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An innovative multilayered neurotoxin injection technique for the mentalis muscle: A comparative study with superficial and deep approaches

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Abstract

Background: The mentalis muscle critically influences chin contour and lower facial aesthetics. Conventional botulinum toxin injections, targeting either superficial or deep layers, often produce variable results in muscle relaxation, skin smoothness, and facial harmony. A multilayered injection strategy may improve outcomes by addressing multiple muscle depths while preserving natural facial movement.

Objective: To compare the aesthetic outcomes and safety of superficial, deep, and multilayered botulinum toxin injection techniques in the mentalis muscle.

Methods: Thirty Middle Eastern female participants were allocated into three groups (n=10 each): superficial, deep, and multilayered injections. Muscle activity was assessed via electromyography, while aesthetic improvements were evaluated using standardized photographs and patient satisfaction scores. Adverse events were systematically recorded.

Results: The multilayered injection group demonstrated superior outcomes, including balanced chin contour, smoother skin texture, and higher patient satisfaction ($p<0.05$) compared to single-depth techniques. This approach minimized excessive relaxation and asymmetry, preserving natural lower facial dynamics. Minor transient effects were observed in other groups, but no major complications occurred.

Conclusion: Multilayered botulinum toxin injections in the mentalis muscle provide enhanced aesthetic outcomes with minimal complications, suggesting a refined and effective alternative to conventional single-depth techniques. Further studies with larger cohorts are warranted to validate these findings.

Keyword: Botulinum toxin; Mentalis muscle; Multilayered injection; Aesthetic outcomes; Facial contour.

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Introduction

The mentalis muscle plays a pivotal role in lower facial aesthetics, particularly in shaping the chin and maintaining proper lower lip positioning. This paired, vertically oriented muscle arises from the anterior mandible and inserts into the overlying chin skin,

contributing to expressions such as pouting and subtle lip movements. Hyperactivity of the mentalis muscle can result in cosmetic concerns, including chin dimpling or the so-called “pebble chin” appearance due to excessive contractions. In more severe cases, increased muscle tonicity may cause exaggerated chin projection or lower lip incompetence, underscoring the clinical importance of modulating its activity for aesthetic enhancement. Targeted administration of botulinum toxin type A (BoNT-A) has become a widely used intervention to achieve controlled relaxation of the mentalis muscle, yet the clinical success of this approach critically depends on the precision of injection technique, including depth, dose distribution, and placement.[1-3]

Traditionally, BoNT-A injections into the mentalis have been performed using either superficial or deep approaches. Superficial injections primarily engage the upper muscle fibers, effectively reducing surface dimpling and fine wrinkles. However, this method may inadequately address deeper hyperactive fibers, limiting the overall improvement in muscle relaxation and chin contour. Conversely, deep injections deliver BoNT-A closer to the muscle’s mandibular attachment, promoting more extensive relaxation of the mentalis. While effective for severe hyperactivity, deep injections carry inherent risks, including excessive flattening of the chin, ptosis, or unintended diffusion into adjacent muscles such as the depressor labii inferioris, potentially resulting in functional impairments. These limitations highlight the need for an advanced injection strategy that achieves precise, balanced muscle relaxation while preserving natural chin aesthetics and lower lip function.[4-7]

In response to these challenges, this study introduces a novel multilayered BoNT-A injection technique, designed to target both superficial and deep planes of the mentalis muscle. By administering BoNT-A at multiple depths, this approach aims to optimize muscle relaxation, enhance chin contour, and reduce the risk of complications. The study undertakes a comparative evaluation of three injection strategies superficial, deep, and multilayered using electromyography to quantify muscle activity, standardized clinical photographs to assess morphological improvements, and patient satisfaction scores to evaluate perceived aesthetic outcomes. All adverse events were systematically documented to determine the safety profile of each technique.

The primary objective of this study is to assess whether the multilayered injection approach provides superior aesthetic results and an improved safety profile compared to conventional single-depth injections. We hypothesize that this technique will achieve more harmonious chin contouring, higher patient satisfaction, and fewer complications, potentially establishing a refined standard for BoNT-A administration in the mentalis muscle.

