MANAGING OEDEMA AND FIBROSIS WITH COORDINATED MOVEMENT

Gerben Schrale, Terence Ryan

It is generally accepted that lymphoedema 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, loss of function, all of which can overtax the circulation. This paper shows that breaking this vicious circle can be used as part of the treatment regimen for chonic oedema to improve patient mobility and quality of life.

Key words

Lymphoedema
Posture
Movement
Exercises

Lymphoedema contributes to impaired mobility and yet there has been little discussion of the nervous system and motor activity in relation to oedema, and it is rarely used as a basis for treatment. In the authors' opinion, the biomedical literature on lymphoedema management in Europe and America pays insufficient attention to the sciences of ergometry and movement.

However, yoga in the Indian System of Medicine (Narahari et al, 2007; 2008) places great emphasis on movements of the body, which are correctly performed only when posture is corrected. All movements are coordinated with breathing for which there are designated practices for different disease processes, including lymphoedema. This paper discusses lymphoedema, oedema, fibrosis, muscle pump function and the compression of the venous system, together with treatment strategies that focus on corrective motor function and exercise.

People adapt their motor functions in response to degenerative processes (Mulder, 1994), such as oedema and fibrosis. The way the body adapts and compensates for the presence of oedema can result in an exacerbation of oedema.

Oedema and its impact on motor function

Oedema and fibrosis impair muscle contraction, which causes ineffective compression and pumping of the venous system in the lower limb. According to the Dynamic System Theory (Bosga and Meulenbroek, 2009), movements of the body make use of the biophysical properties of the locomotor and sensory systems, which are normally unaffected by stiffness or poor coordination. Normal motor function uses gravity (Thelen, 1998) as well as the dynamic properties of the Achilles tendon. However, for the patient in the case report described, that mechanism was inhibited. People tend to adapt their motor functions in response to degenerative processes (Mulder, 1994). The way the body adapts and compensates for the presence of oedema can result in an exacerbation of oedema (*Figure 1*). In the authors' clinical experience, therapy should aim to restore the patient's inhibited movement, and help them to re-learn the elementary processes of normal healthy motor function.

Onge and Feldman (2002) analysed various movements and found that 95% were performed by using only two synergies (functional groupings of structural elements, e.g. neurons, muscles, joints that are temporarily constrained to act as a single coherent unit). Proper coordinated movement is controlled by precisely tuned co-contractions. Forced movement comes at the cost of coordination. When this is greater than 30% of the maximum, coordinated tasks are carried out with less precision as a result of increased co-contraction (van Galen and van Huygevoort, 2000; Bosga and Meulenbroek, 2009).

In patients with complaints related to posture and the locomotor system, the original dynamic take-off and balance

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function (flexion) of the feet often changes to an increased co-contraction, in a dominant dorsal flexion and extension position. This is most visible in the elevated big toe. Due to the increased extension tension, a relatively shorter area of the foot is used to initiate take off and maintain balance, because the variability in the supporting area is decreased.

During walking, the final point of the take-off move is located at the metatarsophalangeal joints, which are pushed in a plantar direction. As a consequence, complaints of excessive strain regularly occur. Movements of the ankle and foot are subsequently carried out under strain, and the muscle pump function of the calf decreases due to continuous tension within the deep calf muscles. It should be noted that the flexors of the toes immediately border and surround the deep veins up to halfway up the calf (Schunke et al, 2005) (*Figure 2*), and may have a direct influence on the deep venous circulation increasing oedema. If these impaired movement patterns exist for a long period, contracture of the joints (claw toe and hammer toe) develops, together with contractures of the extensor muscles of the foot and ankle.

