*Original Article*

# Treatment outcomes and short-term stability in adult anterior openbite patients treated with or without extractions: a National Dental Practice-Based Research Network study

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**ABSTRACT**

**Objectives:** To investigate whether extractions in adult anterior openbite (AOB) patients lead to improved treatment outcomes and better short-term stability.

**Materials and Methods:** Records of extraction (EXT) and nonextraction (NE) adult patients were identified from all patients treated with fixed appliances through the National Dental Practice-Based Research Network. Photographic Openbite Severity Index was used to assess treatment success and stability. Skeletal, dental, and soft tissue treatment outcomes were evaluated using cephalometric analysis.

**Results:** Pretreatment and posttreatment records were collected for 115 patients. Thirty-three were treated with extractions; 82 were treated without extractions. The EXT group was younger, more crowded, and had less previous orthodontic treatment. Success rate of AOB correction in the EXT group was slightly higher (97%) than the NE group (92%) but not statistically different. No significant differences were observed in skeletal outcomes. The EXT group exhibited more lingual tipping and posterior movement of maxillary and mandibular incisors and less extrusion of mandibular incisors. Dental changes in the EXT group were associated with increased nasolabial angle and lip retraction. The small number of patients with AOB relapse did not provide enough power to identify differences in stability between the two groups.

**Conclusions:** Orthodontists have high success correcting AOB with or without extractions. The EXT group displayed more retraction and lingual tipping of incisors as well as increased retraction of soft tissues. Stability of AOB closure was more than 90% for both groups after 1 year, with marginal increases in stability after extractions. (*Angle Orthod*. 2025;95:149–156.)

**KEY WORDS:** Stability; Anterior openbite; Extractions; National Dental PBRN; POSI

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## INTRODUCTION

Anterior openbite (AOB) is a dental condition in which patients are unable to obtain vertical overlap of the incisors while occluding on posterior teeth. The National Health and Nutrition Examination Survey III reported the AOB prevalence in the United States to be approximately 3.5%.[1] The majority of AOB cases are categorized as mild, with a negative overbite in the range of 0 mm to −2 mm. However, some AOBs can be −10 mm or more, and etiologic factors may include dental discrepancies, skeletal discrepancies, oral habits such as thumb-sucking or tongue habits, airway obstruction, and condylar dysplasia.[2,3] Some functional challenges associated with this occlusion include difficulty with eating and speech, and esthetics can be compromised in severe cases.

Orthodontists employ many approaches to achieve AOB closure, including elastic traction, habit appliances, and temporary anchorage device (TAD)-supported intrusion. Most often, practitioners are successful in achieving positive overbite regardless of treatment modality. Todoki et al.[4] reported that positive vertical overlap was achieved for all four incisors in 84% of adult patients with AOB. Extractions are considered helpful in the orthodontic correction of AOB. Removal of teeth is believed to have two potential benefits: the wedge effect bringing the point of posterior dental contact further away from the mandible's axis of closure[5] and the drawbridge effect retracting and rotating incisors occlusally to increase vertical overlap.[6]

Maintaining AOB correction is perhaps more difficult than correcting it. The success of both surgical and nonsurgical treatment is estimated to be greater than 75%, but this must be considered cautiously due to the lack of high-quality evidence.[7] Some exploration into these treatment modalities in adolescents has provided support to the notion that EXT treatment is more stable than nonextraction (NE) treatment in AOB patients.[6] However, this conclusion has been contradicted by others who found no stability difference.[8,9]

In this study, we sought more information about the effects of a common treatment strategy, extractions, for treatment of AOB in adults. The National Dental Practice-Based Research Network (Network) Anterior Openbite Study was a multicenter, prospective cohort study exploring treatment recommendations, outcomes, and stability in adults with AOB.[4,10–12] In this study, we test the hypothesis that treatment outcomes and stability vary between EXT and NE treatments in patients treated with fixed appliances (braces).

## MATERIALS AND METHODS

Details regarding the Network practitioners, methods, and findings have previously been published.[4,10–13] Approval for the larger study was obtained from institutional review boards in multiple regions and has been described previously.[12] Included patients were a subset of a larger study group.

