Original paper

# Evaluation of the effect of dry needling according to the FRS concept on gait parameters in patients with chronic low back pain: a prospective, randomised, double-blind clinical trial

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**Key words:** low back pain, gait parameters, dry needling.

## Abstract

**Introduction:** Dry needling (DN) has become an increasingly popular treatment in recent years for a number of musculoskeletal dysfunctions, including low back pain (LBP) syndromes. The Five Regulatory Systems (FRS) concept is an innovative strategy for the use of dry needling, which is based on therapeutic mechanisms.
**Aim of the research:** Evaluation of the effect of dry needling (DN), according to the FRS concept, on gait parameters in patients with chronic LBP.
**Material and methods:** The study included 40 patients with LBP assigned to the experimental group ($n$ = 20, dry needling + rehabilitation) or control group ($n$ = 20, sham dry needling + rehabilitation). A Zebris FDM-T treadmill was used to objectively measure gait parameters. Measurements were taken before and immediately after the intervention and at 1- and 3-month follow-ups.
**Results:** After the treatment, there was no significant improvement in gait in patients in both groups, at both 2 and 4 km/h. There were no differences between the comparison groups for both walking speeds ($p > 0.05$ in all analyses). There were beneficial changes in peak linear velocity during patient ambulation (foot propulsion on the treadmill during walking). However, there were no differences between the comparison groups ($p > 0.05$ in all analyses).
**Conclusions:** Dry needling according to the FRS concept does not have a beneficial effect on improving gait parameters in patients with chronic LBP.

## Introduction

Dry needling (DN) has become an increasingly popular treatment in recent years for a number of musculoskeletal disorders, including low back pain (LBP) syndromes. The effectiveness of this method was demonstrated in the studies of, among others Ilayaraja *et al.* [1] and Bazzaz-Yamchi *et al.* [2].

So far, several interesting meta-analyses and systematic reviews have been published in which the authors argue for certain effectiveness of this method, especially in reducing pain sensations. For example, Lara-Palomo *et al.* [3] in 2023 included 8 randomized clinical trials involving 414 patients in their meta-analysis. All the studies concerned the effectiveness of dry needling in patients with chronic LBP. The collected results suggested that, compared to other treatment methods, dry needling in combination with them was more effective in relieving pain intensity. The researchers conclude that current evidence confirms that dry needling – especially in combination with other forms of therapy – can be recommended to reduce pain sensations in the short term. However, there is no evidence showing that dry needling as a leading or independent treatment method, eliminates pain in the long term, and leads to a significant improvement in the functional status of patients.

Similarly, Yu *et al.* [4] believe that dry needling has a beneficial effect on pain and other subjective feelings of patients regarding the degree of disability and quality of life indicators, although the level of scientific evidence for objective improvement of the clinical health status of patients with LBP syndrome is low.

Sánchez-Infante *et al.* [5] confirm that the use of DN as a physiotherapeutic intervention is justified, indicating that it is more effective than no treatment, sham DN, and other pain-reducing therapies.

The above conclusions confirm the need to search for new technical solutions and to refine all methodological details concerning the optimisation of this method, as well as its further verification based on reliable measurement tools. A certain innovative

