# Comparison of extraction versus nonextraction orthodontic treatment outcomes for borderline Chinese patients

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**Introduction:** The purpose of this study was to compare orthodontic treatment outcomes in Chinese patients with borderline problems treated with and without extractions. **Methods:** Records of 39 borderline patients treated at the Faculty Clinic of the Peking University Orthodontic Department were evaluated retrospectively by 5 associate professors. Sixteen patients had been treated without extractions, and 23 had 4 first or second premolars extracted. Each judge evaluated the posttreatment records independently for tooth alignment, overbite, overjet, midline symmetry, lateral occlusion, and facial profile, and rated them on a scale from 1 to 5. **Results:** The only statistically significant difference between the extraction and nonextraction groups was for facial profile, with the judges preferring the extraction profiles. Fifteen soft-tissue cephalometric variables were measured to determine the source of the difference, and 6 showed statistically significant differences. When profile changes from pretreatment to posttreatment were examined, significant differences in treatment-associated changes between extraction and nonextraction groups were all related to the lower lip and chin. **Conclusions:** In this sample of Chinese borderline orthodontic patients, Chinese clinicians had a statistically significant preference for the facial profiles of the extraction patients, but no statistically significant preferences for tooth alignment, overbite, overjet, midline symmetry, or posterior occlusion. Extraction treatment increases the inclination of the chin and reduces protrusion of the lower lip compared with nonextraction treatment, and this might explain the difference. (Am J Orthod Dentofacial Orthop 2006;129:672-7)

The decision to extract teeth as part of orthodontic treatment is governed mainly by concerns about facial appearance. Some investigators have reported a remarkable consistency in the criteria for facial attractiveness across cultures and ethnic groups,[1-7] but others have reached different conclusions.[8-12] The purpose of this study was to assess preferences of Chinese orthodontic specialists for treatment outcomes related to tooth alignment, overbite, overjet, midline symmetry, lateral occlusion, and facial profile in a sample of growing Chinese children who received fixed-appliance extraction or nonextraction orthodontic treatment. Soft-tissue cephalometric measurements were made to investigate the reasons for the profile differences between the extraction and the nonextraction patients.

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## MATERIAL AND METHODS

The study was conducted in the Orthodontic Department, Peking University School of Stomatology. The sample comprised 39 patients classified as "borderline" by the following method: 5 associate professors evaluated the pretreatment records (study casts, facial photographs, lateral cephalograms, and panoramic x-rays) of patients who had started treatment 2 years previously. Using a method modified from that of Baumrind et al,[13] the 5 judges independently classified each subject in 1 of 3 categories: extraction, nonextraction, or borderline. If it was unanimous (5 to 0) or a clear majority (4 to 1) vote of the judges for either the extraction or the nonextraction category, the subject was assigned to that category. If the judges were unanimous or had a clear majority for the borderline classification, or if more than 3 judges failed to agree on extraction or nonextraction, those subjects were assigned to the borderline group. In this way, 39 patients were chosen as our borderline sample. The distributions by extraction or nonextraction assignment, age, sex, and Angle classification are shown in Table I.

**Table I.** Demographic distribution of 39 borderline subjects

| | Sex (n) | | | Angle classification (n) | | | | Age (y) at start | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Class I | Class II | Class III | Total | Mean | SD |
| Nonextraction | 6 | 10 | 16 | 11 | 5 | 0 | 16 | 12.1 | 1.09 |
| Extraction* | 6 | 17 | 23 | 7 | 14 | 2 | 23 | 12.3 | 1.65 |
| Total | 12 | 27 | 39 | 18 | 19 | 2 | 39 | | |

*Extraction category includes 4PM1 patients (n = 14) and 4PM2 patients (n = 9).

