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Journal of the California Dental Association

ISSN: 1942-4396 (Online) Journal homepage: www.tandfonline.com/journals/ucda20

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To cite this article: David Cheng (2025) Heart Rate Variability Biofeedback in the Management of TMD and Bruxism: Case Report, Journal of the California Dental Association, 53:1, 2565337, DOI: 10.1080/19424396.2025.2565337

To link to this article: https://doi.org/10.1080/19424396.2025.2565337

Published online: 23 Oct 2025.

JOURNAL OF THE CALIFORNIA DENTAL ASSOCIATION
2025, VOL. 53, NO. 1, 2565337
https://doi.org/10.1080/19424396.2025.2565337

Heart Rate Variability Biofeedback in the Management of TMD and Bruxism: Case Report

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ABSTRACT

Background: Sleep bruxism (SB) and temporomandibular dysfunction (TMD) are frequently managed with oral orthotic occlusal devices (OOOD). While these devices protect the teeth, they do not address the underlying autonomic or physiological contributors to SB and TMD. In patients with comorbid obstructive sleep apnea (OSA), OOOD may even be contraindicated, and their overall clinical efficacy remains uncertain.

Case Presentation: A 34-year-old male presented with jaw and temporomandibular joint (TMJ) pain, sleep bruxism, and chronic headaches persisting for over 20 years. He also experienced frequent nocturnal awakenings (four nightly) and symptoms consistent with dysfunctional breathing and autonomic imbalance. Because the patient also reported hypersensitivity to foreign objects, he declined OOOD therapy and pursued a noninvasive intervention involving heart rate variability biofeedback (HRVBF) and resonance frequency breathing biofeedback (RFBBF). Clinical findings included signs of dental attrition in lateral excursions. Initial Beck Anxiety Inventory (BAI) score was 16 (moderate anxiety). Following the biofeedback regimen, the patient's symptoms resolved, and his BAI score decreased to 5 (minimal anxiety).

Conclusion: This case demonstrates the potential of HRVBF and RFBBF as noninvasive alternatives to OOOD in managing SB and TMD, particularly in patients with stress-related autonomic dysregulation and breathing dysfunction. Although the outcome in this case was favorable, further research is warranted to confirm and extend these findings.

ARTICLE HISTORY
Received 8 May 2025
Revised 24 August 2025
Accepted 18 September 2025

KEYWORDS
Case report; heart rate variability biofeedback; resonance frequency breathing biofeedback; hypocapnia; autonomic dysfunction; sleep bruxism; temporomandibular dysfunction

Introduction

Sleep bruxism (SB) and temporomandibular dysfunction (TMD) are traditionally managed using OOOD, which aim to protect dental structures.[1,2] However, these interventions do not address the underlying autonomic or physiological mechanisms that contribute to the onset and perpetuation of SB and TMD. While OOOD may protect teeth, they do not address the genesis of these conditions, and efficacy remains uncertain [3]. In patients who also suffer from OSA, OOOD may worsen outcomes.[4] Research suggests that the genesis of bruxism is often tied to autonomic nervous system arousal.[5]

Alternative strategies targeting autonomic regulation have been explored in other fields, particularly through HRVBF. Authoritative sources described well established evidence for HRVBF in reducing stress, anxiety, and pain-related conditions.[6–9] The present case extends these methods to dentistry, specifically in the management of SB and TMD.

Case Presentation

A 34-year-old male information technology (IT) professional who exercises four times weekly presented with TMJ and masseter pain and reported waking multiple times. Vital signs were blood pressure 110/67 mmHg, pulse 76 bpm, and oxygen saturation 97%. He was supplementing vitamin B12 for deficiency.

His general symptoms included constant headaches for the past 20 years, head pressure worsened by stress, blurry vision, episodic hearing loss, brain fog, chest pain, trapezius pain, fatigue with walking, tingling and foot pain, and frequent nighttime urination. He also reported anxiety and significant sleep disruption. These symptoms were considered in the context of autonomic dysregulation and possible dysfunctional breathing.

