CLINICAL STUDY WITH HUNOVA

Neurology – Parkinson Disease

Treatment of advanced stage Parkinson disease with hunova: a case study

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We would like to share our clinical experience of introducing hunova in the rehabilitation program of an advanced Parkinson disease patient. The progress we noticed encouraged us to share this experience to support other clinicians working with the same condition in advanced stage. Hunova is an engaging device for the patient which allows the integration of traditional rehabilitation treatment with personalized exercises able to improve sitting and standing postural control and guarantees the possibility of quantifying the results achieved. Therefore, we would like to provide an overview about the rehabilitative treatment of an advanced stage Parkinsonian patient in this case report.

Introduction

Balance disorders and postural changes in Parkinson's disease are severely disabling for the patient in the latest stages of the condition. Posture may be affected in its orientation component (camptocormia) or in its balance component (loss of postural reflexes). Physical therapy is, in most cases, the best way to improve postural dysfunction[1]. hunova is an innovative robotic device effective for the rehabilitation of postural control and balance. It is composed of two sensorized platforms that allow to perform exercises both in sitting and upright position, providing the patient with continuous sensorial feedback. In this report we present a case study in which we share how we have achieved clinical improvements on postural control and assisted gait after several treatment sessions on hunova in a case of advanced stage Parkinson's disease.

Medical History

We describe the case of a 70-year-old parkinsonian female patient, in stage 4 of Hoen and Yahr[2], admitted to our intensive rehabilitation facility. The patient presents a marked global motor disability and a severe axial dystonia of the trunk with a camptocormic attitude and lateral left abnormal spinal flexion. The musculature of the trunk was insufficient for autonomous maintenance of the sitting posture without support. The patient was completely dependent on performing position changes in bed and postural passages such as sit to stand as well as performing daily personal care activities. A severe deficit of global standing balance is present due to a tendency to shift the center of gravity forwards and a concomitant misalignment in the frontal plane due to scoliosis and axial dystonia. Ambulation is poorly functional, possible only for

[1]Benatru, I., Marianne Vaugoyeau, and J-P. Azulay. "Postural disorders in Parkinson's disease." Neurophysiologie Clinique/Clinical Neurophysiology 38.6 (2008): 459-465.

[2] Hoehn MM, Yahr MD. Parkinsonism: onset, progression and mortality. *Neurology*. 1967; 17(5): 427–442.

very short length with close assistance and the aid of a 4-wheel walker. Early muscle fatigue required frequent rest breaks.

Overall treatment goals

- Improve postural control
- Decrease in articular and trunk rigidity
- Strengthening trunk musculature
- Education to perform autonomously postural passages from bed to wheelchair
- Improve global balance to reduce risk of falling
- Reduce camptocormia
- Improve limb coordination
- Attempt to improve gait with the aid of a 4-wheel walker.

Initial evaluation

Clinical: Functional independence measure (FIM) score was 70 at admission. This clinical scale is an 18-item of physical, psychological and social function. The tool is used to assess a patient's level of disability as well as change in patient status in response to rehabilitation.

Instrumental: Evaluations were performed at recruitment (T0) and at the end of the treatment (T1). The evaluation consisted of both robotic evaluations on hunova and gait analysis using a specific device called Wiva® MOB[3].

The robotic evaluation included the following tests:

- *Balance test on static base* (Eyes Open - Eyes Closed): the subject must maintain their balance on a static surface in standing position. Evaluators include the area and the range of oscillation, the length of the trajectory of sway. In addition, trunk compensations are evaluated.

- *Balance test on static seat* (Eyes Open - Eyes Closed): the subject must maintain their balance on a static surface in sitting position. The assessment parameters are the same as the test above.

- *Balance test on elastic seat* (Eyes Open - Eyes Closed): the seat is unstable and follows the subject's oscillations who must actively maintain the seat horizontal in the center. This test evaluates sitting dynamic balance controlling the area and the range of sway of the seat together with trunk compensation parameters.

- *Pelvis range of motion*: The subject is seated and must move the seat using their pelvis as far as they can. The test determines the maximum range of motion in all the movement directions.