**Table II.** Demographic distribution of 33 borderline subjects

| | Sex (n) | | Angle classification (n) | | | | Age (y) at start | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Class I | Class II | Class III | Total | Mean | SD |
| Extraction | 5 | 16 | 6 | 13 | 2 | 21 | 12.47 | 1.66 |
| 4PM1 | 4 | 9 | 4 | 8 | 1 | 13 | 12.46 | 1.71 |
| 4PM2 | 1 | 7 | 2 | 5 | 1 | 8 | 12.50 | 1.69 |
| Nonextraction | 6 | 6 | 7 | 5 | 0 | 12 | 12.08 | 1.08 |

**Table III.** Average scoring of treatment results evaluated by 5 specialists and treatment periods of each group

| | n | Alignment (mean ± SD) | OB and OJ (mean ± SD) | Midline (mean ± SD) | Occlusion (mean ± SD) | Profile (mean ± SD) | Treatment time (mean ± SD) (mo) |
|---|---|---|---|---|---|---|---|
| Nonextraction | 16 | 4.28 ± 0.2 | 4.53 ± 0.3 | 4.55 ± 0.3 | 4.18 ± 0.3 | 4.18 ± 0.3 | 22.1 ± 8.3 |
| Extraction | 23 | 4.17 ± 0.2 | 4.40 ± 0.4 | 4.60 ± 0.3 | 4.28 ± 0.2 | 4.47 ± 0.3 | 24.7 ± 8.2 |
| 4PM1 | 14 | 4.22 ± 0.2 | 4.31 ± 0.5 | 4.63 ± 0.3 | 4.31 ± 0.2 | 4.47 ± 0.3 | 25.2 ± 7.7 |
| 4PM2 | 9 | 4.08 ± 0.3 | 4.54 ± 0.3 | 4.56 ± 0.3 | 4.24 ± 0.3 | 4.48 ± 0.2 | 23.9 ± 9.3 |

*OB*, Overbite; *OJ*, overjet.

The judges' decisions were based solely on the examination of pretreatment records. The treating orthodontists were also full-time faculty members in the department. Each orthodontist was blinded with respect to the judges' decisions, and each patient was treated with full fixed appliances solely on the basis of the orthodontist's treatment decision. The sample included 12 boys and 27 girls. Their mean age at the beginning of treatment was 12.4 ± 1.4 years. The sample included 18 subjects with Angle Class I malocclusions, 19 Class II subjects, and 2 Class III subjects. After treatment, it was found that the orthodontists had treated 16 patients without extractions, 14 with extraction of the 4 first premolars, and 9 with extraction of the 4 second premolars.

After treatment, 5 faculty judges evaluated the posttreatment records of each patient independently according to an analog scale from 1 to 5 for tooth alignment, overbite and overjet, midline symmetry, lateral occlusion, and facial profile. Three of the 5 judges had been members of the classifying panel; the other 2 were full-time associate professors but had not previously participated in the study. The scores from different groups were compared with the rank sum test.

To explain profile preferences between the extraction and nonextraction groups, soft-tissue cephalometric measurements were made for 33 patients (6 were excluded because the quality of the soft-tissue images was poor). The distributions by extraction or nonextraction assignment, age, sex, and Angle classification for these 33 patients are shown in Table II.

Two third-year residents located the landmarks on the screen, and the average values were obtained by the computer for cephalometric analysis. Independent sample *t* tests were used for comparison between extraction and nonextraction groups, and between the 2 extraction patterns.

## RESULTS

The average treatment period, and the scoring of treatment results on tooth alignment, overbite and overjet, midline symmetry, lateral occlusion, and facial profile, of the 39 subjects are summarized in Table III. Comparison of the extraction and nonextraction groups showed that the extraction group had a higher score than the nonextraction group only on facial profile (Table III). The rank sum test among the 4 first-premolar (4PM1) extraction group, the 4 second-pre-

