# Technology-supported exercise therapy for patients with chronic non-specific low back pain: a feasibility study

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## Background & Aims

Various technological systems supporting exercise therapy for low back pain (LBP) have been developed in recent years. The current technology-supported exercise therapy programs for LBP mostly adopt an analytical approach and do not offer technological support at home [1]. However, there is growing consensus that exercise programs should be tailored to the patient's specific needs. To improve the additional benefit of technological support, it seems crucial that technological systems can be integrated in this individual and functional approach.

The *aims* of this study are:

1. To develop a functional (home) exercise program compatible with technological support.
2. To assess the feasibility and clinical outcome of this program

## Methods

### *Subjects*

Inclusion
- Chronic non-specific low back pain
- Diagnosis of a motor control impairment
- Age 18-65 years old

Exclusion
- Signs or symptoms of nerve root involvement
- Underlying serious pathology
- Pregnancy or <1 year post-partum
- Known allergy to tape

### *Technological system*

The ValedoMotion® system (version 1.2, Hocoma, Switzerland) is a rehabilitation tool for patients with LBP. It consists of a laptop, a remote control and three inertial wireless motion tracking sensors. Two of the sensors are placed at the L1 and S1 level (Fig. 1), while one sensor is used for the calibration of the system. The sensor signals are sent to the laptop via which the patient can practice pelvic tilt exercises using serious games (Figs. 2A-C), and receive visual and auditory feedback about exercise performance with the 'target application' (Fig. 2D). The visual feedback is displayed as a bull's eye with colored concentric circles. The cursor on the screen can be placed in the middle of the bull's eye to register the neutral position. The system uses the movement of the S1-sensor relative to the L1-sensor to control the games. In this way, the patient has to dissociate pelvic movements (S1) from the upper lumbar spine (L1) and the thoracic spine. The serious gaming was used for thoracolumbar dissociation exercises, while the target application was used to support functional motor control exercises.

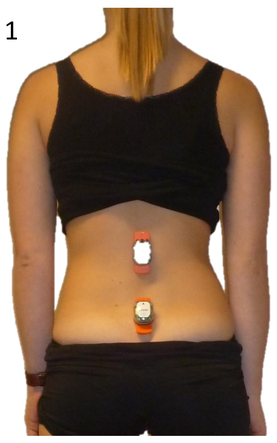
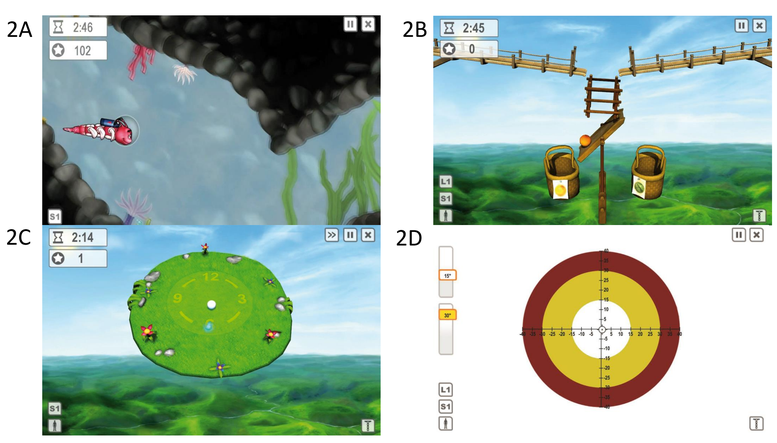



**Fig. 1**. Sensor placement.




**Figs. 2A-C**. Serious games for improving thoracolumbar dissociation. **Fig. 2D**: Target game providing postural feedback

### *Intervention*

A tailored exercise program consisting of 36 partially supervised 2-hour sessions (18 weeks, 2x/week) at an outpatient rehabilitation center. Each session consisted of 30' of general reconditioning and 90' of individually tailored functional motor control exercises (Fig. 3). The motor control exercises were partially supported by postural feedback with the ValedoMotion, both in a hospital setting and at home (Table 1).

