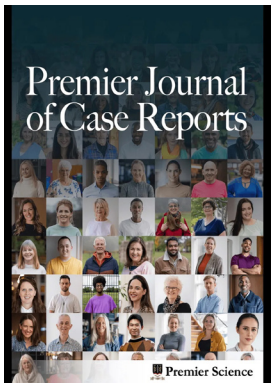

Rehabilitation of Chronic Non-Specific Low Back Pain: A Case Report

Aya Hussein Srour

ABSTRACT

INTRODUCTION AND PURPOSE

Chronic non-specific low back pain (CNSLBP) often presents challenges in management, especially in sedentary office workers. This case report presents the physical therapy management of a 30-year-old sedentary office worker with chronic low back pain (LBP), using a multimodal rehabilitation program including H-Wave® device stimulation, manual therapy, education, and active exercise intervention. While H-Wave® stimulation has been studied in chronic pain, its use in CNSLBP among office workers remains limited. Rather than demonstrating a novel intervention, this case report emphasizes a practical, guideline-based multimodal rehabilitation for CNSLBP in a sedentary office worker, highlighting the extent of therapy, real-world implementation, ergonomic intervention, and clinical reasoning for improved long-term outcomes.

PRESENTATION

The patient is a 30-year-old female office employee who presented to the physical therapy clinic with a 6-month history of LBP, aggravated by prolonged sitting. She rated her pain 6/10 on the Visual Analog Scale (VAS), which significantly affected her daily activities. Clinical assessment showed lumbar stiffness, poor core stability, and decreased range of motion (ROM). Postural evaluation identified anterior pelvic tilt, forward head posture, and increased lumbar lordosis.

CONCLUSION

This case illustrates the practical application of a guideline-based, multimodal rehabilitation program, rather than proposing a new therapy. The integration of manual therapy, education, active exercise, and ergonomics demonstrated significant reductions in symptoms and improvements in functional impairment. Importantly, the case also demonstrates the potential adjunctive value of H-Wave device stimulation within multimodal care, while acknowledging that the current evidence is modest compared to standard electrotherapies, such as transcutaneous electrical nerve stimulation (TENS) or interferential current (therapy) (IFC). Ergonomic modifications and posture retraining were integral to sustaining improvements in this sedentary worker, illustrating the importance of individualized, real-world rehabilitation strategies.

Keywords: Chronic non-specific low back pain, Multimodal physical therapy, Core stabilization training, Sedentary office worker ergonomics, H-wave electrotherapy

Physical Therapist, Istijaba Medical Center and Souzan Special Needs School, Saida, Lebanon

Correspondence to:
Aya Hussein Srour,
ayasrour28@hotmail.com

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Introduction

Non-specific low back pain (NSLBP) is defined as pain localized between the lower margin of the ribs and the buttocks, without an identifiable underlying pathology such as a tumor, infection, lumbar spine fracture, inflammatory disorder, radicular syndrome, or cauda equina syndrome.[1] It is chronic when lasting more than 12 weeks.[1] NSLBP affects all ages, is more prevalent among females, and impacts approximately 619 million people worldwide in 2020, with projections estimating an increase to 843 million cases by 2025.[2] Its etiology is multifactorial, including improper posture, overuse injuries, and obesity. Treatment ranges from conservative approaches, such as medications, education, and physical therapy, to surgical intervention as a last resort.[3,4]

Physical therapy remains one of the most commonly employed conservative treatments for NSLBP.[3] Interventions include home-based exercise programs (e.g., stretching and aerobic exercises), self-management strategies focusing on postural re-education and ergonomics, stabilization exercises, lumbar motor control exercises, and McKenzie therapy.[5] These therapies aim to enhance joint and muscle strength, improve range of motion (ROM) and muscle function, and facilitate recovery to daily activities, with primary goals of improving functional capacity and reducing pain.[6] Moreover, physical exercise often provides psychological and emotional benefits that complement the physical improvements, contributing to overall better outcomes.[5]

It is essential to acknowledge these physical therapy interventions, as they provide a cost-effective alternative to surgical intervention.[3] The rehabilitation program in this case followed best-practice recommendations, including national institute for health and care excellence (NICE) guidelines for low back pain (LBP) and sciatica, the American College of Physicians clinical guidelines, and Cochrane systematic reviews on exercise therapy for chronic LBP.[5,7,8]

Case Presentation

Methods

This case report was documented and was conducted with the patient's informed consent for both participation and publication, following SCARE 2025 guidelines.[9] Institutional policies were followed, and ethical approval was not required for this single case study.

