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Assessment of biomechanical parameters of the shoulder joint at the operated side versus non-operated side in patients treated surgically for breast cancer

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ABSTRACT

Aim: Isokinetic assessment of biomechanical parameters of the shoulder joint at the operated side versus non-operated side in patients treated surgically for breast cancer according to the type of surgery performed.

Background: Despite significant progress in medicine, comprehensive cancer therapy may still cause a number of undesired structural and functional effects. The most frequent complications include long-term weakening of muscles within the shoulder and upper extremity at the operated side.

Materials and methods: The study enrolled 57 patient, divided into two groups: mastectomy and BCT. Diagnostic tests were carried out on the groups to assess biomechanical parameters (peak torque, power, total work) of the shoulder joint in internal and external rotation.

Results: The results of the isokinetic test revealed a considerable reduction of dynamic properties of the muscle groups responsible for the function of the shoulder joint at the operated side. The deficits observed, depending on the angular speed and plane of rotation, were from 22.3% to 32.7% and from 23.1% to 29.4% for muscle power and total work, respectively. The least noticeable loss was that of muscular torque, ranging from 6.5% to 18.3%.

Conclusion: None of the treatment methods applied ensured a full release of the restriction within the shoulder and upper limb. The deficits observed may constitute a serious disorder of the musculoskeletal system; therefore, a clinical study of biomechanical parameters of the shoulder joint may be an important control of patients' functional status after breast cancer treatment.

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1. Background

Breast cancer is the most common malignancy in women. The incidence has been on a rising trend for several decades now. However; owing to early detection programmes and modern treatment methods, the survival rate in patients with that type of cancer is growing. Two out of three diagnosed breast cancer patients are estimated to survive more than 20 years from diagnosis.[1]

It should be noted, however, that despite a significant progress in medicine, a comprehensive cancer therapy (surgery, radiotherapy, systemic adjuvant treatment) may continue to cause a number of undesired, adverse effects of both structural and functional nature. Complications related to cancer treatment may lead to a substantial deterioration of the quality of life and often prevent the patient from returning to her everyday activities from before the disease.

The literature contains a number of publications regarding structural and functional problems experienced by women after cancer therapy. These are most often defined as: "Weakening, impairment of the upper part of the body and upper extremity".[2] The most common symptoms are pain,[3–7] restricted mobility[8–10] and long-term weakening of the muscles located within the shoulder and upper extremity at the operated side that are characterised by considerable deficits of force, power and endurance at the operated side as compared to the healthy side.[10,11]

The latter are caused by direct effects of surgery, such as damage to the myofascial structure and neuropathy, that may result in muscle atrophy, significant overgrowth of scar tissue, adhesions, and radiation-induced tissue fibrosis. Other possible complications may include secondary loss of muscle activity related to the loading of the extremity at the operated side, and restricted mobility of the extremity that may be caused by fear of pain and lymphedema.

In available reports, the assessment of the biomechanical parameters was mostly performed through isometric testing: dynamometric hand muscle strength evaluation[10,12,13] or dynamometric maximum muscle contraction measurement in a set direction, in specific shoulder joint positions.[8,11,14]

In our study, the biomechanics of the shoulder was assessed in isokinetic conditions. The idea of diagnostic measurements and physiotherapeutic exercises performed in such conditions dates back to the 1960s. This area was pioneered by Hislop and Perrine who proposed tests where the work of the muscles is characterised by a constant speed of movement and a self-adjusting variable resistance depending on the force generated by the individual being tested.[15,16] Observation was made of the parameters that enabled to assess muscles' capability of releasing force (*peak torque*), generating power (*average power*) and maintaining adequate strength (*total work*). Those parameters are most frequently analysed and, consequently, most frequently described in literature.[17,18]

2. Aim

The aim of the study was to carry out an isokinetic assessment of biomechanical parameters of the shoulder joint at the operated side versus non-operated side in patients treated surgically for breast cancer according to the type of surgery performed.

3. Materials and methods

The study enrolled a group of 57 patients after breast cancer surgery reporting to the Rehabilitation Clinic of the Greater Poland Cancer Centre. The most common reasons for the patients to visit the clinic were functional problems within the shoulder, thorax and upper extremity at the operated side. Functional problems within the shoulder could be accompanied by persistent pain.

The other qualification criteria were the age of 35 to 65 years, and history of unilateral breast cancer surgery with adjuvant radiation therapy. Exclusion criteria included lymphedema or history of preventive mastectomy or breast reconstruction. Patients with confirmed comorbidities (diabetes, arthritis) as well as those who had undergone surgery for the upper extremities were also excluded from the study.

The study was conducted on patients in whom no clear evidence of relapse was found for at least half a year after the end of therapy. Patients' general health status was determined as good (0 or 1 according to ECOG), thus allowing a clinical assessment of biomechanical parameters.

Depending on the type of surgery performed, the patients were divided into two groups:

- MRM group – patients after Modified Radical Mastectomy,
- BCT group – patients after Breast Conserving Therapy.

The characteristics of the study groups are given in Table 1.

No significant differences were found between patient groups. Course of treatment, medical procedures performed and complications occurring during therapy are specified in Table 2.

For all the participating patients, the right hand was the dominant one. In the MRM group, cancer developed in the right side in 56.7% patients versus 51.9% in the BCT group.

This research project was approved by the Ethics Review Committee at the Karol Marcinkowski University of Medical Sciences, Poznań (decision No. 42/13). The patients participating in the research project had been informed of the method and scope of the study, as well as the form of data processing.

Table 1 – Statistical characteristics of study groups.

	Group 1 – MRM		Group 2 – BCT		Total	
	Mean	SD	Mean	SD	Mean	SD
Number of patients [*n*]	(*n* = 30)		(*n* = 27)		(*n* = 57)	
Age [years]	49.67	8.09	52.81	7.11	51.16	7.74
Height [cm]	163.90	5.39	162.85	6.22	163.40	5.77
Weight [kg]	70.92	10.93	67.26	13.04	69.18	12.01
BMI [kg/m^2]	26.42	3.93	25.27	4.27	25.88	4.06
Time after treatment [mo.]	27.47	25.47	32.15	23.83	29.68	24.60