

Improvements in clinical signs of Parkinson's disease using photobiomodulation: A prospective proof-of-concept study

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Supplementary Table 1. Parameters of the photobiomodulation devices and treatment used in the study.

| PARAMETER | SYMBYX PDCARE LASER | | VIELIGHT NEURO GAMMA | | |
|---------------------------------|-----------------------------|---------------------------------|---------------------------------|-----------------------|-----------------------|
| | | | | | |
| Manufacturer | Spectra Analytic Irradia AB | | Vielight Inc. | | |
| Diodes | 904nm laser diodes (GaAs) | | 5 x LED diodes | | |
| Wavelength | 904nm | | 810 nm | | |
| Laser class | 1 | | - | | |
| | Clinic laser | Home use laser | posterior | anterior | nasal |
| Number of diodes | 4 | 3 | 3 | 1 | 1 |
| Output power | 30 mW | 30 mW | 100 mW | 75 mW | 25mW |
| Peak power | 25,000 mW | 25,000 mW | | | |
| Pulse frequency | 50 Hz | 50 Hz | 40 Hz | 40 Hz | 40 Hz |
| Beam spot size | 0.635 cm ² | 0.635 cm ² | ~1 cm | ~1 cm | ~1 cm |
| Power density per diode | 47 mW/cm ² | 47 mW/cm ² | 100 mW/cm ² | 75 mW/cm ² | 25 mW/cm ² |
| Total output power | 120 mW | 60mW | 400 mW | | |
| Irradiation time per point | 30 s | 60 s | 2100 s | | |
| Total irradiation time | 330 s | 660 s | 2100 s | | |
| Total energy per point | 3.6 J | 3.6 J | 60 J | 45 J | 15 J |
| Number of sites | 11 (9 abdomen, 2 neck) | 11 (9 abdomen, 2 neck) | 3 | 1 | 1 |
| Total energy dose per treatment | 39.6 J | 39.6 J | 180 J | 45 J | 15 J |
| Treatment frequency | weeks 1 to 4 | 3 x per week for 4 weeks | 3 x per week for 4 weeks | | |
| | weeks 5 to 8 | 2 x per week for 4 weeks | 2 x per week for 4 weeks | | |
| | weeks 9 to 12 | 1 x per week for 4 weeks | 1 x per week for 4 weeks | | |
| | weeks 12 to 37 or 52 | 3 x per week for 25 or 40 weeks | 3 x per week for 25 or 40 weeks | | |

Supplementary Table 2. Mean (st dev) of measures of fine motor control, gait, balance and cognition before PBM treatment in a second study of PD treatment with PBM

| | Before treatment |
|-----------------------------------|------------------|
| Gait tests | |
| 10MWT walk speed (m/sec) | 1.69 (0.51) n=7 |
| 10MWT stride length (m) | 0.97 (0.24) n=7 |
| TUG (s) | 7.2 (2.42) n=7 |
| TUG motor (s) | 8.1 (1.85) n=7 |
| TUG cognitive (s) | 8.4 (2.33) n=7 |
| Dynamic Balance test | |
| Step test - affected leg (n) | 15.3 (4.03) n=7 |
| Step test - unaffected leg (n) | 16.6 (5.02) n=7 |
| Cognition test | |
| MoCA | 25.7 (3.08) n=6 |
| Fine Motor Skill tests | |
| NHPT - affected hand (sec) | 29.9 (7.60) n=6 |
| NHPT - unaffected hand (sec) | 26.4 (4.79) n=6 |
| Spiral test - dominant hand (sec) | 25.6 (9.78) n=6 |
| Static Balance | |
| TS affected leg behind (sec) | 14.9 (17.70) n=7 |
| TS unaffected leg behind (sec) | 13.0 (10.94) n=7 |
| SLS affected leg raised (sec) | 7.4 (10.25) n=7 |
| SLS unaffected leg raised (sec) | 8.9 (10.59) n=7 |

10MWT = 10 metre walk test; TUG = Timed-up-and-go; MoCA: Montreal Cognitive Assessment; NHPT = nine-hole peg test; TS = tandem stance (eyes closed); SLS: single leg stance (eyes closed)

Supplementary Table 3. Individual data for participants before and after treatment with the photobiomodulation protocols.

