Effects of Dose and Injection Site on Gingival Smile Treatment with Botulinum Toxin Type A: A Prospective Study

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Background: Botulinum toxin type A is an easy and efficacious treatment for gingival smile. However, the optimal dose and injection site are controversial. The authors compared the reduction in gingival exposure using two methods with different doses and injection sites.

Methods: In this prospective self-controlled study, healthy participants with gingival smile (anterior gingival exposure of >3 mm) underwent two treatment methods. First, participants received a single-point injection of 2 U of botulinum toxin type A per side (simplified method). After 8 months, the individualized method was performed with 2 to 5 U of botulinum toxin type A (total, 4 to 10 U), which was injected at one or two sites according to pretreatment severity. Data were collected at baseline and at 4, 12, and 32 weeks of follow-up.

Results: Fifty-five participants were enrolled. Anterior gingival exposure and bilateral posterior gingival exposure were significantly reduced 4 and 12 weeks after botulinum toxin type A injection ($P \leq 0.05$) with both methods. These parameters returned to baseline by 32 weeks ($P > 0.05$). Posttreatment anterior gingival exposure at 4 weeks and 12 weeks with the individualized method was significantly lower compared with the simplified method (both $P \leq 0.05$). Patient satisfaction with the individualized method was preferred compared with the simplified method ($P \leq 0.05$). Few adverse events were observed with both methods without statistical significance.

Conclusion: It is necessary to increase the injection dose and tailor the injection site according to the pretreatment severity of anterior gingival smile. (*Plast. Reconstr. Surg.* 151: 56e, 2023.)

The smile is one of the universal facial expressions of humans. Gingival smile is characterized by gingival exposure of greater than 3 mm when smiling. The degree of gingival exposure can vary substantially between patients, with patients presenting gingival exposure of up to more than 10 mm.[1,2] The prevalence of gingival smile is 10.57%,[3] and it is more frequently observed in female patients.[4,5] Although gingival smile is merely an anatomical variation, it can be considered unattractive, causing significant distress and impacting one's quality of life.[6] Moreover, most orthodontists and dentists regard gingival smile as an important risk factor for dental treatment.[7]

Gingival smile involves a complex interaction between the facial muscles, bone, and skin; specifically, it is related to hypermobility of the upper lip with muscle involvement and alterations in anatomical features, such as a short clinical dental crown, anterior dentoalveolar extrusion, maxillary

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excess, and a short upper lip.[4,8–10] Therapies for gingival smile range from botulinum toxin injections to surgical interventions according to its cause. Although the outcomes of surgical procedures are long-lasting, botulinum toxin type A treatment is an easy and fast outpatient procedure that requires no downtime and has high efficacy rates.[1,11–19] Nevertheless, there are controversies around the optimal dose and injection site of botulinum toxin type A. Moreover, the efficacy of botulinum toxin type A for gingival smile varies markedly between studies, with the improvement rate of gingival exposure ranging from 62.06% to 98%.[1,16,19,20] Sucupira and Abramovitz[16] advocate the use of an average amount of botulinum toxin type A of 2 U at bilateral levator labii superioris alaeque nasi muscles for the treatment of gingival smile. They noted an average satisfaction level of 9.75 on a 10-point scale with this approach. In their article, use of higher doses and additional injection sites was discouraged. They claimed that targeting other muscles does not provide further benefit, and in fact could lead to lip ptosis, asymmetry, and excessive upper lip length.[16] However, Polo[13,15,17] disagreed with their argument, claiming that botulinum toxin type A dose and injection site need to be individualized according to the severity of gingival smile.[15] However, no clinical studies have verified this divergence, and highly personal experiences and uncertainty still limit the use of botulinum toxin type A for gingival smile treatment. Some authors believe that injection of botulinum toxin type A is a safe and cosmetically effective treatment for gingival smile only when performed by experienced practitioners.[14] Other studies preferred to initiate treatment with average-dose botulinum toxin type A injection to single sites initially, with retouching at a later stage, as required.[1,21] Based on lack of studies at the time of designing this study, we compared botulinum toxin type A efficacy using the simplified method (2 U of botulinum toxin type A at bilateral levator labii superioris alaeque nasi muscles) and the individualized method (dose and injection site determined according to the severity of anterior gingival smile). We aimed to assess the safety of these approaches and patient satisfaction with treatment.

PATIENTS AND METHODS

Study Design and Participants

A prospective, self-controlled clinical study was conducted from February of 2019 to June of 2020. All participants with a chief complaint of gingival smile were referred to the Second Clinical Division of Peking University School and Hospital of Stomatology in Beijing, People's Republic of China. Written informed consent was obtained from all participants, and the study was approved by the institutional review board of Peking University Health Science Center (no. PKUSSIRB-201838109).

The inclusion criteria were as follows: healthy people with anterior gingival exposure of greater than or equal to 3.0 mm on unrestricted, "full-blown" smiling; and age between 18 and 60 years. The following exclusion criteria were applied: contraindications to botulinum toxin type A; facial paralysis; previous disease or treatment affecting the position of the gingiva or upper lip; a history of botulinum toxin type A injection to the head or neck region within 1 year; received and/or receiving active orthodontic treatment, including vertical dimension treatment, such as for extrusion or intrusion; presence of periodontal disease; and refusal to participate.

