

Effect of Metronome-Based Structured Rhythmic Exercise Program on Freezing and Gait Parameters in Parkinson Disease

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PROTOCOL

In both groups, exercises will be performed for approximately 45-60 minutes, 3 days a week. The exercise program is planned for 4 weeks and a total of 12 sessions, and the exercises will be changed and advanced weekly according to the patient's performance. When the participants complete the exercise program of the relevant week with an 80% success rate, they will be advanced to the next week's exercise program. If the target success rate is not reached, the exercise program of the relevant week will be repeated. At the beginning of the week, a physiotherapist will visit the homes of the participants in both groups. During this visit, the exercises planned for that week will be taught to the participant, and the first of the 3 exercise sessions in the relevant week will be performed face-to-face with the physiotherapist, and the remaining two sessions will be performed under the supervision of the caregiver with the physiotherapist via online video conference via WhatsApp Messenger. In addition, the exercise program planned for each week will be prepared as a visual and sent to the participant or caregiver via the WhatsApp Messenger application. In addition, at the end of the first session held face-to-face at the beginning of the week, the patient's caregiver will be given training by the physiotherapist, including the relevant safety instructions, the arrangements that need to be made in the home environment for the exercise application, and the instructions that need to be applied in the online video conference call.

The exercise program structured by the physiotherapist will be applied to the REG group for 3 sessions per week with metronome rhythms for 4 weeks. The metronome rhythms determined according to the participant's performance will be played to the participant during the exercise applications via an application called 'Google Metronome' that the patients will download to their phones. For the EG participants, the same exercises as REG will be applied at the patients' own pace without metronome rhythms for 4 weeks.

EXERCISE PROGRAM

The exercise program generally consists of walking preparation, walking, standing up from sitting, trunk rotations, turning, climbing steps, and obstacle crossing exercises.

Determination of Metronome Rhythms to be Applied in the Exercise Program for REG

In order to determine the metronome rhythm, timed performance tests will be performed face-to-face during the evaluation interview before starting the study. If the participant gets tired during the tests, they will be allowed to rest, but the time will not be stopped. According to the results of these tests, the number of beats per minute corresponding to 80% of the person's own performance or capacity will be determined as the metronome rhythm (MR) for the first week. This determined MR will be used in the exercises to be performed during the first week. In the following weeks, it is planned to increase the initially determined MR to 85%, 100% and 110%, respectively, depending on the patient's compliance with the exercises, and the exercises are requested to be performed with these new metronome rhythms.

1. Determination of Walking Metronome Rhythm

The gait cadence (GC) of the participants walking on a flat surface without metronome stimulation during the 10 m Walking Test will be determined.

2. Determining the Metronome Rhythm for Step Exercise

While the participants climb a 10-step staircase as quickly and safely as possible, the time from the first foot contact to the final foot placement is recorded (Ouellette et al. test is applied (2024)), and the duration of one step is calculated in minutes. According to this time, the number of steps per minute (cadence) is determined as the step climbing cadence (SCC) and the metronome rhythm is created.

3. Determining the Metronome Rhythm for Sit-Stand

During the 1 Minute Sit-Stand Test, the participant is instructed to stand up and sit down as many times as possible for 1 minute. The stopwatch is started with the "start" command and stopped when the time is completed. Only repetitions in which a full stand-up is achieved will be recorded. The test is performed on a standard height chair (46 cm) without armrests. (Bohannon et al. (2019)). The number of movements per minute (cadence) of the individual will be calculated and this data obtained will be used to determine the sit-stand cadence (SSC) metronome rhythm.

4. Determining the Metronome Rhythm for Rotation Exercises

The timed stand-up test walking cadence (TMW) obtained as a result of this test, which ends with the participant getting up from where he/she is sitting, walking 3 meters away, coming back and sitting down again, will be used to determine the metronome rhythm in the 180o and 360o rotation exercises.

