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Brief report

The effects of sandals on postural stability in patients with rheumatoid arthritis: An exploratory study

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ABSTRACT

Background: Rheumatoid arthritis results in postural instability, pain and functional limitations. As rheumatoid arthritis progresses, localised forefoot deformities such as hallux valgus and clawing of the lesser toes occur, leading to a high proportion of people with rheumatoid arthritis wearing sandals. Sandals may affect postural stability due to poor motion control. The aim was to assess two different open-toe sandals on postural stability in people with rheumatoid arthritis.

Methods: Twenty women with rheumatoid arthritis were assessed in quiet standing under four conditions: (1) open-back sandal; (2) closed-back sandal; (3) own footwear and (4) bare feet. Postural stability was assessed as postural sway in the anterior-posterior and medial-lateral directions, with eyes open and eyes closed, using a pressure mat. Repeated measures analysis of variance tested the interaction effect of the footwear and eye conditions on anterior-posterior and medial-lateral sway.

Findings: In eyes-open, there was no significant difference in anterior–posterior sway ($P = .169$) and medial-lateral sway ($P = .325$) for footwear conditions. In eyes-closed testing, compared with barefoot conditions, increased anterior–posterior sway was observed with participants' footwear ($P < .0001$), the open-back sandal ($P = .005$), and the closed-back sandal ($P = .017$). With eyes closed, increased anterior–posterior sway was also observed with the participants' footwear compared with the closed-back sandal ($P = .041$). Increased medial-lateral sway was observed with the closed-back sandal compared with bare feet ($P = .014$).

Interpretation: Sandals may be detrimental to older women with well-established rheumatoid arthritis when eyes are closed. Further investigation is needed to evaluate the effect of sandals on dynamic tasks.

1. Introduction

Rheumatoid arthritis (RA) is a chronic, systemic, inflammatory, joint disease affecting 0.5 to 1.0% of the world population (Scott et al., 2010). The foot is a common site of pathology in early RA and forefoot involvement becomes greater with disease progression (Michelson et al., 1994; Wiener-Ogilvie, 1999). Control of balance, or postural stability, is essential in all static and dynamic activities. A previous study reported that static postural stability, in the anterior–posterior centre of pressure excursion during the eyes open task and the eyes closed task is decreased in RA compared to the non-RA population (Rome et al., 2009a). As a result, people with RA may have difficulty maintaining postural control leading to balance problems in everyday activities (Rome et al., 2009a).

Footwear has a role to play in postural stability by facilitating somatosensory feedback to the foot by the proprioceptive system that detects and processes tactile stimulation/information (Brenton-Rule et al., 2011; Hijmans et al., 2007; Perry et al., 2007). Cutaneous mechanoreceptors, located in the plantar surface of the feet, detect tactile stimuli and provides the central nervous system (CNS) with information regarding plantar pressure distribution (Hijmans et al., 2007). This is important, as changes in foot pressure are often related to changes in an upright position (Kavounoudias et al., 1998). Footwear may also control foot motion, thus potentially affecting foot function and balance (Barton et al., 2009; Menz and Lord, 1999). Previous studies in the older adult population have reported that poor footwear type and poor footwear characteristics lead to postural instability (Brenton-Rule et al., 2011; Keegan et al., 2004; Sherrington and Menz, 2003). Sherrington and Menz (2003) reported unsafe features of shoes identified included excessively flexible heel counter and an excessively soft sole. Furthermore, Keegan et al. (2004) found that slip-on shoes and sandals were associated with a greater risk of a foot fracture from a fall.

Sandals have been found to be worn by the majority of patients in two recent studies from New Zealand of people with RA (Rome et al.,

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2009b; Silvester et al., 2010). It is possible that people with RA wear open-type sandals in order to better accommodate forefoot deformity associated with the disease such as clawing of the lesser digits and severe bunions. However, sandals may have a detrimental effect on balance due to poor footwear characteristics such as minimal heel counter stiffness and poor motion control. Variation in sandal design includes backless (no back-strap), open-back (back-strap only) and closed-back (full heel counter). Laboratory based research into the effect of heel counter stiffness on postural stability is not evident in the literature. However, heel counter stiffness is thought to be important in rear foot control and a stiff heel counter may provide mechanical support to the foot (Barton et al., 2009). Flimsy or excessively flexible heel counter has also been associated with falls in older adults (Finlay, 1986; Sherrington and Menz, 2003). Therefore, the aim of the current study is to evaluate the effect of open-back and closed-back sandals, in relation to postural stability, in women with established RA.

