Case Report

Effect of Supervised Yogic Intervention on Pain Status, Flexibility, and Corticomotor Excitability in Fibromyalgia Patients: A Unique Case Report

Abstract

Fibromyalgia is an idiopathic chronic widespread pain syndrome marked with specified tender points. There is no permanent cure of the disease. A 50-year-old man and his 49-year-old wife suffered from widespread pain, morning stiffness, sleep problems, and fatigue with complaints of brain fogging and forgetfulness from the past 13 and 26 years, respectively. Blood examinations were negative for rheumatic diseases; they were diagnosed with fibromyalgia. Supervised yogic intervention was administered to the couple for 4 weeks and assessed pain, flexibility, and cortical excitability before and after the intervention. Pain was assessed both objectively using quantitative sensory testing and subjectively using questionnaires. Flexibility and range of motion were assessed using the sit and reach test, Schober's test, and goniometry. Corticomotor excitability was recorded using transcranial magnetic stimulation figure of 8 coils. Reduction in pain on the numerical rating scale and descriptors' score was observed after yoga. There was an elevation in pressure pain thresholds, specifically at the painful areas using a digital algometer. Flexibility parameters showed an improvement in both the cases. The resting motor threshold was reduced by 2% of the maximum stimulus output; other corticomotor excitability parameters also showed some changes indicating the beneficial effect of yoga. At least 4 weeks of regular and supervised yogic intervention can harness pain relief, flexibility, and range of motion and improve corticomotor excitability in fibromyalgia patients.

Keywords: *Cortical excitability, fibromyalgia, flexibility and range of motion, pain profile, yoga science*

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Introduction

Fibromyalgia is a chronic widespread musculoskeletal pain syndrome, prevalent in almost 2%–4% of the global population, predominantly in females.[1] Disease is 80%–85% more frequent in women. Most often patients with this illness experience fatigue, complaint brain fogging and have sleep problems.[1,2] Diagnosis of the patients is usually performed by widespread pain index and symptom severity score. Fibromyalgia involves psychosomatic alterations and its exact pathophysiology is still unclear, which is the vital reason for the void in the discovery of a proper treatment strategy for its management.[3,4]

Therapeutic drugs such as duloxetine, milnacipran, and pregabalin are approved by the Food and Drug Administration for transient symptomatic attenuation.[5] Lifestyle interventions such as physical and resistance exercises have been recommended by the The European Alliance of Associations for Rheumatology (EULAR) for the management of fibromyalgia patients. Recently, yogic intervention has been proven to improve pain, sleep quality, overall impact, and quality of life in various chronic pain conditions such as chronic low back pain, arthritis, migraine, and many more.[6-10] Existing literature emphasize more on the subjective outcomes of pain and disability; however, thorough scientific evidence on the actual benefits of yoga has not been explored systematically.[11,12] Therefore, the present study was designed to understand the effect of yoga on objective parameters of recovery from pain and associated symptoms of fibromyalgia including cortical excitability.

The aim of the present study was to investigate the effect of 4 weeks of regular supervised yoga on pain, flexibility, and cortical

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excitability in two fibromyalgia cases (couple), adhering to our previously devised protocol by Arya *et al*. in 2022.[6]

Case Report

Case details and presenting complaints

- Case I. A 50-year-old male patient, diagnosed with fibromyalgia; body mass index, 24.3; and self-employed
- Case II. A 49-year-old female patient, spouse of Case I, recently diagnosed with fibromyalgia; body mass index, 24.7; and homemaker.

Complete instructions and safety checks for the study were provided. There were no family histories of any rheumatic disease, diabetes, or any other musculoskeletal pain condition. Cases were right handed.[13]

Case history

- Case I. The patient initially felt pain in the foot region which spread further to the leg region then lower back and finally to the shoulders and neck within a couple of years. The patient complained of severe sleep disturbances with a sleep latency of up to 3 h. The COVID-19 pandemic led to a sudden rise in pain (Visual Analog Scale [VAS] score of 4–6)
- Case II. Origin of pain was from lower back, so it was diagnosed as chronic low back pain until its further spread to the shoulders and neck areas. Headache as well as morning stiffness was reported by the patient. The patient reported the onset of pain after the first childbirth with a subsequent increase in the pain intensity after the second childbirth.

