



QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



KALSZTEIN, Julia, KUBIAK, Weronika, CZAPIŃSKI, Olgierd, MALEK, Zuzanna, WYCIŚŁOK, Aleksandra, WAŚKOWSKA, Katarzyna, WIERTELAK-MAKAŁA, Kacper and KWIATKOWSKA, Marta. Contemporary Therapeutic Strategies for Gummy Smile Correction: A Narrative Review of Botulinum Toxin, Combined Techniques, and Functional Preservation in Sports Dentistry. *Quality in Sport*. 2026;66:74131. <https://doi.org/10.12775/QS.2026.66.74131>

ARTICLE TIMELINE

Received: 08.07.2026. Revised: 02.08.2026. Accepted: 02.08.2026. Published: 10.08.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych). © The Authors 2026.

OPEN ACCESS · CC BY-NC-SA 4.0 This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland, and is distributed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (<http://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited. The authors declare no conflict of interest regarding the publication of this paper.

Contemporary Therapeutic Strategies for Gummy Smile Correction: A Narrative Review of Botulinum Toxin, Combined Techniques, and Functional Preservation in Sports Dentistry

Julia Kalsztein

ORCID: <https://orcid.org/0009-0000-4018-8827>

juliakalsztein@icloud.com

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,

ul. Pomorska 251, 92-213 Łódź, Poland

Olgierd Czapiński

ORCID: <https://orcid.org/0009-0007-7894-7201>

olgierd.czapinski@gmail.com

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,

ul. Pomorska 251, 92-213 Łódź, Poland

Zuzanna Małek

ORCID: <https://orcid.org/0009-0003-2427-3257>

zuzia_malek@wp.pl

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Weronika Kubiak

ORCID: <https://orcid.org/0009-0008-0335-0635>

weronka333@gmail.com

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Aleksandra Wyciślok

ORCID: <https://orcid.org/0009-0004-5249-3625>

olawy2010@gmail.com

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Katarzyna Waśkowska

ORCID: <https://orcid.org/0009-0005-4761-0425>

k.waskowska534@wp.pl

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Kacper Wiertelak-Makala

ORCID: <https://orcid.org/0009-0001-8236-3395>

kacper.wiertelak-makala@stud.umed.lodz.pl

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Marta Kwiatkowska

ORCID: <https://orcid.org/0009-0008-0198-0115>

marta.kwiatek2001@gmail.com

Institute of Dentistry of the Central Clinical Hospital of the Medical University of Lodz,
ul. Pomorska 251, 92-213 Łódź, Poland

Corresponding Author:

Julia Kalsztein

juliakalsztein@icloud.com

Abstract

Background: Gummy smile (GS), or excessive gingival display (EGD), is defined as >2–3 mm of visible gingiva during smiling. It affects 10.5–29% of the population, with a higher prevalence in women, and may significantly impair self-esteem and quality of life. Its etiology is multifactorial, involving skeletal, dental, muscular, and soft tissue factors.

Aim: To evaluate the effectiveness of contemporary treatment methods for gummy smile and provide an etiology-based framework for selecting the most appropriate therapeutic approach.

Materials and Methods: A literature review was performed focusing on classification systems (Mazzuco and Hexsel, Mercado-Rosso), severity scales (Chu and Garber-Salama), and diagnostic techniques, including clinical examination, CBCT, electromyography (EMG), and digital smile analysis.

Results: Botulinum toxin type A (BTX-A) effectively reduces gingival display by relaxing the LLSAN, LLS, and ZMi muscles, with maximal improvement after 14 days and a duration of 3–6 months. Hyaluronic acid (HA) fillers used for myomodulation provide longer-lasting correction (6–18 months) and greater patient satisfaction. Surgical lip repositioning improves smile aesthetics but is associated with recurrence, which may be reduced by adjunctive BTX-A. Laser gingivectomy provides predictable results in altered passive eruption, whereas orthodontic intrusion using Temporary Anchorage Devices (TADs) offers a less invasive

alternative to orthognathic surgery. Micro-autologous fat transplantation (MAFT) produces a stable spacer effect lasting up to 24 months.

Conclusions: Successful management of gummy smile requires accurate diagnosis and etiology-driven treatment selection. Combined protocols integrating surgical or orthodontic procedures with pharmacological modulation, particularly BTX-A, provide the most predictable and durable outcomes. Minimally invasive methods are especially advantageous for athletes because of shorter recovery. Further standardized protocols and long-term prospective studies are needed.

Keywords: gummy smile, botulinum toxin, hyaluronic acid, myomodulation, lip repositioning, gingivectomy, orthodontics

1. Introduction

1.1 Definition of a gummy smile

A smile is an important facial expression that plays a key role in social communication, self-confidence, and interaction with other people. (1–3) A gummy smile, also known as excessive gingival display (EGD), is a condition in which more than 2–3 mm of the upper gingiva is visible during smiling. (1,4–6) A small amount of gingival display is generally considered normal and aesthetically acceptable and may give the face a younger appearance. However, excessive gingival exposure is often regarded as an aesthetic problem that affects the harmony of the face and the appearance of the smile. (5,6)

1.2 Epidemiology and Prevalence

Epidemiological data indicate that a gummy smile is a common feature found in approximately 10.5% to 29% of the population. (1,5,7) This condition is observed significantly more often in women than in men - studies estimate its prevalence at 14% in women and 7% in men. (1,8) Women also show a statistically greater interest in improving the aesthetics of their smile in this regard. (2)

1.3 Psychological aspects of a gummy smile and their impact on patients' quality of life.

The psychological aspects of a gummy smile significantly impact patients' quality of life. (7,8) Excessive gum exposure often leads to reduced self-confidence, feelings of embarrassment, and self-consciousness in social situations. (2,5,9) Patients affected by this problem often try to

control their smile or cover their mouth with their hand when laughing, which negatively affects their mental well-being and ease in interpersonal interactions. (5,8)

1.4 Objectives of the review: analysis of the effectiveness of minimally invasive and surgical methods.

The etiology of this condition is multifactorial and may result from overactivity of the levator labii superioris muscles, vertical maxillary excess, a short upper lip, or dental eruption disorders. (1,5,10,11) This review aims to provide a comprehensive analysis of the effectiveness of available treatment methods, covering both minimally invasive approaches and surgical procedures. Among minimally invasive methods, the analysis will primarily focus on botulinum toxin type A injections and hyaluronic acid fillers. (1,12–14) In terms of surgical methods, procedures such as gingivectomy, upper lip repositioning, and orthognathic surgery will be considered. (1,2,4,7)

2. Etiology and Diagnosis

2.1 Classification of the Causes of a Gummy Smile

The classification of gummy smile causes is complex and multifactorial, including skeletal, dental, muscular, and soft-tissue factors. (1,15) Skeletal factors cover structural defects of the maxilla, such as vertical maxillary excess (VME), maxillary protrusion, and congenital deformities. VME is the excessive vertical growth of the maxilla. (1,4,5,7) Maxillary protrusion is the forward displacement of the maxilla, primarily associated with Class II malocclusions. (1,16) Congenital deformities are developmental abnormalities of the facial skeleton present from birth. (4)

Dental, alveolar, and gingival factors also contribute to the development of a gummy smile. These are related to abnormal tooth positioning and the anatomy of the surrounding tissues. They include: delayed or altered passive eruption, dento-alveolar extrusion, gingival hyperplasia, and a short clinical crown. Delayed or altered passive eruption is a situation in which the gingiva has not retreated apically to the level of the enamel-cementum junction, resulting in a short clinical crown. (1,4,5) It may also result from excessive tooth wear. (6,12) Alveolar extrusion is the excessive eruption of anterior teeth along with the alveolar process (1,10,15). Gingival overgrowth may be caused by inflammation, medications (e.g., cyclosporine, calcium channel blockers), or hereditary factors (3,4,10,17).

