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Effects of camouflage treatment on dentofacial structures in Class II division 1 mandibular retrognathic patients

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SUMMARY The aims of this study were to determine the changes in the dentofacial structures of Class II division 1 mandibular retrognathic patients treated with bilateral extraction of the upper first premolars, and to compare pre- and post-treatment values with the cephalometric norms of Anatolian Turkish adults. The Class II division 1 subjects included 20 males and 33 females (mean age: 17.08 ± 1.03 years). All received comprehensive orthodontic treatment using an edgewise appliance and appropriate headgear. Lateral cephalograms were taken at the beginning and end of treatment. Twenty-five (14 linear and 11 angular) measurements were analysed on each radiograph. Each cephalogram was traced and digitized. For statistical evaluation, paired and independent-samples *t*-tests were performed.

When the pre- and post-treatment measurements were compared, statistically significant differences were found for nine of 25 measurements. During treatment the facial axis, U1–SN (°), U1–NA (mm), U1–NA (°), H angle and upper lip to E plane measurements decreased, while N-ANS, interincisal angle and upper lip to Steiner S line increased. No statistically significant gender differences were found. Significant improvements were determined in ANS–Me and L1–APo measurements compared with Turkish norms. However, statistically significant deterioration was found in values related to point A, upper incisor and lower lip measurements. The findings demonstrates that camouflage treatment in Class II, mandibular retrognathic subjects has characteristic skeletal, dental and soft tissue effects on the dentofacial complex.

Introduction

The indications for extractions in orthodontic practice have historically been controversial (Case, 1964a,b; Hahn, 1944; Tweed, 1944). Premolars are probably the most commonly extracted teeth for orthodontic purposes, conveniently located between the anterior and posterior segments. Variations in extraction sequences including upper and lower first or second premolars have been recommended by different authors for a variety of reasons (Staggers, 1990; Luecke and Johnston, 1992; Proffit *et al.*, 1992; Paquette *et al.*, 1992; Taner-Sarısoy and Darendeliler, 1999; Basciftci and Usumez, 2003).

Ideally, the ability to identify specific abnormalities should lead to elimination of a malocclusion by normalization of the defective structures. In many situations, however, diagnosis is not matched by comparable differential treatment objectives and procedures. This problem is particularly evident in the correction of severe malocclusions of skeletal origin. Treatment for the correction of Class II malocclusions in non-growing patients usually includes orthognathic surgery or selective removal of permanent teeth, with subsequent dental camouflage to mask the skeletal discrepancy. In the present study, a surgical approach to treatment was not desired by the patients or their families, and although the underlying sagittal jaw discrepancy was severe, the selective extraction of permanent teeth was considered acceptable.

Several studies have addressed treatment of Class II division 1 malocclusions with fixed orthodontic appliances (Paquette *et al.*, 1992; Proffit *et al.*, 1992; Bishara *et al.*, 1994; Bishara, 1998; Basciftci and Usumez, 2003). Additionally, many investigations have been undertaken to examine the effects of four premolar extractions in Class II division 1 subjects (Yamaguchi and Nanda, 1991; Bishara *et al.*, 1994, 1995; Al-Nimri, 2003; Basciftci and Usumez, 2003). However, limited information is available regarding the dentofacial changes induced by extraction of two upper first premolars in Class II division 1 patients (Luecke and Johnston, 1992; Paquette *et al.*, 1992; Proffit *et al.*, 1992; Meral *et al.*, 2004).

Luecke and Johnston (1992) studied the effects of maxillary first premolar extraction and incisor retraction using the edgewise technique on the mandibular position in 42 patients and found that the mandibular basal bone displaced anteriorly in 70 per cent of the subjects.

The long-term effects of extraction and non-extraction edgewise treatments were compared in 63 patients with Class II division 1 malocclusions by Paquette *et al.* (1992). The authors concluded that the dentofacial structures following premolar extraction in 'borderline' patients were acceptable.

Meral *et al.* (2004), who compared 13 patients treated with extraction of bilateral upper first premolars with an untreated

control group of 13 subjects, indicated that anterior growth of the mandible was inhibited in the extraction group. They suggested that upper premolar extractions might affect the mandibular rotation tendency

Although the effects of four premolar extraction treatment and non-extraction treatment on dentofacial structures have been reported, the pure effects of bilateral upper premolar extractions have not been widely investigated. Therefore, the aims of this retrospective study were to determine the changes in dentofacial structures in Class II division 1 mandibular retrognathic patients treated with extraction of two upper first premolars and to compare pre- and post-treatment values with the cephalometric norms of young Anatolian Turkish adults (Basciftci *et al.*, 2004). The null hypotheses assumed that: (1) upper premolar extractions in Class II division 1 camouflage treatment did not significantly alter the dentofacial structures, and (2) did not induce significant cephalometric differences when compared with the previously established norms.

