Chapter

Physiotherapeutic Management in Breast Cancer Patients

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Abstract

Breast cancer treatment can lead to various physic and psychic long-term morbidities, such as restricted shoulder joint range of motion, lymphedema, impaired muscle strength, or cancer-related fatigue. Physiotherapy is a body-oriented approach to tackle these different complaints. This chapter starts with possible prehabilitation approaches until therapy or surgery. It continues with early post-op mobilization and shoulder-arm exercises during the early stages and additionally breathing exercises. In the following rehabilitation period and after hospital discharge, the focus lies on shoulder joint range of motion, muscle strengthening, and body posture to regain normal activities of daily life. This is supported by easy learnable exercises and therapy measures. Lymphedema prevention and treatment are discussed as well as sports therapy, which is divided into endurance and strength training. Therefore, an active lifestyle is encouraged by also considering necessary precautions while training during chemotherapy cycles. Common symptoms and problems, such as cancer-related fatigue and chemotherapy-induced polyneuropathy, are tackled with techniques, such as yoga or balance training. Scar therapy and radiation-induced lung injury are delineated followed by massage therapy proposals and specified exercises to enhance oxygen uptake.

Keywords: prehabilitation, rehabilitation, shoulder joint mobility, lymphedema, endurance training, strength training, relaxation

1. Introduction

Breast cancer is the most common cancer type in women. The latest improvements in early detection and therapy have led to a 10-year overall survival rate of up to 78% [1] in central Europe. At the time of diagnosis, most women are between 55 and 69 years old [2], but also younger women are increasingly affected, every one of these interested in an ongoing high quality of life after completing therapy. This has necessarily brought attention to the treatment of morbidities following the diagnosis and/or side effects of modern breast cancer treatment [3]. Women not only resume their working position but also want to return to sports after breast cancer treatment and/or reconstructive breast surgery and therefore need support, advice, and medical expertise.

Physiotherapy is a body- and patient-oriented approach for tackling different complaints of breast cancer patients after surgery (breast-conserving surgery BCS, mastectomy, and/or breast reconstruction), radiation therapy (RT), chemotherapy

(CT), or hormone therapy. It aims at shoulder joint immobility, pain, scar complaints, or lymphedema with means of "hands-on techniques." Patients are furthermore educated to perform customized exercises, that is, "hands-off exercises" to regain their mobility and strength [4] and in doing so act as their own therapist.

The physiotherapeutic process starts with a thorough patient anamnesis, inspection and palpation, and further assessments to figure out the reason for the patient's problem. Afterward, the physiotherapist suggests a suitable treatment approach according to her/his expertise, medical research evidence, and the patient's values and preferences. Patient adherence to therapy is crucial for ongoing success.

This chapter gives an overview of different physiotherapeutic approaches, therefore guiding breast cancer patients through different stages of cancer treatment and afterward. Various common complaints and deficits are depicted followed by evidence-based exercise and therapy suggestions. It describes physiotherapy as an important part of the whole therapy concept contributing to a patient's better quality of life. Even in case of cancer-recurrence or metastasis, and during palliative stages, adapted training and activity of life guidance is possible and can facilitate the patient's remaining life.

2. Prehabilitation

Prehabilitation is the approach to start therapy shortly after definite breast cancer diagnosis to make use of the remaining time until surgery (30 ± 17 days) or other medical treatments are planned. Prehabilitation has been able to improve bodily functions, shoulder range of motion (ROM), activities of daily life (ADL), and led to a shorter recovering period after surgery [5]. Acknowledging the fact that patients' activities will inevitably diminish post-surgery, by employing prehabilitation, women can guarantee that the percentage change will be of lesser consequence. Physical as well as psychological parameters can be improved during the weeks until the therapy starts.

To achieve this, patients are encouraged to take longer walks or go for Nordic walking (30–60 min) at an average or higher walking speed (4–5,5 km/h) on flat ground and even on gradient tracks. This leads to better oxygen uptake and cardiopulmonary function. They are instructed to do specific shoulder exercises to enhance a) shoulder ROM and b) shoulder girdle muscle strength by resistance training [6]. The training furthermore affords an opportunity to distract patients from disease-centered thoughts and can divert constant and circulating worries. It should, therefore, be complemented by an easy-to-learn kind of relaxation therapy, for example, deep breathing exercises [7] or Jacobson's progressive relaxation.

3. Postoperative phase

Out-of-bed mobilization starts on post-surgery day one for BCS and mastectomy. With certain reconstructive breast surgeries, this is delayed for one or two more days. Early mobilization improves patients' independence for basic ADLs and protects against deep vein thrombosis. In a short time, patients are independent to use the toilet, to take meals at the table or to perform basic body hygiene for themselves.