Other causes of a gummy smile include muscular factors. These include: hypermobility of the upper lip, hyperactivity of the muscle complex, and the action of the nasal septum depressor

muscle. Hypermobility of the upper lip occurs due to excessive contraction of the levator muscles, which lift the lip too high (1,11,17,18). Hyperactivity of the muscle complex: the main factors cited here are hyperactivity of the levator labii superioris alaeque nasi (LLSAN), hyperactivity of the levator labii superioris (LLS), and hyperactivity of the zygomaticus minor (ZMi) (1,5,19,20). The action of the nasal septum depressor muscle may cause the tip of the nose to droop and the lip to lift further during a smile (8,13,17).

Soft tissue factors also contribute to the development of a gummy smile, such as: a short upper lip, inversion of the vermillion border, and deficits in bone and fat tissue volume. A short upper lip is an anatomical feature and does not sufficiently cover the gums at rest or during a smile (1,5,11,21). Vertex inversion is the inward curling of the lip during a smile due to the force of the orbicularis oris muscle, which visually increases gum exposure (17). Deficits in bone and fat tissue volume result in a lack of adequate structural support in the maxillary region and the infraglingular area, which promotes excessive wrinkling and elevation of soft tissues (6,17,18).

2.2 Diagnostic Methods

A proper diagnosis of a gummy smile includes the evaluation of clinical, radiographic, photographic, and functional factors. This assessment is important for identifying the etiology of the condition and planning effective treatment (1,3,5).

Clinical examination and direct measurements involve diagnosing based on data collected from the oral cavity and face. These include crown measurements, i.e., determining the length of the clinical crown (from the gingival margin to the incisal edge) and the anatomical crown (from the enamel-cement junction to the incisal edge) (1,5). The standard height of the central incisors is typically between 9.5 and 11 mm (1). To supplement these measurements, we perform an examination of the width of the keratinized gingiva, an assessment of the position of the upper labial frenum attachment, and probing depth, which constitute a general assessment of the periodontium. (1,5). The occlusal parameters we measure include vertical overbite and horizontal overjet, as well as an assessment of the occlusal plane inclination (1,5). Measurements of exposure at rest and during smiling are also performed. The distance from the lower border of the upper lip to the incisal edge of the teeth or the gingival zenith should be measured at rest and during spontaneous and forced smiling (3,8,11).

Radiographic examinations are crucial for identifying skeletal causes. X-rays and cephalometry allow identification of vertical maxillary excess and maxillary protrusion, as well as the assessment of facial bone proportions, such as a dolichofacial profile (1,5,16,22). CBCT and

3D scanning are modern imaging methods using cone-beam computed tomography. They are used to assess bone levels relative to the cemento-enamel junction and bone support within the maxilla (1,7,17).

Modern diagnostics relies heavily on image analysis. Standardized digital photography involves taking a series of facial photographs (front and profile views) at rest and during a maximum smile while maintaining a constant head position and lighting (1,2,4,8,10). The use of software such as Adobe Photoshop, which is used to precisely measure gingival exposure in millimeters in photographs, often using a central incisor or a ruler as a reference for calibrating the scale (3,8,10,11). Video analysis, i.e., a digital recording that allows for the assessment of the dynamics of the smile, which is more difficult to capture in static photographs (2,15,17).

Diagnosis also involves clinical assessment of soft tissues and evaluation of lip dynamics. The length of the upper lip, measured from the subnasal point to the lowest point of the upper lip (stomion), is typically 20–24 mm (5,10,11). The lip hypermobility test is calculated by subtracting the exposure of the incisors at rest from the gingival exposure during a smile (11). Hypermobility is diagnosed when the lip lifts by 8 mm or more. Often, this is less than half the normal value (7,10,16). One should also assess vermilion border inversion, checking whether the vermilion border curls inward during a smile, which optically increases gingival exposure (17).

Electromyography (EMG) is also used in diagnosis. This method serves to objectively assess muscle activity. C-MAP measurement records the compound muscle action potential (CMAP) and allows for the determination of the contraction force of the levator labii superioris alveolaris muscle (LLSAN, LLS, ZMi) (1,3). Electromyography is used to locate points of hyperactivity. This helps in precisely determining the sites for botulinum toxin injection, for example, at the Yonsei point (the convergence point of the main levators) (1,17,23).

3. Therapeutic Classification Systems

3.1 Traditional classifications based on the location of gingival exposure

The literature identifies several key classification systems for the gingival smile, which are used to precisely select therapeutic methods.

Traditional classifications based on the location of gingival exposure include the Mazzucco and Hexsel classifications. This is one of the most commonly used systems, which divides the gingival smile into four types depending on which part of the gingiva is excessively visible (3,12,17,24). Type 1, or anterior gingival exposure (>3 mm), occurs between the maxillary

canines. It results mainly from hyperactivity of the levator labii superioris alaeque nasi (LLSAN) muscle (3,12). Type 2 – posterior gingival display occurs distally from the canines. This type is primarily caused by the zygomatic muscles (3,24). Mixed type: gingival display occurs in both the anterior and posterior regions (3,12,24). Asymmetrical type: excessive gingival exposure occurs on only one side (right or left) (3,24).

3.2 Modern classification systems focused on selecting the injection technique.

The Mercado-Rosso classification takes into account both aesthetic and functional aspects. It is a modern classification system that focuses on the underlying mechanism of the problem and facilitates treatment planning with hyaluronic acid (6). Type 1 results from a lack of bone support and/or insufficient maxillary projection. It is characterized by a thin upper lip and the presence of perioral wrinkles (6). Type 2 is caused by an imbalance between the strength of the levator muscles and the resistance of the soft tissues (6). Type 3 is associated with excessive zygomatic muscle strength, resulting in a very wide smile and high visibility of the molars (6).

3.3 The “Gingival Balance Face” Subclassification and the Role of Bone and Fat Volume Deficits.

The “Gingival Balance Face” subclassification was proposed as an extension of treatments using semi-permanent fillers, categorizing defects in terms of specific corrective measures (17). Type 1 involves refinement of the lip red field and focuses on correcting inversion, i.e., the inward turning of the lip when smiling (17). Type 2 involves bone and fat volume deficits. These indicate the need for structural support in the maxillary region, the glenoid fossa, or the chin (17). Type 3 involves muscular hypermobility; in this case, the focus should be on myomodulation of specific muscle groups (LLSAN, LLS, nasal septum muscle, zygomatic muscles) (17).

3.4 Additional therapeutic classifications used in practice.

Classification of defect severity according to Chu and Garber-Salam. This system assesses the severity of the defect based on the measurement of gingival exposure in millimeters, which determines the invasiveness of the procedures (1,6). Degree 1: gingival exposure is 2–4 mm. It is common in patients undergoing orthodontic, periodontal, or prosthetic treatment (1,6). Degree 2: gingival exposure is 4–8 mm (1,6). Degree 3: exposure is greater than 8 mm. This typically requires the most radical methods, such as orthognathic surgery (1,6).

Smile line classification according to Tjan et al. It divides patients into three groups based on the degree of tooth and gum exposure during a smile (4). A high smile occurs when the entire

clinical crowns and bands of gingival tissue are exposed; this is the classic gingival smile (4,6). An average smile is classified when 75–100% of the tooth crown is exposed (4,6). A low smile is classified when less than 75% (according to some sources, less than 50%) of the anterior tooth crowns are visible (4,6).