Subjects

Twenty male and 33 female Class II division 1 patients (mean age: 17.08 ± 1.03 years) treated in the Department of Orthodontics at Selcuk University were included in the study. The subjects were informed about surgical orthognathic treatment but all of them refused. The chief complaint was an excessive overjet and a dental improvement was the desired treatment outcome.

In the present group, the average initial value was 5.06 ± 1.97 degrees for the ANB angle (mean SNA angle: 79.83 ± 3.48 degrees, mean SNB angle: 74.76 ± 3.04 degrees) and 36.23 ± 6.65 degrees for the SN–MP angle. The mean overjet before treatment was 6.68 ± 2.12 mm.

The following inclusion criteria were used for the selection of the sample:

1. Congenital anomalies, significant facial asymmetries, or congenitally missing teeth (excluding third molars);
2. An overjet of greater than 4.5 mm;
3. All had received comprehensive orthodontic treatment using the same edgewise appliance and the appropriate type of headgear (14 combination headgear; 39 high-pull headgear). The patients were supervised by various clinicians in the postgraduate clinic;
4. On the basis of the diagnosis of the presenting malocclusion, the extraction of premolars, combined with maximum anchorage in the maxillary arch, was indicated in all subjects;
5. Treatment was completed in 30 months;
6. The length of time between the pre- and post-treatment cephalometric radiographs was not more than 12 months of non-treatment. This restriction was used to minimize the confounding effects of growth changes on those resulting from treatment;
7. No functional appliance was used, or surgical procedure carried out, during treatment;
8. At the end of the treatment, all subjects were considered to be well-treated by three experienced orthodontists, and displayed a Class I canine and Class II molar relationship, an overbite of between 10 and 25 per cent, and well-aligned and interdigitated arches.

Methods

Standardized lateral cephalometric radiographs of each patient in centric occlusion were obtained at the start (T1) and end (T2) of treatment. Final cephalometric radiographs were taken at a mean of 16.5 (± 3.0) months after the beginning of treatment.

The lateral cephalometric radiographs were taken using a Planmeca Cephalometer (PM 2002 EC Proline; Helsinki, Finland). All subjects were positioned in the cephalostat with the sagittal plane at a right angle to the path of the X-rays, the Frankfort plane parallel to the horizontal, the teeth in centric occlusion, and the lips relaxed (Erbay *et al.*, 2002).

The radiographs were digitized and traced by one author (AD) using the Quick-Ceph Program (Orthodontic Processing, Chula Vista, California, USA) and all angular (°) and linear (mm) measurements were performed by computer. Twenty five measurements (14 linear and 11 angular) were calculated on each radiograph. The landmarks were identified according to the definitions provided by Swlerenga *et al.* (1994).

The landmarks and measurements used in the study are shown in Figures 1 and 2.

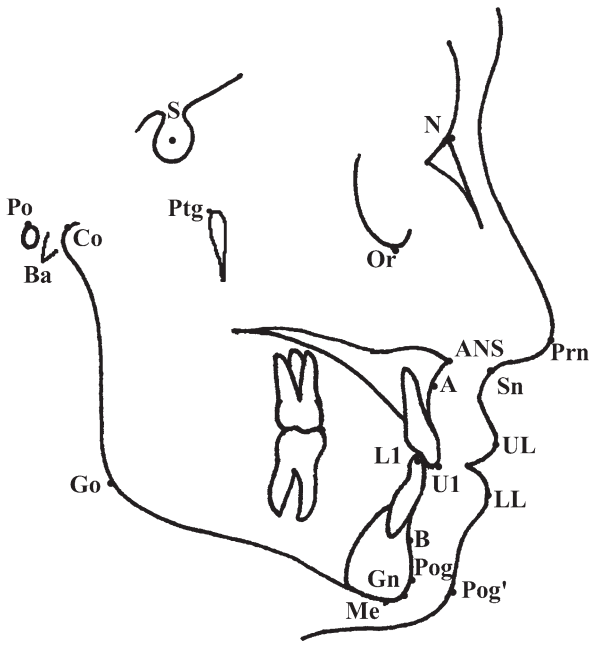

Figure 1 Hard and soft tissue landmarks.