Interventions

Participants were allocated to two treatment methods: the simplified method for the first injection and the individualized method 8 months later. The injection protocol is shown in Table 1.

Simplified Method

With the simplified method, a uniform botulinum toxin type A injection technique[22] [a single-site injection of 2 U of botulinum toxin type A (total, 4 U) at both the right and left levator labii superioris alaeque nasi muscles] was administered. The injection points were located at the muscle bulge at the uppermost part of the nasolabial fold (Fig. 1 and Table 1) (point A).

Individualized Method

With this method, patients were administered botulinum toxin type A after 8 months when the effect of the previous injection had vanished.

Table 1. Injection Protocol

Method	Anterior Gingival Exposure (mm)	Total Dosage (U)	Dosage per Side (U)	Injection Site[a]
Simplified	≥3	4.0	2.0	Point A
Individualized	3–5	4.0	2.0	Point A
	5–7	6.0	3.0	Point A and point B
	≥7	10.0	5.0	Point A and point B

[a]Point A, levator labii superioris alaeque nasi muscle point; point B, Yonsei point.

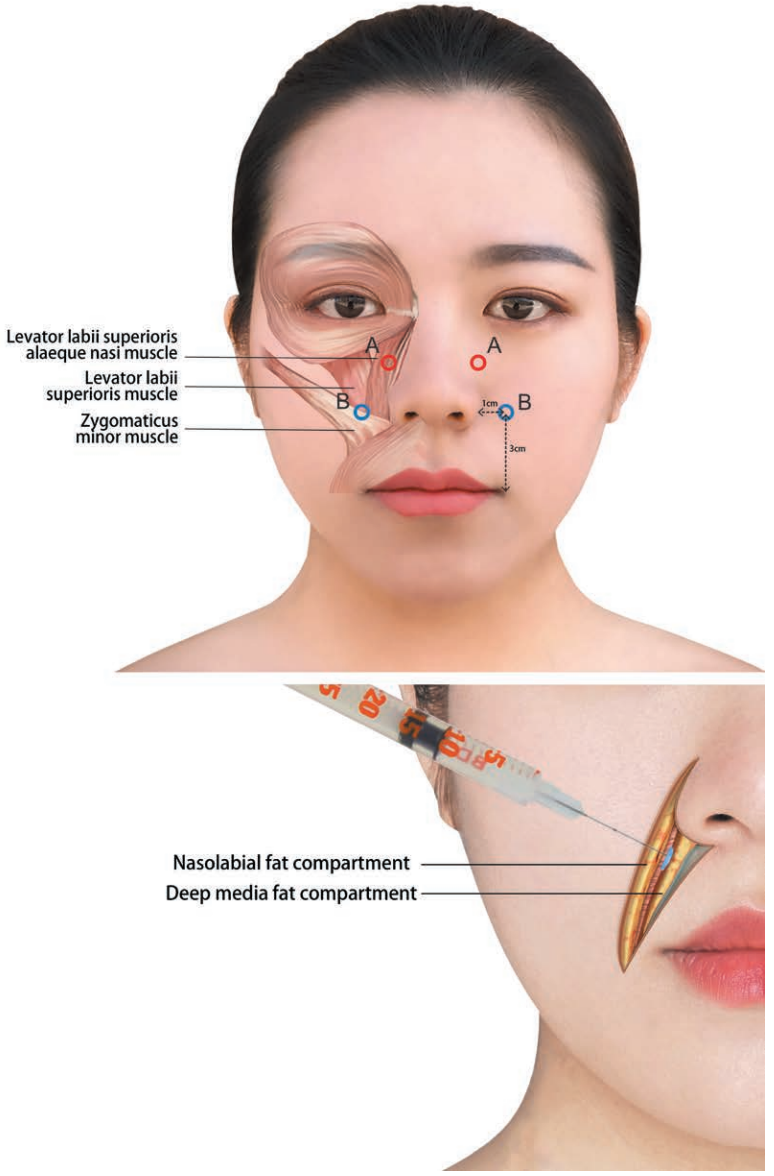

Fig. 1. (*Above*) Illustration of specific muscle injection points. *Point A* is the injection site at the bilateral levator labii superioris alaeque nasi located at the uppermost part of the nasolabial fold. *Point B* is the injection site at the Yonsei point localized 1 cm lateral to the alae nasi horizontally and 3 cm above the lip line vertically, which targets the whole of the levator labii superioris alaeque nasi, levator labii superioris, and zygomaticus minor muscles. (*Below*) Illustration of injection depth. Relatively thin fat tissues at the proposed injection point allow intramuscular injection of botulinum toxin type A at a rather superficial level, which avoids possible needle injury to anatomical structures located in the deeper layers.