4. Minimally invasive treatment – Botulinum Toxin Type A (BTX-A)

4.1 Mechanism of action of the neurotoxin.

The mechanism of action of botulinum toxin type A is based on the inhibition of acetylcholine release, a key neurotransmitter responsible for the activation of skeletal muscle contraction and glandular secretion (1,10,15,25). This process leads to localized muscle weakness. After intramuscular injection, the toxin binds to receptors on the nerve endings of motor or sympathetic neurons (2,9,14). BTX-A exhibits endopeptidase activity, which allows it to cleave the SNAP-25 protein (2,9,19,23,25). This protein is essential for the proper docking of acetylcholine vesicles to the presynaptic membrane of the nerve terminal (9,25). Its damage prevents the fusion of vesicles with the membrane, which completely blocks the release of acetylcholine into the synaptic cleft (25,26). The absence of a chemical signal prevents the nerve impulse from reaching the muscle, resulting in its partial chemical denervation and flaccid paralysis (1,2,9,26). In the context of treating a gummy smile, this process leads to relaxation of the levator muscles of the upper lip, which limits its excessive elevation during smiling (1,5,13,26). The effect of the neurotoxin is temporary and reversible, as over time the SNAP-25 protein regenerates and the original neuromuscular junctions are restored (1,23–25).

4.2 Muscular Anatomy and Key Injection Sites

The injection of botulinum toxin type A to treat a gummy smile requires a precise understanding of muscular anatomy in order to achieve a natural aesthetic result and avoid complications (11). A key element of the therapy is targeting the neurotoxin at the group of muscles responsible for elevating the upper lip (19). This is a group of facial muscles that interact with the orbicularis oris muscle (9,23). In the pathogenesis of muscle-related gingival smile, the overactivity of three muscles plays a key role: the levator labii superioris alaeque nasi (LLSAN), the levator labii superioris (LLS), and the zygomaticus minor (ZMi). The LLSAN exhibits the strongest activity in the central part of the lip, responsible for its elevation and eversion, as well as for the flaring of the nostrils (20,24). The LLS is the primary muscle responsible for elevating the central part of the upper lip to the level of the nasolabial fold (3,8). The ZMi assists in lifting the upper lip, acting more laterally than the LLS and LLSAN (20,24). Hyperactivity of these

muscles causes the upper lip to be pulled up too high during a smile, resulting in excessive gum exposure (8,19).

The Yonsei point is considered the gold standard and the most predictable injection site for botulinum toxin in the treatment of a gummy smile (22,25). This point is located at the center of the triangle formed by the LLSAN, LLS, and ZMi muscles (1,11,19). Clinically, the Yonsei point is located approximately 1 cm lateral to the nasal wing and approximately 3 cm above the corner of the mouth (2,7,13). This injection site targets the three main muscles responsible for lifting the upper lip, allowing them to be treated with one injection (13,19,23). Compared with separate injections into each muscle, this method is simpler, safer, and more effective (19,23). The injection is administered into the muscle at a depth of approximately 2 mm beneath the skin (11). Some experts recommend deeper administration (approx. 6–7 mm) using a 30G needle to ensure direct action on the muscle fibers (27). The injection should be tailored to the type of smile. A frontal smile requires injection into the Yonsei point or the LLSAN and LLS muscles (3,24). A posterior smile, on the other hand, requires lateral administration of the toxin, targeting the zygomatic muscles (ZMi and ZMj), approximately 2 cm lateral to the standard point, on the tragus line (3,24). For mixed and asymmetrical smiles, a combination of injection sites is used, or different doses are administered to the right and left sides of the face to even out the smile line (1,3,24). Precise targeting of the Yonsei point minimizes the risk of complications, such as smile asymmetry or difficulties with speaking and eating, which can occur with unintended diffusion of the toxin into adjacent muscles, such as the zygomatic major or levator anguli oris (1,20).

4.3 Dosage tailored to different ethnic groups.

The dosage and administration techniques for BTX-A in the treatment of a gummy smile vary depending on the severity of the problem, the patient's gender, and the standards established for specific ethnic groups (1,20,21). Dosage values vary depending on expert recommendations and the severity of gum exposure. The most commonly recommended dose is 2 to 3 units (U) per side of the face at the Yonsei point (19,20,22,25). Other studies suggest a range of 1.25 U to 5 U per side, depending on the strength of the levator muscles (1,3,21). Patients with gingival exposure of less than 5 mm may be treated with a dose of 3 U per side, while cases exceeding 5 mm often require a dose of 5 U per side (4). Some studies indicate that in patients with very severe gingival exposure (>7 mm), increasing the number of injection sites along the levator muscles may be considered to ensure a more stable effect (1,3). Men typically require higher doses of toxin than women due to the greater volume of the upper lip muscles and thicker skin

(1,5,20). Given ethnic differences in Asian patients, the recommended total dose ranges from 2 to 6 U per side, most often administered at a single injection site (20). Studies in this group have confirmed that the Yonsei point is a safe and effective injection site (20,23). International guidelines for the Indian population recommend administering 2 to 3 U per side, often divided between two injection sites to ensure a more stable result (20). European and American guidelines recommend doses of 2–4 U per side of the upper lip (20).

5. The Use of Hyaluronic Acid (HA)-Based Fillers

5.1 The Concept of Myomodulation and “Dynamic Restructuring”

Hyaluronic acid (HA)-based fillers act in the treatment of a gummy smile not only as volumizing agents, but primarily through the mechanism of myomodulation (6,18).

Hyaluronic acid works by mechanically limiting the mobility of the levator labii superioris muscles (primarily the LLSAN and LLS complexes) (8,18). The filler can be administered superficially to weaken muscle function or deeply to compress muscle fibers and create a physical barrier to their contraction (6,8,18).

In the case of hyaluronic acid-based fillers, we refer to the concept of Dynamic Restructuring (RD). This involves restoring the balance between muscle strength and the resistance of soft tissues and facial structures, such as bone and adipose tissue (6). As a result of HA injections, tissue stiffness increases, making it more difficult for the muscles to wrinkle the skin when smiling (6).

5.2 HA as an alternative to botulinum toxin (BTX-A).

Botulinum toxin is considered the standard of care for treating the muscular causes of a gummy smile; however, hyaluronic acid offers advantages in several key areas. In terms of the duration of effects, results following HA injection last significantly longer, typically 6 to 12 months, and in some cases up to 18 months (8,21,28). With BTX-A injections, effects typically fade after 3–6 months (8,10,21). Regarding stability and satisfaction following administration of both substances, clinical studies have shown that while both methods provide similar improvement in the first few weeks, after 60 and 90 days, the HA-treated group demonstrates significantly better stability of results and higher satisfaction on the GAIS scale (28). It is worth noting that HA is a fully reversible method thanks to the use of hyaluronidase, which allows for immediate dissolution of the preparation in the event of complications (6,8,18). The effect of botulinum toxin cannot be immediately reversed by administering the preparation. Its effect must subside spontaneously (6). If the goal in clinical practice is to achieve a subtle correction without the

risk of complete muscle paralysis, it is worth considering an HA-based product. This is because, by using it, we eliminate concerns about a frozen facial expression or smile asymmetry—a certainty not provided by the use of BTX-A (6,18).

The outcome of the treatment depends on correct filler placement and proper knowledge of facial anatomy. Hyaluronic acid (HA) is commonly injected into the canine fossa, nasal bridge, columella, and upper lip. A small volume of HA (approximately 0.2–0.3 mL on each side) injected into the canine fossa can reduce the activity of the levator labii superioris alaeque nasi (LLSAN) muscle by applying pressure to its fibers. This helps decrease gingival exposure during smiling (8,17,18). Injecting the agent into the areas of the alar spine and columella blocks the action of the depressor of the nasal septum muscle, which prevents the tip of the nose from drooping and excessive elevation of the central part of the lip (8,17,18). The use of HA in the vermillion border area increases lip volume, which corrects inward lip inversion. It optically reduces gum exposure (17,29).

5.3 Use of HA in the treatment of “black triangles” and improvement of gingival aesthetics.

Hyaluronic acid has become a valuable tool for improving the aesthetics of the oral mucosa, enabling minimally invasive correction of gingival defects.

“Black triangles” are open spaces between teeth caused by the loss of interdental papillae. They may develop due to aging, periodontal tissue loss, or orthodontic treatment (11). Hyaluronic acid (HA) injections can be used to increase the volume of the interdental papilla and improve its shape. This treatment helps reduce visible gaps between teeth and improves smile aesthetics. Clinical reports have shown that even one HA injection can produce a visible improvement in papilla appearance and patient satisfaction (11).