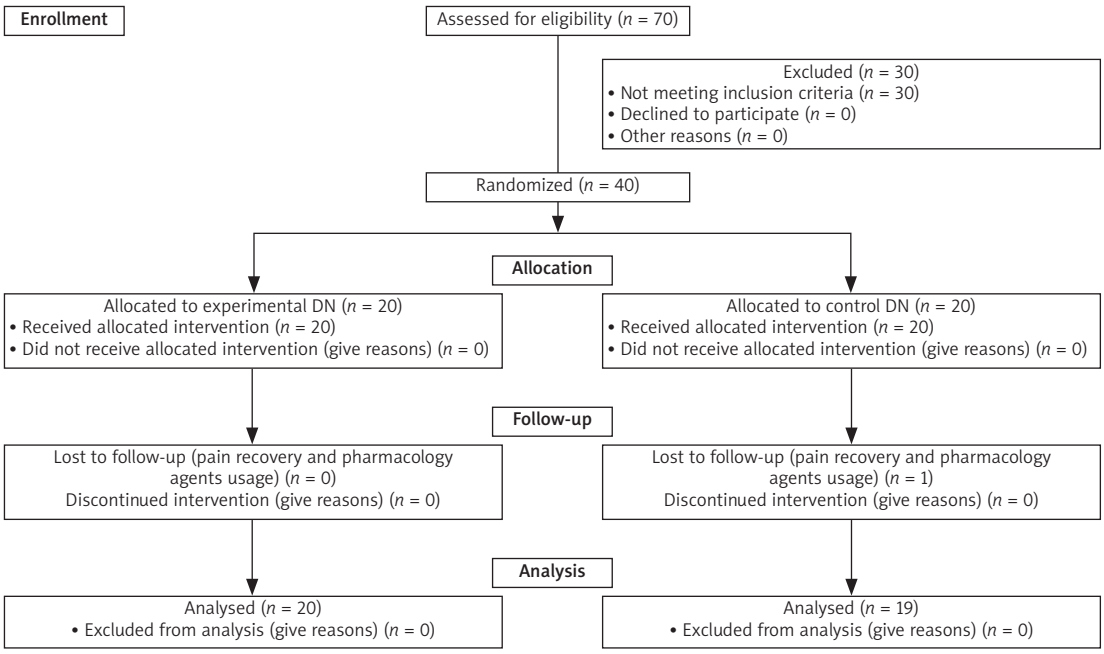


**Figure 1**. CONSORT flow chart of study participants

*DN – dry needling.*

strategy for the use of dry needling is the FRS concept (Five Regulatory Systems concept) [6], which is based on therapeutic mechanisms such as releasing fascial structures and loosening the surrounding tissues, stimulating local outflow of lymph, venous blood, and extracellular fluid, as well as analgesic effects and stimulation of sensation proprioceptive [7, 8]. Our team has published clinical papers in recent years [9, 10], in which the FRSc technique proved helpful in reducing pain and improving subjective functional status, body posture, and some quality-of-life indicators. At this stage, it is worth expanding the knowledge of this procedure based on other aspects.

## Aim of the research

The aim of the study was to assess the effect of DN according to the FRS concept on gait parameters in patients with chronic LBP.

## Material and methods

The study was conducted in the laboratory at the Institute of Health Sciences of the University of Opole. The local Bioethics Committee (KB/91/FI/2018) approved this research project, and it was prospectively registered on one of the websites as a randomized clinical trial (ISRCTN no. 16627714). The study was conducted in accordance with the principles of the Helsinki Declaration and the guidelines of the Consolidated Standards of Reporting Trials (CONSORT).

The research project was a prospective, double-blind, randomised clinical trial with a 3-month long-term follow-up.

Participants with LBP were recruited from rehabilitation wards and rehabilitation clinics and were qualified for this study by a team consisting of an internist, radiologist, neurologist, neurosurgeon, orthopaedist, and physiotherapist. The selection for the study was purposeful. Patients with degenerative changes at the lumbar-sacral level, chronic pain (at least 3 months), and no surgical intervention in the spine were included. The participants were adults and had current magnetic resonance imaging (MRI). Eligible participants had no previous dry needling treatments.

The exclusion criteria were the absence of pain and decreased mobility in the lumbar-sacral spine, pregnancy, implanted pacemaker, coxarthrosis, degenerative knee disease, ankle joint instability, foot defects and deformities, blood clotting disorders, sensory disorders, mental disorders, tumours, skin lesions in the treatment area, viral and bacterial infections, fever, balance disorders, ear labyrinth disorders, Parkinson's disease, multiple sclerosis, post-stroke status, peripheral nerve damage in the lower limbs, unstable arterial hypertension, fear of needles, no consent to undergo needling procedures, and persons taking anticoagulants, analgesics, and anti-inflammatory drugs. Figure 1 shows the patient flow according to the CONSORT principles.

Qualified participants were randomly assigned in a 1 : 1 ratio to 2 research groups: the experimental

group (rehabilitation program + dry needling according to the FRSc concept) and the control group (rehabilitation program + sham dry needling, which mimics the FRSc concept). All screening tests and measurements were performed by 2 physiotherapists who had practiced the repeatability and accuracy of the procedures for 4 months prior to the start of the study. Dry needling according to the FRS concept was performed by one experienced physiotherapist with instructor qualifications. The standard rehabilitation program was conducted one-on-one and was conducted for all participants by certified therapists, who also practiced the course of each session 4 months in advance. The people performing the therapy and measurements had no contact with the qualification team and those who analysed the final results.