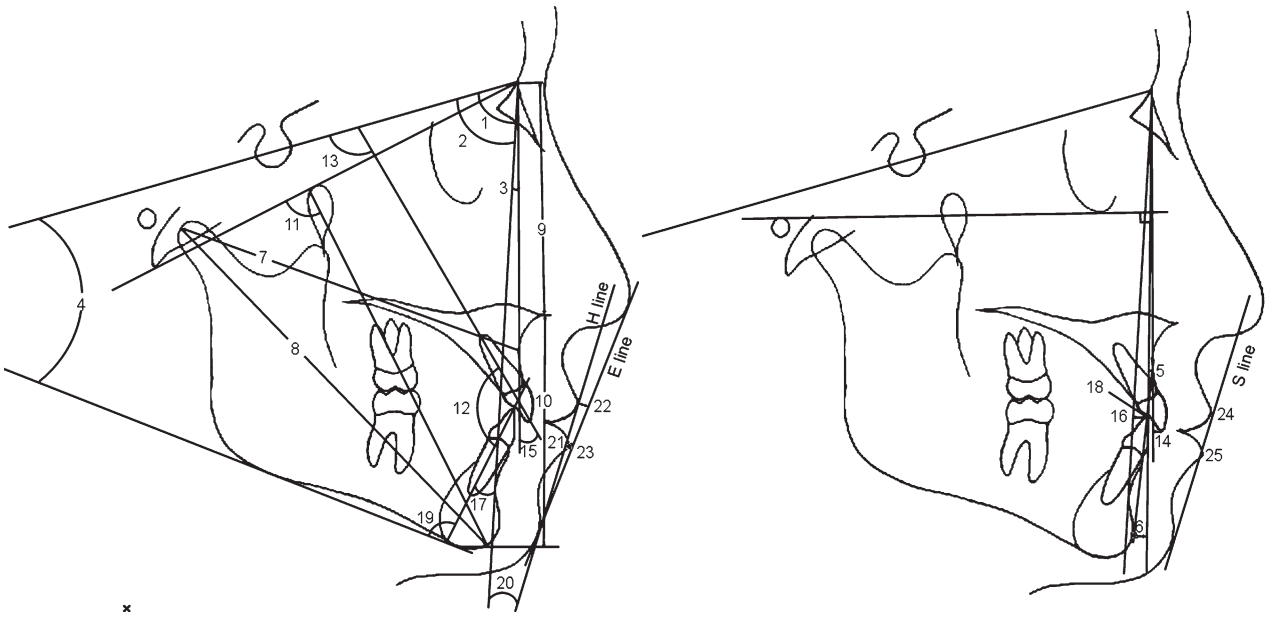

Figure 2 Skeletal, dental and soft tissue measurements used in the study. 1. SNA, 2. SNB, 3. ANB, 4. SN–MP, 5. A to Na perpen, 6. Pog to Na perpen, 7. Co–A, 8. Co–Gn, 9. N–ANS, 10. ANS–Me, 11. Facial axis angle, 12. Interincisal angle, 13. U1–SN, 14. U1–NA (mm), 15. U1–NA (degrees), 16. L1–NB (mm), 17. L1–NB (degrees), 18. L1–APog (mm), 19. L1–MP, 20. H angle, 21. Lower lip to H line, 22. Upper lip to E plane, 23. Lower lip to E plane, 24. Upper lip to Steiner S line, 25. Lower lip to Steiner S line.

