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Research Article

The State and Therapy of Paravertebral Muscles in Spine Diseases

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ABSTRACT

The annual incidence of pain syndrome is 5% and the complaints rate of second to acute respiratory diseases with backaches being more common in the active population group aged between 30 and 50. Researchers discovered that intervertebral discs could reabsorb liquid and restore their normal structures, following a spinal distraction. It was the goal of this research to study the efficiency of Cordus and Sacrus gravity device therapy of the spine; Cordus and Sacrus are the two devices designed to provide relaxation to paravertebral muscles. The rehabilitation course was conducted at the Center for Science and Research of Sport Science and Psychophysiology of South Ural State University in 18 patients aged between 23 and 65, suffering from various myofascial pain syndromes. The rigidity and the tone in the paravertebral muscle decreased significantly ($p > 0.05$) in most of the subjects who had elevated muscle tones before the session. It is worthy of note that working on deep-seated muscles of the lumbar and sacral muscles reduced stiffness and improved elasticity of the leg muscles (m. Gastrocnemius). The research findings suggest that paravertebral relaxation device gravity therapy, if performed by qualified staff, yields positive results on most of patients having no contraindications (>84% of the subjects), coming in the shape of pain relief and improved mobility of joints. The devices can be used as part of combination therapy for a wide range of spine conditions.

Keywords: Electroencephalography; Psychophysical relaxation session; Background record; Open eyes test; Eyes closing test; British Institute of Standards

INTRODUCTION

A total of 45% to 80% of the global population suffers from pain syndrome and osteochondrosis, with 48% being genetically predisposed to osteochondrosis [1]. Developmental, biomechanical, and functional triggers, environmental and vascular conditions play a substantial role in the pathogenesis of osteochondrosis and myofascial pain syndrome (MPS) [2].

The occurrence of local myogenic pain syndromes (LMPS), which are predominantly localized in paravertebral muscles, is approximately 24%. Repetitive or ongoing low-level muscle contractions, maximal or submaximal concentric muscle contractions, and long-term strain on individual muscle groups – postural muscle overstrains in people leading a sedentary lifestyle – are believed to be the most common causes underlying MPSs [3,4]. According to practitioners range from 30% to 90% [5].

The findings of the research into pain syndrome epidemiology suggest that chronic backaches are found in 42.4% to 56.7% of the Russian adult population [5]. The annual incidence of pain syndrome is 5%, and the complaints rate second to acute respiratory diseases [6], with backaches being more common in the active population group aged between 30 and 50 [7].

Restoring functional health to the body in those who suffer from substantial physical strain and those leading a sedentary life, may include various manual and device therapy techniques [8-11]. That said, modern device methods and techniques are used currently as part of combination therapy for spinal pain syndromes and osteochondrosis. Gravity therapy that provides distraction to the spine and relaxation to its muscles and ligaments under the patient's own weight is one of the latest medical techniques in this field.

The advantage of the method is in being both absolutely safe and providing distraction evenly to all spinal regions. Researchers discovered that intervertebral discs could reabsorb liquid and restore their normal structures, following a spinal distraction [12].

That said, it was the goal of this research to study the efficiency of Cordus and Sacrus gravity device therapy of the spine; Cordus

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and Sacrus are the two devices designed to provide relaxation to paravertebral muscles.

RESEARCH METHODOLOGY

Cordus and Sacrus gravity therapy is based on providing physiological and comfortable relaxation to muscles and ligaments – primarily, paravertebral muscles (Cordus), skull muscles, pelvic and diaphragmal muscles (Sacrus), as well as giving soft spinal distraction to restore the normal spinal function.

Cordus is an innovative device designed to provide deep relaxation to paravertebral muscle areas (Figure 1). It is primarily used for gravity therapy of osteochondrosis and myofascial pain syndrome in the thoracic and lumbar regions, as well as to address herniations in these regions.

The Sacrus design provides soft and deep relief to the sacral and diaphragmal regions, and the skull, relaxing muscles that are attached to these regions (Figure 2). Sacrus has been designed to fit to the anatomy of the sacrum, and is specifically efficient in providing therapeutic relaxation to the piriformis in patients suffering from sciatic pain.

A gravity therapy session is placing a Cordus or Sacrus device under an affected spinal area anywhere along the spine, between the back of the neck and the sacrum of a patient lying flat on their back. Following a thirty-minute-long relaxation session, the patient was to perform a number of distraction mobilization exercises.