### Inclusion Criteria

- Eighteen years or older.
- AOB diagnosis with one or more incisors not vertically overlapping teeth in the opposing arch. Remaining incisors may have minimal incisor overlap, but none can contact the opposing arch.
- Treatment completed with braces only.
- Pretreatment and posttreatment cephalograms or frontal intraoral photographs available.
- Crowding in at least one arch.
- EXT patients had at least one incisor, canine, or premolar extracted for current treatment.

### Exclusion Criteria

- Treatment with aligners, TADs, or orthognathic surgery.
- Clefts or craniofacial syndromes.
- No pretreatment or posttreatment records.
- Nondiagnostic radiographs or frontal intraoral photographs.
- Significant physical, mental, or medical conditions affecting treatment.

Patients were assigned to the EXT group if at least one incisor, canine, or premolar was extracted as part of the planned orthodontic treatment. Molar extractions were not part of any treatment plan. All included patients had mild to severe crowding in at least one dental arch. Crowding was reported by practitioners as mild (1–3 mm), moderate (4–6 mm), or severe (>6 mm). If crowding scores differed for the maxillary and mandibular arches, patients were categorized by the arch with more significant crowding. A power calculation was performed comparing mean change in overbite (OB) of two independent samples with effect size of 1 mm and standard deviation of 1.5 mm. The level of significance was $\alpha = 0.05$ and the desired power was 0.8. Power analysis indicated that a sample size of 36 in each group would be required to detect a clinically significant 1 mm difference in overbite correction.

Data were collected from October 2016 to December 2017. To reduce selection bias, practitioners were asked to enroll all eligible patients. A maximum of 15 patients were used for each provider and were sequentially selected according to treatment start date.

Pretreatment (T1) questionnaires were completed by patients and practitioners. Information regarding the amount of pretreatment crowding, the method of treatment provided, and patient characteristics were

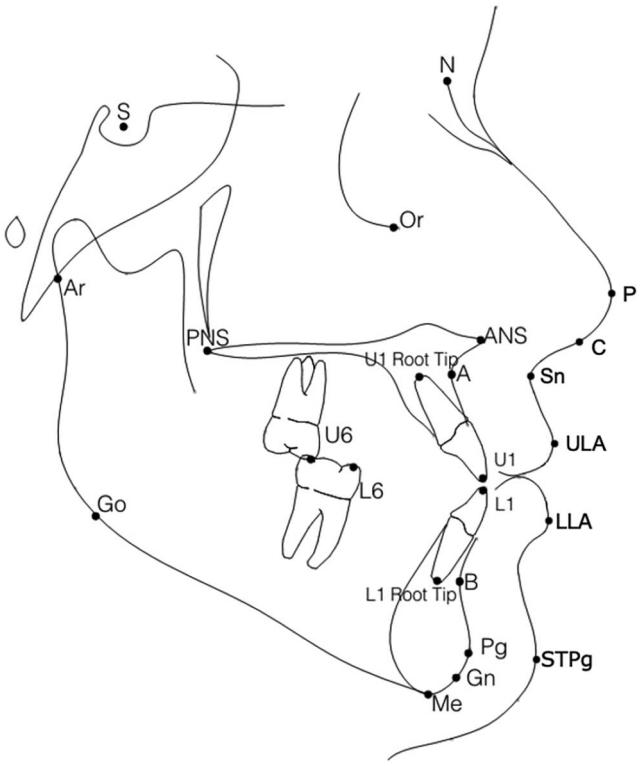


**Figure 1.** Cephalometric landmarks.

included in the doctor's questionnaire. Cephalograms and intraoral photographs were also obtained at this timepoint.

At the completion of treatment (T2), cephalograms and intraoral photographs were collected. Skeletal and dental cephalometric landmarks and measurements were identified and measured as part of a previous study[4] (Figure 1). Magnification calibration protocol and interrater and intrarater reliability testing were also reported previously.[4] Soft tissue landmarks were acquired on the T1 and T2 cephalograms (Figure 1). Imaging software (Dolphin Imaging v. 11, Chatsworth, Calif) was used for landmark identification on pretreatment (T1) and posttreatment (T2) cephalograms, and an automated custom analysis was created to generate measurements (Table 1).

