3D and electromyographic evaluation of upper extremity movement patterns of trans-radial amputees

BACKGROUND

Assessment tests are the gold standard to measure the functionality of hand prostheses, but they evaluate how fast a patient is able to perform a specific task and do not assess quality of movement. The wide range of UL movements leads to a big challenge to assess and interpret data. Therefore, UL 3D motion analysis is a difficult task in clinical practice, thus there is still a major lack of published normative data. Further research is needed to understand the effectiveness of medical treatments.

AIM

The aim of the study is to highlight compensatory movements of trans-radial amputees using different hand prostheses in comparison to normative subjects.

METHOD

Kinematic, electromyographic (EMG) data and arm profile scores are compared to able-bodied participants (N= 20, 26.3 years ±2.17, BMI: 23±1.44 kg/m^2) during eight daily tasks. The electrodes are placed on the dominant hand of the normative subjects and the affected side of the users, as well as on both sides of the back. Five valid trials are measured and they are normalized into sub phases. The EMG signals are bandpass-filtered (4th order butterworth, 30–500 Hz). The use of 30Hz eliminates ECG contamination [1] and the root mean square (80ms) is estimated for linear enveloping.

RESULTS

Figure 1 exemplifies the movement pattern of a prosthesis user compared to the normative group for the elbow joint in transversal plane and clavicle elevation. Corresponding electromyographic data of the trapezius (pars descendens) and major pectoralis muscles are shown in Figure 2. The three lines (prosthesis 1: green line, prosthesis 2: blue line: prosthesis 3: red, grey band: norm) represent different types of hand prostheses, the vertical dashed lines define the sub phases. The blue line shows increased clavicle elevation in the second and third phase and increased supination during the whole movement. The EMG signal (blue line) presents higher activation of the trapezius muscle and reduced activation of the major pectoralis muscle in the second and third phase.

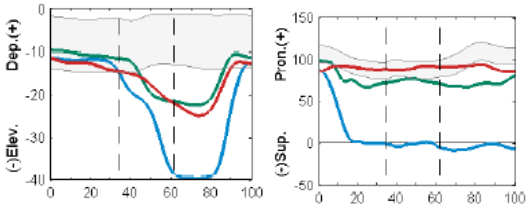

Figure 1. Kinematic data (mean of five trials) of a user with 3 prosthetic devices: left: clavicle elevation / depression, right: elbow pronation / supination

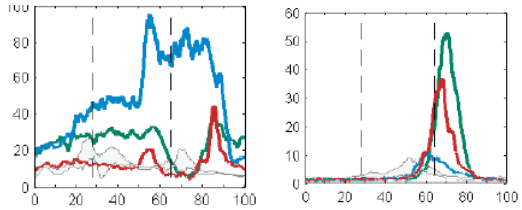

Figure 2. EMG data (mean of five trials) of a user with 3 prosthetic devices: left: trapezius pars desc., right: pectoralis major

DISCUSSION & CONCLUSION

The kinematic data in combination with electromyography clearly highlights the different amount of compensatory movements between the three prosthetic devices, and the differences to the normative group. Prosthesis 2 shows increased elbow supination and clavicle elevation compared to the others. This is also clearly visible in the ectromyographic data, which show an increased activity of the trapezius muscle and a reduction in the major pectoralis muscle. Hence, the presented example elucidates the benefit of kinematic and electromyographic data for clinical evaluation of prosthetic devices.

REFERENCES

NW. Willigenburg, 2012, J Electromyog Kines: 22:485-493