

Exercise and Lymphedema in Context Cancer Rehabilitation.

A Historical Review

Johansson K*¹, Johnsson A² and Jonsson C¹

¹Dept of Health Sciences, Lund University, Sweden

²Dept of Clinical Sciences, Lund University, Sweden

***Corresponding author:** Karin Johansson, Dept of Health Sciences, Lund University, Lymphedema Unit, SOK Skane University Hospital 221 85 Lund, Sweden, Tel: 46 706167593; Email: karin.johansson@med.lu.se

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Abstract

The historical review is based on key articles and systematic reviews including meta-analysis during the last decades and describes the development preceding the paradigm shift that has taken place in cancer rehabilitation, in particular in exercise and lymphedema. Cancer survivors were for long recommended to live a sedentary life as it was believed that vigorous exercise might provoke development of lymphedema. However, in the 1990ies it was found that the cancer survival rate was dependent on exercise level, and since then it has been proven, in breast cancer patients, that vigorous exercises is safe both for cancer survivors at risk of developing upper limb lymphedema and for those who already have one. Further research is needed for lower limb lymphedema, but there is reason to believe that exercise for these patients can be performed with similar protocol.

Background

During the last decades the cancer survival rate has increased tremendous in the Western countries, however, leaving a lot of survivors with impairments. One of these impairments is lymphedema. If the diagnosis can be set on a very early stage and treated immediately, the condition can resolve [1]. Still the most common scenario is that the edema develops to a chronic condition.

Lymphedema develops as a result of accumulation of fluid in the tissue spaces due to an imbalance between interstitial fluid production and the transport system. After cancer treatment this imbalance is mostly caused by trauma to the lymph system, in particular when both lymph node surgery and radiotherapy is given. The incidence is 30-50% both in the upper limb after breast cancer treatment and in the lower limb after

gynecological, however a bit lower, about 10%, in prostate cancer [2-4]. Recent studies have reported that lymphedema secondary to cancer treatment has a negative impact on quality of life and more on patients with lower limb than with upper limb lymphedema [5].

Cancer survivors were for long recommended to live a sedentary life, however, a paradigm shift has taken place in cancer rehabilitation during the last decades, in particular in exercise and lymphedema. The aim of this narrative review is to describe this shift in a historical perspective.

Method

No literature search has been performed solely for the present historical review, but is based on key articles and

systematic reviews including meta-analysis [6-12] during the last decades.

The History of Exercise Related to Lymphedema Risk

The most efficient treatment for lymphedema, related to cancer treatment, is compression by garments or bandages, but patient education also including exercise is an important implement [13]. However, for long exercises for lymphedema patients were recommended to be "remedial" which at that time in the 70's and 80's, mostly included different range of motion movements of the limb, slow and without weights [14]. This behavior was probably based on the theory that simple obstruction of the lymph flow by lymph node surgery was the sole cause of cancer related lymphedema. Therefore it was believed that if cancer survivors were performing vigorous exercises, the lymph production would increase and thereby increase the limb volume. The conclusion was that only movement therapy should be used with the intention to support the venous and lymphatic flow in the bandage, meaning muscle contractions without increased blood flow [14].

Another reason for not performing vigorous exercise may be based on the doctor's experience that patients have claimed that a development of lymphedema started by e.g. lifting a heavy object, and therefor started to recommend patients not to do heavy lifting. Recommendations were even specified that far those patients were told not to carry anything more heavily than 2 liter of milk. At that time recommendations very easily were established without any evidence. Unfortunately that also happens quite often today too. When a new medicine is introduced it has to be tested step by step on animals, healthy subjects and patients before it is allowed into the market, but advices and recommendations are never tested that way and are most often not even evidence based. Still they can have an enormous influence to the patient e.g. for exercise.

For breast cancer patients the recommendations developed into issues like to avoid heavy work with the arm and not to "overload" the lymphatic system and "to be careful". And further on this was recommended not only to lymphedema patients but also as prevention for lymphedema development. These kind of recommendations from professionals created fear in the patients for development of lymphedema and promoted the idea that inactivity was beneficial. Due to this, many breast cancer patients became physically inactive with the arm even before a lymphedema had started [15]. In that

way they most likely slowly reduced strength and circulation to such a low level that even a small exertion, which normally would have been of no damage, suddenly provoked an impairment.

Another inactivity reason during the 90's was due to that chemo was introduced as an adjuvant cancer treatment causing side-effects like fatigue that in those days were "cured" with rest. Later we experienced that fatigue would rather be treated with physical activity and exercise. About the same time in the late 90's both patients and physiotherapists, out of experience, started to question the exercise restrictions that had been set previously. In the early 2000 evidence came for exercise being preventive for breast cancer when doing a couple of hours of medium level exercise per week [16]. Some years later it was also shown that physical activity after breast cancer diagnosis could reduce mortality [7]. Later on other cancer diagnosis, like prostate cancer and colon cancer could be included in the exercise prevention [17,18]. In the last years there are also growing evidence about exercise as pre-habilitation, that is an intervention with exercise, ideally in a multi-modal together with psychological and nutritional optimization, preparing patients immediately post-diagnosis for anti-cancer treatment, mostly surgery [19]. Many of these studies have included patients with gastrointestinal cancer or lung cancer, but could be important in other diagnosis as well.

The Need for Exercise in Cancer Rehabilitation

Today there is strong evidence that exercise is well tolerated and health-enhancing when performed in an individual tailored manner. Exercise during and after cancer treatment has a positive impact on side-effects and well-being, such as cancer-related fatigue, anxiety, and decreased physical function and Health Related Quality of Life [6,10]. Aerobic and resistance exercise training have also similar effects in patients with a cancer diagnosis, as in healthy individuals. When performing aerobic exercise training, body fat percentage and fitness level will be improved, and resistance training will improve muscle strength and lean mass.