Timeline

The patient was a 30-year-old female office worker presenting with a 6-month history of LBP (Table 1).

Table 1 | Timeline of events

Time Point	Event
~6 months before presentation	Onset of LBP symptoms
Week 0	Initial clinical assessment and diagnosis
Week 1–6	Multimodal physical therapy intervention (two sessions/week × 45 minutes)
Week 3 (session 6)	Initiation of H-Wave device stimulation therapy
Week 6	End of treatment phase
Week 10	Follow and reevaluation

Notes: H-Wave = High-Wave Electrotherapy Device.

Conflicts of interest: N/a
Author contribution: Aya Hussein Srour – Conceptualization, Writing – original draft, review and editing
Guarantor: Aya Hussein Srour
Provenance and peer-review: Unsolicited and externally peer-reviewed
Data availability statement: N/a

She was 167 cm tall, weighed 57 kg body mass index ((BMI) 20.45), and described her pain as a dull, localized lumbar ache rated 6/10 on the Visual Analog Scale (VAS), which worsened after prolonged sitting and at the end of the workday. Symptom onset was gradual, with no trauma, neurological symptoms, or systemic signs. Magnetic resonance imaging (MRI) and screening for serious pathology were unremarkable.

Her work involved 8–9 hours of computer-based sitting with minimal breaks, contributing to postural strain, mental fatigue, reduced activity tolerance, and occasional sleep disturbances. She had not received physical therapy previously, and analgesics provided only temporary relief. There was no significant medical, surgical, or psychological history, and she did not smoke or consume alcohol.

Environmental and occupational factors, including a non-adjustable workstation and a culture discouraging breaks, were considered in designing her rehabilitation program. A diagnosis of chronic non-specific low back pain (CNSLBP) was made based on clinical history and examination, consistent with mechanical LBP without neurological involvement.

Observation, Evaluation, and Examination

General Morphological

The patient presented independently, with no observable gait abnormalities. Clinical observation revealed postural deviations, including forward head posture and rounded shoulders.

Morphostatic Assessment

Anterior View: Upper limbs and external projections appeared symmetrical. Clavicles and shoulders were slightly rounded and protracted. The head was positioned forward relative to the torso. No pelvic asymmetry was observed.

Posterior View: Lumbar hyperlordosis was evident in the trunk. Scapulae appeared slightly protracted, consistent with rounded shoulders. Pelvic crests were level bilaterally. No abnormalities noted in the lower limbs.

Lateral View: There was marked lumbar hyperlordosis accompanied by an anterior pelvic tilt. Forward head posture and increased thoracic kyphosis were also noted.

Pain Assessment

1. Date of onset: Gradual onset approximately from 6 months ago (around 11/1/2024).
2. Quality: mechanical nociceptive pain.
3. Duration: chronic (persisting for more than 6 months).
4. Onset pattern: gradual worsening over time.
5. Location: localized to the lumbar region (L3–L5).
6. Frequency: intermittent, with episodes triggered by activity.
7. Depth of pain: deep aching sensation.
8. Description of pain: nagging and aching discomfort.
9. Time of day: worsens with prolonged sitting and at night.
10. Triggering factors: prolonged sitting, bending, lifting, and transitions from sitting to standing.
11. Aggravating factors: sitting for extended periods, poor posture, and transitions from sitting to standing.
12. Relieving factors: movement, postural correction, rest, analgesics.
13. Impact on activities of daily living (ADL)/mood/sleep: reduced ability to perform work-related tasks, disturbed sleep, and decreased physical activity.
14. Pain intensity: initially rated 6/10 on VAS, triggered with activity and prolonged sitting.