The changes in the take-off movement and balance function alter the entire posture of the body. When there is no appropriate use of the toe muscles, the relative forwards/backwards support area of the foot is shortened, the degree of freedom in posture and movement is reduced, and the body's centre of gravity is moved backwards and the pelvis tilted. Patients will have to compensate for this restriction in movement; an adjustment that requires more muscle tension and body rigidity to compensate (Graaf, 2008). This occurs not only in the foot and ankle region, but also in increased tension in muscles elsewhere (Meyers, 2009). This rigidity reduces the ability of the abdomen and thorax spaces to expand freely, thus inhibiting respiratory movements. This also has an influence on the volume of the venous and lymph distribution within the body (Willeput, 1984; Földi et al, 1996; Klabunde, 2007).

Exercises to correct posture, such as tilting the pelvis, holding the stomach in and walking 'tall' with an upright posture, as well as behaviour-related factors, such as stress, also influence body rigidity and muscle tone.

Compression of the common iliac vein: a possible cause of leg oedema

Early development *in utero* of the venous system of the lower limbs comes from the cardinal veins, which are symmetrically aligned on the right and left and connected by anastomoses. During development, a single inferior vena cava shifts venous drainage more to the right. One of the anastomoses becomes the left common iliac vein, which is longer than the right iliac vein and awkwardly enters the right post-cardinal vein at a right angle. It can have various congenital deformities and even be imperforate (Mozes and Gloviczi, 2007). Thus, there are a number of theories about causation of consequent lower limb oedema. When Calnan et al (1962) proposed that the obstruction of the common iliac vein was due to compression by the overlying common iliac artery, as both vessels passed over the pelvic brim, it was also thought that tilting of the pelvis, as in the obese or pregnant patient, would enhance this. It has become common practice to manage both congenital and acquired venous and lymphatic pathology by iliac venous stenting (Firas et al, 2007, Raju et al, 2011) and to suggest that misdiagnosis of venous oedema as primary lymphoedema is prevalent. There is also the proximity inside the pelvis of an iliopsoas bursa becoming

