

Article

Effects of different forms of sensorimotor training on postural control and functional status in patients with chronic low back pain

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Abstract: The aim of this study was to compare three sensorimotor training forms in patients with chronic low back pain to determine their effects in the reduction of pain-related impairment and changes in posturography. Over two weeks, during multimodal pain therapy (MMPT) period, six sessions of either sensorimotor physiotherapy, training on the Galileo® or Posturomed® (n = 25 per group) were performed. A significant reduction in pain-related impairment after the intervention phase was shown across all groups (time effect: $p < 0.001$; $\eta_p^2 = 0.415$). There was no change in postural stability (time effect: $p = 0.666$; $\eta_p^2 = 0.003$), but there was a significant improvement in the peripheral vestibular system (time effect: $p = 0.014$; $\eta_p^2 = 0.081$). An interaction effect was calculated for the fore-foot-hindfoot ratio ($p = 0.014$; 0.111). Only the Posturomed® group showed an improvement in anterior-posterior weight distribution (heel load: 47% vs. 49%). These findings suggest that these forms of sensorimotor training in the context of a multimodal pain therapy are suitable for reducing pain-related impairment. Posturography demonstrated stimulation of a subsystem, but no improvement in postural stability.

Keywords: Galileo®; Posturomed®; chronic, low back pain; sensory, motor, physiotherapy; rehabilitation

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Supplementary Materials:

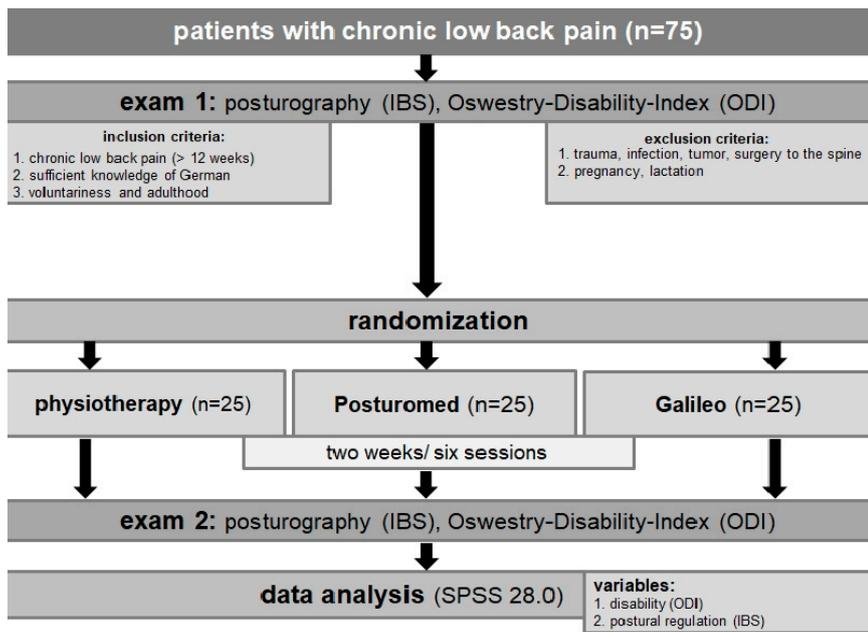


Figure S1: Flow-Chart to the study

29
30

33



Figure S2: Galileo®

31
32



Figure S3: Posturomed®

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35

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37

Table S1: IBS parameters [30,31]

| Category | Parameter | Interpretation/Explanation |
|--------------------|---------------------------------|--|
| Process parameters | Frequency band 1 (0.03–0.1 Hz) | Visual and nigrostriatal system |
| | Frequency band 2-4 (0.1–0.5 Hz) | Peripheral-vestibular system |
| | Frequency band 5-6 (0.5–1.0 Hz) | Somatosensory system |
| | Frequency band 7-8 (>1.0 Hz) | Cerebellar system |
| Product parameters | Stability indicator (ST) | The stability indicator (ST) was determined as the root mean square of the differences between |

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| | | pressure distributions on the plates and describes the postural stability. The larger the stability indicator, the higher the instability of the person is to be rated. |
| | Weight distribution index (WDI): | The WDI calculates the standard deviation in the weight distribution on the plates assuming that 25% of the body weight is distributed evenly across the four plates. |
| | Synchronization (Synch.) | Six values that describe the relationship of vibration patterns between plates calculated as a scalar product: 1000—complete coactivity; -1000—complete compensation; 0—no coactivity or compensation |
| | Forefoot–hindfoot ratio (Heel): | Percentage of load distribution between the forefoot and hindfoot with an emphasis on heel loading. |
| | Left–right ratio (Left) | Percentage of load distribution between the left and right feet with an emphasis on left side loading. |

