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# Digital Revolution in Bruxism Diagnosis: From Traditional Clinical Assessment to Wearables and Artificial Intelligence: A Literature Review

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## ABSTRACT

There is some evidence that contemporary digital technology and wearable sensor systems could be used for the objective evaluation of masticatory muscle functions in people with bruxism. In recent years, dentists have started applying wearables, smart splints, and artificial intelligence (AI) for better diagnostics. This work seeks to establish a distinction between those diagnoses that can be applied to ensure the predictability of results while applying digital bruxism monitors and the unfavorable diagnoses. This work seeks to conduct a review of existing literature to evaluate the use of modern diagnostics in practice. It was revealed that wearable EMG monitors and ear sensors can be used for ambulatory diagnosis with a high level of accuracy in comparison with PSG in the laboratory. With machine learning modifications, it is now possible to separate bruxism events from physiological oral behaviors. In many cases, high equipment costs, data privacy concerns, and signal noise are obstacles for digital procedures. There is an element of unpredictability regarding the long-term use of such technologies by the patients using these apps and gadgets. There is some research that suggests that there may be a risk of gadget fatigue. Utilizing digital technologies in the diagnosis of bruxism is a dependable method of diagnosis under specific circumstances. Digital dentistry is a relatively new technology, and any development in this area should be monitored by all practitioners concerned. Although new technologies have already demonstrated themselves, there is still a need for further research before their widespread application.

**Keywords:** bruxism; sleep bruxism; awake bruxism; wearable devices; artificial intelligence; electromyography

## 1. INTRODUCTION

Excessive jaw muscle activity and occlusal overload can lead to tooth structure loss and temporomandibular disorders, requiring clinicians to carry out thorough diagnostic assessments (Rotstein and Ingle, 2019). Traditional clinical evaluation inevitably focuses on irreversible tooth damage and reduces diagnostic objectivity. The visual-only diagnosis does not reflect current muscular activity. The dentin and enamel suffer deterioration of structural integrity because of mechanical damage, making the diagnosis of current bruxism difficult. Bruxism develops asymptomatically or leads to the use of unnecessary occlusal splints due to the absence of monitoring in the process of examination (Koyano et al., 2020).

While visual inspection was once the primary available tool, in 2018 revolutionary findings demonstrated that bruxism is a neurobiological muscle behavior rather than a dental pathology. These findings redefined the concept of jaw muscle activity. This phenomenon has since been categorized into sleep bruxism (SB) and awake bruxism (AB) (Lobbezoo et al., 2018). Previously, there has been an assumption that tooth attrition was associated with the ongoing grinding process. The newest studies concerning the physiology of the mouth indicate that evaluation of muscle work during bruxism may allow for assessment of this condition objectively. People's muscle work is determined by such aspects as histological and functional characteristics of muscles. Contemporary methods of diagnostics are based on the use of biosensors, applications, and algorithms for monitoring muscle work during mastication. Digital diagnostic tools seem to be quite promising for treatment; however, they require high precision and standards. Evidence found in the literature shows that the diagnostic reliability of wearable EMG systems is comparable to PSG (Chen et al., 2022). This paper explores the indications and limitations for digital bruxism diagnosis. The subject matter is not yet well-explored enough when it comes to its practice. By means of the exploration of the existing literature on the issue, this study will try to figure out its practical usage and the cases when some uncertainty still exists.