Conclusion: The patient presents with chronic mechanical nociceptive LBP, aggravated by prolonged sitting and physical activities such as bending and lifting. Pain intensity is rated 6/10 and is partially relieved by rest and analgesics.

Articular Assessment

- Observation:
  - Lumbar hyperlordosis
  - Forward head posture
  - Increased thoracic kyphosis
  - Anterior pelvic tilt
  - Rounded shoulder

- Passive ROM:
  - Passive trunk extension and flexion were limited due to pain (soft end feel).

- Measurement:
  The Lumbar ROM results are shown in Table 2.

Conclusion: All lumbar movements caused pain during performance, except trunk extension, which was pain-free.

Table 2 | Lumbar ROM results

Trunk extension: 20°	Trunk flexion: 30°
Left side bend: 11°	Right side bend: 15°
Left rotation: 15°	Right rotation: 19°

Note: ROM = Range of Motion.

Muscle Testing

The manual muscle testing results are shown in Table 3.

Conclusion: The patient demonstrates generalized muscle weakness in the hips and trunk, with hip flexors, abductors, trunk side bending, and rotation graded 3/5 bilaterally, and trunk extension slightly stronger at 4/5. Muscle weakness limits performance against gravity, with pain and early fatigue preventing full completion of repetitions (Table 3).

Table 3 | Manual muscle testing (MMT) results

	RIGHT	LEFT
Hip flexion	3/5	3/5
Hip abduction	3/5	3/5
Hip adduction	5/5	5/5
Trunk side bending	3/5	3/5
Trunk rotation	3/5	3/5
Trunk flexion	3/5	
Trunk extension	4/5	

Note: Muscle strength graded on a 0–5 scale (0 = no contractions, 5 = normal strength).

Functional Assessment

Qualitative:

- Lower extremity:
  - Walk: difficulty with prolonged walking. Run: unable to run at normal speed.
  - Jump: unable to perform jumping. Go downstairs: able.
  - Go upstairs: able.
  - Return: performs with mild limitation.

Quantitative:

- The Oswestry Disability Index (ODI) was used to assess the patient's functional disability.
  - The baseline ODI Questionnaire score was: 45% severe disability.

Conclusion: The patient experiences significant functional limitations, including difficulty with prolonged walking and the inability to jump or run. Stair navigation was possible but limited. An ODI score of 45% reflected severe disability with a substantial impact on daily activities.

Special Tests

1. Straight leg raise: NEGATIVE
2. Slump: NEGATIVE
3. Manual lumbar distraction: POSITIVE, the patient said that it made her feel like pressure.

Outcome Measures Used

- **VAS:** VAS (0–10), with a minimal detectable change of 1.5 points.
- **ODI:** ODI, version 2.1a, 0–100%, minimal detectable change 10%. Previously translated and linguistically validated for Arabic-speaking Lebanese populations.
- **MMT:** measures muscle strength in the hips and trunk (0–5 scale).
- **Functional Assessment:** evaluates the ability to perform daily activities like walking and stair use.
- **ROM:** Measured in degrees using a goniometer for lumbar flexion, extension, and lateral bending. Lumbar ROM was measured using a single digital inclinometer, following standard clinical protocols.

These tools were selected based on age and clinical relevance to NSLBP. Assessments were conducted at baseline and at periodic follow-ups to guide treatment modification.

Clinical Findings

Lumbar ROM was moderately restricted in flexion and extension. Mild tenderness was present over the paraspinal muscle at L4–L5. Postural assessment revealed forward head posture, anterior pelvic tilt, and increased lumbar lordosis. Trunk muscle strength and core stability were reduced, particularly during dynamic balance and endurance tasks. Neurological examination was normal. Palpation revealed bilateral tightness in the gluteal, latissimus dorsi, and lumbar paraspinal muscles, with tenderness to moderate pressure.

Results-Figure

The clinical outcomes are shown in Figure 1.

Diagnosis and Physical Therapy Intervention

The patient was diagnosed with chronic non-specific mechanical LBP, primarily attributed to prolonged sedentary behavior, poor postural alignment, and reduced core stability. The condition was classified as mechanical, with symptoms aggravated by prolonged sitting and relieved by movement and postural correction.