Given this clinical profile, biofeedback was recommended as a noninvasive intervention. The patient also declined OOOD therapy due to hypersensitivity to foreign objects such as rings, watches and high-collar clothing.

A care-compliant timeline summarizing the clinical course is provided in Figure 1.

Materials and Methods

The patient underwent both assessment and biofeedback training using the Capnotrainer (Better Physiology, Wyoming, USA). The assessment phase included an Interview Checklist (Figure 2) and initial session on August 2, 2022 (Figure 3). The physiological monitoring tools included end-tidal CO_2

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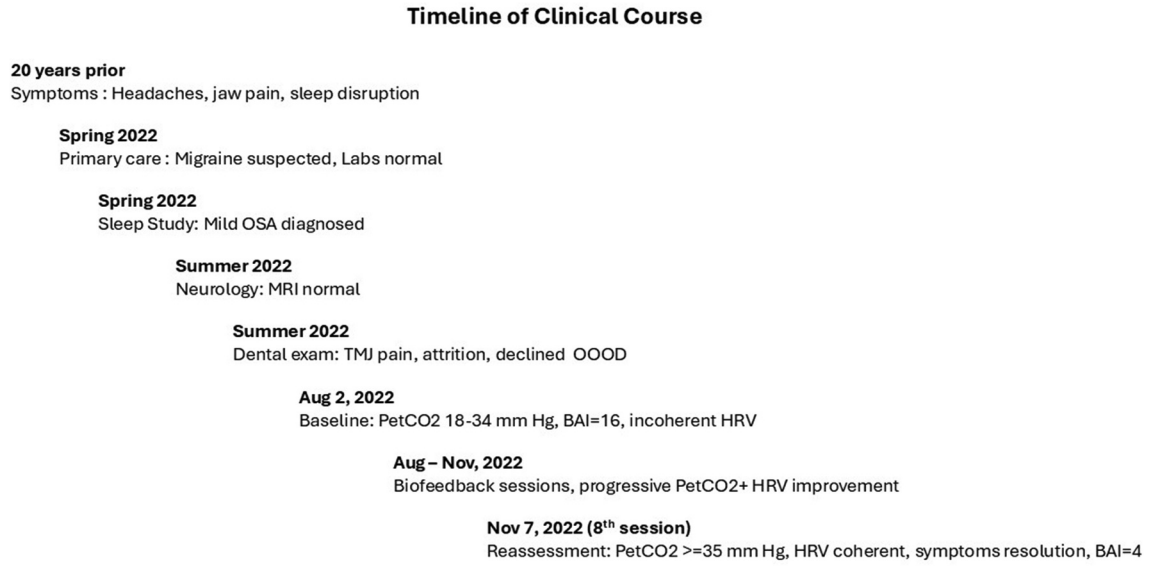

Figure 1. Timeline of clinical course. Chronological summary of the patient's case, including symptom onset, diagnostic evaluations, baseline assessment, biofeedback intervention, and outcomes. The timeline highlights progression from chronic symptoms and diagnostic work-up through HRV biofeedback training, culminating in symptom resolution and sustained improvement at follow-up.

($PetCO_2$), a noninvasive measure of exhaled CO2 at the end of expiration. Normal (eucapnia) values typically range from 35–45 mmHg. Values below 35 mmHg indicate hypocapnia, which reflects excessive ventilation and is associated with reduced cerebral blood flow, respiratory alkalosis, and symptoms such as dizziness, anxiety, or muscle tension.[10,11] PetCO2 was recorded at a sampling frequency of 50 Hz and HRV measured using photoplethysmography (PPG) at 10 Hz.

Education was structured in two phases. The first phase emphasized awareness of breath, diaphragmatic control, nasal inhalation, and slow natural pacing. The second phase introduced guided breathing techniques and employed classical and operant conditioning to support new behaviors. Once $PetCO_2$ consistently reached 35 mmHg, resonance frequency breathing (RFB) was initiated at a pace of approximately five breaths/min.