The dose and injection sites were individualized according to the severity of anterior gingival exposure before treatment. For mild gingival smile (3 to 5 mm), 2 U of botulinum toxin type A was injected at bilateral levator labii superioris alaeque nasi muscles (point A) (Fig. 1 and Table 1). For moderate (5 to 7 mm) and severe (≥7 mm) gingival smile, 3 and 5 U of botulinum toxin type A, respectively, were injected per side (total, 6 and 10 U, respectively). The injection points were located at bilateral levator labii superioris alaeque nasi muscles and at the Yonsei point[23] (point B) (Fig. 1 and Table 1), with half doses administered at each point. [**See Video (online)**, which shows

the depth and placement of botulinum toxin type A injection with the specific muscles injected.]

All participants underwent two injections, with no change in botulinum toxin type A (Botox; Allergan, Inc., Irvine, CA) or other injection details. Lyophilized Botox (100 U) was reconstituted in 2.5 ml of 0.9% sodium chloride solution.[24] Injection was performed using a 27-gauge insulin syringe. Treatment was performed as an outpatient procedure, and all injections were performed by one of the authors (X.G.). No anesthesia was given during the procedure.

Outcome Measurements

Participants were assessed before treatment, and reexamined 4, 12, and 32 weeks after treatment. All participants underwent standardized measurements, and all measurements were taken by one of the authors (X.G.) three times for each participant using a digital vernier caliper. Extremely funny jokes, statements, singing, and/or dancing were played out to participants to induce full, unrestricted, spontaneous smiling, as described by Sarver and Ackerman.[7] The severity and type of gingival smile were evaluated by measuring anterior gingival exposure and bilateral posterior gingival exposure, which were defined as the distance between the superior margin of the right incisor and the lower margin of the upper lip and the distance from the bilateral first premolars and the lower margin of the upper lip on maximal smiling, respectively (Fig. 2).

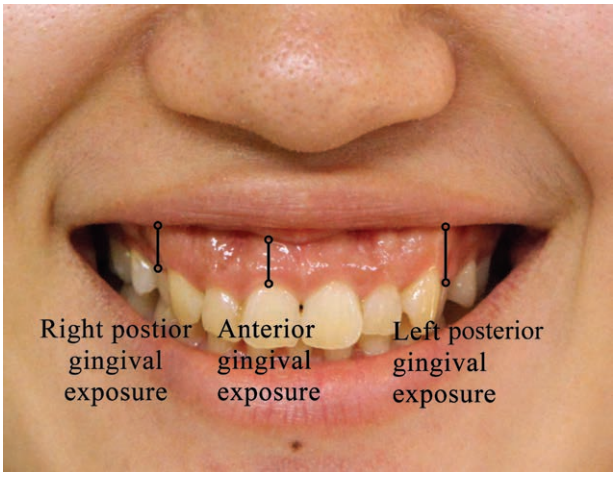

Fig. 2. Reference points for dynamic measurement shown on a pretreatment photograph of a 28-year-old female participant. The severity of the gingival smile, including anterior gingival exposure, was defined as the distance between the superior margin of the right incisor and the lower margin of the upper lip; right and left posterior gingival exposure was defined as the distance between the superior margin of the bilateral first premolars and the lower margin of the upper lip.

The causes of gingival smile were also evaluated by the following aspect. Upper lip mobility from rest to maximal smiling, to determine the presence of hypermobility of the upper lip, was measured over the maxillary right central incisor. Hypermobility of the upper lip was diagnosed when upper lip mobility during smiling measured greater than 8 mm.[25–27] To assess alterations in anatomical features, a short clinical crown was defined as a width-to-length ratio of maxillary incisor teeth of greater than or equal to 0.85.[10,28] Anterior dentoalveolar extrusion was assessed by the overbite and overjet of the anterior teeth. Deep overbite was diagnosed when the vertical overlap of the upper and lower incisors was greater than one-third of the lower incisor tooth height. Deep overjet was considered when the extent of horizontal (anterior to posterior) overlap of the maxillary central incisors over the mandibular central incisors was greater than or equal to 3 mm. Short upper lips were characterized when the upper lip was shorter than 15 mm, measured from the subnasale to the lower border of the upper lip.[10] Tooth display at rest (distance between the inferior margin of the right incisor and the lower margin of the upper lip) was also measured. Patients with maxillary hyperplasia and/or short upper lips present with excessive tooth exposure at rest.[29] A cephalometric analysis was conducted using a single lateral cephalometric radiograph (ProMax; Planmeca, Helsinki, Finland), and the sella, nasion, point A angle; a linear measurement from the nasion point to the anterior nasal spine; and a linear measurement from the nasion point to the superior prosthion were measured twice by two orthodontists (B.X.Y. and J.J.L.).

In addition, facial photographs and videos were obtained. An on-paper questionnaire was distributed by one of the authors (G.C.Y.), and was completed anonymously to evaluate patient satisfaction, side effects, willingness to undergo repeated treatment, and a perceived improvement in the nasolabial fold. (**See Appendix, Supplemental Digital Content 1**, which shows a questionnaire entitled Effects of Dose and Injection Site on Gingival Smile Treatment with Botulinum Toxin Type A: A Prospective Study, ***http://links.lww.com/PRS/F503***.)