### Interventions

Forty patients underwent a standard rehabilitation program for a month (45 minutes a day, 5 times a week, from Monday to Friday). Physical exercises were performed under guidance from certified therapists. The therapeutic protocol consisted of myofascial release techniques, activation of the lumbosacral-iliac complex, exercises for selected back muscles, stimulation of correct breathing pattern and diaphragm mechanics, exercises for activation of the transverse abdominis muscle, and elements of postural training. In the experimental group ($n$ = 20), additional dry needling procedures were performed according to the FRS concept. The procedures were performed twice a week (Monday and Thursday) for a month (a total of 8 procedures). A single application lasted 60 minutes. The FRSc technique was based on the following activities: 1) application of the area of the sulcus between the spinous processes of the spine and the course of the erector spinae muscle, in the caudal and spinal direction (needle length 75 mm); 2) application within palpable connective tissue bands arranged transversely on the mass of the erector spinae muscle (needle length 30 mm); 3) application within the so-called neurocompartment of the superior gluteal nerve, consisting of puncturing and generating contractions (LTR – local twitch response) within palpably tender places of possible crossings of the course of the superior gluteal nerve (both the upper and lower branches) with the muscles: gluteus maximus, gluteus medius, and tensor fascia lata (needle length 100 mm); 4) application to the area of myogelosis of the piriformis muscle, palpated as a tender fibrous thickening that jumps under the fingers (needle length 100 mm) (Figure 2). In turn, in the control group ($n$ = 20), techniques from the scope of sham procedures were performed using telescopic needles (Figure 3), which was a method of blinding the actual dry needling and an attempt to estimate the impact of the placebo effect. The design of the needles allowed them to be placed on the skin surface without piercing the body's integuments. All

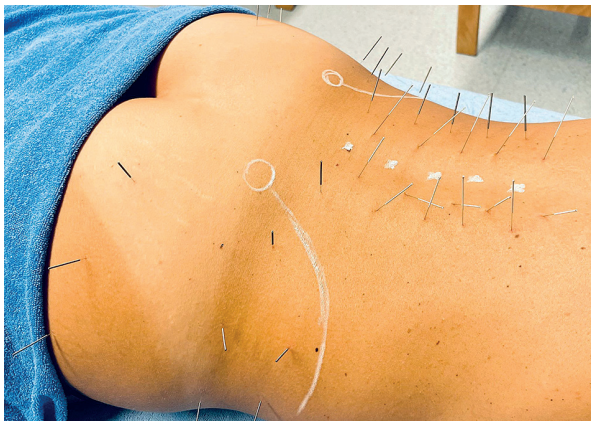

**Figure 2**. DN according to the FRSc concept in LBP

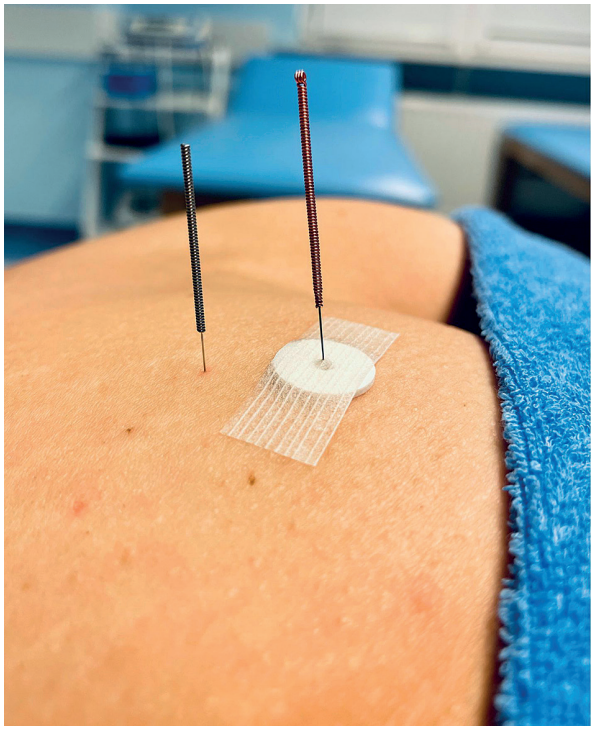

**Figure 3**. DN application in the control group using telescopic needle (sham therapy)

dry needling treatments were performed by one experienced physiotherapist with an instructor license.

A Zebris FDM-T treadmill (Technomex Inc., Poland) was used for objective gait parameter measurement. It allowed for observation of gait phase components at different speeds and the number of steps performed by the subject. Before data collection, each patient walked on the platform to familiarise themselves with the test procedures. Data were collected for 5 trials for each patient. Measurements were taken at speeds of 2 and 4 km/h. Analysis of stance and swing phases and changes in maximum gait line

speed was performed. In both groups, all measurements were taken before and immediately after treatment. In the long-term follow-up, control measurements were taken after one and three months from the end of the therapeutic protocol. During this time, the participants did not use any physiotherapy or pharmacotherapy, which could have influenced further clinical effects. During this period, the patients also did not continue the rehabilitation exercises from the first stage of the research project.