Skeletal angular and linear measurements

SNA angle (SNA): The inward angle toward the cranium between the NA line and the SN plane.
SNB angle (SNB): The inward angle toward the cranium between the NB line and the SN plane.
ANB angle: The angle between the NA and NB line obtained by subtracting SNB from SNA.
Sella nasion plane to mandibular plane angle (SN–MP): The angle between the SN plane and the mandibular plane (MP).
Point A to nasion perpendicular (A to Na perpen): The distance between point A and the nasion perpendicular line measured perpendicular to the nasion perpendicular line.
Pogonion to nasion perpendicular (Pog to Na perpen): The distance between pogonion and the nasion perpendicular line measured perpendicular to the nasion perpendicular line.
Condylion to point A (Co–A) – Effective mid-facial length: The measurement was taken from a line drawn from condylion to point A.
Condylion to gnathion (Co–Gn) – Effective mandibular length: The measurement was taken from a line drawn between condylion and gnathion.
Nasion to anterior nasal spine (N–ANS) – Upper anterior face height: Measured in millimetres from nasion to anterior nasal spine (ANS).
Anterior nasal spine to menton (ANS–Me) – Lower anterior face height: Measured in millimeters from ANS to menton.
Basion–nasion to pterygoid point–gnathion (Ba–N to Pt–Gn) – Facial axis angle: A line drawn between pterygoid and gnathion, which forms the central axis of the face or the facial axis. The facial axis is related to a line drawn between nasion and basion. Where these two lines cross is point 'CC' (centre of cranium) and forms the facial axis angle; the angle measured is the most posterior inferior angle.

Dental angular and linear measurements

Maxillary central incisor to mandibular central incisor (U1–L1) – Interincisal angle: The angle between the extension of the maxillary and mandibular incisor long axis line – the most posterior angle was measured.
Maxillary incisor to sella nasion plane (U1–SN): The most inferior inward angle formed by the extension of the long axis of the maxillary incisor to the SN plane.
Maxillary incisor to NA plane (U1–NA) (mm): The distance between the tip of the upper incisor and a line from nasion to point A.
Maxillary incisor to NA angle (U1–NA) (º): The angle formed by the long axis of the upper incisor to a line from nasion to point A.
Mandibular incisor to NB (L1–NB) (mm): The distance between the tip of the lower incisor and a line from nasion to point B.
Mandibular incisor to NB angle (L1–NB) (º): The angle formed by the long axis of the lower incisor to a line from nasion to point B.
Mandibular incisor to A–Po line (L1–APog) (mm): The distance between the tip of the lower incisor and a line from point A to pogonion.
Mandibular incisor to mandibular plane (L1–MP): The long axis of the mandibular incisor is measured to the

mandibular plane. The most inward angle toward the body of the mandible was measured.

Soft tissue angular and linear measurements

H line: A tangent drawn from the tip of the chin to the upper lip.
H angle: The angle formed between the soft tissue facial plane line (soft tissue nasion–pogonion) and the H line.
Lower lip to H line: The measurement of the lower lip to the Holdaway H line.
Upper lip to E plane: The distance between the upper lip and a line from the tip of the nose to the end of the chin.
Lower lip to E plane: The distance between the lower lip and a line from the tip of the nose to the end of the chin.
Upper lip to Steiner S line: The distance between the upper lip and a line from the middle of the Steiner S curve to the end of the chin.
Lower lip to Steiner S line: The distance between the lower lip and a line from the middle of the Steiner S curve to the end of the chin.

Statistical methods

All statistical analyses were performed using the SPSS software package (Statistical Package for Social Sciences for Windows 98, version 10.0, SPSS Inc., Chicago, Illinois, USA). For each variable, arithmetic mean, and standard deviation (SD) were calculated.

A paired-samples *t*-test was used to evaluate the treatment changes. To compare the changes observed in males and females and in the comparison of the pre- and post-treatment values with the Turkish cephalometric norms, an independent-samples *t*-test was performed.

To determine the errors associated with radiographic measurements, 25 radiographs were randomly selected. Their tracings and measurements were repeated two weeks after the first measurement. A paired *t*-test was applied to the first and second measurements. It was found that the difference between the first and second measurements of the 25 radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value to be 0.989 for the upper lip to E plane distance and the lowest *r* value to be 0.898 for the interincisal angle.

The method error was calculated using Dahlberg's method error formula (Dahlberg, 1940). The errors varied from 0.321 to 0.940 and were within acceptable limits. The results are shown in Table 1.

The total mean error in landmark identification was almost identical and was less than 1 pixel (0.67 pixel, 2.7 mm.). The upper incisor tip was the most accurate, and porion the least accurate landmark identified.

Table 1 Error of the method.