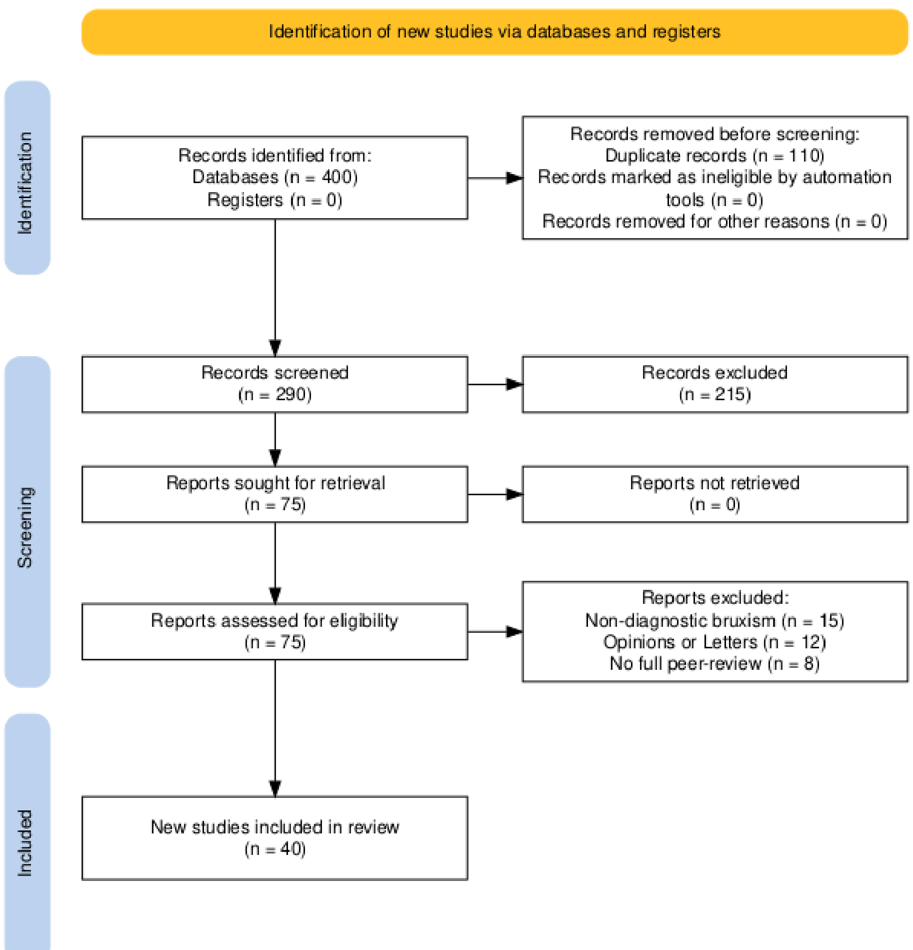


**Figure 1**. PRISMA 2020 Flow Diagram of Study Selection.

## 2. REVIEW METHODS

The study is considered to be a narrative literature analysis. Scientific papers were obtained using searches in databases such as PubMed and Google Scholar. The keywords used during the search are the following: “bruxism”, “sleep bruxism”, “wearable device”, "electromyography," and "artificial intelligence". The inclusion criteria were the following: publication in a peer-reviewed journal, topic – indications and limitations of digital diagnostic devices, and evidence base, either clinical or experimental. Exclusion criteria were: papers devoted only to mechanical wear of teeth not related to diagnostic devices, in vitro experiments, opinions, letters to editors, and papers without full peer review. Total 40 papers were chosen for the analysis (Figure 1).

## 3. RESULTS AND DISCUSSION

**The Limitations of Traditional Diagnostic Methods**

Clinical diagnostic procedures require precise tools to thoroughly evaluate masticatory muscle activity. However, the masticatory system is a complex network rather than a simple mechanical joint. The system consists of biological elements like the pathways of the central nervous system, autonomic nervous system signaling, and TMJ tissue (Ahlberg et al., 2023). The complex nature of the physiology is difficult to objectively evaluate during dental examinations, especially because factors like stress and fear of dentistry increase the risk of a misdiagnosis. Clinical outcomes in traditional management are thus heavily influenced by the nature of the interaction between historical tooth wear and current muscle strain (Manfredini et al., 2021). Ultimately, good physiological knowledge is necessary for clinicians to treat persistent muscle pain and TMD (Lavigne et al., 2022).