Statistical Analysis

Tests for paired means were performed to determine the sample size required for the groups using PASS 11.0 (NCSS, Kaysville, UT), with a power of 90% and an α-error of 5%. The results indicated an estimated sample size of 49 (the

difference in anterior gingival exposure between the two methods at 4 weeks was 1.4 ± 3.0 mm). Considering loss to follow-up and loss for other reasons, the estimated sample size was expanded by 10%; thus, the final sample size was 55.

All statistical analyses were performed using IBM SPSS version 20.0 (IBM Corp., Armonk, NY). The mean and standard deviation were used to describe normally distributed numerical values, and a paired-samples *t* test was used to identify differences. The Wilcoxon signed rank test was used for nonnormally distributed numerical values, and the McNemar-Bowker test was used to compare dichotomous variables. A value of $P < 0.05$ was considered statistically significant.

RESULTS

Fifty-five heathy participants (51 women and four men; average age, 28.87 ± 5.85 years) were enrolled in this study. In terms of gingival smile cause, the prevalence of hypermobility of the upper lip was 70.9% (39 patients). The maxillary incisor width-to-length ratio of 36 participants (65.5%) was greater than or equal to 0.85. The prevalence of overbite and overjet of the anterior teeth were 72.7% and 58.2%, respectively. The length of the upper lip was 23.5 ± 2.5 mm, with one participant (1.8%) having an upper lip shorter than 15 mm. Tooth display at rest was 5.2 ± 2.0 mm, with 53 participants (96.4%) having a tooth display greater than or equal to 2 mm. The cephalometric analysis showed sella, nasion, point A angle; nasion point to the anterior nasal spine; and nasion point to the superior prosthion values of 82.8 ± 2.8 degrees, 54.8 ± 2.5 mm, and 74.8 ± 3.2 mm, respectively.

All participants benefited from botulinum toxin type A treatment, regardless of the method used to deliver this treatment. Posttreatment anterior gingival exposure and bilateral posterior gingival exposure were significantly reduced compared with pretreatment gingival exposure with both methods at 4 weeks and 12 weeks ($P \leq 0.05$). These parameters returned to baseline at 32 weeks ($P > 0.05$) (Table 2). The time interval between the first injection using the simplified method and the following injection (reinjection time) using the individualized method was 32 weeks, and there was no significant difference between pretreatment measurements between treatment methods ($P > 0.05$) (Table 2). However, when anterior gingival exposure was evaluated at 4 weeks and 12 weeks, there was a significant difference in effectiveness between the two methods, with the individualized method being better (Table 2). An evaluation of bilateral posterior gingival exposure revealed no significant difference between the two methods ($P > 0.05$) (Table 2). Tooth display at rest and upper lip length changed at 4 and 12 weeks compared with baseline ($P \leq 0.05$) and returned to baseline at 32 weeks, without differences between the two methods ($P > 0.05$) (Table 2). When the subgroups were analyzed according to basic anterior gingival exposure, 12.7% of patients had a mild gingival smile, 49.1% had a moderate gingival smile, and 38.2% had a severe gingival smile (Table 3). A significant difference was found only in the severe group at 4 and 12 weeks ($P \leq 0.05$) (Table 3). Based on gingival smile types,[1] there were two participants (3.6%) with anterior type, 44 (80%) with mixed type, and four (7.2%) with asymmetric type. A significant difference was observed in participants with mixed type at 4 and 12 weeks ($P \leq 0.05$). Table 3 and Figures 3 through 5 show the before-and-after images in animation to represent the treatment effects in the three severity groups.

A subjective evaluation of participant satisfaction and side effects is shown in Table 4. Participants were generally more satisfied with the results of the individualized method ($P \leq 0.05$). When participants were asked which method they were more satisfied with, 30 participants (54.5%) said that they preferred the individualized method, 28 of whom had moderate or severe gingival smile (anterior gingival exposure ≥5 mm) before treatment. Eleven participants (20.0%) said that they preferred the simplified method, and 14 patients (25.5%) said that they did not know. In addition to an improvement in gingival smile, 19 of 55 participants (34.5%) after injection with the simplified method and 31 of 55 participants (56.4%) after injection with the individualized method noticed that the nasolabial fold had some degree of smoothness. Adverse effects were noted in very few participants, without a significant relationship between the two methods. All adverse effects were mild, could not be verified during clinical examination, and disappeared within 3 weeks without further intervention.

