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MODULATION OF EMOTIONS USING BOTULINUM TOXIN IN INDIVIDUALS WITHOUT PSYCHIATRIC DISORDERS: A NARRATIVE REVIEW

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ABSTRACT

Aim: This review aims to discuss the mechanisms by which reducing facial muscle activity in the glabellar region may influence emotional processing and regulation in individuals without diagnosed mental disorders.
Material and Methods: A literature search was conducted using MedLine/PubMed databases in both Polish and English. Additionally, reference lists of selected articles were screened to identify further relevant studies.
Results: Botulinum toxin exerts its effect by blocking acetylcholine release at the neuromuscular junction, resulting in temporary muscle paralysis. According to the facial feedback hypothesis, facial expressions not only reflect emotions but also influence their experience and regulation. Limiting the activity of muscles responsible for negative emotional expressions may modulate subjective emotional experience. Available studies suggest that botulinum toxin injections in the glabellar region may be associated with improved mood and increased subjective well-being in individuals without psychiatric disorders.
Conclusions: Botulinum toxin may influence emotional regulation by altering feedback from facial muscles in individuals without mental disorders. However, high-quality studies are still needed to confirm these findings.

KEYWORDS

Botulinum Toxin, Emotional Modulation, Facial Feedback, Well-Being

CITATION

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1. Introduction

Emotions constitute one of the fundamental components of human functioning, influencing cognitive processes, behavior, and social interactions. For many years, it was widely believed that emotions arise exclusively from processes occurring within the brain, while facial expressions were considered merely their external manifestation. However, contemporary research indicates a bidirectional relationship between facial expression and emotional experience, commonly referred to as the facial feedback theory. According to this concept, feedback signals originating from facial muscles are transmitted to the central nervous system and may modulate subjective emotional experiences [1–3].

Botulinum toxin, widely used in aesthetic medicine to reduce dynamic facial wrinkles, induces a temporary reduction in muscle activity by blocking the release of acetylcholine at the neuromuscular junction [4]. Inhibition of contractions in muscles responsible for the expression of negative emotions may reduce afferent feedback to the brain, thereby potentially influencing the way emotions are processed and experienced. In recent years, particular attention has been given to the use of botulinum toxin in the treatment of depressive disorders, where its role as an adjunctive therapy has been supported by multiple studies [5–7].

The aim of this paper is to present the concept of facial feedback and to discuss the role of botulinum toxin as a tool for modulating facial muscle activity, as well as its potential impact on emotional processes in individuals without diagnosed mental disorders.

2. Methods

This study was conducted as a narrative review with a structured literature search. The review process was guided by selected elements of the PRISMA 2020 framework to ensure transparency in study identification and selection; however, due to the heterogeneity of the available data, a full systematic review methodology was not applied.

A search of the MedLine/PubMed database was performed in both Polish and English, covering the period from May 1982 to March 2026. The following search strategy was applied to identify potentially

relevant articles: (“botox” OR “botulinum toxin” OR “BTX” OR “BoNT/A” OR “botulinum toxins”) AND (“emotion” OR “facial feedback”). Additionally, the reference lists of selected publications were manually screened to identify further relevant studies.

Inclusion criteria comprised studies investigating the effects of botulinum toxin on emotional processes in adults (>18 years), including individuals without diagnosed mental disorders, published in English or Polish, with an experimental or observational design, as well as case reports, and with full-text availability.

Exclusion criteria included studies focusing exclusively on depression or other psychiatric disorders, publications without full-text access, animal studies, and articles without original data.

The selection process involved identification of records, removal of duplicates, screening of titles and abstracts, and full-text assessment.

A total of 45 records were identified (43 from database searches and 2 from reference lists). After removal of 2 duplicates, 11 studies were selected based on title screening. Following abstract evaluation, 7 articles were retained, and after full-text assessment, 6 studies were ultimately included in the review. One study was excluded at the full-text stage due to the absence of relevant emotional outcome measures.

The study selection process is presented in the PRISMA flow diagram (Figure 1).

A formal risk-of-bias assessment using standardized tools was not performed, which represents a limitation of this review. However, key methodological limitations of the included studies—such as small sample sizes, lack of randomization, and potential selection bias—were critically discussed in the Discussion section.