| | GROUP AA PARTICIPANTS | | | | | | GROUP AB PARTICIPANTS | | | | | |
|------------------------------------|-----------------------|-------------|-------------|--------------|-------------|--------------|-----------------------|-------------|--------------|-------------|-------------|-------------|
| | AA1 | AA2 | AA3 | AA4 | AA5 | AA6 | AB1 | AB2 | AB3 | AB4 | AB5 | AB6 |
| NHPT (seconds) | | | | | | | | | | | | |
| affected hand | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 29.0 | 45.8 | 19.6 | 25.1 | 21.0 | 24.0 |
| immediately before treatment | 22.5 | 23.0 | 21.2 | 26.1 | 21.5 | 21.6 | 22.2 (23%) | 56.5 (-23%) | 19.5 (1%) | 31.3 (-24%) | 22.3 (-6%) | 22.8 (5%) |
| after 4 weeks treatment (CT) | | | | | | | 25.8 (11%) | 48.2 (-5%) | 21.5 (-10%) | 25.7 (-2%) | 22.3 (-6%) | 19.2 (20%) |
| after 12 weeks treatment (CT) | 21.1 (6%) | 28.6 (-24%) | 28.0 (-32%) | 37.1 (-42%) | 17.9 (17%) | 27.1 (-25%) | 27.9 (4%) | 47.6 (-4%) | 20.5 (-4%) | 34.8 (-38%) | 24.1 (-15%) | 23.2 (3%) |
| after 26/38 week home treatm | 21.8 (3%) | | | 27.3 (-5%) | 21.6 (0%) | 29.6 (-37%) | 29.4 (-1%) | 69.9 (-53%) | 22.0 (-12%) | 23.4 (7%) | 16.4 (22%) | 24.4 (-2%) |
| dominant hand | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 20.1 | 30.2 | 19.6 | 24.1 | 21.9 | 24.0 |
| immediately before treatment | 29.3 | 18.1 | 33.7 | 26.4 | 16.0 | 25.7 | 18.0 (11%) | 29.1 (4%) | 19.5 (1%) | 26.6 (-10%) | 17.9 (18%) | 22.8 (5%) |
| after 4 weeks treatment (CT) | | | | | | | 16.5 (18%) | 24.9 (18%) | 21.5 (-10%) | 26.8 (-11%) | 18.7 (15%) | 19.2 (20%) |
| after 12 weeks treatment (CT) | 25.8 (12%) | 17.9 (1%) | 27.7 (18%) | 26.8 (-2%) | 17.7 (-10%) | 20.0 (22%) | 25.5 (-27%) | 28.3 (6%) | 20.5 (-4%) | 28.8 (-20%) | 20.1 (8%) | 23.2 (3%) |
| after 26/38 week home treatm | 21.8 (26%) | | | 27.9 (-6%) | 17.0 (-6%) | 27.1 (-5%) | 17.1 (15%) | 29.6 (2%) | 20.1 (-2%) | 28.8 (-20%) | 21.4 (2%) | 22.5 (6%) |
| SPIRAL TEST (seconds) | | | | | | | | | | | | |
| dominant hand | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 32.4 | 37.5 | 48.6 | 33.9 | 29.3 | 36.5 |
| immediately before treatment | 20.4 | 23.8 | 29.3 | 52.5 | 22.6 | 26.2 | 29.6 (9%) | 38.2 (-2%) | 28.7 (41%) | 42.0 (-24%) | 20.7 (29%) | 40.3 (-10%) |
| after 4 weeks treatment (CT) | | | | | | | 19.4 (40%) | 30.8 (18%) | 18.7 (61%) | 41.7 (-23%) | 23.7 (19%) | 31.2 (15%) |
| after 12 weeks treatment (CT) | 16.8 (18%) | 23.7 (0%) | 31.9 (-9%) | 23.2 (56%) | 16.5 (27%) | 21.1 (19%) | 28.9 (11%) | 29.9 (20%) | 29.1 (40%) | 45.9 (-35%) | 14.1 (52%) | 21.7 (41%) |
| after 26/38 week home treatm | 17.8 (13%) | 27.6 (-16%) | | 44.2 (16%) | 17.4 (23%) | 14.9 (43%) | 34.4 (-6%) | 34.2 (9%) | 19.8 (59%) | 35.9 (-6%) | 21.1 (28%) | 27.9 (24%) |
| STEP TEST (number of steps) | | | | | | | | | | | | |
| affected foot | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 17 | 11 | 14 | 9 | 9 | 7 |