DISCUSSION

This study evaluated the change in gingival display and the return to baseline gingival exposure over time as a result of botulinum toxin type A injection with two different methods in one group of participants with an interval of 32 weeks. The optimal dose of botulinum toxin type A has

Table 2. Follow-Up Measurements[a]

		Baseline	4 Wk	Δ	12 Wk	Δ	32 Wk	Δ
Anterior gingival exposure	Simplified method	6.5 ± 1.3 (n = 55)	4.1 ± 1.8 (n = 53)	2.3 ± 1.4	4.9 ± 1.7 (n = 54)	1.6 ± 1.3	6.6 ± 1.4 (n = 54)	−0.1 ± 1.1
	Individualized method	6.6 ± 1.4 (n = 55)	3.8 ± 1.6 (n = 54)	2.8 ± 1.2	4.5 ± 1.7 (n = 38)[b]	2.0 ± 1.0	6.5 ± 1.7 (n = 35)[b]	0.0 ± 0.6
	P	0.535	0.022	0.04	0.023	0.055	0.831	0.775
Right posterior gingival exposure	Simplified method	6.5 ± 1.7	3.5 ± 1.9	2.2 ± 1.6	4.3 ± 2.3	2.4 ± 1.7	5.7 ± 2.0	0.1 ± 0.7
	Individualized method	5.7 ± 2.0	3.9 ± 2.4	1.9 ± 1.4	4.9 ± 2.5	1.0 ± 1.0	6.1 ± 2.5	−0.3 ± 1.0
	P	0.417	0.102	0.382	0.112	0.156	0.809	0.13
Left posterior gingival exposure	Simplified method	5.7 ± 2.2	3.6 ± 2.0	2.1 ± 1.4	4.3 ± 2.3	1.4 ± 1.5	5.7 ± 2.2	0.0 ± 0.8
	Individualized method	5.8 ± 2.2	4.2 ± 2.4	1.6 ± 1.3	4.9 ± 2.4	0.9 ± 1.2	5.6 ± 2.5	0.0 ± 1.2
	P	0.809	0.053	0.088	0.232	0.266	0.943	0.945
Tooth display at rest	Simplified method	5.2 ± 2.0	4.7 ± 1.9	0.4 ± 1.2	4.8 ± 1.9	0.4 ± 1.4	5.3 ± 1.9	−0.2 ± 1.2
	Individualized method	5.3 ± 1.9	4.8 ± 1.8	0.5 ± 1.3	4.7 ± 1.9	0.6 ± 0.7	5.0 ± 2.2	0.1 ± 0.7
	P	0.324	0.437	0.831	0.536	0.562	0.285	0.466
Upper lip length	Simplified method	23.5 ± 2.5	23.1 ± 2.1	0.4 ±2.2	22.9 ± 2.7	1.0 ± 2.6	22.7 ± 2.8	0.9 ± 2.7
	Individualized method	23.3 ± 2.9	22.5 ± 2.1	0.2 ± 2.0	22.7 ± 2.5	0.3 ± 2.2	22.9 ± 2.6	0.6 ± 2.8
	P	0.381	0.330	0.577	0.177	0.396	0.826	0.259
Medial incisor length	Simplified method	9.3 ± 1.0	9.3 ± 1.1	−0.1 ± 0.5	9.4 ± 1.1	0.0 ± 0.5	9.4 ± 1.1	−0.1 ± 0.5
	Individualized method	9.4 ± 1.0	9.3 ± 1.0	0.0 ± 0.4	9.4 ± 1.1	0.0 ± 0.4	9.4 ± 1.3	−0.1 ± 1.0
	P	0.105	0.902	0.285	0.376	0.323	0.741	0.601

[a]A paired-samples t test was used to compare the effects of both methods. The mean value of these differences (i.e., Δ) was used to compare the two treatment methods with the Wilcoxon rank sum test.

[b]The number of participants was 55 (51 women and four men) at baseline for both injections. After the first injection, 53 participants (52 women and three men) at 4 weeks, 54 participants (50 women and four men) at 12 weeks, and 54 participants (50 women and four men) at 32 weeks were followed up. After reinjection, 54 participants (75 women and 17 men) at 4 weeks, 38 participants (35 women and three men) at 12 weeks, and 35 participants (32 women and three men) at 32 weeks were followed up. The number of participants in the latest two follow-up examinations was affected by COVID-19.

Table 3. Stratified Analysis of Anterior Gingival Exposure Based on the Severity of Gingival Smile, Sex of Participants, and Type of Gingival Smile[a]

