GRADUATION PROJECT

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Bruxism: Symptoms, Treatment & Prevention

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ABSTRACT

Introduction: Bruxism is a parafunctional activity that can lead to significant orofacial pain, tooth wear and temporomandibular dysfunction. Conventional treatments such as occlusal splints are widely used, but do not always alleviate associated symptoms, particularly in cases involving muscle hyperactivity. In recent years, botulinum toxin type A has emerged as a potential alternative therapeutic approach.

Objectives: This systematized review aimed to evaluate the clinical effects of botulinum toxin type A in patients with bruxism and compare its outcomes with those of other treatment modalities.

Methodology: A literature review was conducted based on a PICO framework. Databases including PubMed and Medline Complete were searched for randomized clinical trials published within the past 20 years. A total of seven studies met the inclusion criteria. Additionally, five systematic reviews were analyzed to contextualize and support the discussion.

Results: The reviewed studies indicated that botulinum toxin type A effectively reduced muscle activity, pain levels and occlusal force in bruxism patients. However, it did not consistently reduce the frequency of bruxism episodes. While temporary side effects were reported, such as mild chewing discomfort, the treatment was generally well-tolerated.

Conclusions: Botulinum toxin type A is a safe and effective adjunctive treatment for managing bruxism-related symptoms, especially in patients unresponsive to occlusal splints. Nevertheless, further research is necessary to establish standardized protocols and assess long-term outcomes.

Keywords: Dentistry, bruxism, botulinum toxin, pain management, muscle activity.

RESUMEN

Introducción: El bruxismo es una actividad parafuncional que puede provocar dolor orofacial significativo, desgaste dental y disfunción temporomandibular. Los tratamientos convencionales, como las férulas de descarga, son ampliamente utilizados, pero no siempre alivian los síntomas asociados, especialmente en casos de hiperactividad muscular. En los últimos años, la toxina botulínica tipo A ha surgido como un posible enfoque terapéutico alternativo.
Objetivos: Esta revisión sistematizada tuvo como objetivo evaluar los efectos clínicos de la toxina botulínica tipo A en pacientes con bruxismo y comparar sus resultados con los de otras terapias.
Metodología: Se realizó una revisión de la literatura basada en el marco PICO. Se consultaron bases de datos como PubMed y Medline Complete para buscar ensayos clínicos aleatorizados publicados en los últimos 20 años. Siete estudios cumplieron con los criterios de inclusión. Además, se analizaron cinco revisiones sistemáticas para contextualizar y respaldar la discusión.
Resultados: Los estudios revisados indicaron que la toxina botulínica tipo A reduce eficazmente la actividad muscular, los niveles de dolor y la fuerza oclusal en pacientes con bruxismo. Sin embargo, no logró reducir de forma constante la frecuencia de los episodios de bruxismo. Aunque se reportaron efectos secundarios temporales, como molestias leves al masticar, el tratamiento fue generalmente bien tolerado.
Conclusiones: La toxina botulínica tipo A es un tratamiento complementario seguro y eficaz para el manejo de los síntomas relacionados con el bruxismo, especialmente en pacientes que no responden a las férulas oclusales. No obstante, se requieren más investigaciones para establecer protocolos estandarizados y evaluar los efectos a largo plazo.

Palabras clave: Odontología, bruxismo, toxina botulínica, control del dolor, actividad muscular.

TABLE OF CONTENTS

1. INTRODUCTION

Bruxism is a topic within the dento-medical field that comprises as of today 2024 a large body of already published research which keeps expanding day by day with new articles deepening the understanding of its various aspects. However, this sheer amount of scientific data also conveys an important complexity of the subject matter making it in turn sometimes difficult to grasp the different peculiarities of bruxism, from definition, over clinical manifestations to the numerous treatment options and preventive measures.

1.1. Definition

When attempting to define bruxism it can be described as a spectrum of centrally mediated, repetitive, involuntary, masticatory motor activities characterized by teeth grinding or clenching potentially accompanied by mandibular thrusting or bracing (1,2). This parafunctional jaw muscle activity can be classified into sleep (nocturnal) or awake (diurnal) bruxism according to the circadian phenotype that the masticatory muscle behavior exhibits (1,2). In subjects exhibiting awake bruxism it is said that the jaw clenching is accompanied by a sense of awareness (3). The differentiation of awake bruxism and sleep bruxism can present a challenge for the treating dentist and should be guided by the patient's chief complaint, clinical manifestations and eventually referred information from family or life partners e.g. grinding sounds during sleep (3). Delving further into the different subtypes of bruxism and their implications on an individual's well-being and overall health some authors suggest to classify bruxism into normo-bruxism, not entailing any damage to a person's health, vs patho-bruxism which in turn comprises negative repercussions on a person's well-being (4). Whether or not a pattern of bruxism should be considered as a disorder in otherwise healthy individuals can sometimes be challenging and subsequently depends on the entire set of clinical parameters and findings that are encountered, paired with the patient's subjective experience, meaning their symptoms (3). This holistic approach upon the attempt of defining and differentiating the different forms of bruxism is crucial given the fact that bruxism not only and exclusively always constitutes a deleterious habit, but also under certain circumstances can function as a protective and hence beneficial mechanism. This being said, some authors suggest that sleep bruxism might have a positive effect in certain patients suffering from obstructive sleep apnea. In those individuals the mandibular protrusion produced by sleep bruxism may increase airway permeability which partially alleviates the obstructive sleep apnea events. A rather protective role has also been observed in other conditions such as gastro-esophageal reflux disease and xerostomia where increased saliva secretion combined with better airway permeability procured some degree of relief in patients (5). Moving on, the primary focus of this systematized review is set on bruxism in its pathological form.

