Original Article

Yoga protocol for treatment of breast cancer-related lymphedema

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ABSTRACT

Introduction: Vaqas and Ryan (2003) advocated yoga and breathing exercises for lymphedema. Narahari *et al*. (2007) developed an integrative medicine protocol for lower-limb lymphedema using yoga. Studies have hypothesized that yoga plays a similar role as that of central manual lymph drainage of Foldi's technique. This study explains how we have used yoga and breathing as a self-care intervention for breast cancer-related lymphedema (BCRL).

Methods: The study outcome was to create a yoga protocol for BCRL. Selection of yoga was based on the actions of muscles on joints, anatomical areas associated with different groups of lymph nodes, stretching of skin, and method of breathing in each yoga. The protocol was piloted in eight BCRL patients, observed its difficulties by interacting with patients. A literature search was conducted in PubMed and Cochrane library to identify the yoga protocols for BCRL.

Results: Twenty yoga and 5 breathing exercises were adopted. They have slow, methodical joint movements which helped patients to tolerate pain. Breathing was long and diaphragmatic. Flexion of joints was coordinated with exhalation and extension with inhalation. Alternate yoga was introduced to facilitate patients to perform complex movements. Yoga's joint movements, initial positions, and mode of breathing were compared to two other protocols. The volume reduced from 2.4 to 1.2 L in eight patients after continuous practice of yoga and compression at home for 3 months. There was improvement in the range of movement and intensity of pain.

Discussion: Yoga exercises were selected on the basis of their role in chest expansion, maximizing range of movements: flexion of large muscles, maximum stretch of skin, and thus part-by-part lymph drainage from center and periphery. This protocol addressed functional, volume, and movement issues of BCRL and was found to be superior to other BCRL yoga protocols. However, this protocol needs to be tested in centers routinely managing BCRL.

Key words: Breast cancer-related lymphedema; breathing; integrative medicine; range of movement; yoga.

INTRODUCTION

Options for the management of lymphedema in long term which promote self-efficacy and improved function are integral to patient management. Yoga for lymphedema was first successfully demonstrated, both in institutional and community setting as self-care tool for lower-limb lymphedema by Narahari *et al*.[1,2] They used yoga in 3543 patients as part of the integrative treatment. The integrative medicine (IM) protocol included skin wash, soaking with herbalized solution, *phanta*, bacterial entry point (BEP) care using modern dermatology drugs, Indian Manual Lymph Drainage (IMLD), and compression bandaging with two sessions of yoga. Aggithaya *et al*. used yoga as the only

Access this article online

Website: www.ijoy.org.in

DOI: 10.4103/0973-6131.183713

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How to cite this article: Narahari SR, Aggithaya MG, Thernoe L, Bose KS, Ryan TJ. Yoga protocol for treatment of breast cancer-related lymphedema. Int J Yoga 2016;9:145-55.

intervention in 425 patients in village camps.[3] Since then, yoga is used by many patients with lymphedema.[4] Yoga is currently the focus of a number of studies internationally. "Using yoga in breast cancer-related lymphedema (BCRL)" was reviewed by Loudon *et al*.[5] They identified differences in the interventions of using yoga as the only intervention in each protocol. It is important that therapists gain quality, objective evidence about its benefits physically, medically, and mentally. When it is shown to be effective, it means an increasing emphasis on home-based management and patient-centered protocol. To use yoga as a self-care tool in the management of BCRL, it should be in alignment with the International Consensus of Lymphology.[6] Only then studies conducted in higher levels of evidence methods will reflect actual benefit in BCRL. However, there is a dearth of researches on structured ways of using yoga exercises (postures/asana, commonly known as yoga) for upper-limb lymphedema.[5]

This study explains the methodology used to develop yoga and breathing as a self-care protocol for upper-limb lymphedema and the physiological basis of yoga sequence to achieve maximum outcome.

METHODS

Research design

The objective was to develop an appropriate yoga sequence/protocol for upper-limb lymphedema to achieve the desired range of movements, reducing fibrosis, and improving lymph drainage. Several focus group discussions of multi system medical team (MSMT) were conducted to develop a yoga protocol for upper-limb lymphedema. The MSMT comprised biomedical dermatologists, physiotherapists, ayurvedic physicians, yoga therapists, and nurses. The discussions were moderated by a dermatologist (SRN), who is an expert in lymphedema research. Yoga therapist demonstrated yoga as per narrations in the book, "Complete Illustrated Book of Yoga," written by Swami Vishnudevananda.[7] MSMT documented joint movements, actions of muscles on joints, anatomical areas associated with different groups of lymph nodes and stretching of skin in each yoga and brainstormed its appropriateness for international consensus outcomes of BCRL. Other components of IM for lymphedema are already standardized, elaborated, and discussed earlier.[8] The protocol was then reviewed by lymphedema expert (TJR) and physiotherapist (LT) and validated [Table 1].