In addition to its volumetric properties, hyaluronic acid also stimulates fibroblasts and angiogenesis. In this way, it aids in the healing of periodontal wounds and improves the hydration and elasticity of the mucosa (11). It is also used in the treatment of gingival recession and as an adjunct in implant procedures (11).

6. Surgical and Combined Methods

The multifactorial etiology of a gummy smile accounts for the variety of treatment methods used, including both surgical and combined approaches. The traditional surgical approach focuses on permanent correction of anatomical structures. Despite their high efficacy, purely surgical methods carry a risk of complications, are highly invasive, and—as in the case of lip

repositioning—are associated with a high recurrence rate (11,19). These limitations have spurred the development of combined methods that combine the precision of surgery with the modulating effects of botulinum toxin or modern technology (7,11,26).

6.1 Gingivectomy and Clinical Crown Lengthening

Gingivectomy and aesthetic clinical crown lengthening are the primary surgical procedures used to treat a gummy smile, particularly when it is caused by dento-gingival factors (1,5). These procedures aim to remove excess gingival tissue to expose the anatomical crown of the tooth, restore proper aesthetic proportions, and reduce excessive soft tissue exposure during smiling (5,26).

These procedures are recommended in cases of delayed or altered passive eruption (APE), a condition in which the gingival margin has not moved apically to the level of the enamel-cementum junction, causing the teeth to appear short and square (5,11). Indications also include gingival overgrowth, which may be caused by genetic factors, inflammation, or the use of certain medications (4,26). We also include a short clinical crown resulting, for example, from pathological tooth wear (1,4).

Modern surgery offers two main approaches to performing these procedures: the conventional method using a scalpel and the laser method.

The conventional method involves making oblique external incisions to remove excess tissue (5). This method is effective but is associated with increased intraoperative bleeding, the need for surgical dressings, and longer procedure and recovery times (26).

Laser gingivectomy is a procedure that uses a diode laser with a wavelength of 655–980 nm. It is increasingly preferred due to its high precision and benefits for the patient (26). This is because the laser provides immediate hemostasis or vessel coagulation, which eliminates bleeding and the need for sutures or dressings (26). Additionally, the laser's action stimulates tissue regeneration and reduces postoperative pain by blocking pain receptors (26).

Clinical crown lengthening procedures are characterized by high efficacy and stable results (5,26). After tissue healing—which, in the case of laser treatment, occurs within a week—patients report a significant improvement in self-confidence and smile aesthetics without reporting any significant complications (5,26).

6.2 Surgical repositioning of the upper lip

Surgical repositioning of the upper lip is a conservative surgical technique used to reduce a gummy smile by limiting the vertical movement of the upper lip (7). This procedure involves removing a strip of epithelium from the oral vestibule, above the mucogingival junction. The lip mucosa is then sutured closer to the teeth, resulting in mechanical shortening of the epithelium (5,7,11). This method is particularly indicated in patients with upper lip hypermobility and represents a less invasive alternative to orthognathic surgery in cases ranging from mild to moderate severity (11). Despite high initial patient satisfaction, the main limitation of this method is the high relapse rate, which is often observed as early as within the first 6–8 weeks after surgery (11,21). Relapses result from the strong force of the levator labii superioris muscles, which over time can stretch the scar tissue, returning the lip to its original position (5,11). To improve the stability of results, some modifications of this technique involve performing a myotomy, i.e., an incision in the muscles, or a myectomy to weaken the levator complex (1,7,11).

6.3 Combining botulinum toxin with surgical procedures to stabilize results.

Combining botulinum toxin with surgical procedures allows for more stable and predictable treatment outcomes in cases of gummy smile, particularly in cases with complex etiology (5,24). The primary goal of using neurotoxin to support surgery, especially in cases of upper lip repositioning, is to eliminate the tension and pulling force of the levator muscles on the newly formed surgical site (11). This mechanism allows for better tissue healing during the critical period and the stabilization of the new position of the oral vestibule, which prevents premature recurrence of the defect (7,11). The combined approach offers specific benefits for patients. Clinical studies indicate improved healing stability, reduced recurrence, and increased durability of results. Administration of botulinum toxin (e.g., incobotulinumtoxinA) two weeks prior to surgery ensures maximum muscle relaxation at the time of surgery and immediately afterward (11). Surgical lip repositioning carries a high risk of recurrence, which often occurs after 6–8 weeks, due to strong muscle strength. The addition of botulinum toxin significantly improves outcomes during the 3-month post-operative period (7,11). Even after surgical lip repositioning, a protocol involving repeated botulinum toxin injections at postoperative intervals—for example, at 2, 4, and 8 months—allows for the maintenance of a stable aesthetic result for at least one year, thereby preventing the postoperative scar from being stretched by the active muscles (11). A combined approach is also frequently considered as an alternative to radical surgery. In patients with severe gingival display, even up to 11–12 mm, for whom

orthognathic surgery would be indicated, combining a less invasive procedure such as gingivectomy with botulinum toxin allows for satisfactory aesthetic and functional rehabilitation (5). The modern interdisciplinary approach also involves the use of botulinum toxin as a “pharmaceutical splint” that reduces parafunctional forces and teeth clenching before and after periodontal surgery, which promotes bone and gum regeneration (24). Furthermore, the integration of botulinum toxin with orthodontic treatment using microimplants (TADs) allows for effective control of lip hypermobility after the completion of active tooth intrusion (16).

6.4 Orthodontic treatment and the role of microimplants (TADs) in tooth intrusion.

Orthodontic treatment, particularly using microimplants (TADs – Temporary Anchorage Devices), is an effective and increasingly common method for correcting a gummy smile, especially in cases with dento-alveolar or skeletal etiology (11). Microimplants serve as a stable skeletal anchor, allowing for simultaneous intrusion (moving teeth deeper into the bone) and distalization of the anterior teeth without loss of vertical control or anchorage (11). Infrazygomatic crest (IZC) mini-screws are primarily used for distalization of the maxillary arch and stabilization of anchorage (11). Interradicular mini-screws are often placed between the upper central incisors and are used directly for intrusion of the anterior maxillary segment, which is crucial for reducing a gummy smile (11). The use of TADs allows for the treatment of malocclusions that previously required surgical intervention, such as LeFort I osteotomy, providing patients with a less invasive and more cost-effective alternative (11). They are particularly helpful in correcting deep overbite and excessive gingival display (11). Studies show that treatment outcomes for gummy smiles using microimplants are predictable and characterized by good stability, as observed in follow-up examinations 2 years after the completion of the active tooth movement phase (11).

Orthodontic treatment is the method of choice when a gummy smile is caused by dentoalveolar extrusion or Class II skeletal malocclusions (1,11). In cases where a gummy smile is caused by overactivity of the levator labii superioris muscles, orthodontic treatment alone, which focuses on hard tissues, may be insufficient to fully resolve the problem (11). Additionally, orthodontic treatment carries a risk of complications. During intensive intrusion of the anterior teeth, a slight degree of root resorption may occur due to the applied forces, though this typically remains at a clinically acceptable level (11).

Orthodontic treatment alone is not always sufficient, which is why it is often supplemented with botulinum toxin. This so-called combination therapy often yields the best aesthetic results. It

combines tooth intrusion using microimplants with injections of botulinum toxin (BTX-A) (11). Orthodontic appliances correct tooth position, while botulinum toxin counteracts the effects of a hypermobile lip (11). The use of BTX-A in patients with severe muscle tension or a habit of clenching their teeth can also shorten the duration of orthodontic treatment by reducing the vertical muscle forces that counteract the movement of the braces (11).