1.2. Epidemiology

As for the epidemiology of bruxism, the global prevalence of both the asleep and awake form is estimated to be around 22% (6). This estimation includes both pediatric and adult populations and it is noteworthy that across the different continents the prevalence of bruxism differs, with North America showing the highest prevalence (29%). Besides that, the bruxism prevalence also differs amongst different age groups, with age being an especially important variable within the female population. Furthermore, being of female sex in itself comprises an important factor which predisposes one to suffer from bruxism since females appear to be more often affected compared to their male counterparts (3,6,7).

1.3. Etiology

The etiology of bruxism is multifaceted and may be influenced by a number of different factors which will be discussed later on. As for sleep bruxism, scientific evidence has demonstrated that the root of the abnormal masticatory motor activity resides in micro-arousals which occur during different phases within the sleep cycle and are centrally mediated. Most sleep bruxism episodes seem to take place throughout light non-REM sleep stages 1 and 2 with a peak of episodes being registered right before REM sleep during the transition period (8,9). Given bruxism's inherently multidimensional and complex pathophysiology, diverse research avenues keep being investigated in order to deepen the understanding of its underlying mechanisms further.

1.4. Diagnosis

When it comes to the detection of bruxism there is a wide range of tools and methods that can be applied in order to reach more or less reliable diagnoses. These methods include on one side non-instrumental tools based on clinical findings, questionnaires, self-reports and medical history, and on the other side instrumental tools such as polysomnography, electromyography and intra-oral bite appliances. Polysomnography up to date is considered the gold standard for diagnosing bruxism. However, one major drawback of this method is the high cost in time and financial terms, requiring access to advanced facilities and measuring equipment that record brain waves, audio-visual cues, muscle activity and pulse oximetry among other parameters. The facilities in which polysomnography most commonly are performed are sleep laboratories (10). At the time of conducting a polysomnography or a comparable diagnostic procedure, it is advisable to record both video and audio signals simultaneously. This allows the clinician to superpose the recorded data which subsequently makes it easier to discriminate bruxism related signals from any other oromandibular activities, that may generate acoustic or visual signals e.g. deglutition, sleep talking or chewing. In addition to that, during an awake state there is also a set of usual and unusual / parafunctional oromandibular activities that must not be confused with bruxism. Amongst these activities we can mention for instance object or nail biting, gum chewing, lip licking, cheek biting and many more (3). A grading system initially established in 2013 (1) and reviewed in 2018 following concerns and criticism regarding the old version (11) aims to aid in the diagnostic process, suggesting to categorize sleep and awake bruxism into possible, probable and definite bruxism (2). This proposed classification can be seen in table 1.

Possible Bruxism	Positive self-report
Probable Bruxism	Positive clinical evaluation with or without a positive self-report
Definite Bruxism	Positive instrumental analysis with or without a positive clinical evaluation and/or a positive self-report

Table 1. Grading system for bruxism as proposed by Lobbezoo et al. in 2018 (2).

Once there is a concern of bruxism being a potential condition in a patient a confirmatory diagnosis should be obtained in order to make sure that the parafunctional habit really exists in the given individual. For yielding such a confirmatory diagnosis the scientific literature suggests that the non-instrumental approaches alone are insufficient and that the utilization of instrumental tools should be applied with caution given the variable diagnostic accuracy depending on the specific tool used (10). When resorting for instance to polysomnography as an instrumental tool to confirm an underlying suspicion of bruxism, the condition can be correctly diagnosed with a sensitivity and specificity of over 80% (12). Based on this knowledge

it should be clear that there is a certain hierarchy regarding the value of different diagnostic procedures and techniques. Nevertheless, one should never completely neglect a certain type of diagnostic method. For instance the report of grinding noises by a sleep partner, even though potentially very subjective, can be an essential hint prompting a diagnostic search based on more objective and hence more "reliable" techniques such as polysomnography (3). Given this situation it might be advisable to issue bruxism diagnoses based on a multifocal approach, taking into account both clinical history, signs and symptoms as well as instrumental measurements (10).

1.5. Clinical Manifestations

Despite the rather scarce beneficial side effects of sleep bruxism in some patients with certain specific conditions such as sleep apnea, as discussed before (5), the vast majority and major concerns when it comes to bruxism behavior remain within the realm of pathology. With that said, the following outlook on clinical manifestations continues to treat bruxism as a disorder, meaning a condition that disrupts normal physical and mental functions which involves a degree of harm to the affected individual's health. Clinical signs and symptoms related to bruxism are numerous and vary according to the subject and the severity of the condition. The occlusal overloads that bruxism is able to produce due to the augmented masticatory muscle activity can cause dental complications. Although inconclusive regarding the exact association between tooth wear and bruxism, the literature suggests some sort of relationship favoring the appearance of excessive dental wear in bruxers (13–15). This clinical manifestation and its ramifications (e.g. higher risk of dental restoration failure, high demands in terms of mechanical strength for dental restorative materials etc.) underline the importance of dentists within the care and management of bruxism. However, as already mentioned, increased dental wear is not the only clinical expression of bruxism. The scope of bruxism related manifestations goes far beyond tooth wear and can be found both intra-orally as well as extra-orally. Masticatory muscle hypertrophy, jaw locking, temporomandibular joint dysfunction (TMD), tongue indentations, perceivable grinding sounds, temporal headaches and orofacial pain or fatigue all count amongst the countless signs and symptoms that can be experienced by the affected individual (in the case of symptoms) or detected by the treating clinician (in the case of signs) (1,3). Remarkable regarding bruxism induced craniofacial pain is the complex, multifaceted and nonlinear relationship between the two which is very well elaborated in the work of Svensson et. al (16). Apart from the aforementioned signs and symptoms, bruxism may even have social repercussions, bearing the potential to cause marital problems attributable to the grinding noise caused by the bruxer during sleeping times (3,17). More recent studies also found a relationship between sleep bruxism and cardiovascular complications such as hypertension, mediated by a mechanism of sympathetic hyperactivity (18).