For some patients, frontal intraoral photographs were submitted at least 1 year after treatment completion (T3). T1, T2, and T3 openbite severity was assessed using the Photographic Openbite Severity Index (POSI; Figure 2). This system was developed to categorize the severity of the AOB pretreatment and posttreatment and has been tested for validity and reliability.[10,11,14] The seven categories are the following:

0 = All four incisors exhibit vertical overlap (no AOB).

1 = 1 or 2 maxillary lateral incisors without vertical overlap (both maxillary central incisors have overlap).

2 = 1 maxillary central incisor without vertical overlap (other maxillary central has vertical overlap).

3 = Two maxillary central incisors without vertical overlap ($\geq$1 maxillary lateral has vertical overlap).

4 = All four maxillary incisors without vertical overlap.

5 = All anterior teeth without overlap (canine to canine).

6 = Category 5 plus at least one premolar without vertical overlap.

POSI scores were previously determined by two examiners and intrarater and interrater reliability testing was completed.[4] For this study, treatment success was defined as a POSI score of 0 or 1, indicating a successful treatment included vertical overlap at both central incisors.

Pretreatment patient demographics were collected for the EXT and NE groups. Treatment success was defined as a POSI score of 0 or 1 and was also evaluated with cephalometric overbite. Both methods assessed positive vertical overlap at the central incisors.

Means for all cephalometric outcomes were calculated at T1 and T2. A multivariable linear regression analysis was performed for each outcome variable to adjust for the influence of age, gender, previous treatment, previous extraction, and moderate to severe crowding. This model was used to assess the impact of extractions on cephalometric treatment outcomes after adjustment for explanatory variables.

Stability was evaluated for patients that achieved success (POSI = 0 or 1) posttreatment. T2 and T3 POSI scores were compared with Fischer's exact test.

## RESULTS

A total of 115 patients qualified for this study. All contributed to the data at T1 and T2, but a reduced number had T3 data. The sample was divided into an EXT group (n = 33) and a NE group (n = 82). Here, 66 patients (11 EXT and 55 NE) had intraoral photographs at least 1 year after treatment completion to assess short-term stability.

At enrollment, the mean patient age was 33.2 years. The EXT mean age was 29.6 and contained greater numbers of young adult patients aged 18 to 30. Most of the extracted teeth were premolars, followed by canines and incisors. The NE patients were older and more evenly distributed, with a mean age of 37.7. Both groups were predominately female. Here, 18.2% of EXT and 37.3% of NE reported previous orthodontic treatment. Also, 10.8% of NE already had extractions as part of their previous orthodontic treatment (Table 2).

**Table 1.** Cephalometric Measurement Abbreviations and Definitions

| Measurement | Definition |
|---|---|
| Skeletal measurements | |
| ANB (°) | A point–Nasion–B point |
| SNA (°) | Sella-Nasion line to A point |
| SNB (°) | Sella-Nasion line to B point |
| MPSN (°) | Mandibular plane to Sella-Nasion line |
| LAFH (mm): lower anterior facial height | ANS-Me |
| Dental measurements | |
| OB (mm): overbite | Vertical distance between the incisal edge of the maxillary incisors and mandibular incisors |
| U1-PP (°): maxillary incisor inclination | A measurement of the angle between the palatal plane and a line drawn through the long axis of the maxillary incisor |
| L1-NB (°): mandibular incisor inclination | A measurement of the angle between the Nasion–B point line and a line drawn through the long axis of the lower incisor |
| U1-NA (mm): maxillary incisor protrusion | Millimetric distance between the incisal edge of the maxillary incisor and NA |
| L1-NB (mm): mandibular incisor protrusion | Millimetric distance between the incisal edge of the mandibular incisor and the Nasion–B point line |
| U1-PP (mm): maxillary incisor vertical position | Millimetric distance of a line drawn from the incisal edge of the maxillary incisor perpendicular to the palatal plane |
| L1-MP (mm): mandibular incisor vertical position | Millimetric distance of a line drawn from the incisal edge of the mandibular incisor perpendicular to the mandibular plane |
| Soft tissue measurements | |
| ULip-E plane (mm): upper lip protrusion | Millimetric measurement of the most anterior point of the upper lip to the esthetic plane |
| LLip-E plane (mm): lower lip protrusion | Millimetric measurement of the most anterior point of the lower lip to the esthetic plane |
| NLA (°): nasolabial angle | Angular measurement: upper lip anterior-subnasale-columella |