Materials and Methods

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants after providing a detailed explanation of the study objectives, procedures, potential risks, and anticipated benefits. Participant confidentiality and anonymity were strictly maintained throughout the study.

This prospective, comparative study enrolled 30 female participants aged 23-38 years who presented to our clinic for aesthetic evaluation. Participants were allocated into three equal groups (n=10 per group) according to the injection technique administered:

Group 1: Superficial neurotoxin injection

Group 2: Deep neurotoxin injection

Group 3: Multilayered neurotoxin injection (T-shaped Tox Technique)

Exclusion criteria included a history of neuromuscular disorders, prior botulinum toxin injections within the

preceding six months, pregnancy or lactation, and any known hypersensitivity to botulinum toxin.

Botulinum Toxin and Injection Protocol

Bocouture® (incobotulinumtoxin A), a purified botulinum toxin type A formulation without complexing proteins, was used in this study. Each 100-unit vial was reconstituted with 2 mL of sterile 0.9% saline immediately prior to injection. Injection depth and technique were tailored to the allocated group to ensure optimal distribution within the mentalis muscle.

Group 1 (Superficial Injection) Bocouture was delivered into the superficial layer of the mentalis using a 31G × 6 mm insulin syringe. A total of 3 units was divided among three superficial injection points, with a penetration depth of approximately 2 mm into the subdermal layer. This approach targeted the upper portion of the muscle to reduce surface dimpling while minimizing excessive relaxation.

Group 2 (Deep Injection) Injections were administered at a depth of approximately 5 mm, near the muscle's mandibular attachment. A total of 3 units was divided among three injection points to achieve enhanced relaxation of deeper muscle fibers. This technique addressed pronounced hyperactivity but carried a potential risk of excessive chin flattening or ptosis.

Group 3 (Multilayered Injection; T-shaped Tox Technique) This technique combined superficial and deep injections to optimize muscle relaxation across multiple layers. The needle was advanced from an inferior approach, parallel to the inferior border of the chin, toward the menton until bone contact was achieved. After slight retraction, 3 units were injected at the deep plane, and additional 3 units were delivered retrogradely along the needle track to cover superficial fibers. A midline was drawn to divide the chin into bilateral sections, followed by multilayered injections at two points located 1 cm lateral to the midline and 1 cm above the inferior border of the chin. Each point received 3 units in a multilayered fashion. This method

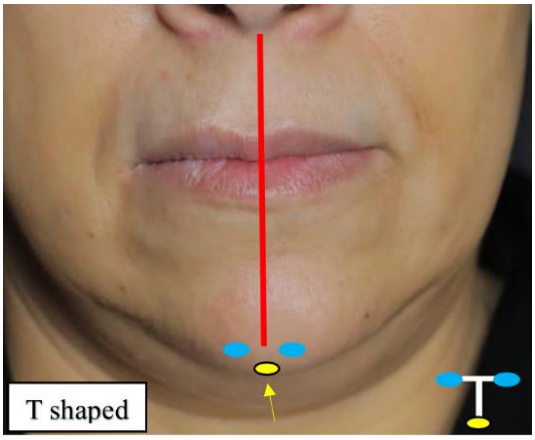

Figure 1 Diagram showing the multilayered neurotoxin treatment for the hyperactive mentalis. The black dot is injected from an inferior direction parallel to the inferior border of the chin while the blue dots are injected at a 90 degree angle.

aimed to balance muscle relaxation, improve chin contour, and minimize complications such as asymmetry or exaggerated relaxation **(Figure 1)**.