| immediately before treatment | 12 | 12 | 8 | 14 | 18 | 14 | 21 (24%) | 12 (9%) | 15 (7%) | 13 (44%) | 13 (44%) | 15 (114%) |
| after 4 weeks treatment (CT) | | | | | | | 23 (35%) | 14 (27%) | 17 (21%) | 15 (67%) | 15 (67%) | 14 (100%) |
| after 12 weeks treatment (CT) | 15 (25%) | 18 (50%) | 11 (38%) | 20 (43%) | 23 (28%) | 17 (21%) | 23 (35%) | 14 (27%) | 19 (36%) | 11 (22%) | 16 (78%) | 15 (114%) |
| after 26/38 week home treatm | 15 (25%) | nd | nd | 18 (29%) | 21 (17%) | 17 (21%) | 20 (18%) | 12 (9%) | 21 (50%) | 11 (22%) | 18 (100%) | 14 (100%) |
| dominant foot | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 12 | 10 | 14 | 11 | 12 | 7 |
| immediately before treatment | 12 | 11 | 9 | 12 | 20 | 14 | 18 (50%) | 12 (20%) | 15 (7%) | 11 (0%) | 12 (0%) | 15 (114%) |
| after 4 weeks treatment (CT) | | | | | | | 21 (75%) | 12 (20%) | 17 (21%) | 15 (36%) | 15 (25%) | 14 (100%) |
| after 12 weeks treatment (CT) | 14 (17%) | 18 (64%) | 11 (22%) | 16 (33%) | 22 (10%) | 17 (21%) | 21 (75%) | 12 (20%) | 19 (36%) | 13 (18%) | 17 (42%) | 15 (114%) |
| after 26/38 week home treatm | 14 (17%) | nd | nd | 20 (67%) | 21 (5%) | 17 (21%) | 24 (100%) | 13 (30%) | 21 (50%) | 13 (18%) | 19 (58%) | 14 (100%) |
| TS (seconds) | | | | | | | | | | | | |
| affected foot behind | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 8.0 | 0.0 | 2.0 | 4.0 | 2.0 | 0.0 |
| immediately before treatment | 30.0 | 12.0 | 0.0 | 0.0 | 1.0 | 6.0 | 8.0 (0%) | 1.0 | 7.5 (275%) | 14.0 (250%) | 3.6 (80%) | 0.0 |
| after 4 weeks treatment (CT) | | | | | | | 30.0 (275%) | 4.7 | 30.0 (1400%) | 30.0 (650%) | 9.0 (350%) | 2.7 |
| after 12 weeks treatment (CT) | 30.0 | 30.0 (150%) | 9.5 | 0.0 | 2.0 (100%) | 2.0 (-67%) | 15.0 (88%) | 1.0 | 5.6 (180%) | 30.0 (650%) | 6.0 (200%) | 1.0 |
| after 26/38 week home treatm | 30.0 | nd | nd | 0.0 | 4.0 (300%) | 3.9 (-34%) | 30.0 (275%) | nd | 30.0 (1400%) | 3.9 (-2%) | 3.4 (70%) | 3.0 |
| unaffected foot behind | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 1.0 | 0.0 | 1.0 | 7.0 | 4.0 | 0.0 |
| immediately before treatment | 30.0 | 2.0 | 0.0 | 0.0 | 4.0 | 7.0 | 9.2 (820%) | 0.0 | 4.3 (330%) | 4.0 (-43%) | 13.0 (225%) | 0.0 |
| after 4 weeks treatment (CT) | | | | | | | 30.0 (2900%) | 3.1 | 3.0 (200%) | 30.0 (329%) | 3.0 (-25%) | 3.3 |
| after 12 weeks treatment (CT) | 24.3 (-19%) | 30.0 ##### | 2.3 | 1.0 | 3.0 (-25%) | 6.0 (-14%) | 30.0 (2900%) | 2.5 | 2.0 (100%) | 20.0 (186%) | 2.0 (-50%) | 1.0 |
| after 26/38 week home treatm | 30.0 (0%) | nd | nd | 0.0 | 2.7 (-33%) | 3.9 (-44%) | 30.0 (2900%) | nd | 10.7 (972%) | 30.0 (329%) | 3.4 (-15%) | 3.2 |
| SLS (seconds) | | | | | | | | | | | | |
| affected foot raised | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 8.9 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0 |