Patients should train and/or walk two times a day for overall 10–20 minutes with an assured blood pressure of a minimum of 105/70 to a maximum of 150/90 and a heart rate of (180 minus age minus 10%). The walking speed is set at 60–80 steps per minute, which corresponds to a low intensity of 25–50 Watts. A recumbent bike can

be used after removing urinary catheter and drains. When using the (new) BORG Scale as an intensity level parameter, patients should specify their personal level of exhaustion at 1–2/10 during training sessions.

Patients are educated to perform their own breathing exercises and thrombosis prophylaxis, that is, calf-muscle pump, by moving and circling their ankles. In their own interest, this should be done every hour with 20–30 repetitions and 2–3 sets. While lying or sitting upright in bed or in a buxton chair in their room, the pursed-lips technique is used for exhaling combined with a deep breathing technique, preferably through the nose, while inhaling. The breathing is guided to the thoracic flank, the abdominal region, or the pulmonal apex region stimulated by the patient's own hands. From 12 to 15 breathing cycle repetitions are necessary for three series, interrupted by 30–60 sec breaks. Breathing exercises can also be combined with low-level shoulder exercises [8], such as shoulder shrugs, shoulder circles, arm flexion, and arm abduction.

Patients are lying supine in bed, and the affected side's arm is supported by one or more pillows to ensure low pain levels and to enhance lymphatic flow. A heart-shaped pillow placed in the axillary region can reduce pain and muscle tension after axillary lymphadenectomy. Patients are provided with such a pillow as an individual present at the ward. For reconstructive breast surgery, such as the DIEP flap or the TRAM flap, even more pillows or a positioning block is needed to support the calves/legs to relieve the abdominal region from exorbitant scar tension.

Arm exercises at the wrist and elbow level also start on day one. This improves wound healing, pain, and quality of life [9–11]. Shoulder exercises start on day three for BCS, but are restricted to 90° flexion and abduction and should respect lower levels if patients report pain [12]. Starting too early or in a too progressive regime could lead to an enhanced risk of seroma formation [13], lymphedema, or higher fluid drainage [8]. Mastectomy patients should wait with shoulder exercises until day 5 to diminish the risk of bleeding [14]. Arm lever, and therefore, weight during shoulder exercises, should be reduced in the beginning by maximal elbow flexion, which places the fingers at the corresponding shoulder. To remember these exercises correctly, patients are receiving a written information leaflet with precise instructions and further precaution measures to be taken in the following weeks and months.

After removing surgery drains [15], which is approximately on day 2–6 for breast and axillary drains, respectively, with the axillary drain normally remaining longer than the breast drain, the physiotherapist (PT) can induce passive and passive-assisted hands-on techniques in different directions. This will enhance scapular and humerus movements and can reduce excessive muscular tensions, for example, in the rhomboid or trapezius muscle and therefore pain (cp. **Figure 1**).

Figure 1.
Scapular movements: Cranial/caudal; ventral/dorsal and in diagonal shape (anterior elevation/posterior depression).

The patient is discharged from the hospital on days 2–14, depending on type of surgery (longer for several breast reconstructions), eventual complications, and personal wound healing. Given this possible short in-patient time, it is crucial to ensure that patients are provided with all information necessary and behavior tips to pay attention to after discharge. This can be supplemented by a list of available outpatients' services if they are in need of further therapy or advice. The wound and the scar need support and protection for at least 4–6 weeks. Exercises started during the in-patient period are to be prolonged for the following weeks and maybe even months depending on the individual symptoms. In case of breast and trunk, RT thorax stretching and breathing exercises are recommended for several months to counteract tissue fibrosis.

4. Rehabilitation

Rehabilitation for breast cancer survivors can be very heterogenous [3] depending on the different complaints and symptoms. It aims at restoring the best possible state of health, in a somatic as well as a psychic manner. In the first weeks after surgery, some precautionary measures have to be taken to not impede proper wound healing. This includes not carrying or lifting heavy weights or children with the affected arm and avoiding exhausting household tasks, such as vacuum cleaning, window cleaning, lawn mowing, snow shoveling, or lifting out heavy cooking pots. On the other hand, women are encouraged to use their arms increasingly, for example, body hygiene, such as teeth brushing or hair combing or easy household tasks, for example, dusting off. This is relevant to not becoming accustomed to prolonged "cradling of the arm" protectively against the body, which compromises shoulder ROM and/or arm swing during walking and furthermore affects posture badly.

In case of long-lasting side effects, patients should be taught compensatory mechanisms and ways to improve and economize their ADLs. This also includes supplying the patient with several necessary tools, for example, a long-handled reacher.

Even in the case of cancer recurrence, with improved medical possibilities and treatments, many patients are facing several years of life to come. This shows the need for body-oriented therapies and approaches to improve patients' symptoms and facilitate the patients' ongoing life in the aspect of mobility, edema, or pain. These recommendations should be considered even if disease progression is complicating therapy application increasingly [16]. If necessary, relatives or other caregivers should be involved in the therapy procedure to facilitate ADLs and transfers. In palliative contexts, this not only empowers and strengthens these people but also simplifies the relationship between the patient and her caregiver at home.

