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A Retrospective Study of Chinese-Specific Glabellar Contraction Patterns

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BACKGROUND Botulinum toxin has been widely accepted as safe and effective for the treatment of glabellar lines, and previous studies have classified glabellar contraction patterns into 5 categories.

OBJECTIVE To classify the glabellar contraction patterns among a large-scale Chinese population and provide a reference for injections in Chinese patients.

METHODS Four hundred eighty-nine Chinese subjects who received botulinum toxin for the treatment of glabellar lines were selected for a retrospective photographic analysis of their glabellar contraction patterns. Using 2 separate previously established classification systems, the patterns were analyzed and classified by a panel of certified Chinese dermatologists.

RESULTS Two separate classification systems showed different distributions of glabellar contraction patterns among Chinese compared with Caucasians and Koreans. The classifications allowed for identification of the most frequent patterns in Chinese, which were "converging arrows" and "11" pattern, and provided references for identifying the most important muscles.

CONCLUSION Both classification systems are applicable to the Chinese population with varying distributions. Because the classification system of de Almeida and colleagues focuses more on the muscles involved in the formation of glabellar lines, the authors' subjects classified according to this system displayed a more balanced distribution among the 5 patterns. This provides an easier reference for dermatologists in daily clinical practice and guiding treatment strategies.

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Aesthetic treatment of glabellar rhytides with Botulinum Toxin A (BoNTA) has been practiced for more than 2 decades[1] and is arguably the most popular cosmetic procedure among Chinese people for easing glabellar wrinkles. Ever since its initial cosmetic application, the safety and efficacy of BoNTA have been well established and widely accepted.

Classifications of glabellar lines have been devised by various authors to serve as guidance for intramuscular injections of BoNTA.[2–4] Since de Almeida and colleagues[3,4] introduced classification of glabellar contraction patterns, other authors have also attempted to come up with their own classification to tailor to specific ethnic populations.[5] However, such classifications described in literatures focused on Westerners and Koreans, and have not been able to accurately reflect characteristics specific to Chinese.

Despite sharing similar anatomy in facial musculature, differences in lifestyle habits, habitual facial expressions, and aesthetic standards, in addition to the effects

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of photoaging as a result of differing length and intensity of sun exposure, culminate to different wrinkle patterns between Chinese and Caucasian women.[6,7] Due to a paucity of literature concerning Chinese glabellar contraction patterns, the authors of this study have recognized the importance of proposing a Chinese-specific classification in hope of establishing a standardized reference for guiding BoNTA injections.

Objective

The objective of this retrospective study was to identify and classify glabellar contraction patterns in Chinese using 2 different previously introduced classification systems. The authors aim to provide an additional large-scale database of glabellar contraction patterns among the Chinese population. The quantified results of this study shall serve as additional reference for BoNTA injections to treat Asians, especially those of Chinese descent seeking treatment for glabellar lines.

Materials and Methods

This study was designed as a retrospective photographic analysis of glabellar contraction patterns of 489 healthy Chinese subjects receiving botulinum toxin for the treatment of glabellar lines in Beijing, China. Photographic evaluation of 77 men and 412 women was conducted. The age of the subjects ranged from 18 to 65 years and the mean age was 43.7 years (SD: 9.56). The photographs were taken in repose and during maximum contraction (on request) under consistent lighting, position, and distance. Standardized analysis of the glabellar contraction patterns was performed on each photograph by a panel of 3 experienced dermatologists using 2 different classification systems introduced by de Almeida and colleagues[4] and Kim and colleagues.[5] The classification results from the 2 systems were analyzed statistically using the chi-square test to compare the distribution of patterns with Caucasians and Koreans.