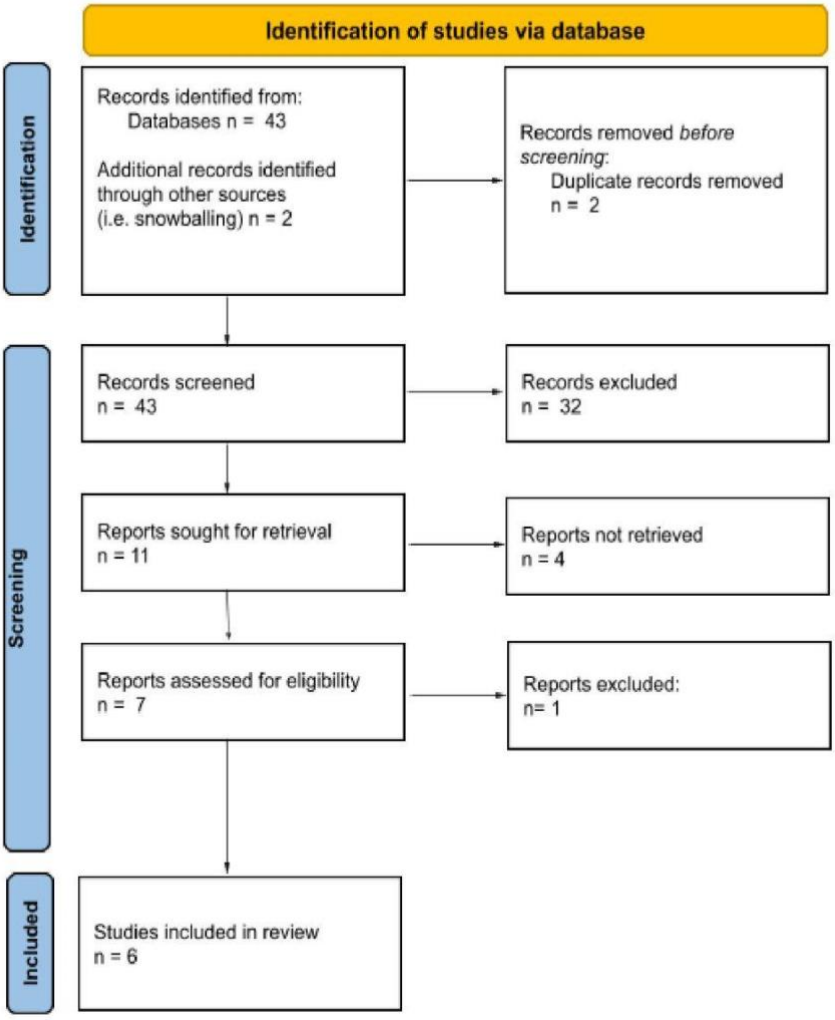

Fig. 1. *Prisma flow diagram illustrating selection process*

3. Facial Feedback

Research on the influence of muscle activity and body posture on the intensity of emotional responses dates back to the work of Charles Darwin [1], who in 1872 proposed a concept now known as the facial feedback theory.

Since then, numerous studies have attempted to determine whether facial expressions can influence the experience and processing of emotions, even in the absence of conscious awareness of this effect.

In 1988, Fritz Strack and colleagues [2] conducted a landmark experiment in this field. The study compared levels of amusement in response to cartoons between two groups of participants. One group held a pen between their teeth, while the other held it between their lips. To minimize the influence of awareness and avoid bias related to the study's purpose, participants were told that the task aimed to assess their psychomotor coordination.

The experimental condition—holding a pen between the teeth—was designed to activate the zygomaticus major muscle, which is responsible for producing a natural, spontaneous smile. Participants who unknowingly simulated a smiling expression rated the cartoons as more amusing compared to the control group.

A similar methodological approach was employed by Randolph J. Larsen [3], who focused on facial expressions associated with negative emotions such as anger, fear, and sadness, particularly involving the corrugator supercilii muscle. In this study, participants were asked to bring together small objects attached near the medial part of the eyebrows, thereby inducing a frowning expression. Subsequently, they evaluated images in terms of the level of sadness they evoked. Induced facial expressions associated with negative affect led participants to rate stimuli as more negative compared to a relaxed control group.

Further evidence supporting the relationship between facial activity and emotional processing comes from electromyographic (EMG) studies of the corrugator supercilii muscle, which have demonstrated a correlation between increased muscle activity and imagined negative emotional states [8] and exposure to emotionally negative stimuli [9].

Additionally, neuroimaging studies have shown that temporary paralysis of the muscles responsible for frowning can influence the activity of brain regions involved in emotional processing, particularly the amygdala [10–11]. In a functional magnetic resonance imaging (fMRI) study [12], it was observed that following botulinum toxin injection, amygdala responses to emotional stimuli were attenuated, returning to baseline after the effect of the toxin subsided. These findings provide direct evidence for the role of facial feedback in modulating neural activity associated with emotional processing.