		Before Injection	4 Wk	Δ	12 Wk	Δ	32 Wk	Δ
Basic anterior gingival exposure: 3–5 mm ($n = 7$)	Simplified method	4.3 ± 0.6	2.6 ± 1.6 ($n = 7$)	1.7 ± 1.6	3.1 ± 1.4 ($n = 7$)	1.2 ± 1.2	5.4 ± 1.5 ($n = 7$)	−1.1 ± 1.2
	Individualized method	5.4 ± 1.5	2.5 ± 0.8 ($n = 7$)	2.9 ± 0.9	2.6 ± 1.2 ($n = 5$)	2.4 ± 0.5	5.1 ± 1.6 ($n = 5$)	0.2 ± 0.2
	P	0.053	0.768	0.158	0.669	0.251	0.144	0.142
Basic anterior gingival exposure: 5–7 mm ($n = 27$)	Simplified method	6.0 ± 0.5	3.6 ± 1.1 ($n = 26$)	2.4 ± 1.1	4.4 ± 1.2 ($n = 27$)	1.6 ± 1.0	6.2 ± 0.9 ($n = 26$)	−0.2 ± 0.8
	Individualized method	6.1 ± 0.9	3.5 ± 1.0 ($n = 27$)	2.7 ± 1.0	4.3 ± 1.2 ($n = 17$)	1.8 ± 0.9	6.0 ± 0.8 ($n = 15$)	−0.2 ± 0.5
	P	0.492	0.424	0.385	0.514	0.326	0.278	0.481
Basic anterior gingival exposure: >7 mm ($n = 21$)	Simplified method	7.8 ± 0.6	5.3 ± 1.9 ($n = 20$)	2.5 ± 1.7	6.0 ± 1.8 ($n = 20$)	1.8 ± 1.7	7.5 ± 1.4 ($n = 21$)	0.3 ± 1.3
	Individualized method	7.5 ± 1.4	4.6 ± 1.9 ($n = 20$)	3.0 ± 1.5	5.4 ± 1.8 ($n = 16$)	2.2 ± 1.1	7.5 ± 1.8 ($n = 15$)	0.1 ± 0.8
	P	0.374	0.022	0.224	0.001	0.261	0.505	0.875
Female ($n = 51$)	Simplified method	6.5 ± 1.2	4.7 ± 3.7 ($n = 50$)	2.4 ± 1.4	4.4 ± 2.6 ($n = 50$)	1.6± 1.4	6.6 ± 1.4 ($n = 50$)	−1.0 ± 1.1
	Individualized method	6.6 ± 1.4	3.6 ± 1.9 ($n = 50$)	2.8 ± 1.2	3.6 ± 3.3 ($n = 35$)	2.0 ± 1.0	6.6 ± 1.6 ($n = 33$)	0.0 ± 0.6
	P	0.677	0.046	0.076	0.055	0.104	0.752	0.781
Male ($n = 4$)	Simplified method	5.8 ± 2.2	4.7 ± 3.7 ($n = 3$)	0.9 ± 1.1	4.4 ± 2.6 ($n = 4$)	1.4 ± 0.7	6.2 ± 2.3 ($n = 4$)	−0.4 ± 0.6
	Individualized method	6.2 ± 2.3	3.6 ± 1.9 ($n = 4$)	2.6 ± 1.0	3.6 ± 3.3 ($n = 3$)	2.1 ± 0.9	4.6 ± 2.1 ($n = 2$)	−0.2 ± 0.3
	P	0.219	0.297	0.243	0.160	0.152	0.565	0.882
Anterior type ($n = 2$)	Simplified method	6.5 ± 0.4	2.4 ± 1.7 ($n = 2$)	4.0 ± 1.3	4.0 ± 0.5 ($n = 2$)	2.5 ± 0.1	5.5 ± 0.4 ($n = 2$)	−1.1 ± 1.2
	Individualized method	5.5 ± 0.4	2.3 ± 0.6 ($n = 2$)	3.2 ± 1.0	2.9 ($n = 1$)	2.9 ± 0.0	5.3 ± 0.0 ($n = 2$)	0.2 ± 0.2
	P	0.333	0.859	0.185		0.562	0.558	—
Mixed type ($n = 44$)	Simplified method	6.4 ± 1.3	4.3 ± 1.8 ($n = 42$)	2.1 ± 1.3	5.0 ± 1.8 ($n = 43$)	1.4 ± 1.3	6.7 ± 1.5 ($n = 44$)	−0.2 ± 0.8
	Individualized method	6.7 ± 1.5	3.9 ± 1.5 ($n = 44$)	2.8 ± 1.0	4.7 ± 1.8 ($n = 29$)	2.0 ± 0.9	6.8 ± 1.8 ($n = 26$)	−0.2 ± 0.5
	P	0.066	0.048	0.009	0.064	0.016	0.471	0.412
Asymmetric type ($n = 4$)	Simplified method	6.6 ± 1.3	2.6 ± 1.3 ($n = 4$)	4.0 ± 0.9	3.5 ± 1.3 ($n = 4$)	3.0± 0.5	6.2 ± 1.4 ($n = 4$)	0.3 ± 1.3
	Individualized method	6.2 ± 1.4	1.5 ± 1.4 ($n = 3$)	4.4 ± 1.4	3.3 ± 1.3 ($n = 4$)	2.9 ± 0.9	5.6 ± 0.9 ($n = 3$)	0.1 ± 0.8
	P	0.452	0.634	0.741	0.731	0.747	0.551	0.972

[a]A paired-samples *t* test was used to compare the effects of both methods. The mean value of these differences (i.e., Δ) was used to compare the two treatment methods with the Wilcoxon rank sum test.