Overall, the diverse oral and non-oral clinical manifestations emphasize the great complexity of bruxism and its consequences. Therefore, the list of signs and symptoms related to bruxism behavior mentioned in this paragraph does not claim to be exhaustive and is very likely to be completed in the future with new research continuing to be published concerning this topic.

1.6. Risk Factors

Various risk factors and stimulating substances are linked to an exacerbating effect on bruxism, some of which are even suspected to be involved at least partially as a potential causative agent in certain types of bruxism. These factors include caffein consumption, smoking, alcoholism (19,20), MDMA (21), chronic antidopaminergic drug exposure (22), type A personality (characterized by perfectionism, competitiveness, etc.), anxiety (23,24) and certain sleep disorders (e.g. snoring, obstructive sleep apnea) (25,26). In case of drugs or medical disorders being present and causative in a bruxer, bruxism is considered secondary or iatrogenic, whereas in otherwise healthy subjects without any medication or medical condition the behavior is

considered as primary or idiopathic (3). Moving on, we will take a closer look at some commonly brought up risk factors.

To begin with, scientific literature has established a mild to moderate association between bruxism (either diurnal or nocturnal) and certain sleep related respiratory disturbances such as snoring, the most common one (3). Considering the occurrence of bruxism along with other sleep related pathologies, it becomes clear that sleep medicine is an important area of interest within bruxism research and management.

On the psychological end of the spectrum of possible risk factors, many dentists believe that there is a link between bruxism and anxiety or stress. This common shared belief is supported by studies that found a higher catecholamine concentration in the urine of bruxers which corroborates a likely association between bruxism and emotional stress (27,28). Emotional stress can present in many different forms e.g. intense workload, increased family duties, high expectations towards oneself. Clearly, to which degree exactly increased emotional stress effects bruxism behavior depends on each individual and the intensity of the lived experience. Therefore, more in depth research would be required to further the understanding in that field (3).

Nutrition also has been suggested to play a role in bruxism's etiology. Vitamin D deficiency has been found in a study to be present in 60% of bruxers, making it a notable dietary vector for the parafunctional behavior (29,30).

Another possible predisposing factor for bruxism might be encountered within the family history of patients and linked to genetics. Twin studies have shown that there likely is a genetic component playing into the probability of exhibiting sleep or awake bruxism. One systematic review and meta-analysis for example discerned that there is a higher concordance of sleep bruxism in monozygotic twins in comparison to their dizygotic counterparts, implying a genetic influence on the apparition of the disorder (31). However, to which extent genetics alter the likelihood of suffering bruxism is not entirely clear yet and it is speculated that multiple genes rather than one single gene expression drive the changes observed in oromandibular motor activity leading to bruxism (3).

When taking a look at the implication of occlusion, the scientific evidence does not support any causal relationship of occlusal interferences or malocclusion in general with bruxism. This goes contrary to an old and outdated popular belief in dentistry according to which interferences and bruxism were somehow related to each other and from which arose the idea of occlusal rehabilitation as a treatment option. As stated by newer research that concept is unfounded (3,32).

To conclude, it is important to stress that the relationship between bruxism and potential risk factors is very complex and multifaceted, given the fact that several of the above stated conditions may appear in clusters, exerting an effect together. Hence, concomitant disorders of various kinds, drugs, genetics, lifestyle and other perhaps still unknown parameters, constitute all important factors in the etiology and expression of bruxism behavior.

1.7. Treatment Options

Considering the numerous adverse effects that bruxism may have on a person's health, paired with the potentially decreased quality of life due to the negative consequences of both the awake and sleep form, it is essential for the treating clinician to be aware of the possible therapeutic options out there that may help improve the bruxers condition. Nowadays, dentists and other medical specialists dealing with bruxism patients dispose of a relatively large set of techniques, methods and procedures to alleviate the suffering of their patient and ameliorate their well-being. Hereby, the scientific base of each one of these treatment options may vary and not all highly praised remedies might yield the promised effect. Therefore, it is important to tailor the therapeutic approach to each individual case, taking into account not only the current scientific evidence but also a wide series of different patient-specific variables (e.g. age,

economic situation, severity of the bruxism behavior, type of bruxism). Next will be discussed some of the most relevant therapeutic options available to treat bruxism.
As for the treatment of children, a recently published systematic review and meta-analysis has identified photobiomodulation (PBM) and hydroxyzine to be effective. PBM is a method based on light therapy which targets specific points located in areas associated with the masticatory musculature (e.g. masseter, temporalis). It is promised to help in the reduction of muscle contractions, pain and symptoms related to TMDs. Ultimately, PMB relaxes masticatory muscles procuring the pediatric patient a sense of relief. Hydroxyzine on the other hand is a pharmacological agent (1st generation antihistamine) which exhibits anti-anxiety properties. Its mechanism of action is centrally mediated, possibly reducing bruxism by means of anxiety reduction (33,34). In addition to that, alternatives that also were demonstrated to be effective within the pediatric population include occlusal splints (mouth guards), orthodontic treatments and physical and psychological interventions (34).
When it comes to occlusal splints as a treatment modality (mainly for sleep bruxism) it is important to note that the current scientific literature provides rather mixed evidence for its effectiveness. Some studies report a reduction of bruxism episodes. However, these results were not always statistically significant. Nevertheless, mouth guards may protect from aggravated tooth wear (simply by means of the physical barrier they constitute, shielding off against toot-to-tooth friction) and improve muscle relaxation (35,36).
Another controversial treatment option is biofeedback which is a method utilizing electrical, auditory and visual stimuli that aim to create awareness among bruxers of their jaw muscle activity. That in return is supposed to allow them to consciously reduce or regulate masticatory muscle activity, particularly during sleep. Nonetheless, the scientific evidence is not very strong, with certain studies demonstrating positive results, whereas others show a lack of significant differences in comparison to control groups. Thus, more high quality studies are required in order to deepen the understanding of biofeedback as a bruxism treatment modality (37,38).
A rather well-documented pharmacological option is the injection of botulinum toxin type A (BTX-A) into certain masticatory muscles, typically the masseter and the temporalis muscles. BTX-A has a solid scientific track-record proving it to be quite versatile, safe and easy to handle (39). In the context of bruxism, it can be used to procure alleviation in both the awake and sleep form, effectively reducing pain intensity and bite strength. It has also been shown that BTX-A provides a more rapid pain relief than occlusal splinting, making it a treatment of choice for patients with severe pain (35). Hereby, higher doses correspond to a greater reduction in pain and occlusal force, however the effect of BTX-A and its benefits also diminish with time resulting in the necessity to renew injections periodically (40).

