p. 569), finding that the abduction movement was the most affected, given that the range of motion was reduced by 30 to 60 degrees. Patients who received local post-operative radiotherapy also experienced a more pronounced decrease in joint mobility compared to those who underwent mastectomy alone.

Springer et al. (2010) say that pre- and post-operative measurements including "body weight, shoulder ranges of motion (ROM), manual muscle tests, pain levels, upper limb volume, and an upper limb disability questionnaire" (p. 135) help to identify the remaining function after mastectomy. Providing pre-operative exercise and education regarding post-mastectomy indications and contraindications also facilitate functional rehabilitation.

Warburton et al. (2006) conducted a literature review and systematised a series of clinical studies according to the implications of exercise on the functional rehabilitation of breast cancer patients, highlighting the undeniable importance of physical activity. The exercises used in the individualised therapeutic protocol aim at muscle activation and patient reintegration into domestic and socio-professional activities.

Over time, studies have shown that cardiorespiratory fitness (Klassen et al., 2014) and muscle strength are significantly reduced after chemotherapy (Klassen et al., 2017). Schmidt et al. (2017) examined the effects of a kinetic programme consisting of cycling, Nordic walking and progressive resistance exercises performed during the administration of adjuvant treatment and observed that the recovery process of breast cancer patients was easier for those engaged in exercise compared to those who avoided exercising.

Moderate-intensity aerobic exercise performed twice a week during chemotherapy has much more beneficial effects on muscle strength, fatigue, and cardiovascular activity than low-intensity exercise (van Waart et al., 2015).

Sweeney et al. (2019) checked the effects of aerobic exercise applied three times a week to overweight or obese patients with breast cancer and found that, after a 16-week intervention programme, their shoulder function significantly improved.

A meta-analysis by Fong et al. (2012) also emphasises the effects of physical activity on breast cancer patients. The types of exercise used for them consisted of aerobic exercise, low-intensity exercise and resistive exercise. All studies have shown that physical activity has beneficial effects on quality of life, promotes weight loss in overweight patients and improves cardiovascular fitness and the upper limb function on the side of the surgery.

Exercises used in the kinetic programme aim to activate the muscle pump and improve mobility; portable objects can be used, such as sticks, small balls, weights of 0.5 kg and elastic bands. These exercises are based on flexion/extension, pronation/supination, abduction and circumduction performed on both sides with different ranges of motion (circumduction movements gradually go from low to high amplitude).

Ki-Yong et al. (2019) analysed the effects of aerobic exercise, resistance exercise and combined exercise applied post-mastectomy, concluding that "combined exercise during and after chemotherapy may be optimal for breast cancer patients" (p. 159).

McKenzie and Kalda (2003) highlighted the positive effect of exercise on the quality of life of breast cancer patients. Their study included 14 patients who followed an 8-week upper-body exercise programme consisting of active stretching exercises, active mobilisations with light weights, cycling and treadmill walking. All patients reported an improvement in physical functioning, overall health and vitality at the end of the programme.

Foldi and Strossenreuther (2003) point out that a decongestant effect can be obtained by keeping the upper limbs in an inclined position; low- and moderate-intensity aerobic exercise is recommended to be used. It is also important to include stretching exercises.

Decreased upper limb function is directly influenced by the presence of lymphoedema (Smoot et al., 2010). Patients with lymphoedema have higher body mass index, higher DASH (Disabilities of the Arm, Shoulder and Hand) scores, less range of motion in the shoulder, elbow and hand, lower muscle strength and decreased tactile sensitivity. The above authors believe that early detection of lymphoedema and remaining function is essential for the socio-professional reintegration of patients.

Hayes et al. (2008) analysed the incidence of lymphoedema secondary to mastectomy. Their study included 287 patients diagnosed with invasive breast cancer, who were assessed every 3 months, between 6 and 18 months after surgery. The main method used was bioimpedance spectroscopy associated with the self-administered DASH questionnaire investigating symptoms and how lymphoedema affected quality of life. According to this study, 33% of patients developed lymphoedema within 6 months after surgery. The authors believe that lymphoedema is a public health issue with important implications on the upper limb function, requiring more attention and systematic monitoring for early diagnosis.