In both the cases, sleep problems and gastrointestinal complications were reported.

Treatment history

Cases were completely dependent on medications for more than 10 years; initially, they were prescribed 325 mg acetaminophen, and/or 37.5 mg tramadol along with Vitamin D supplement. Later, 75 mg pregabalin (100 mg gabapentin to Case II) and 125 mg calcium supplements were recommended to reduce pain and associated symptoms. Once they were diagnosed with fibromyalgia, 20 mg duloxetine along with 125 mg calcium supplement were started. Even after 2–3 years of the later medications, the patient reported no improvement.

Case I was referred from the rheumatology clinic and enrolled in our 4-week long yoga program; inspired by his benefits Case II had joined the subsequent sessions. There was no treatment history of physical or lifestyle interventions.

Case examinations at first visit

The study was approved by the Institute Ethics Committee, All India Institute of Medical Sciences, New Delhi (Ref. No. IEC-PG/611/October 28, 2021).

Patients were referred from the Rheumatology Outpatients' Clinic, All India Institute of Medical Sciences, New Delhi. On Day 0 (at first to the Pain Research and transcranial magnetic stimulation [TMS] Laboratory), cases were screened and confirmed for fibromyalgia based on widespread pain at the tender points and symptom severity along with associated symptoms according to the American College of Rheumatology criteria, 2010/2016.[4] Detailed medical history along with socioeconomic and education details were taken. Participants consent form was obtained in written from the patients after explaining all the details about the study.

On Day 1 (T0), demographic parameters such as age, height, socioeconomic status, site of onset of symptoms, and duration with the disease at the time of recruitment (baseline) were recorded [Table 1]. The pain was subjectively assessed using VAS, short form of the McGill Pain Questionnaire, Pain Catastrophizing Scale, and Fibromyalgia Impact Questionnaire. Sleep disturbances associated with fibromyalgia were reported using the Pittsburgh Sleep Quality Index. Objective assessment of pain was done using tender point counts (TPCs) and quantitative sensory testing with pressure pain threshold (PPT) and tolerance as per the previous study at four sites as mentioned in Figure 1.[3] Flexibility and range of motion were recorded using sit and reach test, Schober's test, and goniometry.[3] For cortical excitability, TMS machine was used to record cortical parameters such as resting motor threshold (RMT), motor-evoked potential (MEP), duration and amplitude of maximum voluntary contraction (MVC). Further, MEP and cortical silent period (CSP) recruitment curves starting from 90% of RMT to its 150% were plotted.

After 4 weeks of standard therapy starting from T0 (T1), all the parameters were again measured. The next day onwards 4-week yoga program was started.

After completion of 4 weeks (T2) and 8 weeks (T3) of the yoga regime, we recorded all the parameters assessed at T0 and T1. One of the cases (Case II) has declined to participate further beyond 4 weeks.

Intervention protocol

Prestandardized regular and supervised *Hatha* yoga sessions were administered in the Integral Health and Wellness Clinic, Department of Physiology (five sessions/week). Both the cases were advised to take a healthy diet – "Saatvic Ahara;" high protein, high fibers, low carbohydrates, and

Table 1: Demographic features of cases at baseline

Parameters	Case 1	Case 2
Age (years)	50	49
Height (m)	1.71	1.51
Handedness	Right	Right
Socioeconomic status	Working (business)	Nonworking
Education level	12	12
Duration with disease (years)	13	26
Onset of symptoms	Foot	Lower back