4.1 Shoulder joint

During the second week after surgery and after suture removal, shoulder joint mobility progresses without any limit [11] to reach high ROM as soon as possible. This is not only important for the patient herself, but is also paramount for starting an RT, which requires a certain patient position with maximal arm flexion and/or abduction to reach the axillary region. Otherwise, the RT could be delayed with unfavorable patients' outcomes [17]. Therefore, it is recommended to employ several techniques and exercises. Patients have already been taught their individualized home exercise program, which they should apply at least three times a week but better daily for 3 more months [15] with 10–20 repetitions for each exercise. Flexion, abduction, and

external rotation are the most limited shoulder movements, so the focus lies on these motions. Scar treatment and muscle stretching are in close connection with shoulder ROM and complete the program enriched by relaxation techniques.

While exercising, patients are lying supine or sideward, sitting on a stool, or are standing securely on even ground. Exercise and stretching can induce a certain feeling of discomfort but should not trigger pain. If so, this exercise has to be finished or slightly varied until the pain subsides. Patients are using their own arm weight as a means of resistance or easily available tools, such as a rubber band, little hand weights or dumbbells, a broomstick, a towel, or filled small mineral water bottles as a weight substitute.

External rotation can be exercised with a yellow or later red rubber band fixed on a door handle while standing. The patient is holding her arm in a neutral position and the elbow close to the trunk with a 90° elbow flexion and is holding the loose end. She is then pulling against the rubber band resistance for the maximal possible external rotation and slowly easing back, which induces both concentric and excentric muscle activities.

For the so-called "elbow clam exercise" to enhance shoulder abduction, the patient is lying supine, both hands are crossed behind the head, and elbows together in front of the face. Now, the patient is abducting her arms, ideally, until the elbows touch the ground, left, and right (cp. **Figure 2**). She is holding this final position for at least 10 seconds, breathing steadily, and then moves slowly back.

Flexion can be enhanced, for example, with the "cleaning the door exercise." The patient stands facing the door, and the hand of the affected arm is resting on the door

Figure 2.
Elbow clam.

panel with a small cloth in between. Now the arm is slowly gliding upward as high as possible at the time given and back to breast level. The arm's weight is resting partially on the door. During the exercise, the patient is instructed to maintain an upright body posture and not to lean back as a form of compensatory movement. Arm flexion is combined with inhaling and extension with exhaling.

4.2 Posture

Out of 82% women, after breast cancer surgery, only 35% of women develop a bad body posture [18]. This includes shoulder elevation, shoulder protraction, subacromial space reduction, trunk rotation, head rotation, and thoracic spine kyphosis [19–21]. Explainable reasons for these are pain, high muscle tension, axillary seroma, and a disproportional weight distribution after mastectomy without a breast prosthesis or a heavy-weight external prosthesis. The kyphosis also correlates with a kind of "startle pattern" so as not to show the missing/operated breast to their surroundings. The misguided postures lead to prolonged shoulder immobility, as the humerus cannot glide freely. Furthermore, muscle tension triggered pain [22] or even gait changes can follow.

Remedies are the bilateral arm exercises with the proprioceptive neuromuscular facilitation (PNF) concept [23]. This combines shoulder flexion, abduction, and external rotation with rubber-band resistance. Besides shoulder ROM improvement, trunk erection is also involved (cp. **Figure 3**). The patient is sitting on a stool, with her feet fixing both loose ends on the floor. The band is then crossed at lower legs height and fixed around both palms. In the beginning, the left hand is resting on the right knee and *vice versa*. She then starts the movement by lifting, abducting, and rotating both her arms, which inhibits unwarranted trunk movements until her maximal shoulder position is possible. The tension at the final position is to beheld for a few seconds, then the movement is slowly reversed back until both hands are resting on the knees as in the beginning.

While executing the so-called popular PT exercise "block game," the sitting patient is taught to actively feel, correct, and erect her three blocks, that is, the head, the trunk, and the pelvis in a vertical axis, one on top of the other. She then stabilizes and strengthens the now erect trunk by deploying both abdominal and back musculatures by moving the trunk slightly forward and backward without leaving the erect spine position.

Self-mobilizing exercises with the arm resting on a soft flexible ball while sitting sideward to a table correct the humerus direction caudal by activating the scapula (rhomboid muscle, transverse trapezius muscle) toward the spine, while simultaneously giving pressure on the ball and slightly abducting the arm by rolling the ball sideward (cp. **Figure 4**).