Number	Measurement	Dahlberg's calculation	Reliability coefficient
1	SNA (°)	0.460	0.926
2	SNB (°)	0.441	0.994
3	ANB (°)	0.321	0.930
4	SN–MP (°)	0.757	0.978
5	A to Na perpen (mm)	0.341	0.987
6	Pog to Na perpen (mm)	0.676	0.946
7	Co–A (mm)	0.430	0.980
8	Co–Gn (mm)	0.620	0.954
9	N–ANS (mm)	0.474	0.949
10	ANS–Me (mm)	0.841	0.921
11	Facial axis (°)	0.930	0.954
12	Interincisal angle (°)	0.494	0.898
13	U1–SN (°)	0.940	0.949
14	U1–NA (mm)	0.795	0.954
15	U1–NA (°)	0.734	0.954
16	L1–NB (mm)	0.661	0.949
17	L1–NB (°)	0.616	0.937
18	L1–APog (mm)	0.874	0.945
19	L1–MP (°)	0.814	0.911
20	Holdaway H angle (°)	0.576	0.919
21	Lower lip to H line	0.454	0.943
22	Upper lip to E line	0.910	0.989
23	Lower lip to E line	0.895	0.905
24	Upper lip to Steiner S line	0.668	0.945
25	Lower lip to Steiner S line	0.498	0.934

Results

Gender comparisons

An independent-samples *t*-test indicated no statistically significant gender differences for any of the skeletal, dental or soft tissue measurements.

Skeletal measurements

Treatment changes. Between the means of the pre- and post-treatment measurements, upper anterior face height (N–ANS) increased ($P < 0.01$), and facial axis ($P < 0.05$) decreased (Table 2).
Comparison with norms. Table 3 shows the comparison of the pre- and post-treatment skeletal measurements for patients with extraction of two upper premolars with Anatolian Turkish adult norms. Seven skeletal variables showed statistically significant differences. These were SNA ($P < 0.01$), SNB ($P < 0.001$), ANB ($P < 0.001$), SN–MP ($P < 0.01$), pogonion to nasion perpendicular ($P < 0.001$), ANS–Me ($P < 0.05$), and facial axis ($P < 0.001$). Statistically significant differences were found between post-treatment values and Turkish norms for SNA ($P < 0.001$), SNB ($P < 0.001$), ANB ($P < 0.001$), SN–MP ($P < 0.01$), point A to nasion perpendicular ($P < 0.01$), pogonion to nasion perpendicular ($P < 0.001$), and facial axis ($P < 0.001$).

Dental measurements

Treatment changes. According to the pre- and post-treatment comparisons, statistically significant differences

Table 2 Pre- and post-treatment mean values and standard deviations (SD) ($n = 53$) of measurements for the extraction of two upper first premolar cases and results of statistical comparisons.

	Pre-treatment		Post-treatment		Difference		Paired samples *t*-test
	Mean	SD	Mean	SD	Mean	SD	
SNA (°)	79.83	3.48	79.10	3.63	–0.73	2.21	NS
SNB (°)	74.76	3.04	74.17	3.67	–0.59	1.45	NS
ANB (°)	5.06	1.97	4.92	2.04	–0.14	1.64	NS
SN–MP (°)	36.23	6.65	36.51	7.73	0.28	2.70	NS
A to Na perpen (mm)	–0.56	3.88	–1.82	4.88	–1.26	3.38	NS
Pog to Na perpen (mm)	–10.36	7.90	–12.00	9.68	–1.64	5.03	NS
Co–A (mm)	92.55	4.17	92.28	4.85	–0.27	3.50	NS
Co–Gn (mm)	121.77	5.65	123.03	8.04	1.26	4.64	NS
N–ANS (mm)	55.41	3.79	56.68	3.67	1.27	2.02	**
ANS–Me (mm)	69.55	5.49	70.26	6.43	0.71	3.43	NS
Facial axis (°)	83.87	4.54	83.06	5.19	–0.81	1.74	*
Interincisal angle (°)	123.59	11.20	128.28	10.47	4.69	10.80	*
U1–SN (°)	103.77	8.25	97.74	7.63	–6.03	9.44	**
U1–NA (mm)	5.13	3.33	2.77	2.55	–2.36	3.58	**
U1–NA (°)	23.98	8.13	18.63	7.85	–5.35	9.60	**
L1–NB (mm)	6.45	2.48	6.78	2.74	0.33	1.90	NS
L1–NB (°)	27.19	5.16	28.18	6.78	0.99	6.65	NS
L1–APog (mm)	0.94	2.55	1.44	2.63	0.50	1.48	NS
L1–MP (°)	96.71	7.29	97.48	8.18	0.77	7.64	NS
Holdaway H angle (°)	16.63	3.79	15.51	3.52	–1.12	3.35	*
Lower lip to H line	0.21	2.03	–0.28	1.92	–0.49	1.46	NS
Upper lip to E line	–2.93	2.56	–4.24	3.00	–1.31	2.14	**
Lower lip to E line	–2.12	3.76	–2.64	3.52	–0.52	2.21	NS
Upper lip to Steiner S line	0.44	2.22	–1.50	2.77	–1.94	2.08	*
Lower lip to Steiner S line	0.48	3.17	0.76	3.33	0.28	2.14	NS

*$P < 0.05$; **$P < 0.01$; NS, not significant.

were found for four dental measurements. U1–SN, U1–NA, and U1–NA decreased ($P < 0.01$), while the interincisal angle increased ($P < 0.05$; Table 2).