2. OBJECTIVES

For the objectives of this research the following PICO framework was established:

- P(opulation): adults.
- I(ntervention): botulinum toxin type A (BTX-A) injections.
- C(omparison): adults with another or no treatment received.
- O(utcome): effectiveness of BTX in the treatment for bruxism.

Based on this PICO formula, the objective can be defined as the assessment of botox's effectiveness in reducing signs and symptoms in patients suffering from bruxism. Combined with the comparison group, the following research question results: In adults, how do BTX-A injections as a means of treatment compared to no or other treatment modalities affect the clinical signs and symptomatology of bruxism? Based on already conducted research and current scientific knowledge the hypothesis can be established that BTX-A should have a positive effect on the clinical picture of bruxism thanks to its atrophying and paralyzing action that is likely to

inhibit temporarily the uncontrolled and excessive contraction of masticatory muscles (masseter and temporalis) that are involved in bruxism.

3. METHODOLOGY

To conduct this systematic review the digital databases PubMed and Medline Complete were consulted. Based on the previously defined PICO formula the following key words were used: “bruxism”, “adults” and “botulinum toxin”. To connect these keywords the Boolean operator “AND” was utilized. Besides that, to carry out the Medline Complete search, the MeSH terms “clenching”, “grinding”, “botox” and “botulinum-toxin-a” were employed to complement the keywords “bruxism” and “botulinum toxin” respectively, with the goal of amplifying the results obtained. The combination of the key words and the Boolean operators gave the following definitive search equations that can be seen in figures 2 and 3.

((bruxism) AND (adults)) AND (botulinum toxin)

Figure 1. Definitive search equation as used for PubMed.

(bruxism or clenching or grinding) AND adults AND (botulinum toxin or botox or botulinum-toxin-a)

Figure 2. Definitive search equation as used for Medline Complete.

Employing the above-stated search formulas, a preliminary search was conducted in December 2024 which yielded a total of 138 papers. In a second step, duplicates were removed using the Rayyan software. Furthermore, in order to identify suitable articles for this systematized review a set of inclusion and exclusion criteria were established (Figure 4 and 5), as well as filters applied that discarded non-eligible research.

- Randomized controlled trials (RCT) (-> primary scientific evidence).
- Studies published within the past 20 years.
- Samples composed of an adult population.
- Free full text article available.
- Studies looking at variables linked to bruxism-related pain and/or jaw muscle activity.

Figure 3. Inclusion Criteria.

- Case reports, systematic reviews or other studies that do not meet the RCT study design criteria.
- Studies published before 2004 (-> over 20 years old).
- Samples including children.

Figure 4. Exclusion Criteria.

After the removal of duplicates 81 records were screened by applying a filter to isolate randomized controlled trials (RCT). That step eliminated most systematic reviews, case reports, cohort studies or any other research not complying with the RCT criteria, leaving a total of 15 papers which were sought for retrieval. Subsequently, only free full text reports were isolated, resulting in eleven articles that then were screened for eligibility. The eligibility screening

discarded two more systematic reviews, which had not been automatically filtered previously, as well as two studies that were not in accordance with the PICO question. Following this article selection procedure (Figure 6), a total amount of seven papers were identified as eligible for this systematic review.