5. Determining the Metronome Rhythm for Dorsi-Plantar Flexion Exercise

It will be determined with the 1-minute Dorsi-Plantar Flexion Test. The participant will perform dorsiflexion-plantar flexion with the ankles for 1 minute while the knees are extended. The data obtained from the number of movements (cadence) that the participant can perform for 1 minute by holding the stopwatch will be used to determine the dorsi-plantar flexion cadence (DPFC) metronome rhythm.

6. Determination of the Fingertip Rise Metronome Rhythm

The metronome rhythm will be determined according to the Fingertip Rise Cadence (FRC) obtained with the 1-minute Fingertip Rise Test. While standing, the participant will put weight on the fingertips for 1 minute, breaking the heels' contact with the ground, then re-establishing heel contact. The total number of movements the participant can perform for 1 minute by holding the stopwatch indicates the fingertip rise cadence per minute.

7. Determination of the Body Rotation Rhythm

The metronome rhythm will be determined according to the body rotation cadence (BRC) obtained from the 1-minute Body Rotation Test. The patient is seated on the chair with their back straight and their feet touching the ground. The arms are joined in a crossed position on the chest and with the starting command, they are asked to perform as many full rotations as possible by rotating the body to the right and left. Each right and left rotation is counted as one full movement. The total number of movements at the end of one minute is recorded. This total number indicates the individual's body rotation cadence per minute.

EXERCISE PROGRAM

All exercises except walking activities will be performed as 10 repetitions x 3 sets with 90 seconds (s) rest between sets. Straight, side and backward walking activities will be performed 3 repetitions and there will be 90 seconds rest between repetitions.

WEEK 1

- Initiating Walking: Step rhythmically forward with the right and left lower extremities alternately, then return the foot to the starting position. MR = 80% GC
- Straight Walking: Walk straight for 10 meters, focusing on the rhythm. MR = 80% GC
- Side Walking: Walk sideways for 10 meters, focusing on the rhythm. MR = 80% GC
- 180° Turning: Walk straight between two chairs placed 3 meters apart, focusing on the rhythm. Make a half turn around the chair, continue walking towards the starting point, make another half turn around the first chair, and sit down. MR = 80% GC
- Ankle Dorsiflexion- Plantar Flexion Exercise: With knees in extension, move the ankles rhythmically into dorsiflexion and plantar flexion positions alternately. MR = 80% DPFC
- Toe Raises: While standing upright, rhythmically shift weight onto the toes so that the heels slightly lift off the ground, then bring the heels back into contact with the floor. MR = 80% TRC
- Hip Flexion (Seated): While sitting with feet fully contacting the ground, perform rhythmic hip flexion. MR = 100% GC
- Knee Extension (Seated): Perform knee extension alternately in both lower extremities while sitting. MR = 100% GC
- Sit-to-Stand: Perform rhythmic sit-to-stand movements at a 60° angle. MR = 80% SSC
- Trunk Rotation (Seated): While sitting with feet flat on the floor, hold the shoulders and arms in 90° flexion. Perform upper trunk rotation to the right and left without pelvic rotation. MR = 80% TRC

WEEK 2

- Marching in Place: While standing, perform alternating 90° hip and knee flexion rhythmically with both legs. MR = 100% GC
- Straight Walking: Walk 10 meters straight focusing on rhythm. MR = 100% GC
- Side Walking: Walk 10 meters sideways focusing on rhythm. MR = 100% GC
- Backward Walking: Walk 10 meters backward focusing on rhythm. MR = 80% GC
- Walking with Reciprocal Arm Swings: Exaggerated reciprocal arm swings with 10 meters of straight walking, rhythmically. MR = 80% GC
- Step Exercise: Step rhythmically onto an 18 cm high step, transfer weight to the step foot, and return the other foot next to it. MR = 80% SCC
- Figure-Eight Walking: Walk in a figure-eight pattern between two floor markers rhythmically. MR = 100% GC
- 360° Turning: Walk straight between two chairs placed 3 meters apart. Turn fully around one chair, walk back, turn around the other chair, and sit down. MR = 80% GC
- Sit-to-Stand: Perform rhythmic sit-to-stand from a 90° seated angle. MR = 80% SSC
- Trunk Rotation (Standing): While standing, hold shoulders and arms at 90° flexion. Rotate upper trunk right and left without pelvic movement. MR = 100% BRC

