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|---|---|
| **Reference** | |

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# Reduced cortical brain activity with the use of microprocessor-controlled prosthetic knees during walking

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## Products

**Microprocessor-controlled prosthetic knee joints (MPK)[a] vs. Non-microprocessor-controlled prosthetics knee joints (non-MPK)[b] vs. Healthy controls**

[a] C-Leg (Ottobock), Genium (Ottobock), Rheo Knee (Ossur), Very Good Knee (Orthomobility)

[b] 3R-80 (Ottobock), Mauch (Ossur), Total Knee (Ossur), Ultimate Knee (Ortho Europe)

## Major Findings

- → **Less cortical brain activity while walking with an MPK compared to a non-MPK**
- → **Higher cortical brain activity while walking with a non-MPK compared to healthy controls**
- → **No difference in cortical brain activity while walking with an MPK compared to healthy controls**
- → **Prostheses users walked slower, used more steps on a 10 meter walking test than healthy individuals**
- → **Prostheses users covered less distances on a 6-minutes walk test than healthy individual**

## Population

| | |
|---|---|
| Subjects: | 29 subjects (15 MPK-users, 14 non-MPK-users)<br>16 healthy controls |
| Previous prosthesis: | not reported |
| Amputation causes: | 11 Tumour, 13 Trauma, 4 Vascular, 1 Infection |
| Mean age: | MPK-users: 50.1 ± 10.8 years<br>Non-MPK-users: 50.8 ± 14.9 years<br>Controls: 47 years (no individual data reported) |
| Mean time since amputation: | MPK-users: 16.1 ± 14.7 years<br>Non-MPK-users: 19.1 ± 12.9 years |
| Prosthetic use score: | MPK-users: 84.9 ± 17.2 points<br>Non-MPK-users: 69.4 ± 35.1 points |

## Study Design

Cross-sectional study:

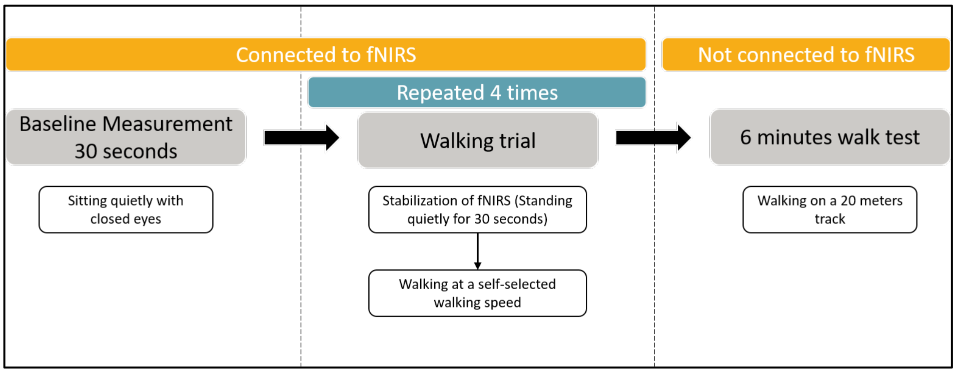


Figure 1, Experimental protocol

Participants attended a single session and were able to use their normal walking aid for the session. The experimental protocol was constructed as follows:

Prior to testing, participants were fitted with the fNIRS system (functional near-infrared spectroscopy; a wireless, portable, continuous wave system to record haemodynamic responses). fNIRS systems record the relative changes in concentration of oxygenated (oxyHb) and deoxygenated (de-oxyHb) haemoglobin, which results from neural activation. An increase in oxyHb concentration and a simultaneous decrease in de-oxyHb concentration would typically be observed as a response to regional brain activation.

Prior to the first testing, baseline measurements were collected for 30 seconds with the participants sitting quietly, with closed eyes. Following the baseline measures, participants then stood for another 30 seconds to allow to stabilization of fNIRS signals before given the signal to commence testing. Each walking trial was repeated for 4 times. A quiet rest of 30 seconds was given between each round.

Participants walked back and forth at a self-selected walking speed over a distance of 14 meters. Measurements of temporospatial data was recorded on the first 10 meters. After the fNIR probes were removed, they also fulfilled a 6 minutes walk test (on a 20 meter track rather than a 30 meter track due to space constraints).

## Results

| Functions and Activities | | | | | | Participation | | | Environment |
|---|---|---|---|---|---|---|---|---|---|
| **Level walking** | Stairs | Ramps, Hills | Uneven ground, Obstacles | **Cognitive demand** | Energy | Safety | Activity, Mobility, ADLs | Preference, Satisfaction, QoL | Health, Economics |

| **Category** | **Outcomes** | **Results for MPKs vs. Non-MPKs vs. Control** | **Sig.*** |
|---|---|---|---|
| Cognitive Demand | Haemodynamic response | Significantly increased oxyHb and decreased de-oxyHb in both prefrontal and motor cortices in individuals walking with a non-MPK when compared to controls (p<0.0167). | |
| | | Significantly lower oxyHb concentrations in the prefrontal and motor cortex in individuals walking with an MPK compared to those walking with a non-MPK (p<0.0167). | -- |

| Category | Outcomes | Results for MPKs vs. Non-MPKs vs. Control | Sig.* |
|---|---|---|---|
| | | No differences could be detected in de-oxyHb when comparing individuals walking with an MPK and non-MPK. | ++ |
| | | No significant differences were seen in oxyHb between MPK users and controls. | 0 |
| | | A significant decrease on de-oxyHb concentrations in the motor cortex for controls when compared to the MPK group could be detected (p<0.0167). | 0 |
| | | Significant differences could be shown for the time taken on the 10 meters walking distance when comparing controls to prosthesis users (non-MPK vs. controls p<0.001; MPK vs. control p<0.001). | -- |
| Level Walking | Temporospatial | Significant differences could be shown for the number of steps taken on the 10 meters walking distance when comparing controls to prosthesis users (non-MPK vs. controls p<0.001; MPK vs. control p<0.025). | -- |
| | | Significant differences could be shown for the covered walking distance in the 6-minutes walking test when comparing controls to prosthesis users (non-MPK vs. controls p<0.001; MPK vs. control p<0.002). | -- |
| | | No differences regarding walking time on the 10-meters, steps taken on the 10 meters and covered walking distance on the 6 minutes walk test could be detected when comparing the MPK group and the non-MPK group. | -- |
| | | No differences regarding walking time on the 10-meters, steps taken on the 10 meters and covered walking distance on the 6 minutes walk test could be detected when comparing the MPK group and the non-MPK group. | 0 |

## Author’s Conclusion

“Persons walking with a non-MPK have an increase in cortical brain activity during ambulation when compared to healthy controls. Furthermore, individuals using an MPK joint require less prefrontal cortical brain activity to ambulate when compared to those using a non-MPK joint. Findings suggest that prescription of microprocessor-controlled prosthetic knees in relatively young and healthy users of TF and KD prostheses may help to reduce reliance on executive functions during gait.” (Möller et al, 2019)

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