Clinical outcomes were assessed at baseline, 2 weeks, and 1 month post-injection. Standardized frontal photographs documented changes in chin contour and skin texture. Muscle activity was quantified using electromyography to objectively measure neuromuscular relaxation. Aesthetic outcomes were evaluated through patient-reported satisfaction scores on a 5-point Likert scale (1= very dissatisfied, 5= very satisfied) and blinded physician assessments of pre- and post-treatment images. Adverse events, including asymmetry, excessive relaxation, chin ptosis, or dimpling, were systematically recorded.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as mean±standard deviation (SD). One-way ANOVA was applied to compare patient satisfaction scores, physician evaluations, and electromyographic measurements across the three groups. Tukey's post hoc test was employed for pairwise comparisons. A p-value< 0.05 was considered statistically significant.

Results

A total of 30 female participants, aged 23–38 years, were included, with 10 individuals in each group. Clinical evaluations were conducted at baseline, 2 weeks, and 1 month post-injection to assess muscle activity, aesthetic improvements, and potential adverse events associated with each injection technique.

The multilayered injection group (Group 3) demonstrated the most favorable aesthetic outcomes, with significantly higher patient satisfaction scores compared to both superficial (Group 1) and deep (Group 2) injection groups ($p < 0.05$). This combined superficial and deep approach resulted in well-defined chin contours, minimizing residual dimpling and avoiding excessive flattening. Blinded physician assessments corroborated these findings, indicating smoother skin texture, improved symmetry, and a more natural overall appearance in Group 3.

Patients in the superficial injection group (Group 1) showed moderate improvement in chin dimpling; however, some individuals retained minor contour irregularities, which was reflected in lower satisfaction scores. Deep injections (Group 2) effectively reduced hyperactivity of the mentalis muscle but were associated with a higher incidence of mild lower lip dysfunction, likely due to unintended diffusion into the depressor labii inferioris (DLI). Specifically, 20% of participants in Group 2 exhibited transient lower lip asymmetry, while 30% of participants in Group 1 retained mild residual dimpling. Importantly, no severe complications were reported in any group, and Group 3 demonstrated a complete absence of adverse events, emphasizing both its efficacy and safety.

Comparative analysis of injection techniques

Multilayered injection (Group 3) provided the most favorable aesthetic outcomes with no complications. Deep injection (Group 2) effectively reduced mentalis hyperactivity but increased the risk of lower lip dysfunction. Superficial injection (Group 1) improved chin dimpling but resulted in lower overall patient satisfaction due to residual irregularities **(Figure 2)**.

Figure 2 Clinical outcomes of the hyperactive mentalis muscle following the multilayered "T-shaped Tox" injection technique. A: Baseline pre-treatment appearance demonstrating chin dimpling and contour irregularities. B: Post-treatment appearance showing improved chin contour, reduced dimpling, and enhanced symmetry.

Statistical Evaluation

One-way ANOVA revealed statistically significant differences among the three groups for muscle activity, patient satisfaction scores, and physician-assessed aesthetic scores ($p < 0.05$). Post hoc analysis using Tukey's test confirmed that Group 3 consistently outperformed Groups 1 and 2 across all outcome measures. Detailed values for muscle power, patient satisfaction, and physician assessments are summarized in **Tables 1-3** and illustrated in **Figures 3-5**.

Discussion

This study demonstrates that multilayered botulinum toxin type A (BoNT-A) injections in the mentalis muscle provide superior aesthetic outcomes, enhanced patient satisfaction, and a favorable safety profile compared to conventional superficial or deep single-plane injections. Across all outcome measures including electromyographic assessment of muscle

Table 1 *Muscle power* analysis across groups.

Group	*Muscle power*			*ANOVA p-value*	*Post Hoc Comparison*	*Significance*
	Baseline (Mean ± SD)	*2 Weeks (Mean ± SD)*	*1 Month (Mean ± SD)*			
Superficial	4.2 ± 0.8	6.5 ± 1.2	6.9 ± 1.1	0.022	1 vs. 3: p<0.01; 1 vs. 2: p=0.15	Significant
Deep	4.1 ± 0.7	7.2 ± 1.3	7.0 ± 1.2	0.017	2 vs. 3: p<0.01; 2 vs. 1: p=0.15	Significant
Multilayered	4.3 ± 0.6	8.5 ± 1.1	9.0 ± 1.0	<0.001	3 vs. 1: p<0.01; 3 vs. 2: p<0.01	Highly Significant