4. Mechanism of Action of Botulinum Toxin and Facial Anatomy

Botulinum toxin type A (BTA) is a neurotoxin produced by the bacterium Clostridium botulinum. It is one of the most potent biological toxins known and exerts its effect by inhibiting neuromuscular transmission through blockade of acetylcholine release at the neuromuscular junction [4].

In clinical practice, its ability to induce temporary muscle relaxation has been utilized in the treatment of conditions such as dystonia, migraine, bruxism, hyperhidrosis, and overactive bladder. However, its most widespread application remains in aesthetic medicine, where it is used to reduce facial muscle activity and, consequently, dynamic wrinkles.

The generation of a genuine, spontaneous smile—known as a Duchenne smile—requires the coordinated contraction of both upper and lower facial muscles, particularly the zygomaticus major and orbicularis oculi muscles. This type of smile is associated with increased subjective well-being and is perceived as more genuine and socially engaging [13]. Contraction of the orbicularis oculi muscle may lead to the formation of lateral periorbital wrinkles, commonly referred to as "crow's feet," which are a frequent target for botulinum toxin treatment.

In contrast, negative emotions such as anger, frustration, or fear are primarily associated with the activity of the corrugator supercilii muscle in the glabellar region. Chronic contraction of this muscle may result in the formation of vertical glabellar lines, often described as "frown lines", "omega" or "anger lines."

5. Results

Studies investigating the effects of botulinum toxin on overall well-being in individuals without diagnosed mental disorders yield inconclusive results. This contrasts with studies conducted in patients with depression, where improvements in mood and reductions in depressive symptoms have been consistently demonstrated [5–7,14].

In a study conducted by a research team in Kobe [15], all participants reported a significant improvement in overall mood ($p = 0.008$) and a reduction in emotional tension ($p = 0.003$) following glabellar botulinum toxin injections. Emotional state was assessed using the BMMC/BMC-J questionnaire, which evaluates primary emotions such as happiness, sadness, anger, anticipation, fear, loneliness, jealousy, disgust, surprise, and trust—emotions associated with amygdala processing.

Another study demonstrated a significant reduction in the intensity of negative emotions ($p = 0.001$ [16]; $p = 0.003$ [17]) and a significant improvement in mood ($p = 0.007$) [17] following botulinum toxin treatment [16,17]. It is important to note that in this study participants self-selected into either the treatment or control group.

In a separate experiment, participants were asked to categorize 60 sentences according to emotional valence (happiness, sadness, anger), and response times were measured.

A significant delay in processing sentences with negative emotional content (sadness: $p = 0.024$; anger: $p = 0.025$) was observed in individuals following botulinum toxin injections, with no significant effect for positive stimuli ($p = 0.825$).

Another study employed a three-stage protocol: (1) rating sentences according to emotional intensity (ranging from strong to moderate to neutral), (2) assessing facial expressions and their intensity, and (3) categorizing facial expressions as “happy” or “sad” under time pressure. Each stage was conducted before and after treatment. The results demonstrated a significant reduction in the attribution of moderate emotional intensity to stimuli ($p < 0.01$), with no differences observed for neutral or highly intense stimuli following botulinum toxin injections. A similar pattern was observed in facial expression assessments, where the number of faces categorized as expressing moderate emotions decreased significantly ($p < 0.01$).

The final study included in the analysis did not demonstrate differences in the evaluation of short video clips in terms of emotional valence between individuals who received botulinum toxin and those who did not. However, a statistically significant decrease in the perception of stimuli as moderately positive was observed ($p = 0.02$).

Table 1. Summary of studies on the effects of botulinum toxin on emotional processing in healthy individuals

Study (Author, Year)	Study Design	Sample Size (BTX vs Control)	Population	Intervention	Outcome Measures	Main Findings	Limitations
Lewis & Bowler, 2009	Observational	12 / 13	Healthy females	BTX vs other treatment	IDAS	Reduced depressive symptoms ($p = 0.003$)	Small sample, only women
Havas et al., 2010	Experimental	41 / –	Healthy adults	BTX (glabellar)	Emotional sentence processing	Slower processing of angry ($p = 0.025$) and sad sentences ($p = 0.024$)	No control group, recruitment by a plastic surgery clinic
Davis et al., 2010	Controlled study	33 / 35	Healthy adults	BTX vs other treatment	Emotional response to video clips	No change in strong emotions; reduced response to mildly positive stimuli ($p = 0.02$)	Self-selection bias

