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Authors details:

Rhian Noble-Jones, Lymphoedema Specialist Physiotherapist and University Lecturer, University of Glasgow, rhian.noble-jones@glasgow.ac.uk

Lynne Rowley, Chair of the British Association of Prosthetist and Orthotists, NHS Forth Valley, Scotland. Chair@bapo.com

Chris Rowley, Orthotic Clinical Lead, NHS Greater Glasgow and Clyde, Scotland.

Wider collaboration on lymphoedema research: footwear and gait analysis.

Rhian Noble-Jones, Lymphoedema Specialist Physiotherapist and University Teacher, University of Glasgow, and Lynne Rowley, Chair of the British Association of Prosthetist and Orthotists, NHS Forth Valley, Scotland. Chris Rowley, Orthotic Clinical Lead, NHS Greater Glasgow and Clyde, Scotland.

Introduction.

Health care professionals specialising in lymphoedema management are familiar with the concept of working within a multidisciplinary team for maximal benefit to lymphoedema patients. This team often includes Nurses, Physiotherapists (PT), Occupational Therapists (OT), Doctors and, on occasion, Social Workers, but Podiatrists and Orthotists are rarely considered. This is surprising, given that complex foot problems, including difficult decisions on the bandaging of diabetic wounds, are acknowledged in patients with lower leg chronic oedema (Chadwick 2006) (Fig 1.). The knock-on effect for joint alignment, however, is rarely discussed.



Figure 1 Bilateral foot deformity from lymphoedema

Podiatrists and lymphoedema

In a national study, Podiatrists in Scotland identified they had a role in lymphoedema identification and management, and consequentially, an education need (Davies 2012). Their top learning needs were:

- how to advise patient on skin care to avoid cellulitis
- differential diagnosis of lymphoedema and other oedemas
- awareness of current lymphoedema management techniques
- identification of those at risk of lymphoedema

Geyer and colleagues (unpublished) of the University of Pittsburgh Foot Research Study undertook a snapshot study during the ILF conference 2011 in Toronto, Canada, using 3-D scanning equipment in a joint assessment by a pedorthist (footwear specialist) and lymphoedema specialist and completion of questionnaires by patients. Despite this pilot work and indicators from clinical practice, lymphoedema research involving podiatrists (or pedorthists) seem curiously absent.

Orthotists and lymphoedema

Similarly, there is a dearth of literature on the possible advantages of incorporating the expertise of Orthotists into our understanding of the impact of lymphoedema on the body. Yet this group of professionals are expected to deal with complex issues such as the longstanding effects of joint malalignment due to abnormal weight distribution through the joints (fig 2).



Figure 2 Female with Primary lymphoedema requiring multiple orthoses

Orthotists are interested in the mechanics of human locomotion in particular forces and the impact these forces have on the body during standing and locomotion. They assess gait and prescribe orthoses to alter these abnormal forces to reduce *moments* about joints to impact on pain and improve alignment ($\text{Moment} = \text{force} \times \text{distance}$). They also advise on footwear and where required, prescribe footwear to accommodate the increased body mass and altered foot shape.

The increase in mass in a body segment due to the presence of excess fluid in lymphoedema results in an increase in the forces needed to achieve locomotion (Force= Mass x acceleration).

An increase in body mass can be correlated to an increase in body mass index (BMI). There is strong evidence linking an increase in BMI to an increase in knee osteoarthritis but not the hip (Reijman et al, 2007; Oliveria,1999); so logically with altered biomechanics and forces on joints combined with an increase in weight of the affected body segment could be linked to advancement of osteoarthritis and joint pain. Further research is required to investigate this supposition.

A limb affected by lymphoedema would exhibit abnormal anthropometrical characteristics e.g. length to circumference ratio, with an altered centre of mass. Changing the centre of mass in a limb segment alters the moment about that joint requiring the muscles to increase the force required to control the body segment compared to the non-affected limb. Figure 3 below illustrates the increase in force required when the equilibrium of a joint is affected by the movement of the centre of mass doubling the force required by the set of muscles B to maintain the stability of the limb. If movement is required then the muscles B have to work twice as hard as set A.