Furthermore exercise meliorate the immune function and especially resistance training, also the chemotherapy tolerance [20]. There are research today suggesting that exercise improve efficacy of chemotherapy and maybe also radiotherapy, which could be a part of the explanation/ to the link between exercise and survival [21].

These findings, that the survival rate was dependent on exercise level, put a strong light on the exercise restrictions for lymphedema patients. The conclusion was obviously that patients with breast cancer related lymphedema were risking their lives by being less physically active than required.

At this time it was also found that a high Body Mass Index was a risk factor for development of lymphedema [22]. Though we know that reduction of body weight needs change of diet, increased physical activity is also an important part. These facts of course also increased the need for lymphedema patients to do exercise.

Exercise and Lymphedema Today

In particular for lymphedema patients, we have come a long way. It has been shown that the obstruction theory described above is a far too simple explanation [8] and the theory nowadays is rather based on the assumption that the lymphatic system and lymphedema may actually benefit from exercise [23].

Already in the mid 1990ies researchers in Canada observed that breast cancer survivors reduced fitness after cancer treatment [24]. They questioned the exercise restrictions and in 2000 a paper was published on Dragoon boat racing for breast cancer treated women, showing that a two months muscle strength training program followed by an eight month competition season did not increase the risk of getting lymphedema in the group [25]. Later on it has been followed by other studies revealing no risk of developing lymphedema by vigorous exercise [8]. In a larger study on almost hundred breast cancer survivors at risk of lymphedema, doing progressive weight-lifting with no upper limit, during a year, only 7% developed lymphedema in the arm compared to a control group with no exercise where more than three times (22%) got lymphedema [26]. These results point at that exercise may even serve as prevention. Later it was shown that a high-load weight-lifting program, applying 80% of 1 repetition maximum with 6-10 repetitions per set were as safe as a low-load program applying 60% with 15-20 repetitions, in patients with breast cancer related arm lymphedema [27].

Even more studies has been done to prove that an already established lymphedema do not get worse by vigorous exercise [9]. However, it is very important to notice that eg weight bearing exercises with the aim of increasing strength should be progressive meaning that if the patient had had no exercise for long, the exercise should be started on a low level and slowly increased and

supervised by skilled professionals checking for signs of increasing swollenness. On the other hand, a lot of studies show that cancer patients very well can do vigorous exercise during cancer treatment and benefit from it [19]. The more these findings are applied in practice within health care the less will the risk be that cancer survivors are totally sedentary during a long period of cancer treatment. Such a behavior will most likely also reduce the lymphedema incidence by time.

However, not all exercises are about weight lifting. Water-based exercises have been tested in several studies [12] with the idea that the pressure of the water may increase the effect of the exercise on the lymph flow. This benefit has not yet been proven, most likely depending on that some of the exercise programs tested have only been performed once a week which is too low frequency to be able to show an effect in any exercise. However, in a study evaluating the effect of pole-walking, twenty-three women with unilateral lymphedema completed an eight week exercise intervention consisting of pole walking 3-5 times per week, for 30-60 minutes, at 70-80 % of their maximum heart rate, preceded by a two week control period. The results revealed a lymphedema volume reduction and the high exercise frequency is probably the key to the effect and may be due to increased capillary supply providing a larger surface for capillary filtration and conductance [23,28].

Exercise like yoga and Qigong are very popular among cancer survivors and have been found to improve sleep quality and overall quality of life, and reduce fatigue [29]. However, very few studies of the effect on lymphedema has been published. A recent yoga protocol for breast cancer related arm lymphedema [30], including compression treatment and slow joint movements, appears very similar to what was recommended in the 70's by the Vodder school, see above. Breathing exercises has been added [31], however, deep breathing solely has never been observed to increase lymph flow, excepted for by high force inhalation in healthy subjects [32], and is not considered to give any clinical effect on lymphedema.

The vast majority of exercise studies are related to upper limb lymphedema and there are very few studies performed concerning lower limb lymphedema. This is most likely due to the fact that measurements of lower limb is much more difficult to get reliable than for the upper limb, where you most often has a healthy side to compare to. A healthy side cannot be guaranteed in cancer related lower limb lymphedema because nodes are often taken and radiation is often given to both sides. It is still a challenge to researcher to handle these difficulties.

Katz, et al. showed in a pilot and feasibility study that progressive weight training for 5 months does not worsen total leg volume in 10 patients with LLL secondary to cancer treatment [33]. This supports the thought that there is no reason to believe that exercise for patients with lower limb lymphedema should be performed in any other way than exercise for upper limb lymphedema. It is also reasonable to assume that water based exercise standing and walking on the bottom of the pool would be beneficial to lower limb lymphedema as the water pressure by the foot (1 m water \approx 70 mmHg) then can be even higher than by compression stockings (> 60 mmHg for highest compression class 4).

At last the question of wearing or not wearing compression garment while exercising. A recent review stated that there is no consistent evidence for the importance of wearing compression during exercise [10]. There may be a small favor of wearing compression but on the other hand no deterioration was found when not wearing compression. The conclusion was that the compression should be applied on an individual basis, that is, it is better to refrain from compression than to refrain from exercise because the compression is not comfortable [10].

In summary, this historical review points at the sedentary behavior, earlier recommended to patients at risk of developing or with already established lymphedema in upper or lower limb, found not being beneficial for these groups of patients. On the contrary they can be encouraged to regularly perform vigorous exercise, starting on a low level with progression of exacerbation with no upper limit as long as no deterioration can be found. To our clinical experience the kind of exercise is less important as long as large muscle groups of the affected limb are involved and the training is performed with high frequency.

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