Results

Initial session on August 2, 2022 (Figure 3) showed mild to moderate hypocapnia ($PetCO_2$: 18–34 mmHg) and HRV ranging from 60–94 bpm. Breathing behaviors contributing to hypocapnia included aborted breathing, fast and forced exhalation, chest and mouth breathing.

By November 7, 2022 (Figure 4), $PetCO_2$ exceeded 35 mmHg, with some reaching 40 mmHg. HRV ranged from 50–70 bpm.

Two key figures are compared:

Non-RFB session (Figure 5): $PetCO_2$ <35 mmHg, breath rate ~ 11/min, incoherent HRV, elevated VLF and HF activity.

RFB session (Figure 6): $PetCO_2$ at 35 mmHg, breath rate 5.5/min, coherent HRV, dominant LF peak indicating autonomic balance.

Breathing is intricately influenced by emotional and cognitive factors.[12] Patient variability between sessions – such as anxiety, stress, and cognitive load – had measurable effects on the physiological responses observed during training. This underscores the complexity of modifying breathing behavior and highlights the role of psychological readiness and feedback in successful autonomic retraining. Multi-session data (Figure 7) showed variability across sessions tied to psychological factors. Continued sessions improved awareness of breath and physiological feedback.

By the eighth session, the patient reported resolution of dental and systemic symptoms, including jaw pain, bruxism, frequent nighttime awakenings, and chronic headaches. Objective data supported these reports: $PetCO_2$ reached eucapnia levels, HRV showed coherent patterns, and the BAI score decreased from 16 to 5, reflecting a shift from moderate to minimal anxiety. Continued sessions improved awareness of breath and physiological feedback.

Improvements were confirmed by patient self-report, clinical exam, physiological data and validated BAI score.

Patient Perspective

The patient expressed gratitude for the biofeedback intervention, noting that it relieved long-standing pain and discomfort. He reported that the resolution of brain fog was particularly impactful, stating that his mind now felt so clear that he could "do the work of three people." This improvement restored his sense of productivity and overall well-being.

Discussion

OOOD is commonly prescribed for managing SB and TMD in dental settings.[1,2] While OOOD can protect dentition during sleep bruxism, they do not address awake bruxism (AB) or the physiological genesis of bruxism.[5] The effectiveness of OOOD remains debatable.[3] Notably, most controlled studies in dentistry have focused on EMG-based biofeedback rather than HRVBF. A randomized controlled trial demonstrated that cognitive-behavioral therapy (BFB-CBT) incorporating EMG biofeedback was at least as effective as OOOD in reducing pain

INTERVIEW CHECKLIST

For learning about your breathing habits

This checklist has been designed to serve as a "guideline" for assisting you in exploring whether or not your breathing habits are consistent with optimal respiration, and if not, how they may be affecting you at specific times and places.

Name [redacted] **Date** July 29, 2022 **Email** [redacted]

Tel [redacted] **Sex** M **Age** 34 **Sig other?** No **Children?** No **Issue** Dizziness, Headaches, Brain Fog

Do you think you might have a dysfunctional breathing habit? If so, what difficulties are you having that might be related to breathing?
I think so. Dizziness, Headaches, Brain Fog, Cannot easily find words.

Do you ever experience any of the 24 symptoms listed below? Check the **Y column** for "YES," OR the **N column** for "NO," after each symptom listed. If you checked YES, indicate *how frequently you experience the symptom* by checking a number 1 through 7, where 1 is rarely and 7 is daily. Then enter in the *situations in which you experience a symptom*, in the "situation column," by entering a number that corresponds to one of the 21 situations listed at the bottom of the page. For example, you might check column #6 for "dizziness" and then enter in situations #14 (expressing feelings) and #19 (learning new tasks). If the situation is not shown on the list, write it into the "comment" column. Focus on when, where, and with whom these symptoms may occur.