Humerus correction direction dorsal is achieved by the patient while standing with the face toward a wall. Both arms are lifted to 90° arm flexion, elbows 90° flexed, and the lower arms and hands in connection with the wall. She then approaches the sternum toward the wall slightly for correcting the humerus position, because the humerus is gliding posterior at this very moment. Secondly, she pushes her trunk slightly back from the wall. The latter also strengthens the serratus anterior muscle, which is sometimes weakened because of the possible corresponding nerve damage during surgery (cp. **Figure 5**).

The therapist instructs the patient to a) recognize and b) correct her posture. This can involve lowering the shoulder, straightening up, and de-rotating the trunk and/or head. In most cases, the trunk is pathologically rotated with the operated side moving

Figure 3.
PNF arm flexion/abduction/external rotation with a rubber band.

forward, while the head is rotated backward in the other direction to keep clear sight in front of the head. A mirror helps the patient to control herself and adjust her position accordingly.

4.3 Muscle stretching and strength

Different muscles incline to shorten, above all the pectoralis major and minor and the latissimus dorsi muscle because of pain, RT, or non-usage. Stretching is possible as a hands-on (cp. **Figure 6**) and a hands-off procedure by the patient herself. Other muscles, such as the trapezius, levator scapulae, or deltoid muscle [24], but also the rectus capitis or semispinalis capitis muscle [25] tend to develop an often painful

Figure 4.
Self-mobilizing humerus caudal.

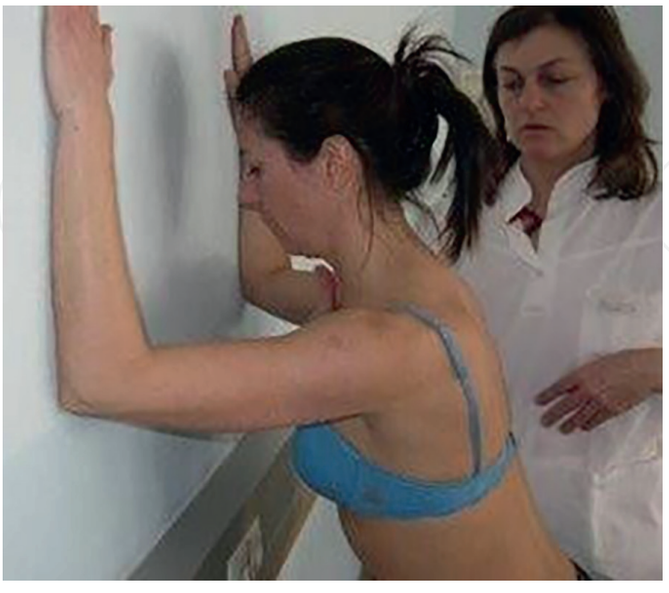

Figure 5.
Self-mobilizing humerus dorsal.

Figure 6.
Therapeutic pectoralis major stretching.

hypertonus. Pain and the described "arm-cradling" imply muscle weakness. The overall loss of strength lies at 25% with an incidence of 18–23% [15], all of which can lead to shoulder instability [26] and even rotator cuff dysfunctions [19].

For auto-stretching, yoga exercises are appropriate means. The "Crocodile position," that is, "Makarasana" is an ideal exercise to stretch the pectoralis muscle and secondly to induce a deep breathing cycle at the affected trunk side. This is also important to counteract possible RT skin and lung and connective tissue side effects, such as long-term fibrosis. The arm position can be varied according to the patient's shoulder ROM and possible lymphedema. A pillow should then ensure that the arm is supported and that the hand is in the highest position that facilitates lymphatic flow.

Another yoga asana is the adapted "Cow face" or "Gomukhasana." With the aid of a towel or a belt, one arm is extended behind the back, while the other one is flexed over the head, both with flexed elbows, holding the towel/belt with both hands. The goal is for both hands to reach out to one another as close as possible. The healthy arm is supporting the affected arm by a pull on the before-mentioned belt or towel. This enhances flexion, extension, and both in- and outward rotations.

Strength training should be focused on but not limited to the affected arm, but also include the trunk for posture, the other arm for symmetry, and the lower limbs for easier ADLs. To combine upper limb strength training with additional balance training, patients should assume a standing position while exercising with both upper and lower limbs simultaneously. One can eventually combine a) squats and double-sided elbow flexion aggravated by hand weights (0.5–1.5 kg; cp. **Figure** 7), or b) "good morning" exercises, that is, bending the trunk forward by flexing the hip combined with horizontal abduction of both arms while both hands are behind the head, or c) lower limb lunges with both arms shoulder extension aggravated by hand weights.