Results

Through the analysis of the 489 subjects, the glabellar patterns observed were identified and classified according to the classification systems proposed by de Almeida and colleagues and Kim and colleagues as follows:

When classified according to de Almeida and colleagues' 5 Glabellar contraction patterns, "converging arrows" and "U" patterns were the 2 most frequently seen patterns in Chinese subjects, followed by "V," "inverted omega," and "omega" patterns. When compared with Caucasians as described by de Almeida and colleagues,[3] Chinese exhibited higher frequency of "converging arrows" (30.3% vs 19.2%) and a lower frequency of "V" pattern (18.2% vs 30.2%). There was a statistically significant difference ($\rho < 0.0001$, chi-square test) in the distribution of glabellar patterns between Chinese and Caucasians as shown in Table 1.

When classified according to Kim and colleagues' 5 Glabellar contraction patterns, the "11" pattern was the most frequently observed in Chinese subjects, followed by "U," "π," "X," and "I." When compared with Koreans as described by Kim and colleagues,[5] Chinese had significantly more "11" pattern (60.74% vs 29.5%) and less "U" pattern (22.7% vs 44.6%). There was a statistically significant difference ($\rho < 0.0001$, chi-square test) in the distribution of glabellar patterns between Chinese and Koreans as shown in Table 2.

TABLE 1. Comparison of Glabellar Contraction Patterns Between Chinese and Western Population

	This Study				*Results of de Almeida and Colleagues*[3]			
	Male	*Female*	*Number*	*Percentage*	*Number*	*Percentage*	χ^2	ρ
U	11	130	141	28.8	107	32.0	26.3	<0.0001
V	22	67	89	18.2	101	30.2		
Converging arrows	29	119	148	30.3	64	19.2		
Omega	5	43	48	9.8	34	10.2		
Inverted omega	10	53	63	12.9	28	8.4		
Total	77	412	489	100	334	100		

TABLE 2. Comparison of Glabellar Contraction Patterns Between Chinese and Korean Population

	This Study				*Results of Kim and Colleagues*[5]			
	Male	*Female*	*Number*	*Percentage*	*Number*	*Percentage*	χ^2	ρ
U	23	88	111	22.7	62	44.6	47.4	<0.0001
11	43	254	297	60.74	41	29.5		
X	5	26	31	6.34	20	14.4		
π	5	43	48	9.8	15	10.8		
I	1	1	2	0.41	1	0.7		
Total	77	412	489	100	139	100		

Among the 489 subjects classified according to the classification system of de Almeida and colleagues, they were further subclassified according to the classification system of Kim and colleagues to show corresponding relationship between the 2 systems (Table 3 and Figures 1–5).

Discussion

The development of botulinum toxin for cosmetic usage is arguably one of the most important events in minimally invasive cosmetic procedures,[8] especially in treating the glabella region whose muscles are responsible for the main noticeable alterations of aging as they have a strong depressant action.[9] Ever since BoNTA was established as safe and effective in treating facial wrinkles,[1] the use of BoNTA to treat glabellar lines has become one of the most popular cosmetic procedures among Asians[2] and the Chinese population. Variations in glabellar contraction patterns have been studied and were recently classified by de Almeida and colleagues[4] and Kim and colleagues.[5] However, through their large-scale recruitment of subjects and analysis of retrospective photographic images, the authors discovered that Chinese people possess unique characteristics and different distributions of glabellar contraction patterns from Caucasians and Koreans. To better reflect these characteristics specific to the Chinese, the authors have classified the Chinese subjects in this study according to the 2 previously introduced classification systems and analyzed the correlations that were found between the 2 systems.

TABLE 3. Correlation of Glabellar Patterns Between Two Different Classification Systems

Frequency of Contraction Patterns According to de Almeida and Colleagues' Classification System		*Corresponding Frequency to Kim and Colleagues' Classification System of 5 Glabellar Contraction Patterns*	
Pattern	*Number (%)*	*Pattern*	*Number*
U	141 (28.8)	U	29
		11	112
V	89 (18.2)	U	47
		11	41
		I	1
Converging arrows	148 (30.3)	U	3
		11	144
		I	1
Omega	48 (9.8)	π	48
Inverted omega	63 (12.9)	U	32
		X	31
Total	489 (100)	Total	489

Figure 1. An example of 2 subjects both classified as "U" pattern according to de Almeida and colleagues' classification system, but classified as (A) "U" pattern and (B) "11" pattern according to Kim and colleagues' classification system.