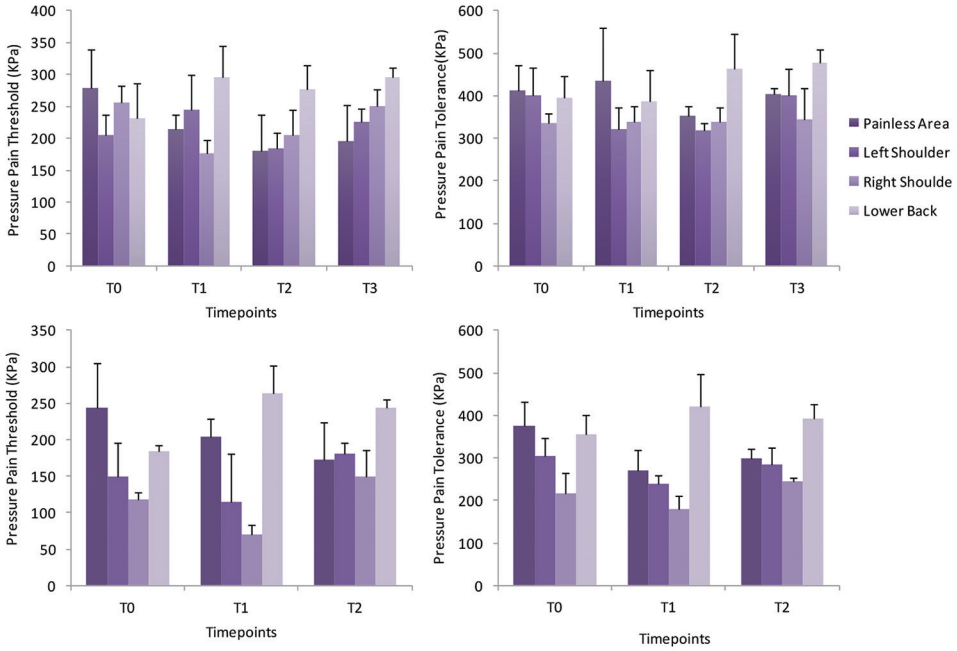

Figure 1: Pressure pain parameters using quantitative sensory testing at different time points of the cases. Data are represented as mean ± standard deviation of four trials in kilopascal of pressure applied on the test site. T0: Baseline at first visit, T1: Assessment after 4 weeks of standard therapy, T2: Assessment after 4 weeks of yogic intervention, T3: Assessment after 8 weeks of yogic intervention

low-fat diets. Green and leafy vegetables and fruits were also recommended to the patients. We have recommended not stopping the ongoing medications. Each session comprised of a yoga session (60 min) and a counseling session (30 min). The former consists of *Asanas* (physical postures), relaxation techniques, and *Pranayamas* (breathing exercises). Asanas comprise sitting, supine, prone as well as standing asanas in three repetitions each. Case 1 attendance = 100% and Case II attendance = 95%.

Clinical findings

The data were fed and stored in the Microsoft Excel 2016 version (Microsoft Corporation, Washington, US). Primary data analysis and representation were performed in the Excel sheet only; GraphPad v9 (GraphPad Software Inc., La Jolla, US) was used for plotting graphs. Symptomatologic history, demographic details, and socioeconomic status of the cases at baseline are given in Table 1. A reduction in body mass index in the cases after at least 4 weeks of yoga was observed [Table 2]. Case II showed an improvement in systolic and diastolic blood pressure; heart rate of Case I after yoga was also found to be reduced by 15 bpm post 8 weeks (T3) from T0.

Pain assessment

An increase in the PPT and pressure pain tolerance at painful sites of the couple after yoga [Figure 1] was reported, whereas the change in pressure pain parameters from T0 to T1 (standard therapy) is less marked [Figure 1]. We found a reduction in VAS score, sleep score, fibromyalgia impact score, catastrophization score, MPQ score, and TPCs after yoga in both the cases. At T3, the scores were found more depressed, showing the subsequent reduction in the pain and associated symptoms. In addition, standard therapy had less role in improving pain and associated symptoms [Figure 2a and b].

Flexibility and range of motion

A robust increase in the overall flexion using sit and reach test was observed, predominantly in the first 4 weeks of yoga; further yoga sessions had also harnessed flexibility [Figure 3a]. Lumbar flexion and range of motion tests using Schober's test and goniometry, respectively, have also shown improvement after yoga only [Figure 3b-d].

Cortical excitability

RMT of the cases was reduced by 2% maximum stimulus output after 4 weeks of yoga; whereas other parameters of cortical excitability were unaltered. We also found an increase in the amplitude of MVC after yoga [Table 2]. A decrease in the slope of the MEP recruitment curve was found following intervention (T2, T3) in Case 1 [Figure 4a]. Case II showed a similar trend line [Figure 4b]. An elongation of CSP from baseline (T0) to the completion of the yoga program (either T2 or T3) was reported [Figure 4c and d]. All the references for the techniques used is the case report is adopted from the literatures mentioned in Supplementary Table 1.

