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Lower limb kinematics following unilateral avascular necrosis of the femoral head

W. Dickens[1], J. Van Der Meulen[2], J. Fernandes[3], M.J. Bell[3]. [1]*Gait Laboratory, Sheffield Children's Hospital;* [2]*Medical Physics, Sheffield Teaching Hospitals;* [3]*Trauma and Orthopaedics, Sheffield Children's Hospital, UK*

Summary and Conclusions: Three dimensional gait analysis post avascular necrosis (AVN) of the femoral head, revealed distinct kinematic characteristics for both affected and unaffected sides. Significant differences were found between affected, unaffected and normal. Establishing the gait characteristics of this condition provides a baseline against which surgical outcomes can be evaluated and may also be useful in surgical decision-making.

Introduction: AVN of the femoral head has devastating long term consequences for hip joint mobility and lower limb function. Management is complex, there is no accepted gold standard treatment and there has been only limited evaluation of the gait characteristics of this group [1,2]. To evaluate the management of this condition functionally, a two-stage study has been undertaken. Stage one, a retrospective cohort study of the gait of young people with femoral head AVN (current paper) and stage two, evaluation of these patients post pelvic support osteotomy.

Patients/Materials and Methods: A standard three-dimensional gait analysis was performed on 11 patients with femoral head AVN using a 6-camera Vicon® 370 system, Kistler® force platform and Plug in Gait® software. From a representative cycle for each patient, mean ± 1 standard deviation were calculated for waveform throughout the cycle for affected and unaffected sides. These were compared to the laboratory normal adult dataset (Figure 1). Paired t-tests were performed where data were normally distributed.

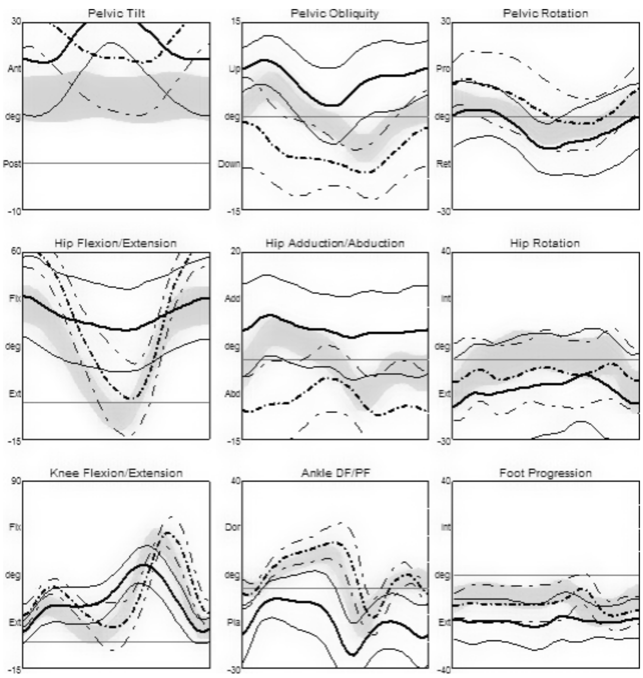

Figure 1. Averaged gait kinematics (mean ± 1 SD): affected side (solid curves), unaffected side (dashed curves), laboratory normal adult data (shaded).

Results: The cohort comprised 6 males and 5 females, mean age 15 years (range 13–16). At the pelvis, excursion was increased in all planes compared to normal and asymmetrical, affected side (A) raised, unaffected side lowered (U) (A = 6±5º, U = –6±5º, $p < 0.01$). Affected hips were persistently flexed with reduced sagittal excursion and typically adducted and externally rotated throughout. Affected and unaffected hips differed significantly in minimum flexion (A = 28±17º, U = 0±14º, $p < 0.01$); flexion range (A = 16±4º, U = 64±9º, $p < 0.01$) and mean adduction (A = 6±8º, $p < 0.01$). At the knee there were significant differences in flexion at initial contact (A = 6±7º, U = 15±6º, $p < 0.01$) and range of motion (A = 41±5º, U = 60±8º, $p < 0.01$). Peak flexion was also earlier on the affected side. At the ankle the majority of the cohort demonstrated compensatory equinus on their affected side with forefoot contact throughout stance. There was a difference in mean DF/PF across the cycle (A = –12±10º, $p < 0.01$, U = 6±4º, $p < 0.01$) and ankle range (A = 26±8º, U = 32±5º, $p = 0.04$). The affected side also demonstrated greater external foot progression (A = 19±8º, U = 12±6º, $p = 0.02$).