Moment= force x distance

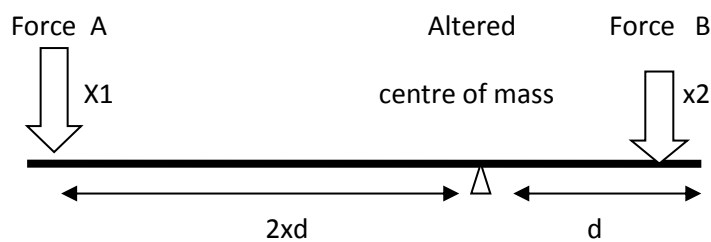


Figure 3 The potential change in forces around a joint in lymphoedema

An additional problem is that swelling in a body segment often restricts/alters range of motion (ROM). Restricted ROM results in compensation at other joints or gait deviations. Narahari et al (2013) conducted an interesting study of over 2000 patients diagnosed with lymphoedema and the effects of yoga on their condition. As part of the study they captured gait deviations present in this population. The most common gait abnormality was antalgic gait. This is typically an altered gait pattern to avoid pain, notably shortened stride length and stance phase is shorter than swing phase of gait. Structural and functional abnormalities were observed in hip, knee and ankle joints combined with muscle weakness. These factors result in altered biomechanics during gait.

Gait analysis

The abnormal distribution of weight that occurs with lymphoedema, particularly when unilateral, can disturb normal gait and daily functional activities. Problems not only arise when the legs are

severely oedematous (fig 4), but a heavy oedematous arm can also affect balance and gait. Simple observation can establish that a swollen arm has the potential to significantly redistribute weight/balance affecting the biomechanics of other muscles and joints and therein gait, yet there is a dearth of research on this aspect. Specifically in relation to lower limb, the shift in centre of gravity can combine with difficulties in obtaining suitable footwear, in the vulnerable this can lead to an increased risk of falls. In addition these problems combine to impact on one of the most important components of lymphoedema management – exercise.

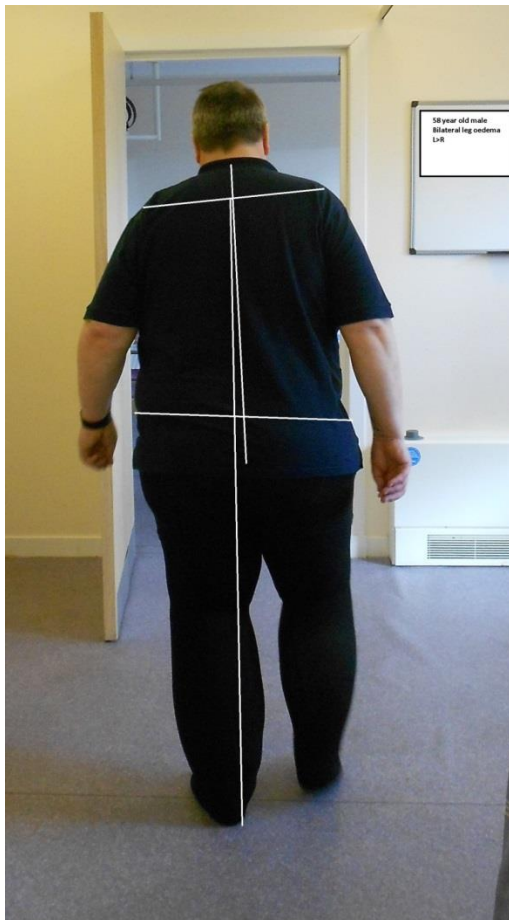


Figure 4 Left leg >Right leg volume shifts centre of gravity on walking gait

Clinical gait analysis is often conducted using the observational skill of the clinician however with the improvement in technology in recent years video analysis is easily achievable using mobile technology such as mobile telephones and video cameras (Figure 4). In addition, forces can be captured during gait by mapping pressure from in-shoe pressure monitoring systems. These have their own limitation depending on the system such as trailing wires or limited pressure sensors. To capture ground reaction forces during locomotion, access to a force plate normally located in gait laboratories is required. This technology is relatively expensive to install and run, however it can be used to determine where the forces need to be re aligned and measured pre and post treatment to accurately capture the effect of treatments on gait. Further, electronic shape capture can be used to

monitor changes in volume and also be used to manufacture custom orthoses. With the improvement in scanning technology such as hand held scanners and cad cam systems, accuracy and speed of manufacture is increasing.