6.5 Micro-Autologous Fat Transplantation (MAFT) as an Innovative Alternative.

Micro-autologous fat transplantation (MAFT) is an innovative, minimally invasive, and long-lasting alternative to traditional treatments for a gummy smile, such as botulinum toxin injections or extensive surgical procedures (30). The main innovation of the MAFT technique in correcting a gummy smile is the use of transplanted adipose tissue as an autologous spacer, referred to as the “spacer” effect (30). Portions of fat are precisely injected into the nasolabial fold area and the area above the upper lip, creating a physical barrier for the levator muscles of the upper lip (including LLSAN, LLS, and ZMi) (30). The mass of the transplanted fat (on average approx. 16.1 ml, weighing approx. 14.8 g) limits the vertical range of motion of the lip during smiling (30). Fat grafting increases the volume and vertical width of the upper lip and lengthens the subnasal groove (ergotrid), which optically reduces the visibility of the gums without altering the appearance of the face at rest (30).

The key to therapeutic success and long-lasting results is the use of the patented MAFT-GUN device, which enables extremely precise fat injection (30). The small size of the injected particles (1–2 mm in diameter) is crucial for their survival, as it allows for the free diffusion of nutrients and prevents central necrosis, which is a common problem in traditional fat grafting (30). Fat is most commonly harvested from the patient’s abdomen or thighs and then purified through centrifugation (3,000 rpm for 3 minutes) (30).

Studies have demonstrated the high effectiveness of the MAFT method. The average reduction in gum visibility after the procedure ranged from 3.8 mm to 4.9 mm depending on the group of teeth examined (incisors, canines) (30). The stability of the aesthetic result was confirmed in follow-up examinations after an average of 12.9 months, and in some cases even after 24 months following a single procedure (30).

The MAFT method allows for the achievement of natural facial contours without causing facial distortion either at rest or when smiling (30). No serious side effects, such as infections, skin necrosis, or fibrosis, were reported (30). Postoperative swelling is mild and usually subsides

within 7–10 days (30). The patient's own fat does not cause immune reactions, as it is an autologous material (30).

MAFT is considered an effective and safe method for patients seeking a permanent solution to a gummy smile who wish to avoid repeated botulinum toxin injections or invasive oral surgery (30).

7. Therapeutic Outcomes and Duration of Effects

7.1 Dynamics of Changes Following BTX-A Injection

The therapeutic outcomes of treating a gummy smile with botulinum toxin type A are characterized by a rapid onset of action, but they are temporary and reversible (1,12). The first effects of weakness in the levator labii superioris muscles usually become noticeable within 2 to 10 days after the procedure (3,24,25). The peak of therapeutic activity and maximum reduction in gingival exposure occur after approximately 2 weeks (1–4,21,24,28). During this period, a statistically significant reduction in the gingival smile is observed, averaging from 3 to over 5 mm, which allows many patients to achieve an aesthetically acceptable smile line (1–3,5,19,21). Treatment results remain stable for approximately 8 weeks (15). After this time, there is a gradual return of neuromuscular activity (15,21). Most studies indicate that the effect of the toxin wears off completely within 3 to 6 months after injection, after which muscle activity gradually returns to its baseline state, requiring a repeat treatment (1,3,5,16,20,24–26). Although a slight improvement may be measurable in some patients even after 24 weeks, smile parameters typically return to baseline values after this time, necessitating a repeat procedure (1–4,10,15).

7.2 The effect of repeated injections on long-term muscle weakness.

Some authors suggest that repeated BTX-A injections may lead to a prolongation of the therapeutic effects (3,5). This mechanism is explained by the fact that prolonged muscle paralysis resulting from serial treatments may lead to partial muscle atrophy and a permanent decrease in contractile capacity, even after the toxic effects of the preparation have subsided (3,5,12). Repeated applications may promote neuromuscular adaptation, which helps “mask” a gummy smile over the long term (4). Despite the above theories, more recent clinical studies with one-year follow-up question the possibility of achieving a permanent effect through injections alone (10). It was found that even after two cycles of injections administered at 4- or 8-month intervals, patients eventually returned to their baseline state, suggesting that botulinum toxin remains a purely temporary method (10).

7.3 Assessment of patient satisfaction using the GAIS scale.

Patient satisfaction following BTX-A treatments is typically very high immediately after injection, as confirmed by studies using the Global Aesthetic Improvement Scale (GAIS) (28). In comparative studies 14 days after treatment, 100% of patients treated with BTX-A reported “exceptional improvement” (score 1 on the GAIS scale). This result remained at the same level even after 30 days (28). In contrast to hyaluronic acid-based fillers, whose GAIS scores remain stable, satisfaction following BTX-A drops drastically after 60 and 90 days (28). Two months after injection, the number of patients reporting exceptional improvement drops to 0%, and after three months, some patients assess the condition of their smile as worsened compared to immediately after the procedure due to the recurrence of muscle hyperactivity (28). Despite the temporary nature of the effects, most patients (approximately 70–100%) express a willingness to undergo the procedure again and would recommend this method to others, appreciating its minimally invasive nature and lack of pain compared to surgical alternatives (1–3,5,8).

8. Complications and Limitations of the Methods

8.1. Common Side Effects and Complications

Although the use of BTX-A and dermal fillers is considered safe, these procedures carry a risk of side effects, and their effectiveness is limited by biological factors and the lack of uniform clinical guidelines (1,5,17). The use of neurotoxin in the perioral area, due to the high mobility and complex anatomy of this region, can lead to a number of complications (20,21). Improper injection technique or unintended diffusion of the toxin into adjacent muscles, such as the zygomatic major or levator anguli oris, can result in an asymmetrical smile (1,5,20). Another common complication is the so-called “Joker smile,” resulting from excessive lateral pulling of the lip by the zygomatic muscles while the central levators are paralyzed (2,3,5). Overdosing the preparation can cause ptosis, i.e., drooping of the upper lip, which leads to excessive coverage of the teeth when smiling (1,5,8). This may also cause difficulty speaking, eating, and drinking, as well as weakened contraction of the orbicularis oris muscle, manifesting, for example, as difficulty whistling or blowing kisses (5,20)). The most common, though transient, effects include pain at the injection site, swelling, redness, and hematomas and bruises, particularly in highly vascularized areas (1,2,17,20).

Horizontal Animation Deformity is a rare complication characterized by the appearance of a horizontal line of depression, which appears as a wrinkle on the upper lip when smiling (29). It results from an imbalance between the paralyzed levator muscles and the still-active zygomatic

major and risorius muscles, causing excess tissue in the upper part of the lip while simultaneously thinning it in the lower part (29).

8.2. Contraindications for the use of botulinum toxin.

Contraindications for the use of botulinum toxin in the treatment of a gummy smile can be divided into several key categories: medical (systemic and neurological), pharmacological, local, and psychological. The use of botulinum toxin is strictly contraindicated in patients suffering from conditions affecting neuromuscular transmission (1,5,25). These include: myasthenia gravis, Eaton-Lambert syndrome, and amyotrophic lateral sclerosis (ALS) (4,20,25). Administration of the neurotoxin in such cases may exacerbate the symptoms of the underlying disease (4). Botulinum toxin is classified as a Category C drug, meaning that its effects on the fetus have not been fully studied (4,25). For this reason, pregnancy and lactation are standard contraindications for the procedure (1,2,5,20). Particular caution should be exercised in patients taking medications that interfere with neuromuscular transmission, such as aminoglycoside antibiotics (e.g., gentamicin, neomycin), calcium channel blockers, quinidine, cyclosporine, as well as penicillamine, magnesium sulfate, succinylcholine, and polymyxin (1,2,4,5,20,24,25). These drug interactions may exacerbate the effects of the toxin and increase the risk of complications (4,25). Known hypersensitivity to any component of the preparation is a contraindication (1,5,20). Attention should be paid to the excipients contained in various brands of botulinum toxin, such as human albumin, lactose, and sodium succinate, as well as allergies to cow's milk proteins (in the case of certain preparations, e.g., abobotulinumtoxinA) (2,4,20,25). There are also local contraindications that require the procedure to be postponed or abandoned. These include: active infections or inflammation at the planned injection site, facial muscle weakness (e.g., due to Bell's palsy) in the treatment area, and a tendency to develop keloids (1,5,20). An important part of the evaluation is assessing the patient's motivation. Treatment should be avoided in patients with unrealistic expectations, psychological conditions such as Body Dysmorphic Disorder (BDD), or in individuals whose work relies heavily on facial movements (2,4,20,25). Extra caution is recommended for professions such as acting, singing, and playing musical instruments, where normal facial expression is important (25). Botulinum toxin is not recommended as the sole treatment method if a gummy smile results exclusively from anatomical factors that the neurotoxin cannot affect, such as vertical maxillary excess (VME) or delayed passive eruption of teeth (short clinical crowns) (1,15). In such cases, surgical interventions, such as Le Fort I osteotomy or gingivectomy, are more appropriate (15). Furthermore, toxin injection is not recommended if

the patient plans to undergo surgical smile correction in the near future, as its effect is temporary (1).

