Reference

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Abstract

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STATIC LOAD BEARING DURING EARLY REHABILITATION OF TRANSFEMORAL AMPUTEES USING OSSEOINTEGRATED FIXATION

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INTRODUCTION

Many transfemoral amputees wearing conventional socket prostheses experience pain related to the socket-residuum interface and difficulties with socket retention or fit due to a short residuum (Hagberg and Brånemark, 2001, Mak et al., 2001). In consideration of these problems a direct skeletal fixation method has been developed whereby a titanium implant is screwed into the medullary canal of the residual femur. Prosthetic components are directly attached to the fixation, once osseointegrated, removing the need for a prosthetic socket (Robinson et al., 2004).

The rehabilitation program to return to ambulation involves incremental static loading of the fixation until full weight bearing is achieved. The rate of loading, which is intended to be isolated to the long axis of the fixation, is determined by the quality of the residual skeleton and a qualitative assessment of the pain experienced by the amputee on loading. Rotational loading of the implant is to be avoided at this stage. The amputee uses a domestic weigh-scale to provide feedback of the load applied. This study aims to measure the true load applied to the fixation and compare this with the clinically prescribed axial load.

METHOD

Subjects: One male amputee participated in the pilot study (age: 46yrs, height: 1.82m, mass: 96.10Kg, side of amputation: left, cause of amputation: trauma, length of time with osseointegrated fixation: 1 year).

Apparatus: A six channel commercial force transducer was fitted between the fixation and the pylon of the short training prosthesis(Frossard et al., 2003a). The transducer was mounted so that it's principal axes aligned with the long, anterior-posterior and medio-lateral anatomical axes of the femur. A serial cable connected the transducer to a laptop for data collection. A commercial weigh-scale was used to monitor the force applied to the fixation. A support frame was provided to help the participant apply the prescribed force to the fixation.

Procedures: The set up used during the rehabilitation program was replicated. The scale was placed on the floor in front of the amputee. It was zeroed prior to loading but not calibrated. The support frame was positioned in front of the scale. The amputee was asked to apply 40Kg (392.4N) on the scale, from a kneeling position as would be clinically prescribed. The amputee applied the load for a period of five seconds and monitored the load using the visual display on the scale during this time. Four loading trials were performed.

Data Analysis: The data analysis involved two steps.

- Step 1: The data corresponding to the period when the load was at the intended level of 40Kg was isolated for data analysis.
- Step 2: Each component of force and moment from step 1 were collated over the four trials and averaged to provide a mean value of the forces and moments applied to the fixation.

RESULTS

Table 1 presents the mean value and standard deviation of the forces and moments applied to the long, anterior-posterior and medio-lateral axes of the fixation.

Forces (N)	Mean	SD
FAP	-15.58	3.9
FML	181.22	3.68
FL	427.69	3.06
Moments (Nm)	Mean	SD
MAP	1.91	2.15
MML	12.73	0.57
ML	1.9	0.41

Table 1. Mean and Standard Deviation (SD) of the components of force and moment applied to the fixation.

DISCUSSION

Forces and moments were measured on all three axes indicating that the true loads applied differed from that clinically intended. Thus loading was not applied on the long axis of the fixation only and rotational loading was not avoided. The true loading applied to the long axis of the fixation has been shown to be greater than the prescribed load. This indicates that the domestic weigh-scale, without calibration, does not accurately measure the axial load applied to the fixation and does not measure the forces and moments that are applied to the anterior-posterior and medio-lateral axes. If the load applied to the fixation is critical at this stage of rehabilitation it may be more relevant to measure the forces and moments applied to all three axes of the fixation rather than focus on the axial load.

The loads applied to the fixation during independent ambulation have indicated significant forces and moments applied to the medio-lateral and anterior-posterior axes when walking in a straight line and around in a circle(Frossard et al., 2003b). Is the application of a purely axial load justified considering the range of loads the fixation is subjected to during use?

Future work will continue to investigate the correlation between the true load and the prescribed load, and the determinants thereof, on a larger population size.

CONCLUSION

The pilot study highlights that the static load bearing program could benefit from further research to better understand the loading applied to the osseointegrated fixation and use this information to justify or modify the existing protocol.

REFERENCES

Frossard, L., Beck, J., Dillon, M., Chappell, M. and Evans, J. H. (2003a) *Journal of Prothetics and Orthotics,* **15,** 135-142.

Frossard, L., Lee Gow, D., Contoyannis, B., Ewins, D., Sullivan, J., Tranberg, R., Haggstrom, E. and Brånemark, R. (2003b) In *Proceedings of XIXth Congress of the International Society of Biomechanics*University of Otago, Dunedin, New Zealand, pp. 114.

Hagberg, K. and Brånemark, R. (2001) *Prosthetics and Orthotics International,* **25,** 186-194.

Mak, A., Zhang, M. and Boone, D. (2001) *Journal of Rehabilitation Research & Development,* **38,** 161-74.

Robinson, K. P., Brånemark, R. and Ward, D. A. (2004) In *Atlas of Amputations and Limb Deficiencies: Surgical, Prosthetic and Rehabilitation Principles*, pp. 673-681.