In this case, the main point of discussion lies in the contraindications of visual examination for patients with bruxism. Some opinions state that EMG would be the better alternative for patients with anatomical limitations in the form of restorations and wear. In such cases where there is a high risk of misjudging current activity, wearable sensors can reduce the need for aggressive restorative interventions in asymptomatic patients (Castroflorio et al., 2020). Digital procedures offer a way to manage patients who are technically difficult to evaluate with standard paper questionnaires (Martins et al., 2021). The conventional scales can only be used in measuring past damage (Koyano et al., 2020).

Polysomnography can be used in the assessment of sleep bruxism and sleep architecture (Lavigne et al., 2022). However, the diagnostic challenges in polysomnography act as a great hindrance to its use in clinical practice. Moreover, handling the first night effect in sleep laboratories is difficult. Laboratory setups used in PSG may be contraindicated in patients requiring long-term natural sleep evaluation. Furthermore, complex clinical requirements need a more conservative, portable approach (Fujisawa et al., 2020). Yet to fully determine characteristics of diagnostic indications for portable devices, there is a need for precise guidelines in terms of signal thresholding. Although there is no consensus between published studies on the optimal sampling rate utilized in ambulatory monitoring (Kato et al., 2023), very few data are available on the reliability of portable EMG compared with polysomnography (PSG) in complicated sleep disorders. In order for portable diagnosis to reach the gold standard level, it is crucial that there should be a high degree of concordance in clinical trials, mostly related to sleep bruxism (Chen et al., 2022).

**Wearable EMG Devices and In-Ear Biosensors**

Pathologic muscle overload occurs when the natural homeostasis between jaw elevators and TMJ structures is disrupted. Under normal conditions, masticatory muscles remain relaxed during rest because of central motor regulation. When psychological or central mechanisms weaken these protective systems, rhythmic masticatory muscle activity is started. The start of rhythmic masticatory muscle activity leads to the contraction of the masseter muscle fibers. The contraction causes mechanical pressure to be exerted on the dental hard tissue and the cartilage of the joint (Miyawaki et al., 2020). In sleep bruxism, the autonomic arousal responses that are generated in the central nervous system are distributed via brainstem channels to the motor trigeminal nucleus (Lavigne et al., 2022). The distribution results in rapid and gradual muscle contractions in the jaw. The condition is characterized by unique challenges in diagnosis because it lacks symptoms during the day. In most cases, only bed partner reports or unexpected tooth fractures, lead to the diagnosis.

The other type important to this review is referred to as awake bruxism. It involves subconscious muscle bracing located between periods of normal jaw rest, which undergoes pathological clenching that expands during daytime stress (Winocur et al., 2020). The aforementioned mechanism, being under continuous psychological stress without adequate supervision, leads to muscle fatigue and orofacial pain (Wang et al., 2025).

Traditional night guards protect teeth from wear, but currently available splints are not able to evaluate and reduce muscle activity that causes this mechanism. As a result, the use of wearable EMG sensors has been gaining popularity as a method of diagnosis. New technology allows evaluation of muscles' state in patients suffering from these disorders (Kim et al., 2021; Smith et al., 2021).

The modern scientific literature shows that wearable electromyographic sensors and in-ear sensors are effective and promising devices in resolving any diagnostic uncertainty (Table 1). According to one systematic study, the use of wearable biosensors helped record muscle events and obtain objective criteria in all but one case (Castroflorio et al., 2020). It also suggested that in-ear monitoring may be a promising prospect to eliminate facial skin irritation, yet this aspect needs more clinical research (Sato et al., 2021). Another study reveals the significantly reduced time required for setup in comparison to the laboratory PSG. This is a significant factor that can be utilized to improve patient compliance (Tanaka et al., 2022). Some recent case series have proved that wireless monitoring in patients is possible for extended periods (Zhang et al., 2023). Recent research is working in the area of multi-sensing technology and laser microelectronics (Rao et al., 2024; Silva et al., 2022).

