Review of direct measurement of inner prosthesis loading in transfemoral amputation: Potential benefits for evidence-based practice

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Background. The understanding of the load applied on the residuum through the prosthesis of individuals with transfemoral amputation (TFA) is essential to address a number of concerns that could strongly reduce their quality of life (e.g., residuum skin lesion, prosthesis fitting, alignment). This inner prosthesis loading could be estimated using a typical gait laboratory relying on inverse dynamics equations. Alternative, technological advances proposed over the last decade enabled direct measurement of this kinetic information in a broad variety of situations that could potentially be more relevant in clinical settings. The purposes of this presentation are (A) to review the literature about recent developments in measure and analyses of inner prosthesis loading of TFA, and (B) to extract information that could potentially contribute to a better evidence-based practice.

Method. Approximately 20 articles focusing on the direct measurements of forces and moments applied on the residuum of TFA fitted with a socket or osseointegrated fixation were selected and reviewed.

Results. The inner prosthesis loading has been measured using load cells embedded into the prosthetic knee and residuum for small cohorts of TFA (e.g., up to 12 participants) during:

- Different phases of rehabilitation program to determine the effects of loading bearing exercises[1], walking aids[2], prosthetic components, walking ability[3],
- Activities of daily living including standardized activities like gait[4-8] and open environment[9, 10] as well as during a fall[11, 12].

The analyses of the forces and moments applied on the three axes of the residuum focused mainly on the general pattern, temporal gait characteristics, peak values, loading slopes and impulse.

Discussion. The overall grading of this group of publications was weakened by the fact that most of them were proof-of-concept or preliminary studies. However, this review showed clearly that inner prosthetic loading could potentially provide relevant information to clinicians for a better evidence-based design of components (e.g., socket, implant), conception of rehabilitation programs, fitting and alignment of prosthesis. In particular, kinetic data could assist in the rating in functional levels (e.g., K2 vs K3) while addressing issues of under- and over-prescription.

Conclusion and Clinical Application. The inclusion of these direct measurements within the daily practice of clinicians (e.g., prosthetists) is already facilitated by the emergence of affordable and friendly-user sensors that can be attached and detached easily. Upcoming improvements in technology and data processing will accelerate the use of load cell in clinical settings to obtain kinetic measurements routinely. Further developments might focus on means to extract rapidly relevant and useful information via a comprehensive computer interface, while more research should be conducted to provide a better understanding of the full benefits of the data provided by the load cell.

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