Effectiveness of complex physical therapy of lymphoedema - evaluation in clinical practice

Ocena efektów leczenia fizjoterapeutycznego obrzęku chłonnego w praktyce

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Abstract

Combined Physical Therapy (CPT) is an effective method in the therapy of developed limb lymphoedema. It results in marked clinical effects including: oedema volume reduction, limb function improvement, decreasing physical symptoms. There are numerous assessment methods available, which creates difficulties in relative evaluation / meta-analyses (eg. among different therapeutical schools). Basic method of evaluation involves comparing affected limb volume or oedema volume (i.e. the difference in limb volumes between the affected and unaffected side) calculated from circumference measurements, before and after physical treatment. Relating limb volume or edema volume to normal limb volume allows us to compare patients with lymphoedema who are constitutionally different. Apart from limb volumes assessment, evaluation of oedema consistency is also important (pitting edema vs. non-pitting edema on palpation), which provides an information about disease progression. Other methods of assessment involve comparison of limb function – joint mobility defect, gripping force and evaluation of disturbances of hand manipulation and walking. Yet, another method of evaluation involves comparison of physical disorders associated with lymphoedema (usually limb pain, heaviness and weakness) and the health-related quality of life. Lymphoscintigraphy seems to be an objective method of evaluating lymphatic transport and the morphology of lymph distribution. Both dynamic and static scintigraphy are useful for assessing spontaneous lymph outflow from the affected limb before and after physiotherapy. In this article, methods of evaluating the efficiency of lymphoedema treatment are discussed, and a practical approach to lymphoedema management is proposed.

Słowa kluczowe

Obrzęk chłonny, obrzęk limfatyczny, kompleksowa fizjoterapia obrzęku, drenaż limfatyczny, kompresjoterapia, limfoscyntygrafia.

Streszczenie

Kompleksowa fizjoterapia (Combined Physical Therapy, CPT) jest znaną od dawna i skuteczną metodą postępowania leczniczego z wyboru w rozwiniętym obrzęku chłonnym - limfatycznym kończyn. Przynosi ona wymierny efekt kliniczny polegający na zmniejszeniu się wielkości obrzęku, ogólnej poprawie sprawności, zmniejszeniu się dolegliwości towarzyszących chorobie. W ocenie skuteczności terapii stosuje się różne metody, co stwarza trudności porównawcze (np. pomiędzy różnymi ośrodkami fizjoterapeutycznymi). Podstawowym sposobem ewaluacji jest porównanie objętości kończyn lub obrzęku (rozumianego jako różnica pomiędzy kończyną chorą i zdrową) obliczonych w oparciu o zmierzone obwody, przed rozpoczęciem i po zakończeniu leczenia. Odniesienie objętości kończyny lub obrzęku do objętości kończyny pozwala na

porównanie zaawansowania u chorych różnych konstytucjonalnie. Istotna jest też ocena konsystencji obrzęku (tj. charakter plastyczny, elastyczny lub twardy) świadcząca o stopniu zaawansowania choroby. Kolejnym sposobem oceny jest porównanie sprawności kończyny, w oparciu o ograniczenie zakresu ruchów w stawach, ubytek siły mięśniowej oraz o ocenę zaburzeń funkcji manipulacyjnej ręki lub patologii chodu. Inną wykorzystywaną metodą oceny jest porównanie wybranych dolegliwości fizycznych towarzyszących obrzękowi i często zgłaszanych przez chorych (zwykle są to ból kończyny, nadmierny ciężar lub osłabienie, rzadziej rozpieranie skóry, drętwienie i mrowienie) oraz ocena jakości życia związanej ze zdrowiem (HRQoL). Obiektywną metodą oceny szybkości przemieszczenia się płynu tkankowego oraz morfologii jego rozmieszczenia w zajętych obrzękiem tkankach jest limfoscyntygrafia. Zarówno badanie dynamiczne (w pierwszych minutach) jak i statyczne (po kilku godzinach) można wykorzystać do oceny niewymuszonego odpływu chłonki przed i po leczeniu. W pracy szczegółowo omówiono poszczególne sposoby oceny kompleksowego leczenia obrzęku i zaproponowano jej modelowy system możliwy do zastosowania w praktyce.