The rehabilitation course was conducted at the Center for Science and Research of Sport Science and Psychophysiology of South Ural State University in 18 patients aged between 23 and 65, suffering from various myofascial pain syndromes. Prior to Cordus and Sacrus sessions, the physiotherapists were familiarized with the parameters, operation, and usage of the devices. The course consisted of twelve sessions per subject, which included spinal relaxation by Cordus and Sacrus devices, followed by doing exercises to mobilize spinal motor segments.

The patients were selected, following an interview and upon their informed consent to participate in research. Quantitative assessment was conducted on the visual analog scale (VAS) [13]. Manual diagnostics was conducted to assess motion volumes of each spinal segment in all directions; asymmetry of paravetebral muscle tone was assessed by a MIOTON device.

The selected persons for the studies were informed about the technique of correction of the spine with the help of the device, existing contraindications to the above product, the procedure for correcting the spine was conducted after preliminary conversation and obtaining informed consent for the study. The course of correction of the spine was 1 month.

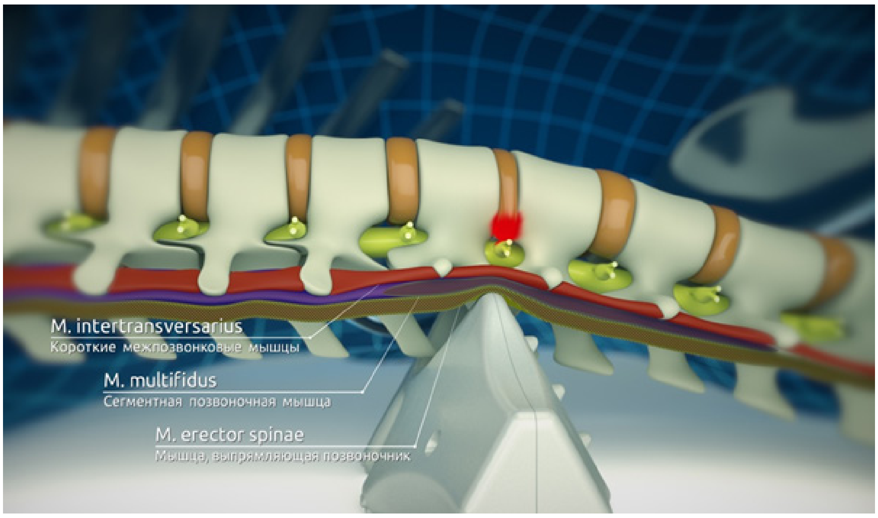

Figure 1: Cordus device works on paravertebral muscles.

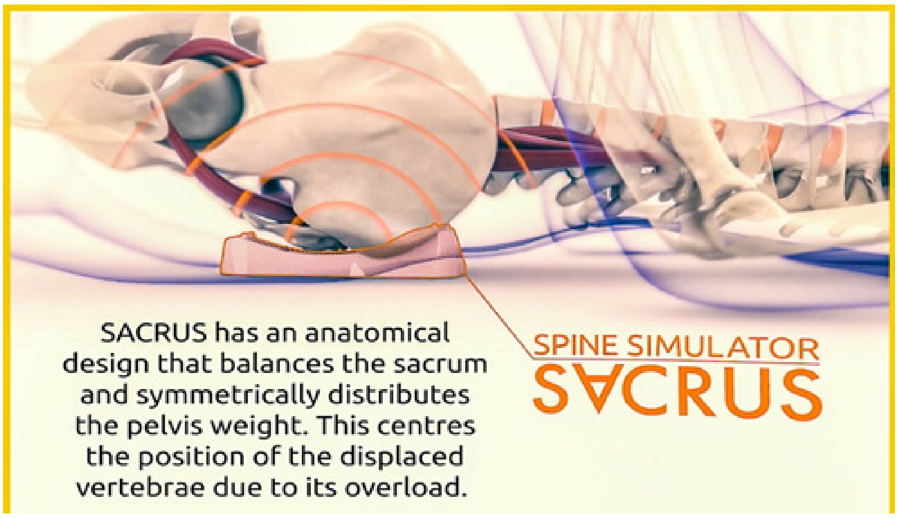

Figure 2: The treatment of the sacral region with Sacrus device, providing relaxation to the piriformis and lumbar muscles.