How often? 1 = rarely ..... 7 = every day

Do you experience the following? If so, how often?	*N*	*Y*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*Situations*	*Comment*
Chest tightness, pressure, or pain •		X			X					7, 9, 11, 16	
Intentional breathing, purposeful regulation		X	X							6	
Blurred or hazy vision		X					X			1, 6, 7,13	
Dizziness, light-headedness, fainting •		X						X		, 6, 7, 9, 10, 13	
Disconnected, things seem distant		X				X				5, 7, 10, 11, 14	
Shortness of breath, difficulty breathing •		X	X							5, 6, 9	
Tingling or numbness, e.g., fingers, lips •		X		X						5, 6, 18	
Disoriented, confused		X					X			5, 6, 7, 10, 11	
Unable to breathe deeply •		X		X							Cannot pinpoint it
Muscle pain, stiffness, e.g., hands, jaw, back		X				X				5, 6, 13, 16, 18	Jaw
Not exhaling completely, aborting the exhale •		X		X						5, 6, 9	
Deep breathing, like during talking •	X										
Fast or irregular heartbeat	X										
Chest breathing, effortful breathing •		X			X					5, 6, 9, 10, 13	
Breath holding, irregular breathing	X										
Poor concentration, focus, memory		X							X	5, 6, 9, 10	Most of the time
Rapid breathing, panicky breathing •	X										
Fatigue easily		X						X		2, 7, 10, 11	
Worried about my breathing •		X	X								
Mouth breathing •		X					X			8	
Hard to swallow, nauseous	X										
Can't seem to get enough oxygen •		X		X						8	
Hyper-aroused, can't calm down, anxious	X										
Unexpected mood changes (e.g., anger)		X									Unexpected but controlled

***SITUATIONS: circumstances under which you experience the above symptoms**

(1) working (employment)
(2) resting (between tasks)
(3) performing (e.g., test taking)
(4) talking, eating, singing
(5) feeling anxious or worried
(6) feeling tired or stressed
(7) interacting in groups
(08) physical challenges, exercising
(09) being confronted by others
(10) traveling, unfamiliar places
(11) socializing, meeting people
(12) speaking in public, in groups
(13) feeling angry or upset
(14) intimacy, expressing feelings
(15) physical discomfort, pain
(16) meeting authority figures
(17) going to sleep, while asleep
(18) being accountable, in-charge
(19) learning new tasks, new info
(20) feeling unsure of self
(21) allergens, weather, foods

General comments:

Figure 2. Interview checklist for dysfunctional breathing habits. Patient-reported symptoms and breathing-related behaviors were assessed using a standardized 24-item questionnaire. The checklist also recorded symptom frequency and contextual triggers, revealing widespread physiological and cognitive impacts tied to suboptimal breathing patterns.

Figure 3. Initial HRV and $PetCO_2$ tracing during baseline assessment (August 2, 2022). HRV (top panel) shows no coherence, and $PetCO_2$ (bottom panel) fluctuates below 35 mmHg, indicating persistent hypocapnia. Breathing irregularities were evident under both rest and task conditions.

Figure 4. Post-intervention HRV and $PetCO_2$ tracing (November 7, 2022). $PetCO_2$ levels improved with values consistently exceeding 35 mmHg, and HRV demonstrated increased coherence. Changes reflect enhanced autonomic regulation and respiratory stability after biofeedback training.