Discussion

Fibromyalgia is a psychosomatic syndrome affecting predominantly women of middle age with excruciating

Table 2: Demographic and cortical parameters of cases at different time points

Parameters	T0		T1		T2		T3
Cases	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1
Weight (kg)	71	56	71	57	69	52.5	70
BMI (kg/m^2)	24.3	24.7	24.3	24.9	23.6	22.9	23.9
Heart rate (beats/min)	104	88	98	88	83	92	89
Blood pressure (mmHg)							
Systolic	138	130	130	131	132	107	143
Diastolic	93	92	91	91	96	82	98
RMT (% MSO)	47	56	44	54	43	54	45
MEP (mV)	0.06	0.072	0.088	0.06	0.079	0.076	0.052
Duration (ms)	5.9	7.75	3.25	5.8	5.1	9.4	6.3
MVC (µV)	713	345	522	408	506	471	1348

BMI: Body mass index, RMT: Resting motor threshold, MSO: Maximum stimulation output, MEP: Motor-evoked potential, MVC: Maximum voluntary contraction, T0: Baseline at first visit, T1: Assessment after 4 weeks of standard therapy, T2: Assessment after 4 weeks of yogic intervention, T3: Assessment after 8 weeks of yogic intervention

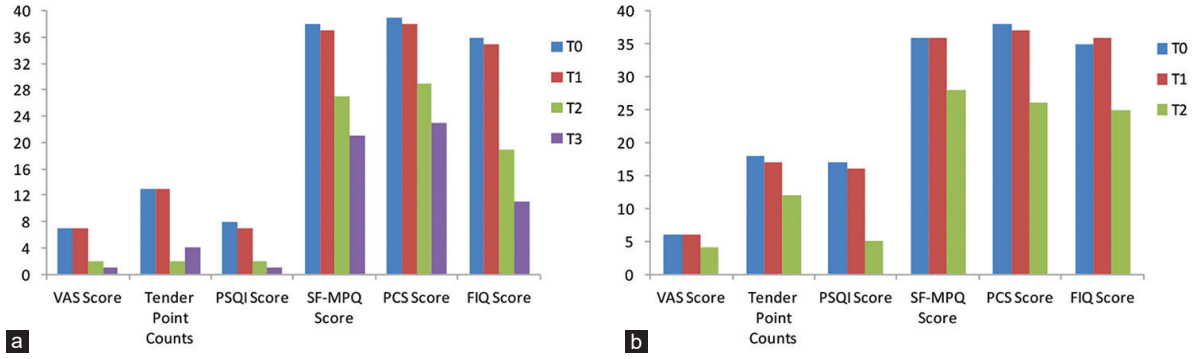

Figure 2: Real-time pain intensity variation in the cases. Histogram depicts the raw scores of descriptor-based assessments in the cases. (a and b) T0: Baseline at first visit, T1: Assessment after 4 weeks of standard therapy, T2: Assessment after 4 weeks of yogic intervention, T3: Assessment after 8 weeks of yogic intervention