Based on the studies carried out the following conclusion was made:

Most of the subjects noted the disappearance or significant reduction in pain, increase in efficiency and normalization of sleep (Table 1).

Muscle mechanical properties

The MyotonPRO device was used to assess trapezius muscle (TMd), Erector spin (Es) and gastrocnemius muscle (Gn) muscle stiffness, tone and decrement (elasticity). A standardized protocol for using this hand-held device was followed [14]. The device elicits oscillations of muscle after a probe applies a brief mechanical impulse following a constant pre-load to the skin over the muscle. From these oscillations, the device quantifies various parameters simultaneously, including non-neural tone and mechanical properties such as dynamic stiffness and decrement [15]. The frequency determined by fast Fourier transform (FFT) which was most characteristic in the registered oscillation acceleration signal, indicates resting tone or state of tension of an activated muscle (Fmax; (Hz)). Stiffness (N/m) is a measure of the muscle's ability to resist an external force that modifies its shape, the higher the N/m value, the stiffer the muscle [14]. Logarithmic decrement describes the tissue's ability to restore its shape after being deformed, and defined as the dissipation of mechanical energy in the tissue during an oscillation cycle. The smaller the decrement value, the smaller the subsequent dissipation of mechanical energy and the higher the elasticity [14].

A record of the MMPs using a hand myotonometry (MyotonPro®, Estonia) was made in both lumbar and cervical spines. The MyotonPro® provides a controlled preload of 0.18 N for an initial compression of the subcutaneous tissue, imposing an additional 15 ms pulse and 0.40 N of mechanical force, which induces a natural damped oscillation in the targeted tissue. This response is measured by an accelerometer [16]. The MMPs recorded in this study included: frequency, measured in Hz, representing the muscle tone at rest (the higher frequency, the higher muscle tone); stiffness, measured in N/m, reflecting the capacity of the muscle to resist contraction or external pressure to deform (the greater stiffness, the greater muscle toughness); logarithmic decrement of oscillation amplitude, that has no unit, and is a measure of muscle elasticity (the higher decrement, the lower elasticity [17]); creep, that has also no unit, the material property in which progressive deformation occurs with time while a constant stress is applied; and, relaxation, measured in ms, describing the phenomenon of stress decrease with time, while the applied strain is constant, being the stress relaxation time the recovery time for the material to return to its normal state after deformation [18] (Figure 3).

Statistical analysis

Categorical variables are presented as counts and percentages. Continuous data were described by mean and standard deviation with a 95% confidence interval (95% CI). The Kolmogorov–Smirnov test showed their normal distribution (all variables: $p > 0.05$).

For the primary aim of the study, when the three groups were compared, one-way ANOVAs, with Tukey test for post hoc analyses, were conducted. When only spinal pain groups were included in the analysis, as occurred with fear of pain and kinesiophobia questionnaires, the unpaired Student t-test were applied.

To determine if each MMP of spinal musculature and each spinal ROM can classify individuals between the three groups, receiver operating characteristics (ROC) curves were developed. To interpret them, statistical significance and the area under the curve (AUC) were calculated. For the AUC, a value of 0.5 was considered fail to discriminate, 0.6–0.7 was considered poor, 0.7–0.8 was considered acceptable, 0.8–0.9 was considered excellent, and outstanding when more than 0.9 [19].

RESULTS

The biomechanical diagnostics of paravertebral muscle tones detected the elimination of muscle tone asymmetry (Figure 4), and normalized postural balance (evened out the center of gravity), which concurred with the relief of pain syndrome (decreased from 7.6 - 0.8 to 3.1 - 0.6 of the VAS average), following a gravity therapy session for intervertebral muscles.

Acting on proprioceptors of paravertebral muscles, gravity therapy relaxed the erector spinae, which had had an elevated tone before the session (Figure 5).

The rigidity and the tone in the left muscle decreased significantly ($p > 0.05$) in most of the subjects who had elevated muscle tones before the session, Figure 6 below. Similar changes were detected in the right erectors, following two or three sessions. It is worthy of note that working on deep-seated muscles of the lumbar and sacral muscles reduced stiffness and improved elasticity of the leg muscles (m. Gastrocnemius). In addition to relaxation, the subjects reported a feeling of warmth going up and down their legs, which could be attributed to the hemodynamic effect from the treatment of the spinal muscles, coming in the shape of dilated peripheral vessels.