Discussion: The cohort demonstrated significant kinematic differences in affected and unaffected sides. Both sides differed from normal. The affected side changes are attributable to the clinical features of femoral head AVN including reduced hip ROM, fixed hip deformities, generalised weakness and true and functional leg length discrepancy. The unaffected side changes are essentially compensatory for the affected side. Kinetic and spatio-temporal data were also collected on this cohort. These data complete the 3-D dataset and will be presented separately.

References

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[2] Siegel D. et al. Journal of Bone and Joint Surgery 1991, 73-A: 659–666.

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Gait adaptations in unilateral transtibial amputees during rehabilitation

C. Barnett[1], N. Vanicek[1], R. Polman[1], A. Hancock[2], B. Brown[2], L. Smith[2]. [1]*Department of Sport, Health and Exercise Science, University of Hull;* [2]*Department of Amputee Rehabilitation, Castle Hill Hospital, UK*

Summary: Two groups of transtibial amputees used different early walking aids (EWA) during rehabilitation, either the AMA or the PPAM Aid, prior to receiving and walking with a functional prosthesis. Walking speed, temporal-spatial parameters and kinematic joint profiles were similar at discharge. Therefore, neither EWA produced better results in gait patterns during gait retraining.

Conclusions: Although the AMA and PPAM aid practice different gait abilities in unilateral transtibial amputees, the findings from this study revealed that patient's gait patterns were similar once they began to use their functional prosthesis. Until discharge, gait retraining with either EWA did not appear to offer greater gait benefits.

Introduction: Transtibial amputees typically follow a program of rehabilitation and treatment after surgery, using early walking aids (EWA). In the UK, there are two different EWAs commonly used in amputee rehabilitation: the Amputee Mobility Aid (AMA) with an articulated knee joint and the Pneumatic Post Amputation Aid

(PPAM Aid) with a non-articulated knee joint. The aim of this study was to assess longitudinal gait adaptations that occurred in unilateral transtibial amputees during rehabilitation and to determine if either EWA had gait benefits.

Patients/Materials and Methods: Transtibal amputees (AMA = 8 and PPAM = 7) were assessed at the initial (Visit 1) and final (Visit 2) rehabilitation sessions using EWAs. Participants were also assessed at the initial use of functional prostheses (Visit 3), again two weeks later (Visit 4) and at discharge from rehabilitation (Visit 5). 3D kinematic gait data were recorded at each visit. Participants completed a minimum of five walking trials at a self selected walking velocity. Paired t-tests and a mixed design repeated measures ANOVA were performed on data ($P < 0.05$).