Goals

Short-Term Goals:

- Reduce pain
- Patient education
  - Home exercise program

Long-Term Goals:

- Increase trunk ROM
- Increase muscle strength and endurance
- Increase core stability

Plan of Care

Intervention/Treatment: The patient underwent a multimodal rehabilitation program based on guideline recommendations, delivered twice weekly for 6 weeks (45 minutes per session).

The Program Combined

Education and Ergonomics: Addressing posture, workstation modifications, and activity pacing.

Manual Therapy: Soft tissue mobilization and lumbar segmental mobilization (Maitland Grade II–III) to reduce stiffness and facilitate movement.

Exercise Therapy: A structured, progressive program emphasizing stretching, core stabilization, strengthening, and functional integration.

Adjunctive Electrotherapy: H-Wave stimulation, introduced from week 3 onward.

Exercises Progressed Across Four Phases: Stretching/activation (weeks 1–2), core stabilization (weeks 3–4), strengthening and endurance (weeks 5–6), and functional movement integration (weeks 7–8). Progression was based on tolerance (pain ≤ 3/10, correct control, and absence of symptom aggravation).

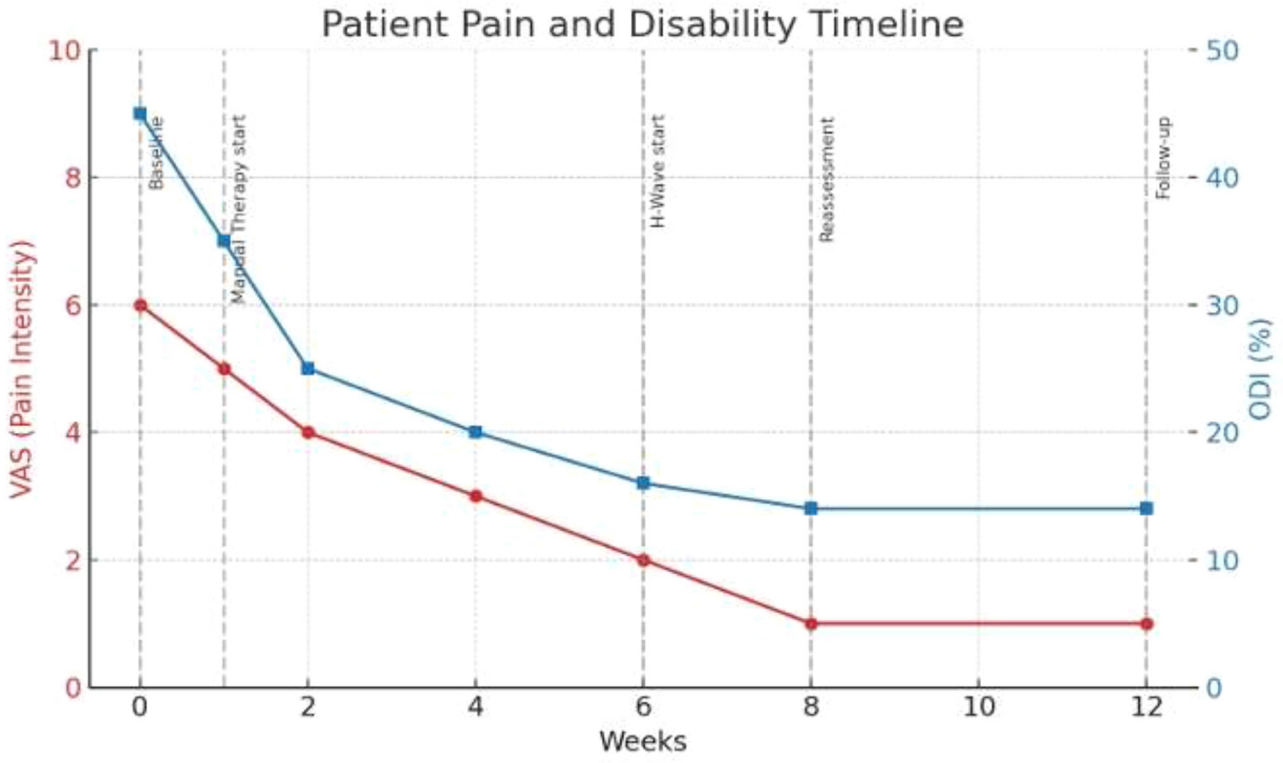

Fig 1 | Timeline of the multimodal physical therapy intervention and assessment points over the 8-week period. Pain intensity (VAS, 0–10), functional disability (ODI, %), and muscle strength (MMT, 0–5) improved progressively over time. ROM = Range of Motion; VAS = Visual Analogue Scale; ODI = Oswestry Disability Index; MMT = Manual Muscle Testing

Note: 3-month follow-up data are not displayed in the figure but are provided in Table 4 for transparency

Detailed exercise lists, progression criteria, and session flow are provided in **Supplementary Appendices A–C.**

H-Wave device stimulation was included as an adjunct modality within the multimodal program to address postural muscle fatigue and pain modulation.

H-Wave Device Stimulation