Despite the promising results obtained, further research is needed since studies involving ear canal pressure sensors have used a limited number of samples. The problem is that most of the available literature has presented only successful results. Another limitation of EMG is the absence of a standardized protocol for measuring burst amplitude. Some dentists use high thresholds that could miss the low-force clenching, while other dentists take a more sensitive approach (Kato et al., 2023; Yamada et al., 2023). Most studies conduct only masseter EMG recordings. The effectiveness of wearables in recording temporalis or lateral pterygoid activity needs more attention from the scientific community.

Based on the available literature, wireless EMG patches appear as an indication for ambulatory diagnostic screening and rival classic sleep laboratory protocols. Promising but lacking broad verification is the use of in-ear acoustic sensors (Sato et al., 2021; Nguyen et al., 2025). Application of wearable biosensors in complex TMD cases could be groundbreaking, but that remains a hopeful contemplation.

**Table 1**. Selected diagnostic methods comparison

| Diagnostic Method | Standard Diagnostic Approach | Approach with Digital Technologies | Notes |
|---|---|---|---|
| **Sleep Bruxism** | Polysomnography (PSG) | Wearable wireless EMG patches | Reduces first-night effect; high correlation with PSG |
| **Awake Bruxism** | Retrospective paper questionnaires | Mobile health apps (EMA) | Real-time biofeedback; improves patient awareness |
| **Occlusal Force** | Clinical wear inspection | Smart splints with pressure sensors | Measures force distribution; technical moisture risks |
| **EMG Data Analysis** | Manual visual scoring | Machine learning algorithms | High accuracy; filters swallowing/speech artifacts |

**Smart Splints and Mobile Biofeedback Applications**

Smart splint technology is a procedure closely related to traditional occlusal therapy. Both involve placing an appliance over the arch. The goal of the procedures is to manage occlusal forces and protect dental hard tissues (Gomez et al., 2021). The difference lies in the clinical information generated by the sensors that come as part of it. Traditional splints indicate compliance levels of the patients but do not measure any force. For a smart splint, a proper design that includes force sensors that can communicate wirelessly is required (Lee et al., 2024). One of the important factors that influence accuracy in diagnosis using smart splints is their thickness (Park et al., 2023). It used to be thought that force recording would not be accurate if the sensors were thicker than 1 millimeter. Modern engineering evidence, however, suggests that the use of thin-film piezoresistive sensors with a thickness of up to 0.2 mm allows force recording without considerable change in occlusion (Al-Jadaa et al., 2022; Yoo et al., 2022).

The rapid evolution of digital dentistry has disproved the belief that occlusal treatment inevitably uses passive devices. Active gadgets capable of biofeedback provide great possibilities for muscle retraining (Winocur et al., 2020). At the same time, typical nightguards cannot provide much feedback, being mostly aimed at protecting teeth without lowering the central muscle drive (Gomez et al., 2021). There is evidence showing that biofeedback is able to lower the muscle activity in awake bruxism patients (Souza et al., 2024).

Mobile EMA includes random smartphone notifications followed by the assessment of the jaw position (Paiva et al., 2023). The notification is sent using a special application (Wieckiewicz et al., 2021). The deliberate accent on jaw awareness raises the level of patient consciousness regarding subconscious clenching. After notifications, the user learns to hold the jaw in the relaxed position (Costa et al., 2023). Such a technique expands the chances of behavioral habit reversal and reduces the time needed for muscle relaxation during the daytime (Casado-Gómez et al., 2022).

The clinical benefits of achieving diagnostic tracking with this method are significant when compared to retrospective questionnaires (Table 1). Paper diaries as a protocol to record clenching frequency result in subjective, inaccurate data (Martins et al., 2021). The lack of real-time logging weakens the reliability of patient history. Paper forms are an option that also raises the risk of recall bias (Casado-Gómez et al., 2022). Successful mHealth monitoring can provide objective event logging and symptom tracking, both of which are important for the future management of bruxism (Fernandez et al., 2021). Indication of effectiveness of the behavior change is often seen through the reduction of clenching activity as measured using application analytics (Costa et al., 2023). The improvement process usually happens in a steady manner and starts during the first weeks of application usage (Garcia et al., 2022). Ultimately, this process leads to a decrease in muscle soreness during the day. Four weeks after beginning the Ecological Momentary Assessment (EMA), the modification of habits is confirmed with lower incidences of daytime clenching (Lima et al., 2024). Moreover, clinical evidence shows that such a digital tool can be used as an alternative to traditional behavior advice (Casado-Gómez et al., 2022).

