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RELATION OF THE ARM PROFILE SCORE AND THE LINEAR INDEX OF FUNCTION. IS THE SHAP AN ADEQUATE FUNCTIONALITY ASSESSMENT OF PROSTHETIC USE? A CASE STUDY.

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Introduction

The Southampton Hand Assessment Procedure (SHAP) is a time-based assessment which is commonly utilised in research and rehabilitation to assess the functionality of upper limb prosthetic devices[1]. However, the SHAP provides no information about compensatory movements due to the prosthetic restoration. The main outcome is the time required to accomplish ADLs expressed by the Linear Index of Function (LIF) [2]. However, compensatory movements among transradial amputees seem to provoke future constraints. The Arm Profile Score (APS) makes a statement about deviation from normative subjects based on kinematic data [3].

Aim

Therefore the aim of this work is to determine whether there is a relation of compensatory movements and execution speed of prothesis user while performing the SHAP.

Figure 1: Prothesis user equiped with Michelangelo Hand (Otto Bock Healthcare GmbH) and two electrode conventional control performing the SHAP - Test task „jar lid“. 63 retroreflective markers and 14 EMG channels were attached to the trunk and upper extremities.

Method

We used 14 infrared cameras (Vicon, UK), the ULEMA model with 63 retroreflective markers to capture 24 normative subjects while performing the SHAP with both sides to receive normative joint angles and calculate the LIF. To investigate the relationship between APS (low APS) and LIF, we have been captured two skilled prosthesis users up to now. Both were equipped with a Michelangelo Hand (Otto Bock Healthcare GmbH), and they used a conventional two electrode control algorithm. We calculated the APS and LIF based on the 24 normative subjects as overall value (oa), for every single task (st) and every prehensile patterns (pp). A low APS indicates a small deviation to the normative groupe. A LIF value with 100 corresponds to the norm and a low LIF a slow time accomplish the task. Subsequently, we calculated Spearman correlation for the single tasks and prehensile patterns. Due to the low number of cases no correlation with the over all values was performed.

Results

Subject 1 shows a LIFoa = 64.7 and an APSoa with 19°. Subject 2 shows a LIFoa = 66.1 and an APSoa with 17°. We find significant correlations between the following values: APSst/LIFst for both subjects (r = -0.583, p = 0.000**, n = 52), APSst/LIFst for subject 1 (r = -0.542, p = 0.004*, n = 26), APSst/LIFst for subject 2 (r = -0.643, p = 0.000**, n = 26) (Fig. 2).
The analysis of the pp shows no significant results for both subjects (r = 0.112, p = 0.729, n = 52) and for individual analysis (subject 1: r = -0.143, p = 0.787, n = 6; subject 2: r = 0.29, p = 0.957, n = 6). The normative LIF is 100, and the normative APS is 7.6°.

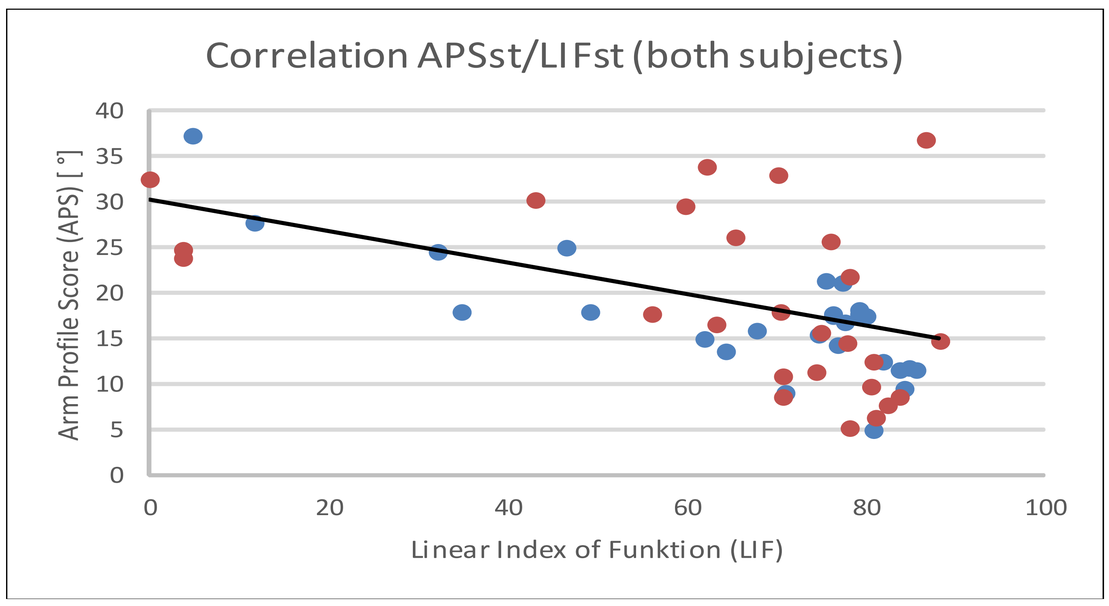

Figure 2: Correlation between Arm Profile Score (APS) and Linear Index of Function (LIF) for single SHAP tasks and both subjects (r = -0.583, p = 0.000**, n = 52). The red dots represent subject 1 (r = -0.542, p = 0.004*, n = 26). The blue dots represent subject 2 (r = -0.643, p = 0.000**, n = 26).

Discussion

The results show a moderate negative correlation between APSst and LIFst values per task. That might indicate a faster execution is related with a lower deviation in kinematics. These results seem to be a hint that the LIF gives an indication about occurring compensatory movements in transradial amputees. That appears valuable regarding overuse induced constraints. However, individual analysis show that subject 1 accomplish certain tasks in a fast manner and with a movement behavior that deviates from normative group quit a lot (Fig. 2). He is able to perform certain tasks effective and fast with occuring compensatory movements. Subject 2 shows high deviation (APS > 25°) only when performing the tasks slow (LIF < 50). Here we find the highest correlation (r = -0.643). However Bouwsema et al. 2012 also found subjects among transradial amputees who show a fast execution and a wide rande of motion while performing the SHAP [4]. The correlations we got are only weak to moderate. Due to the low number of cases we calculated the LIF score per individual task. To correlate the LIFoa with APSoa a higher number of cases is necessary. These are mentionable limitations.

Conclusion

Due to the fact that we found no strong correlation between APS and LIF it appears doubtful that the SHAP is an adequate assessment to detect compensatory movements in transradial amputees. Individual considerations are useful. Additional investigations with a higher number of cases are necessary.

Sources:
[1] Light et al. 2002, Archives of Physical Medicine and Rehabilitation (83, 6), 776 - 783.
[2] Burgerhof et al. 2017, Journal of Hand Therapy (30,1), 49 - 57.
[3] Jasper et al. 2011, Gait and Posture (43, 2), 227 - 233.
[4] Bouwaema et al. 2012, Journal of Rehabilitation Research & Development (47, 4), 1331 - 1347.

This work was supported by the European Union´s Horizon 2020 research and innovation program under grant agreement number 787795 (project INPUT).