Table 1: The sequence of yoga practiced in upper-limb lymphedema in the Institute of Applied Dermatology

Pre-IMLD yoga[ii]	Post-IMLD yoga[i]
Warm up yogaii	Warm-up yoga
Tada asana 1 and 2 (*Thada*=mountain)	*Tada asana* 1
Trikona asana (*Trikona*=triangle)	*Trikona asana*
Pranayamas	*Pranayamas*
Ujjayee (*Ut*=up; *Jayi*=victory, toward victory)	*Ujjayee*
Anuloma-viloma (inspiration and expiration in one nostril)	*Anuloma-viloma*
Rechaka - kumbhaka (inspiration and expiration using alternate nostrils)	*Rechaka - kumbhaka*
Suryabhedana (passing through *suryanadi* [right nostril])	*Suryabhedana*
Bhastrika (bellows of a blacksmith)	*Bhastrika*
Yoga to improve ROM and facilitate peripheral lymph drainage	Yoga to improve ROM and facilitate peripheral lymph drainage
Swastikasana (*Swastika*=an auspicious sign)	*Swastikasana*
Vajrasana (*Vajra*=diamond)	*Vajrasana*
Gomukha asana (*Go*=cow, *Mukha*=face)	*Greeva Sanchalana*
Greeva Sanchalana (*Greeva*=neck; *sanchalana*=movement)	*Mustikabandha*
Mustikabandha (*Mustika*=fist; *bandha*=tight holding)	*Manibandha naman*
Manibandha naman (*Manibandha*=wrist; *namana*=bending)	*Manibandha chakra asana*
Manibandha chakra asana (*Manibandha*=wrist; *Chakra*=rotatory movement)	*Rajjukarshana asana*
KehuniNamana (*Kehuni*=elbow; *Namana*=bending)	*Kashta Takshana asana*
Skanda chakra asana (*Skandha*=shoulder; *Chakra*=rotatory movement)	*Prasrutha Hasthapada asana*
Rajjukarshana asana (*Rajju*=rope; *Karshana*=pulling)	
Kashta Takshana asana (*Kashta*=wooden log; *Takshana*=breaking using axe)	
Bhekasana (*Bheka*=frog)	
Makarasana (*Makara*=crocodile)	
Prasrutha Hasthapada asana (*Prasrutha*=elevated, *Hasta*=hand, *Pada*=leg)	
Viparithakarani (*Vipareetha*=opposite, *Karani*=body)	
Relaxation	Relaxation
Shava asana 1 and 2 (*Shava*=cadaver)	*Shavasana* 1 and 2

[i]Pre-IMLD yoga was done prior to compression bandage and post-IMLD yoga was practiced with compression; The exercises which need flexion of the joints were avoided in post-IMLD yoga; Post-IMLD yoga was performed after 3 h of pre-IMLD yoga; [ii]*Asana* means posture; All the yoga are to be performed in sequence of Group 1 to Group 4. In Foldi's technique, the MLD treatment of an extremity starts proximally; This allows the successful mobilization of fluid from periphery; Here, yoga were adopted to achieve movements and pressure over the group of lymph nodes in the same pattern to simulate MLD of Foldi's technique. Yoga exercises are generally named after an object, animal, or naturally occurring things. The name of the yoga is in italic (Sanskrit) and its meaning in parenthesis. IMLD = Indian Manual Lymph Drainage, ROM = Range of motion

The protocol piloted with 8 BCRL patients with grade 3 upper-limb lymphedema with a mean age of 59.25 years attended the Institute of Applied Dermatology's (IAD) integrative lymphedema clinic during 2007–2014. The duration of the disease ranged from 4 to 19 years. Those patients, who agreed to long-term treatment and had a family member for assistance, were enrolled in this study. Patients signed written consent forms after attending the pretreatment counseling. Volume and girth measurements

were done in all patients at baseline and follow-ups. Yoga was performed in the presence of MSMT to observe patients' difficulty to perform the exercises. We developed alternate postures to the patients who could not perform these as desired by the therapist to facilitate yoga learning [Table 2].

The developed protocol was demonstrated and discussed in a separate yoga session during the 2nd and 3rd International Lymphedema Framework conferences held in Brighton (2010)[9] and Toronto, Canada (2011),[10] respectively.

A literature search identified PubMed,[11] the Cochrane library[12] clinical trials done on yoga, and breast cancer survivors (BCS). Another search was conducted for clinical trials using yoga for BCRL patients. The search strategy was (upper-limb lymphedema OR BCRL OR postmastectomy lymphedema) AND yoga AND (Limb volume OR Volume OR Limb circumference OR Circumference OR Limb girth measurement OR Girth measurement OR Girth OR Quality of life OR Health-related quality of life OR arm circumference OR arm OR arm volume OR hand grip strength OR grip strength). MSMT studied the retrieved literature to identify the possible mechanisms of lymphatic drainage. We compared the action of the yoga in joint movements of yoga sequences of retrieved yoga protocols. Our yoga therapist performed all yoga. A raw data table for both protocols was prepared. Then the average of each joint movement was taken. For example, the spinal column has 5 joint movements: Flexion, extension/hyperextension, lateral flexion, reduction, and rotation. If a particular yoga has 3 joint movements, the ratio will become 3/5, i.e., a score of 0.6. In total, the ratio was taken assuming "1" as all movements in a particular joint and "0" as no joint movement. Then, joints were subdivided based on their action on possible upper-limb lymph drainage. Yoga involves whole body movement, and all joints are of concern including neck and shoulder joints (neck, shoulder, and upper limb) and peripheral joints (lower

Table 2: Alternate postures for difficult yoga initially taught to patients that helped them to achieve perfection as desired by the yoga therapist