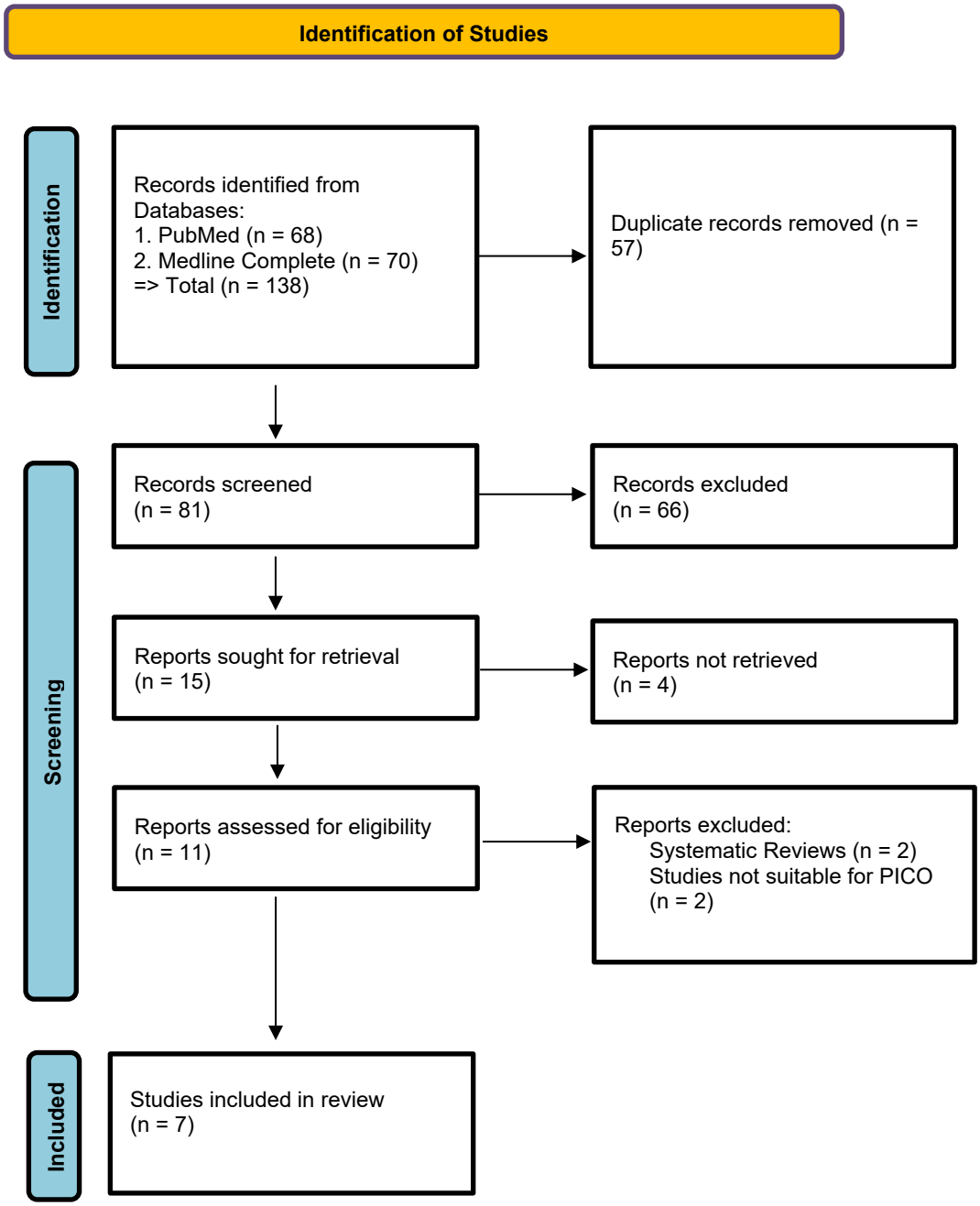

Figure 6. PRISMA Chart showing the article selection procedure.

4. RESULTS

Study	Study Design	Sample (Size & Population)	BTX Dosage & Injection Sites	Follow-up Period	Key Outcome Measures	Main Findings	Limitations
Guarda-Nardini et al. (2008)	Double-blind, placebo-controlled RCT	20 patients (10 BTX, 10 placebo), 25–45 years old, diagnosed bruxism & myofascial pain	30U in masseter, 20U in anterior temporalis (bilaterally), total 100U	1 week, 1 month, 6 months	Pain at rest & chewing (VAS), mastication efficiency, mandibular movements	Significant pain reduction in BTX group, improved mandibular function, subjective improvement reported	Small sample size, no EMG assessment
Lee et al. (2010)	Double-blind, placebo-controlled RCT with EMG monitoring	12 patients (6 BTX, 6 placebo), 20–30 years old, self-reported nocturnal bruxism	80U in masseter (bilaterally, 3 injection sites per side)	4, 8, 12 weeks	Nocturnal bruxism episodes (EMG), subjective symptoms	Significant reduction in bruxism events in masseter group; no change in temporalis	Small sample size, no pain assessment, short follow-up
Shim et al. (2014)	Double-blind RCT with polysomnography (comparing two active treatment groups)	20 patients with diagnosed sleep bruxism (10 BTX only in masseter, 10 BTX in both masseter & temporalis)	30U per masseter, 20U per temporalis (bilaterally), total 100U	4 weeks	Sleep bruxism episodes, EMG activity, muscle contraction index	Significant reduction in jaw motor activity & sleep bruxism episodes	Short follow-up, subjective symptoms not assessed, not placebo-controlled

Jadhao et al. (2017)	Double-blind, placebo-controlled RCT	24 patients (8 BTX, 8 placebos, 8 control), 20–35 years old, diagnosed bruxism & myofascial pain	30U in masseter, 20U in temporalis (bilaterally), total 100U	1 week, 3 months, 6 months	Pain at rest & chewing (VAS), occlusal force analysis	BTX group showed reduced pain & lower occlusal force compared to control & placebo	No placebo-controlled long-term follow-up
Cahlin et al. (2019)	Double-blind, placebo-controlled RCT	12 patients with CP & bruxism (6 BTX, 6 placebo)	30U in masseter, 20U in temporalis (bilaterally), total 100U	4, 12, 16 weeks	Masticatory function, pain assessment, bite force	No significant improvement in function or pain compared to placebo	Small sample size, high variability in CP symptoms
Shim et al. (2020)	Double-blind, placebo-controlled RCT with polysomnography	30 patients (15 BTX, 15 placebo), diagnosed sleep bruxism	25U in masseter (bilaterally), total 50U	4 & 12 weeks	Bruxism index, muscle activity (EMG)	Significant reduction in bruxism index & EMG amplitude compared to placebo	Short follow-up, small sample size
Chisini et al. (2024)	RCT (comparing two active treatment groups, only assessor blinded)	59 patients (30 occlusal splints, 29 BTX), probable sleep bruxism with jaw pain	30U in masseter (bilaterally & 3 sites, each 10U, per side), total 60U	3 & 6 months	Pain reduction (GCPS), mandibular mobility, quality of life (OHIP-14)	Both BTX & occlusal splints are effective; occlusal splints had slight advantages in functional outcomes.	No long-term follow-up, no placebo control, no double-blinding

Table 2. Key data of the trials that were assessed in results.

For results, a total of seven articles, published between 2008 to 2024, were analyzed and a comprehensive summary of key data can be seen in table 2.