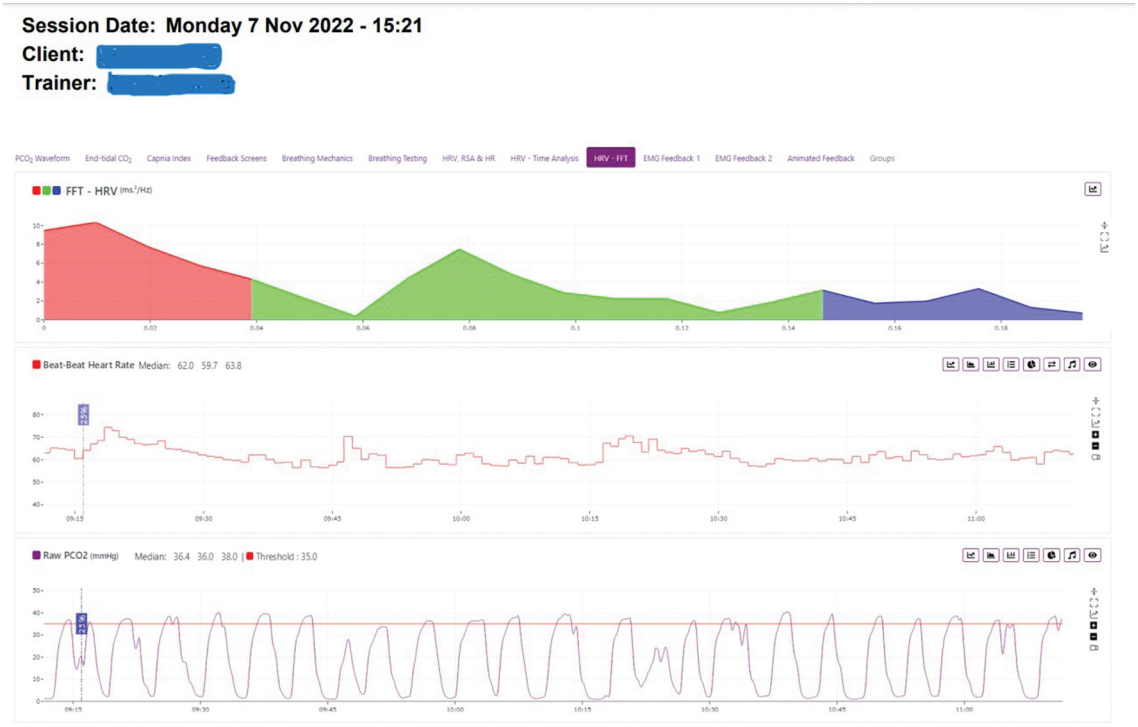

Figure 5. Non-resonance frequency breathing (non-RFB) session analysis. $PetCO_2$ remained below eucapnic levels, with erratic HRV patterns and increased very low frequency(VLF) power indicative of sympathetic dominance.