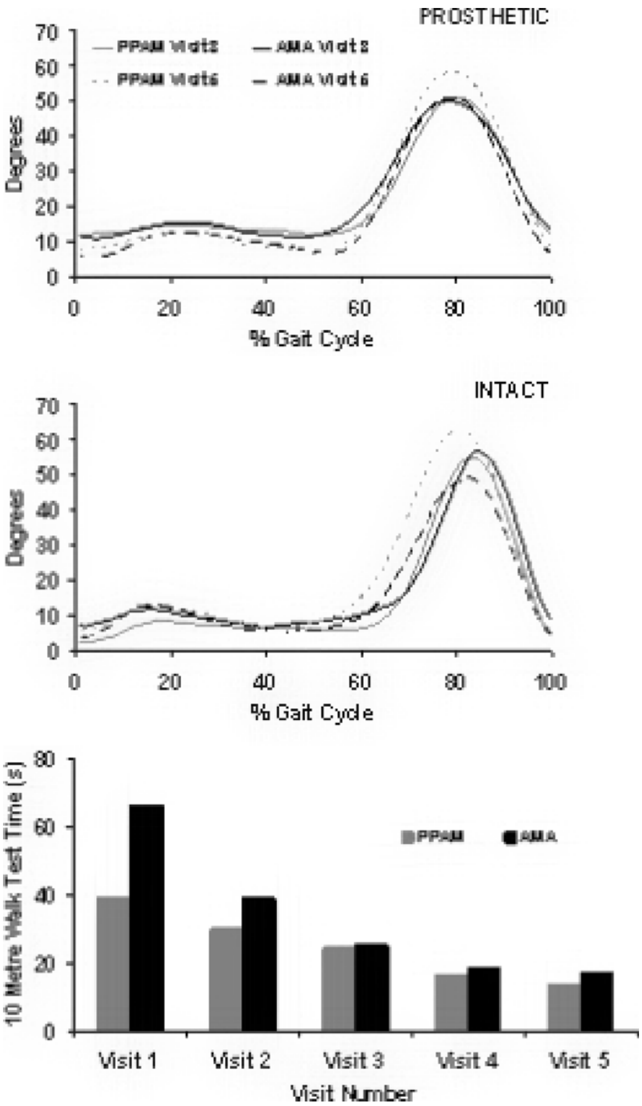

Figure 1.

Results: AMA and PPAM group mean prosthetic and intact limb knee angle profiles at Visits 3 and 5 and AMA and PPAM group mean 10-metre walk test time (Figure 1). The AMA group performed the 10-metre walk test significantly slower than the PPAM group at Visits 1 and 2. The PPAM group received slightly fewer treatments between Visits 1 and 2 (5.1 vs. 6.7 treatments) and the AMA group fewer between Visits 3 and 5 (8.4 vs. 11 treatments), although these differences were not significant. Both groups developed a greater range of sagittal plane knee motion during loading response from Visit 3 to 5. The PPAM group displayed a larger improvement in prosthetic limb hip range of motion from Visit 3 to 5 at around 55% of the gait cycle.

Discussion: Number of treatments received and 10-metre walk test performance were similar between groups at discharge indicating that neither EWA was more beneficial. Both groups developed similar sagittal plane knee motion during loading response from Visit 3 to 5. However, the PPAM group displayed increased knee flexion during swing phase, similar to values apparent in experienced amputee gait [1]. Hip joints of all participants were constantly flexed and although the PPAM group displayed some improvement, participant's hip joints never fully extended.

References

[1] Sanderson DJ and Martin PE. Gait Posture 1997; 6: 126–13.

O038

Biomechanical differences in transtibial amputee fallers vs. non-fallers during level walking

N. Vanicek[1], S. Strike[2], L. McNaughton[1], R. Polman[1]. [1]*Sport, Health & Exercise Science, University of Hull;* [2]*School of Human Life Sciences, Roehampton University, UK*

Summary: This study compared the gait patterns of recent fallers vs. non-fallers among transtibial amputees and age-matched control participants during level walking. The results have shown that biomechanical differences existed between amputee fallers (A-F) and non-fallers (A-NF). While kinematic profiles were similar, significant differences were found for kinetic variables including vertical GRF, and ankle and hip power profiles.

Conclusions: Understanding the biomechanical differences between amputee fallers vs. non-fallers would have important implications for rehabilitation programmes for lower limb amputees. Recommendations for prosthetic rehabilitation could include improving muscle strength surrounding the knee and hip joints, and improving joint range of motion. Amputees who have reported a fall should be encouraged to participate in falls prevention and exercise programmes to reduce the further occurrence of a fall.

Introduction: 52% of lower limb amputees report a fall every year [1]. The loss of the plantarflexor muscles and the mechanical limitations of the prosthetic foot indicate that transtibial amputees are at an increased risk of falling compared to age-matched, able-bodied individuals [1]. In order to understand how gait patterns could be useful in predicting and preventing falls in lower limb amputees, it is important to determine whether gait differences could be identified between recent fallers and non-fallers during level walking. This study focused on the deceleration and support phase in stance.

Patients/Materials and Methods: Eleven unilateral, transtibial amputees (Mean±SD: age; 56±16 yrs) and nine age-matched, able-bodied control individuals (age; 61±16 yrs) participated in this study. Participants were classified into either the non-faller or faller groups based on their falls history in the 9-month period leading up to testing. 3D kinematic and kinetic values were obtained while the participants walked along a 10-m walkway. Data for the controls are presented as an average of both limbs. A Kruskal-Wallis H Test was used to determine if falls history