Muscle Power analysis across groups at baseline, 2 weeks, and 1 month post-injection. Electromyographic measurements of mentalis muscle activity (Mean ± SD) in the superficial, deep, and multilayered injection groups at baseline, 2 weeks, and 1 month post-injection. Lower values indicate greater muscle relaxation. Statistical comparisons were performed using one-way ANOVA with Tukey's post hoc test. Group 3 (multilayered injection) demonstrated significantly greater muscle relaxation compared to Groups 1 and 2 at 2 weeks and 1 month ($p < 0.01$).

Table 2 *Patient satisfaction scores across groups*.

Group	*Patient satisfaction scores*			*ANOVA p-value*	*Post Hoc Comparison*	*Significance*
	Baseline (Mean±SD)	*2 Weeks (Mean±SD)*	*1 Month (Mean±SD)*			
Superficial	4.0 ± 0.7	6.0 ± 1.1	6.8 ± 1.0	0.025	1 vs. 3: p<0.01; 1 vs. 2: p=0.14	Significant
Deep	4.1 ± 0.8	6.8 ± 1.2	7.1 ± 1.1	0.019	2 vs. 3: p<0.01; 2 vs. 1: p=0.14	Significant
Multilayered	4.2 ± 0.6	8.7 ± 1.0	9.2 ± 0.9	<0.001	3 vs. 1: p<0.01; 3 vs. 2: p<0.01	Highly Significant

Patient satisfaction scores across groups at baseline, 2 weeks, and 1 month post-injection. Patient-reported satisfaction scores (Mean ± SD) on a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied) following superficial, deep, and multilayered mentalis injections. One-way ANOVA with Tukey's post hoc test was used for statistical analysis. Group 3 showed significantly higher satisfaction scores at 2 weeks and 1 month compared to Groups 1 and 2 ($p < 0.01$), reflecting improved aesthetic outcomes and patient-perceived effectiveness.

relaxation, patient-reported satisfaction, and physician-assessed aesthetic scores participants receiving multilayered injections (Group 3) consistently exhibited the most pronounced improvements, with statistically significant differences relative to superficial and deep injection groups ($p< 0.01$). These results underscore the clinical advantage of distributing the neurotoxin across multiple muscle layers to achieve balanced relaxation while preserving natural chin dynamics.

The superiority of the multilayered approach can be explained by anatomical and pharmacological considerations. The mentalis muscle consists of both superficial and deep fibers, with over activity contributing to chin dimpling, "pebble chin", and lower lip incompetence. Deep single-plane injections target only the lower fibers near the mandibular attachment, which can reduce hyperactivity but risk over-weakening and diffusion into adjacent muscles, particularly the depressor labii inferioris (DLI). This unintended diffusion may result in lower lip asymmetry, impaired eversion, or functional disturbances, as reported in prior studies.[10,11]

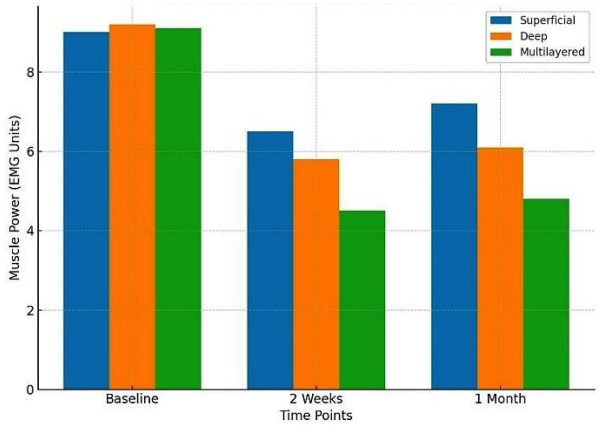

Figure 3 Muscle Power across groups and time points.