More EXT patients (24.2%) had severe crowding than NE patients (8.4%). NE patients had a higher percentage of mild crowding (37%) than EXT (30.3%). Pretreatment cephalometrics were largely similar between the two groups, except for more lip protrusion in EXT (Table 3).

All patients had a POSI score $>0$ at T1 (Table 4). The most common initial score for both groups was POSI 4; 33.7% of NE and 27% of EXT. At T2, 93% of patients had a successful treatment outcome with POSI scores of 0 or 1. Here, 97% of the EXT and 91.5% of the NE had successful closure of their AOB. Eight patients did not achieve treatment success: one from EXT and seven from NE. POSI score worsened from T1 to T2 for one NE patient. Cephalometric overbite analysis showed positive closure in 91% in both groups at T2.

Multivariable regression analysis was used to detect the effect of extractions on cephalometric outcomes after adjustment for age, gender, previous treatment, previous extractions, and crowding (Table 5; Supplemental Table 1). Posttreatment overbite was not associated with extractions or any other pretreatment variable after adjustment. The change in overbite associated with treatment was not different between EXT and NE.

Posttreatment measures of ANB, MPSN, and lower facial height were not significantly related to any pretreatment variables or extractions in the regression model. Posttreatment SNA and SNB were smaller by about 1° in EXT after adjustment. Regression analysis showed previous orthodontic treatment to have a similar $\sim$1° influence on SNA, SNB, and MPSN.

The overbite and maxillary incisor vertical position were similar between EXT and NE on the T2 cephalometric dental measurements. Other dental measurements were quite different between the two groups. EXT had reduced inclination of maxillary and mandibular incisors, on average reducing 10.7° in the maxilla and 8.1° in the mandible. EXT also demonstrated a greater reduction in millimetric incisor protrusion. Distal movement of maxillary incisors was minimal in NE, but an average of 4 mm retraction was found in EXT. Lower incisors in NE had a slight 0.5 mm increase in protrusion, while EXT had a 2.1 mm decrease in protrusion (Table 3). Incisor position was also associated with the amount of crowding, with more crowded patients exhibiting less average retraction or an increase in proclination. Both groups had some maxillary incisor extrusion, but the NE patients had about 2 mm more lower incisor extrusion than the EXT patients.

On average, NLA increased by 4.6° in EXT at the completion of treatment; NE had negligible change. A statistically significant influence of extractions was found on NLA even after adjustment for age, gender,


**Figure 2.** Photographic Openbite Severity Index (POSI).

previous treatment and extractions, and crowding severity. Upper and lower lip retraction was also more than 1 mm greater for EXT. This difference was associated with both extractions and previous treatment.

For assessment of short-term stability, only patients with treatment success (POSI score of 0 or 1) at T2 were evaluated (Table 4). Here, 11 patients in EXT (100%) and 49 (89%) patients in NE maintained closure of their AOB at the T3 follow-up. Fisher's exact test on this difference did not demonstrate a statistical difference between the groups ($P = .58$). Unstable outcomes at T3 were rare, limiting statistical power.

