

## **Impact of exercise and physical activity in women who have undergone breast cancer surgery**

**Antonia Dalla Pria Bankoff<sup>1</sup>, Carlos Aparecido Zamai<sup>2</sup>, Osmar Jesus Macedo<sup>1</sup>, Ieda Maria G. Pacce Bispo<sup>1</sup> and Maicon Douglas Rodrigues<sup>1</sup>**

### **Abstract**

Sixty-two women with mean age of 54.8 years have been part of this study; of them, twenty-nine have undergone unilateral quadrantectomy surgery and thirty-three unilateral radical mastectomy surgery. The mean surgery time was six years and seven months. The study was carried out with women who underwent these types of surgeries over a period over six months and who went to all physiotherapy sessions after surgery recommended by a physician and by the Brazilian Health System (SUS), being it twelve sessions. The joint range of motion was measured by means of a FisioStore goniometer. The movements studied were: flexion and hyperextension of the arm, abduction and adduction of the arm, horizontal extension and flexion of the arm, internal and external rotation of the arm and lifting and lowering of the shoulder. The exercise program was formulated with exercises for proprioception, muscle strengthening, stretching and games. Results: There was gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the left and right surgical sides. For statistical analysis, paired student's t-test was used. Statistical results of the means before and after the provision of a physical exercise program for the range of motion of the shoulder and acromioclavicular joints were significant for all joint movements for the surgical side.

**Keywords:** Physical exercise. Mastectomy. Quadrantectomy. Goniometry.

---

<sup>1</sup> Federal University of Mato Grosso do Sul- Campus of Três Lagoas- Brazil

<sup>2</sup> University of Campinas-Faculty of Physically Education –Brazil

## **1 Introduction**

Physical education classes in school can have great importance in the adult life of women. Several studies present in the current medical literature suggest that exercise during childhood can lower the chances of developing breast cancer in adult women. The fact is caused by the delay of the menarche, the first period of a woman, through exercises: "physical activity reduces estrogen levels and this seems to be the mechanism of action. In the case of children, it slows the onset of the first menstruation and therefore reduces the period of life in which the woman is exposed to hormones." This decreased contact with hormones over the life of a woman would be essential to prevent cancer. "When we talk about the delay of the menarche with physical exercises, we are talking about a natural and physiological intervention. There is no sense or benefit in making it with the use of drugs to prevent cancer"[1].

Regular physical activity is known to be beneficial in the prevention and treatment of various diseases, such as hypertension, diabetes, heart disease, hypercholesterolemia, depression and others. This practice has also been described as beneficial in the prevention of some types of cancer and also to ease the side effects of treatment. A research conducted by the Brazilian Cancer Institute (INCA) in partnership with the World Cancer Research Fund (WCRF) concluded that the prevention of obesity through exercise and healthy eating can prevent 19% of cancer cases[2,3]. A recent review of the literature data showed that regular physical activity has positive effects on the mental and physical health, and it improves the quality of life of cancer patients after the end of treatment. Therefore, in the context of the treatment of cancer, the practice of regular physical activity has a fundamental importance for the well-being of the patient [4].

Most epidemiological studies have focused on breast cancer. The biggest one is an American study that monitored 41,836 menopausal women, for eighteen years (Iowa Women's study). Women who have regular physical activity, such as jogging and swimming or who played sports with rackets, two to three times a week, had 14% lower chances of developing breast cancer. The mechanism of this relationship is based on the fact that excess fat cells increase the production of factors that cause inflammation and contribute to the development of cancer cells [5].

As a result of the treatment of breast cancer, several complications have been reported, among them, those resulting from surgery. Among the surgical techniques, mastectomies or conservative surgeries can be performed, which may be associated with axillary lymphadenectomy (LA) or sentinel lymph node biopsy [6]. Among the surgical complications of LA, there is the long thoracic nerve injury[7]. Most injuries of this nerve are partial and transient (neuropraxia), which gradually recover with conservative treatment [6]. However, when this regression

does not occur in the first six months, the lesion can be considered complete, with few chances of rehabilitation[8].