H-Wave was selected as an adjunctive modality to manual therapy and exercise based on its unique stimulation profile and emerging clinical evidence. Unlike conventional TENS or IFC, which primarily act through sensory-level stimulation and pain gating, H-Wave applies dual-frequency currents (2 and 60 Hz) that elicit non-fatiguing muscle contractions of slow-twitch fibers. The rhythmic activation is hypothesized to enhance microcirculation, lymphatic drainage, and tissue recovery in addition to providing analgesic effects.[10] Preliminary studies suggest that H-Wave may provide longer-lasting functional improvements compared with TENS or IFC in chronic musculoskeletal pain, though direct comparative trials remain limited.[11,12] From a safety standpoint, its contraindications are similar to other electrotherapies (e.g., pacemakers, pregnancy, active malignancy, open wounds), with minimal reported adverse effects. Accessibility is somewhat lower than that of TENS units due to higher device costs and limited availability; however, the potential for improved adherence and sustained functional outcomes can justify its use in selected patients when conventional stimulation is insufficient. In this case, H-Wave was introduced as part of a multimodal program to complement manual therapy, exercise, and ergonomic education.[13]

H-Wave Device Stimulation Protocol

Starting at week 3, H-Wave device stimulation was applied as an adjunct to manual therapy exercise. The protocol used low-frequency stimulation at 2 Hz with a 5 ms pulse width, delivered via four electrodes placed over the lumbar paraspinal muscles (L3–L5) (Figure 2).[14]

Intensity was adjusted to elicit strong comfortable muscle contractions (~35 mA). Sessions lasted 30 minutes, and were performed 2–3 times per week over 4 weeks, totaling 8–12 sessions. This parameter set is supported by clinical evidence demonstrating effectiveness for pain reduction and functional improvement in CNSLBP.[11,12]

Alternative Interventions

Alternative treatment options, such as pharmacological management or other physical modalities, were considered but not pursued based on current clinical guidelines and patient preferences that favored non-pharmacological multimodal rehabilitation.

Adherence and Fidelity

The patient attended all 12 planned sessions over six weeks. Home exercises were monitored through weekly