Yoga	Problems in attaining ideal postures	Alternative postures
Tada asana 1	Balance; difficult to lift the affected limb due to weight and restricted joint movements	Weight bearing and passive movement of affected limb with the help of unaffected limb or standing against a wall if patient has both upper and lower-limb lymphedema
Tada asana 2	Balance; difficult to lift the affected limb due to weight and restricted joint movements	
Trikona asana	Balance; restricted movement and heaviness of affected limb	
Gomukha asana	Restricted shoulder movements, difficult to clasp the fingers of both hands	Holding the cloth in both hands at back initially for few days, then clasping the cotton cloth by decreasing the gap of clasped hands to attain the final position by clasping both hands together
Mustikabandha asana	Difficult to hold the limb parallel to the ground	Sitting in squat position and giving support of knee or to perform in lying position
Manibandha naman asana	Difficult to hold the limb parallel to the ground; restrictions of the finger joints	
Manibandha chakra asana	Difficult to hold the limb parallel to the ground and restrictions in the joints	
Skandachakra asana	Restricted flexion in the shoulder joint due to edema; lack of muscle power to lift the arms during the asana; short muscles on the front of the chest	Passive movements with the help of home caretaker Attain posture in lying position. The arms pointing against the sky; make a smaller flexion in the shoulders
Rajjukarshana asana	Difficult to hold the limb perpendicular to the ground	Weight bearing with the help of unaffected limb
Kashta Takshana asana	Restricted flexion in the elbows; restricted rotation in the glenohumeral joint; lack of power to lift the arms during the rotation	Perform the asana with less flexion of the elbows Passive movements with the help of home caretaker
Bhekasana	Restricted flexion in the knees. Restricted extension in shoulders, hips and lower back	Use cotton band to hold the feet and tighten when shoulder extension and knee flexion become increased
Prasrutha Hasthapada asana	Short hamstrings; short neural tissue	Passive movements with the help of home caretaker
Viparithakarani asana	Restricted flexion in the elbows; difficult to hold the body by affected limb; restricted movement of neck; difficult to balance the body; too little strength in abdominal muscles	
KehuniNamana asana	Restrictions in the elbow and shoulder joints; lifting the weight of the affected arm	

limb joints). Both upper-limb lymphedema yoga protocols were compared in terms of movements achieved.

Intervention

Yoga was one of the components of treatment. The steps of treatment were in the following sequence: Counseling to explain the treatment and long-term treatment, ayurvedic oil massage of affected limb (IMLD - different from manual lymph drainage practiced in Europe), yoga before IMLD and after compression bandaging using long stretch bandages (different from short stretch bandages used in Europe). Tinea manuum, a fungal infection disrupting the epidermal barrier function, was the common bacterial entry lesion (BEP) and was treated using clotrimazole 1% cream. Repeated patient counseling and education was part of the protocol aimed at improving concordance to treatment. The sequence and types of yoga and breathing exercises used as a self-care program in upper-limb lymphedema are listed in Table 1. Other procedures were done as previously described by Narahari *et al*.[1,13]

Yoga was done either on empty stomach or 3 h after food. We advised that yoga should be done in a clean, silent room with good ventilation. Fan or air conditioners were switched off during the period. Patients wore loose garments during yoga. Breathing was incorporated for each movement which is a deviation from traditional practice.

There were two postures for yoga: The starting posture known as *samasthithi* and the final posture known as *sthithi*. The starting posture for all standing yoga was standing erect with feet parallel to each other and touching medially, placing the hands facing downward with stretched fingers. In sitting postures, it was done by patient sitting with both legs stretched and heels together, placing the palms on the floor by the side of the buttocks. The spine, neck, and head were in the same line. The starting posture for yoga done by lying was the supine position. During these postures, patients were asked to look straight ahead or to keep the eyes closed. Similarly, the final position was dependent on the yoga: For example, the final position of *Bhujangasana* was lying in supine position, bending the chest backward from lumbar region with the support of flexed hands and face facing upward (posture resembling a cobra hood). Patients moved from starting position to the final position slowly with breathing coordination and vice versa. The final position lasted for 10–15 breaths. Individual yoga was completed in 1–3 min and the whole session ended in 45 min.

Replica or *symbol* (known as *Mudra*) is the position of fingers and hands used during the yoga, especially while doing breathing exercises (known as *Pranayama*). In our protocol, we used three symbols: Symbol of good (*Chin mudra*), symbol of animal (*Mrigi mudra*), and symbol of salutation (*Namaskara mudra*). *Chin mudra* was performed by keeping thumb and index finger flexed and joined together. Other fingers were kept straight. Both the palms were kept on the folded knee facing upward in either *Padmasana* or *Swastikasana*. *Mrigi Mudra* was used to close nostrils for selective inhalation or exhalation during *Pranayama*. Here, the right forefinger and the middle finger were clenched while the thumb and other two fingers were kept straight. In *Namaskara Mudra*, both palms and fingers were kept together touching each other.

Breathing during yoga was long and diaphragmatic with patient concentrating on a point in front of the eyes. The flexion of joints was coordinated with exhalation and extension with inhalation. In classical yoga, breathing was performed after attaining the final posture. We incorporated breathing during every movement. Breathing methods adopted for different yoga are shown in Table 3.

A yoga therapist coached lymphedema patients. We introduced alternate postures during training sessions to the patients who could not perform these as desired by the therapist to facilitate yoga learning [Table 2]. All patients could gradually be weaned away from alternate postures to desired postures over 2 weeks. Later, patients were advised to continue yoga back at home daily. The follow-up period was 1 month and, 3 months later, it was supervised day care.