Comparison with norms. In the comparison of pre-treatment dental values and Anatolian Turkish adult norms, only two variables (L1–NB and L1–APog) showed statistically significant differences ($P < 0.01$). However, three variables (U1–SN ($P < 0.05$), U1–NA ($P < 0.05$) and L1–NB ($P < 0.001$) were statistically significantly different when the post-treatment values were compared with Turkish norms (Table 3).

Soft tissue measurements

Treatment changes. Between the means of the pre- and post-treatment measurements, it was determined that the H angle and upper lip to E plane decreased ($P < 0.05$ and $P < 0.01$, respectively), while the upper lip to Steiner S line increased ($P < 0.05$).

Comparison with norms. In comparison with Turkish norms, statistically significant differences were found for the upper lip to Steiner S line and lower lip to Steiner S line in pre- and post-treatment measurements.

Discussion

There has been little research on the skeletodental effects of extracting just the maxillary first premolars. The present study evaluated the correction of Class II division 1 mandibular retrognathic patients by extracting only the bilateral maxillary first premolars and compared pre- and post-treatment values of patients with established cephalometric norms of Anatolian Turkish adults (Basciftci *et al.*, 2004).

When comparing the pre-treatment and final cephalometric values, some statistically significant differences were observed in the skeletal, dental or soft tissue measurements. Further comparison indicated that camouflage treatment induced significant cephalometric differences when compared with cephalometric norms. The null hypotheses were thus rejected.

Treatment changes

Careful patient selection for the present study substantially reduced some of the variables which may have adversely affected the results of earlier investigations. To limit growth effects on skeletal, dental and soft tissue structures, an effort was made to select subjects who started treatment at similar ages. Thus the sample was limited to those subjects with a developmental age greater than 16 years, which significantly reduced the effects of growth. Because of the similar age patterns, vertical growth of the dentofacial structures was not considered. Most previous investigators did not try

Table 3 Comparison of pre- and post-treatment measurements of Class II division 1 mandibular retrognathic cases (n = 53) with Anatolian Turkish norms (n = 105).

	Turkish norms		Pre-treatment		Post-treatment		*P* value	
	Mean	SD	Mean	SD	Mean	SD	N-T1	N-T2
SNA (°)	82.57	3.55	79.83	3.48	79.10	3.63	**	***
SNB (°)	79.92	3.44	74.76	3.04	74.17	3.67	***	***
ANB (°)	2.65	1.63	5.06	1.97	4.92	2.04	***	***
SN-MP (°)	31.66	5.25	36.23	6.65	36.51	7.73	**	**
A to Na perpen (mm)	0.48	2.27	–0.56	3.88	–1.82	4.88	NS	**
Pog to Na perpen (mm)	–1.65	4.29	–10.36	7.90	–12.00	9.68	***	***
Co–A (mm)	92.77	5.07	92.55	4.17	92.28	4.85	NS	NS
Co–Gn (mm)	122.08	7.34	121.77	5.65	123.03	8.04	NS	NS
N–ANS (mm)	56.82	5.87	55.41	3.79	56.68	3.67	NS	NS
ANS–Me (mm)	71.70	6.03	69.55	5.49	70.26	6.43	*	NS
Facial axis (°)	91.13	3.70	83.87	4.54	83.06	5.19	***	***
Interincisal angle (°)	128.32	10.06	123.59	11.20	128.28	10.47	NS	NS
U1–SN (°)	102.07	9.73	103.77	8.25	97.74	7.63	NS	*
U1–NA (mm)	4.08	2.18	5.13	3.33	2.77	2.55	NS	*
U1–NA (°)	21.47	6.00	23.98	8.13	18.63	7.85	NS	NS
L1–NB (mm)	4.82	2.00	6.45	2.48	6.78	2.74	**	***
L1–NB (°)	27.68	4.97	27.19	5.16	28.18	6.78	NS	NS
L1–APog (mm)	2.43	2.13	0.94	2.55	1.44	2.63	**	NS
L1–MP (°)	96.50	7.50	96.71	7.29	97.48	8.18	NS	NS
Holdaway H angle (°)	14.92	3.24	16.63	3.79	15.51	3.52	NS	NS
Lower lip to H line	0.55	1.49	0.21	2.03	–0.28	1.92	NS	*
Upper lip to E line	–5.00	2.31	–2.93	2.56	–4.24	3.00	***	NS
Lower lip to E line	–2.12	3.76	–2.24	3.37	–2.64	3.52	NS	NS
Upper lip to Steiner S line	–2.25	1.99	0.44	2.22	–1.50	2.77	***	***
Lower lip to Steiner S line	–0.90	2.14	0.48	3.17	0.76	3.33	*	**