| immediately before treatment | 6.0 | 2.0 | 5.0 | 0.0 | 8.0 | 1.0 | 2.0 (-78%) | 0.0 | 1.1 | 3.1 (210%) | 2.0 (0%) | 1.0 (-50%) |
| after 4 weeks treatment (CT) | | | | | | | 30.0 (237%) | 0.1 | 1.3 | 1.6 (60%) | 0.0 | 1.0 (-50%) |
| after 12 weeks treatment (CT) | 2.6 (-57%) | 14.0 (600%) | 0.0 | 0.0 | 0.0 | 2.0 (100%) | 10.0 (12%) | 0.0 | 1.6 | 5.4 (440%) | 0.0 | 0.0 |
| after 26/38 week home treatm | 3.9 (-35%) | nd | nd | | 5.4 (-32%) | 1.9 (90%) | 23.2 (161%) | nd | 5.0 | 2.1 (110%) | nd | nd |
| unaffected foot raised | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 4.9 | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 |
| immediately before treatment | 5.0 | 2.0 | 3.0 | 1.0 | 3.0 | 2.2 | 12.0 (145%) | 0.0 | 2.1 | 3.1 (210%) | 2.0 (100%) | 0.7 (-30%) |
| after 4 weeks treatment (CT) | | | | | | | 6.7 (37%) | 0.1 | 0.1 | 1.6 (60%) | 0.0 | 0.0 |
| after 12 weeks treatment (CT) | 2.4 (-52%) | 2.7 (35%) | 0.0 | 12.3 (1130%) | 0.0 | 1.0 (-55%) | 26.0 (431%) | 0.0 | 1.7 | 5.4 (440%) | 0.0 | 0.0 |
| after 26/38 week home treatm | 18.9 (278%) | nd | nd | | 30.0 (900%) | 30.0 (1264%) | 30.0 (512%) | nd | 5.0 | 2.1 (110%) | nd | nd |
| WALK SPEED (metres/second) | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 1.22 | 1.03 | 1.62 | 1.20 | 1.33 | 0.76 |
| immediately before treatment | 1.00 | 0.86 | 0.57 | 1.03 | 1.33 | 1.20 | 1.76 (44%) | 1.54 (50%) | 1.88 (16%) | 1.94 (61%) | 1.90 (43%) | 1.50 (98%) |
| after 4 weeks treatment (CT) | | | | | | | 1.94 (58%) | 1.62 (58%) | 2.00 (23%) | 1.94 (61%) | 2.04 (53%) | 1.55 (104%) |
| after 12 weeks treatment (CT) | 1.54 (54%) | 1.62 (89%) | 0.79 (39%) | 1.67 (61%) | 1.94 (45%) | 1.71 (43%) | 1.94 (58%) | 1.60 (56%) | 2.21 (36%) | 1.94 (61%) | 1.96 (47%) | 1.50 (98%) |
| after 26/38 week home treatm | 1.72 (72%) | nd | nd | 1.33 (29%) | 1.75 (32%) | 1.09 (-9%) | 2.07 (69%) | 1.69 (64%) | 2.54 (57%) | 1.93 (61%) | 2.00 (50%) | 1.54 (103%) |
| WALK STRIDE LENGTH (metres) | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.5 |
| immediately before treatment | 0.5 | 0.5 | 0.4 | 0.5 | 0.6 | 0.5 | 0.6 (20%) | 0.7 (33%) | 0.8 (38%) | 0.9 (43%) | 0.6 (0%) | 0.7 (33%) |
| after 4 weeks treatment (CT) | | | | | | | 0.4 (-20%) | 0.8 (50%) | 0.7 (22%) | 0.9 (43%) | 0.8 (25%) | 0.7 (33%) |
| after 12 weeks treatment (CT) | 0.7 (22%) | 0.5 (18%) | 0.5 (8%) | 0.7 (33%) | 0.5 (-23%) | 0.8 (38%) | 0.7 (33%) | 0.7 (33%) | 0.8 (38%) | 0.9 (43%) | 0.8 (25%) | 0.7 (33%) |
| after 26/38 week home treatm | 0.8 (38%) | nd | nd | 0.6 (20%) | 0.8 (25%) | 0.7 (22%) | 0.8 (50%) | 0.7 (33%) | 0.8 (38%) | 0.8 (25%) | 0.8 (25%) | 0.8 (50%) |
| TUG (seconds) | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 7.9 | 9.7 | 6.8 | 7.6 | 7.8 | 13.8 |
| immediately before treatment | 10.2 | 8.0 | 18.0 | 11.0 | 6.5 | 7.5 | 7.4 (6%) | 8.5 (12%) | 6.5 (4%) | 7.3 (4%) | 6.7 (14%) | 9.3 (33%) |