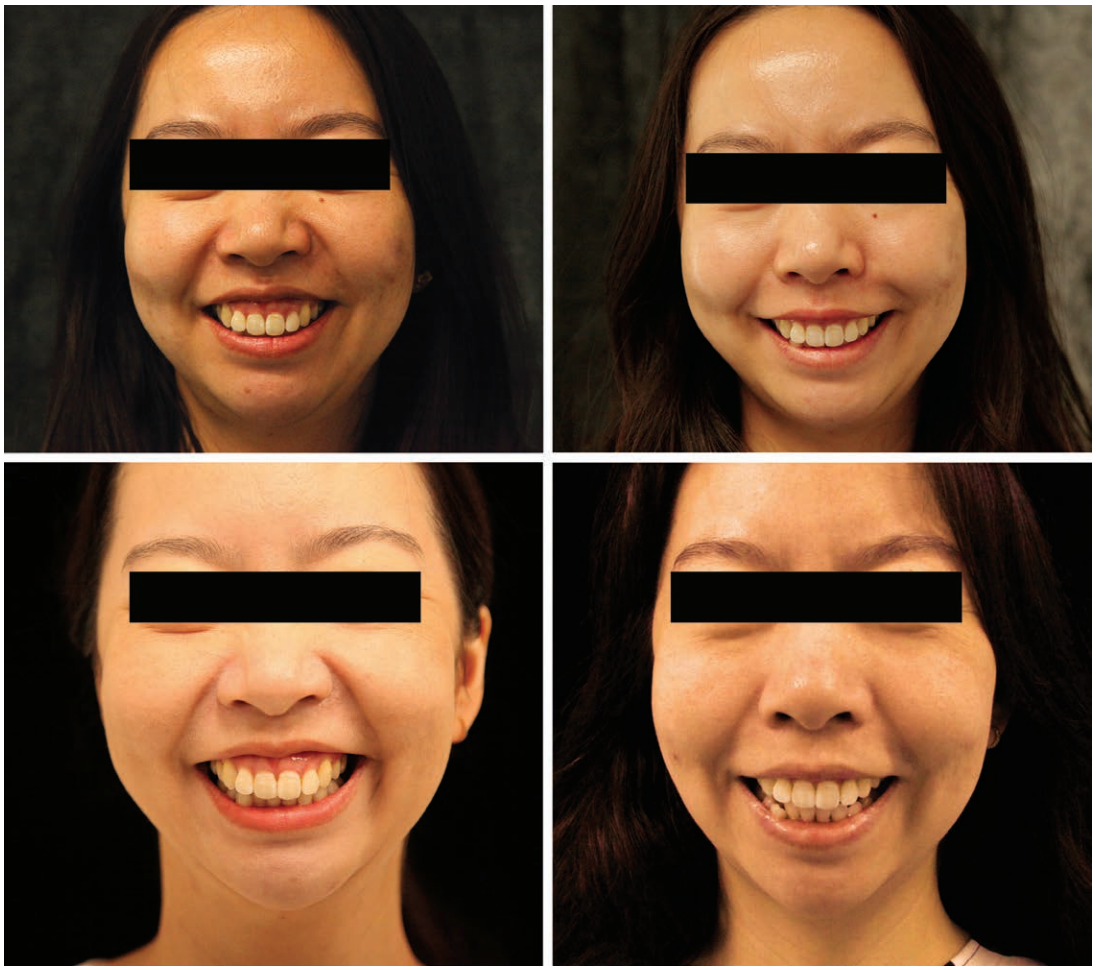

Fig. 3. Photographs of a 37-year-old female patient who presented with a mild gummy smile (anterior gingival exposure, 4.50 mm). (*Above*, *left*) Pretreatment and (*above*, *right*) posttreatment (4 weeks) photographs with the simplified method. (*Below*, *left*) Pretreatment and (*Below*, *right*) posttreatment (4 weeks) photographs with the individualized method.

attracted some controversy in the literature.[1,6,15,16,20] Injection of less than the optimal dose will result in limited gingival smile reduction and duration. In contrast, overinjection will result in side effects, such as excessive upper lip ptosis, asymmetry, and sad smile, causing patient dissatisfaction. The simplified method in this study was performed according to a method advocated by Sucupira and Abramovitz,[16] whereas the individualized method was performed according to a method advocated by Polo.[15] We found that the reduction in gingival exposure and patient satisfaction with the individualized method were generally better compared with the simplified method, and there was no difference in side effects. This result supports the recommendation of Polo,[13,15,17] showing that it is necessary to increase the injection dose and tailor the injection site according to the severity of anterior gingival smile at baseline.

For mild gingival smile, the treatment method was the same for both groups, with injection of botulinum toxin type A (2 U) at bilateral levator labii superioris alaeque nasi muscles. The reasons for repeating the same treatment were to compare overall differences between the two methods and to use this subgroup as a negative control. The results of the two injections were satisfactory (anterior gingival exposure at 4 weeks was <3 mm), and there was no significant difference. This result is consistent with the literature, as Polo[13,15,17] speculated that the good results of Sucupira and Abramovitz[16] might have inferred that the severity of gingival smile in their sample was smaller (an average pretreatment gingival exposure of 3.62 mm). Gong et al.[30] injected 94 participants with 2 U of botulinum toxin type A (total, 4 U). They showed that gingival smile severity affected the treatment effect, and only female

Fig. 4. Photographs of a 27-year-old female patient who presented with a moderate gummy smile (anterior gingival exposure, 6.58 mm). (*Above*, *left*) Pretreatment and (*above*, *right*) posttreatment (4 weeks) photographs with the simplified method. (*Below*, *left*) Pretreatment and (*below*, *right*) posttreatment (4 weeks) photographs with the individualized method.

participants with a baseline anterior gingival exposure of less than 5.3 mm were likely to show complete improvement after 4 weeks with this dose of botulinum toxin type A.