Criticism of mHealth tools has been motivated by app fatigue and dependence on the motivation of the user (Garcia et al., 2022). Motivation dependency is reduced if gamification features are implemented, yet this needs to be further backed up by broad studies (Lima et al., 2024). Until 2020, relatively few clinical studies investigated EMA in dentistry, but an increased interest in this field has appeared recently. Currently, it is too early to consider mHealth apps a replacement for in-person clinical consultations. However, this approach proves to be promising, and further developments in this sphere require serious consideration.

Unlike the above-mentioned approach, the newest algorithms of artificial intelligence allow implementing the automatic scoring of EMG data and processing EMG signals without the need for manual examination (Liu et al., 2023; Huang et al., 2024). Although automation technology can classify bruxism events and predict muscle fatigue, it is more complex than biofeedback and requires software validation (Zhao et al., 2025).

**Artificial Intelligence and Diagnostic Challenges**

Clinicians use AI algorithms to process bio-signal data, but there is a lack of evidence on long-term data privacy protocols following these interventions (Wieckiewicz et al., 2021). Only a small number of clinical studies explore this interaction (Borges et al., 2022). There are very few pieces of information on cloud technology for dental diagnostics. Recent research has proved that deep neural networks can diagnose sleep bruxism automatically (Zhao et al., 2025). These researchers suggest that machine learning techniques will be able to decrease the number of mistakes made in the diagnostic process (Huang et al., 2024). However, other researchers prove the opposite, and therefore, the problem needs further investigation.

In particular, a case series considered whether the movement artifacts might affect EMG measurements collected by wearable devices and found that signal noise could sometimes produce false positives. Data security issues were described in a different report while transmitting data in the cloud (Wieckiewicz et al., 2021). However, conflicting findings indicate that the dental industry is yet to understand the limitations of AI-based diagnostic tools regarding the technical and ethical aspects involved.

However, compatibility issues of the software with the current database system and the fine-tuning of filters need to be evaluated prior to using this software (Huang et al., 2024). Furthermore, the encryption of cloud-based data can be considered (Wieckiewicz et al., 2021). Yet, it is not clear if the necessity to forego digital monitoring for technology-illiterate individuals needs to be bypassed. The necessity of technical validation to detect any possible errors and incorrect readings has been proven. While preparing to conduct the diagnostic procedure, doctors should take into account patients' preferences regarding the wearing of the device. Patients need to know about the technical risks of data recording and privacy before monitoring (Wieckiewicz et al., 2021).

## 4. CONCLUSION

While in recent years digital bruxism diagnosis became better understood, its precise indications and limitations remain an evolving topic. The newest literature provided evidence for some tools to emerge while others remain a topic that needs to be further explored. The uses of digital technologies for bruxism identified through this review are as follows: sleep bruxism testing using portable EMG, awake bruxism testing using ecological momentary assessment (EMA) technology, occlusal force assessment using smart splints, and analysis of signals through the use of artificial intelligence. Modern devices offer a promising solution for monitoring muscle behavior in the patient's home environment. At this state of knowledge, it is hard to distinguish between definitive contraindications and areas that require elevated caution. These cases include patients with severe skin allergies to EMG adhesives or those with significant auditory canal variations limiting in-ear sensor placement. The availability of the shared data via the cloud poses privacy concerns that go beyond the safe practice standards. The application of the intelligent splint in cases where there is a high gag reflex is an effective way of ensuring quality healthcare; however, there are no clear guidelines on this. Moreover, while it may not be outright prohibited, non-compliance and digital fatigue are major concerns.

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**Data and materials availability**
All data associated with this study will be available based on the reasonable request to corresponding author.

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