4.4 Lymphedema

About 20–25% of women after axillary lymph node dissection [27] and about 5% after sentinel lymph node biopsy [28] develop lymphedema (LE), most of them within the first 2–3 years [29]. As an incurable condition, LE has grave consequences

Figure 7.
Combined squats and resisted elbow flexion.

for patients' physical and psychic quality of life. LE is divided into four stages: 0 = subclinical; I = pitting edema; II = non-pitting edema, and III = elephantiasis. LE can possibly be preceded by an axillary web syndrome, also called cording, with visible and palpable cords in the middle of the axilla and the upper arm. Other early factors proved to contribute to LE formation are high BMI (≥26), skin puncture, mastectomy, RT, or wound infection [30–32]. Taxan-based CT can furthermore compromise lymphangiomotoric function, that is, lymphatic contractions [33].
To capture LE early, a preoperative circumference or volume assessment is recommended. For high-risk patients, post-surgery indocyanine green lymph scintigraphy can be indicated. Women should be educated on early symptoms and how to perform regular self-measurements (pitting test, stemmer's test, and arm circumference with

a one-hand tape measure). Measurements should be taken for at least one, better three-year post-surgery [34]. The gold standard for measuring and capturing LE is perometry or the water displacement method. Overall, arm edema incidence is reclining, whereas breast edema incidence is inclining [35]. Therefore, medical staff should be familiar with the corresponding symptoms and signs and be attentive.

The standard treatment for LE is complex decongestional therapy (CDT), which consists of manual lymphatic drainage (MLD) [36], compression therapy (CT), exercises, skin maintenance, patient education, and if necessary, dietary programs. CDT is divided into two phases, that is, intensive and maintenance phase. If primary edema volume exceeds 40%, in comparison with the healthy arm, patients are asked to complete first an inpatient rehabilitation continued afterward with phase II at home. MLD is a very gentle kind of massage, with the intention to redirect lymphatic fluid to non-compromised body quadrants by using accessory lymph paths. These are the non-affected axilla *via* ventral and dorsal, the neck and the ipsilateral inguinal region by improving lymphangiomotoricity. A thorough MLD includes treatment of the neck, the unaffected breast and back, the affected breast and back, and the whole of the arm, including the fingers. Afterward, in phase I, the patient is provided with a multi-layer compression bandaging inclusive of extended padding. In phase II, a customized compression sleeve and/or bra is prescribed to be worn daily from morning till evening. The most prescribed upper limb compression is class II, which ranges from 23 to 32 mmHg. If a glove is also necessary for finger or hand edema, this should be separated from the sleeve for easier donning. In lymphedema stage I, the patient is instructed to adopt elevated arm positions while resting; later on, this has no effect on the now chronic edema. Patient's adherence to CT is crucial for therapy success [37], which makes patient information and education even more important.

Exercises consist of a) endurance exercises and b) resistance exercises. The compression must be worn during these exercises to avoid lymphatic backflow. Possibilities are fist-pumping exercises or squeezing a little ball with the hand (30 repetitions, 3 series) [38] or moving a hand ergometer at 10–25 Watts [15], or any other exercise which incorporates parts of the arm musculature. If possible, the arm exercises should be combined with high arm positioning. Nordic walking [39] is also recommended as a whole-body endurance therapy and for achieving an upright walking posture. Enhanced breathing during this endurance training leads to a suction of the lymph fluid from the thoracic duct into the central veins (subclavian, jugular internal vein).

For skin maintenance, the patient applies suitable moisturizers or lotions on their arm after doffing the compression sleeve and before going to bed. While doing this, she should always distribute the lotion by stroking from the distal hand to the proximal arm. Keeping healthy and well-nourished skin is paramount for erysipelas prophylaxis. Patients should further carry along a little bottle of disinfectant at all times. In case of little wounds, for example, insect stings, thorn injury, the disinfectant should be applied immediately to protect against bacteria and secondly, erysipelas.

Patient education can be administered single-wise or group-wise [40]. Patients are learning to interpret early symptoms [41], do their self-assessments as mentioned before, and learn about arm mobility, everyday behavior, hygiene, erysipelas and lymphedema prophylaxis, wound-healing, and scar formation [42]. All these measures improve patients' health literacy [43] and facilitate ongoing shared decision-making.

Dietary measures are important if patients are overweight, that is, have a BMI exceeding 26. A correlation has been established between this high BMI and the lymphedema stage, so patients are advised to maintain or reach a healthy body weight [31]. This is achieved by a) diet and b) sports therapy.

4.5 Sports therapy

Women should be encouraged to start or re-start sporting activities. This is rewarded by easier ADLs, a better quality of life, better coping with the disease, and a better adherence to ongoing cancer therapies. Furthermore, women can reach a reduction of overall and disease-specific mortality as well as an extended recurrence-free time [44].