**Table IV.** Comparison of extraction group and nonextraction group

| | *Pretreatment* | | | *Posttreatment* | | | *Changes* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Extraction* | *Nonextraction* | P | *Extraction* | *Nonextraction* | P | *Extraction* | *Nonextraction* | P |
| Ns-Sn-Pos | 165.7 ± 7.2 | 165.4 ± 6.1 | .914 | 164.6 ± 4.4 | 163.8 ± 4.5 | .594 | −1.1 ± 4.9 | −1.6 ± 4.4 | .728 |
| Cm-Sn-UL | 97.8 ± 12.3 | 95.7 ± 12.3 | .646 | 105.2 ± 9.9 | 100.4 ± 10.3 | .197 | 7.4 ± 11.4 | 4.7 ± 9.1 | .484 |
| LL-Bs-Pos | 134.2 ± 9.0 | 128.2 ± 16.2 | .182 | 134.7 ± 9.0 | 136.2 ± 11.5 | .679 | 0.5 ± 7.3 | 8.0 ± 11.3 | .028* |
| AsUL-FH | 61.1 ± 7.9 | 58.1 ± 7.6 | .296 | 67.0 ± 6.1 | 61.3 ± 8.8 | .037* | 5.9 ± 7.4 | 3.2 ± 8.5 | .346 |
| BsLL-FH | 38.3 ± 8.7 | 38.4 ± 12.3 | .979 | 44.7 ± 8.1 | 44.6 ± 8.7 | .963 | 6.4 ± 5.2 | 6.2 ± 11.7 | .937 |
| PosBs-FH | 84.1 ± 9.3 | 90.2 ± 7.2 | .062 | 90.0 ± 9.4 | 88.4 ± 4.4 | .575 | 5.9 ± 6.7 | −1.8 ± 5.5 | .002† |
| UL-EP | −0.4 ± 2.1 | 1.0 ± 3.8 | .183 | −1.6 ± 1.5 | 0.1 ± 2.1 | .014* | −1.2 ± 1.7 | −0.9 ± 2.4 | .755 |
| LL-EP | 2.7 ± 2.5 | 2.0 ± 3.1 | .509 | 0.2 ± 1.8 | 1.6 ± 1.1 | .023* | −2.4 ± 1.9 | -0.4 ± 3.4 | .031* |
| UL-SnPos | 7.0 ± 2.1 | 8.2 ± 3.1 | .220 | 5.8 ± 1.5 | 7.5 ± 1.9 | .008† | −1.3 ± 1.8 | −0.7 ± 1.8 | .380 |
| LL-SnPos | 6.7 ± 2.8 | 6.0 ± 2.7 | .474 | 4.6 ± 2.1 | 6.1 ± 1.1 | .021* | −2.1 ± 2.0 | 0.2 ± 2.6 | .007† |
| Bs-LiPos | 4.7 ± 0.9 | 5.4 ± 1.7 | .139 | 5.0 ± 0.8 | 5.1 ± 1.3 | .867 | 0.4 ± 0.7 | −0.3 ± 1.0 | .044* |
| As-E-line | −6.4 ± 2.3 | −5.1 ± 2.8 | .177 | −7.2 ± 1.7 | −6.5 ± 2.1 | .280 | −0.8 ± 2.2 | −1.3 ± 3.0 | .570 |
| H-angle | 16.8 ± 3.9 | 19.0 ± 6.0 | .218 | 15.4 ± 3.1 | 18.3 ± 3.5 | .021* | −1.5 ± 2.3 | −0.7 ± 3.9 | .506 |
| Bs-E-line | −3.2 ± 1.8 | −4.3 ± 1.8 | .092 | −4.9 ± 1.5 | −4.2 ± 1.3 | .179 | −1.7 ± 1.5 | 0.1 ± 1.0 | .001† |
| UL-Ns-LL | 4.1 ± 1.4 | 5.2 ± 2.5 | .111 | 4.0 ± 1.3 | 4.3 ± 1.8 | .510 | −0.1 ± 1.6 | −0.9 ± 1.2 | .165 |

*$p < 0.05$.
†$p < 0.01$.

molar (4PM2) extraction group, and the nonextraction group showed no statistically significant differences except for facial profile between the 4PM1 extraction group and the nonextraction group, and between the 4PM2 extraction group and the nonextraction group. The 4PM2 extraction group received the highest score, and the nonextraction group received the lowest score.

The soft-tissue cephalometric measurements are shown in Table IV. (The results for 4PM1 and 4PM2 extraction treatments are reported separately in Tables V, VI, and VII, which are available online at www.mosby.com/AJODO.)

## DISCUSSION

The concept of the borderline patient has been widely discussed in orthodontics, but few attempts have been made to define the term exactly. Carey,[14] who was probably among the first to use the term in the literature, used it in a somewhat different sense from that in which it is used today. He suggested that patients with arch-length discrepancies of less than 2.5 mm should be treated by nonextraction, whereas those with discrepancies of more than 5 mm should be treated by extraction of the 4 first premolars. Intermediate, or borderline, patients with 2.5 to 5 mm of discrepancy were to be treated by extraction of the 4 second premolars. With improved understanding, orthodontists now believe that the decision of whether to extract is multifactorial, depending also on such additional factors as incisor protrusion, arch width, curve of Spee, growth pattern and potential, facial profile, stability, and the clinician's education or training. Also, in modern usage, borderline now refers to patients for whom it is uncertain as to whether extractions should be performed.