According to a 5-year study conducted in Pennsylvania (Norman et al., 2009), lymphoedema secondary to mastectomy affects many patients. The authors classify the forms of lymphoedema as mild, moderate and severe. Their study included 631 randomly selected patients who were periodically assessed at an interval of 7 to 9 months. The assessment was performed by measuring the circumference of the arm and forearm and through a questionnaire on the quality of life. The results showed that 238 patients (42%) developed lymphoedema and, in 80% of cases, lymphoedema occurred within two years after diagnosis.

A study by Sagen et al. (2009) verifies the influence of physical activity on the occurrence of arm lymphoedema after mastectomy and axillary lymph node dissection. The study included 204 women aged between 45 and 55 years, who were divided into two groups: a group with no physical activity restrictions and a group with physical activity restrictions. The assessment consisted in measuring the difference in arm volume between the affected and healthy upper limb using the Simplified Water Displacement Instrument (SWDI). For pain assessment, the Visual Analogue Scale (VAS) was used. Patients assigned to the group with no physical activity restrictions followed a supervised kinetic programme two-three times a week in an outpatient treatment clinic. The kinetic programme consisted of resistive exercises performed with weights of 0.5 to 2 kg and aimed at increasing muscle tone. Each patient in the group with activity restrictions received detailed information on the restricted activities. Patients were advised to avoid aerobic exercise and strenuous or difficult physical activities, but also to avoid carrying or lifting objects weighing more than 3 kg. Following this study, it was found that as the lymphoedema decreased, the functional level improved.

Hydrokinetic therapy refers to performing exercises or movements with the body in immersion and benefiting from the complex action of thermal, mechanical and chemical factors, which is why it has an important role in medical rehabilitation after mastectomy. Immersion can be partial or total and can be done in tubs or pools. In breast cancer patients, mechanical factors are the most important water factors that act on the body. The ascending force is based on Archimedes' principle and generates an apparent decrease in body weight, given that the buoyant force of a submerged object is equal to the weight of the fluid displaced (Mooventhan & Nivethitha, 2014).

Thus, the biomechanics of movement is facilitated, and exercises and mobilisations can be performed even with patients who are not able to train on land or have contraindications in this regard. Water resistance accompanies every movement and allows performing resistive exercises in all directions. Hydrostatic pressure really massages the body segments, which contributes to preventing or reducing lymphoedema. Specialists from the Foldi European Lymphology Center use hydrokinetic therapy as a component of kinetic treatment and recommend a water temperature between 22 and 30°C (Foldi & Strossenreuther, 2003).

Hydrokinetic therapy has immediate beneficial effects on lymphoedema, but all specific and non-specific kinetic means need to be used in the long run (Tidhar & Katz-Leurer, 2009).

Purpose. The research aims to verify the effectiveness of applying an individualised kinetic programme to improve the functionality of the upper limb on the side of the surgery.

Tasks:

- Application of the functional tests proposed by Magee (2014) before and after the rehabilitation programme;
- Development of an individualised kinetic protocol.

Hypothesis: The application of an individualised kinetic programme increases the functional level of the scapulohumeral joint on the side of the surgery.

Methodology

Research methods

The observation method used in the form of participatory observation allowed us to evaluate patient involvement in performing the recommended kinetic programme. Through this method, we were able to analyse data regarding the patients' functional characteristics, the degree of mobility of the scapulohumeral joint and the stage of lymphoedema.

The anamnestic interview is a flexible tool with which we identified information about the history of the patient's current condition and previous treatment. The quantitative interview used in the preliminary research was structured and applied in the same way to all individuals through the question-response technique (Predoiu, 2020). The questions used were open-ended, giving respondents the opportunity to freely express their ideas. This approach helped us observe the echo that the cancer had on the patients' mental level.

The case study method was used to perform a preliminary research on a group of five patients with radical mastectomy and axillary lymph node dissection.

The mathematical statistics method was used to process and interpret the obtained results. All results were recorded in tables and statistically processed through the synthetic indicators of statistical distributions (mean, median, standard deviation, minimum value, maximum value, range, coefficient of variation) and the Wilcoxon test.

Participants

The research included five participants who were selected based on criteria found in the literature.

Inclusion criteria: type of surgery: radical mastectomy and axillary lymph node dissection; 6 months after surgery; age: 45-67 years. Exclusion criteria: the presence of metastases; no previous surgery for breast cancer; double mastectomy. We considered it useful to include in the research only patients who had undergone mastectomy surgery 6 months earlier. Their ages ranged from 45 to 67 years, with the average being 60 years.