In order to minimize the negative impact caused by cancer and its treatment on the quality of life of women, physiotherapy must be implemented in order to encourage the return to activities of daily living (ADLs) and better quality of life, being necessary at all stages of treatment of breast cancer. Pre-treatment (diagnosis and assessment), during treatment (chemotherapy, radiotherapy, surgery and hormone therapy), after treatment (follow-up) and in palliative care. It is important to know and identify the demands of the patient, the symptoms and their causes and their impact on the ADLs, in each of these steps. Physiotherapeutic conduct must be then planned through domiciliary guidelines and specific treatments [9].

After mastectomy and removal of adjacent lymph nodes, the patient may present some complications such as: pain, upper-limb lymphedema and adhesions in the chest wall, which can result in increased risk of postoperative pulmonary complications, decreased range of motion (ROM) of the shoulder of the side involved and postural deformity of the torso [10].

With thoracic nerve damage, and the total and/or partial removal of the chest muscles, the kinesiology and biomechanics of the muscles and joints of the upper limb of the surgical side are affected, decreasing the angle of movement and making it difficult to carry out simple day-to-day tasks. The non-surgical side overloads the joint and the muscles causing deviation of the spine, pelvic tilt, changes in the lower limbs, changes in posture and changes in balance [11,12,13].

[14] has studied, by electromyography, the muscles that participate in the movement of the shoulder joint and scapula in women who have undergone breast cancer surgeries. He has reported that the serratus anterior muscle transmitted electromyographic signals considered as weak when the movements were analyzed, thus signaling possible injury because of surgeries.

[11] has studied, by simple goniometry, the range of motions of the shoulder joint in women who have undergone mastectomies and quadrantectomies and has found the following results: there was no significant difference in the range of motions of the joint between the types of surgery (mastectomy and quadrantectomy). In the surgical side, the difference of the range of motions was always greater than 20° when compared with the non-surgical side. In the case of arm flexion, the difference was 40° less for the surgical side.

Physical exercises, proprioception exercises and physical activities, significantly contribute to increase the angle of movements and to improve posture, body balance and also the quality of life of women [11].

The literature reports several physical difficulties related to breast cancer therapy, including changes in the functionality of the upper limb of the women, which directly interfere in the quality of life after surgery. Although we did not find the same findings for the change of mobility and sensitivity of the limb in our study, the prevalence of the inability to perform activities that require great efforts with the arm may reflect the fact that the patients had physiotherapy monitoring since the diagnosis [15,16,17].

[18] Have studied the functionality of the upper limb in women who have undergone breast cancer treatment and concluded that the patients had a satisfactory degree regarding the functional capacity and performed their ADLs without difficulty. They report that this result can occur because of early physiotherapy in the treatment of these patients, thus proving the real need of physical therapy and the importance of the practice of physical exercises.

## **2 Material and Method**

We have studied by goniometry the range of motions of the shoulder and acromioclavicular joints in order to verify the differences between the surgical side after applying a physical exercise program lasting six months, twice a week, of 50 minutes each class.

### **2.1 Population**

Sixty-two women with mean age of 54.8 years were part of this study; of them, twenty-nine have undergone unilateral quadrantectomy surgery and thirty-three unilateral radical mastectomy surgery. The mean surgery time was six years and seven months. The study was carried out with women who underwent these types of surgeries over a period over six months and who went to all physiotherapy sessions after surgery recommended by a physician and by the Brazilian Health System (SUS), being it twelve sessions.

### **2.2 Method**

#### **Instruments, Procedures and Data Acquisition**

The joint range of motion was measured by means of a FisioStore goniometer. The assessment was carried out weekly where they were treated. All subjects of the research wore a bra in the upper part of the body, thus avoiding interference in joint measurement during the movement.

The study was developed by the University of Campinas (UNICAMP) in partnership with the Federal University of Mato Grosso do Sul - Três Lagoas Campus. For each procedure, before starting data acquisition, we asked the subjects to perform the sequential activities of shoulder joint movements three times, in this way avoiding some type of error during the execution. All

participants were assessed before and after the physical exercise program.