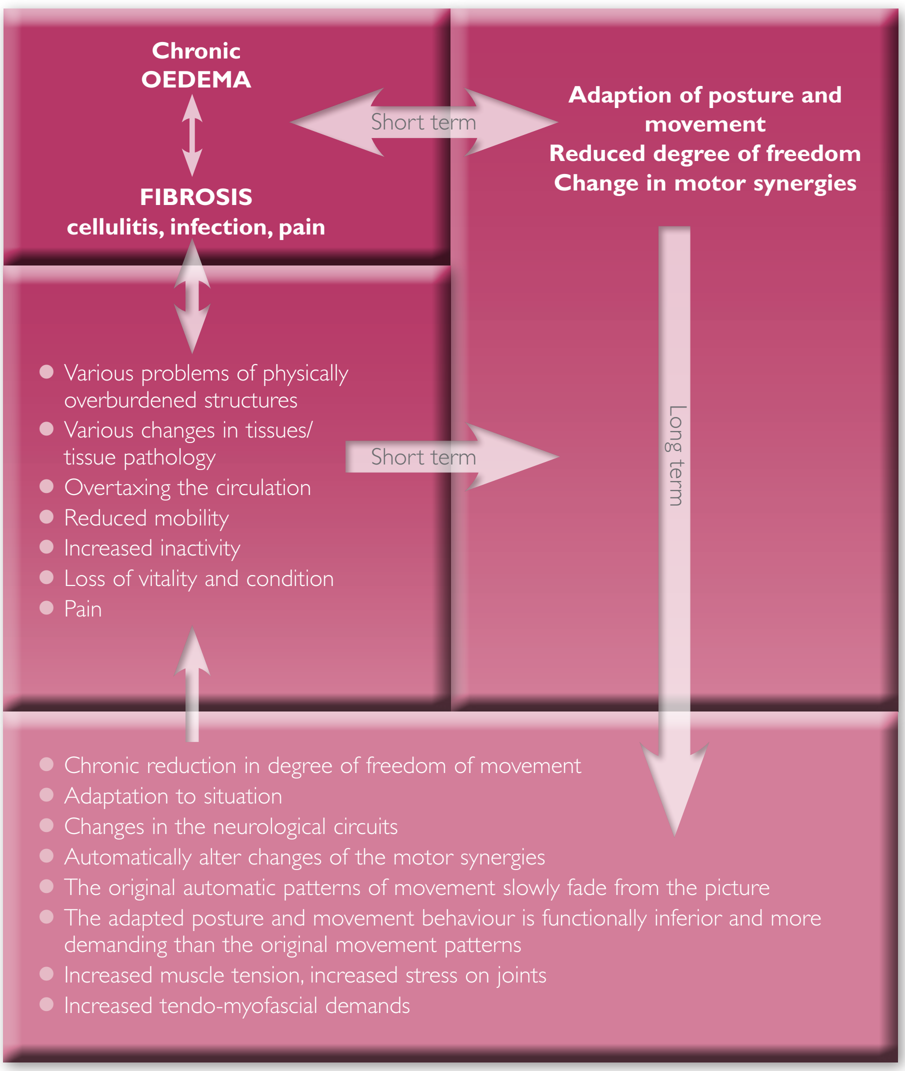

Figure 1. Vicious circle of the adaptation process due to chronic oedema.

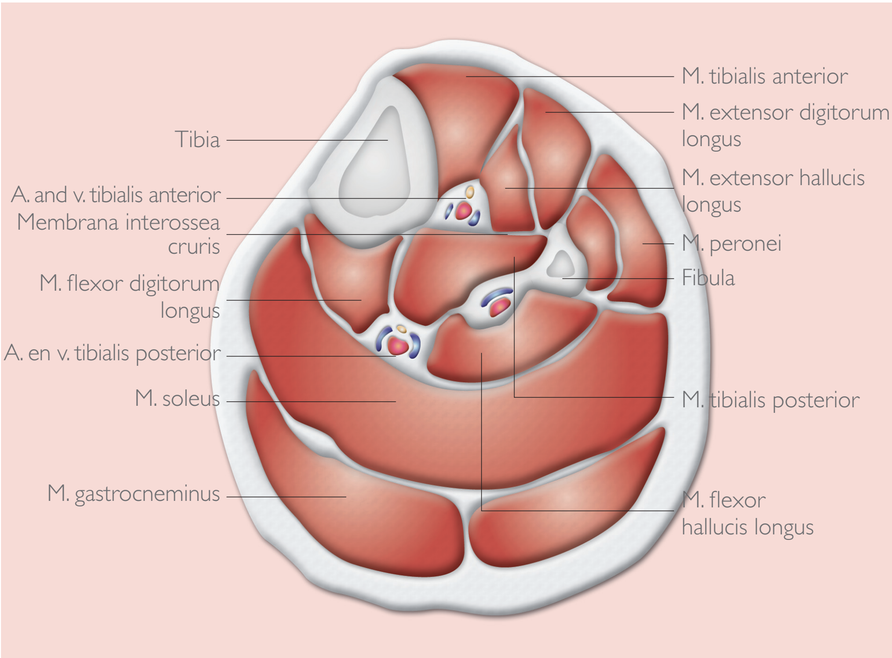

Figure 2. The flexors and extensors of the toes immediately border on and surround the deep veins up-to halfway up the calf. Persistent contraction may have a direct influence on the deep venous system increasing oedema.

hypertrophic, when it may also compress the venous system within the pelvis (Yang et al, 1993; Schunke et al, 2005). Thus, there are a number of theories that revolve around how early development, posture and movement,and factors such as obesity relate to the pelvic veins and play a role in lymphoedema (Földi et al, 1996; Sugerman, 2001). The authors are presenting their clinical experience as to how correction of posture may make invasive procedures such as stenting or surgery unnecessary.

Using posture and corrected movement to treat oedema: a case report

A 34-year old female, who had been a competition swimmer, presented with oedema of 20 years' duration. A diagnosis of primary lymphoedema had been made by her dermatologist. She had frequently had bouts of cellulitis and had been treated with manual lymphatic drainage (MLD) and compression therapy. However, she had not had therapy for the past three years, apart from wearing compression class 3 support stockings. Her oedema increased throughout the day and she had marked swelling in the evening. She was not in pain, but she invariably had discomfort in her back, neck and pelvis.