RESULTS

MSMT developed yoga and breathing protocol for BCRL and used them in a right sequence with an objective of achieving the desired range of movements, reducing fibrosis and improving lymph drainage. Twenty yoga and five breathing exercises were selected on the basis of their role in chest expansion, maximizing the range of movements of neck, shoulder, elbow, carpometacarpal, metacarpophalangeal, and interphalangeal joints: Activating muscle pumps in large muscles, maximum stretch of skin and activating muscles around axillary and cervical lymph nodes [Table 4]. Initial three yoga exercises were in standing position, next eleven were in sitting position, and the last four were done in lying position. All patients were trained to perform the yoga as shown in Table 1. Some yoga exercises such as *Mayurasana* (resembling peacock) were later removed from the list as patients could not be weaned away from alternate positions to final posture (*sthithi*). All yoga exercises were later aligned with the principles of lymph drainage described by Foldi *et al*.[14]

Yoga protocol was developed considering the feasibility of these complex movements in a disability of grade 3 lymphedema. The inclusion of yoga aimed at

Table 3: The breathing methods in yoga

Yoga	Breathing method
Tada asana 1, *Trikona asana*	Increased inhalation by chest expansion
Tada asana 2	Forceful exhalation due to increased abdominal pressure by flexion of spinal column
Swastikasana, Vajrasana	Relaxed abdominal muscles; thoracic breathing
Gomuka asana	Increased inhalation by chest expansion
Greeva Sanchalan, Mustikabandha, Manibandha naman, Manibandha chakra asanas, Kehuni Namana, Skandachakraasanas	Deep, slow inhalation with extension or abduction and exhalation with flexion or adduction of joints. The length of inhalation was more compared to exhalation
Rajjukarshana asana	Deep inhalation due to expansion of chest followed by forceful exhalation by sudden jerky depression of shoulder girdle
Kashta Takshana asana	Deep, slow inhalation followed by forceful exhalation by sudden jerky adduction of shoulder joint
Bhekasana	Higher abdominal pressure due to extension of spinal column and passive inward pressure of prone position; increased lung air capacity due to expansion of chest
Makara asana	Relaxed breathing; inward passive pressure on thorax and abdomen due to prone position
Shava asana 1 and 2	Relaxed breathing
Prasrutha Hasthapada asana, Viparithakarani asana	Here, flexion of hip leads to higher abdominal pressure. This influences breathing
Ujjayee, Anuloma-viloma, Rechaka - kumbhaka, Suryabhedanapranayamas	Deep, slow breathing either using both nostrils simultaneously or inhalation through right nostril, exhalation through left and vice versa
Bhastrika pranayama	Deep, slow, inhalation followed by forceful, multiple exhalations induced by abdominal and diaphragmatic contractions, leading to emptying of lung field

Table 4: Joint movements and muscles acting during yoga for upper-limb lymphedema

Yoga	Joint movements and actions	Benefits
Asanas acting on overall body *Thada* 1 and 2 *Trikona* *Bheka* *Makara* *Swastika* *Vajra* *Gomuka* *Rajjukarshana* *Kashta Takshana*	The joints involved are, spinal column, shoulder girdle, shoulder, elbow, wrist, hip, knee, ankle, tarsometatarsal and metatarsophallengeal joints These asanas act on all major muscles of the body	Activation of muscles over the lymph node groups Stretching induces dermal stretch such as anterior stretch in *Paschimothana asana*, posterior in *Tada asana* 2, *Bhujangasana* and *Bhekasana*, lateral in *Trikona asana* and upward stretch in *Tada asana* 1. This improves lymph drainage Increased abdominal pressure in *Bhujangasana* and *Bhekasana* activates rectus muscles *Gomukha asana* and *Bhekasana* allow chest expansion. This facilitates pressure change in thoracic regions which helps central lymph drainage
Pranayama *Ujjayee* *Anuloma-viloma* *Rechaka - kumbhaka* *Suryabhedana* *Bhastrika*	No significant joint movement but intercostal muscles, diaphragm, rectus muscles are activated	Improves respiration, thus increases oxygen consumption of the body Central lymph drainage
Asanas acting around lymph node groups *Greeva Sanchalana* *Mustikabandha* *Manibandha naman* *Manibandha chakra* *Kehuni Namana* *Skanda chakra*	The joints involved are neck, shoulder, elbow, wrist, carpometacarpaland metacarpophallengeal joint. Major muscles are sternocleidomastoid, obliquuscapitis, longissimus capitis, trapezius, deltoid, pectoralis major, coracobrachialis, biceps brachii, teres major, triceps brachii and other muscles	Increases joint movement Helpsperipheral lymph drainage due to the activation of muscles Nodal drainage
Asanas acting around lower part of the body *Prasrutha hasthapada* *Vipareethakarani*	The joints involved are neck, shoulder joint, hip and ankle joint Major muscles are gluteus maximus, adductors (longus, brevis, magnus), iliopsoas, tensor fasciae latae, rectus femoris, sartorius, semitendiunosus, semimembranosus, biceps femoris, gastrocnemius, soleus, plantaris, tibialis posterior, flexor hallucis posterior, flexor digitoriumlongus, tibialisanterior, extension digitorumlongus, extensor hallucislongus, peroneus tertius	Strengthening of abdominal muscles Allows chest expansion

improving shoulder joint movement and function, pain, inactivity, reducing the fibrosis of interscapular region, improvement in disabilities of shoulder and hand joints, improving grip strength, and reducing volume and weight of affected upper limb. Yoga protocol was developed with a sequence for part-by-part movement of the body joints to facilitate central to peripheral lymph drainage. This was done by observing the muscle actions and joint movements when a yoga therapist performed different kinds of yoga. Repeated trial and error experimentation (several rounds of yoga performed by therapists) helped to rearrange the sequence and adopting the yoga. Tables 1 and 4 give details of the observation when yoga therapist performed yoga and later confirmed when grade 3 lymphedema patients practiced this protocol. Alternate positions were used to introduce yoga to patients and negotiate their painful movements in fibrosed lymphedematous limbs. They were done using other supportive measures such as holding the cloth [Figure 1] and passive exercises with the support of unaffected limb [Figures 2 and 3] or with the support of therapist/home caretaker [Figure 4]. The volume reduced from 2.4 to 1.2 L in eight patients after continuous practice of yoga and compression at home for 3 months. There was significant improvement in the range of movement and pain.

