LOADING APPLIED TO THE IMPLANT OF TRANSFEMORAL AMPUTEES FITTED WITH A DIRECT SKELETAL FIXATION DURING LOAD BEARING EXERCISES

L. Frossard[1], D. Lee Gow[2], B. Contoyannis[3], D. Ewins[4], J. Sullivan[5], R. Tranberg[6], E. Haggstrom[6], R. Brånemark[7]

[1]Centre for Rehabilitation Science and Engineering , QUT, Brisbane
[2]Caulfield General Medical Centre, Melbourne
[3]RehabTech, Monash Rehabilitation Technology Research Unit, Melbourne
[4]Centre for Biomedical Engineering, University of Surrey, Guildford, UK
[5]Queen's Mary Hospital, Roehompton, UK
[6]Lundberg Laboratory for Orthopaedic Research, Gothenburg, Sweden
[7]Centre for Orthopaedic Osseointegration, Gothenburg, Sweden

INTRODUCTION

As described by Hagberg and Brånemark (2002), the main sources of pain and discomfort experienced by transfemoral amputees are associated with the interface between the residuum of the limb and the socket keeping the prosthesis attached to the residuum. Over the last ten years, a team led by Dr Rickard Brånemark attempted to alleviate these concerns by developing a new method of attachment of their prosthetic leg based on a direct skeletal anchorage (Brånemark et al. 2001). In this case, the socket is replaced by a titanium implant fitted into the shaft of the femur. Around 60 amputees living in Europe and two in Australia have experienced the benefits of this new technique.

After the osseointegration of the implant, the amputees start a rehabilitation program involving a step-by-step increase of weights to be applied to their residuum (load bearing exercises) until they can tolerate their own body weight.

This paper aimed to provide the forces and moments applied to the abutment of transfemoral amputees directly measured during the load bearing exercises.

METHOD

A total of 16 transfemoral amputees, representing 30% of the existing population, located around the Melbourne, London and Gothenburg areas participated to this study.

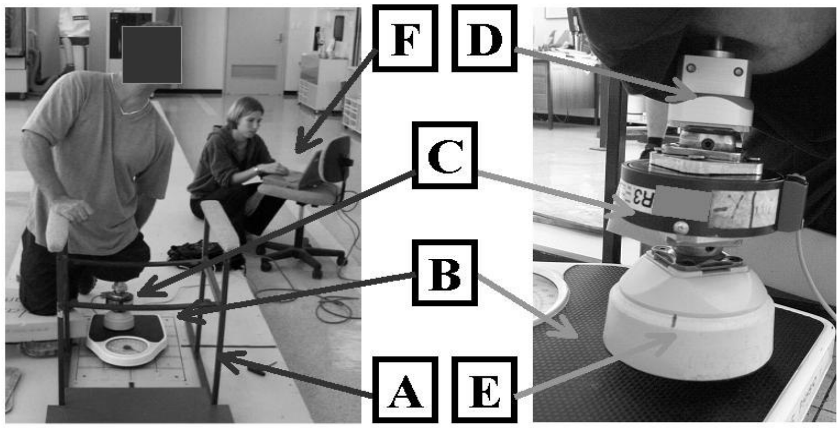
The forces and moments were measured directly by a six-channel transducer at a sampling frequency of 200 Hz. The transducer was mounted between the adaptor and the pylon (Figure 1).

Initially, the subjects were in a kneeling position on the floor in front of a scale and a frame. Then, they were asked to apply a load of 40 kg on the scale with their prosthesis for about five seconds. During this period, the load was applied at a constant rate via self-monitoring of the scale.

RESULTS

In the example presented in Table 1, the resultant of the force applied to the residuum was 464.76±6.17 N. The component of the force along the long axis of the residuum corresponded to 45.37±0.32 % of the body weight (BW) and represented 92.02±0.66 % of the resultant. The component of the force along the medio-lateral axis of the residuum was applied laterally and

Figure 1: Setup used during the load bearing exercise including a support frame (A), a commercial scale (B) as well as a prosthesis equipped with a transducer (C) mounted between an adaptor (D) and a pylon (E). The transducer was connected to a laptop (F)



corresponded to 19.22±0.39 % of the BW and represented 38.99±0.79 % of the resultant. The component of the force along the antero-posterior axis of the residuum was applied on the posterior direction and corresponded to 1.65±0.41 % BW and represented 3.35±0.84 % of the resultant.

The moment around the medio-lateral axis was six times higher than the moments around the antero-posterior and long axes which had the same magnitude.

Table 1: Example of mean, standard deviation, coefficient of variation (CV), minimum (Min), maximum (Max) of the three components of forces (Fx, Fy, Fz) and moments (Mx, My, Mz) applied to the residuum when 40 kg (41.6% of the BW) was applied to the scale over a period of time of 19.2 sec.

	Mean	**SD**	**CV**	**Min**	**Max**
Forces	**(N)**	**(N)**		**(N)**	**(N)**
Fx	-15.58	3.90	-0.25	-22.69	-6.53
Fy	181.22	3.68	0.02	172.49	193.31
Fz	427.69	3.06	0.01	416.03	440.58
Moments	**(N.m)**	**(N.m)**		**(N.m)**	**(N.m)**
Mx	1.91	2.15	1.12	-2.58	5.88
My	12.73	0.57	0.04	11.04	14.28
Mz	1.90	0.41	0.22	1.03	2.75

DISCUSSION AND CONCLUSION

It was demonstrated that the resultant of force as well as its component to the long axis of the residuum were actually significantly higher than the one required (40 kg).

The method and the results presented here presented some limitations as no information was collected about the general body shape. Therefore, a sound understanding of the results obtained with the transducer will required the simultaneous recording of the position of each body segment, using a 3D motion analysis system for example.

It is anticipated that this study might open up new perspectives for the multi-disciplinary teams facing the challenge to safely restore the locomotion of transfemoral amputees fitted with ossoeintegrated implant. The use of a transducer might lead these teams to refine the rational and the practical setting of the load bearing exercise.

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