All subjects of the research signed an informed consent to participate in the research. The project was approved by the Ethics Committee of UNICAMP according to opinion No. 984/2010. The movements studied were: flexion and hyperextension of the arm, abduction and adduction of the arm, horizontal extension and flexion of the arm, internal and external rotation of the arm and lifting and lowering of the shoulder.

### **3 Physical Exercise Program**

The physical exercise program was prepared exclusively for the research group.

#### **Proprioception exercises**

Proprioception is the perception of the position of the body in space, also known as synesthesia. This perception is only possible thanks to neural sensors (pressorreceptores) and the nervous system that receive information and quickly send a response. It is important to improve the self-esteem of the participant, so she can have a better relationship with herself. We prioritized the proprioception exercises, by touch and with couples.

#### **Muscle strengthening exercises**

The focus of the muscle strengthening was the body balance exercises, respecting the limit of each subject. We also added weight exercises. For example: 500 ml water bottles with sand and then 1.5 ml PET bottles with sand were used for exercises of the upper and lower limbs (in the case of lower limbs, they had handles).

#### **Stretching exercises**

The stretching exercises followed the sequence starting from the head and neck, upper limbs, torso and lower limbs in the standing and supine positions.

#### **Final**

In the last part of the class, a game was offered which they developed themselves or there was free conversation.

### **4 Results**

Each survey participant offered two individual measures for each variable analyzed in the survey, one before having participated in the exercise program and another after physical training. This case has generated two dependent samples and for this reason we applied the Student t test in paired statistical analysis.

Table 1 - Data regarding the overall means, degree of freedom and difference of averages of the first and second assessment of the women who have undergone breast cancer surgeries before and after a physical exercise program (surgical right side).

	Variables								LiftSca	LowSca
	Flex.	Hyp	Adduc.	Abduc.	HFlex	HEx.	IntRot	ExtRot		
OA1	87.55	33.5	57.45	69.2	12.95	11.45	32.25	35.2	2.28	2.31
OA2	102.25	45.3	70.8	85.8	24.4	23.25	44.4	45.9	2.94	2.96
SD1	12.35	7.37	15.01	14.63	3.96	3.47	8.51	8.08	0.76	0.72
SD2	9.10	6.12	10.76	13.46	5.43	4.66	6.99	4.96	0.72	0.69
Difference of Average	14.7	11.8	13.35	16.6	11.45	11.8	12.15	10.7	0.66cm	0.65 cm

OA1-Overall Average 1, OA2-Overall Average 2, Standard Deviation 1, Standard Deviation 2, Flexion, Hyperextension, Adduction, Abduction, Horizontal flexion, Horizontal extension, Internal rotation, External rotation, Lift scapula, Low scapula.

Are shown in Table 1 the results of the assessments before and after the exercise program: first assessment and second assessment on the range of motion. We can observe that there was a gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the right surgical side. The greatest gains in range were for the movements of abduction: 16.6 degrees; flexion, 14.7 degrees; and adduction, 13.3 degrees.

Table 2 - Data regarding the overall means, degree of freedom and difference of averages of the first and second assessment of the women who have undergone breast cancer surgeries before and after a physical exercise program (surgical left side).

	Variables								LiftSca	LowSca
	Flex.	Hyp	Adduc	Abduc	HFlex	HExt	IntRot	ExtRot		
OA1	88.33	38.19	57.47	69.80	19.04	21.71	34.38	51.14	2.10	2.11
OA2	111.66	49.95	72.71	85.95	32	36.23	51.14	54.38	3.07	2.74
SD1	12.51	3.66	12.03	12.61	8.91	9.38	5.15	4.69	0.46	0.4
SD2	11.64	5.76	11.20	11.22	12.91	15.61	4.69	3.55	0.61	0.48
Difference of Average	23.33	11.76	15.24	16.14	12.96	14.52	16.76	3.24	0.97 cm	0.64 m

OA1-Overall Average 1, OA2-Overall Average 2, Standard Deviation 1, Standard Deviation 2, Flexion, Hyperextension, Adduction, Abduction, Horizontal flexion, Horizontal extension, Internal rotation, External rotation, Lift scapula, Low scapula.