Another difference between the two methods was the injection site, as erroneous selection of injection sites or target muscles affects smile aesthetics. The levator labii superioris alaeque nasi originates from the frontal process of the maxilla and inserts into the upper lip and the skin tissue of the ala of the nose. In this study, injection into bilateral levator labii superioris alaeque nasi muscles was preferred for both methods, because this is one of the most used muscles for botulinum toxin injection for gingival smile. The levator labii superioris originates from the orbital rim of the maxilla and inserts into the upper lip. The zygomaticus minor originates from the zygomatic bone and inserts into the upper lip (Fig. 1). The insertion of the levator labii superioris is covered partially or entirely by the levator labii superioris alaeque nasi and the zygomaticus minor, and the three muscles converge at the area lateral to the ala of the nose. The three muscles, which determine the degree of lip elevation that occurs during smiling, pass near a triangular region. The center of this triangle is the Yonsei point.[23] In this study, for participants with moderate or severe gingival smile who underwent the individualized method, we added an injection site at the Yonsei point, which is localized 1 cm lateral to the alae nasi horizontally and 3 cm above the lip line vertically.[23] Preliminary research shows that the Yonsei point is an appropriate injection point for botulinum toxin type A, because it is easily located and targets the levator labii superioris alaeque nasi,

Fig. 5. Photographs of a 24-year-old female patient who presented with a severe gummy smile (anterior gingival exposure, 8.25 mm). (*Above*, *left*) Pretreatment and (*above*, *right*) posttreatment (4 weeks) photographs with the simplified method. (*Below*, *left*) Pretreatment and (*below*, *right*) posttreatment (4 weeks) photographs with the individualized method.

the levator labii superioris, and the zygomaticus minor muscles with a single injection.[8,31,32] Future studies will be designed to expand the sample size and use controls to validate the efficacy of the Yonsei point.

A systematic review found that botulinum toxin type A has a significant effect in reducing gingival display and that its results decrease gradually with time, although they are still satisfactorily maintained and do not return to baseline after 12 weeks.[33] Only a few studies have evaluated gingival display at 24 weeks after injection, and the results show that measurements at 24 weeks do not return to their baselines values.[6,17] Furthermore, Chagas et al.[33] speculated that return of measurements to baseline averages is not achieved until 30 to 32 weeks after treatment based on postinjection data at all weeks

Table 4. Evaluation of Subjective Satisfaction and Side Effects at 4 Weeks[a]

			GS	Mild GS	Moderate GS	Severe GS
Satisfied with treatment effects	Simplified method	Satisfied	6	3	6	0
		Could be improved	40	3	18	15
		Dissatisfied	5	0	1	4
		Not paying attention	4	1	2	2
	Individualized method	Satisfied	21	0	10	8
		Could be improved	24	7	13	8
		Dissatisfied	1	0	0	1
		Not paying attention	9	0	4	4
		P	0.02	—	—	—
Smoothness of the nasolabial fold	Simplified method	Good	2	0	0	2
		Fair	17	3	7	7
		Poor	10	2	5	3
		Not paying attention	26	2	15	9
	Individualized method	Good	3	1	0	2
		Fair	28	3	19	6
		Poor	7	0	2	5
		Not paying attention	17	3	6	8
		P	0.074	—	0.005	0.675
Complaint of lip ptosis[b]	Simplified method	Positive	6	0	4	2
	Individualized method	Positive	6	2	2	2
Complaint of asymmetry[b]	Simplified method	Positive	2	0	1	1
	Individualized method	Positive	4	0	1	3
Complaint of sad smile[b]	Simplified method	Positive	2	2	0	0
	Individualized method	Positive	3	2	0	1

GS, gummy smile.
[a]The McNemar-Bowker test was used to compare the effects of both methods.
[b]No statistically significant difference was observed between the two methods.

using a third-degree polynomial. Our study confirmed that measured values at 32 weeks after treatment return to baseline; that is, they were not significantly different when compared with initial baseline values ($P > 0.05$) (Table 2).

The main limitation of this study is that anterior gingival exposure at 4 weeks was unsatisfactory when using the individualized method in participants with moderate gingival smile (≥3 mm), which was not significantly different compared with the simplified method ($P > 0.05$) (Table 3). For severe gingival smile, the efficacy of the two methods was significantly different, but a satisfactory effect (<3 mm) was still not achieved. In addition, adverse effects were few; thus, we speculated that present doses for moderate and severe gingival smile are still insufficient. Thus, further research should explore the appropriate dose for moderate to severe gingival smile.

CONCLUSIONS

Both the simplified method and the individualized method used in this study improved gingival smile. The degree of gingival exposure decreased significantly at 4 weeks and relapsed by 12 weeks. The degree of gingival exposure returned to baseline by 32 weeks. The reduction in gingival exposure and patient satisfaction with the individualized method were generally better compared with the simplified method.

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PATIENT CONSENT

Patients provided written informed consent for the use of their images.

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