



BEYOND AESTHETICS: EXPANDING THE FRONTIERS OF BOTULINUM TOXIN IN MODERN DENTAL PRACTICE

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ABSTRACT Botulinum toxin (BoNT), widely known for its cosmetic applications, is increasingly finding therapeutic relevance in the field of dentistry. This review explores the multifaceted applications of BoNT in dental practice, including its roles in managing temporomandibular joint disorders (TMD), bruxism, orofacial pain, sialorrhea, and aesthetic enhancements such as the treatment of excessive gingival display. Drawing from recent literature published in the last five years, the review highlights both the clinical efficacy and potential future directions of this neuromodulator in dental medicine. A novel perspective is introduced by proposing a hybrid approach combining BoNT with biofeedback therapy, aiming for longer-lasting neuromuscular re-education in patients with parafunctional habits. Additionally, the article introduces an emerging role of BoNT in post-operative recovery and implant success modulation.

KEYWORDS : Botulinum toxin, BoNT, dentistry, bruxism, temporomandibular disorders, facial aesthetics, gummy smile, neuromodulation, biofeedback, implantology

INTRODUCTION

Clostridium botulinum is the bacterium that produces the neurotoxin known as botulinum toxin (BoNT). It is best known for its cosmetic applications, particularly in the reduction of facial wrinkles, a treatment that has gained widespread popularity worldwide. However, in recent years, its potential in medical and dental therapies has emerged as an exciting area of research. With its ability to modulate neuromuscular function, BoNT is increasingly being explored for a range of dental and orofacial conditions.

The therapeutic applications of BoNT are grounded in its mechanism of action: it blocks the release of acetylcholine at the neuromuscular junction, which results in temporary paralysis of the injected muscle. This process is not only effective in controlling hyperactive muscle function but can also provide relief from conditions that are exacerbated by muscular tension and spasms, such as temporomandibular joint disorders (TMD), bruxism, and myofascial pain. Additionally, BoNT has found a growing role in aesthetic treatments, particularly in enhancing smile aesthetics and treating conditions like excessive gingival display, or “gummy smile.”

Historically, the use of BoNT in dentistry was initially met with skepticism, but as the body of evidence supporting its safety and efficacy has expanded, so too has its integration into dental practices. Studies from recent years have consistently demonstrated that BoNT provides significant therapeutic benefits for patients suffering from conditions such as TMD, bruxism, and chronic facial pain^{1,2,3}. Additionally, the cosmetic benefits of BoNT, such as its role in improving facial symmetry and treating gummy smiles, have made it an appealing option for aesthetic enhancement within the dental field^{4,5}. As the use of BoNT in dentistry continues to evolve, new areas of application are being explored, including its role in post-surgical recovery and its potential in promoting the success of dental implants. Furthermore, researchers are investigating the combination of BoNT with other therapies, such as biofeedback, to improve patient outcomes and provide long-term management of conditions that are traditionally difficult to treat. The ability to combine these therapies may open up novel therapeutic avenues for patients with chronic parafunctional habits and facial pain syndromes^{6,7}.

With such advancements in mind, the goal of this review is to provide a comprehensive understanding of the current and future roles of BoNT in dentistry. By examining its wide range of applications—from functional to aesthetic—this review aims to offer insights into how BoNT is reshaping modern dental practice and expanding beyond its cosmetic origins.

Applications Of Botulinum Toxin In Dentistry**1. Management Of Temporomandibular Joint Disorders (TMD)**

Temporomandibular joint disorders (TMD) encompass a broad range of musculoskeletal and neuromuscular conditions affecting the temporomandibular joint, masticatory muscles, and associated

structures. Patients often experience jaw pain, joint noises, restricted mandibular movement, and muscle tenderness, frequently aggravated by hyperactivity or spasm of the masticatory muscles.

BoNT has emerged as a viable and minimally invasive therapeutic option for TMD management. It acts by inhibiting acetylcholine release at the neuromuscular junction, thereby relaxing hyperactive muscles such as the masseter and temporalis, which are commonly implicated in TMD symptoms⁽³⁾. Clinical application of BoNT leads to significant reduction in muscular pain, improved mandibular range of motion, and decreased muscle tension.