The first paper that was analyzed is a pilot study conducted by Guarda-Nardini et al. in 2008 (41). The authors chose a randomized, double-blind placebo controlled clinical trial as their study design to investigate the effects of botulinum toxin A (BTX-A) on myofascial pain in patients with bruxism. The sample comprised 20 individuals, aged 25 to 45 years old, of which 10 received botox injections and 10 a placebo. The BTX-A group received 30U per masseter and 20U temporalis muscle on both sides which added up to a total dose of 100U per patient. On the other hand, the control group received saline injections. All participants were evaluated at intervals of 1 week, 1 month and 6 months post-injection. These follow-up evaluations looked at mandibular function, pain levels and subjective treatment perception. The results demonstrated that BTX-A injections significantly reduced pain at rest and during chewing, while at the same time improving mandibular movements such as lateral and protrusive excursions (not significant) as well as non-assisted mouth opening (4mm). As for differences between the two groups of the study, participants within the botox group reported greater subjective improvement of their condition. Nevertheless, due to the small sample size, some of the reported differences were not statistically significant. That being said, Guarda-Nardini et al. concluded that BTX is a promising treatment option for bruxism-related myofascial pain, however larger trials would be necessary to corroborate these findings.

Another randomized, double-blind and placebo-controlled trial entitled “Effect of Botulinum Toxin Injection on Nocturnal Bruxism” and conducted by Lee et al. in 2010 (42) aimed to determine whether botox reduces nocturnal bruxism as measured by electromyography (EMG) activity. Based on self-reported sleep bruxism a total of 12 patients aged 20 to 30 years old were recruited and divided into two groups (6 patients receiving BTX-A and 6 receiving placebo saline injections). Botox was exclusively injected into the masseter muscle at 3 injection sites per side and adding up to a total of 80U. Prior to BTX-A injection and accompanying the follow-up at 4, 8 and 12 weeks post-injection, portable EMG device records were taken in order to monitor bruxism activity. Even though BTX-A injections were only administered in the masseter muscles, both masseter as well as temporalis muscle activity were recorded. The results showed a significant reduction in masseter muscle bruxism episodes within the BTX-A group (from 4.5 to 2.1 episodes per hour at 12 weeks), whereas the placebo group did not express any change (remaining around 4.8 episodes / h). Interestingly, there was no statistically significant effect on the activity of the temporalis muscle, suggesting that botox mainly affects masseter-mediated clenching rather than overall bruxism patterns. Subjective symptoms (as for instance jaw tightness in the morning) improved in both the BTX-A and the placebo group, which indicates a potential placebo effect when it comes to self-reported symptomatology. The authors concluded that masseter BTX-A injections effectively reduce nocturnal bruxism episodes by decreasing muscle activity rather than influencing central nervous system (CNS) related mechanisms. As in the previous study, Lee et al. acknowledged that the small sample size is a limiting factor. Besides that, the lack of pain assessment constitutes another limitation of the trial.

A 2014 randomized, double-blind, however not placebo-controlled trial conducted by Shim et al. (43) also focused on nocturnal bruxism, assessing botox’s effect on jaw muscle activity via polysomnography (PSG) and EMG recordings. 20 participants, of which 10 received BTX-A injections exclusively into the masseter (Group A) and 10 into both the masseter and temporalis muscles (Group B), were included in the study. BTX-A injections were administered at 30U per masseter (3 injection points, each 10U) and 20U per temporalis muscle (2 injections points, each 10U) bilaterally, adding up to a total dose of 60U for group A participants and 100U for group B participants. Patients were monitored for EMG activity, muscle contraction index and bruxism episodes before and 4 weeks after the BTX administration. The findings of this study revealed that BTX-A lead to a significant reduction of the intensity of nocturnal bruxism episodes (rhythmic masticatory muscle activity (RMMA) change from 290.5 μV to 72.4 μV), without

however significantly altering the frequency nor the duration of those RMMA events during sleep. Moreover, jaw motor activity and EMG amplitude (peak EMG amplitude during maximal voluntary clenching (MVC) in masseter dropped from 216.3 μV to 43.1 μV) were also significantly reduced, suggesting botox's effectiveness when it comes to controlling muscle hyperactivity whilst asleep. Nevertheless, with the follow-up being limited to only 4 weeks, long-term effects of the BTX-A intervention were not assessed. In addition, the trial did not evaluate any variables of subjective pain or functional improvements. The researchers drew the conclusion that BTX-A is a promising option for reducing nocturnal bruxism, though further scientific investigation is required in order to evaluate its impact beyond the short-term frame of muscle activity reduction.

Jadhao et al. carried out a randomized, double blind, placebo-controlled trial in 2017 (44) which aimed to assess the effect of botox on occlusal force characteristics and myofascial pain in patients suffering from bruxism. A total of 24 bruxism patients were enrolled in the study and divided into the following three categories: 8 BTX-A, 8 placebo (saline injections) and 8 controls without any injections. A total dose of 100U BTX was administered, targeting bilaterally masseter (30U each) and temporalis (20U each) muscles. Follow-ups were set for 1 week, 3 months and 6 months. The results indicated that BTX significantly reduced pain (measured via VAS), both at rest and during mastication. Furthermore, it decreased the maximum occlusal force (reduction of 37.64kg) compared to the placebo and control groups (reduction of 11.32kg). This suggests that BTX not only alleviates pain but also lowers bite force, which in turn potentially reduces mechanical stress on the temporomandibular joint (TMJ) and the dentition. Nonetheless, the authors acknowledged that conclusions about sustained efficacy are limited due to the lack of a long-term placebo-controlled follow-up.