On inspection there was bilateral lymphoedema of the forefoot and toes with hallux valgus. A Stemmer's test and the pinch and roll test were increasingly positive distally from the last 5cm on the dorsum of the foot. Oedema was located in the skin and in the loose connective tissue around the Achilles tendons, the ankles and the dorsa of the feet. There was pitting over the tibia but the knee cavity was free of oedema. The oedema was stage 2 (Foldi and Foldi, 1996). The calves had decreased muscle mass compared with the muscles in the rest of her body, as would be expected. Oedema in this region could also be reduced as a result of a combination of manual compression and passive and assisted active muscle pump movements.

MLD lessened the diffuse fibrosis and, in the short term, the function was markedly improved. The fibrosis and oedema both influenced the patient's passive mechanical mobility. All structures on the dorsum of the feet, the short extensor muscles of the feet, the extensor tendons, fasciae, connective tissue, the interosseous muscles and phalangeal and metatarsophalangeal joints were contracted in the direction of the flexion movement. The structures of the calf were contracted in the direction of extension. The calf function (muscle power and coordination) and the flexion function of the foot and ankle were limited.

When recumbent, the patient was unable to flex her foot without paradoxical extension of the big toe (*Figure 3*). The tension of the extensor tendons could not be seen due to the oedema.

Movement was initiated by means of hip flexion of the leading leg in place of an energetic initiating movement of the forefoot of the standing leg. The leg was moved forward and, by doing so, the centre of gravity was transferred backwards onto the standing leg and the pelvis tilted backwards. Foot and ankle action were limited and the extension of the big toe of the moving front leg was pronounced. When jumping, the patient did not make full use of the calves and foot muscles, and, on landing, she had insufficient power and function to prevent herself from landing flatly and in hyperextension. The patient was unaware of this impairment, but she was not enjoying walking or running.

Her chronic oedema and stiffening of the leg and calf muscles had disturbed the pattern of initiation and progression of movement. The venous muscle pump action was also impaired, and there were contractures of the connective tissue. The loss of normal coordinated movement resulted in aches in the

Figure 3. In a recumbent position and sitting down, with legs extended, the patient was unable to carry out a functional initiating pressure of the foot without paradoxical extension of the toes, particularly the big toe.

patient's truncal region and a loss of fine tuning in the foot, with stronger muscle contractions in some small muscles giving rise to paradoxical extension of the toes (*Figure 4*).

Fibrosis and the decreased plasticity within the calf and foot muscles forced the patient to use more power to perform different functions. Toe tensors and flexors are needed for the fine coordinating functions used in balance and walking and are not well suited for power. Furthermore, foot extensors are small in size compared to flexors. A small increase in resistance of the flexors can therefore have a disproportionate effect on the muscle tension of the extensors. This may explain the over-contraction and the paradoxical extension of the toes.

The symptoms and signs described here may be used as an example of the problems frequently seen in patients with oedema and chronic venous insufficiency. Unusually, this case report concerns a young patient who, aside from oedema, was energetic and healthy, had little associated pathology and no problems with excessive weight. The fitness training she was doing had provided cardiovascular exercise but had not been able to correct her dysfunctional movement. Her treatment programme was based on readjusting her locomotor system to achieve a stable, more efficient, flexible and reliable movement pattern.

Treatment

The patient was given exercises aimed at activating the muscle synergies from different positions, such as in a sitting position with legs outstretched, sitting with legs hanging down, lying on her back, standing, standing on unstable ground, standing and rotating, standing using a pulley, walking, corrected jumping, and running.

The training programme integrated MLD and mobilisation techniques.