The five patients were from urban areas. Regarding their marital status, three patients (60%) were married and two (40%) were divorced. All participants received chemotherapy.

Only three patients (60%) underwent radiotherapy, and one patient (20%) underwent reconstruction by breast augmentation at the same time with mastectomy.

Procedure

The research was conducted between May and December 2021. For the global functional assessment of the scapulohumeral joint adapted to breast cancer patients, the three tests proposed by Magee (2014) were used to identify the remaining function in the scapulohumeral joint. These tests are quantified on a scale of 0 to 4; during the assessment, the patient is seated on a chair without a backrest. The test description is as follows:

✓ ***Test 1*** - bringing the hand to the back of the neck, where:

0 - fingers touch the back of the neck with full abduction and external rotation;

1 - fingers touch the back of the neck but the shoulder is not in full abduction;

2 - fingers touch the back of the neck; the affected limb compensates for the movement through adduction;

3 - fingers do not touch the back of the neck;

4 - fingers do not exceed shoulder level.

✓ ***Test 2*** - touching the scapula with the hand by performing flexion, adduction and internal rotation, where:

0 - the hand touches the spine of the opposite scapula through adduction and internal rotation of the scapulohumeral joint;

1 - the hand touches the spine of the opposite scapula through adduction, without internal rotation;

2 - the hand exceeds the middle line of the torso;

3 - the hand does not exceed the middle line of the torso;

4 - the affected limb cannot be mobilised away from the body.

✓ ***Test 3*** - touching the scapula with the hand by performing extension, adduction and external rotation, where:

0 - the hand touches the opposite scapula;

1 - the hand touches the torso 6-15 cm below the opposite scapula;

2 - the hand touches the opposite iliac crest;

3 - the hand touches the buttocks on the same side;

4 - the affected limb cannot be mobilised away from the body.

Kinetic programme

The novelty elements of the proposed programme consist in the association of kinetic means. Before starting the exercises, manual lymph drainage was performed and a multilayer compression bandage was applied.

The kinetic means used in the functional rehabilitation of patients are classified into specific means (exercise and massage) and non-specific means (multilayer compression bandage).

The exercise programme focused on regaining a joint and muscle status able to ensure functional independence of the upper limb.

Each patient performed a rehabilitation programme based on the objectives of the therapeutic approach. To comply with the principle of progression, the number of repetitions varied between 6 and 10 for each exercise. This complex exercise programme was carried out twice a week and consisted of:

- exercises aimed at increasing the range of possible movements in the scapulohumeral joint in specific axes and planes of motion, which were performed freely and with portable objects;
- stimulating the lymphatic system (given that the upper limb muscles act as a pump on the lymphatic capillaries), which were performed after applying multilayer compression bandages.

Results

The individual results obtained from the initial assessment (IA) and final assessment (FA) were recorded in the evaluation sheet of each patient, and the data are shown in Table 1.

Table 1. *Functional test results*

Initials	Test 1		Test 2		Test 3		Total	
	IA	FA	IA	FA	IA	FA	IA	FA
D.I.	1	0	1	0	2	0	4	0
P.N.	1	0	0	0	1	0	2	0
C.M.	1	0	2	1	2	1	5	2
I.D.	3	1	2	0	3	1	8	2
F.M.	1	0	1	0	2	1	4	1

- Test 1 - bringing the hand to the back of the neck

The average score of obtained by patients decreased by 1.2, from 1.4 in the initial assessment to 0.2 in the final assessment. Mean values show progress for the entire group, from “fingers touch the back of the neck but the shoulder is not in full abduction” to “fingers touch the back of the neck with full abduction and external rotation”. The minimum value decreased from 1 to 0, and the maximum value decreased from 3 to 1. The measured values are unevenly dispersed in both assessments. (Table 2)

Table 2. *Results – Test 1*

Assessment	Average	Mean Difference	Median	Standard Deviation	Min	Max	Range	Coefficient of Variation
Initial	1.4	-1.2	1.0	0.89	1	3	2	63.9%
Final	0.2		0.0	0.45	0	1	1	223.6%

- Test 2 - touching the scapula with the hand by performing flexion, adduction and internal rotation