Cahlin et al. published in 2019 a randomized, double-blind, placebo-controlled trial (45) which has the particularity of having looked at the effects of BTX-A in patients who suffered not only from bruxism but also from cerebral palsy (CP), a neurological disorder affecting movement, muscle tone and posture due to abnormal brain development or perinatal brain damage. Out of 12 participants, 6 received BTX-A injections (30U per masseter + 20U per temporalis bilaterally = 100U in total) and 6 received placebo (saline) injections. Assessments, including masticatory function, bite force and pain levels, were performed prior to BTX injection as well as at 4, 12 and 16 weeks post treatment. Interestingly, and in contrast to the other previously mentioned studies, the obtained results did not show significant differences between the botox and placebo groups regarding objective measures of function and pain. However, many participants expressed interest in continuing the BTX-A treatment, suggesting that subjective benefits may indeed exist despite the lack of statistically significant and measurable changes. Important to not with regards to this study is the very small and heterogenous sample, expressing a high variability in CP-related muscle dysfunction, which constitutes a major limiting factor and makes drawing broad conclusions difficult.

Another randomized, double-blind, placebo-controlled trial by Shim et al., built upon the researcher's 2014 trail and published in 2020 (46), investigated botox's effects on nocturnal bruxism in a 30-patient panel. Participants were divided into intervention (15 individuals) and placebo (15 individuals) groups. The patients of the intervention group received 25U of BTX-A per masseter muscle bilaterally (50U total dose) and were assessed at 4-weeks and 12-weeks follow-up appointments. The baseline and follow-up period measurements in the sleep laboratory replicated the same polysomnographic recording protocol as the 2014 trial by Shim et al. The findings showed a significant reduction in muscle activity and bruxism index in the BTX-A group (reduction of bruxism index by 55%) compared to the placebos, suggesting that lower doses of BTX can still yield an effective and measurable clinical outcome. However, the trial's main limitations, namely a small sample size and a relatively short follow-up duration, make it unclear whether or not the obtained benefits extend beyond the 12-week period.

Lastly, a recent randomized controlled trial conducted by Chisini et al. and published in 2024 (47) compared BTX-A injections to occlusal splints in a sample of 59 patients (30 full-arch rigid

maxillary occlusal splints, 29 BTX-A) with probable sleep bruxism and jaw pain. BTX-A was injected at 3 sites per masseter bilaterally, with each injection site receiving 10U and making up a total dose of 60U. The occlusal splint group used a night guard for 6 months. The assessed key outcome measures included pain (Graded Chronic Pain Scale), mandibular mobility, jaw function (JFLS-20) and quality of life (OHIP-14). The results showed that both occlusal splints and BTX were effective in reducing jaw muscle pain and improving quality of life. However, occlusal splints were superior regarding functional outcomes, showing for instance less limitations in jaw movements. Additionally, 79.3% of BTX-A patients reported mild discomfort upon mastication, which resolved within a week. The authors of the study concluded that both interventions are viable treatment options, however occlusal splints may present functional advantages. The main limitations of the trial reside in the absence of a placebo control group and no double-blinded design due to practical reasons, with only the evaluator having been blinded.

5. DISCUSSION

The effectiveness of botulinum toxin type A (BTX-A) as a treatment option for bruxism remains a topic of ongoing research, with studies yielding mixed yet generally favorable results, which corroborate its safety and efficacy. The findings from the 7 studies analyzed in this research align with key insights from broader, already conducted systematic reviews and meta-analyses (36,40,48–50). This body of research provides valuable context for evaluating the role of BTX-A in bruxism management.

5.1. Reduction in Bruxism Episodes and Muscle Activity

Several papers confirmed that BTX-A significantly reduces the intensity and frequency of bruxism episodes by decreasing muscle activity, as seen for instance in the randomized controlled trials of Shim et al. (2014, 2020) (43,46) and Lee et al. (2020) (42). These studies namely demonstrated a reduction in electromyographic (EMG) activity along with a decrease in bruxism index. In line with these findings is the meta-analysis by Chen et al. (2023) (40) which concluded that BTX-A is effective in reducing nocturnal bruxism episodes, though the magnitude of its effects varies depending on the administered dosage and the assessment methods implemented to record the clinical changes. Nevertheless, De la Torre Canales et al. (49) highlighted a critical limitation in their 2017 published systematic literature review. While BTX-A reduces muscle contraction intensity, it does not always eliminate bruxism episodes entirely. Some of the studies that were reviewed within this publication did not find any significant decrease in bruxism frequency when measured with polysomnography. That being said, these results reinforce the notion that BTX-A primarily yields a reduction in muscle force rather than stopping bruxism altogether.

5.2. Comparison with Occlusal Splints

Another key point of the current scientific debate is how BTX-A compares to other treatment alternatives in bruxism management. One frequent treatment option that clinicians like to resort to in order to treat their bruxism patients is occlusal splints, also known as night guards. BTX-A vs occlusal splints was the subject of direct comparative investigation in the RCT of Chisini et al. (2024) (47) which suggested that both treatment modalities significantly reduce pain, however occlusal splints provide slightly better functional outcomes in terms of mandibular mobility. Although Hardy and Bonsor's (2021) (36) systematic review, included multiple studies (14 in total) on occlusal splints, they concluded that there is insufficient high-quality evidence to affirm the effectiveness of night guards in the treatment of bruxism due to the limited number and high risk of bias in available studies. Nonetheless, occlusal splints are still commonly used

and a generally reliable treatment option particularly when it comes to preventing dental attrition and temporomandibular joint dysfunction (TMD).
Besides that, it is noteworthy that occlusal splints do not actively reduce muscle hyperactivity the way BTX-A does. Furthermore, Chisini et al. in their 2024 RCT did not find any major differences in terms of pain relief when comparing occlusal splints and BTX-A injections.