- *Seated limits of stability*: The subject is seated and must move the load as far as they can in the indicated directions (right, left and forwards). The test calculates the range of movement of the load in the different directions.

- *Seated Reaching test*: The subject is seated and must move and control the seat to reach as many targets as possible.

Treatment intervention

The patient regularly performed the rehabilitation program in the gym despite some initial difficulties linked to daily motor fluctuations (in Parkinson disease moments of good motility alternate with moments of motor block) and the appearance of hypotensive episodes during the early hours of the morning. Following some therapeutic adjustments, a greater stability on the clinical level has been appreciated allowing to diversify and expand the proposed treatments.
Ten personalized hunova training sessions with variation of difficulty depending on the patient's performance were prescribed together with conventional physical therapy.
Each training session on hunova lasted 30 minutes, 1 a day. Sessions were focused on:

- Sitting postural control
- Balance in sitting position in static and dynamic conditions
- Trunk range of motion and control
- Pelvis range of motion and control
- Reaching tasks
- Limits of stability

Results

Clinical scale - At the end of the rehabilitative program, at discharge - T1, the functional independence measure (FIM) score increased to 86, gaining points in the personal care, mobility and locomotion functional sub scores.

Gait analysis - As shown in Table 1, at the final evaluation (T1) the patient shows improvements in locomotion with the assistive device (walker) in different parameters that characterize gait. Gait speed [m/min], pace [stride/min] and stride length [m] improve in respect to T0 but are still lower than the normality range, as expected. The duration of the gait cycle decreases and is better distributed symmetrically between the two limbs. The duration of the two phases (stance and swing) as a percentage of the step cycle at T1 is close to normal.

Parameter name	T0	T1
GAIT SPEED [M/MIN]	25.1*	40.9*
PACE [STRIDE/MIN]	25.1*	38*
STRIDE LENGTH [M]	1.04*	1.11*
GAIT CYCLE DURATION [S]	2.39*	1.58*
LEFT STEP DURATION	58%	50.60%
RIGHT STEP DURATION	45.90%	48.70%
STANCE DURATION [% of the cycle]	45.8*	55.1*
SWING DURATION [% of the cycle]	34.4*	44.8*

Table 1: Gait analysis data. Each parameter was calculated at T0 and T1. Asterisks (*) indicate that the value is not normal.

Robotic evaluation - At T0 the robotic evaluation *Balance test on static base* performed in standing position reports abnormal values for most of the test's evaluators. The numeric results at T1 indicate a general improvement in balance when in orthostatic position with bipodalic stance and static conditions (Table 2). In fact, the values of the sway area decrease (both with open and closed eyes), and the pathlength decreases (in closed eyes condition falls into normal). The medio lateral sway ranges of the Center of Pressure have normal values at T1. As far as the trunk, the range of oscillation with closed eyes is smaller, both in mediolateral and anteroposterior directions, indicating less compensation with the upper body.

[3] http://www.loran-engineering.com/wiva_science_mob.html

Parameter name	T0	T1
SWAY AREA - EC [cm2]	26.74*	7.22
SWAY AREA - EO [cm2]	15.75*	4.17*
PATHLENGTH - EO [cm]	36.12*	31.7*
PATHLENGTH - EC [cm]	53.04*	28.12
SWAY RANGE AP - EO [cm]	8.54*	3.44*
SWAY RANGE AP - EC [cm]	6.85*	4.02*
SWAY RANGE ML - EO [cm]	2.63*	1.39
SWAY RANGE ML - EC [cm]	5.33*	1.87
TRUNK SWAY RANGE AP - EO [deg]	13.7*	16.81*
TRUNK SWAY RANGE AP - EC [deg]	25.71*	12.55*
TRUNK SWAY RANGE ML - EO [deg]	3.78*	4.14*
TRUNK SWAY RANGE ML - EC [deg]	6.13*	3.33*

Table 2: Balance test on static base. Each parameter was calculated at T0 and T1. Asterisks (*) mean that the value is not normal. Abbreviations: EC Eyes closed; EO Eyes open; AP Antero-posterior; ML medio lateral.

