Gait characteristics as indicators of cognitive impairment in geriatric patients

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SUMMARY

The rising life expectancy will result in an increased number of 'older old adults' who will need specialized geriatric care to slow functional decline. Cognitive impairment is a major cause of disability in geriatric patients. Even though there is no cure yet to reverse neurodegeneration, tailored interventions can slow disease progression and reduce symptoms. Because of the abundant evidence from experimental, neuroscientific, and behavioral studies that underscored the close link between motor- and cognitive function, the present thesis proposed to use gait characteristics as non-invasive indicators of cognitive impairment and falls in geriatric patients. The main objective therefore was to increase our understanding of the relationship between gait and cognition in this vulnerable population, in which gait outcomes were calculated from 3D-acceleration signals of the lower trunk that were collected with an iPod Touch 4G. The 'Loss of Complexity' hypothesis provided a theoretical framework. Multivariate analyses were applied to dynamic gait outcomes in relation to cognitive- and fall-status (**Chapter 1**).

Chapter 2 presents a systematic literature review including 20 longitudinal studies that examined associations between baseline gait function and future cognitive decline. A slow gait speed was associated with future decline in global cognition and in specific cognitive functions, and with an increased risk for Mild Cognitive Impairment (MCI) and dementia (maximal odds and hazard ratios of 10.4 and 11.1, respectively) in 4.5 years on average. The review projected that future research could increase the specificity of the gait-cognition link by indexing gait and cognition in more detail.

From this perspective, **Chapter 3** examined whether an extensive cognitive evaluation (global cognition, memory, and executive functioning) and fine-grained, dynamic gait outcomes could add to a usual fall-risk screening. The overall classification accuracy of fallers and non-fallers increased from Area Under the Curve (AUC) =0.86 to AUC=0.93. The specificity of the fall-classification model increased from 60% to 72% when cognitive outcomes were added, and from 72% up to 80% when gait dynamics were added to the model. The results underscored the need for a multifactorial approach in fall risk assessment in geriatric patients, including a detailed evaluation of cognitive- and gait function.

Chapter 4 explored what gait outcomes are most susceptible to change with cognitive decline, and examined multiple gait outcomes in relation to cognitive impairment. Outcomes related to gait speed, regularity, predictability, and stability revealed with the highest discriminative power, indicated by the Variable Importance in Projection (VIP)-values for single- and dual-tasking (average VIP-score of 1.12, with a VIP-score>1 indicating a high discriminative power). Geriatric patients walked slower, less regular, and less stable than healthy old controls. However, the discrimination of geriatric patients with- and without cognitive impairment based on gait outcomes alone was poor, with 57% (single-task) and 64% (dual-task) of the patients being misclassified.

In **Chapter 5,** the gait outcomes with the highest discriminative power in chapter 4 were studied in a prospective pilot study. Significant cognitive decline (in global cognition, memory, and executive functioning) over 14.4 months on average correlated with a more

regular (ρ=0.579*) and more predictable (ρ=0.486*) gait at baseline, but not with baseline gait speed (ρ=0.073). The increased gait regularity and predictability reflected a loss of gait complexity and this loss of gait complexity may thus predict future cognitive decline in geriatric patients.

The results are summarized and discussed in **Chapter 6** of this thesis. Cognitive impairment in the geriatric population possibly becomes manifested trough increased gait regularity and predictability, reflecting a loss of gait complexity. Therefore, dynamic gait outcomes could increase the specificity of the gait-cognition link, and can be considered promising indicators of cognitive impairment and falls. Ultimately, the assessment of gait function provides a cheap and non-invasive mobility measure that in the future could be added to routine geriatric assessments. However, clinicians and researchers should be aware of the effects of multiple, co-existing, conditions in geriatric patients that interact with each other and with gait function. An accurate identification of cognitive impairment and falls thus most likely necessitates a multifactorial approach in this vulnerable population.