### Statistical analysis

Statistical analysis was performed using Statistica 13 (TIBCO, Inc., USA). Arithmetic means, medians, standard deviations, quartiles, and range of variability (extreme values) were calculated for measurable variables. For qualitative variables, their frequencies (percentages) were calculated. All quantitative variables were tested using the Shapiro-Wilk test to determine the type of distribution. Comparison of qualitative variables between groups was performed using the chi-square test ($\chi^2$). Intragroup comparison between results was performed using Friedman's analysis of variance and post-hoc test (Dunn's test). Comparison of results between the study group and placebo was assessed using the Mann-Whitney *U* test. The level of $\alpha = 0.05$ was used for all comparisons.

## Results

All patients were homogeneous in both comparison groups with respect to basic demographic characteristics (Table 1).

After the treatment, there was no significant improvement in gait in both groups, at both 2 and 4 km/h. Detailed results are presented in Tables 2, 3.

In the case of the stance phase, a favourable trend of shortening was noted for the dominant limb in the experimental group, from 66.5 to 66.1% for the speed of 2 km/h and from 61.9 to 61.8% for the speed of 4 km/h, although in the long-term observations the gait pattern deteriorated. It was similar in the control group, but unfavourable changes were even more pronounced in the period without motor improvement in the long-term observation, achieving statistical significance (Table 2). No differences were found between the comparative groups for both gait speeds ($p > 0.05$ in all analyses).

Similarly, in the case of the stance phase for the non-dominant leg, also no statistically significant differences were noted in the individual measurements and stages of the research project (Table 3). No differences were found between the comparative groups for both gait speeds ($p > 0.05$ in all analyses).

Also, for both the dominant leg (Table 4) and the non-dominant leg (Table 5) in the swing phase no statistically significant changes were observed at the speeds of 2 and 4 km/h, although in all situations there was a beneficial extension of this phase in the form of a negligible trend – especially for the dominant limb at the speed of 2 km/h, i.e. from 33.2 to 33.4% in the experimental group and from as much as 36.1 to 37.8 km/h in the control group. No differences were found between the comparative groups for both walking speeds ($p > 0.05$ in all analyses).

In turn, Tables 6 and 7 show beneficial changes in the peak linear velocity during the patients' movement (foot propulsion on the treadmill during walking). The gradual increase in the foot rolling parameter was maintained for up to one month after the end of the therapeutic procedure in both groups, and then it was subject to gradual reduction. The changes were not statistically significant in most cases, although a significant increase for the non-dominant limb at a walking speed of 4 km/h in both groups is noteworthy (Table 7). No differences were found between the comparative groups ($p > 0.05$ in all analyses).

In summary, despite some favourable trends in the normalisation of gait parameters in both groups, no therapeutic advantage of dry needling according to the FRS concept was found in relation to sham procedures.

**Table 1.** Characteristics of the participants

| Variable | Experimental DN group | | | | | | | Control DN group | | | | | | | *P*-value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | |
| Age [years] | 52.7 | 54.0 | 29.0 | 56.0 | 39.0 | 47.0 | 7.7 | 54.4 | 55.5 | 35.0 | 74.0 | 47.0 | 64.0 | 11.5 | 0.245* |
| Body weight [kg] | 74.5 | 74.5 | 58.0 | 88.0 | 61.5 | 83.0 | 10.9 | 74.3 | 72.5 | 50.0 | 92.0 | 62.5 | 82.5 | 11.7 | 0.911* |
| Body height [cm] | 173.1 | 170.2 | 163.0 | 186.8 | 166.0 | 178.0 | 6.8 | 168.7 | 170.4 | 152.0 | 181.0 | 159.0 | 175.0 | 8.6 | 0.102* |
| BMI [kg/m$^2$] | 25.2 | 24.8 | 19.9 | 30.1 | 21.8 | 27.1 | 3.3 | 26.6 | 26.2 | 19.0 | 30.1 | 22.8 | 28.1 | 3.2 | 0.211* |
| Sex | F – *n* = 9; 45.0%<br>M – *n* = 11; 55.0% | | | | | | | F – *n* = 12; 60.0%<br>M – *n* = 8; 40.0% | | | | | | | 0.342** |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, F – female, M – male. *U-Mann-Whitney, **$\chi^2$ test.*

## Discussion

So far it is only the third publication in the world on the use of dry needling according to the FRS concept in the treatment of chronic low back pain. In the works published so far [9, 10] by us, the usefulness of the tested method in reducing pain and the degree of disability, and increasing the range of motion in the lumbar spine has been demonstrated. The patients' positive impressions regarding their own feelings of pain and functional status do not translate into