Table 2 shows the results of the assessments before and after the physical exercise program: first assessment and second assessment on the range of motion. We can observe that there was a gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the left surgical side. The greatest gains in range were for the movements of flexion: 23.3 degrees; abduction, 16.1 degrees; and internal rotation, 16.7 degrees. If we compare the differences in degrees of the range of motion between the right and left surgical sides, the gain was greater for the left side.

Table 3: Statistics of data regarding the range of motion of the shoulder and acromioclavicular joints of the women who have undergone breast cancer surgeries before and after a physical exercise program (surgical right side). Student's t-test for the variables Paired.

Variable	t value	Degrees of Freedom	Difference between means	Confidence interval for the difference of means (before – after) - 95%		P value	Significance
				Lower Limit	Upper Limit		
Flexion	-7.2687	19	-14.7	-18.93288	-10.46712	6.752e-07	YES
Hyperext	-11.484	19	-11.8	-13.950616	-9.649384	5.423e-10	YES
Adduction	-8.8919	19	-13.35	-16.49238	-10.20762	3.369e-08	YES
Abduction	-9.7709	19	-16.6	-20.15587	-13.04413	7.634e-09	YES
H.FLex	-14.439	19	-11.45	-13.109724	-9.790276	1.074e-11	YES
	2						
H.Ext	-11.689	19	-11.8	-13.91276	-9.68724	4.027e-10	YES
	8						
Int.Rot	-11.258	19	-12.15	-14.408726	-9.891274	7.547e-10	YES
	7						
Ext.Rot	-9.7871	19	-10.7	-12.988263	-8.411737	7.436e-09	YES
Lift.Scap	-5.6377	19	-0.66	-0.9050292	-0.4149708	1.953e-05	YES
Low.Scap	-6.253	19	-0.655	-0.8742423	-0.4357577	5.269e-06	YES

Variables: Flexion, Hyperextension, Adduction, Abduction, Horizontal flexion, Horizontal extension, Internal rotation, External rotation, Lift scapula, Low scapula.

Table 3 shows the statistical results of the difference of means obtained before and after the provision of a physical exercise program for the range of motion of the shoulder and acromioclavicular joints of the Paired Student's t-test. We can see that the results were significant for all joint movements of the right surgical side.

Table 4 - Statistics of data regarding the range of motion of the shoulder and acromioclavicular joints of the women who have undergone breast cancer surgeries before and after a physical exercise program (surgical left side). Student's t-test for the variables Paired.

Variable	t value	Degrees of Freedom	Difference between means	Confidence interval for the difference of means (before – after) - 95%		P value	Significance
				Lower Limit	Upper Limit		
Flexion	-10.2402	20	-23.33333	-28.08643	-18.58024	2.12e-09	YES
Hyperext	-11.7927	20	-11.7619	-13.842422	-9.681388	1.849e-10	YES
Adduction	-6.6045	20	-15.2381	-20.05091	-10.42528	1.967e-06	YES
Abduction	-8.6863	20	-16.14286	-20.01946	-12.26625	3.195e-08	YES
H.Flex	-8.9332	20	-12.95238	-15.976861	-9.927901	2.035e-08	YES
H.Ext	-7.9515	20	-14.52381	-18.33392	-10.71370	1.28e-07	YES
Int.Rot	-12.0863	20	-16.7619	-19.65483	-13.86898	1.198e-10	YES
Ext.Rot.	-7.5568	20	-15.2381	-19.44441	-11.03178	2.78e-07	YES
Lif.Scap	-8.1196	20	-0.7761905	-0.9755973	-0.5767837	9.261e-08	YES
Low.Scap	-6.0043	20	-0.6285714	-0.8469428	-0.4102000	7.175e-06	YES

Flexion, Hyperextension, Adduction, Abduction, Horizontal flexion, Horizontal extension, Internal rotation, External rotation, Lift scapula, Low scapula.