In this context, Luppanapornlarp and Johnston[15] and Paquette et al[16] used discriminant-function analysis to identify various borderline cephalometric measurements for which some clinicians would treat nonextraction whereas others would treat with premolar extractions. With a somewhat similar line of reasoning, Baumrind et al[13] pointed out that any clinician planning treatment for a patient must ultimately decide either to extract or not to extract. Hence, they believed that borderline appropriately refers to patients for whom some skilled clinicians, each given all appropriate diagnostic information, would be likely to make opposite decisions. To our knowledge, our study is the first in which reviewing clinicians have been asked to identify borderline patients. It provides a new method for comparing clinical controversies.

When the charts of the patients who had completed active treatment were checked 1 year after the study began, it was found that, among the 39 patients, 16 had received nonextraction treatment and 23 had received extraction treatment. Among the extraction patients, 14 had first premolars extracted and 9 had second premolars extracted, an approach that, in Carey's sense,[14] could be considered a compromise between extraction and nonextraction. The comparisons among these 3 groups are the focus of this study.

### Clinician's preference for treatment results

A successful treatment is difficult to quantify. Cephalometric analysis is used to determine abnormal values

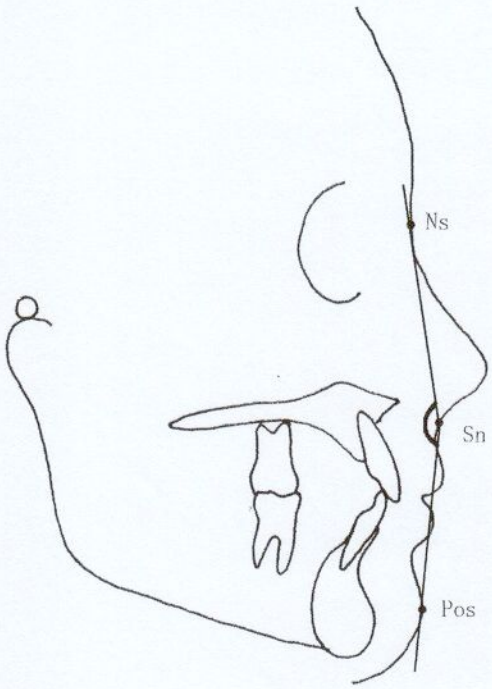


**Fig 1.** Ns-Sn-Pos angle was smaller in 4PM1 group than in 4PM2 group in borderline patients.

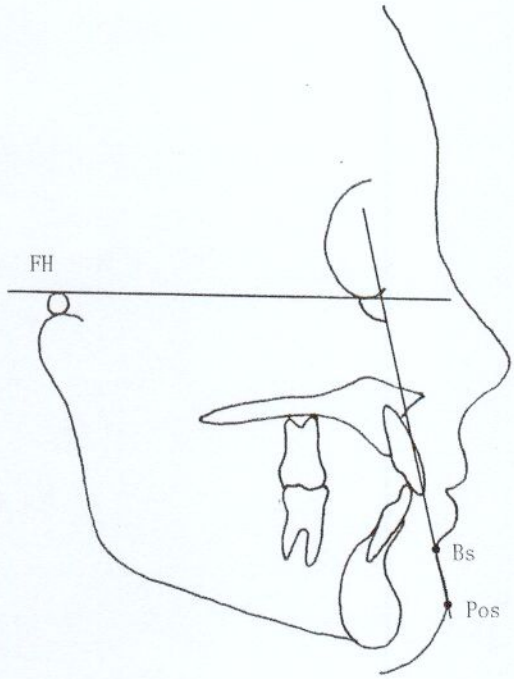


**Fig 2.** PosBs/FH angle was smaller in 4PM1 group than in nonextraction group in borderline patients. Extraction treatment can increase this angle.