Introduction

Physiotherapy as a method of treatment of developed oedemas has been known for over one hundred years. A therapy with this method, involving delicate massage originating in central regions, bandaging with non-elastic bandages, maintenance of skin hygiene and performing physical exercises, was first described in the Billroth's manual of surgery by a Belgian F. Winiwarter in 1892[1]. The technique of manual lymph drainage (MLD) was improved by E. Vodder et al.[2] in the thirties. Currently, the so-called combined physical therapy (CPT), more and more commonly used also in Poland in the last several years, is the treatment of choice in developed lymphoedema. It involves a special form of lymph drainage – completely distinct from the classical massage, compression therapy using pneumatic pumps and/or multi-layer bandaging with poorly elastic, heavy-woven bandage, appropriately selected physical and respiratory exercises, as well as education of patients on trauma prevention and skin hygiene. Two CPT phases can be distinguished: the early phase, usually several to twenty days, aiming at fast reduction in oedema size, and the late, life-time phase, enabling maintenance of the effect achieved earlier. Various components of CPT are emphasised in several leading therapeutic schools (Vodder, Földi, Leduc, Casley-Smith).

Physical therapy results in a measurable effect involving a reduction in oedema size, improvement of limb function, alleviation of ailments, as well as an improved spontaneous lymph drainage from the affected limb. Authors evaluating therapeutic efficacy use various assessment methods. This is associated with a difficulty in comparing effectiveness of various therapeutic schools and with problems in the evaluation of particular components of therapy.

Consistency of lymphoedema and skin trophic changes

The degree of lymph drainage insufficiency and its duration affects oedema consistency and size. Initially, it is small, temporarily disappears (e.g. after the night or when the extremity is elevated) and has plastic properties – i.e. following its pressure with a finger, small foveas are formed (as a result of accumulation and retention of fluid in the subcutaneous tissue). With disease duration, the cells suspended in the oedematous tissue form a new connective tissue thus changing oedema consistency, which then becomes more resilient but is still soft. In the next phase, there is a progressive disturbance of blood supply to the tissues and skin complications develop (such as hyperkeratosis, skin papillae, infections, exudation of the tissue fluid or ulcerations), which results in augmentation of the present imbalance between the formation and drainage of the lymph thus aggravating the oedema.

Introduction of the appropriate treatment of lymphoedema induces inhibition and reversal of the above mentioned pathophysiological changes. A change in the size of large plastic oedemas (dominance of fluid over the connective tissue within the oedema) into a small elastic oedema resulting from removal of excessive fluid (the connective tissue remains) is an early evident effect of the physiotherapeutic treatment. Practically, palpation is a sufficient method of oedema assessment. In clinical studies, specially designed tonometers are applied that use similar assessment methods as the mechanical ophthalmologic tonometers[3].

Limb volume and oedema size

For the estimation of limb size, volume of water expelled by the extremity, optoelectronic measurement and measurements of limb circumferences are used. The first of the methods is associated with difficulties in the disinfection of the measurement vessel, the second involves access to expensive devices. Measurements of limb circumferences is a practical method, characterised by high precision and reproducibility – sufficient for clinical assessment. It is usually recommended to measure the circumferences every 4 or 10 cm on the same heights, most often at bone eminences of the limbs. For the evaluation of oedema therapy efficacy, both particular limb circumferences and their sum prior to and after the treatment are compared.

Based on the circumferences of the extremity measured every 4 cm, it is possible to estimate its volume, e.g. applying a simplified formula for the volume of a truncated cone[4] (Equation 1).

Equation 1
A simplified formula for the volume of truncated cone

$$V = \frac{1}{4}\ \pi\ (c_1c_2 + c_2c_3 + c_3c_4 + ... + c_{n-1}c_n)$$

V – limb volume (w cm^3)
c – circumferences measured every 4 cm
n – number of measurements

When the volumes of the affected and the non-affected extremity are calculated, the size of the oedema can be determined (expressed as the between-limb difference) (Equation 2). Referring the oedema size to the size of the healthy extremity enables a comparison of lymphoedema (LO) severity among different patients.

Equation 1
Calculation of relative oedema volume

$$Vrel = \frac{V_{aff} - V_{hlth}}{V_{hlth}} 100\% = \frac{V_o}{Vhlth} 100\%$$

V_{rel} – relative oedema volume (size) expressed in %
V_{aff} – volume of the affected extremity
V_{hlth} - volume of the healthy (not affected) extremity
V_o – oedema volume

For the assessment of therapy efficacy based on the limb volume, three methods can be used: one of them is based on the measurement of the affected extremity only, the two remaining methods involve calculation of the differences between the affected and the healthy limb.