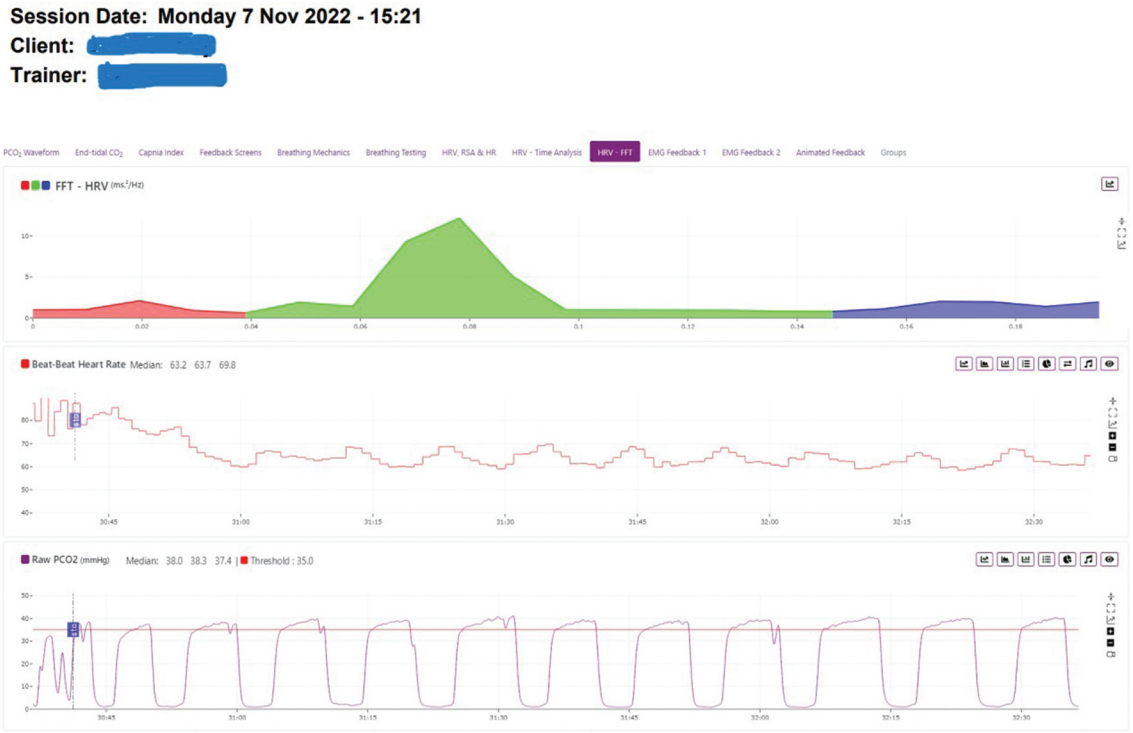

Figure 6. Resonance frequency breathing (RFB) session analysis. $PetCO_2$ reached 35 mmHg, HRV showed synchronized, coherent waveforms with a dominant low-frequency (LF) peak, signifying balanced autonomic tone and effective parasympathetic activation.