8.3. Challenges associated with the lack of standardized treatment protocols.

The main limitation to the widespread use of BTX-A in the treatment of a gummy smile is the lack of consensus regarding classification and therapeutic protocols (6,17). The scientific literature lacks a systematic clinical algorithm that would precisely define doses and injection sites depending on the etiopathogenesis of the problem (17,21). There is a wide variation in recommended doses (ranging from 1.25 to 7.5 units per side) and a lack of specific descriptions regarding the optimal injection depth, which contributes to the heterogeneity of the results obtained (20,21,27). A gingival smile is a multifactorial phenomenon, and failure to account for all components (e.g., bone and fat tissue deficits) in the diagnosis often leads to unsatisfactory results (17). The need for more prospective studies with a control group and a long follow-up period (over 12 months) is emphasized in order to reliably assess the predictability of outcomes and minimize the risk of recurrence (15,21).

9. Gingival Smile in Sports. Aesthetics, Function, and Regeneration.

9.1 Sports-Related Etiology. Stress and Parafunctions.

In the context of correcting a gummy smile in physically active individuals, sports-related etiology is inextricably linked to the impact of physical and psychological stress on the development of parafunctions, such as bruxism and pathological jaw clenching (25). These phenomena have a direct impact on both the hard dental structures and facial muscle dynamics, which can exacerbate the gingival smile. Occupational stress and extreme physical exertion are recognized as etiological factors in temporomandibular disorders (TMD) and muscle spasticity (25). During sports activities, excessive occlusal forces are generated, which far exceed the forces required for chewing food (25). Such chronic stress leads to pathological jaw clenching and bruxism. Intense parafunctional activities cause pathological wear of tooth crowns (25). This results in a shortening of the clinical crown, which, in the classification of causes of a gummy smile, constitutes a direct dentogingival factor that increases soft tissue exposure (6,17). In these patients, a gummy smile may be acquired, resulting from a loss of tooth height while the elevator muscles remain active (4). Prolonged stress and habitual clenching of the jaws lead to hypertrophy of the masseter muscles, which alters facial contours and may affect the tone of the entire facial musculature (20,25). Additionally, stress may exacerbate upper lip

hypermobility through increased recruitment of motor units in the levator muscles (LLSAN, LLS), which is a key muscular cause of a gummy smile (17,19).

9.2 The Pharmaceutical Approach and Recovery in Athletes.

The use of botulinum toxin (BTX-A) in physically active individuals serves as a pharmaceutical splint (4,19). This mechanism reduces parafunctional forces and limits excessive contraction of the masseter and levator muscles, thereby protecting hard tissues from overuse injuries (4,13). It also helps stabilize the healing process and reduce muscle tension following surgical procedures (e.g., gingivectomy), which promotes unimpeded regeneration of bone and gums (4,19).

For athletes, it is crucial to choose minimally invasive methods that result in minimal downtime from training (4,19,20). Injections of BTX-A and hyaluronic acid (HA) are preferred because they do not require hospitalization and provide nearly immediate aesthetic results (4,20). The use of hyaluronic acid in the mechanism of myomodulation helps restore structural balance while preserving the full naturalness of facial expressions, which is essential for an athlete's public image (6,18). Despite the low invasiveness of the procedure, athletes must adhere to strict post-treatment protocols following BTX-A administration. Training is prohibited. All physical activity should be avoided for at least 1 to 4 hours after injection to prevent unwanted diffusion of the preparation into adjacent muscles (11,20). For the first 24 hours, it is recommended to avoid bending over and mechanical irritation of the injection sites (11). Treatment of a gummy smile should improve smile aesthetics while maintaining normal oral function. Injectable procedures, such as botulinum toxin type A and hyaluronic acid, are minimally invasive treatment options that provide good aesthetic results with a short recovery time.

10. Summary and Conclusions

10.1 Algorithm for selecting a treatment method based on the severity of gingival exposure and the causative factor.

The selection of the optimal treatment method for a gummy smile depends on an accurate diagnosis, the causative factor, and the severity of the defect, as determined by the millimeter classification (1,5,6,11,15). The etiology of a gummy smile is multifactorial, which requires tailoring the technique to the specific problem (1,5–8,13,17,21).

In cases of bony causes (e.g., vertical maxillary excess [VME], protrusion). In mild to moderate cases, orthodontic treatment using microimplants (TADs), which allow for tooth intrusion, is recommended (2,8,9,16,19). In severe cases, orthognathic surgery (e.g., Le Fort I osteotomy) is indicated (1,6,15,21,24,25).

Dental and gingival causes (e.g., delayed passive eruption—APE, gingival hyperplasia). Recommended procedures include gingivectomy or aesthetic clinical crown lengthening (using traditional or laser methods) to expose the anatomical portion of the tooth crown (1,5–7,21,24,25). The use of a diode laser shortens procedure time and improves healing (7,15,26).

Muscular causes (hyperactivity of the levator labii superioris muscles). We use one of the following methods: botulinum toxin (BTX-A), hyaluronic acid (HA), or micro-autogenous fat transfer (MAFT) (1,6,14,17–21,30).

Soft-tissue causes (e.g., short or hypermobile lip, inversion of the vermilion border). Surgical repositioning of the upper lip (lip repositioning), fillers (HA), and botulinum toxin (BTX-A) are indicated (1,16,17).

The severity of gingival exposure, measured in millimeters, determines the invasiveness of the procedures. Using the scale by Chu and Garber-Salama:

Grade I (2–4 mm): The least invasive approach. Often corrected through orthodontic, periodontal, or prosthetic treatment (1,6,21).

Grade II (4–8 mm): Usually requires more advanced treatment, such as surgical lip repositioning or a combination of different treatment methods (1,6,21).

Grade III (>8 mm): In most cases, surgical treatment is necessary, with orthognathic surgery considered the standard approach for severe excessive gingival display (1,6,21).

Modern protocols often combine methods to stabilize treatment outcomes.

Combination of surgery and BTX-A. Administration of botulinum toxin before or after surgical lip repositioning significantly reduces the risk of recurrence by eliminating the pulling force of the muscles during healing (7,11).

The use of orthodontics and BTX-A. Botulinum toxin helps control lip hypermobility after completion of tooth intrusion with braces (16,19).

A hybrid approach combining gingivectomies with BTX-A may serve as an alternative to orthognathic surgery in patients with significant exposure (up to 11–12 mm) who do not opt for invasive bone surgery (5).

10.2 Future research directions: hybrid protocols and long-term prospective studies.

Future research on the correction of a gummy smile will focus on increasing the longevity of results and standardizing clinical procedures (1,7,13,25). Based on the literature, two main areas of development can be identified. One of them is the development of hybrid protocols (11,21,24). Modern aesthetic medicine and surgery aim to combine various techniques to overcome the limitations of individual methods. In the case of surgical procedures, pharmacology plays an important role. A key approach is combining surgical lip repositioning with botulinum toxin (BTX-A) injections (7,11). Here, the toxin acts as a “pharmaceutical splint” that eliminates muscle tension during healing, which significantly reduces the high recurrence rate typical of surgery alone (7,11). Hybrid protocols have also been developed in orthodontics. The integration of treatment with braces, microimplants (TADs), and botulinum toxin allows for simultaneous correction of tooth position and control of lip hypermobility after the completion of active intrusion (8,16).