38

Table S2: Exercise program in physiotherapy

39

| Surface | Task | Duration/ Rest/Reps |
|---------------|--|------------------------|
| <u>Stable</u> | 1. Stand upright on both feet, eyes open. | 10 s/20 s/3 |
| | 2. Stand upright on both feet, eyes closed. | 10 s/20 s/3 |
| | 3. Stand upright on one leg, eyes open. | 10 s/20 s/3 |
| | 4. Stand upright on one leg, eyes closed. | 10 s/20 s/3 |
| | 5. Stand upright on both feet, eyes open, pass ball around body at waist height (clockwise and counter-clockwise). | 10 s/20 s/3 |
| | 6. Stand upright on both feet, eyes closed, pass the ball around the body at waist level (clockwise and counterclockwise). | 10 s/20 s/3 |

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| | 7. Stand upright on one leg, eyes open, pass the ball around the body at waist level (clockwise and counterclockwise). | 10 s/20 s/3 |
| | 8. Stand upright on both feet, eyes open, throw the ball up (about 30cm) and catch it. | 8 s/20 s/3 |
| | 9. Stand upright on one leg, eyes open, throw the ball up (about 30cm) and catch it. | 8 s/20 s/3 |
| <u>Unstable</u> (on a gymnastic mat) | 10. Stand upright on both feet, eyes open. | 10 s/20 s/3 |
| | 11. Stand upright on both feet, eyes closed. | 10 s/20 s/3 |
| | 12. Stand upright on one leg, eyes open. | 10 s/20 s/3 |
| | 13. Stand upright on one leg, eyes closed. | 10 s/20 s/3 |
| | 14. Stand upright on both feet, eyes open, pass ball around body at waist height (clockwise and counterclockwise). | 10 s/20 s/3 |
| | 15. Stand upright on one leg, eyes open, pass ball around body at waist height (clockwise and counterclockwise). | 10 s/20 s/3 |
| | 16. Stand upright on both feet, eyes open, throw the ball up (about 30cm) and catch it. | 8 s/20 s/3 |

Table S3: Exercise program in Galileo®-Group

| Exercise Tasks | Position | Duration/Frequency/Rest |
|--------------------------------|--|-------------------------|
| 1. Warm up and Acclimatization | Stand upright in the middle of the vibration plate, feet about shoulder-width apart, flexion in the hip/knee joint about 45°, extension of the ankle joint about 45° (basic position). | 60 s/5 Hz/30 s |
| 2. Muscle tension | Stand upright, move pelvis ventrally. | 30 s/18 Hz/30 s |
| 3. Muscle tension | Basic position. | 30 s/15-25 Hz/30 s |
| 4. Muscle tension | Lifting the heels. | 30 s/15-25 Hz/60 s |
| 5. Muscle tension | Arms crossed behind the head, pelvic movement in the plane from dorsal to ventral. | 45 s/15-25 Hz/60 s |
| 6. Back Coordination | Arms crossed behind the head, pelvic movement in the plane from dorsal to ventral. | 60 s/5-7 Hz/60 s |
| 7. Relaxation | Basic position, support via the bracket. | 30 s/10 Hz/30 s |

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Table S4: Exercise program in Posturomed®-Group

| Level | Locks | Exercise | Execution | Number of throws |
|-------|-------------|---|--|------------------|
| 1 | Both closed | Step on the spot, one-legged stand. | Raise your feet alternately by approx. 10-15 cm in an upright position, hold every 3 changes in one-legged position for approx. 2 s. | 0 |
| 2 | Both closed | Throwing and catching in the medial sagittal plane. | Same as in level 1, with one-legged stand, but throw a ball (diameter 20cm, weight 100g) 1-5 times at a height of approx. 60-80 cm and catch it with both hands. | 1-5 |
| 3 | Both closed | Throwing and catching after rotation. | Same as in level 2, but rotate the leg during the one-legged stand 10-15° in the pelvic/shoulder line, then throw and catch the ball 2-6x ascending. | 2-6 |
| 4 | One opened | Step on the spot, one-legged stand. | Raise your feet alternately by approx. 10-15 cm in an upright position, hold every 3 changes in one-legged position for approx. 2 s. | 0 |
| 5 | One opened | Throwing and catching in the medial sagittal plane | Same as in level 4, but with the one-legged stand, throw a ball 1-5x at a height of approx. 60-80 cm and catch it with both hands. | 1-5 |
| 6 | One opened | Throwing and catching after rotation. | Same as in level 5, but rotate the leg during the one-legged stand 10-15° in the pelvic/shoulder line, then throw and catch the ball 2-6x ascending. | 2-6 |
| 7 | Both opened | Step on the spot, one-legged stand. | Raise your feet alternately by approx. 10-15 cm in an upright position, hold every 3 changes in one-legged position for approx. 2 s. | 0 |
| 8 | Both opened | Throwing and catching in the medial sagittal plane | Same as in level 7, but when standing on one leg throw a ball up 1-5x at a height of approx. 60-80 cm and catch it with both hands. | 1-5 |

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|---|-------------|-------------------------------------|--|-----|
| 9 | Both opened | Step on the spot, one-legged stand. | Same as in level 8, but rotate the leg during the one-legged stand 10-15° in the pelvis/shoulder line, then throw and catch the ball 2-6x ascending. | 2-6 |
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