In the beginning, an oncologic physician's assessment to evaluate heart and kidney condition by taking the blood pressure, ECG, echocardiography, and fitness level is indispensable. A 6-minute-walk-test supports in assessing the patient's actual fitness level and is afterward used to define her walking speed during walking exercises. Lastly, a multiple repetition maximum test determines the possible repetitions for resistance exercises within different muscles/muscle groups. Sports therapy can be conducted during and after oncologic treatment with certain adaptations and precautionary measures. All in all, 150 minutes of activities per week with a level of 3–6 METs (metabolic equivalent of tasks) are recommended [45]. For example, brisk walking takes place at an intensity of approximately 5 METs. To ensure safety, patients should wear a portable heart rate monitor or watch. If dyspnea has to be taken into consideration, also, oxygen saturation should be measured during the training session and be constant above 90%. During all kinds of exercises, the compression sleeve should be worn [46]. The most popular sports after breast cancer surgery are gymnastics, walking, Nordic walking, and swimming. Women should be discouraged from dangerous and arm-exhausting sports such as judo or climbing. Other precautions are necessary in case of a port-a-cath or a PICC (peripherally inserted central catheter), which should not be under local mechanical pressure, or get dislocated or wet.

No sports therapy can be executed on the day of CT and the following day, even if patients are feeling well. There is too high risk of cardiotoxicity and nephrotoxicity. Afterward, the highest possible heart rate should be set between 40 and 60% maximal heart rate if patients still are in between chemo-cycles. Training should of course be postponed if patients have fever, are dizzy, or feel otherwise unwell.

It is possible to start with sports therapy about 4–6 weeks after BCS and 6–8 weeks after mastectomy. In the beginning, types of movement, which focus motoric load on lower limbs, such as walking or stationary cycling, are to be preferred. A combination of endurance training and resistance training promises optimized outcomes in terms of patient-reported outcomes and overall fitness [47].

In the case of bone metastases, training is only possible supervised in not metastasis-affected body regions, For example, the patient can train with the lower limbs if metastases were detected in the humerus. Moreover, the radiologist or oncologist has to give her/his approval if the bones are robust enough for the training. The training focus should have lain on activities of daily life promoting exercises. The potential benefits and harms must be weighed for each individual patient [48]. Manual techniques that rely on heavy stretching or give lots of pressure, resistance, or vibrations on the tissue are contraindicated for these patients because of possible pathological fractures.

4.5.1 Endurance training

Endurance training (ET) takes place if a minimum of 1/6–1/7 of the whole-body musculature is involved in the training. Breast cancer patients are advised to perform ET because their average activity level is about 30% less than that of age-wise comparable inactive women without breast cancer [12]. ET can have positive effects on the cardiopulmonary capacity, for example, heart muscle contractility, quality

of life (QoL), and sleeping quality, and can be a means to control the patients' BMI. Furthermore, it was suggested that ET fosters cerebral plasticity in the case of "chemobrain" [12], and therefore, cognitive functions can improve.

Training is possible during as well as after CT, many training regimes are combined interventions of ET and strength training (ST) [49]. Outdoor activities are recommended for better mental health and an increase in vitamin D levels [50]. As previous or ongoing CT can change heart rate, heart rhythm, and cardial function, the usage of the heart rate as an intensity parameter has to be interpreted with caution. Alternatively, the VO2-max or lactate levels can be determined.

The ideal training type is interval endurance training, as it turns out to be less exhausting and is also feasible in patients with other co-morbidities. One- to two-minute intervals interchange with 30–60 seconds active breaks. The whole training session should last 10–15 minutes at a minimum (training and break minutes added) with an intended increase of 30 minutes over time. Training heart rate is set between 60–80% of maximum heart rate. As the training proceeds, training intervals are intensified, that is, prolonged, as breaks are shortened or even omitted. Recent research was able to demonstrate that even high-intensity interval training, a time-efficient method for improving cardiovascular capacity, is possible in breast cancer patient cohorts, but should be supervised [51]. In high intensity interval training (HIIT) patients are exercising short periods at high intensity (i.e. > 75% VO2 max), followed by low-to-moderate intensity recovery periods (40–50% VO2 max). However, HIIT did not improve outcome when compared with regular ET [52]. While exercising, patients should determine their subjective exhausting level, that is, rate of perceived exertion or BORG Scale with 4–5.5/10 (i.e., moderate). To enhance patient's motivation, the type of ET, for example, walking, running, cycling, and cross-country-skiing, needs to be matched with her preferences and experiences. Overweight women should possibly select a training style with reduced body weight for the lower limbs, that is, (stationary) cycling or swimming to protect the limbs' joints.

4.5.2 Strength training

Strength training is recommended because inactivity, fatigue, cancer cachexia, and CT side effects on protein synthesis deteriorate muscle strength [53]. ST is capable to increase fast twitch muscle fibers type II, improving posture, ROM, coordination, and by facilitating ADL, it secondly optimizes QoL [54]. It can be performed in supervised and unsupervised settings, provided that patients are instructed properly. In former years, strength training was mainly avoided out of concern of triggering lymphedema, a hypothesis that was falsified [55]. Strength training should involve both upper and lower limbs, and a great effect size (ES = 0.99) can be expected [56]. Low-intensity strength training implies an intensity of 30–40% 1-RM (repetition maximum) with 15–30 repetitions or 40–60% with 10–15 repetitions. An increase to 50–80% 1-RM with 8–12 repetitions, that is, moderate intensity is possible [55]. Two or three sets of each exercise incorporating various muscle groups for an overall 30–45 minutes are recommended. The multiple repetition maximum test defines the exact individual training capacity while avoiding the hazards of a real 1-RM test.