A literature search revealed 21 clinical trials in PubMed, which focused on meditation and *pranayama* to achieve mindfulness-based stress reduction, sleep quality, and quality of life of BCS. Four articles were obtained in PubMed describing two protocols for BCRL whereas Cochrane CENTRAL retrieved 3 articles. There were no systematic reviews done for yoga in BCRL. The two yoga protocols are (i) Loudon *et al*.[15] and (ii) Fisher *et al*.[16] The study by Loudon *et al*. is based on the original text of Swami Satyananda Saraswati[17] and Fisher *et al*. did not describe any textual/traditional references. We compared the three yoga protocols based on joint movement, breathing, method of lymphatic drainage, and yoga sequence [Figure 5]. Loudon *et al*.[15] described a 75 min yoga program for BCRL. It included 10 min of settling and breathing by settling with awareness (*Kaya Sthairyam*), inner silence (*Antar Mouna*), and abdominal, thoracic, clavicular, and full yoga breathing (*Pranayama*). The 25 min practice of postures includes 17 yoga exercises. After postures, mindfulness, Pranayama, meditation by *Kaya Sthairyam*, *Antar Mouna* (two levels), alternate nostril breathing (*nadishodhan*), visualization one-pointed focus-lymph system (*dharana*), and meditation one-pointed focus candle (*tratak*) was done for 10 min. The relaxation–meditation was done by 10 min of deep relaxation (*yoga nidra*). This study was done on women who were clinically diagnosed with Stage I lymphedema, and the authors found good compliance, but there may be difficulty in doing the yoga in other two grades of lymphedema due to the associated disability. The protocol starts with meditation, succeeded by abdominal, thoracic, and clavicular breathing exercises, which helps to achieve central lymph drainage as explained by Foldi *et al*.[14] The body movements were coordinated with breathing. Positions needing chest expansion are coordinated with inhalation and vice versa. For example, in *Akarna Dhanurasana* variation, it was advised to inhale while pulling back the bowstring and exhale while releasing the bowstring and bringing the hand forward.

We found that in our yoga protocol, the initial 3 yoga exercises have joint actions of whole body succeeded by neck, shoulder, and upper limb joints, later peripheral joints (wrist, hands, and lower limb). Loudon *et al*.[15] did not achieve part-by-part movement central to the periphery. This is essential to facilitate clearance of lymph by Foldi's technique. We argued previously that yoga might facilitate lymph drainage through muscle, joint

Figure 1: *Gomukha asana* in upper-limb lymphedema patients: (a) Inability to attain final position in *Gomukha asana* due to restricted shoulder movements of affected side and difficulty clasping the fingers of both hands. (b) Alternate yoga position for *Gomukha asana* by holding the cloth

Figure 2: Rajjukarshana asana in upper-limb lymphedema patients: (a) Inability to flex the affected shoulder joint due to the weight and restricted shoulder movements. (b) Alternate yoga position by holding affected limb with unaffected limb

Figure 3: *Manibandha naman* in upper-limb lymphedema patients: (a) Inability to lift the limb parallel to the ground due to the weight of the edema. (b) Alternate yoga positions by support of unaffected limb

movements, and the action of both yielding a kind of nodal drainage of those lymph glands situated close to them.[18] Not every joint movement of Loudon *et al*. is associated with breathing coordination. Movement of shoulder, elbow joints is emphasized compared to wrist and other smaller joints [Figure 5].

The positions taken up for yoga as proposed by Loudon *et al*.[15] are also difficult to comply with. In yoga, 1st, 4th, 9th, 11th, 15th, and 17th yoga positions were done in a sitting position; 2nd, 3rd, 5th, 7th, and 8th yoga were done in a lying position; and 6th, 10th, 12th–14th, and 16th yoga were done in a standing position. Hence, patients have to change their initial positions repeatedly to do yoga. This is another limitation of the study. We compared the starting position of each joint in both yoga protocols [Figure 6]. Figure 6 shows that our protocol has continuity with regard to starting positions.

Fisher *et al*.[16] used another protocol for BCRL. This protocol focused on stretching and isometric exercises of the shoulders, arms, and chest along with compression therapy. Authors recommend meditation, but nothing is discussed on its method. There were warm-ups and centering with 14 yoga activating neck, shoulder, chest, wrist, and spinal joints. There were four yoga types in standing pose to activate the whole body. The seated poses have six yoga and finishing poses have eight yoga. The protocol did not achieve part-by-part movement from central part to periphery. The protocol has more focus on peripheral drainage by activating the muscles of upper extremities, neck, and chest before central clearance. The modifications explained in this protocol will be helpful for the BCRL patients to initially practice yoga.