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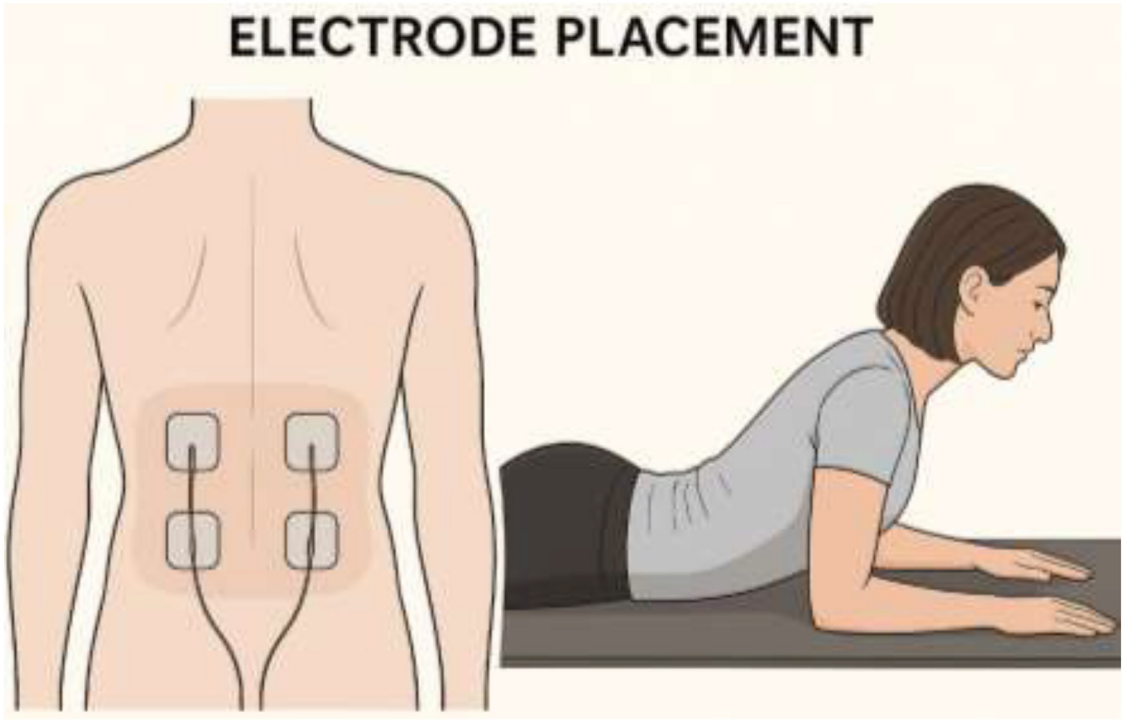

Fig 2 | H-Wave electrotherapy was applied to the lumbar region twice weekly for 4 weeks, targeting the paraspinal muscles at L3–L5

Table 4 | Functional and clinical outcomes pre- and post-intervention

Outcome Measure	Baseline Score	Post-Intervention Score	3-month Follow-up	Change Score	Clinically Important Difference
Pain (VAS, 0–10)	6	1	1	−5	Yes (≥2 points reduction)
ODI %	45%	14%	15%	−31	Yes (≥10% improvement)
Lumbar ROM (flexion/extension)	Moderately limited. Lumbar flexion: 30° Hip flexion: 3/5 Trunk rotation: 3/5	Full, pain-free. Lumbar flexion: 60° Hip flexion: 5/5 Trunk rotation: 5/5	Full, pain-free	Significant	Yes (≥10% increase in ROM)
Muscle strength (hip/trunk)	4/5–5/5	Mostly 5/5	Maintained 5/5	+1 (for trunk flexion)	Yes
Adverse events	None reported	None	None	N/A	N/A

Note: VAS = Visual Analogue Scale; ROM = Range of Motion.

check-ins and patient self-reports, with adherence verified via exercise logs and session feedback. The patient reported completing approximately 85% of prescribed home exercise sessions throughout the treatment period. While objective monitoring was not feasible, adherence was regularly reinforced during clinical visits.

For session flow, see Appendix C.

Exercise Progression Criteria

Exercise intensity and H-Wave stimulation parameters were progressed based on patient tolerance, pain response, and clinical judgment, rather than following a fixed predefined protocol. And if:

- The patient reported **pain ≤ 3/10** during or after the session.
- The exercise was performed with correct control and form.
- No signs of symptom aggravation were observed within 24 hours post-session.

Safety Monitoring

Pain levels were monitored before, during, and after each session to ensure patient comfort. Exercises were supervised to confirm proper technique and pain-free performance. Skin inspections were conducted before and after electrotherapy to detect any adverse reactions. No adverse events or patient concerns were reported throughout the treatment. Contraindications were screened before initiating therapy.

Summary of Exercise Program

For the full list of exercises, see Appendix A.

Step-by-Step Guide for CNSLBP

For the full list of steps, see Appendix B.