A warm-up phase (5–10 minutes light endurance exercise on the treadmill or stationary bike) in advance as well as a cool-down phase (stretching exercises, relaxation) afterward is mandatory. Strength training is recommended two times a week with a minimum of 48 hours in between to recover. If adherence to this training frequency is problematic, even a once-a-week ST could show an increase in muscle

strength and could therefore be an alternative for frail patients [57]. ST can be performed with free weights or rubber bands, own body weight, or strength-training machines. Changing body positions can facilitate or aggravate the training intensity by implementing or eliminating gravity and/or balance and coordination. ST should be postponed if thrombocyte counting is less than 20.000, if hemoglobin falls short of 8 g/dl or if the patient is suffering from arterial hypertension as well as on the days of CT and the following day.

Specific exercises, including arm flexion, above head height should not be implemented for three-month post-surgery. The patient is supposed to maintain steady breathing through all kinds of exercise to avoid a Valsalva mechanism and therefore high intrathoracic pressure. Common exercises are the seated row, leg extension, chest press, or the latissimus pull-down, when exercising with machines. Body weight-driven exercises are squats or lunges, combined with shoulder press, arm abduction, or resisted upper arm curls (cp. **Figure** 7).

Most efficient exercises involve muscles with trunk-associated insertion to furthermore improve spine bone density. This is of special interest in the case of (hormone therapy-associated) osteoporosis. To enhance this effect, patients are exercising while standing, also combined with an unstable surface, such as a balance pad or a tightly rolled-up gymnastic mat.

4.6 Cancer-related fatigue syndrome

Cancer-related fatigue syndrome (CRF) is one of the most troublesome symptoms after cancer and/or its treatments and is often present even after years [58]. Firstly, the patient should keep the so-called "energy-diary" for at least 14 days. Therein, low- and high-exhausting activities and the state of exhaustion should be noted with a numeric rating scale (1–10). This serves to identify energy-robbing activities, which should be avoided, if possible, or split up into smaller segments.

Exercise has been proven to be an efficient means of CRF, and it enhances QoL and depression [59, 60]. Low endurance training [61], that is, 40–60% of the heart rate maximum is recommended, that is, (treadmill) walking at a speed of 4–5 km/h or stationary cycling. Additionally, low-level resistance training with incorporating great muscle groups is indicated. Patients start with only a 5-minute sequence, subsequently increasing the session up to 30 minutes over weeks and months. Concerning endurance training, interval training, that is, alternating training and resting intervals suit these patients' demands better. They start with a 30–60 seconds training period, followed by 60–120 seconds resting period, representing a 1:2 frequency. Training time can be divided into two sessions per day. Patients should assess their personal rate of perceived exertion (BORG Scale) with "very easy" to "easy" (1–2/10). Strength exercises should be chosen with particular consideration of functional ADLs.

Relaxation training is another important part of CRF treatment. It aims at diminishing fear, depression, or sleeping problems. Jacobson's progressive muscle relaxation [62] or very gentle yoga exercises [63], for example, the "Dead Men's Position," "Shavasana," or the "The lying Butterfly," "Supta Baddha Konasana" are recommended in these circumstances. In each of these, the patient is concentrating on her own body, its' functions, and her personal breathing cycle. The positions can be practiced for up to 7–10 minutes. Alternatively, the patient can try a verbally guided relaxation exercise, which takes her to a virtually preferred environment, such as a gentle tropical beach or a lush-green forest surrounding.

4.7 Chemotherapy-induced polyneuropathy

Chemotherapy-induced polyneuropathy (CIPN) affects approximately 30–60% of patients. It affects sensory, motoric, and autonomous nervous system and deteriorates QoL. As a consequence, patients suffer from pain, paresthesia, and tingling sensations. They are furthermore at a high risk of falling [64]. Upper limb ADL dexterity problems, for example, closing buttons, counting coins, or holding cutlery are equally common. Training is even more effective if it is launched in advance of the symptom onset of CIPN [65]. Patients are advised to start walking training [66] and balance training on even and uneven grounds, for example, a rolled-up gymnastic mat, a balance pad, gravel underground, or a soft forest surface. Different standing positions with normal to small-positioned feet, semi-tandem and tandem stance as well as squats or lunges are practiced. If necessary and to ensure safety, patients can grasp a wall or a table. To enhance the exercises' difficulty, patients can close their eyes during exercise or add other motor or cognitive tasks simultaneously [67], for example, open or close a zip while walking, counting while stepping, etc. Furthermore, electric vibration plates can be used combined with different positions, for example, standing, sitting, or bridging the tool with the feet while lying supine with bent legs.