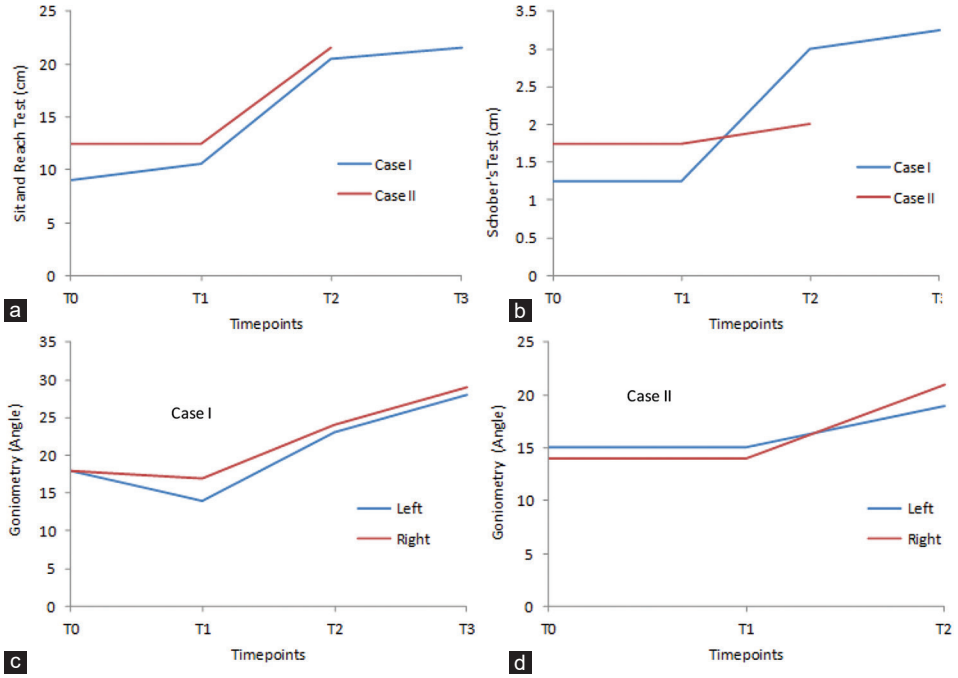

Figure 3: Flexibility and range of motion of the cases at various time points. (a) Sit and Reach test; (b) Scober's Test, (c) Goniometry of Case I & (d) Goniometry of Case II. T0: Baseline at first visit, T1: Assessment after 4 weeks of standard therapy, T2: Assessment after 4 weeks of yogic intervention, T3: Assessment after 8 weeks of yogic intervention

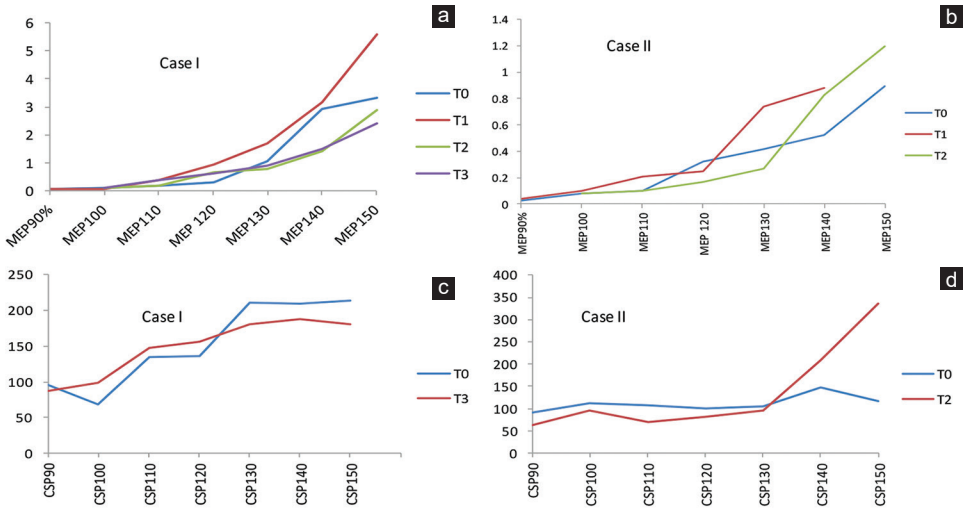

Figure 4: Motor-evoked potential (a and b) and cortical silent period (c and d) recruitment curves of the cases at various time points. MEP: Motor-evoked potential, CSP: Cortical silent period, T0: Baseline at first visit, T1: Assessment after 4 weeks of standard therapy, T2: Assessment after 4 weeks of yogic intervention, T3: Assessment after 8 weeks of yogic intervention

musculoskeletal pain along with several other symptoms such as morning stiffness, fatigue, anxiety, depression, and sleep problems. There are certain defined and localized tender points in the patients where hyperalgesia and allodynia can be reported due to central sensitization.[14,15]

Yoga is a psychosomatic noninvasive practice administered under the supervision of medical experts, yoga therapists, and counselors targeting a specific disease. Arya *et al*. in 2022 devised yoga for chronic low back pain and reported improvement in pain and related disorders before and after 4 weeks of regular intervention.[6,11] Attendance for the cases was at least 95%; Case II had denied to continue as she was dependent on her spouse for travel who had already completed 8 weeks of yogic intervention. We have also reported a reduction in stress and improvement in quality of life in the yoga group better than those of the standard care group.[6,10] Medications for the management of fibromyalgia render drug tolerance due to its long-term dependence and it can be used only for temporary pain relief. Tender points in the fibromyalgia patients coincide with that of chronic low back pain patients. Hence, we have devised the same yoga program to our cases at the Integral Health and Wellness Clinic. Cases with the same handedness were selected to avoid errors in the cortical excitability measures using TMS coil.