The average score obtained by patients decreased by 1.0, from 1.2 in the initial assessment to 0.2 in the final assessment. Mean values indicate progress for the entire group, from “the hand touches the spine of the opposite scapula with the shoulder in full adduction, without

internal rotation" to "the hand touches the spine of the opposite scapula with the shoulder in adduction and full internal rotation". The minimum value did not change, but the maximum value decreased from 2 to 1. The measured values are unevenly dispersed in both assessments. (Table 3)

Table 3. *Results – Test 2*

Assessment	Average	Mean Difference	Median	Standard Deviation	Min	Max	Range	Coefficient of Variation
Initial	1.2	-1.0	1.0	0.84	0	2	2	69.7%
Final	0.2		0.0	0.45	0	1	1	223.6%

- Test 3 - touching the scapula with the hand by performing extension, adduction and external rotation

The average score obtained by patients decreased by 1.4, from 2.0 in the initial assessment to 0.6 in the final assessment. Mean values highlight progress for the entire group, from "the hand touches the opposite iliac crest" to "the hand touches the torso 6-15 cm below the opposite scapula". The minimum value decreased from 1 to 0, and the maximum value decreased from 3 to 1. The measured values are unevenly dispersed in both assessments. (Table 4)

Table 4. *Results – Test 3*

Assessment	Average	Mean Difference	Median	Standard Deviation	Min	Max	Range	Coefficient of Variation
Initial	2.0	-1.4	2.0	0.71	1	3	2	35.4%
Final	0.6		1.0	0.55	0	1	1	91.3%

Each patient performed three tests, and the Wilcoxon test scores were calculated for the entire sample (all values recorded in the initial and final tests) to analyse the progress at group level. The Z value is -3.4078, and the p value is 0.00064. The critical value for W at $N = 15$ ($p < 0.05$) is 25. The result is significant at $p < 0.05$. The data are shown in Table 5.

Table 5. *Wilcoxon test (for all recorded values)*

Mean difference	Z value	Standard deviation (W)	p value	Effect size (r)
1.6	-3.4078	17.61	0.00064	0.87

Discussion and Conclusion

Early application of an individualised kinetic programme improves the functional capacity of the upper limb on the side of the surgery and contributes to reintegration into daily and socio-professional activities. This is highlighted by Kirkham et al. (2018) in a study conducted at the Vancouver Cancer Treatment Center. The authors analyse the effectiveness of an exercise programme applied to early breast cancer patients as part of their adjuvant treatment. The 154 participants performed a programme consisting of moderate-intensity

aerobic exercise and whole-body resistance training two to three times a week during adjuvant treatment. After completion of chemotherapy and radiotherapy treatments, the rehabilitation protocol can be performed twice a week.

In the current study, a significant improvement was obtained (at group level) in terms of functionality of the upper limb on the side of the surgery after applying the individualised kinetic programme. We consider it important to train patients through monthly educational sessions addressing issues such as: maintaining body weight, allowed food and nutritional management for side effects during adjuvant treatment, prevention of chronic diseases. Moreover, according to Harrington et al. (2014), patient assessment can be supplemented by the application of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, which helps to establish the disability coefficient of the upper limb on the side of the surgery.

At the same time, the assessment of muscle strength, lymphoedema and shoulder range of motion contributes to both establishing of a complete functional diagnosis and designing a complex therapeutic protocol with synergistic effects on regaining upper limb mobility, strength and function but also on the lymphoedema.

Surgical treatment together with adjuvant treatment used for cancer patients leads to decreased mobility of the joints that make up the upper limb, which negatively influences the functional level of the upper limb on the side of the surgery.

Study limitations and future research directions

The poor collaboration between family doctors, oncologists, medical rehabilitation doctors, physiotherapists and psychologists in Romania leads to late oncological diagnosis, in advanced stages of the disease, which requires disabling surgical interventions with severe functional implications. The oncologists' lack of confidence in the effectiveness of kinetic therapy for this category of patients makes them not recommend the application of a medical rehabilitation programme.

The small number of participants is another limitation of this study.

Further studies are needed to verify the effects of kinetic programmes on breast cancer-related lymphoedema, muscle strength and quality of life.

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Informed Consent Statement: The patients/participants provided their written informed consent to participate in this study.

Data Availability Statement: Data are available upon request to the contact author.

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