Surprisingly, there has been little use made of modern advanced technology for gait analysis in the study of lymphoedema and its management. Studies of specific treatment modalities with other conditions may show us an indication of the potential of the incorporation of gait analysis as an outcome measure. Gait analysis, along with other outcome measures, has been used in studies of chronic venous insufficiency (CVI). In a study of the effect of Complex Decongestive Physiotherapy (CDP) on CVI in older patients (Bakar et al 2010) pain-free gait was shown to improve significantly with CDP. Similarly, in early stage CVI (up to C3 CEAP) kinesiotaping produced significant pre-/posttreatment improvements in both lower limbs in gait dorsiflexion ROAM (95% CI, 1.02-2.49), cadence (95% CI, 3.45-1.47), stride length (95% CI, 21.48-10.83), step length (95% CI, 1.68-6.61), stance phase (95% CI, 61-107), which were not seen in their non-kinesiotape sample population (Aguilar-Ferrández et al 2014). Given the importance of ankle dorsi-flexion for effective calf muscle pump and venous (and probably lymphatic) return, such data is important to consider. Further, there is some indication that gait analysis is useful as an outcome measure pre/post liposuction as a management intervention: http://www.orthopaedics.dundee.ac.uk/33_Research.html.

Differential analysis of which treatment components are significant and which concurrent outcome measures retain significance may also be illuminated by this additional data. A study by Piesla et al (2009) for example would indicate that pain was more significant to gait disturbance than swelling (oedema) therefore if pain is not present or if pain is not eased by lymphoedema management then the gait would not be a significant outcome measure. However, due to the population studied by Piesla et al (2009) they did not need to take into account the sheer size and weight of the limb which would be additional variables for many lymphoedema patients.

Summary.

Orthotists investigate the altered biomechanics of the body and the impact on function and gait. They design orthoses for individuals to address the identified problems. By improving gait and the range of movement of affected joints, Orthotists could improve quality of life, pain and prevent early onset of osteoarthritis. Further research in this area is recommended to capture the impact and health economics of orthotic treatment and inclusion of the Orthotist in the MDT. Similarly, Podiatrists have a far greater understanding of foot pathology and dynamics than most nurses, PTs, OTs or doctors. Collaborative research has the potential to inform our understanding of the effect of lymphoedema and its management on gait and the likely sequelae. Such understanding may reduce the complex co-morbidities of this population and may help inform management strategies for the growing population of obese patients with co-existing lymphoedema, and the separate, particular problems of lipoedema. The authors are currently pursuing funding for just such a study. In the meantime lymphoedema specialists, and others caring for lymphoedema, chronic oedema and lipoedema, may do well to consider the orthotists and podiatrist as part of their multidisciplinary team when assessing this group of patients.

References

Aguilar-Ferrández, M. E., Moreno-Lorenzo, C., Matarán-Peñarocha, G. A., García-Muro, F., García-Ros, M., & Castro-Sánchez, A. M. (2014). Effect of a Mixed Kinesio Taping–Compression Technique on Quality of Life and Clinical and Gait Parameters in Postmenopausal Women With Chronic Venous Insufficiency: Double-Blinded, Randomized Controlled Trial. *Archives Of Physical Medicine & Rehabilitation*, 95(7), 1229-1239 11p. doi:10.1016/j.apmr.2014.03.024

Bakar, Y., Öztürk, A., Calisal, M., Ertürk, K., & Daglar, B. (2010). Complete decongestive physiotherapy for older people with chronic venous insufficiency. *Topics in Geriatric Rehabilitation*, 26(2), 164-170

Chadwick, P. 2006 Lymphoedema bandaging: the treatment of a patient with chronic diabetic foot ulcer due to venous insufficiency. *Wounds UK* 2(2): 84-85.

Davies, R. 2012. An investigation of the education needs of health care professionals in Scotland in relation to lymphoedema care: executive summary. 2012. Available from: <http://www.nes.scot.nhs.uk/media/842462/executive-summary-lymphoedema-education-needs-finalv2.pdf> [accessed 07.04.2016].

Narahari S.R.; Aggithaya M.G.,(Narahari, Aggithaya) Institute of Applied Dermatology, Kasaragod, Kerala, India, *Indian Journal of Physiology and Pharmacology* 2013; 57(5 SUPPL. 1): 19

Oliveria SA, Felson DT, Cirillo PA, Reed JI, Walker AM: Body weight, body mass index, and incident symptomatic osteoarthritis of the hand, hip, and knee. *Epidemiology* 1999, 10:161–166.

Piesla, M. J., Leventhal, L., Strassle, B. W., Harrison, J. E., Cummons, T. A., Lu, P., & Whiteside, G. T. (2009). Abnormal gait, due to inflammation but not nerve injury, reflects enhanced nociception in preclinical pain models. *Brain Research*, 129589-98. doi:10.1016/j.brainres.2009.07.091

Reijman M, Pols HA, Bergink AP, Hazes JM, Belo JN, Lievens AM, Bierma-Zeinstra SM: Body mass index associated with onset and progression of osteoarthritis of the knee but not of the hip. The Rotterdam Study. *Ann Rheum Dis* 2007, 66:158–62.