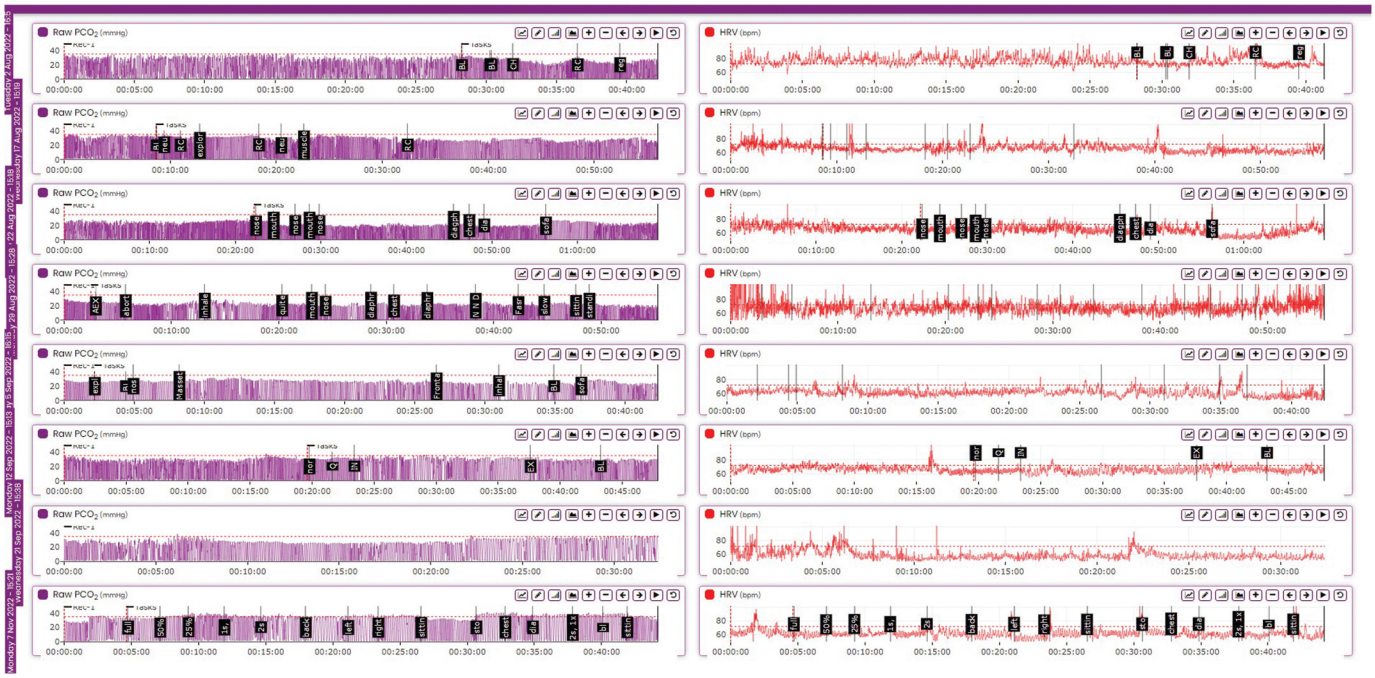

Figure 7. Multisession comparison of HRV and $PetCO_2$ data across training timeline. Eight sessions are depicted, demonstrating progressive stabilization in breathing patterns and autonomic indicators, as seen in rising $PetCO_2$ and improved HRV coherence across time.

and disability, while offering superior improvements in coping skills and psychological outcomes.[13]

SB, TMD, and OSA may overlap in symptomatology and etiology.[4,14] Observation of signs such as dental wear, tooth mobility, cracked tooth syndrome, and muscle tenderness often leads to the prescription of OOOD, assuming bruxism occurs only during sleep. However, Baba et al. showed that the extent of tooth wear is not predictive of sleep bruxism.[15] In patients with mild to moderate OSA, there is a known association with SB.[16] Using an OOOD in these cases could potentially worsen the airway obstruction.[4]

Stress and anxiety are emerging as key factors linking SB, TMD, and OSA. Although not universally accepted,[17] multiple

Beck Anxiety Inventory (BAI)

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding space in the column next to each symptom.

	Not At All	Mildly but it didn't bother me much	Moderately - it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	☐	☐	●	☐
Feeling hot	☐	●	☐	☐
Wobbliness in legs	●	☐	☐	☐
Unable to relax	☐	☐	●	☐
Fear of worst happening	☐	☐	●	☐
Dizzy or lightheaded	☐	☐	●	☐
Heart pounding/racing	●	☐	☐	☐
Unsteady	●	☐	☐	☐
Terrified or afraid	●	☐	☐	☐
Nervous	☐	●	☐	☐
Feeling of choking	●	☐	☐	☐
Hands trembling	●	☐	☐	☐
Shaky / unsteady	●	☐	☐	☐
Fear of losing control	☐	☐	☐	●
Difficulty in breathing	☐	●	☐	☐
Fear of dying	●	☐	☐	☐
Scared	●	☐	☐	☐
Indigestion	●	☐	☐	☐
Faint / lightheaded	☐	☐	●	☐
Face flushed	●	☐	☐	☐
Hot/cold sweats	●	☐	☐	☐

Figure 8. Initial beck anxiety inventory (BAI) results. Patient endorsed moderate levels of physiological anxiety symptoms, particularly dizziness, heart pounding, and difficulty breathing, aligning with reports of stress-linked dysregulation at intake.

studies associate psychological stress with these disorders.[18–20] Elevated cortisol levels, salivary biomarkers, and heightened HPA-axis activity suggest stress involvement in both the development and maintenance of these conditions.

SB patients show increased stress levels, with moderate positive correlations between bruxism intensity and cortisol levels.[18] TMD is multifactorial but has clear links to psychological stress and autonomic hyperactivity.[19] Depression and anxiety have also been associated with increased risk for OSA.[20] Stress activates the sympathetic nervous system (SNS) and reduces parasympathetic tone.[21] Autonomic imbalance is reflected in HRV patterns, making HRV a reliable biomarker for physiological stress and autonomic function.[22] Biofeedback training – particularly HRVBF – has shown efficacy in reducing stress and anxiety while improving HRV.[23,24] Case-level evidence has also demonstrated improvements in pain and sleep outcomes in a patient with TMD treated with biofeedback.[25]

Resonance Frequency Breathing (RFB) is central to HRVBF, optimizing autonomic balance by synchronizing respiratory and cardiac rhythms.[26–28] Practicing RFB at an individualized pace (4.5–7 breaths per minute) enhances HRV coherence.