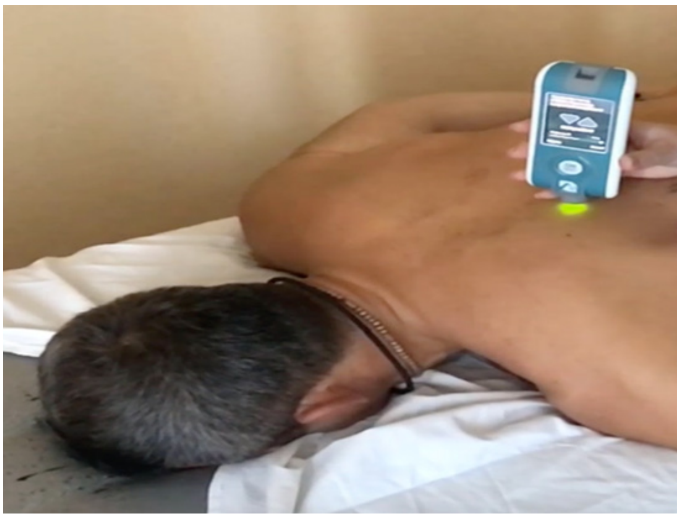

Figure 3: Assessment of muscle mechanical properties (MMPs). Thoracic region myotonometry. Subject position and device location.

Table 1: The quantitative assessment of the pain syndrome showed a significant reduction in the severity of pain (especially in the neck, waist, sacrum and knee area) or even its disappearance after a corrective course.

№№ п/п	Sex, age	Symptoms, Diagnosis	Application and clinical effect
1	M, 48	Thoracalgia	Reduction of pain syndrome. Increased amplitude of motion of the thoracic region
2	W, 49	Displacement C1-C2, pain in the neck	Disappearance of pain syndrome, restoration of mobility in the neck
3	W, 45	Osteochondrosis of the lumbar spine, with painful radicular syndrome	Reduction of pain syndrome, increased mobility in the lumbar spine
4	M, 36	Pinch of the sciatic nerve	Disappearance of pain syndrome, restoration of the biomechanics of walking
5	M, 41	Pain in the neck, cervical osteochondrosis	Reduction of pain syndrome, a sense of ease in the collar zone
6	W, 43	Spondylosis, with painful radicular lumbar syndrome	Reduction of pain syndrome.
7	M, 47	Piriformis muscle syndrome	Disappearance of pain syndrome. Restoring mobility in the lower back
8	W, 32	Protrusion L4-L5 5mm, Back pain and hip joint	Disappearance of pain in the lower back, reduction of pain in the hip joint. Reduction of protrusion to 2 mm.
9	M, 26	Pain in the shoulder, tunnel syndrome	Reduction of pain syndrome, increase in amplitude of motion in the shoulder.
10	W, 28	Pain in the knee and lower back	Disappearing low back pain, reducing pain in the knee.
11	W, 38	Piriformis muscle syndrome	Disappearance of pain syndrome. Restoring mobility in the lower back
12	W, 44	Thoracalgia , Lumbalgia	Reduction of pain syndrome, improvement of sleep
13	M, 54	Scoliosis of II degree	Reduction of pain syndrome, reduction of the angle of curvature from 12 to 9 degrees
14	M, 45	Pain in the legs, knee, sacrum	Decrease of pain in the legs, disappearance of pain in the sacrum.
15	W, 64	Left-sided sacroileitis	Restoration of walking biomechanics, reduction of pain syndrome
16	W, 33	Scoliosis S-shaped	Reducing the angle of curvature, the disappearance of pain in the lower back
17	W, 31	Pinch of the sciatic nerve	Disappearance of pain in the pelvic region and waist, restoration of the biomechanics of walking
18	M, 36	Pain in the back and neck with professional muscular tension	Expressed a relaxing effect, the disappearance of pain in the back and neck.

In addition to a direct impact on the muscles, positive changes were detected in the joints and the overall psychophysical status of the subjects, following the gravity therapy course for intervertebral muscles from the neck to the lumbar region, including the sacral region.

