# Motion Analysis and Postural Stability of Transtibial Prosthesis Users

Akademisk avhandling

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Avhandlingen baseras på följande delarbeten:

I. **Motion-analysis studies of transtibial prosthesis-users: a systematic review.**
Rusaw D., Ramstrand N.
*Prosthetics and Orthotics International, 2011, 35(1), 8-19.*

II. **Sagittal plane position of the functional joint centre of prosthetic foot-ankle mechanisms.**
Rusaw D., Ramstrand N.
*Clinical Biomechanics, 2010, 25(7), 713-720.*

III. **Can vibratory feedback be used to improve postural stability in persons with transtibial limb loss?**
Rusaw D., Hagberg K., Nolan L., Ramstrand N.
*Submitted*

IV. **The contribution of the prosthesis and weight-bearing on EMG response latency following platform perturbation in transtibial prosthesis users.**
Rusaw D., Hagberg K., Nolan L., Ramstrand N.
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Abstract:

The AIMS of the thesis were to critically evaluate motion analysis methods used during investigations of transtibial prosthesis users, and to propose improvements to these methods. Additionally, the aim was to evaluate if vibratory feedback could be used to improve postural stability in transtibial prosthesis users and how being a prosthesis user influenced muscular response to postural perturbations.

MATERIALS AND METHOD *Study I* systematically analyzed 68 peer-reviewed articles investigating lower-limb kinematics in transtibial prosthesis users. *Study II* evaluated motion of prosthetic feet using a functional joint centre (FJC) method. *Study III* evaluated the influence of a vibratory feedback device on postural stability in 24 transtibial prosthesis users. *Study IV* investigated how the prosthetic limb affected EMG response latency in the prosthetic- and intact-limb of 23 transtibial prosthesis users when compared to a matched able-bodied control group (n=23).

RESULTS *Study I* showed a general low level of evidence and low quality in the studies under review and that there were methodological problems which made comparison of studies difficult. *Study II* found that sagittal position of FJCs for prosthetic feet were different between types of prosthetic feet as well as compared to an intact ankle. *Study III* showed vibratory feedback based on pressure under the prosthetic foot caused increased deviations of the centre of pressure in the mediolateral direction, and decreased reaction times in fast voluntary movements of the centre of gravity. *Study IV* showed the EMG response latencies of transtibial prosthesis users were increased in both the intact limb and the prosthetic limb. Increased latencies were found in the contralateral limb when the perturbation was received through the prosthesis.

CONCLUSIONS Methodological issues make interpretation of kinematics of transtibial prosthetic users difficult and motion of the prosthetic foot is not the same in different designs of prosthetic feet or compared to an intact limb. Vibratory feedback can be used to improve some aspects of postural stability, and automatic postural responses are slower in transtibial prosthesis users than in able-bodied controls. These findings contribute to the understanding of how researchers model motion of transtibial prosthesis users and how this group maintains postural stability with a prosthesis.

Keywords: Artificial limb, Balance, Electromyography (EMG), Motion analysis, Postural stability.

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