The first of the methods uses differences between limb volume before and after the treatment. The achieved result can be expressed as percent points, assuming the volume of the affected extremity before CPT as 100%, which is expressed in the Equation 3.

Equation 2

Calculation of therapy efficacy using volume of the affected extremity

$$A = \frac{\mathrm{Vaff2} - \mathrm{V_{aff2}}}{\mathrm{V_{aff1}}} 100\%$$

A – change in the volume of the affected extremity expressed in %

V_{aff2} *– volume of the affected extremity after CPT*

V_{aff1} *- volume of the affected extremity before CPT*

This method enables a calculation, by what percent the affected limb was changed during the therapy as compared to its pre-CPT volume. Although the obtained result informs about a change in oedema, conclusions about the degree, to which oedema was affected by the therapy, cannot be drawn, because it does not represent the size of the oedema, but only describes the volume of the whole limb. It is, therefore, not possible to precisely determine, what part of the oedema was reduced, or whether oedema completely subsided. Besides, this measure does not consider exogenous factors affecting the measured entity – e.g. changes in hydration of the tissues. To correctly conclude based on the results obtained this way, an assumption must be accepted that the influence of exogenous factors on the affected extremity is negligible. Only in such a situation do volume changes of the massaged extremity result from CPT.

Therefore, an attempt to distinguish the oedema itself, defined as the difference between the affected and the contralateral healthy extremity, is useful. Thus, the second method does take into account a model – the healthy, contralateral hand – as the reference enabling estimation of oedema size. The result obtained this way was presented in percent points assuming 100% as the volume of the oedema before the treatment (Equation 4).

Equation 4

Calculation of therapy efficacy based on oedema volume.

$$\mathrm{B} = \frac{\left(V_{aff\,2} - V_{hlth2}\right) - \left(V_{aff\,1} - V_{hlth1}\right)}{V_{aff\,1} - V_{hlth1}} 100\% = \frac{V_{v2} - V_{v1}}{V_{v1}} 100\%$$

B – change in the volume of lymphoedema expressed in %

V_{aff2} *– volume of the affected extremity after CPT*

V_{hlth2} *- volume of the healthy extremity after CPT*

V_{aff1} *- volume of the affected extremity before CPT*

V_{hlth1} *- volume of the healthy extremity before CPT*

V_{v2} *- volume of lymphoedema after CPT*

V_{v1} *– volume of lymphoedema before CPT*

The result obtained this way represents percent change in the oedema size in relation to oedema size before CPT. Therefore, it describes the status of the oedema itself that is the degree of its change following CPT. It can, e.g., determine, whether a complete oedema reduction occurred or not. This result also takes into account the effects of changes in tissue hydration. However, it does not consider a relative character of the oedema in relation to various limb sizes. For example, a 200 cm^3 change in oedema size is interpreted identically in an extremity of a 1500 cm^3 volume and an extremity of a volume of 3000 cm^3. However, in a clinical evaluation, LO has a variable severity in such cases (seems to be more severe in constitutionally thinner limbs). For a correct interpretation of the results obtained based on the changes in oedema volume, it is necessary to assume that exogenous factors affect both extremities identically. Only in such a situation will the difference between the extremities not change and the result depend on CPT.

The problem of relativity of oedema with regard to individual differences in limb size may be solved by relating the oedema size to the size of the healthy extremity (before and after the treatment respectively) (Equation 5)[5].

Equation 5
Calculcation of therapy efficacy based on oedema volume in relation to volume of the healthy extremity

$$C = \frac{\frac{V_{v2}}{V_{hlth2}} - \frac{V_{v1}}{V_{hlth1}}}{\frac{V_{v1}}{V_{hlth1}}} 100\%$$

C – change in relative LO volume

By relating size of the oedema to volume of the healthy extremity enables comparison of lymphoedema severity in different patients independently of individual limb sizes and thus e.g. comparing the effectiveness of therapy in different therapeutic centres. Similarly to the method B, taking into account volume of the healthy extremity, it allows to consider the effects of e.g. various hydration statuses of the tissues before and after the treatment, that is factors that affect volume of both extremities proportionately to their baseline volume. The result obtained this way is, however, more abstract and is less comprehensible for the patients or physiotherapists.

Agility of the extremity

Lymphoedema, especially if large, significantly reduces agility of the extremities, disturbs functioning of the motor system, the nervous system, as well as the cardiovascular and respiratory systems. Joint mobility becomes reduced, muscle strength decreases, manipulative movements of the hand worsen, the gait becomes impaired and the posture is altered[6].