The purpose of classifying Chinese glabellar patterns is to provide reference for BoNTA injections and to achieve effective and individualized results. Botulinum Toxin A injections treat glabellar wrinkles by paralyzing the underlying facial mimetic muscles and an accurate classification can help locate the target muscles, understand the strength of these muscles, and recognize their synergistic and antagonistic actions to achieve "botulinum rebalancing"[10] and functional equilibrium.[10–12]

Although most individuals share similar anatomy, Abramo and colleagues[13] found 3 distinct dermal insertions for corrugator supercilii, demonstrating that there were 3 distinct shapes for the same muscle. It was suggested that each distinct type of corrugator supercilii caused different eyebrow movements or glabellar lines, which generates distinct patterns of vertical glabellar lines.[13] In addition to minor variations in anatomical features, different cultures and languages spoken contribute to different facial expressions and the use of facial musculature may vary among different ethnic groups.[3,14] In a systematic review conducted by Hwang and colleagues,[15] corrugators originate mostly from the medial supraorbital rim or the medial frontal bone and extend through the frontalis and orbicularis oculi. Running superolaterally and inserting mostly into the middle

Figure 2. Both subjects were classified as "V" pattern according to de Almeida and colleagues' classification system, but were classified as (A) "U" pattern and (B) "11" pattern according to Kim and colleagues' classification system.

Figure 3. (A) Example of a "converging arrows" pattern that corresponded fittingly to "11" pattern and an (B) "omega" pattern that corresponded to "π" pattern.

of the eyebrow, the corrugators measured between 38 and 53 mm.[15] The corrugator depresses and pulls the eyebrow downward and medially, inducing vertical glabellar lines.[11,15] The procerus extended inferiorly to the transverse part of the nasalis and interdigitate superiorly with the frontalis,[16] inducing horizontal lines. These depressor muscles are opposed by the frontalis, which is the only muscle that elevates the eyebrow.

After classifying a total of 489 Chinese subjects according to the 2 different classification systems, the authors first attempted to compare the frequency of contraction patterns between Caucasians and Chinese. When compared with Caucasians, Chinese presented with a greater proportion of "converging arrows" and fewer "V" patterns. The main muscles involved in the "converging arrows" are the corrugators and the medial portion of the orbicularis oculi, whereas the "V" pattern involves a stronger muscular contraction of the corrugators and procerus, as well as the important participation of medial portion of orbicularis.[4] The higher and lower frequencies of the "converging arrows" and "V" patterns, respectively, suggest lower muscular activity and strength in age-matched Chinese and the role of procerus was potentially less significant. In addition, differences in anatomical features exist between Chinese and Caucasians, such as a flatter nasal apex and shorter corrugators in Asians found in a study with Chinese cadavers,[5,17] compared with a longer and more transversely developed corrugators in