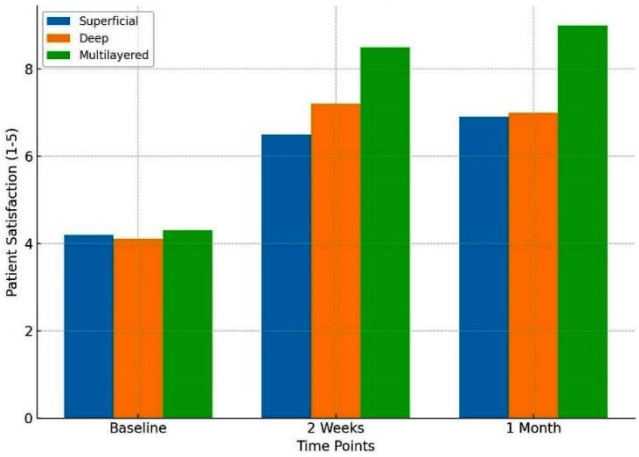

Figure 4 Patient satisfaction across groups and time points.

In contrast, superficial injections primarily relax the upper fibers, improving surface dimpling but failing to address deeper hyperactivity, leading to incomplete aesthetic correction.[7-9]

By combining superficial and deep injections, the multilayered technique simultaneously addresses both fiber layers, ensuring uniform relaxation without excessive weakening of any specific region. This balanced approach likely explains the absence of complications in Group 3, compared with residual dimpling in the superficial group (30%) and lower lip dysfunction in the deep group (20%). These findings align with prior anatomical studies suggesting that even toxin distribution across the mentalis prevents compensatory over activity in untreated fibers, maintaining natural chin movements and avoiding functional compromise.[12,13]

Patient satisfaction and physician-assessed aesthetic scores further validate the clinical relevance of the multilayered approach. Mean patient satisfaction scores in Group 3 increased from 4.3 at baseline to 9.0 at one month, significantly higher than the superficial (6.9) and deep (7.0) groups. Similarly, physician-assessed aesthetic scores demonstrated a greater improvement for Group 3 (4.2→9.2) relative to Groups 1 and 2, reflecting improved chin contour, symmetry, and skin texture. These results reinforce the concept that multi-depth injections provide not only objective functional benefits but also meaningful perceived aesthetic improvements, which are critical in cosmetic practice.

Mechanistically, targeting multiple layers allows BoNT-A to modulate both superficial and deep fibers, promoting uniform relaxation and preventing localized over-weakening. This approach also likely minimizes lateral toxin diffusion to the DLI, preserving lower lip function. Previous studies have highlighted the risk of deep injection-related complications due to diffusion which our multilayered protocol successfully mitigated.[10,11] Furthermore, dividing the total dose across multiple injection points ensures comprehensive coverage of the mentalis, optimizing the neuromodulator's therapeutic effect while maintaining a controlled safety profile.[14-16]

The clinical implications of these findings are significant. Multilayered injections offer an advanced,

Table 3 *Physician-Assessed Aesthetic Scores across groups*.

Group	*Physician-Assessed Aesthetic Scores*			*ANOVA p-value*	*Post Hoc Comparison*	*Significance*
	Baseline (Mean±SD)	*2 Weeks (Mean±SD)*	*1 Month (Mean±SD)*			
Superficial	4.0 ± 0.7	6.0 ± 1.1	6.8 ± 1.0	0.025	1 vs. 3: p<0.01; 1 vs. 2: p=0.14	Significant
Deep	4.1 ± 0.8	6.8 ± 1.2	7.1 ± 1.1	0.019	2 vs. 3: p<0.01; 2 vs. 1: p=0.14	Significant
Multilayered	4.2 ± 0.6	8.7 ± 1.0	9.2 ± 0.9	<0.001	3 vs. 1: p<0.01; 3 vs. 2: p < 0.01	Highly Significant

Physician-Assessed Aesthetic Scores across groups at baseline, 2 weeks, and 1 month post-injection. Mean physician-assessed aesthetic scores (Mean ± SD) assigned by two independent, blinded dermatologists using a standardized 10-point scale, evaluating chin contour, symmetry, and overall aesthetic improvement. Statistical analysis was conducted using one-way ANOVA followed by Tukey's post hoc test. Group 3 (multilayered injection) achieved significantly higher aesthetic scores at 2 weeks and 1 month relative to Groups 1 and 2 ($p < 0.01$), demonstrating superior clinical outcomes.