WEEK 3

- Straight Walking 1: Walk 10 meters straight focusing on rhythm. MR = 110% GC
- Straight Walking 2 (Dual Task): While walking 10 meters straight rhythmically, carry an empty cup (made of unbreakable material) on a tray with both hands. MR = 110% GC
- Side Walking 1: Walk 10 meters sideways focusing on rhythm. MR = 110% GC
- Side Walking 2 (Cognitive Task): Walk 10 meters sideways while verbally naming the days of the week. MR = 110% GC
- Backward Walking 1: Walk 10 meters backward focusing on rhythm. MR = 100% GC
- Backward Walking 2 (Cognitive Task): Walk 10 meters backward while verbally reciting the alphabet. MR = 100% GC
- Reciprocal Arm Swings Walking 1: Perform exaggerated reciprocal arm swings while walking 10 meters straight. MR = 100% GC
- Reciprocal Arm Swings Walking 2 (Trunk Control): Same as above, but with upper trunk rotation without pelvic rotation. MR = 100% GC
- Figure-Eight Walking: Walk in a figure-eight pattern between two markers on the ground. MR = 110% GC
- 360° Turning: Walk between two chairs 3 meters apart, turn fully around one, walk back, turn again, and sit. MR = 100% GC
- Trunk Rotation (Standing): Shoulders and arms at 90° flexion, perform upper trunk rotations without pelvic movement. MR = 100% BRC

- Step Exercise: Step up and down rhythmically with both feet on a 20 cm step. MR = 80% SCC
- Sit-to-Stand: Rhythmic sit-to-stand from a 90° seated angle. MR = 100% SSC
- Obstacle Crossing: Walk rhythmically while stepping over three 20 cm obstacles placed 2 meters apart. MR = 100% GC
- Narrow Path Walking: Walk 10 meters rhythmically, passing between two obstacles placed 60 cm apart and 1 meter long. Setup is repeated every 2 meters. MR = 100% GC

WEEK 4

- Straight Walking 1: Walk 10 meters straight focusing on rhythm. MR = 115% GC
- Straight Walking 2 (Dual Task): Walk 10 meters carrying a water-filled cup on a tray with both hands (unbreakable material). MR = 115% GC
- Side Walking 1: Walk 10 meters sideways focusing on rhythm. MR = 115% GC
- Side Walking 2 (Cognitive Task): Walk 10 meters sideways while counting backwards from 100 by fives. MR = 115% GC
- Backward Walking 1: Walk 10 meters backward focusing on rhythm. MR = 110% GC
- Backward Walking 2 (Cognitive Task): Walk 10 meters backward while verbally naming animals. MR = 110% GC
- Reciprocal Arm Swings Walking 1: Exaggerated reciprocal arm swings during 10-meter walk. MR = 115% GC
- Reciprocal Arm Swings Walking 2 (Trunk Control): Same as above, with upper trunk rotation and no pelvic movement. MR = 115% GC
- Trunk Rotation (Marching): While marching in place, place palms together at chest level. Reach across the body with one arm (without pelvic movement), rotate the upper body, then return to start. Repeat with the other arm. MR = 115% BRC
- Step Exercise: Step rhythmically up and down on a 20 cm step with both feet. MR = 100% SCC
- Sit-to-Stand: Perform rhythmic sit-to-stand from a 90° angle. MR = 115% SSC
- Figure-Eight Walking: Walk rhythmically in a figure-eight pattern between two markers. MR = 115% GC
- 360° Turning: Walk between two chairs (3 m apart), turn fully around one, walk back, turn around the other, and sit down. MR = 115% GC
- Obstacle Crossing: Walk rhythmically, stepping over 20 cm obstacles placed 2 meters apart. MR = 115% GC
- Narrow Path Walking: Walk 10 meters rhythmically, passing between two 60 cm-apart, 1-meter-long obstacles. Setup is repeated every 2 meters. MR = 100% GC