Results

From the comparison between data acquired at different stages, gait analysis documented a better stabilization of lumbopelvic segment during the entire gait cycle with better symmetry on the transversal plane; consequently, a better kinematic pattern of the hips was possible, with a progressive reduction (stage 1 and stage 2) of the hyperextension encountered at stage 0. Progressively, the ROM of the left ankle, which was limited by the outcomes of the surgical procedure, has acquired a better and joint power production, similar to normal gait parameters [2]. The follow-up evaluation performed at stage 2 documented the progressive and continuous improvement of gait kinematic and kinetic parameters, an increase of patient's autonomy during walking and lower level of fatigue in long distance-walking.

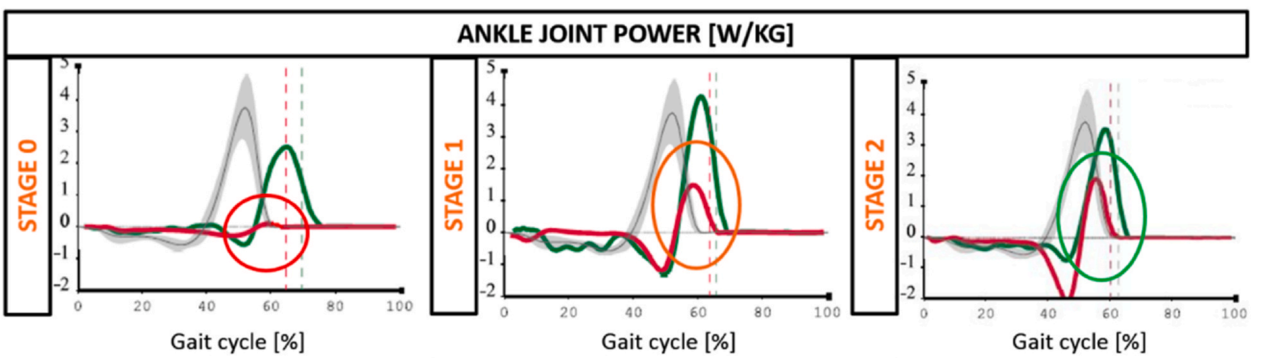

Figure 1. Right (green) and left (red) ankle joint power with respect to normality (grey band) at different rehabilitation stages.

Discussion

In conclusion, the use of gait analysis in the evaluation of innovative chirurgical procedure outcomes has proved to be able to supply useful results for clinical specialists in order to plan the most appropriate rehabilitation and choose the best orthopedic aids to accompany the patient in his path after intervention, according to the patient's needs. If applied before intervention, it could represent a useful tool not only to document and monitor the efficacy of the rehabilitation process and orthopedic aids, but also to provide information that allow clinicians to improve surgical procedure.

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Toward an active omnilateral walking support robotic system

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Introduction

Walking assistive devices for elderly people and patients who have limited mobility have been developed to rehabilitate and restore walking functionality and improve gait stability [1]. However, most of them are handle-type devices with limitations for users that cannot use their hands or harness-type devices, usually too bulky. In this work, we aim to develop an active omnilateral walking support robotic system (Fig. 1) that moves by user intention and assists during walking.

Methods

The platform is intended to follow and physically assist in daily walking activities. Ideally, the user should not perceive resisting forces or other motion constraints while stably walking with the platform. To this end, an admittance controller is developed to implement a dynamic relationship between the user-inserted forces and the robot movements to follow or assist the user as needed. This control method takes as input the forces applied by the person, measured by a force torque sensor (Fig. 1 on the left) directly coupled to the back of the user through a comfortable brace, to determine as output the direction and velocity of movement of the platform.

Results

For the performance assessment, we asked one subject to follow a path that included longitudinal, lateral, and turning sequences. We measured electromyogram (EMG) on eight muscles for assessing the transparency of the platform. The results (Fig. 1 on the right) show that by tuning the mass parameter of the admittance controller, we can operate the platform with high transparency. When the virtual mass value was set to 20 kg, the percentage difference of EMG values with and without the support of the platform was about 17%.