In the *Balance test on elastic seat* improvements were found in the sway area with eyes open (Table 3). This indicates that the patient showed at T1 a better control of the sitting posture in dynamic conditions with fewer compensations with the trunk to maintain stability. In fact, there is a general improvement in the control of the trunk found in the antero-posterior and medio-lateral sway ranges (Table 3).

Parameter name	T0	T1
SWAY AREA - EC [cm2]	132.45	140.87
SWAY AREA -EO [cm2]	206.72	184.93
TRUNK SWAY RANGE AP - EO [deg]	15.6*	7.98
TRUNK SWAY RANGE AP - EC [deg]	23.5*	6.11
TRUNK SWAY RANGE ML - EO [deg]	6.49	8.25
TRUNK SWAY RANGE ML - EC [deg]	13.12*	10.31

Table 3: Balance test on elastic seat. Each parameter was calculated at T0 and T1. Asterisks (*) mean that the value is not normal. Abbreviations: EC Eyes closed; EO Eyes open; AP Antero-posterior; ML medio lateral.

At T1 an improvement was also found in the *Seated Limits of stability* (the patient improves the ability to actively tilt farther the load in the indicated directions) with an increase in the total area of stability from 48.19 cm^2 to 70.58 cm^2 (Figure 1) and in the *Reaching test* in sitting position the patient improves significantly the capacity of moving actively the seat controlling the pelvis (Figure 2) considering that the patient was not able to perform this test at T0 (number of target reached at T0: 1).

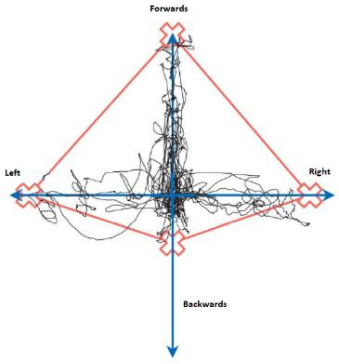

Figure 1: Seated Limits of stability test. Seated center of pressure raw data plotted at T1. The red lines contour the total area of stability.

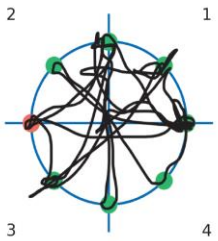

Figure 2: Seated Reaching test. Seat angular displacement raw data plotted at T1. Number of targets reached: 15

Conclusions

Following the rehabilitative treatment, the patient has an important improvement in the overall motor and functional capabilities. The patient could manage postural bed-chair passages with minimal assistance and walk for short distances with the help of the 4-wheel walker, not assisted. It also presents a reduction in global hypertonicity and a greater capacity of controlling actively posture both in sitting and standing positions, although for short periods of time.

From this experience it emerges that hunova contributed to this achievement demonstrating that is an applicable tool for rehabilitation of patients with advanced Parkinson's disease. Hunova is an engaging device for the patient and integrates traditional treatment with personalized exercises able to stimulate sitting and standing postural control. Outcomes obtained both in the clinical and instrumental assessment show the effectiveness of robotic therapy in combination with conventional therapy, with an individualized and interdisciplinary approach. The advanced stage Parkinsonian subject has benefited in a very positive way from the treatment with hunova, in terms of balance, stability and trunk control. It is known that these parameters influence the patient's mobility and gait performance even with the walker. In fact, a better gait analysis was achieved at T1. In real life these good outcomes resulted in improved functionality, independence and social integration of the patient, despite their very advanced condition. We believe that it is important to share our experience and support other clinicians which work with the same patient group.

About us

Our highly specialized rehabilitation clinic is in Cunardo, near Varese, Italy, and welcomes patients who need to carry out intensive multidisciplinary neurological, orthopedic, cardiological and respiratory rehabilitation. It can be accessed in agreement with the NHS or privately, subject to an assessment of appropriateness by referring physicians. It is a modern structure equipped with state-of-the-art robotic equipment and can count on a network of collaboration with different territorial health entities. Specifically, this case study was carried out in the Rehabilitation Section dedicated to patients suffering from Parkinson's disease and Parkinsonism.

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