Assessment of the results in Tables 1, 2, 3 and 4

Table 1 shows the results of the assessments before and after the physical exercise program: first assessment and second assessment on the range of motion. We can observe that there was a gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the right surgical side. The greatest gains in range were for the movements of abduction: 16.6 degrees; flexion, 14.7 degrees; and adduction, 13.3 degrees.

Table 2 shows the results of the assessments before and after the physical exercise program: first assessment and second assessment on the range of motion. We can

observe that there was a gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the left surgical side. The greatest gains in range were for the movements of flexion: 23.3 degrees; abduction, 16.1 degrees; and internal rotation, 16.7 degrees. If we compare the differences in degrees of the range of motion between the right and left surgical sides, the gain was greater for the left side.

Table 3 shows the statistical results of the means before and after the provision of a physical exercise program for the range of motion of the shoulder and acromioclavicular joints of the Paired Student's t-test. We can see that the results were significant for all joint movements of the right surgical side.

Table 4 shows the statistical results of the difference of means obtained before and after the provision of a physical exercise program for the range of motion of the shoulder and acromioclavicular joints of the Paired Student's t-test. We can see that the results were significant for all joint movements of the left surgical side. Considering the significance levels for all joint movements of the right and left surgical sides and the degrees achieved in the range of motions, we can affirm that this physical exercise program applied to this population was highly effective, thus contributing to a better quality of life for these women who have undergone breast cancer surgery. These movements are important in daily tasks, for example: combing the hair, getting dressed, showering, taking a glass of water, eating, cooking, cleaning the house, washing clothes, among other activities. This gain in the range resulted in a great gain in the quality of life and independence of the women.

## **5 Discussion**

It is well known that physical exercise is beneficial for humans. When it comes to the locomotor system, it is essential and beneficial the practice of exercises and physical activities for the gain of bone and muscle mass, as well as, for joints in the increase of the joint range of motion. Several women who have undergone surgeries because of breast cancer may have complications, among them reduced joint mobility specifically in the surgical side, and one of the reasons is the injury to the long thoracic nerve [11,13,6]. Most injuries of this nerve are partial and transient (neuropraxia), which gradually recover with conservative treatment [6]. However, when this regression does not occur in the first six months, the lesion can be considered complete, with few chances of rehabilitation [8].

These surgeries are so aggressive that our participants still had reduced joint mobility after six years and seven months of undergoing the surgeries (Tables 1 and 2). At the beginning of the physical exercise program, the difficulties were enormous and one of the factors was the fear of moving the muscles. We believe

that the proprioception exercises have contributed much for the loss of the fear in the practice of the exercises. The difficulties were not only in the surgical side but in both sides. All subjects declared to have a sedentary lifestyle. As [8] states, if the long thoracic nerve does not recover in the first six months, the injury can be considered complete, with few chances of rehabilitation. It seems that the applied physical exercises contributed to the rehabilitation process and the women have had significant gains in their range of motion. The movements that drew attention were the lifting and lowering of the scapula. When performing these movements, they lifted and lowered their entire body. The impression they left was that the scapula was glued to the body. Gradually, they relaxed their scapula and were able to increase almost 1 cm in the movement.

In the first assessment, we were impressed with the low levels of the joint range of motion. Several times, we had to modify the planning of the physical exercises so that they could do them without being afraid. We realized that after six weeks they were more relaxed. In our opinion, the longer they go without exercising, the greater the difficulty. The articular cartilage is an aneural and avascular connective tissue, and consequently of slow remodeling, and the chondrocytes, located in lacunae in the extracellular matrix, are the only cells present in the articular cartilage, and when there is little movement we have a rigid link in the joint tissue biomechanics[19].

Another interesting factor was in relation to the serratus anterior and intercostal muscles in the women who have undergone breast cancer surgery, as they hold the breath, making it shorter. [11], in a goniometric assessment of women who have undergone breast cancer surgery, have found significant differences in the range of motion of the shoulder and acromioclavicular joints between the surgical and non-surgical sides and found no difference in the range of motion between the types of surgery (mastectomy and quadrantectomy).