## DISCUSSION

The treatment success rates for AOB treatment were similarly high for both EXT and NE groups. Significant

**Table 2.** Initial Patient Demographics

| | All, n = 115 | Nonextraction, n = 82 | Extraction, n = 33 |
|---|---|---|---|
| Age, mean ± SD | 33.2 ± 12.0 | 34.7 ± 12.4 | 29.6 ± 10.3 |
| Age group | | | |
| 18.0–20.9 | 19 (16.5%) | 10 (12.2%) | 9 (27.3%) |
| 21.0–30.9 | 41 (35.7%) | 30 (36.6%) | 11 (33.3%) |
| 31.0–40.9 | 33 (28.7%) | 23 (28%) | 10 (30.3%) |
| 41.0–67.1 | 22 (19.1%) | 19 (23.2%) | 3 (9.1%) |
| Gender | | | |
| Male | 20 (17.2%) | 15 (18.1%) | 5 (15.2%) |
| Female | 96 (82.8%) | 68 (81.9%) | 28 (84.8%) |
| Previous treatment | | | |
| No | 79 (68.1%) | 52 (62.7%) | 27 (81.8%) |
| Yes | 37 (31.9%) | 31 (37.3%) | 6 (18.2%) |
| Previous extraction | | | |
| No | 107 (92.2%) | 74 (89.2%) | 33 (100%) |
| Yes | 9 (7.8%) | 9 (10.8%) | 0 (0%) |
| Crowding | | | |
| Mild (1–3 mm) | 47 (40.5%) | 37 (44.6%) | 10 (30.3%) |
| Moderate (4–6 mm) | 54 (46.6%) | 39 (47%) | 15 (45.5%) |
| Severe (>6 mm) | 15 (12.9%) | 7 (8.4%) | 8 (24.2%) |

**Table 3.** Cephalometric Measurement Value Means: T1 and T2[a]

| | T1 | | T2 | | T2-T1 Change | |
|---|---|---|---|---|---|---|
| | NE Mean ± SD | EXT Mean ± SD | NE Mean ± SD | EXT Mean ± SD | NE Mean Δ | EXT Mean Δ |
| ANB | 3.1 ± 2.3 | 3.7 ± 3.0 | 2.9 ± 2.3 | 3.9 ± 2.8 | −0.2 | 0.2 |
| SNA | 80.1 ± 3.7 | 81.4 ± 3.6 | 80.2 ± 4.1 | 80.5 ± 3.4 | 0.1 | −0.9 |
| SNB | 77.0 ± 3.7 | 77.7 ± 3.9 | 77.3 ± 3.9 | 76.6 ± 4.1 | 0.3 | −1.1 |
| MPSN | 38.1 ± 6.2 | 38.7 ± 5.8 | 38.1 ± 6.2 | 39.1 ± 6.2 | 0.0 | 0.4 |
| LFHmm | 69.1 ± 7.1 | 68.3 ± 4.9 | 70.3 ± 6.7 | 68.6 ± 4.0 | 1.2 | 0.3 |
| OBmm | −2.0 ± 1.7 | −1.9 ± 1.6 | 1.1 ± 1.1 | 1.3 ± 1.0 | 3.1 | 3.2 |
| U1-PP° | 25.1 ± 7.8 | 27.3 ± 7.1 | 22.5 ± 6.6 | 16.6 ± 9.7 | −2.6 | −10.7 |
| L1-NB° | 29.4 ± 7.3 | 33.7 ± 9.3 | 27.3 ± 6.8 | 25.6 ± 8.8 | −2.1 | −8.1 |
| U1-NAmm | 5.9 ± 2.6 | 7.0 ± 2.9 | 5.6 ± 2.5 | 3.0 ± 3.3 | −0.3 | −4.0 |
| L1-NBmm | 6.8 ± 2.7 | 8.1 ± 3.4 | 7.3 ± 2.5 | 6.0 ± 2.8 | 0.5 | −2.1 |
| U1-PPmm | 28.7 ± 3.7 | 29.1 ± 2.9 | 30.7 ± 3.7 | 31.2 ± 3.0 | 2.0 | 2.1 |
| L1-MPmm | 40.6 ± 3.9 | 41.6 ± 3.0 | 42.9 ± 4.2 | 41.5 ± 2.6 | 2.3 | −0.1 |
| ULip-E plane | −4.3 ± 3.2 | −1.6 ± 3.8 | −4.5 ± 3.1 | −2.9 ± 3.5 | −0.2 | −1.3 |
| LLip-E plane | −1.7 ± 3.2 | 0.9 ± 3.6 | −1.4 ± 3.2 | −0.5 ± 3.4 | 0.3 | −1.4 |
| NLA° | 107.2 ± 11.4 | 108.4 ± 9.3 | 107.7 ± 10.7 | 113.0 ± 10.1 | 0.5 | 4.6 |

[a] EXT indicates extraction group; NE, nonextraction group; T1, pretreatment; T2, posttreatment.

relapse was rare for both groups, with 91% of all patients maintaining their successful result. Given that relapse was rather rare at 1 year follow-up, a larger study is necessary to find factors influencing differences in posttreatment stability.