Revaluation

The patient demonstrated significant improvements across multiple domains. Upon reevaluation, muscle strength was 5/5 for most hip and trunk movements,

with trunk flexion 4/5. Lumbar ROM improved with no pain during movement. Subjective pain levels decreased from 6/10 at baseline to 1/10 on VAS. Functional status improved markedly, with the ODI score reducing from 45 (severe disability) to 14% (minimal disability). Follow-up assessments at 8 weeks and 3 months post-treatment showed sustained improvements: pain remained at 1/10, ODI at 15%, lumbar ROM was full and pain-free, and trunk/hip strength was maintained at 5/5.

Discussion

This case illustrates the value of a guideline-based multimodal rehabilitation program for CNSPLBP in a sedentary office worker. The integration of manual therapy, education, core stabilization, and ergonomic adjustments aligns with recent recommendations that emphasize non-pharmacological care as the first-line management.[5,8] While manual therapy likely provided short-term symptom relief and facilitated engagement, the sustained benefits were most evident from active exercise and behavioral modifications, consistent with evidence that movement-based strategies offer the strongest long-term outcomes.

The addition of H-Wave device stimulation coincided with a reduction in pain and disability in this case. H-Wave differs mechanistically from conventional electrotherapies such as TENS or IFC, as it produces rhythmic, non-fatiguing muscle contractions that are hypothesized to improve microcirculation and lymphatic flow. However, the supporting evidence is still limited to small studies of low to moderate certainty, and robust head-to-head trials are lacking. Therefore, H-wave should be regarded as an experimental adjunctive modality within a multimodal rehabilitation program, rather than a superior alternative to standard care. Cost considerations and limited availability may restrict its widespread adoption. The author declares no financial or professional relationship with the device manufacturer. No free devices, discounted pricing, or funding of any kind were provided for this study.

Limitations

Several limitations must be acknowledged. First, as a single-patient case of a young office worker, the findings cannot be generalized to wider populations or other occupational settings. Second, without a control group or sham intervention, improvements cannot be attributed solely to the multimodal therapy, as natural recovery or external influences may have contributed. Third, placebo effects may have played a role, particularly with the introduction of a novel device such as H-Wave, where patient expectations and therapeutic interaction can amplify perceived benefit. Although standardized outcome measures (VAS, ODI, ROM, MMT) and repeated follow-ups were used to reduce bias, observer bias remains possible, as blinding was not feasible in this setting. Fourth, adherence to the home exercise program was based on self-report without objective monitoring, which may overestimate compliance. Fifth, the 3-month follow-up period limits conclusions about long-term sustainability. Finally, the use of a proprietary device introduces potential conflicts of interest, as cost, accessibility, and commercial influences could affect both clinical decision-making and interpretation of outcomes.

Patient Perspective

The patient reported satisfaction with the individualized multimodal physical therapy program, noting a gradual reduction in pain and an improvement in daily activities. She appreciated the integration of ergonomics, manual therapy, and active exercises and expressed motivation to maintain the prescribed routine to prevent future episodes of CNSLBP.

Conclusion

This case underscores the clinical effectiveness of a structured, multimodal rehabilitation program for sedentary adults with CNSLBP. Combining core stabilization exercises, individualized manual therapy, and ergonomic education produced meaningful improvements in posture, function, and pain. A 4-week follow-up showed sustained functional gains with no symptom recurrence. These findings emphasize the value of a patient-centered, comprehensive physical therapy approach that addresses the multiple contributing factors of chronic LBP, particularly in sedentary populations.