For upper limb and hand, sensory functions patients can exercise using a "hedgehog ball" or a spiked acupuncture massage ball, which they move around in their palm. They practice finger dexterity by picking up small objects such as coins, pens, and marbles. Therapists can give patients a hand massage to relieve numbness and pain by increasing blood circulation.

4.8 Scar therapy

Scarring in breast cancer patients is not only a cosmetic issue but can affect patients' physical as well as psychological well-being [68]. Scars can induce pain and additionally impede shoulder joint and thoracic mobility. Furthermore, they can be an obstacle for lymphatic flow [69]. Scar formation in deeper layers can even lead to muscle weakness. Patients can report pruritus and feelings of disfigurement. A well-healed scar is thin and flat, showing a similar color to the surrounding skin. On the contrary, hypertrophic scars are red or pink and raised, while keloids are beyond the original scar region. After the wound-healing process is completed, the scar tissue is manually mobilized, massaged, and stretched by both the PT and the educated patient. The patient cares for the scar by applying special moisturizers. This is even important after RT, which induces skin and tissue fibrosis [70], followed by a deteriorated ROM. Starting too early, on the other hand, would have deleterious effects, for example, aberrant wound healing, such as hypertrophic scarring or even keloids, because of an ongoing inflammation process [71].

Different physiotherapeutic techniques, such as massage, manual lymphatic drainage, connective tissue massage, acupuncture massage, or compression therapy, can be employed to improve the before-mentioned symptoms [72]. Silicone-based wound dressings are recommended for scar management. They ensure hydration and reduce inflammation. Additionally, patients should avoid excessive sun exposure. Scar therapy is possible as a self-treatment after accordingly instruction for five to ten minutes daily. This aims to loosen agglutinated connective fibers, to improve the scar pliability, the itching sensations, the cosmetic outcome, the aberrant color, and the pain [72]. Lymph vessel growth should be induced by stretching the skin during MLD, which is supposed to release vascular endothelial growth factor VEGF-c [73]. Evidence suggests that the activation of lymphatic vessels is correlated with anti-inflammatory

mechanisms [74]. Therefore, it can be hypothesized that regenerated lymphatic function in scar tissue can avoid excessive scarring and scar-associated lymphedema.

It should be mentioned that clearly defined therapy regimes concerning duration, direction, frequency, or intensity are lacking until now [75]. In addition to that, robust scar treatment trials and therapy should utilize validated scar measurement tools.

4.9 Radiation-induced lung injury

Radiation-induced lung fibrosis is a long-term side effect after RT with an incidence of 1–5% in breast cancer patients. RT-induced tissue damages are followed by inflammation processes of the alveoli and lung fibrosis at the final stages. The patient suffers from dyspnea, chest pain or tightness, a dry cough, and low cardiopulmonary function [76]. All in all, this represents a restrictive lung syndrome with reduced lung volumes, lung compliance, gas diffusion, and decreased mucociliary clearance. The patient's dyspnea can be disproportionately in comparison with the radiation dose she was exposed to. The diaphragm's workload during inspiration is intensified because the lung's expansion is more difficult than in healthy conditions.

The compromised oxygen uptake capacity can be enhanced through endurance training (cp. chapter 4.5.1). The patient is educated the learn active diaphragmatic breathing techniques and different lung stretching positions, for example, the "moon position" (the body is forming a "C-shape" in a supine position, arms stretched over the head). Diaphragmatic breathing is facilitated by gravity if patients exercise in a vertical position, that is, sitting [77] and is guided by the hands lying on the abdomen. Additional oxygen can be prescribed for symptomatic relief. Self-mobilizing techniques for the diaphragm while lying supine with one's own fingers reaching up to the diaphragm *via* the short ribs can be taught. Airway secretion mobilization is crucial to avoid high bacterial load and concurrent infections. This includes postural drainage, the instruction of effective coughing techniques, and chest percussions by the therapist's cupped hand or massage machines to induce vibration [78].

5. Conclusion

Breast cancer patients are present with a multitude of complaints and symptoms according to their type of surgery, oncologic treatment, and ongoing behavior. Physiotherapy, as a body- and patient-oriented approach, offers a wide range of hands-on and hands-off treatment modalities and techniques to enhance patients´ physical and psychological well-being. It is the therapists' task to a) assess the patient thoroughly, b) evolve a suitable therapy plan, c) implement, and d) evaluate this plan for effectiveness. Physiotherapy guides the patient from early postoperative mobilization back to daily independence, social participation, and better awareness of a healthy lifestyle and their own bodies. Physiotherapy is a means to complete state-of-the-art medical cancer treatment.

Conflict of interest

The author declares no conflict of interest.

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