Combined techniques are often an alternative to radical surgical procedures (5,21,30).

Protocols combining gingivectomy with BTX-A are being studied, which allow for satisfactory results in patients with significant gingival exposure (up to 11–12 mm) who wish to avoid invasive orthognathic surgery (5,13). It is also worth noting the development of techniques such as MAFT (micro-autogenous fat transfer), which creates a physical barrier for the muscles (the “spacer” effect) and offers a permanent alternative to temporary injections (30).

Another equally important area of development is long-term prospective studies (2,17,23). The sources point to significant gaps in current knowledge that should be addressed in future analyses (3,13,15). The need for prospective studies with a control group and a long follow-up period (more than one year) is emphasized in order to reliably assess the predictability of outcomes and the stability of various methods (16,21). There is also a need to standardize treatment protocols (3,17,21,22). Currently, there is a lack of uniform clinical algorithms defining precise BTX-A doses, injection sites, and injection depths depending on the specific cause of a gummy smile (3,21,27). Future studies should focus on standardizing classification systems, such as the Mercado-Rosso classification and the Gingival Balance Face scale. A unified classification would help clinicians choose the most appropriate treatment and allow

better comparison of clinical outcomes between different studies and treatment centers (6,17). The mechanism of recurrence following surgical procedures and the effect of repeated botulinum toxin injections on potential permanent muscle atrophy—which could extend the intervals between treatments—require detailed investigation (2,3,5,7,10,11).

In summary, the future of gummy smile treatment is based on an interdisciplinary approach that combines surgical techniques with injectable treatments. Further long-term clinical studies are needed to evaluate the effectiveness and safety of these treatment methods (7,13,14).

10.3 Correction of a gummy smile in athletes: the synergy of aesthetics and functional preservation.

A specific group of patients requiring an integrated approach consists of physically active individuals and professional athletes, in whom the etiology of a gummy smile is often associated with high levels of occupational stress and physical exertion (1). These factors are considered key in the development of temporomandibular disorders (TMD) and parafunctional habits, such as bruxism and pathological clenching (1). The resulting excessive occlusal forces lead to pathological wear of the tooth crowns, resulting in their shortening (short clinical crown) and directly exacerbating the gummy smile (1).

In this context, botulinum toxin (BTX-A) goes beyond the scope of a purely aesthetic procedure, serving as a “pharmaceutical splint” (1). By reducing muscle tension in the masseter and levator labii superioris muscles, BTX-A not only corrects gum exposure but, above all, protects the hard tissues of the teeth from further wear and supports the regeneration of periodontal structures (1). For athletes, the priority is to choose minimally invasive methods, such as hyaluronic acid or BTX-A injections, which, due to their short duration and rapid onset of action, allow for minimized recovery time and a quick return to the training routine (1,11).

The key recommendation for this group, however, is the need to strictly adhere to post-treatment protocols, particularly the prohibition of physical activity for at least 1 to 4 hours after the injection, which is essential to prevent unwanted diffusion of the preparation into adjacent muscles (1). Achieving an aesthetically pleasing smile in an athlete thus becomes part of a broader therapy aimed at improving quality of life and stabilizing masticatory function under conditions of extreme physical stress (1).

Disclosure

Supplementary Materials:

Not applicable.

Author's Contribution:

Conceptualization: Julia Kalsztein

Methodology: Weronika Kubiak, Julia Kalsztein, Zuzanna Małek, Marta Kwiatkowska, Kacper Wiertelak-Makała

Software: Not applicable.

Check: Aleksandra Wyciślok, Olgierd Czapiński

Formal analysis: Weronika Kubiak, Katarzyna Waśkowska, Zuzanna Małek

Investigation: Olgierd Czapiński, Zuzanna Małek, Kacper Wiertelak-Makała

Resources: Aleksandra Wyciślok, Olgierd Czapiński, Weronika Kubiak

Data curation: Julia Kalsztein, Weronika Kubiak, Katarzyna Waśkowska

Writing-rough preparation: Zuzanna Małek, Julia Kalsztein, Marta Kwiatkowska

Writing review and editing: Olgierd Czapiński, Zuzanna Małek, Kacper Wiertelak-Makała, Weronika Kubiak, Katarzyna Waśkowska

Visualization: Weronika Kubiak, Julia Kalsztein

Supervision: Kacper Wiertelak-Makała, Olgierd Czapiński

Project administration: Olgierd Czapiński, Aleksandra Wyciślok

Receiving funding: Not applicable.

All authors have read and agreed with the published version of the manuscript.

Funding statement:

This research has not received any external funding.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

Not applicable.

Acknowledgments:

Not applicable.

Conflict of Interest Statement:

The authors deny any conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process:

The authors used Claude (Anthropic) solely for the purpose of improving the linguistic quality and structural organization of the manuscript. The authors maintain full responsibility for the accuracy and integrity of the publication's substantive content.

References:

1. Fatani B. An Approach for Gummy Smile Treatment Using Botulinum Toxin A: A Narrative Review of the Literature. *Cureus*. 15(1):e34032. doi:10.7759/cureus.34032 PubMed PMID: 36824551; PubMed Central PMCID: PMC9941039.
2. Soris BAT, Shenoy KV, Ramadorai A, Kumar CSCS, Marimuthu L. Botulinum Toxin-A in the Treatment of Excessive Gingival Display: A Clinical Study. *J Maxillofac Oral Surg*. marca 2022;21(1):51–7. doi:10.1007/s12663-021-01541-0 PubMed PMID: 35400907; PubMed Central PMCID: PMC8934896.
3. Mate PP, Nilesh K, Joshi A, Panda A. Clinical and electromyographic evaluation of botulinum toxin type A in the treatment of gummy smile: A prospective clinical study. *J Dent Res Dent Clin Dent Prospects*. 2021;15(2):122–8. doi:10.34172/joddd.2021.021 PubMed PMID: 34386184; PubMed Central PMCID: PMC8346717.
4. Rajagopal A, Goyal M, Shukla S, Mittal N. To evaluate the effect and longevity of Botulinum toxin type A (Botox®) in the management of gummy smile – A longitudinal study upto 4 years follow-up. *J Oral Biol Craniofac Res*. 2021;11(2):219–24. doi:10.1016/j.jobcr.2021.02.006 PubMed PMID: 33665071; PubMed Central PMCID: PMC7898180.