**Table 2.** Stance phase scores for the dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Stance phase of the dominant leg [%] 2 km/h | Before | 66.5 | 66.2 | 62.7 | 70.7 | 65.7 | 67.4 | 2.1 | 66.7 | 66.3 | 62.7 | 70.7 | 65.7 | 67.4 | 1.9 |
| | After | 66.1 | 66.2 | 62.7 | 69.6 | 64.4 | 68.1 | 2.1 | 66.5 | 66.4 | 62.7 | 69.6 | 65.5 | 68.2 | 1.8 |
| | 1 month FU | 68.3 | 67.8 | 60.3 | 81.7 | 61.8 | 71.0 | 7.3 | 68.3 | 67.8 | 60.4 | 81.7 | 61.8 | 710 | 7.3 |
| | 3 months FU | 66.3 | 65.5 | 60.0 | 80.8 | 63.6 | 68.4 | 4.5 | 66.9 | 66.6 | 60.0 | 80.8 | 64.8 | 68.4 | 4.3 |
| *P*-value (main effect*) | | | | | 0.883 | | | | | | | 0.710 | | | |
| P-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Stance phase of the dominant leg [%] 4 km/h | Before | 61.9 | 62.0 | 59.7 | 64.8 | 60.8 | 62.6 | 1.41 | 62.0 | 62.0 | 59.7 | 66.8 | 60.8 | 62.6 | 1.7 |
| | After | 61.8 | 61.9 | 59.8 | 64.3 | 61.0 | 62.8 | 1.23 | 62.1 | 61.9 | 59.8 | 66.7 | 61.0 | 62.8 | 1.8 |
| | 1 month FU | 65.0 | 64.7 | 59.8 | 68.8 | 62.6 | 68.2 | 3.11 | 65.3 | 66.4 | 59.8 | 68.8 | 62.6 | 68.2 | 3.1 |
| | 3 months FU | 63.1 | 63.0 | 59.8 | 68.4 | 61.1 | 64.1 | 2.50 | 63.6 | 63.4 | 59.8 | 68.4 | 61.1 | 66.2 | 2.8 |
| *P*-value (main effect*) | | | | | 0.058 | | | | | | | 0.026 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | Before vs. after: $p = 0.840$<br>Before vs. 1 month: $p < 0.001$<br>Before vs. 3 months: $p = 0.046$<br>After vs. 1 month: $p = 0.001$<br>After vs. 3 months: $p = 0.054$<br>1 month vs. 3 months: $p = 0.071$ | | | | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation; FU – follow-up. *Friedman's ANOVA; **Dunn's test.*

**Table 3.** Stance phase scores for the non-dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Stance phase of the non-dominant leg [%] 2 km/h | Before | 66.8 | 66.5 | 61.7 | 71.2 | 65.5 | 68.5 | 2.2 | 66.9 | 66.5 | 61.7 | 71.2 | 65.9 | 68.5 | 2.1 |
| | After | 66.6 | 67.0 | 64.0 | 68.8 | 65.2 | 68.3 | 1.7 | 66.6 | 67.0 | 64.0 | 68.8 | 65.3 | 68.3 | 1.7 |
| | 1 month FU | 65.7 | 65.5 | 60.0 | 75.0 | 62.7 | 68.1 | 3.8 | 66.1 | 66.7 | 60.0 | 75.0 | 63.2 | 68.1 | 3.7 |
| | 3 months FU | 68.7 | 66.8 | 61.5 | 82.9 | 64.8 | 68.7 | 6.4 | 69.0 | 67.0 | 61.5 | 82.9 | 65.4 | 68.7 | 6.2 |
| *P*-value (main effect*) | | | | | 0.710 | | | | | | | 0.971 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Stance phase of the non-dominant leg [%] 4 km/h | Before | 62.6 | 62.4 | 60.9 | 64.8 | 61.8 | 63.4 | 1.1 | 63.2 | 62.4 | 60.9 | 66.5 | 61.8 | 64.7 | 1.9 |
| | After | 62.7 | 62.7 | 61.0 | 64.6 | 61.8 | 63.6 | 1.0 | 63.3 | 62.7 | 61.0 | 66.9 | 61.8 | 64.4 | 2.0 |
| | 1 month FU | 63.8 | 63.4 | 59.8 | 68.4 | 61.8 | 66.2 | 2.8 | 64.1 | 64.0 | 59.8 | 68.4 | 61.8 | 66.7 | 2.9 |
| | 3 months FU | 63.6 | 62.9 | 60.6 | 68.8 | 61.8 | 64.5 | 2.3 | 63.7 | 62.9 | 60.6 | 68.8 | 61.8 | 65.2 | 2.4 |
| P-value (main effect*) | | | | | 0.734 | | | | | | | 0.978 | | | |
| P-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, FU – follow-up. *Friedman's ANOVA, **Dunn's test.*