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Appendix A

Summary of Exercise Program

Table A1 | Summary of exercise program

Phase	Week(s)	Exercise Type	Description	Progression Criteria
Phase 1	1–2	Education + Stretching + Activation + Manual Therapy	• Lumbar spine education (ergonomics) • Hamstring and hip flexor stretching • Supine pelvic tilts (2–3 sets of 10 repetitions or static hold 20 seconds) • Manual therapy: soft-tissue mobilization of lumbar paraspinals, grade II–III central posterior to anterior mobilizations (L3–L5)	Tolerates light activity with controlled movement and pain ≤3/10.
Phase 2	3–4	Core Stabilization + Mobility + Manual Therapy + H-Wave® device stimulation electrotherapy.	• Dead bugs • Bird-dog • Cat-camel mobilization • Bridge withhold + previous exercises (3 sets, 8 rep, hold 20–30 seconds) • Manual therapy: continued PA mobilizations and soft tissue release. • H-Wave® device stimulation: 2 Hz frequency, 5 μs pulse width, 30 minute/session, ~35 mA amplitude, bilateral L3–L5 placement, 2–3 times/week.	No post exercise soreness; improved trunk control; pain reduction; Oswestry Disability Index improvement ≥ 10%.
Phase 3	5–6	Strength + Endurance	• Plank progressions • Side planks • Wall sits + previous exercises with progression (3 sets of 10–15 reps, 20–30 seconds hold)	Hold isometric tasks >20 seconds, reduced sitting pain.
Phase 4	7–8	Functional Movement Integration	• Squats • Hip hinges • Balance drills • Dynamic sitting breaks + previous exercises (3 sets of 10–15 repetitions, 30 seconds hold)	Pain-free full workday and improved posture habits.

Note: H-wave = High-Wave Electrotherapy Device.

Appendix B

Step-by-Step Guide for Chronic Non-Specific Low Back Pain

Table A2 | Summary of physical therapy steps for chronic low back pain managment

Step	Intervention	Details & Frequency	Progression Criteria
1	Assessment	Pain, posture, ROM, strength (once, baseline)	N/A
2	Education & Ergonomics	Posture advice, breaks every 30 minutes, stretching.	Patient adherence
3	Warm-up	10 minutes NuStep low resistance (each session)	Watch for symptom flare-up
4	Manual therapy	Soft tissue, myofascial release, mobilizations (2x/ weeks for 4 weeks)	Taper as symptoms improve
5	Exercises Phase 1	Stretching, pelvic tilts (3 × 10 reps, 3 seconds hold, weeks 1–2)	Pain ≤3/10, good control
6	Exercises Phase 2	Core stabilization + H-Wave® device stimulation (3 × 8 reps, weeks 3–4)	No soreness, improved control.
7	Exercises Phase 3	Strength & endurance (3 × 10–15 reps, weeks 5–6)	Hold >20 seconds, less sitting pain
8	Exercises Phase 4	Functional movements (3 × 10–15 reps, weeks 7–8)	Pain-free workday, better posture
9	Reassessment	Pain, ODI, ROM, strength (baseline, 8 weeks, 3 months)	Guide treatment changes

Note: ROM = Range of Motion; ODI: Oswestry Disability Index; H-Wave = High-Wave Electrotherapy Device.

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Appendix C

Session Flow

- Warm-up: 10 minutes on NuStep (recumbent cross trainer) at low resistance. Response: The patient demonstrated exacerbation of symptoms during the low load warm-up and basic exercises.
- Manual therapy: Soft tissue massage applied to the gluteal and bilateral lumbar muscles.
- Ergonomic (education):
  - Use a chair with good lumbar support
  - Adjust chair height so feet rest flat on the floor
  - Place the computer monitor at eye level, about an arm's length away, to avoid neck strain.
  - Keep the keyboard and mouse at a height that allows elbows to stay close to the body.
  - Sitting upright with shoulder relaxed, avoiding rounded shoulder.
  - Avoid leaning forward for prolonged periods.
  - Take short breaks (1–2 minutes) every 30 minutes for standing, stretching (perform simple exercises neck, shoulder and back stretch)[11]

Outcome

Temporary pain relief was reported.

Session 6 and Above:

- Electrotherapy (H-Wave® device stimulation): Applied at high frequency for 20 minutes per session, consistent with Cochrane review recommendations for supervised exercise programs delivered 1–3 times per week for 3–6 weeks.[5,8]
  - Frequency: 2 Hz (low frequency stimulation).
  - Pulse width: 5 ms (5000 μs).
  - Amplitude: Adjusted individually to achieve strong and comfortable visible muscle contractions, without causing pain or fatigue (approximately 35 mA).
  - Electrode placement: four self-adhesive surface electrodes applied bilaterally to the lumbar region (L3–L5 level).
  - Session duration: 30 minutes per session
  - Session frequency: 2–3 per week for 4 weeks.