A meta-analysis by Thakkar et al⁽⁴⁾ affirmed that BoNT provides substantial relief in TMD patients by reducing pain scores and improving jaw function over long durations. Furthermore, its effectiveness extends to both arthrogenous (joint-originated) and myogenous (muscle-originated) subtypes of TMD. Electromyographic (EMG) data show a marked decrease in muscle activity following BoNT administration, interrupting the pain-spasm-pain cycle. An RCT in 2021 found that BoNT reduced myofascial pain scores by 50% within just four weeks⁽¹⁹⁾.

The incorporation of BoNT into a multidisciplinary treatment protocol, involving cognitive behavioral therapy (CBT), physiotherapy, and occlusal splints, is becoming increasingly common, offering a comprehensive and individualized treatment plan⁽²⁰⁾.

2. Treatment Of Bruxism And Parafunctional Habits

Bruxism, whether sleep-related or awake, involves involuntary grinding or clenching of teeth and is considered one of the most damaging parafunctional habits. It leads to tooth wear, dental restorations failure, myofascial pain, and even temporomandibular dysfunction.

BoNT works by selectively weakening the masseter and temporalis muscles involved in clenching, thereby reducing bite force and protecting both natural dentition and restorations⁽⁶⁾. This neuromodulatory effect not only reduces the frequency and intensity of bruxism episodes but also alleviates associated pain and tension.

Jadhao et al⁽⁵⁾ demonstrated a significant reduction in bruxism-related symptoms such as jaw pain, headaches, and discomfort within weeks of BoNT injection. Clinical relief has been observed to persist for up to six months, depending on the dose and treatment protocol⁽⁶⁾.

MRI studies confirm a reduction in masseter muscle volume after BoNT treatment, correlating with decreased occlusal force⁽⁶⁾. In pediatric populations, especially children with neurodevelopmental disorders, BoNT has shown improvements in oral function, reduced trauma risk, and better tolerance to oral appliances⁽²⁷⁾. Its use is

considered safe when administered in appropriate intervals, generally every 3–6 months.

3. Orofacial Pain Management

Chronic orofacial pain encompasses a variety of conditions, including trigeminal neuralgia, myofascial pain syndrome, and neuropathic facial pain, which can significantly affect quality of life. Traditional treatment regimens often include medications such as anticonvulsants or antidepressants, but these can have undesirable systemic effects.

BoNT offers a targeted, localized alternative by acting on both sensory and motor nerve terminals, effectively reducing pain signaling and muscle hyperactivity⁽¹²⁾. It inhibits the release of neurotransmitters such as substance P and CGRP, which are involved in pain transmission.

Wang et al⁽⁶⁾ demonstrated a marked reduction in pain intensity and muscle tenderness in patients with myofascial pain syndrome following BoNT administration. In cases of refractory trigeminal neuralgia, BoNT has shown promise where carbamazepine fails to offer relief⁽¹⁴⁾. Moreover, it is being explored in off-label applications such as fibromyalgia and burning mouth syndrome, where systemic medications provide limited success⁽²⁹⁾.

Additionally, BoNT has shown superior outcomes compared to corticosteroid injections in managing trigger points of masticatory myalgia, providing longer-lasting relief with fewer systemic side effects.

4. Cosmetic And Aesthetic Enhancements

BoNT's application in aesthetic dentistry has expanded dramatically, offering minimally invasive solutions for improving facial symmetry and smile aesthetics. One of the most prevalent cosmetic indications is the gummy smile, caused by hyperactivity of the levator labii superioris and zygomaticus minor muscles. BoNT injection reduces excessive upper lip elevation, resulting in a more balanced and appealing smile⁽¹⁵⁾.

In cases of facial asymmetry, hemifacial spasm, or facial nerve palsy, BoNT allows for targeted muscle relaxation, improving symmetry and reducing tension in overactive areas⁽¹⁶⁾. This approach often forms part of comprehensive facial aesthetic treatments, especially in patients undergoing smile design or digital smile planning.