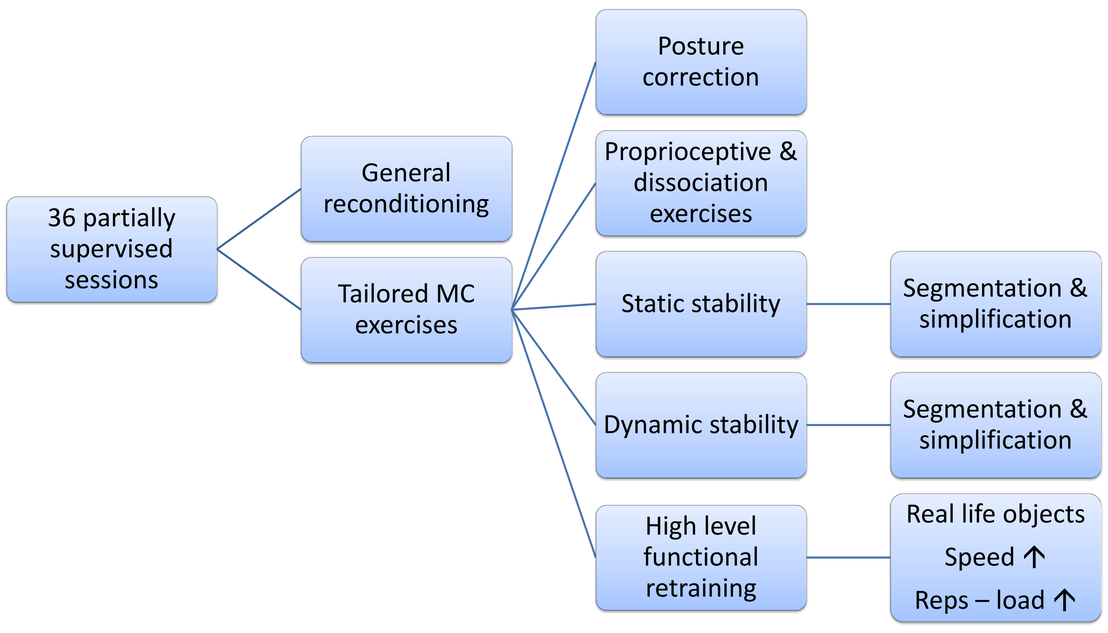



**Fig. 3**. Schematic presentation of intervention

**Table 1**. Different phases of program with indication of availability of technological support

| Week 1-3 | Week 4-5 | Week 6-13 | Week 14-18 |
|---|---|---|---|
| Standard rehabilitation | Familiarization period | Technological support hospital | Weaning-off period |
| No technological support | Technological support at hospital | Technological support home | Standard rehabilitation |

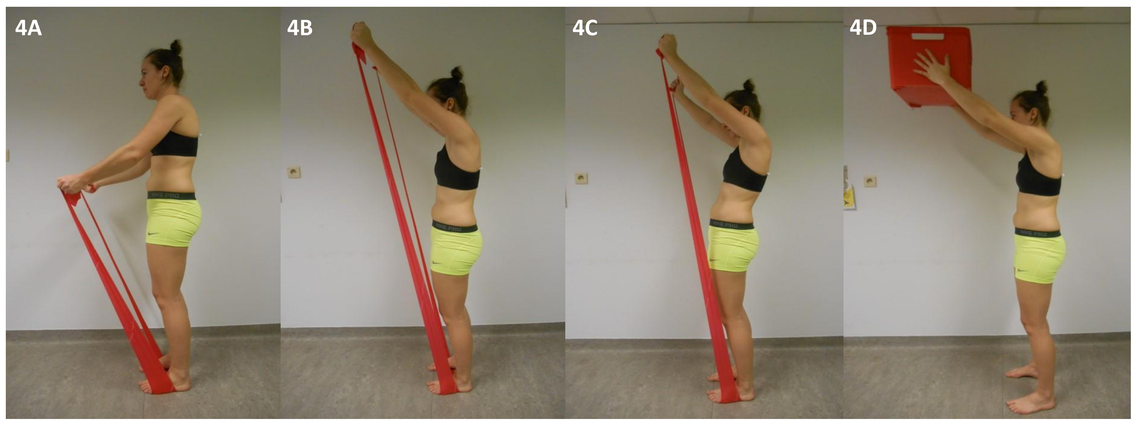



**Fig. 4**. Example of motor control retraining for a motor control problem towards extension. **4A-B**. Correct performance. **4C**. Incorrect performance with excessive lumbar extension. **4D.** Integration of real life objects.