Range of motion (ROM) is the full possible movement of a segment, being maintained by periodic movement of this limb [20,19]. Some factors may lead to decreased ROM. Among them, we point out surgical aggressions and inactivity or immobilization of the limb. In case of radical mastectomy, the pectoralis major and minor are removed, resulting in a decrease in strength and function of the upper limb involved. This also occurs when the nerve of Bell is temporarily traumatized during axillary dissection, resulting in weakness of the serratus anterior muscle, destabilizing the scapula and shoulder abduction of the affected side [21, 22]. The re-education of the shoulder girdle of the upper limb is a basic need in the patient operated for breast cancer, regardless of the surgical technique employed. Its main goal is to restore as quickly as possible the function of the limb [23, 11, 12].

[24] Have studied by computed photogrammetry the shoulder range of motion of twenty-nine women, aged between 33 and 80 years, who underwent mastectomy

with six months or more of surgery. According to the results, significant differences were found in the flexion movements of the shoulder on the same as the mastectomy when compared with the contralateral side. There was a significant decrease in the flexion movement of the shoulder on the same side as the mastectomy.

The gain in the joint range of motion was significant when analyzed statistically by the paired student's t-test, as we can see in Tables 3 and 4 for all the movements studied. Some movements increased their ranges more than others; however, the goal was achieved because the women became more independent, improved their quality of life, no longer had a sedentary lifestyle and learned that the practice of physical exercises is important for their health and quality of life.

## 6 Conclusion

From the results, we can draw the following conclusions:

There was gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the right surgical side.

The greatest gains in range were for the movements of abduction: 16.6 degrees; flexion, 14.7 degrees; and adduction, 13.3 degrees.

There was gain in the joint range of motion in all the movements of the shoulder and acromioclavicular joints of the left surgical side.

The greatest gains in range were for the movements of flexion: 23.3 degrees; abduction, 16.1 degrees; and internal rotation, 16.7 degrees.

If we compare the differences in degrees of the range of motion between the right and left surgical sides, the gain was greater for the left side.

The results were significant for all joint movements of the right surgical side.

The results were significant for all joint movements of the left surgical side.

Considering the significance levels for all joint movements of the right and left surgical sides and the degrees achieved in the range of motion, we can affirm that this physical exercise program applied to this population was highly effective, thus contributing to a better quality of life for these women who have undergone breast cancer surgery.

## References

- [1] Linhares, JC. Exercícios físicos podem prevenir câncer de mama <http://www.unimedse.com.br/vivamais/conteudo.ler.php?cid=1798>. Acesso em 21 de outubro de 2015.
- [2] Thompson R. et al. Preventing cancer: the role of food, nutrition and physical activity. *J Fam Health Care* 2010; 20 (3):100-2.
- [3] Ferrigno R. Atividade Física e Câncer.