DISCUSSION

The objective was to develop and validate an appropriate yoga sequence/protocol for upper-limb lymphedema

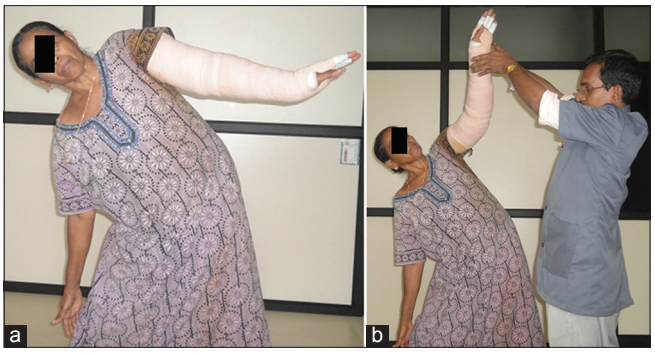

Figure 4: *Trikona asana* in upper-limb lymphedema patients: (a) Inability to attain the final position due to restricted movement and heaviness of affected limb. (b) Alternative position with the support of home caretaker

by observing the actions of muscles on joints and on anatomical areas associated with different groups of lymph nodes and on stretching of skin. The consensus statement of the International Society of Lymphology stresses the self-management in BCRL, which includes skin care and self-massage, the exercises including deep breathing, compression, arm elevation, and BEP care.[19] Our treatment was designed as an integrative module by combining the skin care therapies of Ayurveda, coordinated and slow movements of yoga and dermatology drugs to treat BEP. The pathophysiological basis was according to the Principles of Lymphology included in the consensus statement. The current study outlined the yoga and their sequence for upper-limb lymphedema. Other components on IM treatment for lymphedema were already standardized, elaborated, and were discussed earlier.[8] The study aimed to identify yoga and breathing methods and using them in a right sequence with a view to achieving the desired range of movements, reducing fibrosis and lymph drainage. The protocol was piloted on 8 patients of grade 3 lymphedema which proved to be efficacious.

In general, the European MLD treatment of an extremity starts proximally. This allows the successful mobilization of fluid from the periphery. In BCRL, the stagnated lymph is directed to axillary lymph nodes of the contralateral normal limb and the inguinal lymph nodes of the same side. Thus, before initiating the treatment, these groups of lymph nodes have to be massaged. We selected yoga and breathing postures which focused on gradual movement from head to toe. The joint movements during the yoga help to drain lymph and achieve drainage of lymph nodes situated in the area. Superficial lymph nodes are situated around joints. The joint movements during yoga mimic nodal drainage. There are pressure differences in every yoga, e.g. *Kashta Takshana asana* gives pressure on axillary lymph nodes because of the sudden, jerky movements. Yoga sequences are arranged in such a way that pressure occurs over lymph nodes from extremities to central sites. The initial three and last four yoga exercises [Table 1] act on the lymph nodes over both upper and lower extremities.

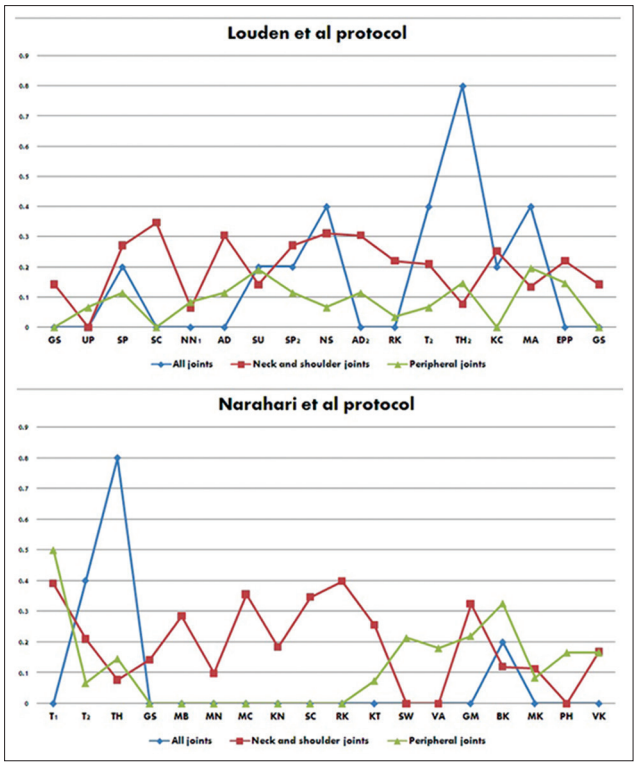

Figure 5: Joints, Muscles, and Stretch movements to synchronize with central and peripheral lymph drainage in two yoga protocols for breast cancer-related lymphedema. In Loudon *et al*. protocol, GS = *Greeva Sanchalana*; UP = *Utthanpadasana*-variation; SP = *Supta Pawanmuktasana*; SC = *Skandha Chakra*; NN = *Naukasana*-variation combined with *Namaskarasana*-variation of arms; AD = *Akarna Dhanurasana*-variation; SU = *Supta Udarakarshanasana*-variation; SP2 = *Supta Pawanmuktasana*; NS = *Nauka Sanchalanasana*; AD2 = *Akarna Dhanurasana*; RK = *RajjuKarshanasana*-variation; TD = *Tada asana*-variation; TK = *Trikona asana* variation; KC = *Kati Chakrasana*; MA = *Marjari-asana*-variation; EPP = *EkaPadaPranamasana*; GS2 = *Greeva Sanchalana*. In Narahari *et al*. protocol, T1 = *Tada asana* 1; T2 = *Tada asana* 2; TH = *Trikona asana*; SW = *Swastikasana*; VA = *Vajrasana*; GM = *Gomukha asana*; GS = *Greeva Sanchalana*; MB = *Mustikabandha*; MN = *Manibandha naman*; MC = *Manibandha chakra asana*; KN = *Kehuni Namana*; SC = *Skandachakra asana*; RK = *Rajjukarshana asana*; KT = *Kashta Takshana asana*; BH = *Bhekasana*; MK = *Makara asana*; PH = *Prasrutha Hasthapada asana*; VK = *Viparithakarani*