from means, but mean value does not mean good result. "Aesthetics is certainly personal and interpretive, and the norms are based on a combination of the author's concept of aesthetics and the sample that the author uses to establish his norms, which in turn is biased by his view of aesthetics."[17] Some indexes, such as the peer assessment rating (PAR) and the index of orthodontic treatment need (IOTN), can be used to evaluate dentition and occlusion, but each was designed for a special purpose. The IOTN is used to prioritize orthodontic treatment.[18] The weighting system of the PAR is also affected by the panel of orthodontists.[19-21] However, patients and doctors have standards in their minds about whether a treatment is good and which treatment result is better than the others, without measuring anything. This study is based on clinicians' mental standards to evaluate the treatment results of a borderline sample of Chinese patients to determine what orthodontists prefer for face, teeth, and occlusion achieved by extraction or nonextraction treatment, respectively. The results showed that, on average, 5 experienced orthodontists preferred the extraction patients' facial profiles over the profiles of the nonextraction patients. Tooth alignment, overbite and overjet, midline symmetry, lateral occlusion, and treatment period were almost the same for the patients treated by either extraction or nonextraction in our sample. That encouraged us to determine what made the difference in the facial profiles of the extraction or nonextraction borderline patients. Because hard-tissue relationships are invisible to clinicians, this study focused on soft-tissue analysis.

### Cephalometric comparison of pretreatment soft-tissue profiles

Facial prognathism is an important factor in planning for extraction or nonextraction. Generally, protrusive lips dictate extraction. But for borderline patients, it is not clear. Table IV shows that none of the pretreatment measurements showed statistically significant differences between the extraction and nonextraction groups, implying that the soft-tissue profile does not determine extraction or nonextraction in borderline patients. However, the Ns-Sn-Pos angle (Fig 1) of the 4PM1 extraction group was much smaller than that of the 4PM2 extraction group at the $P = .014$ level, indicating that the 4PM1 and 4PM2 extraction groups should not be combined into 1 group. When comparing each group with the nonextraction group, the PosBs/FH angle (Fig 2) of the 4PM1 extraction group was much smaller than in the nonextraction group, but none of the 15 soft-tissue measurements showed a statistically significant difference between the 4PM2 extraction group and the nonextraction group. It can be

concluded from the pretreatment soft-tissue comparison that the soft-tissue morphology of the 4PM2 extraction group was similar to that of the nonextraction group, whereas the 4PM1 extraction group was different from the other groups.

### Cephalometric comparison of posttreatment soft-tissue profile

Although the pretreatment soft-tissue morphologies were almost the same between the extraction and nonextraction groups for borderline patients, 6 of 15 posttreatment soft-tissue measurements had statistically significant differences (Table IV), all related to lip protrusion that was reduced more in the extraction group, as expected. The interesting finding is that when splitting the extraction group into 4PM1 and 4PM2 groups and comparing each with the nonextraction group for facial profiles, the situation is just the opposite to that of pretreatment. None of the 15 soft-tissue measurements had statistically significant differences between the 4PM1 extraction group and the nonextraction group; however, 6 of the 15 measurements had statistically significant differences between the 4PM2 extraction group and the nonextraction group. This implies that the choice between the two extraction patterns may have made the difference in the posttreatment soft-tissue profiles. Because all 6 significant measurements reflect less lip protrusion, we tentatively believe that the reason for the 4PM2 extraction group's high score (Table III) is that Chinese orthodontists prefer less protrusive lips. Differences in facial attractiveness preferences of clinicians of various ethnicities and cultural backgrounds are now under investigation between 2 orthodontic departments—Peking University in China and University of the Pacific in the United States.

### Cephalometric comparison of soft-tissue profile changes

Orthodontists care more about treatment changes, the difference in the direction of the changes, and the amount of change caused by extraction and nonextraction. Table IV shows that significant differences of treatment-associated changes between these 2 methods are all related to lower lips and chin. Because there was no significant difference between the changes of the 2 extraction patterns, we paid more attention to the changes between 4PM1 extraction and nonextraction, and between 4PM2 extraction and nonextraction. The results show that, with either 4PM1 or 4PM2 extraction, the more sensitive items related to soft-tissue changes are chin inclination to FH plane (PosBs-FH; Fig 2), lower lip prognathism (LL-SnPos; Fig 3), and soft-tissue B-point to esthetic plane (Bs-EP; Fig 4). Extraction treatment increases chin inclination but decreases lower lip and soft-tissue B-point