5. Mostafa D. A successful management of sever gummy smile using gingivectomy and botulinum toxin injection: A case report. *Int J Surg Case Rep.* 1 grudnia 2017;42:169–74. doi:10.1016/j.ijscr.2017.11.055 PubMed PMID: 29248835; PubMed Central PMCID: PMC5985251.
6. Mercado-García J, Rosso P, Gonzalez-García M, Colina J, Fernández JM. Gummy Smile: Mercado-Rosso Classification System and Dynamic Restructuring with Hyaluronic Acid. *Aesthetic Plast Surg.* 2021;45(5):2338–49. doi:10.1007/s00266-021-02169-8 PubMed PMID: 33619610; PubMed Central PMCID: PMC8481201.
7. Keles M, Sen DO, Oncu E. Comparison of lip repositioning and lip repositioning with botulinum toxin application in gummy smile treatment. *J Oral Biol Craniofacial Res.* 2026;16(2):101422. doi:10.1016/j.jobcr.2026.101422 PubMed PMID: 41732661; PubMed Central PMCID: PMC12925205.
8. Angulo-Manzanque G, Baus-Domínguez M, Ruiz-de-León-Hernández G, Serrera-Figallo MÁ, Torres-Lagares D, Aguilera FS. Evaluation of a New Technique of Gingival Smile Reduction after Hyaluronic Acid Infiltration: A Cohort Study Focusing on Gingival Exposure and Patient-Oriented Outcomes. *Dent J.* 15 października 2024;12(10):329. doi:10.3390/dj12100329 PubMed PMID: 39452457; PubMed Central PMCID: PMC11506583.
9. Dinker S, Anitha A, Sorake A, Kumar K. Management of gummy smile with Botulinum Toxin Type-A: A case report. *J Int Oral Health JIOH.* lutego 2014;6(1):111–5. PubMed PMID: 24653614; PubMed Central PMCID: PMC3959148.
10. Adel N. A Standardized Technique for Gummy Smile Treatment Using Repeated Botulinum Toxins: A 1-year Follow-up Study. *Plast Reconstr Surg Glob Open.* 25 kwietnia 2022;10(4):e4281. doi:10.1097/GOX.0000000000004281 PubMed PMID: 35494889; PubMed Central PMCID: PMC9038448.
11. Adel N. Botulinum Toxins and Lip Repositioning Surgery with Repeated Botulinum Toxin Injection: A Combined Approach for Gummy Smile Treatment. *Plast Reconstr Surg Glob Open.* 15 sierpnia 2023;11(8):e5198. doi:10.1097/GOX.0000000000005198 PubMed PMID: 37588474; PubMed Central PMCID: PMC10427068.

12. Araujo JP, Cruz J, Oliveira JX, Canto AM. Botulinum Toxin Type-A as an alternative treatment for gummy smile: a case report. *Dermatol Online J.* 2018;24(7). doi:10.5070/D3247040926
13. Kim H, Kim S, Cho YD. Pink esthetic treatment of gingival recession, black triangle, and gummy smile: a narrative review. *Maxillofac Plast Reconstr Surg.* 17 lipca 2025;47(1):17. doi:10.1186/s40902-025-00467-8 PubMed PMID: 40676387; PubMed Central PMCID: PMC12271026.
14. Maci M, Fanelli C, Lorusso M, Ferrara D, Caroprese M, Laurenziello M, et al. Botulinum Toxin Type A and Hyaluronic Acid Dermal Fillers in Dentistry: A Systematic Review of Clinical Application and Indications. *J Clin Med Res.* czerwiec 2024;16(6):273–83. doi:10.14740/jocmr5202 PubMed PMID: 39027812; PubMed Central PMCID: PMC11254312.
15. Chagas TF, Almeida NV de, Lisboa CO, Ferreira DMTP, Mattos CT, Mucha JN. Duration of effectiveness of Botulinum toxin type A in excessive gingival display: a systematic review and meta-analysis. *Braz Oral Res.* 2018;32:e30. doi:https://doi.org/10.1590/1807-3107bor-2018.vol32.0030
16. Viet H, Thao DTN, My NK, Phuoc TH, Tuyen HM. Improvements of facial profile and smile aesthetic using temporary anchorage devices and botulinum toxin: a case report. *Arch Craniofac Surg.* październik 2024;25(5):240–6. doi:10.7181/acfs.2024.00052 PubMed PMID: 39501733; PubMed Central PMCID: PMC11540489.
17. Angulo-Manzanque G, Baus-Domínguez M, Ruiz-de-León G, Serrera-Figallo MÁ, Aguilera FS, Torres-Lagares D. Proposal of a New Therapeutic Classification in Gingival Smiles Focused on Treatment with Semi-Permanent Infiltrations. *Dent J.* 5 październik 2024;12(10):319. doi:10.3390/dj12100319 PubMed PMID: 39452447; PubMed Central PMCID: PMC11506444.
18. Germani Vieira M, Rogerio V, Roschel P, Rabelo V, Teixeira T, Muñoz-Lora VRM. Myomodulation using hyaluronic acid fillers as an efficient and innovative treatment for gummy smile: A case report. *J Oral Biol Craniofac Res.* 2022;12(3):376–80. doi:10.1016/j.jobcr.2022.04.009 PubMed PMID: 35586484; PubMed Central PMCID: PMC9108743.

19. Gupta N, Kohli S. Evaluation of a Neurotoxin as an Adjunctive Treatment Modality for the Management of Gummy Smile. *Indian Dermatol Online J.* 28 sierpnia 2019;10(5):560–3. doi:10.4103/idoj.IDOJ_365_18 PubMed PMID: 31544076; PubMed Central PMCID: PMC6743383.

20. Hong SO. Cosmetic Treatment Using Botulinum Toxin in the Oral and Maxillofacial Area: A Narrative Review of Esthetic Techniques. *Toxins.* lutego 2023;15(2):82. doi:10.3390/toxins15020082

21. Rojo-Sanchis C, Montiel-Company JM, Tarazona-Álvarez B, Haas-Junior OL, Peiró-Guijarro MA, Paredes-Gallardo V, et al. Non-Surgical Management of the Gingival Smile with Botulinum Toxin A—A Systematic Review and Meta-Analysis. *J Clin Med.* stycznia 2023;12(4):1433. doi:10.3390/jcm12041433

22. Pedron IG. Comment on “Botulinum toxin type-A as an alternative treatment for gummy smile: a case report”. *Dermatol Online J.* 2019;25(6). doi:10.5070/D3256044499

23. Hwang WS, Hur MS, Hu KS, Song WC, Koh KS, Baik HS, et al. Surface Anatomy of the Lip Elevator Muscles for the Treatment of Gummy Smile Using Botulinum Toxin. *Angle Orthod.* stycznia 2009;79(1):70–7. doi:10.2319/091407-437.1

24. Pedron IG, Mangano A. Gummy Smile Correction Using Botulinum Toxin With Respective Gingival Surgery. *J Dent.* września 2018;19(3):248–52. PubMed PMID: 30175196; PubMed Central PMCID: PMC6092459.

25. Nayyar P, Kumar P, Nayyar PV, Singh A. BOTOX: Broadening the Horizon of Dentistry. *J Clin Diagn Res JCDR.* grudnia 2014;8(12):ZE25–9. doi:10.7860/JCDR/2014/11624.5341 PubMed PMID: 25654058; PubMed Central PMCID: PMC4316364.

26. Mossaad AM, Abdelrahman MA, Kotb AM, Alolayan AB, Elsayed SAH. Gummy Smile Management Using Diode Laser Gingivectomy Versus Botulinum Toxin Injection - A Prospective Study. *Ann Maxillofac Surg.* 2021;11(1):70–4. doi:10.4103/ams.ams_458_20 PubMed PMID: 34522657; PubMed Central PMCID: PMC8407640.

27. Dimasi I, Chalhoub X, Ng ZY. Botulinum Toxin A for Gummy Smile—Keep It Simple. *Aesthet Surg J*. 17 sierpnia 2023;43(9):NP718–9. doi:10.1093/asj/sjad138
28. Sonone TP, Soni VP, Patil CD, Shenava S, Mathew R, Gaonkar P. Comparison of Effectiveness, Duration, and Patient's Satisfaction of Botulinum Toxin A and Hyaluronic Filler in the Treatment of Gummy Smile: An in Vivo Study. *J Pharm Bioallied Sci*. września 2025;17(Suppl 3):S2183–6. doi:10.4103/jpbs.jpbs_753_25
29. Chen G, Oranges CM, Giordano S, Huang R, Wang W. Horizontal animation deformity as unusual complication of neurotoxin modulation of the gummy smile. *Dermatol Online J*. 2019;25(8). doi:10.5070/D3258045143
30. Huang SH, Huang YH, Lin YN, Lee SS, Chou CK, Lin TY, et al. Micro-Autologous Fat Transplantation for Treating a Gummy Smile. *Aesthet Surg J*. sierpnia 2018;38(9):925–37. doi:10.1093/asj/sjy069 PubMed PMID: 29566216; PubMed Central PMCID: PMC6317576.