Measurement of motion range involves application of a goniometer on the planes of movements in the joint. Range of motion of the affected articulation is usually compared with the contralateral side, and in case of restriction of movements on the healthy side, it is referred to the normal value appropriate for the given joint. It is noteworthy that, analogically to the measurement of oedema size (Equation 2), a reduction of mobility can be compared to normative data according to the Equation 6:

Equation 3
Calculation of relative reduction of joint mobility.

$$D_{rel} = \frac{D_{aff} - D_{hlth}}{Dhlth} 100\%$$

D_{rel} – relative reduction in mobility expressed in %
D_{aff} – range of motion in the joint on the affected side
D_{hlth} – range of motion in the joint on the healthy side

Decrease of muscle strength usually results from muscle atrophy or peripheral nerve damage. Tests most frequently used to evaluate muscle strength include exerting manual resistance by the examiner, who subjectively rates the force exerted by the patient. Testing of muscle strength according to a 6-point Lovett scale is also a commonly used method[7]. Using dynamometers (e.g. a sphygmomanometer for the measurement of handgrip strength) allows achievement of more objective results by expressing the reduction of muscle strength as a relative value compared to the healthy extremity (see Equation 6).

Apart from disturbances of joint mobility and muscle strength, in patients with oedema, a reduction in manipulative hand function associated with performance of precise movements as well as gait disturbances is observed. Assessment of the hand as an organ enabling gripping involves its structure and function. Function of

the hand depends not only on its mobility, agility and muscle strength of the fingers, but also on the agility of the extremity as a whole. To evaluate the hand as a gripping organ, assessment of pincers grip, involving picking up a small object held between fingertips of the thumb and the index finger, can be used.

Gait is a complex process depending on proper functioning of the joints, muscles and the nervous system. In gait assessment, the following factors are considered: positioning of the lower extremities (in abduction, adduction, external rotation, internal rotation), loading of the limbs (symmetrical, shortening of the loading phase), stride length, presence of pain or stuttering.

Large lymphoedema unfavourably affects body posture by disturbing the symmetry of position of the shoulders and the pelvis. Shoulder on the affected side is usually lowered. Positioning of the upper extremity in flexion in the elbow joint and adduction towards the chest is characteristic for a large oedema.

Physical complaints

Most frequent complaints reported by the patients include: weakness of the limb, its excessive weight, a feeling of skin distension at the site of oedema, sensory disturbances in a from of numbness and / or tingling. Pain and superficial sensation disturbances can be associated not only with an advanced oedema, but also with peripheral nerve lesion as a result of a surgical procedure (e.g. mastectomy), with post-radiotherapy or post-chemotherapy fibrosis. These ailments are usually mild, although they may also be serious (up to total damage to nerve plexuses) and require pharmacotherapy[8].

The intensity of the ailments can be measured by means of e.g. a simple, five-degree Likert scale, where 0 indicates a lack of a symptom, 1 – a small intensity of a given symptom, 2 – medium intensity, 3 – high intensity, 4 – very high intensity of the evaluated symptom. Intensity of symptoms is more precisely expressed in a numeric scale (Numeric Rating Scale, NRS) or an analogue visual sclae (Visual Analog Scale, VAS). The patient describes the intensity of a given symptom on a sclae ranging from 0 (minimal intensity) to 10 (maximal intensity) on a specially prepared ruler (Figure 1). Reliability of the results obtained in the two scales depends on patients' cognitive function that can be assessed using scales of cognitive functioning (Cognitive Assessment Scale, Mini Mental State Examination)[9]. In cases, where the oedema is not treated for a longer period of time, the risk of occurrence of complications increases, which can further aggravate the symptoms 10.