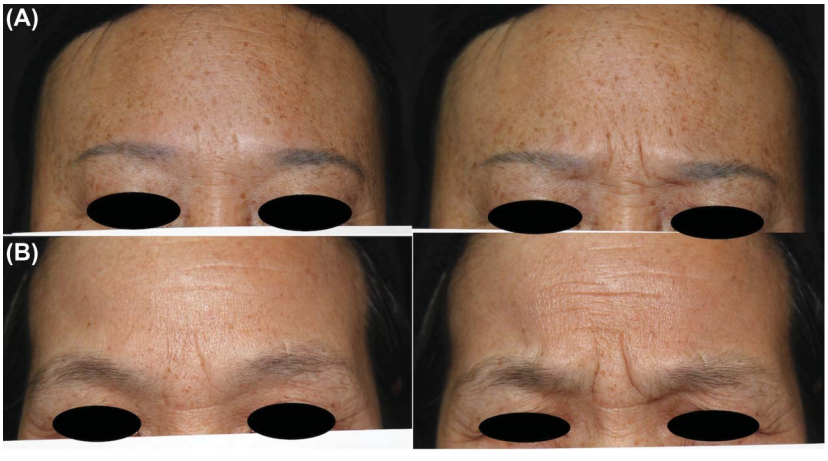

Figure 4. Two subjects classified as "converging arrows" according to de Almeida and colleagues' classification system but classified differently as (A) "U" pattern and (B) "I" pattern according to Kim and colleagues' classification system based on the presence of transverse lines.

Figure 5. Two subjects classified as "inverted omega" according to de Almeida and colleagues' classification system, but classified differently as (A) "U" pattern and (B) "X" pattern according to Kim and colleagues' classification system.

Caucasians.[4] The prevalence of "V" pattern in Caucasians suggests more muscle involvement and heavier muscular contractions, which results in more severe wrinkles.

In this study, the distribution of contraction patterns also showed similarities with a recent study on the patterns and frequency of Chinese glabellar contraction lines.[18] Both studies, which were conducted on the Chinese population, presented with higher frequencies of "converging arrows" and "U" pattern, whereas "V" pattern was significantly lower when compared with Caucasians. However, some differences between the 2 studies on Chinese population were also noted, which may be attributed to several underlying factors. First, all subjects included in the authors' study were patients receiving botulinum toxin for the treatment of glabellar lines. In Phase II of the study by Jiang and colleagues, where all volunteers received BoNTA treatment, the frequency of "U" pattern dropped from 41.4% to 34.7%, whereas the frequency of "V" pattern increased from 5.7% to 14.7%.[18] Frequencies of both patterns converged and showed a more similar trend with the authors' study. Second, the mean age of the authors' subjects was also more than 5 years older than that in the previous study, which is an important factor to consider because the frequency of certain patterns may be associated with age-related volume loss. Third, the patients in the authors' study were recruited in Beijing, which may include a greater proportion of subjects from Northern China, whereas the patients in the other study were from Eastern China. Such a difference in patient demographics may contribute to differences in pattern frequency. Regarding the "V" pattern, de Almeida and colleagues[3] indicated that only in some cases the depression of eyebrow may be so strong that it can extend to the lateral portion. Similarly, simultaneous drooping of the tail of eyebrow was not commonly seen in the authors' study and was not a required criterion for classifying subjects into the "V" pattern. However, Jiang and colleagues[18] seemed to require simultaneous drooping of the tail of eyebrow, which may explain why only 5.7% of volunteers were observed as "V" pattern.

In their second classification according to the classification system of Kim and colleagues, the authors also compared the frequency of contraction patterns between Koreans and Chinese. Comparisons between Koreans and Chinese showed substantial differences in pattern distributions but both Chinese and Koreans displayed significantly more "11" than "converging arrows" in Caucasians, which was described as equivalent counterparts between the 2 classification systems.[5] Kim and colleagues[5] postulated that glabellar wrinkles mostly start with vertical (perpendicular) lines that are induced by corrugators, followed by the gradual involvement of other muscles as one age, such as the procerus (horizontal lines), frontalis

(forehead wrinkles), and nasalis (nasal wrinkles). In addition to the greater prevalence of "11" pattern in Chinese and Koreans, Asians generally have faces with fewer fine rhytides and less laxity compared with Caucasians.[19]

Because Caucasians exhibit greater frequency of "V" pattern, whereas Chinese and Koreans have higher frequency of "converging arrows," the authors' classification findings suggest that both a lower dosage of BoNTA and a lower number of injection points are recommended for treating glabellar wrinkles in Chinese. This is consistent with the Asian consensus recommendations on the aesthetic usage of BoNTA[2] and recommendations from a recent study with Chinese experts.[18] This may also explain why the response rate of a single treatment of 20U of BoNTA in Chinese exceeded the results reported for US studies.[20]