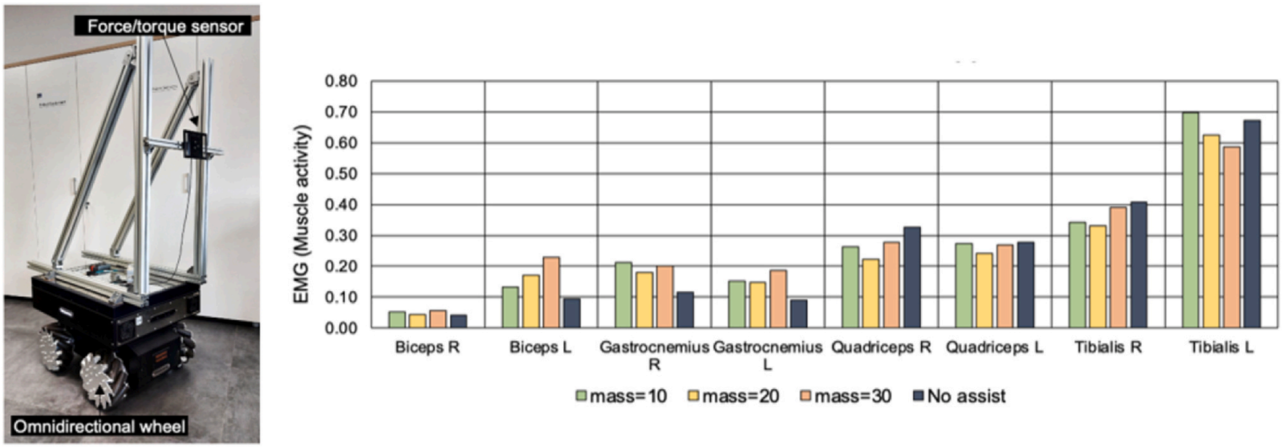

Figure 1. (left) Omnilateral assistive robot system, (right) activity of muscles (R: right, L: left) as root mean square of EMG with varying admittance controller parameters and without the platform.

Discussion

In this work, we presented a prototype of the omnilateral walking support robotic system and we designed an admittance controller based on the interaction force measured on the pelvis of the user. In further work, we will focus on optimizing the parameters of the controller to improve movement transparency. In addition, we will improve the stability of walking, for example, balancing and preventing falls.

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Comparing vertical ground reaction force in patients with Parkinson's disease and healthy subjects walking on a circular path

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Introduction

Curvilinear walking represents a challenging task, due to the cognitive and balance involvements [1,2]. It is known that high-functioning patients with Parkinson disease (PwPD), showed changes in gait parameters during curved trajectories compared to age and speed-matched healthy adults (HS) [3]. Indeed, PwPD diminished the stride length, increased the time spent in double support and had higher variability of swing, single and double support phase during curvilinear paths [3]. However, little it is known about the vertical ground reaction forces (vGRF) in high-functioning PwPD during curvilinear trajectory. The present study aims to compare the vGRF of PwPD and HS during both linear and curvilinear trajectories. We hypothesized that, even when walking at similar speeds, alterations of GRF and their time-course may occur in high-functioning PwPD, especially during curvilinear trajectories.

Methods

We studied a cohort of 18 well-treated PwPD (age 71.4 ± 8.0 years; Hoehn-Yahr range 2-2.5) compared to a group of 18 age and sex-matched HS (age 72.7 ± 7.6 years). HS were purposely selected if walking at the same spontaneous linear speed of PwPD. Participants performed linear and circular walking (1.2 m radius, clockwise and counter-clockwise) at self-selected speed and at random order. Both feet were instrumented with pressure insoles Pedar-X system. We analysed the vGRF of both feet, separated for Foot-In and Foot-Out, during the entire stance normalised as percentage of body weight (%BW) and its time-course expressed in percentage of stride time. The respective coefficients of variation (%CV) have also been analysed.

Results

PwPD showed similar walking speed of HS during curved trajectories ($p = 0.48$). vGRF at heel strike and at toe-off was higher in linear than in curved walking in both groups. At mid-stance, vGRF for both Foot-In and Foot-Out was higher than for linear foot in both groups. No differences in vGRF were found between the two groups in both trajectories. The toe off time-course of PwPD was significantly reduced in both Foot-In ($p < 0.01$) and Foot-Out ($p = 0.05$) compared to HS. No other differences of the time-course variables