BoNT is also used for masseter hypertrophy—a condition more prevalent in Asian and female populations—which contributes to a square lower face. In these patients, BoNT offers a non-surgical contouring solution. Combined with dermal fillers or thread lifts, BoNT enhances facial rejuvenation outcomes and maintains a harmonious lower facial third⁽⁸⁾.

5. Sialorrhea Control

Sialorrhea or excessive salivation, while not harmful itself, can lead to embarrassment, aspiration risk, and prosthesis instability, especially in neurologically compromised individuals. BoNT reduces salivary output by inhibiting acetylcholine release at the neuroglandular junction, leading to temporary glandular hypofunction⁽⁷⁾.

Intraparotid and submandibular BoNT injections, often guided by ultrasound, significantly reduce drooling and its associated complications⁽¹⁸⁾. In pediatric patients with cerebral palsy, studies have shown reduced drooling scores for up to 24 weeks post-injection, improving both hygiene and prosthetic comfort⁽⁷⁾.

6. Prosthodontic Applications

In prosthodontics, BoNT serves as both a preventive and therapeutic adjunct. For patients with parafunctional habits such as clenching or grinding, BoNT reduces the forces exerted on prosthetic restorations, thereby minimizing wear, fractures, and early failure⁽²⁹⁾.

In edentulous patients with severe ridge resorption, hyperactive muscles often destabilize dentures. BoNT, by reducing activity in buccinator, orbicularis oris, and masseter muscles, allows better prosthesis adaptation and improved retention.

New studies have also demonstrated that BoNT contributes to accurate centric relation recording, as relaxed muscles allow more reproducible jaw positioning⁽⁹⁾. This leads to improved occlusion and reduced

prosthesis-related complaints, especially in difficult-to-manage cases with high muscle tonicity.

7. Orthodontic And Surgical Adjunct

BoNT is gaining traction as a perioperative adjunct in both orthodontic and surgical disciplines. In orthodontics, it is used to alleviate muscle imbalances that interfere with treatment outcomes. For instance, overactive mentalis or buccinator muscles can resist tooth movement or relapse post-treatment⁽²⁰⁾.

In orthognathic surgery, BoNT administration helps reduce muscle tension, enabling smoother repositioning of segments and minimizing postoperative relapse. Its application prior to surgery enhances healing and scar minimization by reducing soft tissue strain. Additionally, in cleft lip/palate rehabilitation, BoNT is being employed to aid muscle retraining pre- and post-repair, particularly in infants with poor muscle coordination⁽¹⁵⁾⁽¹⁶⁾.

Innovative Approach: Combining BoNT with Biofeedback Therapy

One of the most exciting developments in BoNT use is its integration with biofeedback therapy—a modality that teaches patients to control muscle activity using real-time feedback mechanisms. While BoNT offers immediate relief by relaxing targeted muscles, biofeedback instills long-term neuromuscular control, reducing the need for repeated toxin administration.

In clinical settings, surface electromyography (sEMG) is employed to monitor activity in muscles like the masseter and temporalis. Patients receive visual or auditory signals guiding them to relax these muscles voluntarily, helping break habitual parafunctional cycles. This dual-phase approach—BoNT for relaxation, biofeedback for retraining—has shown excellent results in managing bruxism, TMD, and myofascial pain syndrome.

Silva et al⁽¹⁷⁾ found that this integrative model significantly improved pain control and muscle coordination. Similarly, Shah et al⁽²²⁾, in a randomized controlled trial, reported superior outcomes in patients receiving both BoNT and biofeedback compared to those receiving BoNT alone.

With the rise of home-based biofeedback devices and digital health platforms, this therapy model is becoming more accessible, empowering patients to take active roles in their treatment and reducing long-term dependency on pharmacologic interventions.

CONCLUSION

Botulinum toxin has evolved into a transformative modality in dentistry, offering therapeutic and aesthetic benefits. From managing TMD, bruxism, and orofacial pain to enhancing facial symmetry and post-surgical recovery, BoNT holds vast potential. When used responsibly and in combination with advancing technologies like biofeedback, BoNT contributes to personalized, minimally invasive, and effective patient care.

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