CO_2 plays a critical role in pH balance, respiratory drive, and oxygen delivery. According to the Henderson-Hasselbalch equation, reduced $PetCO_2$ below 35 mmHg leads to respiratory alkalosis and compromised oxygen offloading.[10,11,29] Hypocapnia triggers vasoconstriction and decreases cerebral blood flow, which can result in fatigue, dizziness, anxiety, and neurological symptoms.[30,31] Restoration of $PetCO_2$ to eucapnia levels is essential before initiating RFB.

Dysfunctional breathing, characterized by fast, shallow, or mouth breathing, can contribute to TMD by over-recruiting accessory inspiratory muscles.[32] Capnography and HRVBF are instrumental in addressing these patterns. Power spectral

Beck Anxiety Inventory (BAI)

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	Not At All	Mildly but it didn't bother me much	Moderately - it wasn't pleasant at times	Severely – it bothered me a lot
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Feeling hot	☐	☐	☐	☐
Wobbliness in legs	☐	☐	☐	☐
Unable to relax	☐	☐	☐	☐
Fear of worst happening	☐	☐	☐	☐
Dizzy or lightheaded	☐	☐	☐	☐
Heart pounding/racing	☐	☐	☐	☐
Unsteady	☐	☐	☐	☐
Terrified or afraid	☐	☐	☐	☐
Nervous	☐	☐	☐	☐
Feeling of choking	☐	☐	☐	☐
Hands trembling	☐	☐	☐	☐
Shaky / unsteady	☐	☐	☐	☐
Fear of losing control	☐	☐	☐	☐
Difficulty in breathing	☐	☐	☐	☐
Fear of dying	☐	☐	☐	☐
Scared	☐	☐	☐	☐
Indigestion	☐	☐	☐	☐
Faint / lightheaded	☐	☐	☐	☐
Face flushed	☐	☐	☐	☐
Hot/cold sweats	☐	☐	☐	☐

Figure 9. Post-intervention BAI results. Significant reduction in symptom reporting was noted, with most scores indicating only mild or no anxiety. This reduction paralleled improvements in breathing function and symptoms resolution.

analysis of HRV using Fast Fourier Transformation (FFT) allows clinicians to monitor autonomic trends.[33–35]

Finally, BAI (Figures 8 and 9) may serve as a useful screening tool in TMD, OSA, and SB patients.[36–38]

Conclusion

This case report illustrates the potential of HRVBF and RFBBF as effective noninvasive therapies for the management of SB and TMD. By addressing dysfunctional breathing and autonomic imbalance, these interventions resolved long-standing symptoms in this individual patient. The clinical integration of biofeedback into interdisciplinary care model may provide a valuable adjunct or alternative to mechanical approaches. Although the outcome in this case was favorable, further research is warranted to confirm and extend these findings.

Acknowledgments

The author thanks Dr. Peter Litchfield, Dr. Maria Katsamanis, Sandra Reamer, Muhammad Arshad Khan, the support staff involved in the biofeedback training sessions and the patient for participating in this case study.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Notes on contributor

Dr. David Cheng, DDS, BA, FAGD, FICOI, is a clinician, educator, and researcher specializing in comprehensive and functional dentistry. Based in Vancouver, British Columbia, he leads WestcoastSmile Dental and founded Dentistry on King in Toronto. With over three decades of clinical experience, he has pursued advanced training at the LD Pankey Institute,

the Misch Implant Institute, the University of Michigan, and the Kois Center, where he serves as a mentor. Dr. Cheng's work bridges occlusion, temporomandibular disorders, and sleep-disordered breathing with autonomic regulation through heart rate variability and CO_2 biofeedback, positioning dentistry as an integral component of systemic health and human performance.

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Informed Consent

The patient provided informed consent for publication of this case report and the accompanying figures.

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