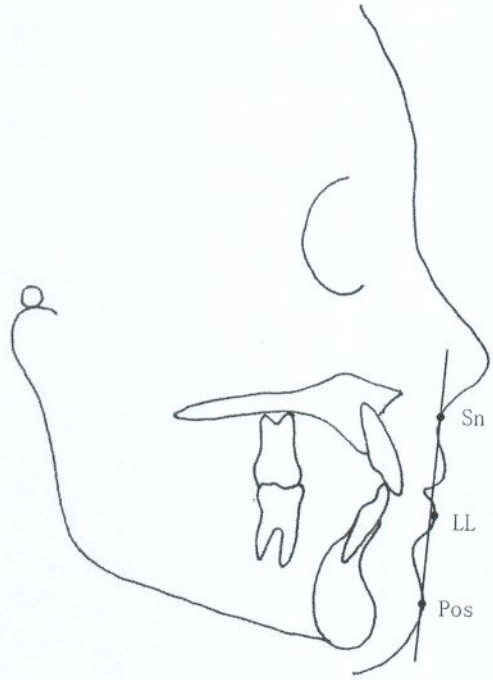


**Fig 3.** LL-SnPos. Extraction treatment makes lower lip prognathism decrease more than nonextraction treatment.

prognathism. The interesting finding is that, although orthodontists care more about upper-lip prognathism, extraction treatment did not change it significantly more than nonextraction treatment did. The probable reasons are (1) the average pretreatment prognathism for the extraction and nonextraction groups of borderline patients are similar, and, because are usually not very bad at the beginning, orthodontists would not change them much; and (2) orthodontists might have "ideal" or "standard" upper lip positions in their minds, so that they move the molars distally for nonextraction patients or mesially for extraction patients after they set the goals for upper-lip position. That makes the significant difference between the changes of extraction and nonextraction treatment limited to the lower-lip and the chin areas; orthodontists pay less attention to these in their treatment plans, although the changes affect their subjective evaluations, as shown in this study.

## CONCLUSIONS

Treatment of borderline patients, whether by extraction or nonextraction, achieved generally similar results for tooth alignment, overbite and overjet, midline symmetry, and lateral occlusion as judged by Chinese clinicians in this Chinese sample.

In the group of borderline subjects, extraction of either 4 first premolars or 4 second premolars resulted in facial

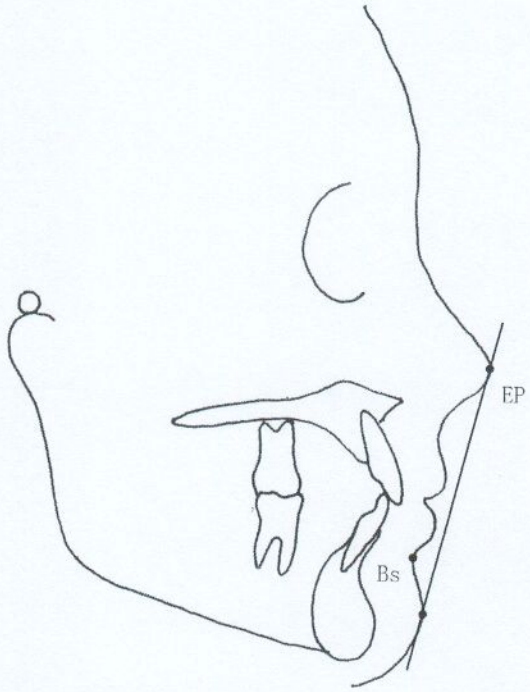


**Fig 4.** Bs-EP. Extraction treatment makes soft-tissue B-point prognathism decrease compared with nonextraction.

profiles that were preferred by a group of Chinese orthodontists, compared with nonextraction treatment. The probable reason is that Chinese clinicians prefer less protrusive facial profiles.

In the group of borderline subjects, the pretreatment soft-tissue morphology of the 4PM2 patients was similar to that of the nonextraction group; the soft-tissue morphology of the 4PM1 group was different from the other 2 groups.

The main differences between changes caused by extraction or nonextraction treatment are in the lower-lip and chin areas; these might affect clinicians' preferences in facial profiles.

## SUPPLEMENTARY DATA

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ajodo.2005.12.015.

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