**Table 4.** Transfer phase scores for the dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Transfer phase of the dominant leg [%] 2 km/h | Before | 33.2 | 33.5 | 28.8 | 38.3 | 31.5 | 34.5 | 2.2 | 36.1 | 34.7 | 28.8 | 41.7 | 33.6 | 40.3 | 3.9 |
| | After | 33.4 | 33.0 | 31.2 | 36.0 | 31.7 | 34.8 | 1.7 | 37.8 | 37.6 | 33.0 | 41.8 | 34.8 | 41.2 | 3.2 |
| | 1 month FU | 34.3 | 34.5 | 25.0 | 40.0 | 31.9 | 37.3 | 3.8 | 37.5 | 39.2 | 25.0 | 41.9 | 35.2 | 41.3 | 4.4 |
| | 3 months FU | 31.3 | 33.2 | 17.1 | 38.5 | 31.3 | 35.2 | 6.4 | 33.7 | 35.2 | 17.1 | 41.9 | 32.5 | 39.3 | 7.8 |
| *P*-value (main effect*) | | | | | 0.710 | | | | | | | 0.655 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Transfer phase of the dominant leg [%] 4 km/h | Before | 37.4 | 37.6 | 35.2 | 39.1 | 36.6 | 38.2 | 1.1 | 38.3 | 37.6 | 35.2 | 41.7 | 36.6 | 41.1 | 2.2 |
| | After | 37.3 | 37.3 | 35.4 | 39.0 | 36.4 | 38.2 | 1.0 | 37.9 | 37.4 | 35.4 | 41.5 | 36.4 | 39.0 | 2.0 |
| | 1 month FU | 36.2 | 36.6 | 31.6 | 40.2 | 33.8 | 38.2 | 2.8 | 38.5 | 39.2 | 33.0 | 41.8 | 36.2 | 41.1 | 2.6 |
| | 3 months FU | 36.4 | 37.1 | 31.2 | 39.4 | 35.5 | 38.2 | 2.3 | 38.2 | 37.4 | 34.2 | 41.5 | 35.8 | 41.1 | 2.7 |
| *P*-value (main effect*) | | | | | 0.734 | | | | | | | 0.559 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, FU – follow-up. *Friedman's ANOVA, **Dunn's test.*

**Table 5.** Transfer phase scores for the non-dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Transfer phase of the non-dominant leg [%] 2 km/h | Before | 33.5 | 33.8 | 29.3 | 37.3 | 32.6 | 34.4 | 2.1 | 35.8 | 34.4 | 33.2 | 41.8 | 33.8 | 38.2 | 2.8 |
| | After | 33.9 | 33.8 | 30.4 | 37.3 | 31.9 | 35.6 | 2.1 | 36.0 | 35.5 | 30.4 | 41.9 | 33.6 | 37.1 | 3.5 |
| | 1 month FU | 31.7 | 32.2 | 18.3 | 39.7 | 29.0 | 38.2 | 7.3 | 34.5 | 39.0 | 18.4 | 42.0 | 29.6 | 41.2 | 8.6 |
| | 3 months FU | 33.7 | 34.5 | 19.2 | 40.0 | 31.6 | 36.5 | 4.5 | 35.1 | 35.9 | 19.2 | 41.9 | 33.4 | 38.2 | 5.1 |
| *P*-value (main effect*) | | | | | 0.883 | | | | | | | 0.739 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Transfer phase of the non-dominant leg [%] 4 km/h | Before | 38.1 | 38.0 | 35.2 | 40.3 | 37.4 | 39.2 | 1.4 | 38.9 | 39.2 | 35.2 | 41.9 | 37.4 | 40.7 | 2.0 |
| | After | 38.2 | 38.1 | 35.7 | 40.2 | 37.2 | 39.0 | 1.2 | 39.2 | 39.5 | 35.7 | 42.0 | 37.2 | 41.1 | 2.1 |
| | 1 month FU | 35.0 | 35.3 | 31.2 | 40.2 | 31.8 | 37.4 | 3.1 | 39.3 | 39.7 | 34.2 | 41.8 | 37.3 | 41.3 | 2.3 |
| | 3 months FU | 36.9 | 37.0 | 31.6 | 40.2 | 35.9 | 38.9 | 2.5 | 38.5 | 38.2 | 33.0 | 42.0 | 36.2 | 41.3 | 2.7 |
| *P*-value (main effect*) | | | | | 0.058 | | | | | | | 0.202 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, FU – follow-up. *Friedman's ANOVA, **Dunn's test.*

objectively measured gait parameters in this research project. This is extremely intriguing, especially since theoretically a significant reduction in pain should have a very significant impact on the qualitative improvement of the gait pattern. This issue is a very interesting challenge for the future because, in their own opinion, patients feel a significant improvement under the influence of dry needling (despite the use of "blinding" and sham procedures), which, however, does not clearly correlate with the indicators measured using laboratory equipment, for example in the form of a treadmill for gait analysis.