2. Methods

Twenty participants were recruited from a rheumatology outpatient clinic in Auckland, New Zealand. The study was approved by the Auckland University of Technology Ethics Committee and participants provided written informed consent. Inclusion for the study was women older than 18 years with a diagnosis of RA (Aletaha et al., 2010). People were excluded from the study if they had a neurological condition which could impair balance (including history of stroke, multiple sclerosis and Parkinson's disease); lower limb amputation or diabetes with previously diagnosed peripheral neuropathy.

Participant general features and clinical characteristics were recorded prior to testing. Current disease activity was determined through the assessment of tender and swollen joints and calculation of the four variable disease activity score (DAS28) (Van Riel, 2004). Foot pain in the past week and current patient global assessment of disease activity were recorded using a 100 mm visual analogue scale (VAS). The Health Assessment Questionnaire-II (HAQ-II) (Fries et al., 1980) and the Leeds Foot Impact Scale (LFIS), that evaluates foot disability and impairment (Helliwell et al., 2005), were also completed by each participant. Participants' own footwear, which was worn to the study visit, was documented using a list of 17 footwear styles adapted from a previous study (Menz and Sherrington, 2000).

Postural stability was assessed through the measurement of postural sway (oscillations around the centre-of-mass) in the anterior–posterior (AP) and medial–lateral (ML) directions, during quiet standing. Sway parameters were measured using the excursion (mm) of the centre of pressure (COP) in the AP and ML directions. Postural sway was measured using a pressure mat; TekScan MatScan® model 3150 (TekScan Inc., South Boston, USA). The MatScan® is a low profile floor mat (5 mm thick) consisting of 2288 resistive sensors with a spatial resolution of 1.4 cells per cm^2 and a sampling frequency of 40 Hz. This portable pressure system has been shown to be reliable for the measurement of postural sway in older adults with RA (Brenton-Rule et al., 2012). The Sway Analysis Module (SAM™) software was used to analyse the data.

Two different types of sandal were used in the study (Fig. 1): an open-toe, open-back sandal (shoe 1) and an open-toe, closed-back sandal (shoe 2). The shoes were constructed of a synthetic, "leather look" upper with a padded insole. Both sandals had Velcro fasteners and were adjustable at the midfoot and forefoot, to accommodate structural foot changes associated with RA, such as hallux valgus (bunion) deformity. Shoe 1 also adjusted at the rear foot and had a semi-rigid midsole. Shoe 2 had a closed-in heel counter and a rigid midsole. Both sandals had a solid 3 cm rubber wedge heel. All sandals were new at the time of testing.

Participants were tested on one occasion wearing the two different types of sandal, their own footwear (Table 1) and no footwear (bare feet). Nylon hosiery was worn with the study sandals. Participants were asked to stand on the pressure mat and adopt their preferred, comfortable, quiet standing position with their arms by their sides whilst looking straight ahead at a circular black target of 10-cm diameter, fixed at a distance of 2 m at eye level. Each participant was asked to

Fig. 1. Shoe 1 (top), Shoe 2 (bottom).

Table 1
Participant demographic and clinical characteristics.

Variable	Value
Age, years, mean (SD) range	67.6 (12.3) 44–84
Ethnicity, n (%)	
European	18 (90%)
Pacific Island	2 (10%)
BMI, kg/m^2, mean (SD) range	27.7 (5.3) 21.9–40
Disease duration, years, mean (SD) range	21.5 (11.5) 2–38
Disease type, n (%)	
Rheumatoid factor positive	13 (65%)
Anti-cyclic citrullinated peptide antibody positive	6 (60%)
Seronegative	3 (9%)
Tender joint count, mean (SD) range	14.6 (18.3) 0–61
Swollen joint count, mean (SD) range	12.6 (15.9) 2–59
Erosive foot disease, n (%)	18 (90%)
Medications, n (%)	
Methotrexate	18 (90%)
Other disease modifying anti-rheumatic drugs	13 (65%)
Biologics	4 (20%)
Corticosteroids	7 (35%)
DAS28-ESR, mean (SD) range	3.81 (0.96) 2.78–5.59
DAS28-CRP, mean (SD) range	4.06 (1.16) 2–5.76
VAS foot pain, mean (SD) range	45 (22.8) 8–80
VAS patient global assessment, mean (SD) range	35.7 (20.9) 8–94
HAQ-II, mean (SD) range	1.07 (0.42) 0.2–2
LFIS total score, mean (SD) range	30 (9.5) 12–44
LFIS impairments/footwear, mean (SD) range	12.7 (3.2) 5–18
LFIS activities/participation, mean (SD) range	17.3 (7.3) 5–28
Participants' footwear at study visit, n (%)	
Sandal	6 (30%)
Athletic shoe	6 (30%)
Closed back sandal	2 (10%)
Jandal	2 (10%)
Walking shoe	2 (10%)
Oxford shoe	1 (5%)
Backless sandal	1 (5%)