5.3. Impact on Orofacial Pain and Occlusal Force

Orofacial pain reduction in the masticatory muscle area is one of the most consistent benefits observed with BTX-A treatment. Studies such as Guarda-Nardini et al. (41) and Jadhao et al. (44) discerned statistically significant reductions in pain sensitivity (based on VAS scores) alongside with improvements in mandibular function as a result of BTX-A injections. These findings are supported by those generated by systematic reviews such as Sendra et al. (48), which confirmed that BTX-A consistently reduces myofascial pain in bruxism patients. Similarly, Fernández-Núñez et al. (50) highlighted botox's ability to alleviate jaw discomfort and reduce occlusal force, making it a useful and safe intervention method for bruxism-related pain management. However, it is important to note here that not all patients experienced complete pain relief, which emphasizes the individual variability and susceptibility in terms of treatment response.

5.4. Shortcomings and Adverse Effects

Despite its various benefits, BTX-A also presents certain drawbacks that must be taken into account when considering it as a potential treatment modality in the management of bruxism. One of the main challenges is that the effects of BTX-A are temporary, typically lasting between 3 to 6 months, necessitating regular reinjections to preserve the benefits obtained. This not only impacts patient compliance but may also have economic implications. Additionally, although adverse effects are generally mild and transient, they can include muscle weakness, asymmetry in fascial expression, difficulty in chewing and in rare cases unintended diffusion of the toxin to nearby muscles as reported in multiple studies as for instance by Sandra et al.'s systematic review (48) and Chisini et al.'s randomized clinical trial (47). Apart from that, Cahlin et al. (45) also found that while cerebral palsy (CP) patients with bruxism did not show statistically significant improvement in bite force or function, many of them still reported a subjective preference to continue the BTX-A treatment, suggesting possible placebo effects. This shows that objective measures may not always align with the patient's subjective experience, raising questions about the reliability of patient-reported outcomes in evaluating the efficacy of BTX-A. These concerns echo those expressed by De la Torre Canales et al. (49), who emphasized that whilst BTX offers a promising treatment option for bruxism, its long-term safety, optimal dosage and frequency of reinjection require further research. Additionally, Sendra et al. (48) cautioned that heterogeneity in study protocols (varying doses, injection sites and follow-ups) makes it difficult to establish a universal treatment standard.

5.5. Future Research

A recurrent limitation that the researchers of the RCTs, which were analyzed in the results part, acknowledged was a small sample size, which should be considered and ameliorated in future studies as to improve the overall quality of the scientific evidence they may procure. Apart from that, longer follow-up periods and standardized protocols should also be implemented in order to better evaluate long-term safety and efficacy as well as to define optimal BTX-A dosages, ideal injection sites and treatment intervals. Individual patient variability is another point of interest worth considering in future research projects which may allow to maximize effectiveness and minimize undesired side effects. If put into practice, these measurements would contribute to solidifying the scientific knowledge and documentation of BTX-A for bruxism management, facilitating clinician education and patient care.

6. CONCLUSION

Based on the findings of this systematized review, botulinum toxin type A (BTX-A) appears to be an effective therapeutic option for the management of bruxism, particularly when it comes to reducing associated symptoms such as myofacial pain and excessive occlusal force. Consequently, the initial hypothesis stated in the objectives could be widely confirmed, aligning with the already existing body of research on the topic. The evidence from randomized clinical trials (RCT) demonstrated that BTX-A consistently decreases muscle activity, especially in the masseter muscle, and therefore leads to meaningful reductions in pain intensity and bite force. These improvements were appreciated in both sleep and awake bruxism cases.

However, while BTX-A effectively mitigates muscle contraction intensity, its concrete impact on the frequency of bruxism episodes remains uncertain. Objective measures such as electromyography (EMG) and polysomnography indicate that bruxism activity may persist even after treatment, albeit at reduced intensity. Furthermore, the benefits of BTX-A seem to be short-term, often lasting only a few months, and require regular reinjection to maintain clinical effects and the subjective improvements appreciated by the patients.

In comparison to occlusal splints, which currently are considered a first-line conservative therapy option for bruxism, BTX-A offers a viable alternative, particularly for patients with poor compliance regarding mouth guards or those with muscle-related symptomatology that is unresponsive to conventional management. Nevertheless, BTX-A is not without limitations, including its temporary nature, potential adverse effects and the need for further in-depth research to establish standardized protocols.

In conclusion, BTX-A can be considered a safe and effective adjunctive treatment for the management of bruxism, particularly for symptom control in patients who do not respond adequately to occlusal splints. Nonetheless, given the heterogeneity of current studies and the limited evidence with regards to long-term efficacy, BTX-A should be used with clinical discretion and not yet viewed as a definitive replacement for more established and well-documented therapies.

7. SUSTAINABILITY

This systematized review contributes to the field of dentistry by exploring an alternative therapeutic approach for managing bruxism with botulinum toxin type A (BTX-A), a treatment that has shown promising clinical outcomes. From a social perspective, the findings support more individualized and effective care for patients who may not respond to conventional therapies such as occlusal splints. In turn the alternative BTX-A treatment potentially improves the quality of life and physical and psychological well-being of this subset of patients which corresponds to goal number 3 of the United Nations Sustainable Development Agenda (-> Goal 3: Health & Wellbeing).

In terms of economic sustainability, while BTX-A may initially seem costly due to the necessity of repeated injections, it can reduce indirect costs associated with untreated bruxism, as for example dental wear, prosthetic replacements or chronic pain management. This indirect cost reduction may in turn enable the allocation of investments in other areas of economic and social importance (-> Goal 9: Industry, Innovation & Infrastructure). Offering BTX-A as a therapy option selectively to suitable patients can result in cost-effective, well-targeted high-quality health care.

Although BTX-A is not directly tied to environmental sustainability, this work promotes ethical and responsible use of healthcare resources, advocating for evidence-based, patient-centered treatment decisions. All in all, this systematized review fosters a sustainable approach to clinical decision-making by aligning therapeutic efficacy with long-term positive impact and ethical, well-tailored patient care.

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