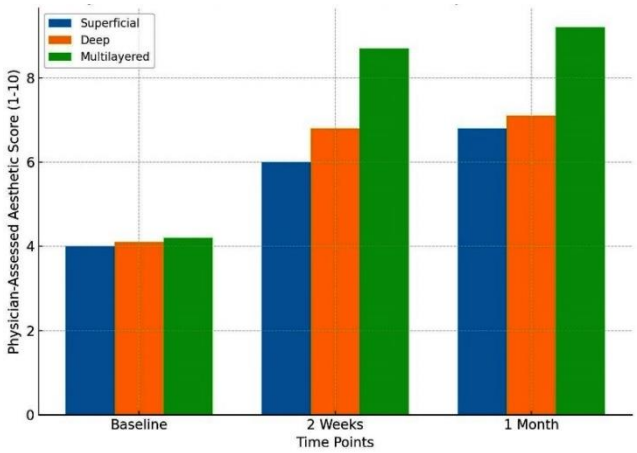

Figure 5 Physician-Assessed Aesthetic Scores across groups and time points.

precision-guided technique for treating hyperactive mentalis muscles, enabling practitioners to achieve superior aesthetic outcomes with minimal risk of adverse effects. The technique's reproducibility, evidenced by consistent improvements across both objective and subjective measures, supports its integration into routine aesthetic practice. Additionally, our data suggest that multilayered injections may reduce the need for repeat interventions, as balanced relaxation of the entire muscle reduces residual hyperactivity and improves long-term outcomes.

Despite these promising results, the study has several limitations. The sample size was relatively small (n=30), limiting statistical power and generalizability. The follow-up period of one month does not capture long-term durability of the aesthetic and functional outcomes, which is critical for neuromodulator-based interventions. Subjective measures, including patient satisfaction and physician aesthetic scoring, although validated and blinded, are inherently prone to bias. Additionally, individual anatomical variations in muscle thickness and depth were not objectively quantified using imaging modalities such as ultrasound, which could further refine injection precision and dosing strategies. Finally, fixed dosing without adjustment for muscle volume or patient-specific anatomy may limit the individualized applicability of our results.

Future studies should aim to address these limitations by incorporating larger, multi-center cohorts, objective imaging-guided injection techniques, and extended follow-up periods. Comparative trials evaluating different BoNT-A formulations and dosing regimens could further refine multilayered injection protocols. Additionally, investigating patient-specific anatomical variations and their impact on outcomes could enable a precision medicine approach to mentalis muscle rejuvenation.

Conclusion

Multilayered botulinum toxin type A injections in the mentalis muscle provide superior aesthetic outcomes, enhanced patient satisfaction, and a favorable safety profile compared to conventional superficial or deep single-plane injections. By targeting both superficial and deep muscle fibers, this technique achieves balanced relaxation, optimized chin contour, and minimal risk of complications such as dimpling, asymmetry, or lower lip dysfunction. These findings support the clinical adoption of multilayered injection strategies as a precise, effective, and safe approach for mentalis muscle rejuvenation. Future studies with larger cohorts and extended follow-up are warranted to validate long-term efficacy and refine individualized treatment protocols.

Declaration of patient consent The author certify that he had obtained all appropriate patient consent.

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Conflict of interest The author affirms that he has no conflicts of interest to disclose.

Author's contribution

NA: Have made substantial contributions to conception and design, acquisition of data and analysis and interpretation of data. Have been involved in drafting the manuscript, revising it critically for important intellectual content.

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