the effect of a physiotherapy treatment on three-dimensional (3D) gait parameters of knee OA patients.

**Methods:** Three-dimensional knee kinematic and kinetic parameters were recorded during gait of 29 participants diagnosed with knee OA before and after they received 12 weeks of physiotherapy treatment. Kinematics data were obtained with an optoelectronic motion analysis system (Vicon 460, Oxford Metrics). Kinetic data were measured by Kistler force plates embedded in a treadmill (ADAL, Medical Development, France). The physiotherapy treatment included isometric quadriceps and hamstring strengthening exercises and was administered twice a week.

**Statistical analysis:** PCA was applied to extract clusters of knee flexion/extension, adduction/abduction and internal/external rotation angle and moment data. Parameters of interest were the mean and range values for angle data and the peak values and angular impulse (moment-time integrals) for joint moment data. The treatment's effect on all parameters was assessed using paired t-tests on 1) the mean of the entire group data (n=29) and 2) the mean of each of the extracted OA clusters.

**Results:** Increased quadriceps and hamstring strength was observed after treatment (p<0.05). Except for the knee flexion/extension angle, two different clusters (C1 and C2) were extracted from the angle and moment data. When pre-post treatment analyses were performed on the clustered data, participants exhibiting a C2 knee moment pattern demonstrated a smaller rotation angle range, a greater first peak flexion moment and lower adduction angular impulse post-treatment (p<0.05). Pre-post treatment comparisons for the entire group showed no treatment effect. Similarly, no effect was demonstrated in the C1 group.

**Conclusions:** The results indicate that the gait pattern of knee OA participants can be clustered with PCA. Low inter-subject variability in flexion/extension angle pattern may explain why the clusters for flexion/extension data were not different. The increase in lower limb muscle strength and knee extension moment observed following treatment may indicate that participants exhibiting a C2 gait pattern are more confident in using their quadriceps during the loading period of gait. The results of the present study suggest that the effect of increased isometric quadriceps and hamstring strength on gait mechanics may be masked if all participants are included in the mean when performing pre-post treatment comparisons.

152

**OBESITY AND BIOMECHANICS OF EVERY DAY MOVEMENTS; A SYSTEMATIC REVIEW**

J. Runhaar, B. Koes, S. Bierma-Zeinstra
Erasmus MC, Rotterdam, Netherlands

**Purpose:** To give a systematic overview of the literature on the differences between obese and normal-weight subjects in biomechanics of the hip, knee and ankle during every day movements to summarize differences in joint load due to higher body weight and additional joint loads caused by differences in movement patterns.

**Methods:** A systematic search was performed in the Pubmed and Embase database up to April 2009. Search items included joints of interest, biomechanical items, every day movements (e.g. gait, posture) and population of interest (e.g. overweight, obesity). Studies had to be performed with 10 or more participants of 19 years or older, who did not suffer of any diseases affecting movement and describing biomechanical differences between obese and normal-weight subjects to be eligible.

**Results:** The search strategy resulted in 479 articles. After screening all articles on the inclusion criteria, 12 articles were eligible.

**Gait (8 articles)**

Obese gait was consistently characterized by a significant greater step width (3 studies), shorter stride length (5 studies and no difference in 1 study), longer relative stance duration (5 studies), longer relative double support time (2 studies), shorter relative swing time (3 studies) and slower preferred walking speed (6 studies).

While walking at a slower speed, some clear (based on experimental protocol and consistency) differences between obese and normal-weight individuals were found. Knee adduction angle (1 study), ankle eversion angle (1 study), external foot rotation (3 studies) and absolute knee adduction moment (2 studies) were higher in obese individuals. Relative to body weight knee adduction moment was not significantly different (3 studies) and ankle inversion moment was (1 study). Inconsistent results were found for hip abduction angle (2 studies), plantarflexion angle (3 studies) and relative plantarflexion moment (2 studies).

Walking at standardized speed resulted in a higher ankle eversion angle (1 study), external foot rotation (1 study), absolute hip extension moment (1 study) and absolute knee adduction moment (1 study) in obese individuals. Hip extension moment relative to body weight was not significantly different (2 studies). Inconsistent results were found for hip, knee and ankle (plantar)flexion angles (2 studies) and knee and ankle (plantar)flexion moments relative to body weight (2 studies).

**Sit-to-stand (3 articles)**

Analysis of sit-to-stand movement in obese and normal-weight individuals consistently revealed different movement strategies between the two groups. Obese individuals initially moved their feet backward and had a significantly lower trunk flexion during rising. Hence, obese individuals show a lower hip flexion and higher knee extension moment relative to body weight.

**Stair climbing (1 article)**

The only study on differences between obese and normal-weight individuals during stair climbing found higher absolute mechanical power, lower velocity and lower mechanical power relative to body weight in obese compared to normal-weight individuals during stair climbing at maximal speed.

**Conclusions:** Because of a higher body weight, obese individuals suffer from higher loads on weight-bearing joints during every day movements. Besides that, these loads are altered in obese individuals, as shown by the higher joint moments relative to body weight, due to different strategies during walking and rising from a sitting position. Together with the rotation of the lower limb found during walking, this leads to higher loads on regions of the cartilage that are not conditioned to chronic ambulatory loading during these every day movements. This load shift has been associated with the initiation of osteoarthritis and may partly explain why obesity is a risk factor for the onset of osteoarthritis.