Subjects noted improved mobility in the cervical, thoracic and lumbar spine, improved mobility in the upper and lower extremities, in the pelvic region, normalization of the walking pattern, recovery of sleep. The procedure of correction of the sacrum zone facilitated the reduction of compression of the intervertebral discs of the lumbar spine, which contributed to a decrease in protrusion by several mm. The combination of correction of the sacrum and exercises for stretching the pear-shaped muscle made it possible to eliminate pinching of the sciatic nerve for 3-5 sessions and normalize the previous walking pattern.

The hardware effect was that the sacro-like anatomical design of the device with acupuncture spines to affect the ligaments and trigger zones allows effective action on the deep muscles and ligaments of the selected segment of the spine (pelvis, knee, diaphragm area, skull base). Thus, relaxation and correction of key segments of the vertebral column up to the ligaments helps to eliminate tension in these zones (including tunnel syndrome), restore mobility in the joint and improve blood circulation of tissues along the segments of corrective action. Microcurrents of the device Sacrus Phisio, due to slow-frequency modulation contribute to the development of the state of relaxation. What helps to relax and remotely located muscles.

DISCUSSION

Repetitive or ongoing low-level muscular contractions are believed to be the most common underlying cause of myofascial pain syndrome (MPS) [20,21]; other common causes include maximal and submaximal concentric muscle contractions; long-term strains of individual muscle groups – postural overstrain in those leading a sedentary life.

As the researchers [22-25] note, a muscle spasm stimulates

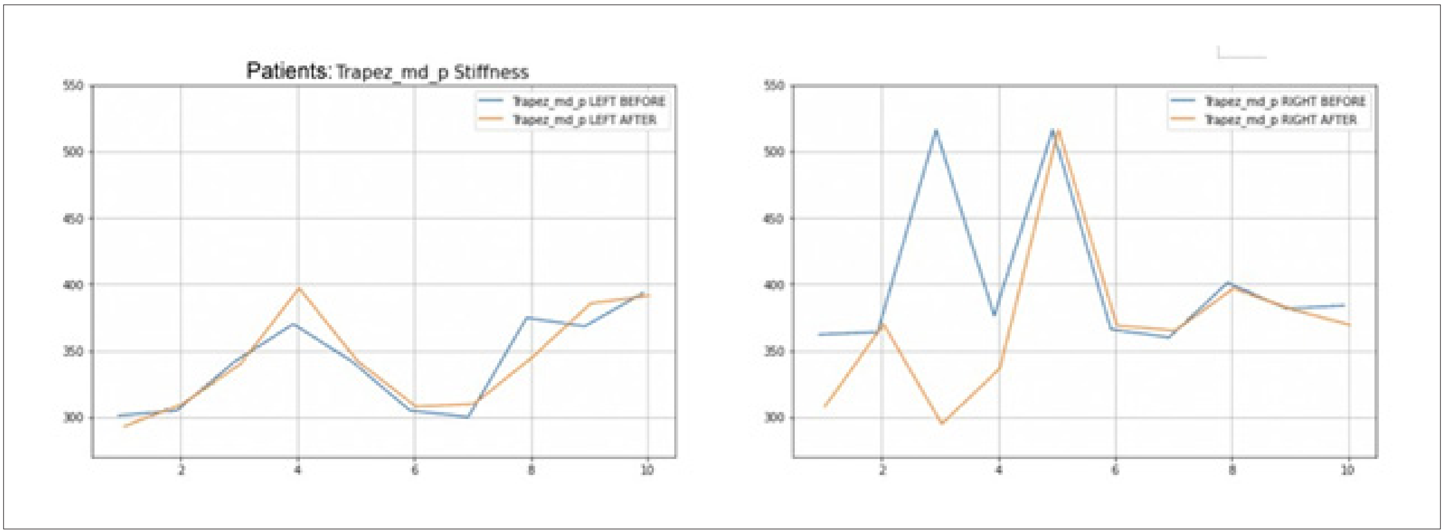

Figure 4: Evening out the right trapezius tone, reduced asymmetry of paravertebral muscles, following gravity therapy.