- <http://www.cancerinfo.com.br/artigo/atividade-fisica-e-cancer.html>. Acesso em 21 de outubro de 2015.
- [4] Fong DYT et al. Physical activity for cancer survivors: meta-analysis of randomised controlled trials. *BMJ* 2012; 344:70-4.
- [5] Bardia A. et al. Recreational physical activity and risk of postmenopausal breast cancer based on hormone receptor status. *Arch Intern Med* 2006; 166 (22):2478-83.
- [6] Langer I, Guller U, Berclaz G, Koechli OR, Schaer G, Fehr MK, et al. Morbidity of sentinel lymph node biopsy (SLN) alone versus SLN and completion axillary lymph node dissection after breast cancer surgery: a prospective Swiss multicenter study on 659 patients. *Ann Surg*. 2007;245(3):452-61.
- [7] Freitas JR, Ribeiro LFJ, Taia L, Kajita D, Fernandes MV, Quiroz GS. Linfodema em pacientes submetidas à mastectomia radical modificada. *Rev Bras Ginecol Obstet* 2001;23(4):205-8.
- [8] Campbell,W. Evaluation and management of peripheral nerve injury. *Clin Neurophysiol*. 2008;119(9):1951-65.
- [9] Bergmann A, Ribeiro MJP, Pedrosa E, Nogueira EA, Oliveira ACG. Fisioterapia e mastologia oncológica rotinas do Hospital do Câncer III/INCA. *Rev bras cancerol*. 2006; 52(1):97-109.
- [10] Kisner RW. *Ginecologia, princípios e prática*. 4a ed. SãoPaulo: Manole; 1989.
- [11] BANKOFF, ADP. Kinesiologic Study of Shoulder Joints and Acromioclavicular Joint in Women Undergoing Unilateral Breast Surgery of the Type Mastectomy and Quadrantectomy. *Surgery v. 2*, p. 1-5, 2012.
- [12] BANKOFF, ADP; JURADO,SR. Electromyographic study of shoulder and acromioclavicular joint muscles in women who underwent unilateral breast surgery of the types mastectomy and quadrantectomy. *Health (Irvine. Print)*, v. 05, p. 1866-1871, 2013.
- [13] BANKOFF, ADP. Estudo da qualidade de vida em mulheres que realizaram cirurgias de mama. *Conexões (Campinas. Online)*, v. 12, p. 42-58, 2014.
- [14] Bankoff, ADP. Estudo eletromiográfico dos músculos peitoral maior e serrátil anterior em mulheres que realizaram cirurgias de mama dos tipos mastectomia e quadrantectomia *HU Revista, Juiz de Fora*, v. 40, n. 1 e 2, p. 55-61, jan./jun. 2015.
- [15] Santos MSM, Panobianco MS, Mamede MV, Meirelles MCCC, Barros VMB. Sensibilidade tátil no membro superior de mulheres submetidas à linfonodectomia axilar por câncer de mama. *Revista brasil ginecol obstetr*. 2009; 31(17):361-6.
- [16] Sant'Anna DK, Almeida V, Petito EL, Gutiérrez MGR. Adesão à prática de exercícios para reabilitação funcional de mulheres com câncer de mama: revisão de literatura *Ciencia y Enfermeria* 2010; 16(1):97-104.
- [17] Hack TF, Kwan WB, Thomas-Maclean RL, Towers A, Miedema B, Tilley A, et al. Predictors of arm morbidity following breast cancer surgery.

- Psychooncology, 2010; 19(11):1205-12.
- [18] Sousa E; De Carvalho FN; Bergmann A;Nogueira EA; DIAS FRA; KOIFMAN RJ. Funcionalidade de Membro Superior em Mulheres Submetidas ao Tratamento do Câncer de Mama. *Revista Brasileira de Cancerologia* 2013; 59(3): 409-417.
- [19] Bankoff,A.D.P. *Morfologia e Cinesiologia Aplicada ao Movimento Humano*. Rio de Janeiro:Editora Guanabara Koogan: 2007.
- [20] Kisner C, Colby LA. *Exercícios terapêuticos: fundamentos e técnicas*. São Paulo: Manole; 1998.
- [21] Box RC, Reul-Hirche HM, Bullock-Saxton JE, Furnival CM. Physiotherapy after breast cancer surgery: results of a randomized controlled study to minimise lymphoedema. *Breast Cancer Res Treat* 2002;75:51-64.
- [22] Camargo MC, Marx AG. *Reabilitação física no câncer de mama*. São Paulo: Editora Roca; 2000.Campbell,W. Evaluation and management of peripheral nerve injury. *Clin Neurophysiol*. 2008;119(9):1951-65.
- [23] Nagel PH, Bruggink ED, Wobbes T, Strobbe LJ. Arm morbidity after complete axillary lymph node dissection for breast cancer. *Acta Chir Belg* 2003;103:212-6.
- [24] BARAÚNA et al. Avaliação da Amplitude de Movimento do Ombro em Mulheres Mastectomizadas Pela Biofotogrametria Computadorizada. *Revista Brasileira de Cancerologia* 2004; 50(1): 27-31.