Bone Biology

153

**RELATIONSHIPS BETWEEN DIFFERENTIAL GENE EXPRESSION AND BONE MICROARCHITECTURAL PROPERTIES IN PRIMARY HIP OSTEOARTHRITIS**

D.D. Kumarasinghe1,2, L. Truong2,3, B. Hopwood2,3, G.J. Atkins3,4, H. Tsangari2,3, J.S. Kuliwaba1,2, N.L. Fazzalari1,2
1Discipline of Pathology, Univ. of Adelaide, Adelaide, Australia; 2Bone & Joint Res. Lab, SA Pathology, Adelaide, Australia; 3Hanson Inst., SA Pathology, Adelaide, Australia; 4Discipline of Orthopaedics & Trauma, Univ. of Adelaide, Adelaide, Australia

**Purpose:** Primary osteoarthritis (OA) of the hip is one of the most common causes of disability in society, and costs the American and Australian economies billions of dollars each year. There is increasing evidence that early systemic changes in the trabecular bone are an underlying cause of this debilitating disease. Specif-
Abstract 153 – Figure 1. Significant linear correlations between gene expression normalised to GAPDH and histomorphometric indices in control (CTL) and primary hip osteoarthritic cases (OA) from trabecular bone of the intertrochanteric region. a) β-catenin (CTNNB1) expression increased significantly with OS/BS (%) (r = +0.66, p=0.01). b) CTNNB1 expression increased significantly with OS/BV (mm²/mm³) (r = +0.65, p=0.01). c) Matrix metalloproteinase-25 (MMP25) expression increased significantly with ES/BS (%) (r= +0.49, p=0.03). d) MMP25 expression increased significantly with ES/BV (mm²/mm³) (r= +0.46, p=0.04).

Methods: An OA cohort of 23 and a CTL cohort of 21 human IT trabecular bone specimens were assessed using real-time PCR and histomorphometry. The data was tested for normality using the Shapiro-Wilk statistic. As applicable the Student’s t-test was performed expressed as mean ± SD, the Mann-Whitney U test was used for the non-parametric data sets expressed as median (25th, 75th percentile). Regression analysis using Pearson (r) statistics was used to examine the relationship between PCR product/GAPDH ratios and bone histomorphometric variables from both cohorts. The critical value for significance was chosen as p<0.05.

Results: Investigation of CTNNB1 and MMP25 mRNA in OA and CTL trabecular IT bone showed no significant difference in expression, similarly no difference was found among the bone formation indices OS/BS and OS/BV. However, a significant difference in median was observed between OA and CTL for ES/BS [2.505 (1.103, 6.867)] vs [8.199 (3.944, 9.265)] (p=0.01) and ES/BV [0.470 (0.193, 0.968)] vs [1.026 (0.651, 2.446)] (p=0.02). Significant correlations were identified in the CTL cohort between CTNNB1 expression and OS/BS, and OS/BV respectively (r = +0.66, p=0.01). Further correlations were found in the OA cohort between MMP25 expression and ES/BS, and OS/BV respectively (r = +0.49, p=0.03; r = +0.46, p=0.04) (Fig. 1a&b).

Conclusions: The associations found in the CTL cohort between CTNNB1 and the two bone formation indices OS/BS and OS/BV are consistent with the known role of CTNNB1 as a central signalling molecule in the canonical WNT pathway. The canonical WNT pathway is essential to osteoblast differentiation and function. In OA the uncoupling of this relationship maybe indicative of aberrant osteoblast function, hence aberrant mineralisation consistent with observed hypomineralisation in OA. The emergence of associations between MMP25 an established degradative enzyme and resorption indices in OA is consistent with joint degradation in the late stages of the disease. These results validate coupled systemic changes in OA at the genetic and bone microarchitectural level furthering our understanding of this complex pathology.

154 CAN SERUM MARKERS OF BONE METABOLISM PREDICT THE PROGRESSION OF KNEE OA?

P.A. Berry1, R.A. Maciewicz2, F.M. Cicuttini1, M.D. Jones3, E.A. Mills4, C.J. Oakley2, A.E. Wluka1
1Dept. of Epidemiology and Preventive Med., Sch. of Publ. Hlth.and Preventive Med., Monash Univ., Melbourne, Australia; 2Respiratory and Inflammation Res. Area, AstraZeneca, Macclesfield, United Kingdom; 3UCB Group, Brussels, Belgium; 4Statistical Sci., AstraZeneca, Macclesfield, United Kingdom

Purpose: Cartilage and bone are affected simultaneously as osteoarthritis progresses, but this relationship is incompletely understood. This study aimed to examine the relationship between serum markers of bone formation and resorption, and change in cartilage quantity over 2 years, and to determine whether ratios of markers of bone formation to resorption provide additional information.

Methods: Change in cartilage volume over 2 years was measured in 117 subjects with symptomatic knee osteoarthritis using MRI. The relationships between change in cartilage volume and baseline levels of serum markers of bone formation (intact N-terminal propeptide of type I procollagen (PINP) and osteocalcin), resorption (N-telopeptide of type I collagen (ICTP), the C-telopeptide of type I collagen (CTX-I) and the C-telopeptide of type I collagen (ICTP), and ratios of markers of bone formation to resorption were examined.

Results: Individually, lower levels of PINP (p = 0.02), osteocalcin (p = 0.01), NTX-I (p = 0.02), and CTX-I (p = 0.02) were associated with elevated medial cartilage volume loss. No significant associ-