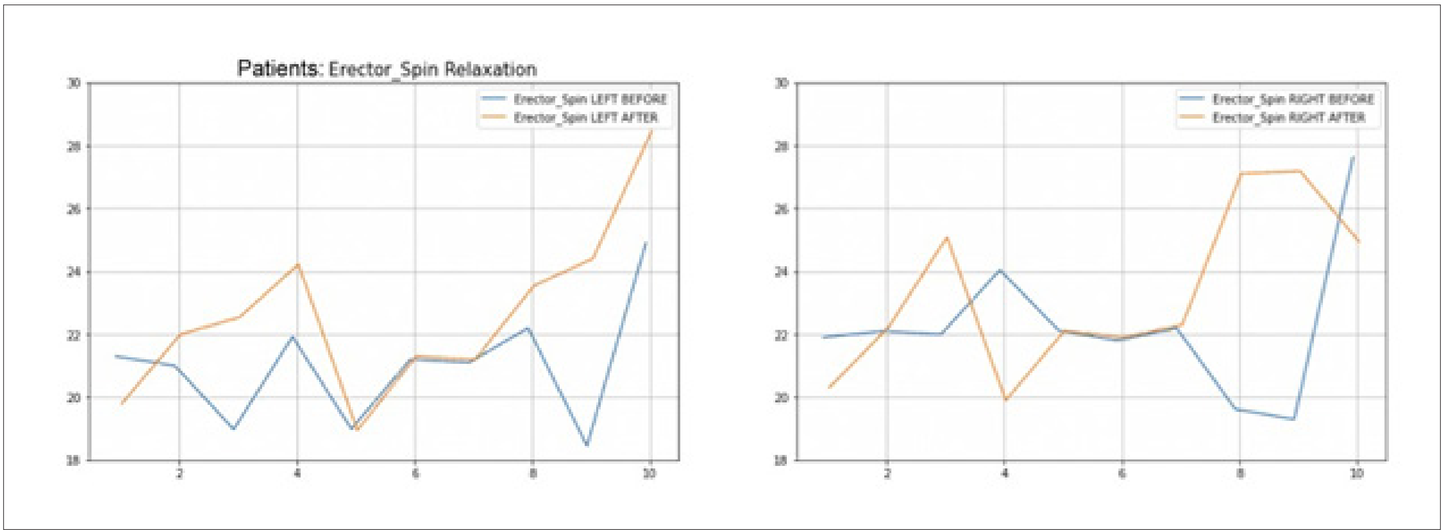

Figure 5: An increase in relaxation of the erector spinae, following a session, the relaxation being low before the session.

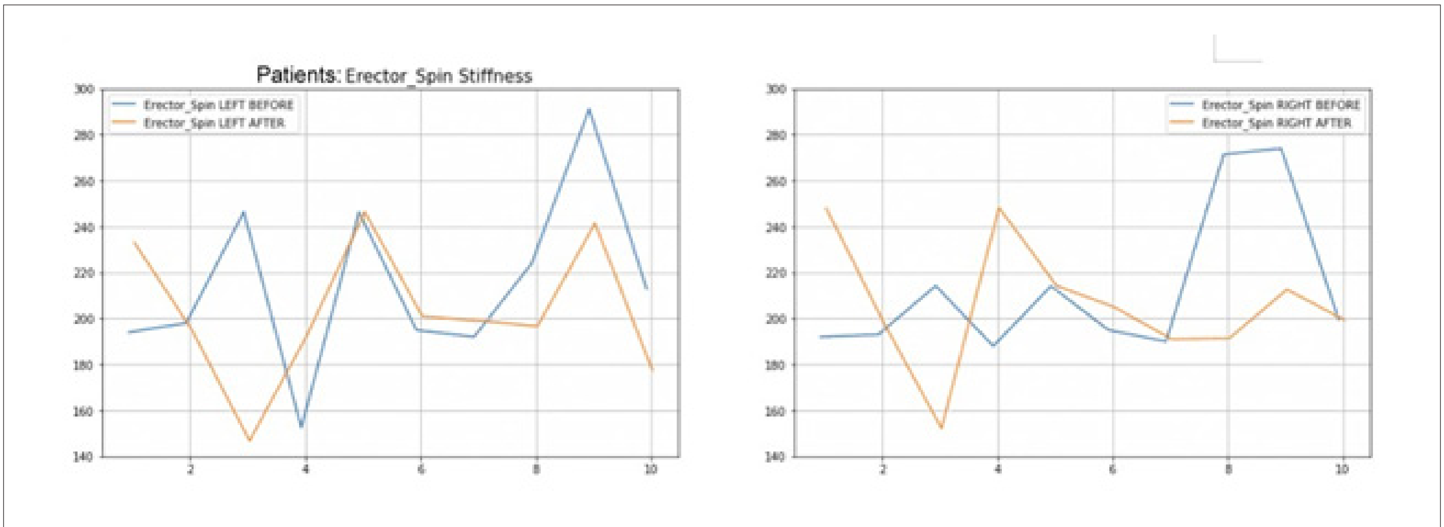

Figure 6: Erector spinae tones evened out on the right and on the left, followed by relief of pain syndrome.