Reports from other authors indicate effective therapeutic effects after the use of dry needling techniques. In a systematic review in 2023, Dach *et al.* [11] showed that dry needling is an effective procedure for the treatment of myofascial pain in patients with acute and chronic lower back pain. The analysed works did not examine

**Table 6.** Linear speed of the foot for the dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Max walking line speed [cm/s] 2 km/h – dominant leg | Before | 273.0 | 201.7 | 88.1 | 617.5 | 175.6 | 316.4 | 160.4 | 289.7 | 201.7 | 88.1 | 617.5 | 189.6 | 403.2 | 164.5 |
| | After | 316.9 | 265.4 | 90.7 | 677.3 | 206.1 | 399.5 | 164.9 | 326.3 | 265.5 | 90.7 | 677.3 | 200.3 | 438.0 | 166.9 |
| | 1 month FU | 322.6 | 306.4 | 163.7 | 692.6 | 210.2 | 399.1 | 135.6 | 334.0 | 347.5 | 166.7 | 692.6 | 204.5 | 408.0 | 140.4 |
| | 3 months FU | 291.1 | 269.0 | 110.9 | 644.3 | 207.4 | 333.2 | 120.9 | 295.5 | 269.0 | 110.9 | 644.4 | 200.3 | 376.8 | 130.3 |
| *P*-value (main effect*) | | | | | 0.420 | | | | | | | 0.528 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Max walking line speed [cm/s] 4 km/h – dominant leg | Before | 188.6 | 190.1 | 137.7 | 279.4 | 143.2 | 204.3 | 42.3 | 193.9 | 190.3 | 141.3 | 279.4 | 176.9 | 205.8 | 38.5 |
| | After | 216.5 | 203.8 | 87.1 | 400.5 | 169.7 | 258.6 | 82.9 | 214.9 | 198.9 | 87.2 | 400.5 | 171.6 | 258.6 | 82.3 |
| | 1 month FU | 263.0 | 243.1 | 87.1 | 514.2 | 168.6 | 333.0 | 119.2 | 266.2 | 220.1 | 87.2 | 514.2 | 176.3 | 382.0 | 122.0 |
| | 3 months FU | 242.7 | 196.0 | 87.1 | 891.2 | 154.5 | 277.0 | 171.3 | 245.9 | 196.0 | 87.2 | 891.2 | 166.9 | 277.0 | 169.6 |
| *P*-value (main effect*) | | | | | 0.093 | | | | | | | 0.440 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, FU – follow-up. *Friedman's ANOVA, **Dunn's test.*