Subjective measures of pain and associated symptoms showed an improvement in both the cases which are in line with the earlier studies on subjective parameters of the disease. There is a paucity of literature for the effect of yoga on objective parameters of pain in fibromyalgia. Pain catastrophization and impact of fibromyalgia correlate with poor quality of life in patients and disturbed sleep.[11,12] TPCs were reduced which might have led to the decrease in VAS score. Pressure pain parameters were reduced in fibromyalgia and other chronic pain patients compared to healthy participants.[13-15] We selected the three most painful areas common in both the cases to vanish site-specific biases and one painless area which was the dorsum of the hand.[16,17] PPTs are widely devised in fibromyalgia patients from very classical studies to assess tenderness and pain sensitivity.[17] Regular 4/8 weeks of yoga had improved PPTs at both the shoulders and lower back. Although we have not found a uniform trend at intervention time points, it can be better resolved in the randomized controlled trials in the larger population. Yoga has improved pain sensitivity in other chronic pain studies as well.[6]

Flexibility and range of motion after yoga program are least reported in fibromyalgia patients. The excruciating pain of fibromyalgia is the lead cause of movement-related disability in fibromyalgia patients.[18] We found improvement in flexibility and range of motion in both the cases after yoga. Yoga is supposed to modulate our brain and is supposed to increase the musculoskeletal strength and thereby activity of the patients with back pain.[6,7]

Chronic pain (including fibromyalgia pain) leads to cortical plasticity in the brain due to aberration in the pain pathway and corticomotor axis through patients' continuous inhibition of the movement of painful areas of the body. Yoga improves corticomotor excitability modulating pain inhibition pathways.[18,19] We have also found a reduction in the cortical excitability of our patients.[18] RMT and MEP are supposed to be the result of a dialogue between the motor cortex and the muscles. Plasticity in the cortical areas will lead to lesser recruitment of muscle fibers and thus reduction in the silent period.[19] However, there is inadequate evidence on the cortical parameters of the fibromyalgia patients; we have a novelty in introducing and correlating pain, movement, and cortical control.

Medical family therapy is a systemic, biopsychosocial meta-framework by which clinicians deliver therapeutic

services to the patients as well as their families who are experiencing physical health problems.[20] Strategic family therapy nowadays is effective in the treatment of mental health problems and psychological distress.[21]

To the best of our knowledge, this is the first study where we have witnessed a spouse suffering from fibromyalgia and planned yoga as a couple-based intervention for them. Another strength of the study is the correlation of nociception, musculoskeletal distress, and cortical excitability in fibromyalgia patients.

Conclusion and Future Direction

At least 4 weeks of regular and supervised yogic intervention in members of the same family can harness pain relief, flexibility, and range of motion and improve corticomotor excitability in fibromyalgia patients. This study paves the way for an elaborate clinical trial for better understanding and establishing the role of yogic intervention in pain relief in fibromyalgia.

Ethics statement and consent to participate

Study was approved by Institute Ethics Committee, All India Institute of Medical Sciences, New Delhi, India (Ethical Approval No. IEC-608/03.07.2020). Both the participants had given written consent to participate in the study and they were allowed to quit at any time during the study.

Availability of data and materials

The authors confirm that the data supporting the findings of this study are available within the article and additional information cannot be provided as they are data of the individual participants.

Author contributions

AK: Protocol/project development, patient screening and recruitment, study execution, parameters recording, data management, manuscript writing. UK: Protocol development, patient care, critically revised the manuscript, patient diagnosis and screening. RKY: Execution of intervention, planning therapy, protocol/project development. RB: Protocol/project development, patient screening, manuscript editing and revision, manuscript submission.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: References of the outcome measures included in the case reports

Outcome measures	Authors for References
QST	[16, 17]
TMS	[18, 19]
Pain catastrophization	[15]
Yogic intervention	[6, 11, 12]
Subjective parameters	[6–12]
Flexibility and range of motion	Lacunae

QST: Quantitative sensory testing, TMS: Transcranial magnetic stimulation