The success rates for AOB closure in this study were very high: 93% of patients had a successful outcome after treatment. Treatment success was expected, but such high rates were surprising, as successful AOB correction in the literature is reported in only 75–80% of patients.[4,6,7] This difference could have been due to the Hawthorne effect; providers knew patients were in a study, motivating them to achieve successful results.[15] Differences could also have been from the methods used for evaluating success. Cephalometric overbite has been typically used to assess AOB correction. In this study, we used the POSI, which does not require follow-up radiographic exposure. Treatment success was defined as a POSI score of 0 or 1, meaning positive vertical overlap of at least both central incisors. These scores were chosen as they most closely correlate with cephalometric overbite which measures overlap of the central incisors. Todoki et al.[4] also used POSI scores to evaluate AOB correction but defined treatment success as a POSI score of 0, resulting in a lower success rate of 80%. Using this definition of success, the results were similar, with 78% of patients achieving a POSI score of 0. Regardless of the evaluation method, the approximately 5% difference in success rates between NE and EXT patients was not statistically different. This finding agrees with recent literature, in which more successful AOB correction for EXT patients is not indicated.[8,9]

The patients that displayed significant posttreatment relapse were all part of the NE treatment group, meaning 100% of EXT patients at the final time point had a stable result, suggesting a stability benefit from extractions as reported by others.[6] Unfortunately, EXT had only 11 patients at T3, and the stability rate was not

**Table 4.** POSI Scores: T1, T2 and T3[a]

| | T1 | | T2 | | T3[b] | |
|---|---|---|---|---|---|---|
| POSI Score | NE, n = 86 | EXT, n = 37 | NE, n = 82 | EXT, n = 33 | NE, n = 55 | EXT, n = 11 |
| 0 | 0 (0%) | 0 (0%) | 65 (79.3%) | 25 (75.8%) | 32 (58.2%) | 9 (81.8%) |
| 1 | 15 (17.4%) | 8 (21.6%) | 10 (12.2%) | 7 (21.2%) | 17 (30.9%) | 2 (18.2%) |
| 2 | 17 (19.8%) | 9 (24.3%) | 1 (1.2%) | 0 (0%) | 1 (1.8%) | 0 (0%) |
| 3 | 7 (8.1%) | 2 (5.4%) | 2 (2.4%) | 0 (0%) | 0 (0%) | 0 (0%) |
| 4 | 29 (33.7%) | 10 (27%) | 1 (1.2%) | 1 (3%) | 5 (9.1%) | 0 (0%) |
| 5 | 5 (5.8%) | 6 (16.2%) | 2 (2.4%) | 0 (0%) | 0 (0%) | 0 (0%) |
| 6 | 13 (15.1%) | 2 (5.4%) | 1 (1.2%) | 0 (0%) | 0 (0%) | 0 (0%) |

[a] EXT indicates extraction group; NE, nonextraction group; POSI, Photographic Openbite Severity Index; T1, pretreatment; T2, posttreatment; T3, at least 1 year after treatment completion.

[b] T3 data includes only those with a successful outcome at T2 (POSI T2 = 0 or 1).