Training programme

The programme started with actively assisted movements (repeats and corrections) to rebuild coordination of the functional synergies needed for correct initiation to walking and moving while standing upright. Exercises started from distal (toes – feet – ankles) and, once perfected, expanded to the knee, hip and body. Initiation is given by resisting the therapist's hand, which is tuning the action (*Figure 5*). No dysfunctional co-contractions were

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allowed anywhere in the body. By feeling the quality of the movement, allowed for maximum control and correction by the therapist. Once performed correctly, the patient was asked to enlarge the power under the same conditions as before. Exercises were given in different positions (sitting, lying on the back, etc).

Coordination training

These exercises were to facilitate the initiation movement of the feet. Initially, this was done only using the calf and feet muscles with a minimum of muscle activity in the knee and hip region. Once performed correctly, the learned facilities are integrated in intrapersonal exercises like foot/ankle exercises (*Figure 6*). The patient was thus taught to recognise and move in an optimal and coordinated way.

The patient was also advised to do these exercises frequently at home (about 10 times a day in short episodes, 15 seconds to two minutes per item). When walking, the author advised the patient to correct herself frequently. However, she was allowed to revert to her former pattern as constant correction is neither possible nor an option in daily activity. The aim being to teach the patient to recognise how to move in an optimal and coordinated way.

Figure 4. When the leg (leading foot) moved forward, the foot action was limited and the extension of the big toe of the forward moving leg doing the lifting was pronounced. The foot of the standing (bearing) leg did not provide any dynamic flexion and hardly provided any propulsion to move.

Figure 5. Result immediately after mobilisation of fibrosis, manual lymphatic drainage, muscle stretching, mobilisation of joints and other structures. There is obviously still an over powered flexion of the toes. The patient will have to re-learn to readjust her locomoter system.

Figure 6. Coordination training — intrapersonal exercises like foot/ankle exercises.

Such a programme depends on the exercise ability of the patient. The aim is to change synergies to those which contribute to the circulation, as well as improving functional movement.

The mobilisation technique for deep oedema and fibrosis is in principle the same. The foot is first aligned in a position where the structures are relaxed and then gently stretched. The effect is achieved by repeating the actions and movement in combination with manual techniques. The treatment is gentle, causing no pain, and can be used for tissue mobilisation as well as for lymph drainage via the supra fascial vessels, deep lymph vessels and the venous system. It is a fast drainage technique. The dorsal fibrotic tissues of the ankle, the foot and toes will be stretched starting from the extension position. From this position, a functional flexion (passive or actively assisted) is applied. During this movement, the elasticity and mobility of the various tissue layers can be both assessed and influenced. In principle, this applies to both the superficial layers and the deeper layers, including the joints.

In this patient, the freedom of movement achieved in the tissue was permanent, and she described her mobility as 'lighter and easier'.

Results

Treatment took place over a three-month period. After six treatments of three-quarters to one hour, involving the exercises described above, MLD, tissue mobilisation, as well as advice about self-management and movement and posture, the push off movement of her feet had improved. The tissue itself was no longer an inhibiting factor and on examination by palpation and stretching, there was only a minimal resistance of the fibrotic tissues of the back of the feet. The patient's walking pattern had become energetic and more powerful (*Figure 7*). When jumping, she now used a strong calf function and, when swimming, she described feeling the easy and powerful thrusting movements of the legs that she lost when she was 14 years old.

After applying hosiery, the oedema was almost totally reduced on both sides. Only minimal oedema was still present in a small area of the forefoot and on the toes. The skin qualitatively improved, being less dry and small wounds and fissures rarely occurred. The patient was also instructed in skin care, bandaging, MLD, mobilisation of contractures of connective tissue and measured up for new support stockings.

Conclusion

The case reported in this paper shows how a treatment regimen that addresses impaired mobility and posture through an exercise programme can, together with MLD, tissue mobilisation, and compression therapy, contribute to reducing oedema and improve patient quality of life and self-esteem. JL

Figures 7. After six treatment sessions the pushing off movement of the feet took place without resistance and the tissue itself was no longer an inhibiting factor. The weight bearing leg is now the leg in front and there is a more appropriate back and downward movement of the forefoot.

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