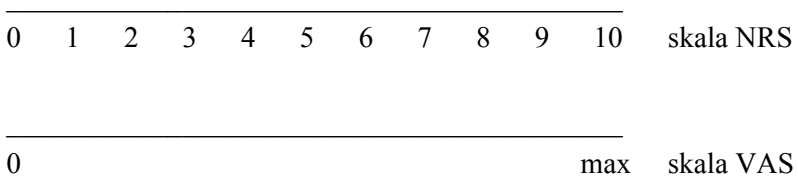

Figure 1
NRS and VAS scales

Health-related quality of life

Health related quality of life (HRQoL) comprises much wider area aside from somatic ailments or the intensity of psychological pathological characteristics. The K. Calman's concept is one of the most widely recognised hypotheses of HRQoL. He assumed the quality of life as a discrepancy between the current real situation and patient's expectations[11]. Greater discrepancy between those areas represents a lower quality of life. Both the real picture and the expectations should be evaluated in different aspects, such as a physical, mental and social aspect. According to this theory, it is possible to improve the quality of life without an improvement (and even at worsening) of the physical or mental aspect. One of the valuable scales assessing HRQoL is the Edmonton Symptom Assessment System (ESAS)[12]. This scale evaluates nine principal aspects of life using the Visual Analogue Scale (VAS): pain, general physical activity, general feeling, nausea, appetite, dyspnoea, depression, anxiety and drowsiness. Polish translation of the ESAS is available[13]. This scale is characterised by appropriate reliability, is easy to use both for the patients, their families and medical staff and is also universal – common in

many oncological centres. For the assessment of HRQoL, it is also possible to use more advanced questionnaires designed specially for patients with lymphoedema, e.g. Lymphoedema Questionnaire[14].

Lymphoscintigraphy

Scintigraphy, a relatively low-invasive, although costly method, is a gold standard in the evaluation of lymphatic drainage[15]. Distribution and rate of translocation of the isotope marker reflects the localisation and shift of the lymph within the extremity in this assessment procedure[16]. An indirect scintigraphy is most frequently used, with shallow subcutaneous administration of the marker into interdigital spaces (usually technetium Tc99m-labeled human albumin, approx. 30 MBq, serves as the marker)[17]. A dynamic study illustrating the dynamics of marker activity in the first minutes following its administration, as well as a static assessment imagining distribution of the marker during the stable distribution phase after several hours. Dynamics of increase of activity in selected limb regions (lymph nodes, cutaneous co-lateralisation of lymph drainage, whole extremity) and morphology of marker distribution during the static assessment are evaluated[18]. By repeating scintigraphy before and after subsequent phases of physiotherapy, especially the static images can be compared, which usually demonstrate a reduction in retention of the marker in the interstitial tissue (decrease of the extent of cutaneous co-lateralisation)[19].

Conclusion

Detailed and systematic evaluation of the effects of therapy of lymphoedema should constitute an integral part of patient care because of the chronic course of the disease and its sequels associated with multiple aspects. During the first visit, special attention is focused on the diagnosis of oedema aetiology, disease duration and past complications. During subsequent visits, concomitant symptoms and patient's quality of life are evaluated. In the examination, general limb outlook is considered, volumes of the affected and healthy limb are measured, as well as limb agility is monitored (Table 1).

The necessity of standardisation (unification) of each assessment method should not be neglected, which should involve performance of subsequent measurements in possibly similar conditions. For example, it is essential for the reproducibility of measurements of limb circumferences to perform them at equal time intervals following termination of each therapeutic session. During the first, more intense phase of physiotherapy, dimensions and consistency of the oedema changes every day; therefore, the assessments are performed more frequently, even on a daily basis (e.g. before each limb bandaging). If subsequent measurements do not demonstrate any further reduction in limb volume, the second treatment phase is initiated – the supportive phase that is performed by the patient himself and involves self-drainage, wearing fitted compression sleeves, systematic performance of physical and respiratory exercises as well as maintenance of appropriate skin hygiene. During this period, periodic ambulatory follow-up visits are also necessary that aim at monitoring the therapy and reinforcement of patients' motivation for systematic rehabilitation and years-long patience. Frequency of subsequent follow-up examinations depends on the previously achieved therapeutic effect and the degree of patients' systematic self-therapy. Initially, follow-up visits are scheduled every several weeks and the inter-visit intervals are gradually prolonged to several months. In case of worsening of oedema or occurrence of complications requiring re-introduction of intensive treatment, it is again necessary to perform the assessments more frequently.

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Tabela 1

Recommended parts of follow-up examination in a patient with lymphoedema

history:	- presence of oedema:	- periodically remitting - altering in time - consolidated	performed routinely
	- localisation		
	- concomitant ailments		
	- quality of life		
physical examination:	- consistency of oedema:	- plastic - elastic - hard	
	- presence of skin changes		
	- volume of the affected limb		
	- volume of oedema		
	- limb agility:	- range of movements - muscle strength - gait, gripping ability	
ancillary tests	biochemical:	when aetiology other than lymphatic system failure is suspected	optionally
	duplex doppler of the arteries and veins:	when disturbances of limb blood flow are suspected	
	lymphoscintigraphy:	when confirmation of lymphatic system failure is necessary	

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