Swastikasana and *vajrasana* apply pressure over inguinal and popliteal lymph nodes and the next eight yoga drain from axillary and anterior and lateral cervical lymph nodes. Since yoga has coordinated slow movements associated with breathing, it may also achieve lymph drainage. Besides, the breathing allows chest expansion leading to maximizing lung capacity.[16] Therefore, our yoga protocol is likely to play a similar role as that of central MLD of Foldi's technique.[14,18]

Restricted joint movements are possible in upper-limb lymphedema due to the increased limb size, structural changes, and pain.[20] The yoga in our treatment protocol is designed to be slow with methodical joint movements. This helped patients to tolerate pain while negotiating to increase the range of movement and encouraged them to attempt movement more frequently. The initial three yoga exercises of our treatment protocol [*Tada asana* 1, *Tada*

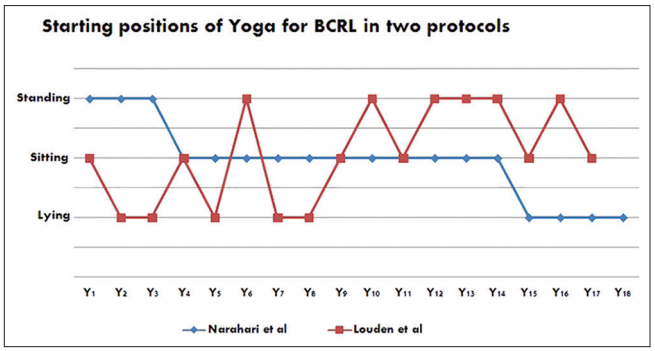

Figure 6: Starting positions of Yoga for breast cancer-related lymphedema in two protocols. The Y1 to Y18 stands for yoga sequences in each protocol. Narahari *et al*. have 18 yoga whereas Loudon *et al*. have 17 yoga

asana 2, and *Trikona asana* Table 1] require movement of all joints of the body activating all major muscles. The pressure differences may stimulate the lymph capillaries all over the body and, thus, help with proximal lymph drainage. *Swastikasana* and *vajrasana* have more action on hip and knee joints with abdominal muscle relaxation. This allows long and uninterrupted respirations. The next yoga exercises, *Gomukha asana*, *Greeva Sanchalana*, *Mustikabandha*, *Manibandha naman*, *Manibandha chakra*, *Rajjukarshana*, and *Kashta takshana asanas* [Table 1] focus on movements of shoulder and elbow joints. Deltoid, pectoralis major, biceps brachii, triceps brachii, and intercostal muscles are activated during these yoga. *Bhekasana* allows movements of all major joints. *Makara asana* and *shava asana* 1 and 2 are relaxing yoga showing minimal or no joint movements [Table 4].

Lymph drains into the venous system when intrathoracic pressure decreases in inspiration whereas expiration allows flow of lymph from extremities.[21] Controlled breathing along with contraction of rectus abdominis, diaphragm, and intercostal muscles as in *Bhastrika* creates pressure differences in both abdomen and thoracic region. These pressure differences allow lymph to drain toward the thorax. In breathing (*pranayama*) exercises such as *Ujjayi*, *Anuloma Viloma*, *suryabhedana*, and *rechakakumbhaka*, the inhalation is prolonged. The strokes of continued exhalation in *Bhastrika* are aimed at completely emptying the air from the thoracic cavity. This yoga maximizes lymphatic emptying and at the same time, forceful movements over the abdomen due to diaphragmatic and abdominal muscles lead to further peripheral drainage.

The chronic effects of radiation are caused by the pathological changes to connective tissues and vascular systems. These changes occur gradually after several years of radiotherapy. Initially, sclerosis of the skin and subcutis may develop, which in turn causes atrophic changes to the skin[14] followed by chronic reduction in degree of freedom of movement, nerve damage, increased

muscle tension, and increased stress on joints. This results in a tendency to adapt compensatory movements.[22] It is generally accepted that lymphedema and fibrosis can lead to impaired mobility. This will generally lead to a process of adaptation and changes in the neuro-motor system and motor activity. These changes can lead to degenerative processes in the articular and muscular structures, resulting in reduced mobility, inactivity, pain, and loss of function, all of which can overtax the circulation. Patients adapt their motor functions in response to degenerative processes such as edema and fibrosis. The way the body adapts and compensates for the presence of edema can result in an exacerbation of edema.[22] The stretching exercises stretch the skin and might help to reduce the brawniness of the skin allowing flow of lymph and venous blood. The *Tada asana* 1 stretches the entire body, *Tada asana* 2 stretches the posterior part of the body, and *Trikona asana* allows stretch of the flanks. In *Bhekasana*, extension of spinal column and shoulder joints achieves maximum stretch of anterior part of the body. Stretching of arteries such as the carotid and aorta has known effects on dilatation and flow due to effects on their intrinsic innervations and the release of endothelin. Tartaglione *et al*. showed lymphoscintigraphy evidence for lymphatic clearance from the affected part due to regular exercises.[23] The exercises also resulted in the creation of new lymphatic vessels draining into lymph nodes found near the neck on the affected side of a patient.[24]

Lymphedema patients were unable to perform complete range of arm movements due to the inactivity, pain, and weight of the limb. Alternate postures and support of the limb were developed for the patients who were unable to perform proper yoga [Figures 1-4]. This led to subjective improvement in the range of movement so that they felt it easier to perform yoga. The alternate versions were developed by observing the joint movements [Table 4], body stretch, and method of breathing [Table 3] done in each yoga.