## Results

**Table 2.** Sociodemographic data (n = 10)

| | Median | Interquartile range |
|---|---|---|
| Age (years) | 35.5 | 28.3 |
| Duration low back pain (years) | 8.5 | 17.6 |
| BMI (kg/m²) | 22.6 | 2.1 |
| Gender (male/female) | 8/2 | |

**Table 3.** Results for clinical and patients' acceptance outcomes (n=10)

| | T0 | T1 | T2 | T3 | T4 | P-value |
|---|---|---|---|---|---|---|
| *Clinical outcome measures* | | | | | | |
| NPRS (/10) | 5.5 (4.0) | - | 3.5 (2.8) | - | 2.5 (2.5)[a] | 0.011 |
| RMQ (/24) | 9.5 (5.5) | - | 4 (4.5)[a] | - | 4 (5.0)[a] | 0.004 |
| PSFS (/10) | 4.7 (1.1) | - | 6.8 (3.7)[a] | - | 7.8 (3.5)[a,b] | < 0.001 |
| TSK (17-68) | 36.5 (15) | - | 31 (12.8) | - | 33 (10.5) | 0.009 |
| PSEQ (/60) | 40 (16.5) | - | 51 (12.25) | - | 54 (12)[a] | 0.002 |
| Short form 36 | | | | | | |
| Physical component | 36.4 (9.2) | - | 49.5 (11.7)[a] | - | 50.1 (11.6)[a] | <0.001 |
| Mental component | 58.1 (9.0) | - | 57.9 (6.7) | - | 58.6 (6.8) | 0.5 |
| Sick leave (yes/no) | 2/6 | - | 1/7 | - | 0/8 | 0.22 |
| *Outcome measures related to patients' acceptance* | | | | | | |
| CEQ (3-27)* | | | | | | |
| Credibility | 21.5 (5.5) | 22.0 (2.8) | 23.0 (5.8) | 23.0 (5.8) | - | 0.63 |
| Expectancy | 17.4 (7.3) | 20.5 (4.9) | 19.7 (5.2) | 19.7 (5.4) | - | 0.4 |
| IMI (3-27)* | | | | | | |
| Interest/enjoyment | 4.6 (1.6) | 4.9 (1.8) | 4.9 (1.7) | 5.4 (1.8) | - | 0.19 |
| Competence | 3.9 (1.5) | 4.5 (2.2) | 5.1 (1.4)[c] | 5.3 (1.5)[c] | - | 0.001 |
| Effort/importance | 5.7 (1.6) | 5.7 (1.6) | 5.9 (1.6) | 5.3 (1.2) | - | 0.39 |
| Pressure/tension | 5.0 (1.4) | 5.4 (0.6) | 6.4 (1.5)[c] | 6.0 (0.6)[c] | - | 0.002 |
| Value/usefulness | 5.9 (1.3) | 5.9 (0.7) | 6.1 (1.2) | 5.9 (1.0) | - | 0.34 |
| Relatedness | 5.3 (1.3) | 5.8 (0.9) | 6.0 (0.8) | 5.4 (1.2) | - | 0.079 |
| Satisfaction (/10) | - | 7.0 (1.5) | 8.0 (1.5) | 8.5 (3.5) | 8 (3) | 0.51 |
| Adherence (1-36) | - | - | - | - | 36 (2.5) | |

Data are denoted as median scores (interquartile range), except for the outcome sick leave. The *p*-values are for comparisons between more than two test occasions. CEQ= credibility and expectancy questionnaire, IMI= intrinsic motivation inventory, NPRS= numeric pain rating scale, RMQ= Roland Morris Questionnaire, PSFS= patient specific functioning scale, TSK= Tampa scale for kinesiophobia, PSEQ= pain self-efficacy questionnaire, Satisfaction= patient satisfaction with the treatment. *Baseline scores were obtained after the first session.
a= significant difference compared to baseline ($p< 0.017$), b= significant difference compared to T2 ($p< 0.017$), c= significant difference compared to baseline ($p< 0.0125$). T0 = baseline, T1 = end week 3, T2 = end week 8, T3 = end week 13, T4 = end week 18.

## Discussion & conclusions

- It seems feasible to support functional motor control exercises with sensor based postural feedback, both in a supervised as in a home environment.
- Patients found the exercise program credible and remained motivated for the full duration of the treatment. Further, the technology-supported exercise program led to clinically significant improvements in various outcomes.
- Results should be interpreted with care because of the small number of participants.
- Explaining and demonstrating the technological system to the participants took about 20-30 minutes. This might be a barrier to use it in daily clinical practice where patients receive less treatments.
- Future trials should assess the additional value of postural feedback to regular therapy, cost-effectiveness and time-efficiency of technological systems.

### *References*

[1] Matheve T, Brumagne S, Timmermans AA. Am J Phys Med Rehabil. 2016 Aug 31

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