*P < 0.05; **P < 0.01; ***P < 0.001; NS, not significant.

to separate the effects of treatment from those of normal growth (Neger, 1959; Rudee, 1964; Jacobs, 1978).

Growth is the usual long-term source of molar and overjet correction. A decision to extract upper first premolars with the objective of leaving the molars in a Class II relationship would seem an eminently logical approach to the treatment of a non-growing adult (Paquette *et al.*, 1992). In a patient with a Class II malocclusion when a portion of the extraction spaces is used to correct the molar relationship, the molars are protracted (Staggers, 1990); yet this protraction does not necessarily produce a loss of vertical dimension. Most orthodontic mechanics are extrusive in nature, and this extrusion appears to maintain or even increase the vertical dimension. In spite of extrusive orthodontic mechanics, lower anterior face height (ANS–Me) did not increase in the present sample during treatment. Protraction of molars may neutralize these effects.

Bravo (1994) compared the changes in patients treated with extraction of four premolars with non-extraction patients. That author showed that SNA diminished in the extraction group, and the decrease in ANB angle was due mainly to the change in SNA and suggested that the retraction of point A occurred because of the marked maxillary incisor retrusion. In spite of the maximum retraction of upper incisors, SNA angle and point A to nasion perpendicular measurements were unchanged during the treatment period in the present sample. According to the present findings, a statistically significant decrease was found in U1–SN and U1–NA angles. However, insufficient torque control during the consolidation period might be the main reason for point A remaining stable.

Meral *et al.* (2004) reported that the inclination of the mandibular plane in the untreated control group decreased almost three times more than in the upper bilateral first premolar extraction group, but the difference between the two groups was not significant. Klapper *et al.* (1992) indicated that changes in the facial axis with extraction or non-extraction treatment showed no statistically significant difference in patients with dolichofacial and brachyfacial patterns and the appropriate mechanics. Yamaguchi and Nanda (1991) found that changes in total and lower anterior face heights were significantly greater in the extraction than in the non-extraction group in patients who used high pull facebow headgear. In the present study, when comparing the means of the pre- and post-treatment measurements, it was determined that the facial axis decreased and upper anterior face height increased. Class II elastics were employed in most of the patients. It was considered that the side-effects of intermaxillary elastics were responsible for this increase in upper anterior face height and also for the tipping of the incisors. Because of the vertical vector

of the Class II elastics and continuing vertical growth, the anterior maxilla could rotate in the downward direction and upper anterior face height increase.

Meral *et al.* (2004) investigated the effects of bilateral upper first premolar extractions on the mandible and evaluated the sagittal position of the mandible by the change in SNB angle. Those authors indicated that the difference regarding SNB between the control and extraction groups was not statistically significant. Bishara (1998), in a comparative study of normal, Class II division 1 untreated, and Class II division 1 extraction and non-extraction patients, found that the change in SNB angle was smaller in the extraction female subjects than in non-extraction and normal females, but there was no difference between extraction and non-extraction Class II male subjects. During the treatment period in the current study, SNB angle was reduced slightly due to the effects of incisor retraction; but this change in bilateral upper premolar extraction was not found to be statistically significant.

With orthodontic camouflage, one would expect the upper incisors to be retracted and the lower incisors to be proclined. In the treated cases, the objective was to retract the upper incisors bodily and to minimize forward movement of the lower dentition. According to the pre- and post-treatment comparisons, statistically significant differences were found in four dental measurements. U1–SN, U1–NA, and U1–NA decreased while the interincisal angle increased during treatment. On average the upper incisors tipped lingually more than they were bodily retracted due to the lack of third order control. The overjet was not corrected by bodily retraction of the upper incisors. This is probably due to the Class II elastics which were employed in most of the patients. A known side-effect of the elastics is retroclination of the upper incisors and proclination of the lower incisors, and this was also observed.