The position of the fingers of the hands is traditional without a clear scientific basis but their use to compress one nostril to lateralize nasal breathing has been shown to influence the balance of sympathetic versus parasympathetic nervous systems, especially in cardiac studies of heart rate.[25]

We identified two yoga protocols in PubMed during literature search, (i) Loudon *et al*.[15] and (ii) Fisher *et al*.[16] We compared the three yoga protocols based on joint movement, breathing, method of lymphatic drainage, and yoga sequence [Figure 5]. In Loudon *et al*.[15] protocol, every joint movement is not associated with breathing coordination. Movement of shoulder, elbow joints is emphasized compared to wrist and other smaller joints. This may be the reason for the insignificant results in arm volume and extracellular fluid as measured through bioimpedance spectroscopy. Our protocol had part-by-part movement from central part to the peripheral part, adequate stretching of body for a possible pressure on dermal lymphatic plexus, and breathing coordination with all yoga. Of the eight patients treated in our protocol, the volume reduced from 2.5 to 1.2 L. However, the objective of our study was to develop an appropriate yoga protocol for better patient concordance that also would not contradict the known principles of lymph drainage.[6,19,21] In BCRL, the stagnated lymph is directed to axillary lymph nodes of the contralateral normal limb and the inguinal lymph nodes of the same side. The stretching exercises have a major role in lymph movement. In Loudon *et al*., the *Supta Pawanmuktasana*, *Marjari-asana* variation, *Nauka Sanchalanasana*, *Naukasana* variation combined with *Namaskarasana* variation of arms were able to provide back stretch, *Supta Udarakarshanasana* variation, *Akarna Dhanurasana*, *Trikona asana*-variation, *Kati Chakrasana*, and *Supta Udarakarshanasana*, provide stretching of flanks. In breathing exercises, there is no forceful expulsion as in *Bhastrika*. However, we were not able to explain the role of abdominal, thoracic, and clavicular breathing. The protocol has given more importance to meditation, probably, to achieve stress reduction. The Loudon *et al*.[15] protocol makes the patient to change positions often difficult to comply with [Figure 5]. In addition, we used the alternative positions to facilitate patients to attain the correct yoga final positions. All our patients had grade 3 lymphedema with maximum disability. Compression therapy was part of both our and Loudon *et al*. protocols.

Fisher *et al*.[16] protocol focused on stretching and isometric exercises of the shoulders, arms, and chest along with compression therapy. The modifications explained in this protocol will be helpful for the BCRL patients to initially practice yoga because the modifications suggested are passive exercises, and when the patient can attain the actual position of yoga, they must be withdrawn. Apparently authors found the names of yoga difficult for readers or extracted only the movements of yoga to achieve lymph drainage. This might have persuaded them not to use the reference or actual names of yoga during execution of observational study.

Shakotak is an ayurvedic drug used for the treatment of Lymphatic Filariasis. The Indian Council for Medical Research had to withdraw a study on *shakotak* as it showed cardiotoxic effects. The major reason for this side effect was not following traditional guidelines in patient selection.[26] In India, guidelines for the Institutional Review Boards state that any deviation from classical methods of administration should be investigated before applying in routine practice. The Fischer *et al*. protocol is difficult to

replicate since it has no mention of references or name of yoga and if yoga were done as in classical description.

Previous studies have shown that BCRL has not been shown to result from, or be exacerbated by exercise.[26] Yoga is one of the several complimentary therapies used by women with BCRL. Vaqas and Ryan wrote that there was a potential for the use of yoga and breathing as a way to empty the great veins of the thorax into the heart and promote central lymphatic drainage through the thoracic duct.[21] Yoga offers a self-care management tool for lymphedema albeit there is lack of evidence that breathing actually achieves lymphatic drainage.[18] Yoga is also proved to improve the gait in lower-limb lymphedema patients.[27] Since IAD introduced yoga for lymphedema of lower legs, several lymphologists, therapists, and students have volunteered at IAD to learn the practice of yoga for lymphedema. Although we see only a few patients of upper-limb lymphedema at IAD, the current protocol is taught by yoga therapists to all those who volunteer in IAD. The CDs containing both upper and lower limb yoga protocols are distributed to all patients and volunteers.

CONCLUSION

This study identifies the yoga and their sequence as self-care tool for BCRL. The yoga exercises were selected on the basis of their role in chest expansion, maximizing range of movements: Flexion of large muscles, maximum stretch of skin and thus part-by-part drainage from central to periphery. It has positive effect in volume reduction and heaviness of limb, reducing fibrosis and pain, improving range of movements. Narahari *et al*. yoga plays a similar role as that of central MLD of Foldi's technique while comparing with other two protocols for BCRL. This protocol, however, needs to be put into trial in centers routinely managing BCRL.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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