After comparing the frequencies of Chinese glabellar contraction patterns with those of Caucasians and Koreans, the authors further subclassified their subjects from de Almeida and colleagues' classification system into Kim and colleagues' 5 Glabellar contraction patterns to show correlations between the 2 systems (shown in Table 3). Three subtypes ("U," "V," and "inverted omega") from de Almeida and colleagues' classification system corresponded more dispersedly with subtypes from Kim and colleagues' system. The authors analyzed and considered these differences between the 2 systems due to different perspectives and definitions toward classifying patterns. In de Almeida and colleagues' classification system, glabellar contraction patterns were classified based on the space between the eyebrows to detect the predominant movements,[3] whereas Kim and colleagues[5] identified and classified according to the final shape of the glabellar wrinkles. Of the 141 cases classified as "U" pattern according to de Almeida and colleagues' system, the authors considered only 29 as corresponding to Kim and colleagues' "U" pattern, whereas the remaining 112 cases corresponded to the "11" pattern. With the absence of both perpendicular and transverse glabellar lines, subjects classified as "U" pattern according to de Almeida and colleagues' classification system were considered as corresponding to Kim and colleagues' "11" pattern. In the 89 cases classified as "V" pattern according to de Almeida and colleagues' system, subjects displaying both perpendicular and transverse lines after wide-range approximation and depression of the glabella were classified as corresponding to Kim and colleagues' "U" pattern (47 cases), whereas subjects with only perpendicular lines were classified as corresponding to "11" pattern (41 cases). In the 63 cases classified as inverted omega pattern, which involves the nasalis muscle (although not a glabella muscle) and was defined by de Almeida and colleagues as more depression than approximation (eyebrows barely join),[3] subjects were subclassified as corresponding to Kim and colleagues' "U" pattern (32 cases) and "X" pattern (31 cases) based on the presence of nasal wrinkles and transverse glabellar lines in the final shape of the glabellar wrinkles.

Recent publications have discussed how an increasingly diverse patient demographics and an expanding population seeking treatments have influenced treatment strategies and optimization of outcomes.[21] Patient diversity, and anatomical and cultural differences exist not only between Caucasians and Asians, but also among the large Chinese population, which may even be considered as a heterogeneous group because it encompasses various subpopulations from north to south of China. To provide recommendations for optimal treatment strategies and develop a pan-Asian consensus on aesthetic application of BoNTA, a panel of multinational experts recently proposed a new classification of 3 Asian facial morphotypes, which are "Northern," "Intermediate," and "Southern" morphotypes.[22] Associated facial morphotypes are crucial factors to consider for a fully patient-tailored treatment,[21,23] and analyses of facial morphotypes may reveal further relationship between distinct facial morphotypes and specific patterns of muscular contraction. Unfortunately, the authors were not able to delve deeper into this subject in this study but hope to evaluate this relationship in the future. Nevertheless, this study's findings on a large-scale Chinese population can still serve as future reference for the treatment of glabellar wrinkles in Asians, especially among the Chinese population.

In the authors' study, the classification according to de Almeida and colleagues' system, which focuses more on the muscles involved in the formation of glabellar wrinkles, showed a more balanced distribution. This may deliver a more convenient guidance and easier clinical reference for treating glabellar wrinkles in Chinese patients.

Conclusion

The 2 classification systems of 5 glabellar contraction patterns are both applicable to the Chinese population, despite varying proportions to each pattern. By classifying the glabellar wrinkle patterns, the authors can have a better understanding of the involved muscle movements, which helps with clinical treatment strategies on injection points and dosages. With this, treatment efficacy can be optimized and aesthetic applications of BoNTA remain safe and effective over time. The authors believe that de Almeida and colleagues' classification system provides a more convenient and practical reference for treating Chinese glabellar patterns with BoNTA injections while achieving natural and individualized results.

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