



Dumas, Raphael and Cheze, Laurence and Frossard, Laurent A. (2009) *Load during prosthetic gait : is direct measurement better than inverse dynamics?* In: European Society of Movement Analysis in Adults and Children (ESMAC) 18th Annual General Meeting, 14-19 Sept 2009, Savoy Place, London

© Copyright 2009 [please consult the authors]

Load during prosthetic gait: is direct measurement better than inverse dynamics?

Raphael Dumas¹, Laurence Cheze¹, Laurent Frossard²

¹ Universite Lyon 1, Villerbanne, France

² School of Engineering Systems, Queensland University of Technology, Brisbane, Australia

(Abstract as accepted: Dumas R, Cheze L, Frossard L. Load during prosthetic gait: is direct measurement better than inverse dynamics? 2009. European Society of Movement Analysis in Adults and Children (ESMAC) 18th Annual General Meeting. London, UK. [P8] - p 170)

SUMMARY - The knee forces and moments estimated by inverse dynamics and directly measured by a multiaxial transducer were compared during the gait of a transfemoral amputee. The estimated and directly measured forces and moments were relatively close. However, 3D inverse dynamics estimated only partially the forces and moments associated with the deformation of the prosthetic foot and locking of knee mechanism.

INTRODUCTION

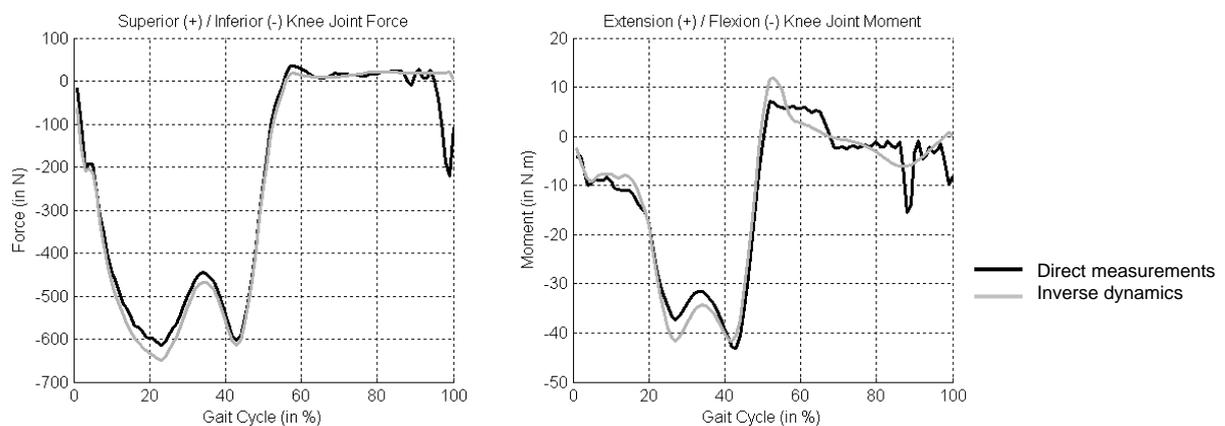
Inverse dynamics estimates net joint forces and moments during walking. However, this method may be prone to errors [1, 2]. Alternatively, transducers can be used to measure directly the load applied on the residuum of transfemoral amputees [3]. So far, a side-by-side assessment of both methods is yet to be performed.

The purpose of this study was to compare the forces and moments applied on a prosthetic knee estimated by inverse dynamics with the ones directly measured.

PATIENTS/MATERIALS AND METHODS

One fully rehabilitated female transfemoral amputee (36 yr, 1.6 m, 62.6 kg) participated in the study. She walked at a self selected speed with a prosthesis including a multiaxial transducer (JR3 Inc). The gait data were recorded simultaneously with a motion analysis system (VICON) and a forceplate (AMTI). The knee joint forces and moments were estimated by 3D inverse dynamics [4] and compared to the direct measurements in terms of Root Mean Squared Error (RMSE) during the gait cycle.

RESULTS



The pattern and magnitude of forces and moments (Figure 1) were typical of transfemoral amputees [1-3]. The RMSEs were all relatively small. For instance, the RMSEs were 42 N for superior-inferior force and 3 N.m for flexion-extension moment.

DISCUSSION

The relatively small errors between forces and moments estimated and directly measured might be due to the lack of soft tissue artefacts compared to asymptomatic gait. However, the estimated knee forces during support revealed over-estimation due to the absorption of the prosthetic foot. In addition, the estimated knee moments during swing revealed under-estimation due to the resistance and impacts of the knee mechanism. Inverse dynamics based on the transducer measurements other than the classical ground reactions might provide better insight for the hip joint forces and moments of the prosthetic limb. Methods based on accelerometers would also help to cope with high-speed dynamics.

CONCLUSIONS

Inverse dynamics gives reasonable estimates of the overall magnitude and pattern of joint forces and moments. However, direct measurement seems to be more sensitive to loading impact of mechanism of prosthetic components. Both methods provide relevant information although direct measurement might be better suited for dynamic alignment, for example.

REFERENCES

- [1] Goldberg et al (2008) *J Biomech* 41(3):695-700.
- [2] Miller & Childress (2005) *Robotica* 23(3): 329–335.
- [3] Frossard et al (2003) *JPO* 15(4): 135-142.
- [4] Dumas et al (2004) *Comput Methods Biomech Biomed Engin* 7(3): 159-166