**Table 5.** Multivariable Regression Analysis: Effect of Extractions After Adjustment

| | Estimate | Standard Error | *t* Value | *P* Value[a] |
|---|---|---|---|---|
| ANB | 0.2 | 0.3 | 0.8 | .45 |
| SNA | −0.9 | 0.4 | −2.0 | **.05** |
| SNB | −1.0 | 0.3 | −3.1 | **<.01** |
| MPSN | 0.7 | 0.4 | 1.9 | .06 |
| LFH | 0.2 | 0.6 | 0.3 | .76 |
| OB | 0.0 | 0.2 | 0.1 | .92 |
| U1-PP° | −6.8 | 1.5 | −4.6 | **<.01** |
| L1-NB° | −6.1 | 1.2 | −5.0 | **<.01** |
| U1-NA mm | −3.2 | 0.5 | −6.2 | **<.01** |
| L1-NB mm | −2.6 | 0.4 | −7.4 | **<.01** |
| U1-PP mm | 0.3 | 0.4 | 0.8 | .41 |
| L1-MP mm | −1.6 | 0.5 | −3.4 | **<.01** |
| ULip-E plane mm | −0.9 | 0.4 | −2.2 | **.03** |
| LLip-E plane mm | −1.6 | 0.4 | −4.0 | **<.01** |
| NLA° | 5.1 | 1.8 | 2.9 | **<.01** |

[a] Adjusted for age, gender, previous treatment, previous extractions, and crowding. Bolded values indicate statistical significance.

statistically different than the 89% found in the larger NE group. A post hoc power analysis indicated that a difference of 20% in stability would have required about 40 patients in each group, while the roughly 10% difference found would have required 100 in each group. Janson et al.[6] reported a 12% stability advantage for EXT patients 5 years after the completion of treatment. They proposed this difference could be due to differences in dental changes throughout treatment. Like in this study, they found that EXT patients had less mandibular incisor extrusion.[6] AOB correction with incisor extrusion may be less stable. The incisor retraction and lingual tipping with extractions contributed more substantially to the AOB correction. Clinicians might recommend extractions based on several factors; a 10–12% increase in stability may not warrant extractions solely for this purpose.

Both groups displayed pretreatment characteristics commonly seen in patients with AOB, including increased LAFH and steep MPSN.[2,3] Changes in LAFH and MPA were minimal at the completion of treatment for both groups. Mean ANB, SNA, and SNB angles differed by less than 1° between treatment groups at the completion of treatment and were largely comparable with pretreatment measurements. The lack of clinically significant skeletal change indicated that AOB correction was mainly achieved through dental effects. A more substantial change in skeletal features would likely be seen if patients treated with TADs or orthognathic surgery were included.[16]

Soft tissue features are an important part of orthodontic treatment planning, particularly when considering extractions. Previously established changes associated with the removal of teeth include increased lip retraction in reference to Rickett's E-plane and an increase in nasolabial angle.[17,18] These changes were associated with extraction treatment in this sample. It is important to note that, at the initial time point, patients in the EXT group had upper and lower lips that were more protrusive on average. This greater protrusion and a desire for facial change may have influenced practitioners to choose an extraction plan, as these patients may have been more amenable to the profile flattening associated with extractions.

An orthodontist's decision to recommend extractions is multifactorial, considering crowding, protrusion, soft tissue profile, and AOB severity. Most patients in the sample accepted the extraction recommendations of their orthodontists. High rates of AOB correction indicated that practitioners are successful in using EXTs to achieve orthodontic goals, including the desired AOB closure. The potential for long-term stability of AOB correction should also be considered when making treatment decisions.

Providers and patients across the nation self-selected to enroll in the Network and may not be truly representative of the general population. To minimize selection bias, patients were sequentially enrolled before treatment was completed. Caution must be exercised in considering the stability assessment because this evaluation was performed on a reduced sample, and the 1 year follow-up time may have been too short to see all potential relapse.

## CONCLUSIONS

- No difference was found for success in closing AOB between adult patients treated with or without extractions, possibly because success levels were high in both groups.
- EXT patients have clinically significant retraction and lingual tipping of incisors with associated retraction of soft tissues at the completion of treatment.
- Over 90% of patients maintained closure of their AOB at follow-up.
- In this study, we indicate a 10% to 12% stability improvement in EXT patients; additional studies with larger samples are needed to definitively address this issue.

## SUPPLEMENTAL DATA

Supplemental Table #1 is available online.

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