Study (Author, Year)	Study Design	Sample Size (BTX vs Control)	Population	Intervention	Outcome Measures	Main Findings	Limitations
Baumeister et al., 2016	Experimental	11 / –	Healthy adults	BTX	Emotional intensity ratings	Decreased emotionality for moderately emotional stimuli ($p < 0.01$)	Very small sample
Lewis et al., 2018	Controlled study	24 / 12	Healthy females	BTX vs other treatment	HADS	Decrease in negative mood ($p = 0.001$), improved in mood ($p = 0.007$)	Self-selection, only women
Hanayama et al., 2024	Observational	47 / –	Healthy adults	BTX (glabellar)	BMC-J	Improved emotional state ($p = 0.008$), reduced negative emotions ($p = 0.003$)	No control group

6. Role in Society

An important aspect of emotion modulation using botulinum toxin is its impact not only on the individual but also on people in their social environment. Facial mimicry and facial contagion are key mechanisms involved in emotional processing within social contexts.

Facial mimicry is defined as the automatic and unintentional activation of facial muscles corresponding to the observed emotional expression of another person. This phenomenon occurs with minimal temporal delay and is considered a component of the perception–action system, supporting emotion recognition through simulation mechanisms.

Facial contagion, in contrast, refers to the process in which the perception of an emotional expression leads not only to its motor imitation but also to the induction of a corresponding affective state in the observer. This mechanism underlies so-called “emotional contagion” and plays a crucial role in the development of empathy and emotional coordination during social interactions. Although functionally related, these phenomena are not identical. Facial mimicry may occur without a full emotional shift, whereas facial contagion reflects deeper affective processing [18,19].

In summary, modifying the expression of negative emotions in an individual may, through these mechanisms, exert a beneficial influence on others in their social environment.

7. Discussion

Inhibition of the corrugator supercilii muscle in the glabellar region limits the ability to generate facial expressions associated with anger, frustration, or sadness. As a consequence, the amount of feedback transmitted to brain structures involved in emotional processing—primarily the amygdala and prefrontal cortex—is reduced. This may lead to a diminished experience of negative emotional states.

When interpreting the findings of the included studies, several limitations must be considered. First, only six studies met the inclusion criteria, and most were conducted on relatively small samples ($n < 50$), predominantly composed of women, which limits the generalizability of the results. Additionally, the lack of randomization and the recruitment of participants through aesthetic medicine clinics or plastic surgery centers introduce potential psychological bias that cannot be fully excluded.

Second, the tools used to assess emotional outcomes varied considerably across studies, making direct comparisons difficult. Another limitation is the lack of detailed information regarding the doses of botulinum toxin administered. Overall, the analyzed studies present a moderate to high risk of bias.

It is worth noting, however, that all included studies were consistent in terms of the absence of diagnosed psychiatric disorders and the lack of prior botulinum toxin injections in the glabellar region among participants.

The use of botulinum toxin to modulate emotions in individuals without psychiatric disorders raises important ethical considerations that extend beyond the traditional scope of aesthetic medicine. Unlike therapeutic interventions aimed at treating disease, this approach targets healthy individuals with the goal of potentially modifying psychological well-being. This raises concerns regarding the medicalization of natural emotional states. The introduction of biological interventions as a means of coping with everyday experiences such as stress, frustration, or sadness may promote the notion that negative emotions should be eliminated rather than understood and regulated through psychological strategies.

Furthermore, potential disruptions in nonverbal communication should be considered. These may arise from a prolonged time required to recognize emotional expressions in others, as demonstrated in previous studies [24,25].

An additional important question is whether the observed emotional modulation results from altered neural feedback to the amygdala or simply from improved physical appearance. Available analyses [26,27] suggest that there is no correlation between wrinkle reduction following varying doses of botulinum toxin and the improvement of depressive symptoms in patients, supporting a mechanism beyond purely aesthetic effects.

8. Conclusions

Available evidence suggests that botulinum toxin may influence emotional regulation by modulating feedback signals from facial muscles in individuals without psychiatric disorders. Given the existing research gap, future studies should focus on well-designed randomized controlled trials involving larger populations of healthy individuals and employing objective measures of emotional responses.

Such measures should include neuroimaging techniques, electromyographic assessment of facial muscle activity, analysis of physiological responses, and the standardized use of questionnaires focusing on primary emotions processed by the amygdala. Additionally, investigating the long-term consequences of these interventions represents an important direction for future research.

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Conflicts of Interest: The authors declare no conflict of interest.

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