| after 4 weeks treatment (CT) | | | | | | | 6.4 (19%) | 7.4 (24%) | 6.3 (7%) | 6.6 (13%) | 6.5 (17%) | 7.9 (43%) |
| after 12 weeks treatment (CT) | 8.4 (18%) | 7.1 (11%) | 15.5 (14%) | 8.5 (23%) | 5.2 (20%) | 6.6 (12%) | 6.6 (16%) | 7.6 (22%) | 5.9 (13%) | 7.1 (6%) | 6.3 (19%) | 7.6 (45%) |
| after 26/38 week home treatm | 8.1 (21%) | nd | nd | 9.9 (10%) | 6.0 (7%) | 5.8 (23%) | 6.6 (16%) | 8.0 (18%) | 6.3 (7%) | 6.6 (13%) | 5.9 (24%) | 7.9 (43%) |
| TUG MOTOR (seconds) | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 8.8 | 9.0 | 6.9 | 7.6 | 8.3 | 11.8 |
| immediately before treatment | 10.9 | 8.2 | 17.7 | 10.6 | 7.1 | 7.2 | 8.2 (7%) | 8.1 (10%) | 6.5 (6%) | 8.3 (-9%) | 6.4 (23%) | 9.1 (23%) |
| after 4 weeks treatment (CT) | | | | | | | 7.4 (16%) | 7.2 (20%) | 6.6 (4%) | 6.9 (9%) | 6.4 (23%) | 8.3 (30%) |
| after 12 weeks treatment (CT) | 8.8 (19%) | 8.2 (0%) | 16.5 (7%) | 9.3 (12%) | 6.6 (7%) | 7.0 (3%) | 6.4 (27%) | 8.5 (6%) | 6.3 (9%) | 7.1 (7%) | 6.6 (20%) | 8.1 (31%) |
| after 26/38 week home treatm | 8.4 (23%) | nd | nd | 13.3 (-26%) | 6.1 (14%) | 6.4 (11%) | 6.0 (32%) | 9.2 (-2%) | 7.0 (-1%) | 6.8 (10%) | 5.8 (30%) | 8.4 (29%) |
| TUG COGNITIVE (seconds) | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 10.3 | 10.6 | 7.2 | 8.7 | 8.8 | 13.8 |
| immediately before treatment | 12.0 | 10.4 | 23.7 | 10.5 | 6.0 | 7.6 | 7.5 (27%) | 8.8 (17%) | 7.3 (-1%) | 7.5 (14%) | 6.7 (24%) | 9.0 (35%) |
| after 4 weeks treatment (CT) | | | | | | | 7.2 (30%) | 8.2 (23%) | 6.7 (7%) | 6.6 (24%) | 6.2 (30%) | 8.7 (37%) |
| after 12 weeks treatment (CT) | 9.3 (23%) | 6.9 (34%) | 18.2 (23%) | 9.3 (11%) | 5.2 (14%) | 6.8 (11%) | 6.3 (39%) | 8.9 (16%) | 6.4 (11%) | 6.8 (22%) | 6.8 (23%) | 8.1 (41%) |
| after 26/38 week home treatm | 8.8 (26%) | nd | nd | 9.8 (6%) | 5.2 (13%) | 5.9 (22%) | 6.7 (35%) | 9.5 (11%) | 6.5 (10%) | 6.4 (27%) | 6.6 (25%) | 8.8 (36%) |
| MoCA score | | | | | | | | | | | | |
| 12 weeks prior to treatment | | | | | | | 26 | 28 | 27 | 26 | 24 | 21 |
| immediately before treatment | 24 | 26 | 26 | 28 | 27 | 24 | 29 (12%) | 29 (4%) | 27 (0%) | 26 (0%) | 28 (17%) | 24 (14%) |
| after 4 weeks treatment (CT) | | | | | | | 28 (8%) | 30 (7%) | 28 (4%) | 26 (0%) | 28 (17%) | 25 (19%) |
| after 12 weeks treatment (CT) | 25 (4%) | 26 (0%) | 28 (8%) | 28 (0%) | 27 (0%) | 29 (21%) | 29 (12%) | 30 (7%) | 27 (0%) | 27 (4%) | 29 (21%) | 29 (38%) |
| after 26/38 week home treatm | 29 (21%) | 29 (12%) | nd | 30 (7%) | 28.7 (6%) | 30 (24%) | 30 (15%) | 30 (7%) | 30 (11%) | 28.7 (10%) | 30 (25%) | nd |

NHPT = nine-hole peg test

TS = tandem stance (eyes closed)

SLS = single leg stance (eyes closed)

TUG = timed up-and-go

MoCA = Montreal Cognitive Assessment

number in brackets is the percentage improvement (positive value) or decline (negative value) in an outcome measure