**Table 7.** Linear speed of the foot for the non-dominant leg at walking speeds of 2 and 4 km/h in both groups

| Variable | Measure | Experimental DN group | | | | | | | Control DN group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD | $\bar{x}$ | Me | Min | Max | Q1 | Q3 | SD |
| Max walking line speed[cm/s] 2 km/h – non-dominant leg | Before | 322.8 | 324.7 | 123.9 | 604.6 | 184.2 | 457.3 | 150.4 | 332.1 | 362.6 | 103.9 | 604.6 | 184.2 | 478.3 | 155.6 |
| | After | 310.7 | 314.7 | 142.2 | 458.0 | 207.3 | 412.0 | 109.0 | 313.7 | 345.0 | 142.2 | 458.0 | 200.4 | 413.1 | 112.5 |
| | 1 month FU | 301.3 | 248.4 | 87.1 | 644.3 | 202.2 | 417.1 | 156.0 | 298.8 | 222.2 | 87.2 | 644.4 | 198.1 | 437.1 | 160.2 |
| | 3 months FU | 380.4 | 399.1 | 142.2 | 1150.4 | 209.3 | 462.1 | 222.1 | 380.1 | 399.1 | 142.2 | 1150.4 | 207.3 | 474.4 | 224.4 |
| *P*-value (main effect*) | | | | | 0.373 | | | | | | | 0.440 | | | |
| *P*-value (multiple comparisons**) | | | | | – | | | | | | | – | | | |
| Max walking line speed[cm/s] 4 km/h – non-dominant leg | Before | 202.2 | 189.5 | 142.1 | 387.0 | 162.1 | 231.3 | 56.9 | 201.9 | 189.5 | 142.1 | 417.0 | 162.1 | 215.6 | 61.3 |
| | After | 302.8 | 251.8 | 123.1 | 891.2 | 195.6 | 323.6 | 180.9 | 308.6 | 250.8 | 103.1 | 891.2 | 191.4 | 412.5 | 187.4 |
| | 1 month FU | 258.2 | 199.5 | 87.1 | 677.3 | 165.4 | 342.4 | 147.5 | 255.6 | 192.2 | 87.2 | 677.3 | 166.9 | 342.3 | 148.7 |
| | 3 months FU | 290.4 | 262.8 | 87.1 | 891.2 | 187.7 | 323.6 | 171.7 | 303.5 | 260.0 | 87.2 | 891.2 | 189.3 | 383.0 | 178.0 |
| *P*-value (main effect*) | | | | | 0.036 | | | | | | | 0.025 | | | |
| P-value (multiple comparisons**) | | Before vs. after: $p = 0.036$<br>Before vs. 1 month: $p = 0.116$<br>Before vs. 3 months: $p = 0.025$<br>After vs. 1 month: $p = 0.431$<br>After vs. 3 months: $p = 0.798$<br>1 month vs. 3 months: $p = 0.604$ | | | | | | | Before vs. after: $p = 0.036$<br>Before vs. 1 month: $p = 0.131$<br>Before vs. 3 months: $p = 0.021$<br>After vs. 1 month: $p = 0.355$<br>After vs. 3 months: $p = 0.919$<br>1 month vs. 3 months: $p = 0.452$ | | | | | | |

*DN – dry needling, n – number of individuals, $\bar{x}$ – mean, Me – median, Min – minimum value, Max – maximum value, Q1 – lower quartile, Q3 – upper quartile, SD – standard deviation, FU – follow-up. *Friedman's ANOVA, **Dunn's test.*

gait parameters in patients with LBP, but an improvement was noted in the assessment of quality of life. On the other hand, the meta-analysis by Hu *et al.* [12] indicated that the DN method is effective in relieving pain and improving fitness in patients with LBP compared to other treatment methods, but current evidence is not sufficient to clearly verify these reports. Similarly, American scientists indicate that it is necessary to conduct research to determine the parameters of DN procedures (including the duration and frequency of DN because most of the studies included in the analysis concerned a single treatment) and what assessment tools are best suited to assess therapeutic progress [13].

Unfortunately, the results we obtained cannot be related to the experiences of other researchers because this is the first work in the available literature on this subject (in our pilot report from 2024 [10] we did not explore this issue in such detail). As mentioned above, there are no clinical studies in the available literature to which the results we obtained can be related. However, the topic of dry needling certainly still requires scientific verification.

An intriguing issue of our research is the lack of significant improvement in gait parameters after standard physiotherapy procedures (after all, dry needling was a supplement to the primary therapeutic program). Another interesting issue is the clearly visible regression of the studied indicators in the period when – despite the lack of previous spectacular and statistically significant changes – the patients did not perform rehabilitation exercises.

Our experience with the FRS concept also allows us to start a discussion on the clinical usefulness of complex, objective measurement devices and their superiority, according to laboratory researchers, over simple, subjective scales or questionnaires (so-called Patient Reported Outcome Measures or PROMs). In turn, practitioners believe that therapeutic progress is often so discrete that it becomes difficult to capture for laboratory equipment. In their opinion, PROMs show greater measurement sensitivity in these cases. This is certainly an interesting field for discussion on the direction of future research in the field of physiotherapy and a specific conflict between theoretical science and everyday practice.

As mentioned earlier, it is also worth using other measurement tools, which will allow for full verification of the usefulness of the presented method. The last challenge is to relate the effectiveness of the FRS concept to other popular therapeutic procedures, such as shock wave (ESWT), manual therapy, massage, Pilates, or acupuncture. It is also worth having other centres revise the results we have obtained, as this will certainly facilitate further discussion. Then we will also learn the real usefulness of this technique in the context of other methods of treatment in cases of LBP syndromes.

## Conclusions

Dry needling according to the FRS concept does not have a beneficial effect on improving gait parameters in patients with chronic LBP and does not constitute a useful supplement to physical rehabilitation in this respect. Further work should be carried out on the research topic undertaken.

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## Ethical approval

Approval number: KB/91/FI/2018.

## Conflict of interest

The authors declare no conflict of interest.

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