Luecke and Johnston (1992) found a mean of –2.2 mm upper lip and –1.4 mm lower lip retraction relative to the E plane in upper premolar extraction cases. Paquette *et al.* (1992) found less change (mean 0.7 mm) in the upper lip to E plane measurement than Luecke and Johnston (1992) during upper first premolar extraction treatment. In the present sample, the upper lip showed a more pronounced retraction relative to Ricketts' E plane and Holdaway's H angle. These findings are similar to those of Luecke and Johnston (1992). In the current sample, the lips were more affected because of the upper incisors tipping lingually more than they were bodily retracted. The sample of Paquette *et al.* (1992) may have had better torque control than either this study or that of Luecke and Johnston's, or there may have been more proclination of the lower incisors. In the present sample the soft tissue changes produced by one arch extraction treatments were, on average, more pronounced than expected, due to less torque. This is a conclusion that reflects the findings of a previous study (Drobocky and Smith, 1989).

Comparison with norms

The pertinent clinical question is whether the treatment changes were desirable or detrimental to the dentofacial complex. Such a determination can be attempted by comparing the treatment changes with those observed in matched normative data derived from Anatolian Turkish adult subjects (Basciftci *et al.*, 2004).

Paquette *et al.* (1992) studied a sample of borderline patients treated without extraction. A statistically similar sample was treated with first premolar extractions. The authors concluded that there was 'nothing wrong' with extraction in 'borderline' patients. In the extraction sample of those authors, the teeth that were extracted were first premolars, but these patients probably had midarch problems and could have been treated with second premolar extractions. For that reason limited deterioration was expected in the sample of Paquette *et al.* (1992).

Bishara *et al.* (1997) suggested that patients undergoing extraction treatment tend to have straighter faces and slightly more upright maxillary and mandibular incisors, whereas the non-extraction groups have the opposite tendencies, when compared with the Iowa growth study normative values. The averages in both groups, however, remain close to the normative standards.

The present results indicate that the pre-treatment dentofacial characteristics of persons with Class II division 1 malocclusions, when compared with normal subjects, have a significantly larger overjet, a larger ANB and SN–MP angle, smaller lower anterior face heights, lower facial axes, more protrusive lips, and more retruded mandibles. The subjects in the present sample could have been treated by orthognathic surgery for correction of facial balance but all refused this alternative. In the current study treatment was initiated with greater facial imbalance and this imbalance was either maintained or deteriorated in value in relation to point A, the upper incisor and the lower lip.

Statistically significant improvements were found in lower anterior face height and mandibular incisor to A–Pog line measurements when compared with Anatolian Turkish norms (Basciftci *et al.*, 2004), but they were fractions of millimetres and certainly not clinically significant. During treatment adequate types of headgear were used to control the face height dimensions (i.e. lower anterior face height, mandibular plane angle).

During the treatment period, whilst statistically significant soft tissue differences were determined (i.e. upper lip to E line and Steiner S line), it was considered that the values were not clinically significant.

Conclusion

This study detailed differences in treatment outcomes of Class II division 1 mandibular retrognathic patients treated with upper two first premolar extractions. All received

comprehensive orthodontic treatment using an edgewise appliance and the appropriate type of headgear.

When the pre- and post-treatment measurements were compared, statistically significant differences were found in the facial axis, upper anterior face height, U1–SN, U1–NA, U1–NA, H angle, upper lip to E plane and upper lip to Steiner S line measurements.

In the comparison with Anatolian Turkish adult norms, 13 of the pre-treatment and 12 of the 25 post-treatment values were in the range of Turkish norms. The pre-treatment dentofacial characteristics of subjects with Class II division 1 malocclusions, when compared with normal subjects, showed a significantly larger overjet, larger ANB and SN–MP angles, smaller lower anterior face heights, lower facial axes, more protrusive lips, and more retruded mandibles. Treatment was initiated with greater facial imbalance and this imbalance was either maintained or deteriorated in value in relation to point A, the upper incisor and the lower lip. Statistically significant improvements were determined in lower anterior face height and mandibular incisor to A–Pog line measurements compared with Anatolian Turkish norms.

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