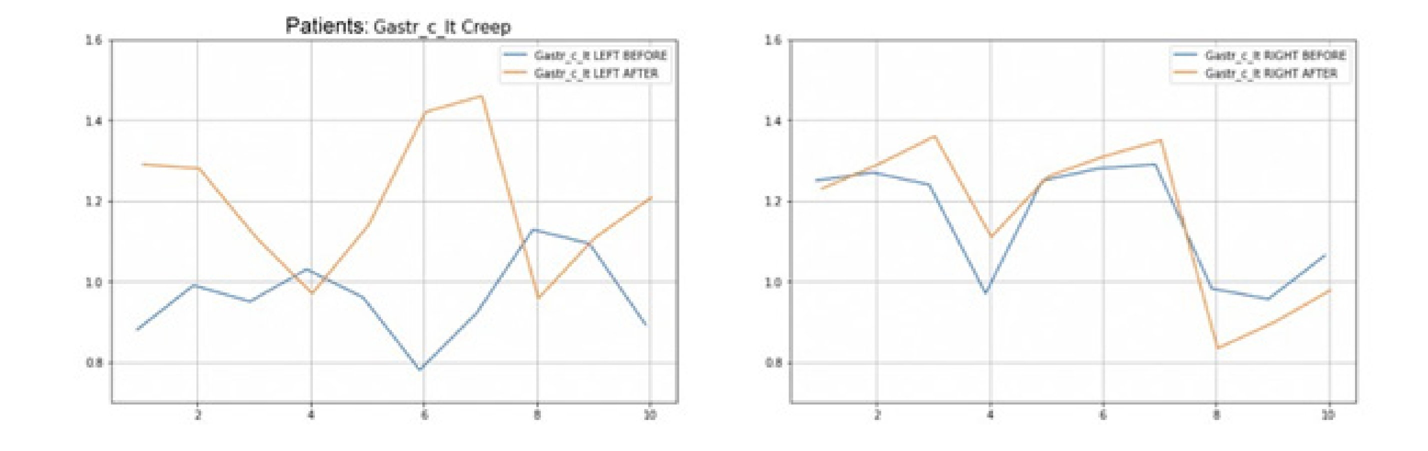

Figure 7: The elasticity of the right and the left calf muscles (m. Gastrocnemius) evened out, following therapy of the intervertebral muscles in the lumbar region.

nociceptors of the very muscle. Local hyperhaemia sets in inside cramped muscles, activating nociceptors of the muscle tissue. A cramped muscle becomes a source of additional nociceptive impulses that are received by the dorsal horns of the same spinal segment. Accordingly, an increased pain impulse flow increases the activity of anterior motor neurons, which makes the muscle cramp even worse. Thus, the vicious circle is closed: Pain – muscle cramp – more pain – muscle cramp gets worse (Figure 7).

The research findings suggest that paravertebral relaxation device gravity therapy, if performed by qualified staff, yields positive results on most of patients having no contraindications (>84% of the subjects), coming in the shape of pain relief and improved mobility of joints. Patients report changes in their psycho-emotional state, improved health, and feelings of a healthy spine, and deep relaxation. That said, the devices can be used as part of combination therapy for a wide range of spine conditions.

CONCLUSIONS

1. The devices act on both muscle proprioceptors and joint receptors, relieving erector spinae hypertonia, providing relaxation to an affected spine area. It takes one to three sessions to relieve pain syndrome.

2. Cordus & Sacrus gravity therapy for paravertebral muscles acts deeply on paravertebral areas reduces muscle stiffness and asymmetry between the right and the left muscle groups, improving muscle elasticity.

3. Combined with distractive mobilization exercises, the device gravity therapy designed for paravertebral muscles, relieves vertebrogenic and myofascial pain syndromes, provides relaxation to cramped muscles, improves blood supply of the limbs, and restores the mobility to the spinal joints.

INFORMED CONSENT

Informed consent was obtained from all subjects involved in the study

DATA AVAIABILITY

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethics approval being required for secondary analyses of these data.

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